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Two Days National Webinar on Approaches Towards Onion Cultivation, 26-27 May, 2020

Organized by

Krushi Vigyan Kendra, Khedbrahma (Sabarkantha),
Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar,
Gujarat-383255.

Proceedings Book

Webinar Coordinators and Editors of Proceedings Book

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Google Hangout

TWO DAYS NATIONAL WEBINAR
ON
APPROACHES TOWARDS ONION CULTIVATION
26-27 MAY, 2020

Organized by
Krushi Vigyan Kendra, Khedbrahma (Sabarkantha),
Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar,
Gujarat-383255.

Inspiring Presence of	
	**Dr. R. K. Patel** Hon. Vice Chancellor, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat.
	**Dr. V. T. Patel** Director of Extension Education, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat.
	**Dr. R. N. Singh** Director of Research, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat.

Webinar Schedule

26/05/2020	
Welcome address 10: 00-10:15AM	**Dr. V. T. Patel**, Director of Extension Education, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat
Inaugural address 10:15-10:30 AM	**Dr. R. K. Patel** Hon. Vice Chancellor, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat
Introductory remarks 10:30-10:45Am	**Dr. R. N. Singh** Director of Research, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat
Expert lecture -1 11:00-11:45AM	**Dr. Vijay Mahajan** Principal Scientist, ICAR-Directorate of Onion and Garlic Research-Rajgurunagar,Pune, Maharashtra, India **"Present scenario, varietal wealth and nursery management in onion"**
Expert lecture -2 11:50-12:30PM	**Dr. Vikram Kad** Associate Professor, Department of Agricultural Process Engineering MPKV., Rahuri, Maharashtra **"Scientific storage to extend shelf life, processing and value addition in onion"**
Expert lecture -3 2:30-3:10PM	**Dr. Preeti H. Dave** Assistant Professor (Scientist), Food and Nutrition, KVK Sabarkantha, Sardarkrushinagar Dantiwada Agricultural University, S. K. Nagar, Gujarat. **"Nutritional and health benefits of onion"**
Expert lecture -4 3:15-03:45PM	**Dr. Yogesh Pawar** Assistant Professor (Scientist), Horticulture, KVK, Deesa, Sardarkrushinagar Dantiwada Agricultural University, S.K. Nagar, Gujarat. **"Water management in onion"**

27/05/2020	
Expert lecture -5 11:00-11:30AM	**Dr. P. A. Sable** Assistant Professor (Scientist), Horticulture, KVK Sabarkantha, Sardarkrushinagar Dantiwada Agricultural University, S. K. Nagar, Gujarat. **"Nutrient and weed management in onion"**
Expert lecture -6 11:40-12:20PM	**Dr. Piyush Verma** I/C, Professor and Head, Department of Horticulture, C. P. College of Agriculture, SDAU., S.K. Nagar, Gujarat **"Seed production in onion"**
Expert lecture -7 2:30-3:00PM	**Dr. Vanita Salunkhe** Scientist SS (Plant Pathology), ICAR-National Institute of Abiotic Stress Management, Baramati, Pune (MS). **"Integrated disease management in onion under changing climate scenario"**
Expert lecture -8 3:10-3:40PM	**Dr. P. S. Patel** Associate Professor, Department of Agril. Entomology, C.P. College of Agriculture, SDAU, S.K. Nagar, Gujarat. **"Pest management in onion"**
Valedictory session	**Dr. J. J. Mistry,** Senior Scientist and Head, KVK Sabarkantha, Sardarkrushinagar Dantiwada Agricultural University, S. K. Nagar, Gujarat.
Vote of Thanks	**Webinar Coordinator**

Theme: Approaches Towards Onion Cultivation

Sub Themes: Scope and benefits of Onion and *kharif* vegetable cultivation, Nursery management, Integrated farming, Organic farming approaches, Scientific storage to extend shelf life, Processing and Value addition.

Call for full length research papers and conceptual papers

Theme based full length research papers and conceptual papers are invited from students, researchers, faculties of SAU's/ ICAR institutes and other institutes. Selected papers will be published in e- souvenir. E- certificates will be issued to the participants attending all the sessions of Webinar.

Important dates

Last date of application: 24 May **Last date of paper receipt : 27 May**

Registration process

The webinar will be available to candidates on first come first basis. Send a filled application form in MSWord and mail to webinar.kvk.2020@gmail.com Selected candidates will be informed by email.

How to join the Webinar

Join meeting by downloading Hangout Meet

Webinar Coordinators

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Declaration

The author / co-authors are soley responsible for the content / matter of the papers submitted by them. Co-ordinators and proceedings book editors will not be responsible if any disputes arise.

Acknowledgement

It is a matter of great pride and privilege for us to work as webinar coordinators for two days National Webinar on “Approaches towards Onion Cultivation” on 26-27 May, 2020. The webinar provided useful information about Onion Cultivation in a scientific manner during COVID-19 with the help of online platform and following the social distancing.

This webinar gave a unique opportunity to us as organizer of the event to bring together experts of this field and to interact with the participants of different states of India. Though webinar organizers, experts and participants were at different places of county, they all were connected digitally for entire two days during webinar and enjoyed informative technical sessions. Following the theme and sub-themes, participants submitted number of scientific papers. Enthusiastic response of participants in terms of submitting scientific papers has motivated us towards preparation of this proceeding book.

We take this opportunity to wholeheartedly thank to Dr. R. K. Patel, Hon’ble Vice Chancellor, Dr. V. T. Patel, Director of Extension and Dr. R. N. Singh, Director of Research of Sardarkrushinagar Dantiwada Agricultural University for their encouraging presence in inaugural session of the webinar. We are thankful towards our eminent speakers Dr. Vijay Mahajan, Dr. Vikram Kad, Dr. Prakash Patel, Dr. Piyush Verma, Dr. Vanita Shalunke, Dr. Sable P. A., Dr. Yogesh Powar and Dr. Preeti H. Dave for delivering informative lectures in the webinar and for giving guidance during active question-answer sessions. We extend our sincere thanks to all the delegates who participated very actively during the sessions gave us very positive and encouraging feedbacks for the webinar.

We record our special gratitude towards Dr. K. E. Lawande, President, Executive Council of Society and Dr. Vijay Mahajan, Menber Secretary of Indian Society of Alliums for considering this manuscript for publication and to turn it into a scientific and usefull publication.

Thank you all once again !

Dr. P. A. Sable,

Dr. Yogesh Pawar

Dr. Preeti. H. Dave

Dr. R. K. Patel
Hon. Vice Chancellor,
Sardarkrushinagar Dantiwada Agricultural University,
Sardarkrushinagar, Gujarat.

Message

I am highly delighted to note that Krushi Vigyan Kendra, Khedbrahma (Sabarkantha), Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat is organizing Two Days National Webinar on Approaches Towards Onion Cultivation, 26-27 May, 2020. The need for diversification to Horticulture sector was acknowledged by the Government of India in mid-eighties by focussing its attention on investment in this sector. Presently Horticulture has established its credibility in improving income through increased productivity, generating employment and in enhancing exports. Resultantly, Horticulture has moved from rural confines to commercial venture. The scenario of Horticulture crops in India has become very encouraging. The per cent share of Horticulture output in Agriculture has become 33 per cent. Under the purview of Agriculture and allied activities, the share of plan outlay for Horticulture which was 3.9 per cent during IX Plan, has increased to 4.6 per cent during the XII Plan. In India, onion was grown on an area 1. 09 million hectare area with production of 23.26 million tonnes and average productivity 18.1 tonnes/ha. The Maharashtra is major onion growing state and other states are Madhya Pradesh, Karnatak and Gujarat. Gujarat has highest productivity of onion 26.54 tonnes/ha. Hence the topic chosen is appropriate and worth with a view to importance of the crop.

I am sure that National Webinar on “Approaches Towards Onion Cultivation” would surely bring out the innovative ideas of research for researchers, scientists, students, extension personals etc. I extend my warm wishes to organizers for a grand success of the Webinar.

Dr. V. T. Patel
Director of Extension Education,
Sardarkrushinagar Dantiwada Agricultural University,
Sardarkrushinagar, Gujarat

Message

It is a matter of immense pleasure that Krushi Vigyan Kendra, Khedbrahma (Sabarkantha), Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat is organizing National Webinar on Approaches Towards Onion Cultivation, 26-27 May, 2020.

The scenario of Horticulture crops in India has become very encouraging. The per cent share of Horticulture output in agriculture has become 33 per cent. Under the purview of Agriculture and allied activities, the share of plan outlay for horticulture which was 3.9 per cent during IX Plan, has increased to 4.6 per cent during the XII Plan. India is second largest producer of Horticultural crops like fruit and vegetables in the world.

Onion is one of the important vegetable crops among TOP crops (Tomato, Potato, Onion). The importance of these crops was acknowledged by Government of India. Our Prime Minister launched Mission Mode Project for stabilizing the prices of these crops in 2018 under Operation Green as these crops impacts Indian economy. Among the various vegetables, onion plays key and vital role in export.

In India, onion was grown on an area 1. 09 million hectare area with production of 23.26 million tonnes and average productivity 18.1 tonnes/ha. The Maharashtra is major onion growing state and other states are Madhya Pradesh, Karnatak and Gujarat. Gujarat has highest productivity of onion 26.54 tonnes/ha. Hence the topic chosen is appropriate and worth with a view to importance of the crop.

I am confident that National Webinar on “Approaches Towards Onion Cultivation” would really be helpful to all the extension professionals, researchers and students to enrich their knowledge.

My best wishes to organizers for a success in this endeavour.

Dr. R. N. Singh
Director of Research,
Sardarkrushinagar Dantiwada Agricultural University,
Sardarkrushinagar, Gujarat

Message

India is the second largest onion growing country in the world. Indian onions are famous for their pungency and are available round the year. Indian onions has two crop cycles, first harvesting starts in November to January i.e. kharif onion and the second harvesting from January to May i.e. rabi onion. The major varieties found in India are Agrifound Dark Red, Agrifound Light Red, NHRDF Red, Agrifound White, Agrifound Rose and Agrifound Red , Pusa Ratnar, Pusa Red, Pusa White Round. There are certain varieties in yellow onion which are suitable for export in European countries Tana F1, Arad-H, Suprex, Granex 55, HA 60 and Granex 429. The Major Onion producing states area Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana and Telangana. Maharashtra ranks first in Onion production with a share of 28.32 %. India produces about 22.43 million tonnes of onion a year, but consumes only about 15.5 million tonnes. Hence, steady exports are necessary to maintain prices. India exports majorly to Asian and Gulf countries wchic accounts for about 1588985.71 tonnes worth Rs. 308882.23 lakh. To further improve the exports, India needs world class and hi-tech Modern packhouses for sorting, grading and packing of the quality onions. Though some infrastructure are availbale at few of the production sites but it is not sufficient. As far as the productivity is concerned Gujarat ranks 2nd in oinion productivity with more than 24 tonnes per ha. Gujarat covers the 22.49 thousand hectare with the production of 546.20 thousand tonnes. In Gujarat Bhavnagar and Amreli and Saurashtra region are the major producers. If we see the China which is number one producer of onion than we find that it produces 23.91 million tonnes from 1.09 million hectare area with the productivity of 22.00 tonnes per hectare. While India produces 19.42 million tonnes from 1.20 million hectare area with the productivity of 16.18 tonnes per hectare. By understanding this we can easily surpass the China provided we have to increase our productivity which possible through scientific cultivation and availability of improved varieties.

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Improvement in onion (*Allium cepa* L.) in India

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Alliums are among the cultivated plant species under family Alliaceae cultivated for food, medicines and religious purpose since early times. These crops are mostly strong flavoured due to presence of sulphur containing compounds responsible for distinctive smell and pungency (Robinowitch and Currah, 2002). Onion and garlic have bulbs and cloves, respectively as an underground storage organ, which are also used for vegetative propagation. Onion has primary centre of origin in Central Asia and secondary centre in the near East (McCollum, 1976). It occupies a vast area in Western Asia, extending from Palestine to India. Garlic has the central Asia as the primary centre and Mediterranean region as the secondary centre of origin (McCollum, 1976). It has long been grown in India and China. In India onion is grown under three crop seasons i.e. *kharif,* late *kharif* and *rabi*. Main crop is in *rabi* which covers about 50% of production whereas, 20% is from *kharif* and 30% from late *kharif.* Maharashtra, Karnataka, Gujarat, Bihar, Madhya Pradesh, Rajasthan, Andhra Pradesh and Tamil Nadu are the main onion growing states. In general, barring North Eastern states and Kerala, all other states grow onion. Country's 26% area and 29% production alone come from Maharashtra. About 90% export of onion is from Maharashtra. From May to November stored onions are used for domestic as well as export market. November to December *kharif* onion is available in the market, whereas from January to March late *kharif* crop from Maharashtra is available but, there is critical shortage in arrivals of onion in the market during November to January. The productivity in late *kharif* and *rabi* is around 25 tons per hectare, whereas in *kharif* season it is 8-10 tons per hectare. Cloudy weather and constant drizzling during *kharif* season favour diseases like anthracnose and bulb rotting leading to low productivity. In *rabi* season high incidence of thrips aggravates the problem of purple blotch and *Stemphylium* blight, which again pulls down the productivity. During 2018-19, total area under onion was over 1219.53('000) hectares with a total production of 22819.42 ('000) metric tons and productivity 18.71 t/ha (NHRDF Database, 2020). Export of onion during 2017-18 was about 2135421.57 MT worth more than Rs 438436 lakhs as per DGCIS 2017-18 reports. The present production of garlic in 2017-18 is about 1610.63 ('000) MT from an area of about 1219.53('000) hectares with productivity of 5.08 t/ha (NHRDF website 2020) with very small quantity of export of 26527.72 MT worth Rs 11858 lakhs only as per DGCIS 2018 report.

Onion is commodity of masses and used as salad and cooked in various ways in curies, fried, boiled, baked and used in soup making and pickles. Besides fresh consumption, onion provides very good raw material for processing industry as it is processed in the form of dehydrated powder, rings, shreds and onion in vinegar or brine. Onion as medicinal herb is known to ancient world, as it is mentioned in the medicinal treaties like "*Charak Samhita"*of third or fourth century A. D. (Ray *et. al.*1980a and 1980b). Sanskrit language equivalent signifying Vedic period and Aryan usage is available for onion as "*Palandu"*(Aiyar and Vaganarayana, 1956). The important principle like

allicin, ajoene, allixin thiosulfinates, and *sulphites* etc. present in onion, make it potential herb. These components help fighting *cancer, high blood cholesterol* and *sugar, liver problems* and *intestinal* problems. Commonly cultivated *Alliums* are Common onion (*A. cepa* var. *cepa* L., 2n=16), Shallot (*A. cepa* var. *aggeregatum* G. Don., 2n=16), Welsh onion (*A. fistulosum* L., 2n=16), Chinese chives *(A. tuberosum* Rotti. Ex Spreng, 2n=32), Garlic (*A. sativum* L., 2n=16), Leek (*A. ampeloprasum* var. *porrum* (L.) J. Gay, 2n=32) and Chives (*A. schoenoprasum* L., 2n=16,24,32)

Domestication:

Adoption of onion in India is carried through from very early times before Christian era. Originally, native of Central Asia of temperate region with perennial/ biennial habit and long day bulbing characters, it has established well in India under tropical and short day (11-11.5 hrs.) photoperiodic conditions (Sheshadri and Chaterjee, 1996). During acclimatization of different kinds of vegetable crops and their varieties, farmers applied selection pressure involuntarily to meet the market preferences. In case of onion, ability to produce seeds indigenously has played an important role in the adaptation. In course of adaptation and diversification, out breeding mechanisms present in onion has promoted selections suited to diverse environments.

In the centre of origin and area between35 to 40^0N latitude, onion is biennial in seed production and requires more than 14 hrs day lengths for bulb production. In subtropical and tropical parts of India between 12 to 25^0N latitude, it is biennial but able to produce bulbs under comparatively shorter photoperiod (11-11.5 hrs.) during winter season. Winter season crop accounts for 60 per cent of total production in the country. The concentration of onion growing in Western Maharashtra and Gujarat is very significant, where two crops – one in rainy season (*kharif*) and other in winter season (*rabi*) – are regularly grown. The tropicalization progresses further southwards towards Bellary region in Northern Karnataka and finally a vegetatively propagated multiplier onion (aggregatum) type got established in Tamil Nadu ($6 – 8\ ^0$N latitude). The adoption to hardy conditions of high rainfall, high temperature and short day photoperiod typical of rainy (*kharif*) season of Western India has not been chronologically documented (Sheshadri & Chaterjee, 1996).

Export trade from Mumbai and Kandla port mainly to Gulf countries predominantly during November to April coincides with harvest of rainy seasons (*kharif*) and late rainy seasons (*Rangda*) crops. This is very typical example that market forces have influenced domestication and diversification to great extend. Demand for highly pungent and pink skinned bulbs from Gulf countries made farmers of Western India to select such type of plants, which can produce seeds under Indian conditions. This kind of adaptations made the crop plant to become annual. This phenomenon resulted in loss of short dormancy of bulbs. This fascinating aspect of onion domestication in Western India had gone unnoticed and unrecorded (Sheshadri and Chaterjee, 1996).

There has been spectacular increase in area and production of onion over last 20 years, however, the productivity has almost remained static i.e. 10-16 tonnes per hectare, which is much less as compared to USA, Netherlands, China, etc.

Collection and Evaluation of Germplasm

Realizing the importance of germplasm in building up resources for future commercial exploitation, Kale *et al* (1994) undertook a detailed survey of traditional and nontraditional onion-growing areas of the state of Maharashtra, and India in general, and collected 148 red-skin and 33 white-skin types of onion, evaluated tropical germplasm and identified some lines on the basis of maximum average bulb weight, high TSS and centerness in the Department of Horticulture, Mahatma

Phule Krishi Vidyapeeth, Rahuri. There is need for identification of areas where off season seed can be produced or to standardize techniques of seed production during kharif season to reduce the time of breeding from biannual to annual particularly for late kharif and rabi season varieties. Some of the reports are available where efforts were made to produce seed during kharif season which was successful (Mahajan et al., 2002) and can be exploited for population improvement for rabi and late kharif onion varieties.

An investigation was undertaken to evaluate 198 local strains and varieties along with Baswant-780 (local control) and identify the best genotype with the best storability and bulb quality during rangda season 2000-01 in Maharashtra, India. Selection Nos. 175, 151, 176, 186 and 168 recorded significantly minimum storage losses of 28.0, 30.0, 32.0, 32.0 and 33.0%, respectively, after 120 days of storage compared with other selections and Baswant-780 (35.0%) (Ranpise *et al.*, 2004).

White onion germplasm were screened for their longer shelf life at NRCOG, Rajgurunagar, Maharashtra. 220 germplasm were evaluated for storage studies. Germplasm W-234, W-353, W-340, W-172, W-361, W-462 and W-079 had less storage losses during Rabi season. (Mahajan *et al.*, 2005)

Out of 318 germplasm evaluated for all the three season 90 germplasm found to give yield more than 40 t/ha during rabi season. 19 lines performed well giving higher total yield as compared with the check PKV White (49.74 t/ha) and 240 lines than Phule Safed (29.69 t/ha) in rabi season. 76 lines gave better yield than the check PKV White (51.55 t/ha) and 188 lines than Phule Safed (43.93 t/ha) during late Kharif season. Germplasm w-404 and w-398 were stable for marketable yield under different environment giving higher mean values than the population mean. From total yield point of view lines w-404, w-418, w-421 and w-103 found to be stable giving higher yield than the population mean. (Mahajan *et al.*, 2005)

Forty-four onion germplasm lines selected from a gene pool were grown in three different seasons (kharif, late kharif and rabi of 2003) to identify stable genotypes with high yield and those that are suitable for cultivation in all three seasons. Genotypes NRCOG-888, 910, 922, 944 and 946 showed supremacy in marketable yield with below unit regression coefficient coupled with minimum deviation from regressions, indicating their stability in unfavorable environments and suitable for cultivation in all the three seasons of western India. (Prasad *et al.*, 2006)

Onion germplasm diversity was collected from three northern Telangana districts of Adilabad, Karimnagar and Nizamabad in April 2009 by Kamala *et al.*. (2011). Seventy-four samples (bulbs-66; seeds-8) were sampled from 33 villages and 23 mandals. Wide range of variation was observed for the two qualitative and six quantitative traits recorded in the field. Highest TSS (>14%) was observed in IC572010 and IC571965 (Adilabad). Promising accessions for equatorial diameter (>60mm) were identified including ICIC571912, (Karimnagar), IC571972 (Adilabad) and ICIC571973 (Adilabad). These cultivars hold potential for possible utilization in breeding programmes.

One hundred fifty-one red onion germplasm along with checks (N-2-4-1, ALR and Arka Niketan) were evaluated during Rabi season 2000-1 to 2008-09 at the experimental farm of Directorate of Onion and Garlic Research, Rajgurunagar, Pune (Maharashtra). Genotypes 670, 1044, 720 and 1015 were having good storability. More than 12% TSS were recorded in 20 genotypes including 549, 698, 739, ALR and 831. Thirty three genotypes were found suitable for Rabi cultivation with more than 30 t/ha marketable yield with good storability and other desirable characters. (Gupta *et al.*, 2011).

White onion germplasm were collected from different parts of the country and 192 lines were evaluated from 2001-2009 for three or more years during Kharif season. Line W-160 was superior for high % of A grade bulbs (38.92%), less double bulbs (4.37%), 85.33% marketable bulbs with highest

MY of 26.66 t/ha and total yield 31.25 t/ha, took 112 days for harvesting and recorded 10.6% TSS. It was followed by W-082, W-448, W-021, W-366, W-302, W-314, W-043, W-075 and W-397, where marketable yield ranged between 21.15 to 23.74 t/ha and total yield from 25.3 to 31.86 t/ha. (Mahajan *et al.*, 2011a). GP lines w-448, w-009, w-355, w-404, w-367, w-172, w-418, and w-056 recorded more than 25 t/ha MY (ranged between 25.01 to 30.88 t/ha) over best check Phule Safed (23.43 t/ha) during all the three seasons i.e. kharif, late kharif and rabi season and have better adaptability to different climate can be exploited in the present situation of climate change (Mahajan *et al..*, 2011b).

Germplasm evaluation for specific characters:

Sharma (1997) screened 86 onion genotypes for resistance to purple blotch in Himachal Pradesh, India. Out of these, lines IC48059, IC48179, IC39887, IC48025 and ALR were found resistant to the disease. Srinivas (2005) reported that many sweet Spanish onion varieties- White Persian, Grano, Sweet Spanish, Crystal Wax, Yellow Bermuda and Spanish White were resistant to *Thrips tabaci* in temperate regions. In India, commercial varieties showed differential response to thrips resistance in different geographical areas. Many germplasm lines were reported resistant to thrips elsewhere in India. However till today there is no promising and consistent variety of onion and garlic is available in India with thrips resistance.

Salt- affected soils are an important ecological entity in the landscape of any arid and semi-arid region. In India nearly 9.38 million ha area is occupied by salt-affected soils out of which 5.5 million ha are saline soils (including coastal) and 3.88 million ha alkali soils (IAB 2000). These occur from Jammu & Kashmir (Ladakh region) in north to Kanyakumari in south and Andaman & Nicobar Islands in the east to Gujarat in the west. Gujarat with an extent of 1.2 m ha contributres to 15 percent of the total salt affected soil in the country. The performance of seven onion (*Allium cepa*) genotypes 'Pusa White Flat', 'Agrifound Dark Red', 'PBR 5', 'Amrawati', 'Pusa White Round', 'Phule Safed' and 'Agrifound Light Red') was evaluated during rabi 1995 and 1996, both under alkaline (pH 9.20, 9.45 and 9.70) and salinity (ECe 3.5 and 5.2 dS/m) stresses besides a non-stress control. Highest mean bulb yield obtained under salinity was by 'Pusa White Flat' followed by 'Amrawati' amongst the different genotypes tested (Sharma *et al..*, 2000). The previous studies conducted in India on the influence of salinity on seed germination, growth, flavor, and yield attributes in onion showed an adverse effect on these traits (Joshi and Sawant, 2012). Chauhan *et al.*. (2007) conducted a field experiment at Karnal and found that onion and garlic can be grown in soils having salinity level of up 4 dS/m.

Genetic Diversity and wild Alliums:

Onion show particular diversity in the eastern Mediterranean countries through Turkmenia and Tajikistan to Pakisthan and India, therefore these regions are most important sources of genetic diversity. The regions of high species diversity exist in Commonwealth of Independent States (CIS), Turkey, Iran, North Iraq, Afghanisthan, Pakisthan and hilly tracts of North and North-Eastern India (Astley et al. (1982). According to the recent surveys, all taxa of the genus *Allium* cultivated in South-East Asia are introduced either from China, central Asia or Europe (Bujisen, 1990). Besides, wild species are generally restricted to the northern hemisphere and totally absent in tropical parts of South-East Asia. The species cultivated in South-East Asia which have their origin and secondary centre of diversity in Sino-Japanese centre, may include Welsh onion, Rakkyo, Chinese chives etc. The above species are also found in India gene centre, some of them still in the wild state. Zeven and Zhukovsky (1975) reported *Allium* species in different centres of diversity as in Chinese Japanese Centre consist of *A. chinense, A. fistulosum, A. sativum, A. schoenoprasum, A. tuberosum,* Hindustani

Centre have *A. ampeloprasum* and Central Asia and Mediterranian region have *A. cepa* and *A. sativum*. Babu, 1977, reported that in India, the genus *Allium* is widely distributed in the temperate and alpine regions and about 30 species have been reported to occur in Indian gene centre. According to Hooker (1973) the most widely cultivated *Allium* species in the Indian sub-continent include, onion, garlic, shallot and leek. Genetic diversity in cultivated alliums has been reported from different parts of the country. The prominent areas of genetic diversity are considered to be Jammu and Kashmir, Himachal Pradesh, Uttaranchal, North-East region, Rajesthan, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu.

Negi and Pant (1992) reported the occurrence of lesser known wild species in mountainous regions and discussed information on their habitat, local uses, etc. The prominent wild species included in the study were *A. carolinianum* D.C. (syn. *A. bladum* Wall.), *A. chinense* G. Don (syn. *A. bakeri* Regel), *A. consanguineum* Kunth, *A. humile* Kunth (syn. *A. govanianum* Wall ex Baker), *A. przewalskianum* Regal (syn. *A. jacquemontii* Regel, *A. stolczkii* Regel), *A. steacheyi* Baker, *A. victorialis* L. and *A. wallichii* Kunth. The National Bureau of Plant Genetic Resources (NBPGR) has conducted extensive plant exploration in different allium-growing states/regions in India and collected wild relatives also, namely, *A. ampeloprasum*, *A. auriculatum*, *A. ascalonicum*, *A. carolinianum*, *A. chinensis*, *A. wallachi*, *A. tuberosum*, and *A. rubellum*. The bureau has also introduced over 1100 accessions of *Allium* germplasm which include related *Allium* species from over 40 countries. (Singh and Rana 1994).

The Himalayan *Allium* species are interesting in many respects. Morphologically and ecologically they represent a very variable assemblage, ranging from sub-temperate, temperate, alpine plants to those inhabiting moist forests or extremely cold arid zones. They comprise a rather diverse assortment of floristic elements. They include important cultivated food plants and taxa having so-called secondary gene pooles, which are of potential value as plant genetic resources for future breeding programs (Xu, 1990; Gohil, 1973, 1992; Nayar *et al.*, 1992; Negi *et al.*, 1991; Chandel & Pandey, 1992). Most of them are potential and already been introduced as semi-domesticated cash crop into the backyards, dooryards and garden of natives of the Himalayan region (Negi, 2006, Negi *et al.*, 1995).

Pathak *et al.* (2001) studied that Stemphylium leaf blight (SLB) (causal agent *Stemphylium vesicarium*) is one of the major onion (*Allium cepa*) diseases of the tropics. Five Welsh onion (*Allium fistulosum*) and 106 *A. cepa* lines were screened in field and laboratory experiments. All the *A. fistulosum* lines were resistant or moderately resistant, whereas all the *A. cepa* lines were susceptible. Crosses were successfully made between five *A. fistulosum* and 29 *A. cepa* lines to introgress SLB resistance into onion lines. Dominant gene observed to control of the resistance trait. Moderate pollen fertility (>30%) and low seed set (>5%) was observed in four crosses. These crosses were further evaluated for disease resistance and fertility in the F_2 and F_3 generations. In the F_2 generation there was a marginal increase in fertility among the four crosses. The crosses CF16 and CF19 had seed set up to 30% in some plants, which were also resistant to SLB. In the F3 generation, resistant plants with high pollen fertility (40-80%) and seed set (20-60%) were obtained in two crosses (CF16 and CF19). In both these crosses *A. cepa* has was used as a female parent. CF19 progenies also had fairly well developed bulbs. The F_3 progenies thus generated in this program combine the traits of both the *A. cepa* and the *A. fistulosum* parents. These progenies are now being used in our breeding program to develop SLB resistant onion lines.

Anitha *et al*.. (2011) reported that Onion (*Allium cepa*) is known to be vulnerable to the attack of several biotic stresses, with yield losses varying from 10–15% annually. Among them, Stemphylium blight (*Stemphylium vesicarium*) and purple blotch (*Alternaria porri*) diseases and onion thrips (*Thrips tabaci*) were identified as of very significant to onion growing world including India. Utilization of resistant sources in the breeding programmes is the most feasible way of combating these pests. The National Bureau of Plant Genetic Resources (NBPGR) is in the forefront of diversity collection in Allium species and subjecting it to characterization and evaluation against biotic and abiotic stresses to support the ongoing crop improvement programmes in India. NBPGR in the Indian context facilitated the import of 1316 accessions of 47 Allium species from 15 countries over the past two decades. The article also elucidates globally available germplasm stocks while distinctly pointing out the sources of resistance to the significant insect pests and diseases and suggests the way forward to enhance the genetic potential of onion varieties through resistance breeding. The need for introducing *Allium ampeloprasum, A. bouddhae, A. obliquum, A. nutans* and *A. odorum* possessing traits of resistance to different pests is highlighted. An attempt has been made to discuss on the possibility of utilization of wild species such as *A. roylei, A. fistulosum and A. altaicum*, which are reservoirs of useful genes.

Murthy *et al*.. (2011) collected white bulbs of 'Wild Onion**,** *Urginea indica*' samples from the hillocks near Vaddagere village of Tumkur district, a southern part of Karnataka. The presence of primary and secondary metabolites such as *carbohydrate, proteins, alkaloids, phenolic compounds, saponins* was confirmed through preliminary phyto-chemical analysis. The extract was found to possess anti-bacterial activity in *E. coli, S. aureus and P. aeruginosa* isolated from infected patients. The Minimum inhibitory concentration (MIC) evaluated by 'Tube dilution' method found to be considerably effective against selected pathogenic bacteria might contribute to explaining the traditional use of wild onion sps, *Urginea indica* in the treatment of wound healing. The antioxidant activity increased with increase in concentration of methanolic fraction of wild Onion sps. The fractions of wild onion sps are free radical scavengers and are able to react with the DPPH radical, which might be attributed to their electron donating ability and suggested that antioxidant components in this Wild Onion sps was capable of reducing oxidants and scavenging free radicals. This also indicates that, tubers of wild onion, *Urginea indica*' are of therapeutic potential due to their high free radical scavenging activity. The presence of high amount of saponins justifies the practice of treatment for disturbances in the gastrointestinal tract by Traditional healers. The role of phyto-chemical constituents of this Wild Onion, *Urginea indica* sps in traditional medicine treatment is discussed. Hence, the formulation of extract of *Urginea indica*' needs to be purified using biophysical techniques towards development of a potential drug/ lead molecule against microbial infection, inflammation and wound healing respectively.

Under utilized Alliums (*Allium* and its allies) are among the plant genetic resources that have been valued for food, feed, medicines, spices and condiments etc. of about 700 species scattered all over the world, 34 species are reported mainly from the alpine and temperate zones of Himalaya, India. Besides cultivated species (*Allium cepa, A. sativum, A. ascalonicum* and *A. ampeloprasum*) some species are semi-domesticated/lesser-known types (*Allium carolineanum, A. chinense, A. c onsanguineum, A. humile, A. victorialis, A. wallichii* and *A. semenovii*) under sporadic cultivation. Large scale collection and utilization of some of the wild species for edible (leaves and bulbs) and flavouring purpose has resulted in loss of the natural diversity reported by Negi, 2011.

Onion Varietal Development in India:

In India systematic breeding programme was started as early as 1960 at Niphad, Nashik and later on at IARI, New Delhi. The early varieties developed through selection were N 2-4-1; Pusa Red and N – 53 that are still dominating the production. The programme was further strengthened under coordinated project through SAUs and ICAR research institutes. As a result 56 varieties of onion including 2 F1 hybrids and 6 varieties of multiplier onion have been developed and released (Table.1). Onion is mainly *Rabi* season crop, but it can be cultivated in kharif and late kharif season also. Therefore varieties are recommended for different seasons. For kharif season, varieties suitable are Baswant – 780, N-53, Agrifound Dark Red, Arka Kalyan and Bhima Super, for late kharif: Baswant – 780, Bhima Red, Bhima Shakti, Phule Samarth, and Agrifound Light Red and for rabi season: N-2-4-1, Arka Niketan,Bhima Raj, Bhima Red, Bhima Kiran, Bhima Shakti, Agrifound Light Red, Pusa Red, Pusa Madhawi, etc. Bhima Raj can be cultivated in kharif and late kharif season also. There are white coloured varieties which can be grown during rabi season are Phule Safed, Pusa White Round, Pusa White Flat, Bhima Sweta, Agrifound White, Punjab Selection, Udaipur – 102 and Bhima Shubra for kharif season. List of varieties released from various research institutes/ universities in India are as follows:

Table 1. Onion Varieties developed by various organizations

Sr. No.	Organization	Variety	Bulb color	Planting season	Year of release
1	Agril. Dept., Maharshtra	N-53	Red	*Kharif*	1975
		*N-2-4-1	Red	*Rabi* and late*Kharif*	1985
		*N-257-9-1	White	*Rabi*	1985
2	MPKV, Rahuri	Baswant -780	Red	*Kharif*	1989
		Phule Safed	White	Late *Kharif* and *Rabi*	1994
		Phule Suvarna	Yellow	*Rabi* and late *Kharif*	2001
		*Phule Samarth (S-1)	Red	Late *Kharif*	2006
3	IARI, N. Delhi	Pusa White Flat	White	*Rabi*	1975
		Pusa White Round	White	*Rabi*	1975
		Early Grano (Long Day type)	Yellow	Late *Kharif* and *Rabi*	1975
		Brown Spanish (Long Day)	Brown	Hills	1975
		*Pusa Red	Red	Late *Kharif* and *Rabi*	1975
		*Pusa Ratnar	Red	*Rabi*	1975
		*Pusa Madhavi (Line-120)	Red	*Rabi*	1987
		*Selection 126	Brown	*Rabi*	2012
4	IIHR, Bangalore	Arka Pragati	Red	*Kharif* and *Rabi*	1984
		*Arka Niketan	Red	*Rabi* and late *Kharif*	1987
		*Arka Kalyan	Red	*Kharif*	1987
		Arka Pitamber	Yellow	*Rabi*	2006
		Arka Bindu	Red	*Kharif,* late *Kharif* and *Rabi*	2006
		Arka Ujjwal (multiplier onion)	Red	*Rabi*	2010
		Arka Swadista	White	*Rabi*	2010

		Arka Vishwas (Rose onion)	Dark red	*Kharif* and *Rabi*	2011
		Arka Sona	Yellow	*Rabi*	2011
		Arka Bhim (tri-parental synthetic)	Red	*Rabi*	2011
		Arka Akshay (tri-parental synthetic)	Dark Red	*Rabi*	2011
5	HAU, Hissar	Hissar- 2	Red	*Rabi*	1976
		*HOS-1	Red	*Rabi*	2006
6	NHRDF, Nashik	*Agrifound Light Red	Red	*Rabi* and late *Kharif*	1988
		*Agrifound Dark Red	Red	*Kharif*	1996
		*NHRDF Red (L-28)	Red	*Rabi*	2006
		* NHRDF Red (L-355)	Red	*Rabi*	2012
		Agrifound Rose	Red	*Rabi*	1987
		Agrifound Red (Multiplier)	Red	*Kharif* and *Rabi*	1987
		Agrifound White	White	*Rabi*	1994
7	VPKAS, Almora	VL-67 (Long Day)	Red	Hills	1973
		*VL-3 (Long Day)	Red	Hills	1990
8	RAU, Rajasthan	Udaipur 101	Red	*Rabi*	
		Udaipur 102	White	*Rabi*	
		Udaipur 103	Red	*Rabi*	
9	PDKV, Akola	*PKV White	White	*Rabi*	2009
10	GAU, Junagarh	Gujarat White Onion (GWO) - 1	White	*Rabi*	2000
11	CSAUAT, Kanpur	Kalyanpur Red Round	Red	*Rabi*	1983
12	PAU, Ludhiana	Punjab Selection	Red	*Rabi*	1973
		*Punjab Red Round	Red	*Rabi*	1993
		Punjab-48 (S-48)	White	*Rabi*	1978
		Punjab White	White	*Rabi*	1998
		*Punjab Naroya (PBR-5)	Red	*Rabi*	1997
13	TNAU, Coimbatore	Co-1 (Multiplier)	Red	*Kharif* and *Rabi*	
		Co - 2	Red	*Kharif* and *Rabi*	1978
		Co - 3	Red	*Kharif* and *Rabi*	1982
		Co - 4	Red	*Kharif* and *Rabi*	1984
		Co - 5		*Kharif* and *Rabi*	
		MDU-1	Red	*Rabi*	1982
14	RARS, Durgapura	Rajasthan Onion-1 (RO-1)	Red	*Rabi*	2004
		Arpita (RO-59)	Red	*Rabi*	2005
		RO 252	Red	*Rabi*	2010
15	DOGR, Rajgurunagar	*Bhima Super	Red	*Kharif*, late *Kharif* and *Rabi*	2006
		*Bhima Raj	Red	*Kharif* and *Rabi*	2007

		*Bhima Red	Red	*Kharif* and late *Kharif*	2009
		*Bhima Shakti	Red	Late *Kharif* and *Rabi*	2010
		*Bhima Kiran	Red	*Rabi*	2010
		*Bhima Shweta	White	*Kharif* and *Rabi*	2010
		*Bhima Shubhra	White	*Kharif* and late *Kharif*	2010
		*Bhima Dark Red	Red	*Kharif*	2012
		*Bhima Safed	White	*Kharif*	2014
		*Bhima Light Red	Red	*Rabi*	2015

* These varieties have been release through All India Coordinated Research Project on Vegetables or All India Network Research Project on Onion and Garlic. Others are identified at institute level.

In India, the varieties developed by various organizations have been tested at different locations under All India Coordinated Vegetable Improvement Project and All India Network Research Project on Onion & Garlic and based on their performance these varieties have been recommended for different zones. So far 30 varieties have been recommended for cultivation under specific agro-climatic zones (Table 2).

Table 2 Onion varieties recommended for cultivation and release through AICRP & AINRPOG.

S.No.	Varieties	Organization	Recommended Zones	Year of identification
1	Punjab Selection	PAU, Ludhiana	IV, VII & VIII	1975
2	Pusa Red	IARI, N. Delhi	IV, VII, VIII	1975
3	Pusa Ratnar	IARI, N. Delhi	IV & VI	1975
4	S-131	IARI, N. Delhi	-	1977
5	N-257-9-1	Agril. Dept., M.S.	-	1985
6	N-2-4-1	Agril. Dept., M.S.	-	1985
7	Line-102	IARI, N. Delhi	I, IV, VI, VII	1987
8	Arka Kalyan	IIHR, Bangalore	IV, VI, VII, VIII	1987
9	Arka Niketan	IIHR, Bangalore	IV,VII, VIII	1987
10	Agrifound Dark Red	NHRDF, Nashik	IV	1987
11	VL-3	VPKAS, Almora	I	1990
12	Agrifound Light Red	NHRDF, Nashik	VI, VIII	1993
13	Punjab Red Round	PAU, Ludhiana	IV	1993
14	PBR-5	PAU, Ludhiana	VI	1997
15	L-28	NHRDF, Nashik	IV & VII	2006
16	HOS-1	HAU, Hissar	VI	2006
17	Bhima Raj	NRCOG, Rajgurunagar	VI	2007
18	Bhima Red	DOGR, Rajgurunagar	VII for rabi & II, V & VI** for kharif	2009 & 2012
19	PKV White	PDKV, Akola	VI	2009
20	RHOR-S1(Phule Samarth	MPKV, Rahuri	VI, VIII	2009
21	Bhima Kiran	DOGR, Rajgurunagar	III & VI*	2010
22	Line-355	NHRDF, Nashik	III, IV & VI*	2010

23	Bhima Shakti	DOGR, Rajgurunagar	III, IV, V, VI*	2011
24	Bhima Shweta	DOGR, Rajgurunagar	III, V, VI* for rabi & IV, V, VI** for Kharif	2011, 2012
25	Sel-126	IARI, N. Delhi	III, IV, V*	2011
26	Bhima Super	DOGR, Rajgurunagar	II, IV, V & VI** for kharif	2012
27	Bhima Dark Red	DOGR, Rajgurunagar	II, IV, V & VI.**	2012
28	Bhima Shubra	DOGR, Rajgurunagar	IV, V & VI** for kharif	2012
29	Bhima Safed	DOGR, Rajgurunagar	IV, V & VI** for kharif	2014
30	Bhima Light Red	DOGR, Rajgurunagar	VI	2015

Details of the Zones under AICRP Vegetables:
Zone I = Himachal Pradesh & U.P. Hills, Zone II = West Bengal & Assam, Zone III = Sikkim, Meghalaya, Manipur, Nagaland, Mizoram, Tripura, Arunachal Pradesh and Andaman & Nicobar Islands, Zone IV = Punjab, Tarai region of U.P. & Bihar, Zone V = Chhattisgarh, Orissa & Andhra Pradesh, Zone VI = Rajesthan, Gujarat, Haryana & Delhi, Zone VII = Madhya Pradesh & Maharashtra, Zone VIII = Karnataka, Tamil Nadu & Kerala

* New zones were decided during 2010 under AINRPOG: Zone III = Delhi, UP, Haryana, Bihar and Punjab, Zone IV = Rajasthan & Gujarat, Zone V = MP, Chhattisgarh & Orissa, Zone VI = Maharashtra, Karnataka and Andhra Pradesh

**Further zones were reclassified in 2011 comprising following centres in different states: Zone I: Srinagar, Almora, Mukteshwar, Palampur, Ooty, Zone II: Jammu, Ludhiana, Delhi, Karnal, Hissar, Durgapura, Zone IV: Jabalpur, Raipur, Chiplima, Akola, Jhalawar, Zone V: Junagadh, Nasik, Rahuri, Pune, Zone VI: Bagalkot, Bangalore, Coimbatore, Dharwad.

The improvement of onion crop has not attracted much attention of the breeders in India. Perhaps, because of biennial habit of the crop requiring longer time for breeding and difficulties in attaining and maintaining genetic uniformity due to high degree of natural cross pollination and rapid inbreeding depression. Though, number of varieties have been developed in India, still there is enough scope to develop varieties with high total soluble solids suitable for dehydration, short day yellow varieties for export and varieties resistant to diseases and insect pests and suitability to different seasons.

Baring few exceptions, the breeder stock of many varieties are not being maintained properly. Some of them never reached to farmers. However, few varieties always remained on the forefront. Despite release of high number of varieties, area under them is not more than 30 per cent. Remaining area is covered with the types maintained by the farmers themselves. Easier seed production for home requirement, at farmers' site is the main hurdle for spread of improved varieties. Non-availability of sufficient seed at reasonable price is the secondary one and finally, probably farmers have not overcome the presumption that all new varieties are *on par* with their material being maintained traditionally. All varieties developed so far and local types maintained by farmers suffer from all

disease and pest, high percentage of twins, bolters and multi-centered bulbs and minor variations in colour, shape and maturity.

The improvement of onion crop has not received any attraction of the breeders in India. Perhaps, it is because of biennial habit of the crop requiring longer time for breeding and difficulties in attaining and maintaining genetic uniformity due to high nature cross pollination and rapid inbreeding depression. Besides, lack of facilities for storage of selected bulbs of breeding lines in controlled storage conditions is another factor for slow progress in onion breeding programme (Swarup, 1990).

Methods adopted for Population Improvement in onion

Being cross – pollinated, onion always provides a scope for using new population improvement methods, as natural variability is created constantly. Tremendous amount of variability is being utilised in onion using various breeding procedures. Different gene actions and gene combinations identified by genetic studies are being employed for generating new varieties and developing material for making new hybrids. Information on the nature and extent of genetic variability and degree of transmission of traits is of paramount importance in enhancing the efficiency of selection. However, knowledge of correlations among various characters and their relative contribution to yield is useful for multiple trait selection.

Worldwide different group of scientists are inventing the new techniques for population improvement in onion utilizing conventional and new techniques for developing varieties and hybrids suitable for different purposes (Table 3).

Table 3. List of different Onion varieties released worldwide using population improvement methods

Sr. No.	Variety released	Improvement Method Used	Scientists Involved/ References
1	N – 53	Mass Selection (Collection from Nashik, Maharashtra)	MPKV, Rahuri, 1975
2	Punjab Selection	Mass Selection in indigenous material (Collection from Punjab)	PAU, Ludhiana, 1975
3	Pusa White Flat	Mass Selection (Local Collection)	IARI, New Delhi, 1975
4	Pusa White Round	Mass Selection Local collection (106)	IARI, New Delhi, 1975
5	Co 2	Mass Selection (Collection from Tamil Nadu)	TNAU, Coimbatore, 1978
6	Punjab – 48	Mass Selection (Collection from Punjab)	PAU, Ludhiana, 1978
7	Pusa Ratnar	Mass Selection (Selection from Red Granex from USA)	IARI, New Delhi, 1978
8	Pusa Red	Mass Selection (Local Collection)	IARI, New Delhi, 1978
9	Co 3	Mass Selection (Collection from Tamil Nadu)	TNAU, Coimbatore, 1982
10	Kalyanpur Red Round	Mass Selection (Collection from U P)	CSUAT, Kanpur, 1983
11	Arka Pragati	Mass Selection (Collection from Nashik, Maharashtra)	IIHR, Bangalore, 1984
12	N – 2 – 4 – 1	Mass Selection (Collection from Pune, Maharashtra)	MPKV, Rahuri, 1985
13	Arka Niketan	Mass Selection (Mass selection from a local collection IIHR – 153)	IIHR, Bangalore, 1987

14	Agrifound Dark Red	Mass Selection (Collection from Nashik, Maharashtra)	NHRDF, Nashik, 1987
15	Pusa Madhavi	Mass Selection (Collection from Muzaffarnagar, U P)	IARI, New Delhi, 1987
16	Arka Kalyan (Sel-14)	Mass Selection (Mass selection from a local collection IIHR – 145)	IIHR, Bangalore, 1987
17	Baswant – 780	Mass Selection (Collection from Pimpalgaon, Maharashtra)	MPKV, Rahuri, 1989
18	'VL Piaz 3'	3 cycles of Mass selection after F_2 of cross 'In-13 x L-43'	Mani V. P., Chauhan V. S., Joshi H. C., Tandon J. P., 1999
19	Genetic analysis in six generations (P1, P2, F1, F2, B1 and B2) of four onion crosses *viz*., PBR 138 x AN 187, PBR 139 x AN 184, PBR 139 x AP 195 and PBR 140 x AN 184	Reciprocal recurrent selection: Exploit all gene actions simultaneously to develop a new resistant line/ variety, being best method to improve trait of resistance to purple blotch disease.	Evoor, S. *et al.*, 2007, Karnataka, India
20	Arka Pitambhar	Pedigree selection from the cross U.D. 102 x IIHR-396	IIHR, Bangalore http://www.iihr.res.in/frmVarities.aspx
21	Bhima Super	Rigorous mass selection for single centeredness & bulb shape	Lawande *et al*., 2007
22	Bhima Red & Bhima Raj	Single bulb selection up to three generations followed by mass selection for all the three seasons viz. kharif, late kharif & rabi	Lawande *et al.*, 2009
23	Bhima Shakti & Bhima Kiran	Mass selectionfor late kharif and rabi season with better storability & mass selection for rabi with good keeping quality	Lawande *et al*., 2010a & b
24	Bhima Shweta	Selection of elite lines from germplasm followed by random matting and mass selection for rabi season white onion	Mahajan *et al*., 2010
25	Bhima Shubra	Selection of white segregating bulb from red germplasm followed by mass selection for white populations for kharif & late kharif season	Mahajan *et al*., 2010

Mass selection & combinations of other methods:

A number of experiments have been reported on inheritance of yield and maturity, many of which were concerned with the estimation of combining ability in various populations. In general, diallel crossing designs have been used for this type of estimation. Joshi and Tandon, in a set of crosses between male sterile and pollinator lines, demonstrated significant GCA effects for yield in the male sterile lines with evidence of SCA for one particular cross. (Joshi and Tandon, 1976).

A major contribution to onion breeding has been the development of new open pollinated (OP) varieties using a range of population improvement methods. OP varieties are defined as genetically variable populations, which are maintained and multiplied by mass pollination in isolation.

The simplest one being mass selection, starting with a chosen parent population, the best approximately 1 to 5 % of mother bulbs of the desired type are selected at harvest or following storage and subsequently replanted to produce flowering plants which are mass pollinated together in isolation. Several cycles of mass selection are usually employed before larger scale multiplication of selected improved population to produce a new variety. Success depends upon presence of the required genetic variability in present population on which selection can operate. A refinement to mass selection is stratified mass selection, whereby the field plot of bulbs grown for selection is subdivided into equal sized areas and same proportion of selected bulbs of desired types chosen from each area. It helps to make allowance for the effect of variable growing conditions within the field plot on appearance of the mother bulbs and correspondingly to increase the chance of picking out heritable variation during the selection process. Arka Kalyan (Sel-14) was developed in 1987 through vigorous mass selection from IIHR 145 Globe shaped bulbs with medium large size. Deep red coloured outer scales and fleshy succulent internal scales. Average bulb weight 130-180g. Pungent with TSS 11-13%. Moderately resistant to purple blotch caused by *Alternaria porii* Seed yield 8 quintals/ha and is suitable for *Kharif* season. Duration 140 days. Yield 47 t/ ha.

Genetical studies, carried out by Singh (1995) found additive gene effects for dry matter content, bulb size and maturity and additive and non-additive gene effects for bulb yield and number of leaves per plant were found to play important role. In India efforts are being made to develop purple blotch resistant varieties, but so far no durable resistant variety is available. However Selections 11–1–1 and IIHR-25 are reported to be resistant, from IIHR, Bangalore and Punjab Red Round and Punjab Narroya (PBR-5) are reported from PAU and tolerant to purple blotch (Singh, D., 1997).

Mani *et. al.*, in 1999 used mass selection, for exploiting general gene effect and additive x additive type of gene interaction in a cross combination 'In-13 x L-43'. Three cycles of mass selection of the F2 of this combination led to the development of an improved high yielding onion strain 'VL 3'. This high yielding open pollinated variety, designated as 'VL Piaz 3' was identified by All India Vegetable Improvement workshop during 1990 for hills and plains of U.P. Recurrent mass selection method was found to be more efficient by up to 86%. Two breeding methods could lead to improved quality characteristics particularly bolting. Mass selection was more efficient in selecting against bolting. The doubling and maturity characters were unchanged by either of the two breeding methods.

Bhima Super was developed by rigorous mass selection for single centeredness up to 7 generations and able to achieve more than 95% single centred bulbs with uniform desirable shape of bulb in India for kharif season (Lawande *et al*., 2007). Bhima Red and Bhima Raj were developed by single bulb selection up to three generations from B-780 followed by mass selection (Lawande *et al*., 2007, 2009). Bhima Shakti (Red) and Bhima Kiran (Light red) were developed through mass selection for late kharif and rabi and rabi season, respectively along with good keeping quality by Lawande *et al.,* 2010. Bhima Sweta a white onion variety suitable for rabi season was developed by selecting white onion elite lines from germplasm followed by random matting and further mass selection for three generation by Mahajan *et al*., 2010. Bhima Shubra variety is suitable for Kharif and late kharif season in Maharashtra was developed by selecting white segregating bulbs from red onion germplasm line which was further purified and developed through mass selection (Mahajan *et al*., 2010)

Reciprocal recurrent selection:

Reciprocal recurrent selection breeding method was suggested by Evoor *et. al.*, in 2007, to exploit all the gene actions simultaneously to develop a new resistant line/ variety, as it is the best method to improve trait of resistance to purple blotch disease. Genetic analysis in six generations (P1, P2, F1, F2, B1 and B2) of four onion crosses viz., PBR 138 x AN 187, PBR 139 x AN 184, PBR 139 x AP 195 and PBR 140 x AN 184 to study the inheritance of resistance to purple blotch disease both under natural epiphytotic condition and artificial inoculation method, revealed that both additive (d and i) and non-additive (h, j and l) gene action were significantly operative in all the crosses. However, the interaction dominance x dominance and dominance type of gene action was predominant. Duplicate type of epistasis was observed in all crosses.

Pedigree Selection:

IIHR, Bangalore, developed Arka Pitambar through pedigree selection from the cross U.D. 102 x IIHR-396, with Medium size (5.2-6.0cm) bulbs having globe shape and thin neck. Mild pungency with TSS 11% and total sugar 9.81%. It was also tolerant to purple blotch, basal rot diseases and thrips.

Need for development of varieties in India:

So many varieties were developed in India but restricted to rabi season and only yield only. Besides lot of germplasm available in India still one is compelled to ask questions as (i) have the available variability and yield potential of tropical short day types exploited fully? (ii) If so, should we continue for searching germplasm for still new varieties? (iii) If not, what should be the breeding strategy for further exploitation?

Breeding for seasonal adaptability

Commercial onion in India is planted between 12 to 25^0 N latitude during following seasons (Table 4).

Table 4: Seasonal various in different states

Sr. No.	Season	Time of Sowing	Time of Transplanting	Time of Harvesting
A.	Maharashtra and some parts of Gujarat			
	1. Kharif 2. Early rabi or late Kharif 3. Rabi	May-June August-Sept. Oct.-Nov. first week	July-August Sept.-October Dec.-January first week	October-December January-March April-June
B.	Tamil Nadu, Karnataka and Andhra Pradesh			
	1. Early Kharif 2. Kharif 3. Rabi	April-May May-June Sept.-Oct.	May-June July-August Nov.-Dec.	August October-Nov. March-April
C.	Rajasthan, U.P., Haryana, Bihar, Punjab, West Bengal and Orissa			
	1.Kharif 2.Rabi	May-June Oct.-Nov.	July-August Dec.-January	Nov.-December May-June
D.	Hills			
	1. Rabi 2. Summer (long day type)	Sept.-Oct. Nov.-Dec.	Oct.-Nov. Feb.-March	June-July August-October

Kharif crop is grown during hot and humid months and ready for harvest when temperatures are low. The bulbs do not become mature as growth continues due to shorter days and cooler temperature. The bulbs of Kharif season do not have good storability. Although, the day length during this period is slightly more than rabi, the critical value of day length available is around 11-11.5 hrs due to cloudy weather. Through centuries of selection the types, which can respond to warm and humid days with 11-11.5 hrs, have been identified and maintained by farmers. From the same material superior genotypes like N-53, Agrifound Dark Red, Basawant 780, Bhima Super, Bhima Shubra and Arka Kalyan have been developed.

Recently due to late monsoon or irregularities of rain in Kharif season there has been shift in planting from Kharif to late Kharif. Availability of irrigation water from September to February, failure of Kharif crop due to high rainfall coupled with high incidence of diseases and pest and poor storage of Kharif produce, farmers in Western Maharashtra are inclining towards late Kharif crop commonly called as Rangda onion. Seedlings are transplanted in September-October and bulbs are ready for harvest in January-February. Low temperature during November -December favours bulb initiation and good development. Warm days during January-February facilitate maturity, as the day length available is again 11-11.5 hrs. The yields are high with good bulb size but percentage of bolting and twins is very high and therefore reduce marketable yield. Further, storability of bulbs is also low as compared to rabi produce. Some of the varieties like Bhima Shakti and Bhima Shubra developed by DOGR and Phule Samarth developed by MPKV, Rahuri was recently recommended for late kharif season. Still there is need to intensify research work in India for different location for late kharif season for early arrivals in market.

In case of winter (rabi) crop seedlings are transplanted in November-December, low temperatures (20-25^0 C) during December-January favour bulb initiation under again short day conditions i.e. 11-11.5 hrs. Bulb growth and maturity is in February and March where nights are cool and days are warm (35-40^{0}C). High temperatures during April-May hasten maturity. There is better curing of neck and such bulbs store well up to 5-6 months. Bulb quality is good. Almost all genotypes grown in this season are of light red coloured. But now a day demand is changing towards dark red onions during rabi season also. Hence there is need to develop dark red onion varieties with good storage during rabi. Bhima Shakti is among these recently recommended having dark red bulbs with good keeping quality during rabi season.

In hills of Uttar Pradesh, Himachal Pradesh, winter crop is transplanted in October-November and harvested in June-July, while summer crop is planted in February-March and harvested in August-October. In hills, days are longer (>13 hrs) and temperatures are cool. Duration is long (>7 months). Due to congenial climate, growth and development is very good, bulb size big and therefore yields are high. Granex types with yellow colour varieties are grown in hills.

In India pink skinned and pungent types are preferred essentially for cooking, due to its strong flavour. In contrast for salad, yellow skinned and sweet onion varieties of western countries are not liked in India and hence long day onions do not find flavour. Incidentally, high productivity in western countries is favoured by long maturity season and long day photoperiodic conditions, which in turn promote high quality (high TSS) and very compact bulbs. Tropical onions maturing under short day conditions and short growing season yield less with somewhat poor quality bulbs. Hence,

Indian average is only 10-12 tonnes/ha against 30 tonnes in countries located between 25 to 30^0N latitude (Sheshadri and Chaterjee, 1996).

Staggered planting in different seasons warrantee for steady supply of onion in the country. Unfortunately there is limited Varietal wealth for Kharif and late Kharif season. Early maturity, dark red colour and resistance to colletotrichum and purple blotch is the need of Kharif season. Further, the varieties need some dormancy for effective marketing. Recommended varieties like N-53, Basawant 780, Arka Kalyan, Agrifound Dark Red and Phule Samarth suffer from these drawbacks. Late Kharif season is becoming more popular in Maharashtra due to high yield and less hazards of diseases and pests. High percentages of bolting and poor storage are the limited factors. There is no suitable variety in dark red as well light red colour at the time of marketing or export is the requirement. Some light red coloured varieties meet the standards; however there is need to develop dark red coloured varieties for rabi season also.

Breeding for Processing Qualities:

Dehydrated products such as flakes, rings, granules, powder etc. and processed onion as onion in vinegar and brine are the important byproducts being prepared and marketed world wide. Processing industries in any commodity play an important role in stabilizing prices in domestic markets. Dehydration industries demand for white onion varieties with globose shape pf bulb and high TSS (>18%). All Indian white onion genotypes are having TSS range between 11-13%. Model variety for dehydration should be pure white, with globose shape, thin neck, free from greening and moulds, high pungency and high T.S.S. The variety should be high yielding with field tolerance/resistance to diseases and pests. Wider seasonal adaptability is also an important character from continuous supply point of view. T.S.S. and pungency is a function of genotype, cultural practices and environment. Indian varieties are short day type mature within 90-120 days. They are basically low T.S.S. varieties. The T.S.S. varies from 10 to 14% in Indian material. Some of the long day varieties which mature within 150-180 days offer high T.S.S. range from 15 to 24%. But long day varieties do-not produce bulbs under Indian short day conditions. However, intermediate short day varieties produce good bulbs but seed production is not possible under plains. In plains of India varieties mature in high temperature, which facilitates high sulphur built up and therefore Indian varieties are more pungent. In India attempts were made for development of white onion varieties by different research institutes. The details are given in Table 5.

Table 5: Performance of white onion varieties developed in India

Sl. No.	Name of Variety	Source	T.S.S. %	Average yield q/ha
1.	Pusa White Round	IARI, New Delhi	11.13	300 – 325
2.	Pusa White Flat	IARI, New Delhi	10.00	325 – 350
3.	Udaipur 102	RAU, Udaipur	10.06	300 – 350
4.	Agrifound White	NHRDF, Nashik	10.76	200 – 250
5.	Phule Safed	MPKV, Rahuri	10.13	250 – 300
6.	PKV White	PDKV, Akola	09.55	250 – 300
7.	Gujarat White	JAU, Junagadh	-	300 – 325
8.	N-257-9-1	Agril. Deptt., M.S.	10.00	250 – 300
9.	Punjab-48	PAU, Ludhiana	11.00	300 – 325
10.	V-12	Jain Food Park	15.00	350 – 400
11.	Nimar Local	Land Race, M.P.	12.50	250 – 300

12.	Talaja Local	Land Race Bhavnagar	12.00	250 - 300

After assessing Indian varieties and land races which do-not offer T.S.S. range more than 12 per cent. Jain Food Park Industries, Jalgaon introduced White Creole, which further subjected to selection pressure, for high T.S.S. character and developed V-12 variety with T.S.S. range from 15-18%. This variety is under contract production for processing but seed production is not possible under Indian plains.

Since, establishment of NRC for Onion and Garlic in 1998 at Rajgurunagar, a special programme for development of high T.S.S. white onion variety was launched through selfing and massing from available germplasm. In the year 2000 about 7199 bulbs were examined for T.S.S. range. Only 2.72% bulbs recorded T.S.S. more than 14 per cent. 109 bulbs offering T.S.S. range from 15 to 23% were selfed and populations were developed. After rejecting poor performing populations, 30 populations having 16 to 19% T.S.S. are advanced. In 4th generation of selection cycle we are able to achieve more than 75% bulbs having average TSS about 18% or even more in about 15 populations in short day onion. It would be possible to develop high T.S.S. open pollinated varieties within 2 to 3 years time suitable for *rabi* and late *kharif* seasons. Further, the programme for incorporation of high T.S.S. genes from long day and intermediate exotic cultivars to Indian genotypes is initiated in temperate region of Srinagar. Other options of mutation breeding are also being tried. Kataria (1990) reported three white mutants developed through chemical and physical mutagens viz., 22-5-1-1, 22-9-2-2 and 106-13-1-1 having TSS range from 25-30 per cent. This excellent material never reflected further in the form of either commercial variety or breeding material for varietal improvement.

Breeding for Export Quality onion

India is number one in export of onion followed by Netherlands. India's export is mostly to South East Asian and Gulf countries. Dark red and light red onions with globe shape are mostly preferred with various diameter sizes. The present practice of export is grading and packing from the total bulk arriving in various onion markets. Uniformity is shape size and colour is seldom attained, as there no systematic control over planting of required varieties. Further, there is lack in varieties, which can suit to exclusive markets. European markets require yellow or brown onion with big size. There are hardly any indigenous varieties, which can meet to these standards. NRCOG has initiated work in this direction and recommended Mercedes, Linda Vista, Cougre and Collina from exotic material for growing in late Kharif season. There is need for development of varieties in dark red and light red colour exclusively for export markets. Breeding work using long day and intermediate day exotic varieties with aim to transfer desirable characters in short day onion varieties is undertaken by this Directorate in collaboration with CITH Srinagar. Crosses were made and further selections for desirable characters were done which is further followed by mass selection.

Breeding for yellow onion

Indians do not prefer yellow onion but these find international market in European. Minimum requirements

for export are: bigger sized (>60 mm diameter), less pungent and single-centered types. As is evident, most work has been done in European countries and USA whereas, in India, research on onion has not been of any great significance. Very little work has been done in India for development of yellow onion varieties, particularly for export. Only two varieties were developed, viz., Phule Swarna from

MPKV, Rahuri and Arka Pitambar from IIHR, Bangalore and were released at the state / institute level. Yield of these varieties was comparatively less than in commercial red onion varieties. Mohanty *et al* (2000) assessed 12 varieties of onion during *kharif* season and found lowest bulb diameter of 4.2 cm in Arka Pitambar, along with low yields.

Varietal Development with special reference to climate change:

Climate change due to global warming and pollution has become major concern to the crop scientists and how to address this and prepare for is an important issue. Effect on total ecology and subsequently on certain important commodities is really not being studied. Onion and garlic are no bar to this shortcoming. No systematic studies are done in this regard. However, visible effect on distribution of rainfall has been noticed, which had exercised effect on increasing disease and pest in *Kharif* onion. *Kharif* onion is a very sensitive and crucial crop in meeting domestic supply from October to January. Failure of *Kharif* crop leads to hike in prices. Sudden rise in temperature in *rabi* season during December-January result in poor bulb initiation and bulb development of *rabi* onion and garlic. Dry weather with high temperature favours incidence of thrips and mites on these crop. Very high temperatures in March-April-May lead to reducing keeping quality of onion and garlic bulbs. Detailed studies under simulated conditions of weather parameters need to be initiated for understanding critical impact of climate change on different crops. Work on development of photo and thermo insensitive varieties is undertaken at Directorate of Onion and Garlic Research, Rajgurunagar to tackle the changing climatic situations. Some of the germplasm were found promising and can be grown in all the three seasons *viz*., *Kharif*, late *Kharif* and Rabi seasons is being exploited for such situations. In short day onion, normally bulb initiation takes place between 10-15^{o}C night and 20-25^{o}C day temperatures. Bulb development is at its best at 18-20^{o}C night and 25-30^{o}C day temperatures and for maturity day temperatures between 35-38^{o}C is required. Many varieties have been developed worldwide but they are restricted for cultivation to specific season or climate and are sensitive to climate change. Near about 45 varieties have been developed in India also but they cannot be cultivated in different photoperiod or temperature conditions. Even fluctuating climate is affecting within the season of cultivation. Looking to these challenges efforts were initiated to develop varieties which can sustain environmental vagaries and different varieties were tested in all the three seasons from 2002 to 2007 in red onion and white onion germplasm were identified 2002 – 2008 tested for at least years and three seasons. The results were encouraging and variety Bhima Super and Bhima Red was the outcome of the findings and were found promising (Lawande *et al*., 2007 & 2009). In white onion out of 75 lines, 8 lines found suitable for all the three seasons. These varieties can be grown from sunshine hours of 2.48 to 9.66 hrs with monthly average temperature range of10.51 to 36.34^{o}C and rainfall from 0 to 273.71 mm. They can be grown in all the three seasons viz. kharif (May to October), late kharif (August to February) and rabi (October to April). These varieties have less effect of photoperiod and temperature and can sustain up to greater extent in changing climate with little modifications in cultivation and management practices. This shows a path and has scope to identify potential germplasm which can be exploited for development of varieties to face environmental challenges in 21st century with the aim to develop photo and thermo insensitive varieties of onion for different locations. Besides this Bhima Shakti a red onion variety has been recommended for cultivation during late kharif and rabi in 2011 and Bhima Shubra a first white variety for kharif and late kharif 2010.

Though onion is biannual in nature, extremely cross-pollinated crop, shows inbreeding depression, have less storage life of seed etc. But looking to the methods exploited in onion improvement in the world, there is lot of scope for population improvement in India also in following

areas but one has to work with patience. There is need for identification of areas where off season seed can be produced or to standardize techniques of seed production during kharif season to reduce the time of breeding from biannual to annual particularly for late kharif and rabi season varieties. Some of the reports are available where efforts were made to produce seed during kharif season which was successful (Mahajan et al., 2002) and can be exploited for population improvement for rabi and late kharif onion varieties. There is need to develop 1. Varieties for different seasons, 2. Varieties for biotic and abiotic stress, 3. Varieties for processing, 4. Varieties for green foliage, 5. Varieties for export quality, 6. Varieties for mechanized farming for large as well as small farmers 7. Varieties for better keeping quality, 8. Varieties according to consumers demand, 9. Varieties for organic cultivation, 10. Varieties for set planting and 10. Varieties to face Climate Change.

References:

Aiyar, A. K., Yaganarayana. 1956. The antiquity of some field and forest flora of India. Bangalore Printing and Publishing Co. Ltd.

Annonymous (2020). NHRDF website Database, 2020

Astley, D., Innes, N.L. and van de Meer, Q.P. 1982. Genetic resources of Allium species. International Board of Plant Genetic Resources.

Babu, C.R. 1977. Herbaceous flora of Dehradun. PID, CSIR, N. Delhi, 721p.

Bujisen, J.R.M. 1990. Taxonomic survey of *Allium* species cultivated in South East Asia. Rijks Herbarium, Rapenburg, 47p.

Chandel, K.P.S. & Pandey, R. 1992. Distribution, diversity, uses and *in-vitro* conservation of cultivated and wild *Alliums* –a brief review. *Indian J. PI. Genetic Resources* **5 (2):** 7-36.

Chauhan, C.P.S., P.K. Shisodia, P.S. Minhas, and R.S. Chauhan. 2007. Response of onion (*Allium cepa*) and garlic (*Allium sativum*) to irrigation with different salinity waters with or without mitigating salinity stress at seedling establishment stage. Indian J. Rice Sci. 77:483–485.

Evoor, S., Veere Gowda R. and Ganeshan G. 2007 Genetics of Resistance to Purple Blotch Disease in Onion (Allium cepa L.) Karnataka J. Agric. Sci., 20 (4): 810-812

Gupta A. J., K. E. Lawande, V. Mahajan , V.S.R. Krishna Prasad and A. Khar. 2011. Evaluation of red onion germplasm for growth, yield and quality during Rabi season. National Symposium on Alliums: Current Scenario and Emerging Trends, 12-14 March, 2011 Pune.

Gohil, R.N. 1973. *Cytogenetic Studies of Some Indian. Alliums* Ph. D. Thesis, University of Kashmir.

Gohil, R.N. 1992. Himalayan representatives of *Allium.* In: *The Genus Allium- Taxonomic Problems and Genetic Resources* (Eds. Hanelt, P., Hammer, K. and Knupffer, H.). . pp. 335-340. Institute of Genetics and Crop Plant Resarch, Gatersleben, Germany

Hosfield, G. L., Vest, G. and Peterson, C. E., 1975, Usefulness of the diallel cross to evaluate combining ability and inbred line performance in hybrid onion breeding programme. HortScience, 10: 313.

Hooker, J.D. 1973. Liliaceae Allium L. flora of British India. Vol. VI, Reprinted by Singh and Singh, N. Connaught Place, Dehradun and Ms. Periodical Experts, Delhi, 337-345.

IIHR, Bangalore, Arka Kalyan, http://www.iihr.res.in/frmVarities.aspx

IIHR, Bangalore, Arka Pitambhar, http://www.iihr.res.in/frmVarities.aspx

Joshi, H. C. and Tandon, J. P. 1976. Heterosis for yield and its genetic basis in the onion. Ind. J. Agric. Sci. 46: 88

Joshi, N. and Sawant, P. 2012. Response of onion (*Allium cepa* L.) seed sermination and early Seedling development to salt level. *International J. Veg. Sci.,* 18:3–19.

Kale, PN; Warade, SD; Midmore, DJ. 1994. International symposium on alliums in the tropics, Bangkok, Thailand. 15-1993. *Acta Horticulturae*, 358:153-156.

Kamala, V.; Gupta A. J., Sivaraj. N.; Pandravada, S. R.; Sunil, N.; Varaprasad , K. S.; Lawande, K. E. 2011. Diversity analysis of onion germplasm collections from Northern Telangana region of Andhra Pradesh. Indian Journal of Plant Genetic Resources. 24(2):163-171.

Kataraia, A. S., Nagendra Singh and Singh, N. 1990 Mutation studies in onion. VI. Effect of mutagens on total soluble solids content. Ind. J. Horti. 47 (2): 216 – 219.

Lakhanpaul, S., Bhat, K.V. and Chandel, K.P.S. 1996. Identification of onion (*Allium cepa* L.) cultivars using AP-PCR. In: fourth International conference on DNA fingerprinting. 3-7 Dec., Melbourne, Australia.

Lawande, K. E., Mahajan, V., Krishna Prasad, V.S.R. and Khar, A. 2007. Proceedings of IRC & DOGR & ICAR, News Letter & Proceedings of XXV AICRP(VC) Group meeting.

Lawande, K. E., Mahajan, V., Krishna Prasad, V.S.R. and Khar, A. 2009. Proceedings of XXVII AICRP (VC) Group Meeting.

Lawande, K.E., Khar, A., Mahajan, V., Krishna Prasad, V.S.R., Devi, A. and Srinivas, P. S. (2010) Proceedings AINRPOG group meeting.

Lawande, K.E., Krishna Prasad, V.S.R., Mahajan, V. and Srinivas, P.S. (2010). Proceedings of IRC, DOGR, DOGR & ICAR News Letter.

Lawande, K. E., Khar, A., Mahajan V., Krishna Prasad, V.S.R., Devi, A. and Srinivas, P.S. (2010). Proceedings of IRC DOGR, DODR & ICAR News Letter.

Mahajan V., Jakse J, Havey M.J. and Lawande K.E. (2009}. Genetic fingerprinting of onion cultivars using SSR markers., *Indian J. Hort. 66(1), March 2009: 62-68*

Mahajan, V.; Lawande, K.E.; Tripathi, P.C.; Devi, A. and Khar, A. (2002). Reduction in breeding cycle of rabi onion by producing seeds during kharif. Paper presented in "International Conference on Vegetables – Vegetables for sustainable food and nutritional security in the new millennium" held at Bangalore, November, 11-14.

Mahajan, V.; Lawande, K.E.; Tripathi, P.C.; Devi, A. and Khar, A. (2002). Reduction in breeding cycle of rabi onion by producing seeds during kharif. Paper presented in "International Conference on Vegetables – Vegetables for sustainable food and nutritional security in the new millennium" held at Bangalore, November, 11-14.

Mahajan V., Krishnaprasad V.S.R. and K. E. Lawande (2005). Screening of white onion germplasm for storage. National symposium on current-trends in onion, garlic, chillies and seed & spices-production, marketing and utilizationon 25-27 Nov., 2005 at NRCOG, Rajgurunagar, Pune.

Mahajan V., Lawande, K.E., Krishna Prasad, V.S.R. and Srinivas, P.S. (2010). Proceedings of IRC DOGR, DOGR& ICAR News Letter.

Mahajan V., K. E. Lawande, V.S. R. Krishna Prasad, A. Khar and A.J. Gupta. 2011a. Evaluation of white onion germplasm during Kharif season. In Souvenir & Abstract: National Symposium on Alliums: Current Scenario and Emerging Trends 2011, P165.

Mahajan V., K. E. Lawande, V.S.R. Krishna Prasad, Anil Khar & A. J. Gupta. 2011b. White onion germplasm lines suitable for changing climatic situations in Souvenir & Abstract: National Symposium on Alliums: Current Scenario and Emerging Trends 2011, P165.

Mani, V. P, Chauhan, V. S., Joshi, H. S. and Tandon, J. P. 1999. Exploiting gene effects for improving bulb yield in onion. The Ind. J. Gen. Pl. Breed. 59(4): 511-514

McCollum G.D. 1976. Onion and allies. In: NW Simmonds (Ed.), Evolution of crop plants. Longman Group Limited, London, 339P.

Meer, O.P. Vandeer and Vries, J.N. 1990. An interspecific crosses between Allium roylei Stearn and Allium cepa L. and back cross to A. cepa. Euphytica, 47: 1, 29-31.

Mohanty, B.K., Hossain, M.M. and Pruthi, A.M. 2000.Varietal assessment of common onion for horticultural traits during *kharif* season. *Orrisa J. Hort.*, **28**:8-11.

Negi, K.S. 2006. *Allium* species in Himalayas and their uses, with special reference to Uttaranchal. **Ethnobotany 18(1&2):** 53- 66.

Negi, K.S. 2011. Scenario of underutilized Alliums in India. Souvenir: Nat. Symp. On Alliums: Current Scenario and Emerging Trends, 12-14, March, 2011: 29-42.

Negi, K.S, Gaur, R.D. & Pant, K.C. 1995. Biodiversity… untapped plant wealth in Uttarakhand. *Indian Hort.* **40 (2):** Cover I, II, IV 32-40.

Negi, K.S., Pant, K.C., Koppar, M.N. & Thomas, T.A. 1991. Wild relatives of gsenus *Allium* L. in Himalayas. *Indian J. PI. Genetic Resources***. 4 (1)**: 732-77.

Negi, K.S. and Pant K.C. 1992. Less known endemic wild species of Allium (Amarylliadaceae). Econ. Bot. 46: 112-116

Nayar, N. M., Ahmedulla, M. & Singh, R. 1992. *Alliums* in South Asia. Importance, ehnobotanical uses, genetic resources, enumeration of species and distribution. In: *The Genus Allium-Taxonomic Problems and Genetic Resources* (Eds. Hanelt, P., Hammer, K. and Knupffer, H.). pp. 205-213.

Prasad,V.S.R.K; Lawande,K.E; Mahajan,V. and Khar, A. 2006. Assessing and prediction of environmental response of short day onion genotypes grown in three seasons of western India. Indian-Journal-of-Horticulture. 63(3): 270-275

Peterka, H., Budahn, H., Schrader, O. and Havey, M.J. 2002. Transfer of a male-sterility-inducing cytoplasm from onion to leek (Allium ampeloprasum). Theo. Applied Genetics, 105: 2-3, 173-181.

Rabinowitch H.D. and Currah L. 2002. Allium Crop Science: Recent advances. CABI Publishing House, UK, 515P.

Ranpise, S.A; Patil,B.T. and More,T.A. 2004. Evaluation of rangda (late kharif) onion germplasm for morphological and storability studies. Journal-of-Maharashtra-Agricultural-Universities. 29(1): 104-106

Ray, P. and Gupta, H. N. 1980a. "Charaka Samhita" Scientific synopsis. Indian National Science Academy, New Delhi

Ray, P., Gupta, H. N. and Roy, M. 1980b. "Sankruta Samhita" Scientific synopsis. Indian National Science Academy, New Delhi

Sharma, I.M. 1997. Screening of onion varieties/lines against purple blotch caused by Alternaria porrii under field conditions. Plant Dis. Res. 12(1): 60-61.

Sharma, P. C.; Mishra, B.; Singh, R. K.; Singh, Y. P.; Tyagi, N. K. 2000. Adaptability of onion (Allium cepa) genotypes to alkali and salinity stresses. Indian Journal of Agricultural Sciences 70 (10): 674-678

Sharma P.C., B.Mishra, R.K.Singh and S.Narayan. 2006. Adaptability of garlic (Allium sativum) genotypes to alkali stress. Indian Journal of Agricultural Sciences 76 (2): 71-76

Shashidhar, T.R., and Dharmatti, P.R. 2005. Genetic divergence studies in garlic. *Karnataka J. Hort*., **1**:12-15

Sheshadri, V. S. and Chaterjee, S. S. 1996. The history and adaptability of some introduced vegetable crops in India. Veg. Sci. 23 (2): 114 – 140

Singh, B.P. and Rana, R.S. 1994. Collection and conservation of allium genetic resources: an indian perspective. Acta Hort. (ISHS) 358:181-190

Singh, D. 1997. Onion improvement in India. I International Symposium on Edible Alliaceae http://www.actahort.org/books/433/433_4.htm

Srinivas, P.S. (2005). Pest management in onion and garlic: Preent and future strategies. Souvenir; SYMSAC-II, 25-27 Nov., 2005: 152-154.

Swarup, Vishnu. 1990. Onion improvement in India. Proceedings of National Symposium on Onion and Garlic pp. 21 – 32

Xu, J.M., Hanelt, P. & Chun-Lin L. 1990. Key to the *Alliums* of China. *Herbertia* **46 (2):** 138-164.

Yang, F., Liu, S. and Wang, X. 2005. Effects of boron in soil on the physiological-biochemical characteristics, yield and quality of garlic. *Sci.Agricultura Sinica*. **38**:1011-1016

Zeven, A.C. and Zhukovsky, P.M. 1975. Dictionary of cultivated plants and their centres of diversity, Wageningen, Netherlands.

Effect of Micro-Sprinkler Irrigation and Nitrogen Levels on *rabi* Onion (*Allium cepa* L.)

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ABSTRACT

An experiment was conducted with an objective to study the performance of rabi onion as influenced by micro-sprinkler irrigation levels and different nitrogen levels & their interaction effect during the *rabi* 2014-2015 at the research farm of Agronomy section, College of Agriculture, Dhule (MPKV., Rahuri).

The application of 100 % ETc (I4) irrigation through micro-sprinkler significantly increased important growth attributes viz., mean plant height, number of functional leaves, leaf area, leaf area index, neck thickness, dry matter of leaves plant^{-1} as compared to other treatments. However, number of functional leaves, leaf area and leaf area index were at par with 85 % ETc (I3) treatment at 90 DAT.

The bulb development attributes *viz.*, equatorial diameter of bulb, polar diameter of bulb, fresh weight of bulb and dry matter of bulb were significantly higher in (N_3) treatment i.e. 125 % RDN (N_3) as compared to rest of treatments. The bulb, foliage yield was significantly higher in (N_3) treatment i.e. 125 % RDN as compared to rest of treatments and quality character i.e. total soluble solid was significantly higher in (N_3) treatment i.e. 125 % RDN as compared to other treatments. The available nitrogen, phosphorus and potassium nutrients were higher under application of 55 % ETc (I_1) treatment through microsprinkler. The nitrogen content in foliage and bulb was significantly higher under application of 100 % ETc (I_4). However, nitrogen use efficiency was significantly higher under application of 100 ETc (I_4) treatment. The consumptive use was significantly higher under treatment (I4) i.e. application of 100 % ETc. However, water use efficiency was significantly higher under treatment (I1) i.e. application of 55 % ETc (I1) over the rest of the treatments.

The interaction effect of irrigation levels and nitrogen levels was found significant in fresh weight of bulb at harvest, bulb yield at harvest and nitrogen use efficiency at harvest.

Key words: ***Micro-sprinkler, Onion, Nitrogen levels, performance, Yield.***

Introduction:

Onion is one of the important vegetable crop commercially grown in India. It is a member of Alliaceae family, rich in sulphur containing compounds that are responsible for their pungent odours and for many of their health promoting effects. It is popularly used both in immature and mature bulb stage as a vegetable and spices. It is an important vegetable crop commercially grown over a large area in the country.

India is the second largest producer of onion in the world, next to China. In India, onion is being grown on an area of 12.03 million hectares with production of 19.40 million tones and productivity is 16.10 t ha^{-1} which is low. Maharashtra produces 30 % onion production of india. In Maharashtra, onion is cultivated on an area of 4.68 million ha with production of 5.86 million tones and the average productivity is 12.50 t ha^{-1} which is low compared to world average. Major onion producing district in Maharashtra are Nasik, Ahmdnagar, Pune, Satara, Solapur, Dhule, Jalgaon, Osmanabad, Beed, Aurangabad . (Anonymus, 2015).

Irrigation is one of the most crucial input for onion. The shortage of irrigation at bulb development stage, which usually coincides with summer season, affects the yield drastically. Onion is mostly grown as irrigated crop in our country and traditionally surface irrigation is commonly used. But nowadays micro sprinkler systems have been recently introduced. In these systems, major problems of both sprinkler and drip systems are minimized. Compared to conventional sprinkler systems, the micro sprinkler irrigation systems require less energy, less pressure and low discharge. There is no runoff as well as deep percolation problems. Visual inspection of the micro sprinklers is simple and fast. Less time is required for the inspection as compared to several emitters in a drip irrigation system (Rathod et al., 2006).

In case of fertilizer management Nitrogen helps in vigorous vegetative growth and imparts deep green colour to the foliage which favors photosynthetic activity of the plants so there is greater accumulation of food material i.e., carbohydrates in the bulb which ultimately results in more synthesis of total soluble solid content (Aswani et al., 2005).

Sprinkler method gives higher yield than the surface irrigation method by using same amount of water because of uniform application of water and comparatively less depletion of soil moisture. The effective use of fertilizer through this system also boosts the yield of crop. Sprinkler can efficiently use the low discharge of water by walls by applying lower depth of

irrigation during each turn, thereby increasing the frequency of irrigation during crop period. Frequent irrigation with low irrigation depth also help in improving the water use efficiency.

Micro irrigation system can play a very important role in increasing water use efficiency. Initial high cost of the system, technical knowledge and skilled labour are considered to be its limiting factor for large adoption in India. As both central and state government are providing subsidies to farmer for adoption of this system to increase the area under micro irrigation. The area is increasing day by day under micro irrigation. As the water is precious and scanty, its paucity in rabi and summer season considering today more crop per drop of water to increase the water use efficiency. Similarly now a days the nitrogenous fertilizers are become costly. The losses due to volatilization and leaching are more in nitrogenous fertilizers. By keeping these points in view, the present experiment was under taken to find out the effect of micro-sprinkler irrigation and nitrogen levels on rabi onion (Allium cepa L.)."

Material and Methods:

A field experiment was conducted during the Rabi season 2014-2015, at Post graduate Research Farm, M.P.K.V's College of Agriculture, Dhule. The field experiment was laid out in a split plot design with twelve treatment combinations and three replications. The main plot treatment comprised of four irrigation levels viz., 55 % ETc (I1), 70 % ETc (I2), 85 % ETc (I3) and 100 % ETc (I4) and the subplot treatment comprised of three treatments of nitrogen levels viz., application of 75 % RDN (N1), 100 % RDN (N2) and 125 % RDN (N3). The recommended dose of phosphorus and potassium fertilizers (50:50 kg PK ha-1) was applied as per treatment. The sources of nitrogen, phosphorous and potash were urea, single super phosphate and murate of potash, respectively.

The transplanting was done fortnight of December 2014. A spacing of 12.5 cm^2 between rows and 7.5 cm^2 between plants was maintained. The gross and net plot sizes were 5.10 x 3.40 m^2 and 4.80 x 3.10 m^2 respectively. The soil of the experimental plot was clay loam in texture. The soil was low in available nitrogen (143.50 Kg ha-1), medium in available phosphorus (17.50 Kg ha-1) and high in available potassium (341.91 kg ha-1). The soil was alkaline in reaction (pH 8.2).

The observations on growth and yield attributes were recorded from 5 randomly selected plants from each plot. The data were recorded for bulb yield on net plot basis and then converted on hectare basis and subjected to statistical analysis.

Results and Discussion:

Different treatment of irrigation levels showed a significant influence on growth parameters viz., plant height, number of functional leaves, leaf area, leaf area index, neck thickness, dry matter of leaves plant-1 and they were significantly influenced with the application of 100 % ETc (I4) treatment. This results were similar with the findings of Kumar *et al.,* (2007) and Sankar *et al.,* (2008). Whereas significantly minimum plant height was registered in 55 % ETc (I1) treatment at 30, 60, 90 DAT and at harvest as compared to rest of the treatments, at all growth stages through microsprinkler. However, number of functional leaves, leaf area and leaf area index were at par with 85 % ETc (I3) treatment at 90 DAT.

The bulb development characters viz., Equatorial diameter of bulb, polar diameter of bulb, fresh weight of bulb were significantly higher under application of irrigation @ 100 % ETc (I4) than rest of the treatment. These results are similar with the findings of Godara and Mehta (2013).

The bulb and foliage yield was significantly higher, when onion was irrigated with 100 % ETc (I4) treatment through microsprinkler. The highest bulb and foliage yield (58.58 q ha-1) was registered with the application of nitrogen 125 % RDN (N3) treatment and it was significantly higher as compared to other treatment. Similarly significantly lower foliage yield was produced by 75 % RDN (N1). The results are in conformity with those reported by Ahmad and Al-Fraihat (2009).

The quality attributes viz., total soluble solid was influenced significantly due to different treatments of irrigation levels. However, total soluble solid was significantly higher under application of irrigation 55 % ETc (I1) treatment through microsprinkler. The significantly highest total soluble solid (11.16 %) was registered with the application of nitrogen 125 % RDN (N3) as compared to other treatment. Whereas, significantly minimum total soluble solid was reported in 75 % RDN (N1) treatment. These results are similar with the findings of Kale (2010), Aswani et al. (2005) and Naik and Hosamani (2003).

The consumptive use was affected significantly due to different treatment of irrigation levels. However, consumptive use of onion was highest under 100 % ETc (I4) treatment. The crop water use efficiency was affected significantly due to different treatment of irrigation levels. However, crop water use efficiency of onion was highest under 55 % ETc (I1) treatment.

The available nitrogen, phosphorus and potassium nutrients after harvest of onion in soil were significantly influenced due to different treatments of irrigation levels. However, available nitrogen, phosphorus and potassium nutrients was significantly higher under application irrigation through microsprinkler @ 55 % ETc (I1) treatment. Nitrogen content in foliage, nitrogen content in bulb and nitrogen use efficiency were found to be significant highest with application of 100 % ETc (I4) irrigation treatment.

The plant height was significantly affected by different nitrogen levels. Significantly the maximum plant height was observed in 125 % RDN (N3) treatment i.e. 22.52, 45.32, 60.75 and 61.75 cm at 30, 60, 90 DAT at harvest respectively as compared to rest of the treatments. However, it was at par with 100 % RDN (N2) treatment at all growth stages except at harvest. These results were similar with the findings of Singh et al. (1988) and Kumar et al. (2001).

The highest gross monetary return (343936 ha-1), cost of cultivation (108433 ha-1) and net monetary return (235503 ha-1) were recorded in the application of 100 % ETc (I4) irrigation level. The similar result was observed in case of B:C ratio. The highest B:C ratio was observed under(I4) treatment i.e. application of 100 % ETc (3.17).

Different treatments of nitrogen levels showed a significant influence on growth parameters viz., plant height, number of functional leaves, leaf area, leaf area index, neck thickness, dry matter of leaves plant-1 which were significantly higher with the application of 125 % RDN (N3) treatment. However, it was at par with 100 % RDN (N2) in case of plant height, number of functional leaves, leaf area, leaf area index at 30, 60, 90 DAT and Neck thickness at 90 DAT.

The bulb development characters viz., Equatorial diameter of bulb, polar diameter of bulb, fresh weight of bulb and dry matter of bulb was significantly higher under application of 125 % RDN (N3) treatment over the rest of treatments of nitrogen level, and it was at par with polar diameter and equatorial diameter at 60 DAT. The bulb and foliage yield was significantly higher when onion was transplanted with application of 125 % RDN (N3) treatment over the rest of treatments. The quality attributes viz., total soluble solid was influenced significantly due to different treatments of nitrogen levels. However, total soluble solid was significantly higher under application of 125 % RDN (N3) treatment.

Consumptive use of rabi onion was not affected significantly due to different treatments of nitrogen levels. However consumptive use of onion was uniform at different

nitrogen levels. Crop water use efficiency was affected significantly due to different treatments of nitrogen levels. However, crop water use efficiency of onion was highest under 125 % RDN (N3) treatment over the rest of the nitrogen levels.

Available nitrogen, phosphorus and potassium nutrients after harvest of rabi onion in soil were significantly influenced due to different treatments of nitrogen levels. Available nitrogen was higher under application of 125 % RDN (N3). However, available phosphorus and potassium was higher under application of 75 % RDN (N1) treatment. Nitrogen content in foliage, nitrogen content in bulb and nitrogen use efficiency were found to be significantly higher in application of 125 % RDN (N3) treatment and it was at par with 100 % RDN in case of nitrogen content in foliage and bulb. However, nitrogen use efficiency was higher under application of 75 % RDN (N1) treatment.

The highest gross monetary return (302068 ha-1), cost of cultivation (105990 ha-1) and net monetary return (196078 ha-1) were recorded in the application of 125 % RDN (N3) treatment. The similar result was observed in case of B:C ratio. The highest B:C ratio was observed under N3 treatment i.e. application of 125 % RDN (N3) (2.84).

Table 1. Effect of micro-sprinkler irrigation levels and Nitrogen levels and their interaction on growth parameters of rabi onion:

Treatment	Plant height				Number of functional leaves				Leaf area (sq.cm)				Leaf area index plant^{-1}				Neck thickness (cm)				Dry matter of leaves plant^{-1} (g)			
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest
A) Irrigation levels (I)																								
I_1–55 % Etc	20.50	40.84	54.58	55.47	4.11	7.15	9.21	7.57	2.31	17.10	20.75	14.54	0.20	1.19	1.59	1.13	0.67	1.59	2.27	1.18	1.39	5.40	8.01	4.11
I_2-70 % Etc	21.27	43.62	57.62	58.51	4.46	7.66	11.43	8.23	3.01	17.64	22.56	16.66	0.27	1.46	1.67	1.27	0.74	1.72	2.50	1.35	1.50	5.53	9.07	5.03
I_3-85 % Etc	21.80	46.58	62.50	63.50	4.79	8.85	12.12	8.78	3.76	18.20	23.80	17.35	0.32	1.68	2.11	1.44	0.79	1.78	2.85	1.52	1.55	5.76	9.93	5.60
I_4-100 % ETc	22.98	47.54	63.48	64.59	5.07	9.16	12.36	9.01	4.00	18.46	24.25	18.16	0.34	1.76	2.17	1.49	0.85	1.83	3.04	1.61	1.61	5.98	10.17	5.98
S. Em ±	0.25	0.27	0.23	0.21	0.07	0.08	0.07	0.06	0.06	0.06	0.18	0.12	0.004	0.024	0.018	0.004	0.01	0.01	0.05	0.01	0.01	0.02	0.05	0.02
CD at 5 %	0.87	0.95	0.80	0.75	0.26	0.28	0.24	0.19	0.23	0.24	0.62	0.43	0.015	0.075	0.064	0.016	0.04	0.04	0.18	0.06	0.03	0.07	0.22	0.08
B) Nitrogen levels (N)																								
N_1-75 % RDN	20.33	43.76	58.04	59.04	4.42	7.97	11.09	8.21	3.10	17.68	22.32	15.84	0.27	1.48	1.86	1.31	0.73	1.69	2.60	1.38	1.48	5.58	9.17	5.03
N_2-100 % RDN	22.07	44.85	59.84	60.76	4.62	8.26	11.29	8.37	3.29	17.92	22.96	16.75	0.28	1.52	1.89	1.33	0.76	1.74	2.63	1.41	1.51	5.67	9.26	5.19
N_3-125 % RDN	22.52	45.32	60.75	61.75	4.79	8.40	11.46	8.51	3.43	17.96	23.24	17.44	0.29	1.56	1.92	1.36	0.80	1.77	2.73	1.47	1.54	5.76	9.46	5.31
S. Em ±	0.21	0.20	0.32	0.27	0.06	0.07	0.08	0.05	0.05	0.06	0.12	0.22	0.005	0.013	0.014	0.006	0.01	0.01	0.03	0.01	0.01	0.02	0.06	0.01
CD at 5 %	0.64	0.60	0.96	0.80	0.20	0.22	0.25	0.13	0.15	0.20	0.38	0.66	0.016	0.041	0.043	0.018	0.03	0.03	0.09	0.05	0.02	0.06	0.19	0.05
C) Interaction																								
S. Em ±	0.42	0.40	0.64	0.54	0.13	0.15	0.16	0.10	0.05	0.06	0.25	0.44	0.01	0.02	0.02	0.01	0.01	0.02	0.06	0.03	0.02	0.04	0.12	0.03
CD at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General mean	21.64	44.64	59.54	60.52	4.61	8.21	11.28	8.36	3.27	17.85	22.84	16.68	0.28	1.52	1.89	1.33	0.76	1.73	2.66	1.42	1.51	5.64	9.30	5.18

Table 2. Effect of micro-sprinkler irrigation levels and Nitrogen levels and their interaction on bulb yield, yield and quality parameters of rabi onion.

Treatment	Equatorial diameter of bulb (cm)				Polar diameter of bulb (cm)				Fresh weight of bulb (g)				Dry matter of bulb plant^{-1} (g)				Bulb yield (q ha^{-1})	Foliage yield (q ha-1)	Total soluble solid (%)
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest			
A) Irrigation levels (I)																			
I_1-55 % Etc	1.27	2.61	4.06	4.62	2.01	3.62	4.42	4.80	2.80	8.37	14.70	23.25	0.17	1.47	2.93	4.05	225.85	40.99	12.16
I_2-70 % Etc	1.34	2.88	4.54	6.39	2.23	4.31	4.91	5.32	3.28	13.15	20.37	29.97	0.28	2.03	3.94	5.12	291.86	53.23	11.85
I_3-85 % Etc	1.44	2.95	4.99	6.64	2.48	4.87	5.33	5.67	3.71	19.07	28.30	36.66	0.39	2.84	4.44	6.07	357.89	60.42	10.68
I_4-100 % ETc	1.48	3.04	5.06	6.89	2.54	4.99	5.47	5.92	4.46	23.30	30.08	43.45	0.50	3.05	4.59	6.27	425.47	71.14	9.51
S. Em ±	0.01	0.02	0.01	0.05	0.01	0.02	0.03	0.06	0.06	0.31	0.51	0.27	0.01	0.03	0.03	0.09	2.63	0.42	0.02
CD at 5 %	0.03	0.07	0.04	0.18	0.02	0.09	0.12	0.24	0.20	1.08	1.79	0.96	0.03	0.12	0.12	0.33	9.11	1.47	0.06
B) Nitrogen levels (N)																			
N_1-75 % RDN	1.35	2.82	4.56	6.02	2.28	4.35	4.89	5.30	3.86	14.72	21.97	28.78	0.30	2.20	3.88	5.25	280.02	52.97	10.93
N_2-100 % RDN	1.38	2.90	4.69	6.14	2.33	4.49	5.06	5.41	3.98	16.13	23.71	33.04	0.33	2.37	3.98	5.43	331.91	55.54	11.06
N_3-125 % RDN	1.42	2.92	4.75	6.25	2.38	4.56	5.15	5.58	4.02	17.07	24.40	38.18	0.37	2.49	4.06	5.46	373.88	58.58	11.16
S. Em ±	0.01	0.01	0.02	0.03	0.01	0.02	0.02	0.05	0.05	0.32	0.38	0.18	0.01	0.03	0.03	0.04	1.71	0.36	0.01
CD at 5 %	0.03	0.03	0.05	0.10	0.04	0.08	0.07	0.16	0.16	0.96	1.15	0.55	0.02	0.10	0.11	0.13	5.14	1.08	0.04
C) Interaction																			
S. Em ±	0.02	0.02	0.04	0.06	0.02	0.05	0.05	0.11	0.10	0.64	0.77	0.37	0.01	0.07	0.07	0.08	3.43	0.72	0.02
CD at 5 %	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**1.11**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**10.29**	**N.S.**	**N.S.**
General mean	1.38	2.87	4.67	6.14	2.34	4.45	5.03	5.43	3.56	15.97	23.36	33.33	0.33	2.35	4.97	5.38	325.17	56.45	11.05

Table 3. Consumptive use, crop water use efficiency of *rabi* onion as influenced periodically by different treatments:

Treatment	Total crop evapotranspiration (mm)	Effective rainfall (mm)	Consumptive use (mm)	Yield (kg ha^{-1})	Crop WUE (kg ha^{-1} mm)
A) Irrigation levels (I)					
I_1–55 % ETc	95.59	12.46	108.05	22584.89	209.02
I_2-70 % ETc	121.66	15.86	137.52	29185.67	212.22
I_3-85 % ETc	147.73	19.26	166.99	35789.22	214.31
I_4-100 % ETc	173.80	22.67	196.47	42547.44	216.55
S. Em ±	-	-	-	263.41	-
CD at 5 %	-	-	-	911.54	-
B) Nitrogen levels (N)					
N_1-75 % RDN	134.69	17.56	152.25	28002.08	183.92
N_2-100 % RDN	134.69	17.56	152.25	32190.67	211.43
N_3-125 % RDN	134.69	17.56	152.25	37387.67	245.56
S. Em ±	-	-	-	171.71	-
CD at 5 %	-	-	-	514.812	-
C) Interaction					
S. Em ±	-	-		343.43	-
CD at 5 %				1029.62	-
General mean	134.69	17.56	152.25	32526.81	210.52

Conclusion:

The irrigation application of 100 % ETc (I4) irrigation treatment through microsprinkler significantly increased growth and bulb development character of rabi onion resulting in higher bulb yield and foliage yield as compared to other treatments.

Nitrogen level with application of 125 % RDN (N3) significantly influences the growth, bulb development character, quality characters of rabi onion resulting in higher bulb yield and foliage yield as compared to other treatments.

The irrigation level application of 55 % ETc (I1) significantly showed higher crop water use efficiency and consumptive use was higher with application of 100 %

ETc (I4) treatment irrigation through microsprinkler. The irrigation level application of 100 % ETc (I4) significantly exhibited higher nitrogen content in foliage and nitrogen content in bulb, nitrogen use efficiency as compared to other treatments of nitrogen.

The rabi onion cultivated with the application of 100 % ETc (I4) produced highest gross monetary return, net monetary return and B:C ratio as compared to other treatment.

The cultivation of rabi onion was found remunerative when it was cultivated with application of irrigation 100 % ETc through microsprinkler and application of nitrogen level 125 % RDN along with recommended dose of phosphorus and potassium for higher yield and economical returns.

References:

Ahmad, H. and Al-Fraihat. 2009. Effect of nitrogen and sulphur fertilizer levels on growth, yield and quality of onion (Allium cepa L.) Jordan J. Agric. Sci. 5 (2): 155-161.

Anonymous, 2015. Indian Hort. Database. pp: 160-168.

Aswani, G., Paliwal, R. and Sarolia, D. K. 2005. Effect of nitrogen and biofertilizer on yield and quality of rabi onion (Allium cepa L.) Cv. Puna Red. Agric. Sci. Digest. 25 (2):124 –126.

Godara, A. S. and Mehta, R. S. 2013. Response of onion (Allium cepa L.) to crop geometry and nitrogen levels. Indian Soc. Horti. Res. Devlop. Prog. Horti. 45 (1): 214-217.

Kale, L. 2010. Studies on effect of different sources of nitrogen and potassium on productivity and shelf life of onion. (Allium cepa L.) var. Arka Kalyan Horticulture Department, University of Agricultural Sciences, Dharwad, Agriculture College, Dharwad 580005 Karnataka State, India. 2010. Thesis submitted to University Library, UAS, Dharwad.

Kumar, G. V., Tamilmani, D., Selvaraj, P. K. and Ramaswamy K. 2001. Moisture movement and nitrogen distribution in onion under drip fertigation in sandy loam soil. Indian J. Soil Conservation. 39 (1) pp. 37-43.

Kumar, S., Imtiyaz, M., Kumar, A. and Singh, R. 2007 a. Response of onion (Allium cepa L.) to different levels of irrigation water. Agric. Water Mgt. 89: 161–166.

Naik, B. H. and Hosamani, R. M. 2003. Effect of spacing and nitrogen levels on growth and yield of Kharif onion. Karnataka J. Agri. Sci. 16 (1): 98-102.

Rathod, S. D., Kamble, B. M. and Chougule, B. A. 2006. Effect of scheduling irrigation on yield of onion (Allium cepa L.) irrigated through micro-sprinkler irrigation system. Asian J. of Bio. Sci. 1 (2): 144-145.

Sankar, V., Lawande, K. E. and Tripathi, P. C. 2008. Effect of micro irrigation practices on growth and yield of garlic (Allium sativum L.) var. G. 41. J. Spices and Aromatic Crops. 17 (3): 230–234.

Singh, K. P., Singh, K. and Jaiswal, R. C. 1998. Effect of various level of nitrogen, spacing and their interaction of seed crop of onion (Allium cepa L.) Veg. Sci. 15 (2): 120-125.

INTEGRATED NUTRIENT MANAGEMENT IN ONION

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Abstract

A field experiment was carry out at the Agronomy Farm, Department of Agronomy, B. A. College of Agriculture, Anand Agricultural University, Anand during *rabi* season of 2011-12 on loamy sand soil to study the effect of integrated nutrient management on growth and yield of onion. The results revealed that significantly higher plant height, length of leaves and number of leaves at 40 and 80 days after transplanting, leaf dry weight, bulb volume, bulb weight and bulb yield were found in 75 per cent recommended dose of fertilizer + vermi-compost at 1.25 tonnes per ha and it also remained economically superior over the rest of the treatments.

Keywords: Organic manures, Inorganic fertilizers, INM, Onion

Introduction

Onion (*Allium cepa* L.) is contributes 12.5 per cent of total vegetable area and 10.3 per cent of total vegetable production. In India, total area under onion cultivation was 1.32 million hectares with total production of about 22.07 MT in 2016-17 (Anon.2018). In Gujarat, estimated area of onion cultivation was 42.06 thousand ha with production of1224.06 thousand tonnes and a productivity of 29104.01 kg/ha (Anon, 2019). The farmers spend greater portion of their capital in purchasing fertilizers. However, chemical fertilizer alone generate several deleterious effect to soil, environment, human health and they should be replenished in every cultivation season because synthetic N, P and K fertilizers are rapidly loss by either volatization or by leaching in drainage water and it causes dangerous

environmental pollution (Aisha *et al.,* 2007). However, only organic manures/fertilizers are not able increase sufficient production of the food in adequate quantity to meet the increasing human population and crop grown alone with chemical fertilizers deteriorate the soil health and environment. Hence, the present experiment was undertaken on integrated use of chemical fertilizers along with organic manures to know yield and yield attributes of onion.

Materials and Methods

A field experiment was conducted to study the combined effect of chemical fertilizers and organic manures on growth and yield of onion during *rabi* Season 2011-12 at the Agronomy Farm, Department of Agronomy, B. A. College of Agriculture, Anand Agricultural University, Anand. There are total twelve treatments like T_1: Absolute control, T_2: Recommended Dose of Fertilizer at 100-75-75 NPK kg ha^{-1}(control). T_3: NADEP compost @ 7 t ha^{-1} , T_4: Vermicompost @ 5 t $ha^{-1,}$ T5: 75 % RDF + NADEP compost @ 1.75 t ha^{-1}, T_6: 50 % RDF + NADEP compost @ 3.5 t ha^{-1}, T_7: 75 % RDF + Vermicompost @ 1.25 t ha^{-1} , T_8: 50 % RDF + Vermicompost @ 2.5 t ha^{-1} , T_9: 50% RDF + NADEP compost @ 1.75 t ha^{-1} + Vermicompost @ 1.25 t ha^{-1} , T_{10}: 50 % RDF + PSB seedling treatment @ 5 ml/l (root dipping for 15 min), T_{11}: 50 % RDF + *Azospirillum* seedling treatment @ 5 ml /l (root dipping for 15 min) and T_{12}: 50 % RDF + PSB seedling treatment @ 5 ml/l + *Azospirillum* seedling treatment @ 5 ml/l (root dip for 15 min) were tested in randomized complete block design with four replication.

The observations on plant height (cm), length of leaves (cm), leaf dry weight (gm), bulb weight (gm), bulb volume (g/m^3), Total Soluble Sugar content, Bolting percentage and bulb yield (kg/ha) were recorded.

Result and Discussion

Effect of integrated nutrient management on growth parameters of Onion

The treatment T_7 (75 % RDF + Vermicompost 1.25 t ha^{-1}) recorded higher plant height of 65.05 cm and 78.80 cm at 40 and 80 days after transplanting and it is statistically at par with T_2 , T_5, T_6, T_8 and T_9. Length of leaves was also recorded maximum of 62.05 cm and 71.35 cm at 40 and 80 days after transplanting and remained statistically at par with treatments T_2, T_5, T_6, T_8 and T_9 and they are also at par with each other (table 1). Number of leaves was also significantly higher in treatment T_7 recorded 6.75 and 8.75 leaves per plant at 40 and 80 days after transplanting and remained statistically at par with T_2 , T_5, T_6, T_8 and T_9, respectively. This might be due to ample supply of nitrogen which in turn encourages the

vegetative growth and also led to carbohydrate formation. Nitrogen is also being constituent of chlorophyll, amino acids, proteins and nucleic acid which promote the cell multiplication and cell elongation, which ultimately accelerate the vegetative growth. The vermi-compost which contains all essential plant nutrients in appropriate proportions and it provides the soil with more stable humus. The stable humus allows air, water and essential nutrients to be held in the aggregates. These present findings are in agreement with Devi and Limi (2005), Balemi *et al.* (2007), Mozumder *et al*. (2007), Adagale *et al*. (2009).

Effect of integrated nitrogen level on yield and yield attributes in onion

The bulb weight and bulb volume were recorded significantly higher (table 1) under the treatment T_7 (75 % RDF + Vermicompost 1.25 t/ ha) i.e. 121.50 (gm) and 132.50 (cm^3), respectively, it was remained statistically at par with treatments like T_2, T_5, T_6, T_8 and T_9 and they are also at par with each other (table 1). This increase in weight and volume of bulb might be due to more dry matter production and translocation of photosynthetes contributed to swelling of bulbs which resulted in increase weight and volume of bulbs at higher nitrogen levels along with vermicompost. In addition to this, increase in nitrogen levels with vermicompost, promotes cell multiplication and cell elongation, which results in accelerating the vegetative growth, more photosynthesis and food accumulation and in turn leads to increased bulb weight and volume. These results are agreement with Yadav *et al.* (2005), Mozumder *et al*. (2007), Hari *et al.* (2009) and Abdissa *et al.* (2011).

The bulb yield was significantly higher under the treatment T_7 (75 % RDF + vermicompost 1.25 t ha^{-1}) i.e. 33.33 t/ ha (table 1) and it was remained at par with treatments like T_2 T_5, T_6, T_8 and T_9 and which are at par with each other. This might be due to increase in weight and volume of bulb observed in present investigation. These are the important yield parameters and their component effects might have resulted into higher bulb yield. The increase in bulb yield due to integrated nitrogen levels were reported by many workers *viz.*, Saxena *et al.* (2008), Sharma *et al.* (2009), Abdissa *et al*. (2011), Ethel *et al.* (2011), Bagali *et al*. (2012).

References

Adagale, S. V., Masalkar, S. D. and Pandure, B. S. (2009). Effect of integrated nutrient management on growth and yield of onion seed production. *The Asian J. Hort*. **4** (2): 484-487.

Aisha, A.H., Rizk, F. A., Shaheen, A.M. and Abdel-Mounty, M. M. (2007). Onion plant growth, bulbs yield and its physical and biological properties as affected by organic and natural fertilization. *The Res. J Agric. and Bio. Sci.* **3**(5): 380-388.

Anonymous (2018). Government of India, Ministry of Agriculture and farmer's welfare, Department of Agriculture, Co-operation and farmers welfare. Directorate of Economics and Statistics.

Anonymous (2019). Third advance estimates of area, production and yield of major kharif / rabi crops of Gujarat state for the year 2019-20. Directorate of Agriculture, Agriculture, Farmer's Welfare and Cooperation Department Government of Gujarat. pp 1.

Abdissa, Y., Tekalign, T. and Pant L. M. (2011). Growth, bulb yield and quality of onion (*Allium cepa* L.) as influenced by nitrogen and phosphorus fertilization on vertisol. *African. J . Agric. Res.* **6**(14) : 3252-3258

Bagali, A.N., Patil, H.B., Chimmad, V. P., Patil, P.L. and Patil, R.V. (2012). Effect of inorganics and organics on growth and yield of onion (*Allium cepa* L.) *Karnataka J. Agric. Sci.* **25** (1): 112-115

Balemi, T., Pal, N. and Saxena, A.K. (2007). Response of onion (*Allium cepa* L.) to combined application of biological and chemical nitrogenous fertilizers. *Acta agriculturae Slovenica*, 89 – 1.

Devi, A. K. B. and Limi, A. (2005). Effect of fertilizers and biofertilizers on physiological growth parameters of multiplier onion (*Allium cepa* var aggregatum). *Indian. J. Agric. Sci.*, **75**(6): 352-354.

Ethel, N., Singh, V. B. and Harmandeep Singh (2011). fertilizing for sustainable onion production system. *Better crops.,* **95**(1) 7-9.

Hari, G.S., Kumar, A.K. and Reddy, A.V. (2009). Effect of organic manure in combination with N fertilizer on growth and yield of onion (*Allium cepa* L.) under irrigated condition of central telangana zone of Andra Pradesh. *Research on crops*. **10**(1): 103-104.

Mozumder, S.N., Moniruzzaman, M. and Halim, G.M.A. (2007). Effect of N, K and S on the Yield and Storability of Transplanted Onion (Allium cepa L.) in the Hilly Region. *Agric. Rural Dev.* **5**(1&2): 58-63.

Saxena, A.K., Singh, S., Shrivastav, A. and Gautam, P. (2008). Yield target approach under integrated nutrient management for assessing fertilizer requirement of onion in mollisol of Uttarakhand. *Indian. J. Hort*. **65** (3): 302-306.

Sharma, R. P., Naveen D. and Girish Chander (2009). Effect of vermicompost, farmyard manure and chemical fertilizers on yield, nutrient uptake and soil fertility in okra (*Abelmoschus esculentus*) -onion (*Allium cepa* L.) sequence in wet temperate zone of Himachal Pradesh. *J. Indian. Soc. Soil Sci.* **73** (3) :357-361.

Yadav, B.D., Khandelwal, R.B. and Sharma, Y.K. (2005). Use of biofertilizer in onion. *Indian. J. Hort*. **62**(2):168-170

Table 1 Effect of Integrated nutrient management on growth and yield of onion										
Treatments	**Plant Height (cm)**		**Length of Leaves (cm)**		**No. of Leaves**		**Leaf dry weight (gm)**	**Bulb Weight (gm)**	**Bulb Volume (cm^3)**	**Yield (t/ha)**
	40 DATP*	80 DATP	40 DATP	80 DATP	40 DATP	80 DATP				
T1	50.25	65.08	47.50	55.71	4.58	6.58	6.02	105.50	116.50	24.07
T2	56.65	71.14	53.70	62.65	6.10	7.78	6.73	114.25	121.50	29.05
T3	51.10	66.15	48.10	57.79	5.15	7.15	6.39	108.00	119.00	24.69
T4	54.80	69.91	51.80	61.55	5.58	7.50	6.40	112.50	120.50	28.49
T5	59.44	73.50	56.69	66.74	5.95	8.08	6.91	116.50	128.00	30.04
T6	58.50	71.94	55.50	66.44	5.78	7.83	6.75	114.00	125.00	29.22
T7	65.05	78.80	62.05	71.35	6.75	8.75	7.03	121.50	128.50	33.33
T8	61.60	75.00	58.60	68.10	6.08	8.20	6.95	116.75	126.50	30.25
T9	62.50	76.60	59.40	69.50	6.38	8.63	6.97	117.25	128.00	30.45
T10	54.25	67.06	51.35	61.25	5.38	7.38	6.44	111.25	121.00	26.34
T11	53.55	66.75	50.05	60.55	5.23	7.23	6.42	110.75	120.00	25.64
T12	54.45	69.45	51.85	61.45	5.58	7.38	6.44	112.00	121.00	26.46
S.Em.±	2.94	2.83	2.94	3.02	0.36	0.42	0.20	2.63	2.45	1.64
C.D. at 5 %	8.46	8.13	8.47	8.71	1.04	1.21	0.58	7.58	7.06	4.74
C.V. %	10.35	7.96	10.91	9.52	12.69	10.88	6.13	4.65	3.99	11.72

* Days after transplanting

Effect of different levels of NPK on seed yield of Onion cv. Akola Safed

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Abstract

A field experiments were conducted during the *rabi* season of 2015-16 and 2016-17 at Main Garden, Department of Horticulture, Dr. PDKV, Akola, to study the effect of different levels of NPK on seed yield of onion Cv. Akola Safed. The treatments consisted of factorial combinations of three levels of each nitrogen (0, 100, 150 kg ha^{-1}), phosphorus (0, 50, 75 kg ha^{-1}) and potassium (0, 50, 75 kg ha^{-1}) laid out in factorial randomized block design with three replications. Results of the two years experiment revealed that, number of primary and secondary umbels per plant, number of seeds per primary and secondary umbel, seed weight per plant and seed yield per hectare were found to be maximum with an application of 150 Kg N ha^{-1}, 75 Kg P_2O_5 ha^{-1} and 50 Kg K_2O ha^{-1}. However, an application of 150 Kg nitrogen (N_2), 75 Kg phosphorus (P_2) and 75 Kg potassium (K_2) per hectare produced maximum diameter of primary and secondary umbel.

Keywords: Onion, fertilizer levels of NPK, growth parameters, seed yield.

Introduction

Among all vegetable crops, onion *(Allium cepa* L.) is the important vegetable crop belong to Alliaceae family. It is a native of Asia and perhaps introduced from Palestine to India. It is important bulbous crop used widely both as condiments and vegetable. It is also popularly used both in mature and immature bulb stages as vegetable and its cultivation is expanding owing to great demand for domestic consumption as well as export as spice crop. India ranked first in area

of 1203 thousand hectares, second in production of 19402 thousand metric tonnes and productivity of 16.13 metric tonnes per hectares of onion in the world (Dhatt, 2017). Maharashtra stands first in total production of onion in the country. Onion is cultivated throughout the India, but the most important onion producing states in India are Maharashtra, Karnataka, Orissa, Uttar Pradesh, Gujrat, Andhra Pradesh and Tamilnadu.

Onion seed is very short lived and retains the viability only for a year. Considering importance of pure, true-to-type seed, it is essential to standardize technology of onion seed production. Quality and quantity of seed produced per unit area greatly varies with the variety, time of planting, spacing, size of mother bulbs, method of seed production and environmental conditions. Furthermore, in addition to this, plant nutrition play an important role in quality seed production and increase the seed yield of onion considerably. Therefore, taking into consideration of these basic facts, present investigation has been proposed to study the effect of different levels of NPK on seed yield of onion cv. Akola Safed.

Materials and methods

The research work was conducted at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *rabi* season of the years 2015-16 and 2016-17. The experiment was conducted in factorial randomized block design with three replications and twenty-seven treatment combinations. The treatments consisted of factorial combinations of three levels of nitrogen (0, 100, 150 kg ha^{-1}), phosphorus (0, 50, 75 kg ha^{-1}) and potassium (0, 50, 75 kg ha^{-1}). The half dose of nitrogen in the form of urea and full dose of phosphorus and potassium (Single super phosphate and Muraite of potash, respectively) were applied at the time of planting. Remaining half dose of nitrogen is applied 30 DAP. The bulbs of 4-6 cm diameter and having 60-80 g weight were planted along one side of the ridge at a spacing of 60 cm X 30 cm. All the required cultural practices such as irrigation, weeding, etc. were given uniformly and

performed as necessary. About 10 percent of the heads were exposed black seed, harvesting was done by cutting or snapping of seed heads (umbels) with a quick turn of the hand, leaving a short piece of stem attached. The data obtained on various parameters was statistically analyzed as per the methods suggested by Panse and Sukhatme (1967)

Results and discussion

1. Number of primary and secondary umbels per plant

1.1 Effect of nitrogen levels

Significantly the maximum number of primary (6.07) and secondary umbels (3.51) per plant were found in treatment N_2. Whereas, the minimum number of primary and secondary umbels per plant were observed in treatment N_0 (3.31 and 1.56, respectively), during the year 2015-16.

In the year 2016-17, the treatment N_2 had produced significantly the maximum number of primary and secondary umbels per plant (6.43 and 3.89, respectively). However, significantly the minimum number of primary and secondary umbels per plant (3.54 and 1.64, respectively) were recorded in treatment N_0 (Table 1). Maximum number of umbels in onion plant grown with the treatment due to higher nitrogen uptake favored the vegetative growth, which in turns played vital role in synthesis of carbohydrates and simultaneously governed higher utilization of phosphorus, which is essential for production of maximum umbels per plant. Similar results have been discussed by the earlier workers El-Damarany *et al.* (2016) in onion.

1.2 Effect of phosphorus levels

During the year 2015-16, maximum primary and secondary umbels per plant (5.40 and 2.94, respectively) were noted in treatment P_2. Whereas, the treatment P_0 produced significantly the minimum primary and secondary umbels per plant (4.12 and 2.10, respectively).

In the year 2016-17, the treatment P_2 had produced significantly the maximum primary and secondary umbels per plant (5.72 and 3.14, respectively). However, significantly the minimum (4.61) primary and

(2.38) secondary umbels per plant were recorded in treatment P_0 (Table 1). Production of maximum number of primary and secondary umbels per plant would be due to the fact that, an adequate supply of phosphorus during plant growth is responsible for the enhanced growth of reproductive parts of the plant like emergence of umbels in onion. The results obtained in the present investigation are in close agreement with the findings of Ahmed and Abdalla (1984) and Sedera (1999) in onion.

1.3 Effect of potassium levels

During the year 2015-16 and 2016-17, the treatment K_1 was recorded maximum primary (5.19 and 5.64, respectively) and secondary (2.89 and 3.07, respectively) umbels per plant. Whereas, minimum primary (4.29 and 4.38, respectively) and secondary (2.15 and 2.41, respectively) umbels per plant in the treatment K_0 (Table 1). This could happen in the bulb crop like onion, due to the fact that, an application of optimum dose of potassium might be responsible for increase in vigour and disease resistance to plant, which might help to increase number of primary umbels per plant. The results of the present investigation are supported by the findings of Khewle (2009) and El-Damarany *et al*. (2016) in onion.

2. Diameter of primary and secondary umbels (cm)

2.1 Effect of nitrogen levels

Significantly the maximum diameter of primary (6.81 cm) and secondary (5.53 cm) umbels were found in treatment N_2. Whereas, the minimum diameter of primary and secondary umbels were observed in treatment N_0 (6.31 cm and 5.06 cm, respectively), during the year 2015-16.

In the year 2016-17, the treatment N_2 had produced significantly the maximum diameter of primary and secondary umbels (7.00 cm and 5.68 cm, respectively). However, significantly the minimum diameter of primary and secondary umbels were recorded (6.46 cm and 5.18 cm, respectively) in treatment N_0 (Table 1). The results obtained in the present investigation are in close agreement with the finding of El-Damarany *et al*. (2016) in onion.

2.2 Effect of phosphorus levels

In the year 2015-16, the treatment P_2 recorded significantly the maximum diameter of primary and secondary umbels (6.73 cm and 5.45 cm, respectively). However, the treatment P_0 recorded significantly the minimum diameter of primary and secondary umbels (6.42 cm and 5.18 cm, respectively). During the year 2016-17, the treatment P_2 recorded significantly the maximum diameter of primary and secondary umbels (6.89 cm and 5.57 cm, respectively). Whereas, the treatment P_0 recorded minimum number of primary and secondary umbels per plant (6.55 cm and 5.29 cm, respectively) (Table 1). The results obtained in the present investigation are in close agreement with the findings of Sedera (1999) in onion.

2.3 Effect of potassium levels

During the years 2015-16 and 2016-17, the treatment K_2 was produced the onion plants with significantly the maximum diameter of primary umbels (7.00 cm and 7.16 cm, respectively) and secondary umbels (5.66 cm and 5.79 cm, respectively). However, the minimum diameter of primary umbels (5.96 and 6.09 cm, respectively) and secondary umbel (4.80 cm and 4.91 cm, respectively) were recorded in the treatment K_0 (Table 1). The earlier worker Khewle (2009) have also reported similar findings in onion.

3. Number of seeds per primary and secondary umbel

The pooled data in respect of seeds per primary umbel during the year 2015-16 and 2016-17 as influenced by nitrogen, phosphorus and potassium levels were presented in Table 2 (a).

3.1 Effect of nitrogen levels

The treatment N_2 recorded significantly the maximum number of seeds per primary and secondary umbel (713.17 and 526.80, respectively), whereas treatment N_0 recorded minimum number of seeds per primary and secondary umbel (511.88 and 361.77, respectively). The large number of seeds per primary and secondary umbels would probably due to large size of umbel. The application of nitrogen would might be responsible for vigorous plant growth and greater synthesis of carbohydrate in plant, which might be resulting in

higher flower and seed set and ultimately yields large number of seeds per umbels. The results of the present investigation are supported by the findings of Chavan (1975) and Khewle (2009) in onion.

3.2 Effect of phosphorus levels

The treatment P_2 recorded significantly the maximum number of seeds per primary and secondary umbel (651.27 and 476.07, respectively). However, significantly minimum number of seeds per primary and secondary umbels (583.66 and 421.04, respectively) were observed in treatment P_0. More number of seeds per umbel could be attributed by the fact that, due to application of phosphorus with highest level. The phosphorus is an integral component of DNA and RNA, that contain the genetic code of plant to produce proteins and other compounds essential for production procedure of seeds and which would ultimately converted into more seed yield. Similar results have been recorded by the earlier workers, Sedera (1999) and Ali *et al*. (2008) in onion.

3.3 Effect of potassium levels

The pooled results indicated that, the treatment K_1 recorded significantly the maximum number of seeds per primary and secondary umbel (652.93 and 477.44, respectively). On the other hand, treatment K_0 recorded significantly the minimum number of seeds per primary and secondary umbel (568.64 and 408.28, respectively). Application of optimum dose of potassium might help to produce large size of umbel, its early emergence and largest resource available for seed setting and development. Further, it play vital role in photosynthesis, translocation of photosynthates and activation of various enzymes in plant, which ultimately resulted in the production of large number of seeds per umbel. Similar results have been recorded by the earlier workers like Khewle (2009) and El-Damarany *et al*. (2016) in onion.

3.4 Interaction effects

3.4.1 Interaction effects between nitrogen and phosphorus

The pooled results in respect of seeds per primary and secondary umbel were presented in Table 2(b) and significantly

influenced due to the interaction effect of nitrogen and phosphorus levels. However, the treatment combination N_2P_2 produced maximum number of seeds per primary and secondary umbel (740.60 and 549.28, respectively). Whereas, minimum seeds per primary and secondary umbel (476.28 and 333.78, respectively) were recorded in the treatment combination N_0P_0. Increased root mass due to an application of nitrogen is mostly responsible for increased plant uptake of phosphorus. More availability of phosphorus might be responsible for early root growth and proliferation, which might resulted into desired nitrogen uptake. Hence, application of nitrogen and phosphorus in conjugation with each other, might resulted into higher number of seeds per umbel. Similar results have been recorded by the earlier workers like Ahmed and Abdalla (1984) in onion.

3.4.2 Interaction effects between nitrogen and potassium

Pooled data specified in Table 2 (c) revealed that, treatment combination N_2K_1 produced maximum seeds per primary and secondary umbel (728.98 and 539.75, respectively). Whereas, the minimum seeds per primary and secondary umbel (448.42 and 309.58, respectively) were recorded in the treatment combination N_0K_0. It is well known fact that, optimum application of potassium is responsible for higher activity of photosynthesis, thereby enhanced enzyme activity and translocation of carbohydrates, which ultimately increased nitrogen uptake assimilation in plant. Vigorous excessive vegetative growth some time influence occurrence of diseases and pests, which would be counteracted by application of optimum dose of potassium. Hence, combined efficient use of nitrogen and potassium might resulted into better plant growth and ultimately produced maximum number of seeds per umbel. The results obtained in the present investigation are in close agreement with the findings of Mishra (1994), Rahim *et al.* (1997) and El-Damarany *et al*. (2016) in onion.

3.4.3 Interaction effects between phosphorus and potassium

The pooled results in view to seeds per primary and secondary umbel were presented in Table 2(d). The treatment combination P_2K_2

produced maximum number of seeds per primary and secondary umbel (678.19 and 498.14, respectively). However, minimum seeds per primary and secondary umbel (513.88 and 364.58, respectively) were recorded in the treatment combination P_0K_0. In the crop like onion, phosphorus uptake and its full utilization in plant is governed by osmatic and water balance maintained by optimum potassium supply. Hence, combined use of phosphorus and potassium might be responsible for greater physiological activity of plant, which ultimately might be resulted into maximum seeds per umbel. These findings are in harmony with the results obtained by Majumder (2011) and Howlader *et al*. (2012) in onion.

3.4.4 Interaction effect between nitrogen, phosphorus and potassium

The pooled data (Table (e)) indicated that, significantly the maximum seeds per primary and secondary umbel (765.18 and 569.42, respectively) in onion were recorded in treatment combination $N_2P_2K_1$. Whereas, the treatment combination $N_0P_0K_0$ had recorded minimum seeds per primary and secondary umbel (438.62 and 305.08, respectively). Maximum seeds per umbel in onion were produced in this treatment combination attributed to the fact that, balanced fertilization with all the primary nutrients *viz*. nitrogen, phosphorus and potassium supplemented with optimum moisture conditions achieved through proper irrigation and good climatic conditions throughout the growth period might be resulted in better plant stand. It seems that, increased dose of nitrogen might accelerate the vegetative growth i.e. height, number of leaves. Further, increased dose of phosphorus might be responsible for more number of seeds per primary and secondary umbel in the present study. Potassium exerts a blanching role or toxicity thereof on the effect of both nitrogen and phosphorus towards dimensions of umbels and its content of seed in slightly reduced quantity. Further, the antagonistic effect of potassium was found to be considerable, when the soil calcium content was reported to be in the range of 8.1 to 8.5 % in present investigation (Jakobsen, 1993), will also equally responsible for reduced number of seeds per umbel to some extend in the crop

like onion. Similar results have been recorded by the earlier workers like Dingre *et al*. (2016) in onion.

4. Seed weight per plant (g) and seed yield per hectare (q)

4.1 Effect of nitrogen levels

The pooled data furnished in Table 2 (a) found that, significantly the maximum seed weight per plant and seed yield per hectare (27.85 g and 12.94 q, respectively) were obtained in treatment N_2. However, the treatment N_0 recorded significantly the minimum seed weight per plant and seed yield per hectare (21.04 g and 9.44 q, respectively). This might be due to the more number of graded seeds per primary and secondary umbel, which would have recorded maximum weight of the seeds per umbel and maximum seed weight per plot. Similar results have been recorded by the earlier workers Chavan (1975), Ahemed and Abdalla (1984) and Khewle (2009) in onion.

4.2 Effect of phosphorus levels

The pooled data indicated that, the treatment P_2 observed significantly the maximum seed weight per plant and seed yield per hectare (25.75 g and 12.25 q, respectively). Whereas, the treatment P_0 noticed significantly the minimum seed weight per plant and seed yield per hectare (23.51 g and 10.68 q, respectively) Table 2 (a). In bulbous crop like onion, the enhanced vigorous growth and development of reproductive parts of onion plant like umbel number and size, seed number and size might be achieved through higher application of phosphorus, which might be resulted into maximum seeds per umbel and thereby seed yield per plot. Similar results have been recorded by the earlier workers like Sedera (1999) and Ali *et al*. (2008) in onion.

4.3 Effect of potassium levels

The pooled data directed that, the treatment K_1 measured significantly the maximum seed weight per plant and seed yield per

hectare (25.82 g and 12.06 q, respectively). However, the treatment K_0 recorded significantly the minimum seed weight per plant and seed yield per hectare (22.92 g and 11.04 q, respectively) Table 2 (a). An application of optimum dose of potassium might help to produce large size of umbel, its early emergence and thereby produced large number of seeds per umbel and ultimately maximum seed yield per plot. The results of present investigation are in close agreement with the findings of Khewle (2009) and El-Damarany *et al*. (2016) in onion.

4.4 Interaction effects

4.4.1 Interaction effects between nitrogen and phosphorus

The pooled results in respect of seed weight per plant and seed yield per hectare were presented in Table 2(f). The treatment combination N_2P_2 produced maximum seed weight per plant and seed yield per hectare (28.75 g and 13.41 q, respectively). Whereas, minimum seed weight per plant and seed yield per hectare (19.85 g and 8.09 q, respectively) were recorded in the treatment combination N_0P_0. Production of higher seed yield per plot with higher level of nitrogen and phosphorus in the present investigation might be justified with the fact that, increased root mass due to application of nitrogen is largely responsible for increased plant uptake of phosphorus. At the same time higher availability of phosphorus might responsible for early root growth and proliferation, which might have resulted into desired nitrogen uptake. Hence, application of nitrogen and phosphorus in conjugation might resulted into maximum number of seeds per umbel, seed weight per plant and ultimately the seed yield per plot. The results of the present investigation are in harmony with findings of Ahmed and Abdalla (1984) in onion.

4.4.2 Interaction effects between nitrogen and potassium

The pooled results in respect of seed weight per plant and seed yield per plot were exhibited significant influence due to the interaction effect of nitrogen and potassium levels treatment and presented in Table 2(g). However, the treatment combination N_2K_1

produced maximum seed weight per plant and seed yield per hectare (28.41 g and 13.35 q, respectively). However, minimum seed weight per plant and seed yield per hectare (18.86 g and 8.53 q, respectively) were recorded in the treatment combination N_0K_0.This might be due to the fact that, optimum level of potassium application might increase nitrogen uptake with an assimilation in plant. Hence, combined efficient use of nitrogen and potassium might have resulted into better plant growth and ultimately maximum seed weight per plot. The results obtained in the present investigation are in close agreement with the findings of El-Damarany *et al*. (2016) in onion.

4.4.3 Interaction effects between phosphorus and potassium

The pooled results in respect of seed weight per plant were significantly influenced due to the interaction effect of phosphorus and potassium levels (Table 2(h). However, the treatment combination P_2K_1 produced maximum seed weight per plant and seed yield per hectare (26.64 g and 12.88 q, respectively). Whereas, minimum seed weight per plant and seed yield per hectare (21.14 g and 10.13 q, respectively) were recorded in the treatment combination P_0K_0. The maximum seed yield of onion with this treatment combination could be ascertained with phosphorus uptake and its full utilization in plant, which was governed by osmatic and water balance maintained by optimum potassium supply. Hence, there would be the possibility of combined use of phosphorus and potassium, which might be responsible for greater physiological activities of plant and thus resulted into maximum seed yield of onion. These findings are in harmony with the results of Majumder (2011) and Howlader *et al*. (2012) in onion.

4.4.4 Interaction effects between nitrogen, phosphorus and potassium

The pooled data presented in Table 2(i) revealed that, significantly the maximum seed weight per plant and seed yield per hectare (29.64 g and 14.12 q, respectively) in onion was recorded in treatment combination $N_2P_2K_1$. Whereas, the treatment combination

$N_0P_0K_0$ had recorded minimum seed weight per plant and seed yield per hectare (18.47 g and 7.18 q, respectively). These results are in line with the findings of earlier workers like Dingre *et al*. (2016) in onion.

Conclusion

The maximum seed yield of onion (14.12 q ha^{-1}) was produced by the combine application of nitrogen (150 kg ha^{-1}), phosphorus (75 kg ha^{-1}) and potassium (50 kg ha^{-1}) (i.e. $N_2P_2K_1$) as compared to rest of the treatment combination.

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Declaration

The information in this article contains agrochemicals like herbicides (pre and post emergent) in agriculture use but the author (s) will not be responsible for such issue like outdated chemicals, banning in future. Ministry of Agriculture and Farmers Welfare is publishing gazette time to time like 14th May, 2020. So under such banning situation and issue of outdated agrochemicals alternatives are to be used in agriculture as per government gazette.

Literature cited

Ali, M.K., M.N. Alam, M.S. Islam, M.K. Islam and M.A. Baree. 2008. Effect of cowdung at different level of phosphorus on growth, yield and quality seed production of onion. Res. J. Agri. and Bio. Sci. 4(1): 86–93.

Ahmed, I.H. and A.A. Abdalla. 1984. Nitrogen and phosphorus fertilization in relation to seed production in onion (*Allium cepa* L.). Acta Hort. 143: 119-125.

Chavan, D. O. 1975. Effect of various doses of nitrogen and phosphorus on seed production of onion var. N-3 in relation to different spacing Thesis Abst. Haryana Agril. Univ. Hissar-1. 62.

Dhatt, A. S. 2017. Development of technologies for increasing productivity and availability of onion. Doubling Farmers Income Through Hort. pp. 155-163

Dingre, S. K., D. D. Pawar, K. D. Kale and M. M. Kadam. 2016. Onion seed productivity, nutrient use, and quality response to drip npk fertigation in semi-arid India. J. Plant Nutri. pp. 1-34.

El-Damarany, A.M., K.A.A. El-Shaikh, H.A. Obiadalla-Ali and M.M. Abdel-Kader. 2016. Effect of nitrogen and potassium fertilization on seed production of onion (*Allium cepa* L.) improved giza 6 cultivar. American-Eurasian J. Agric. and Environ. Sci. 16 (7): 1296-1303.

Howladar, M. M., M. N. Yousuf, M. M. Kamal, M.R. Khatun and H. M. K. Bashar. 2012. Effect of phosphorus, potassium and boron on onion seed production. Inter. J. of Sustainable Agri. Tech. 8 (7) pp. 28-30.

Jakobsen, S. T. 1993. Interaction between plant nutrients: III. Antagonism between Potassium, Magnesium and Calcium. Acta Agri. Scandinavica, Section B – Soil and Plant Sci. 43 (1).

Khewle, Archana, P. 2009. Effect of various nitrogen and potassium levels on seed yield of onion and its storability. Ph.D. Thesis (Unpub.), Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.).

Majumder, B.S. 2011. Effect of phosphorus and potassium fertilizer on the bulb seed production of summer onion *(Allium cepa* L.). Ph.D. Thesis (Unpub.), Bangabandhu Sheikh Mujibur Rahman Agricultural Univ., Gazipur (Bangladesh).

Panse, V. G. and P. V. Sukhatme. 1967. Statistical methods for Agricultural workers. New Delhi, ICAR.

Sedera, F.A.A. 1999. Effect of phosphorus and sulphur fertilizers levels on onion seed yield. Annals of Agri. Sci. Moshtohor. 37 (4): 2735-2747.

Table 1. Effect of nitrogen, phosphorus and potassium levels on number of primary and secondary umbels per plant

Treatments	Primary umbels per plant		Secondary umbels per plant		Diameter of primary umbels (cm)		Diameter of secondary umbels (cm)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nitrogen (N)								
N_0 - 0 Kg ha^{-1}	3.31	3.54	1.56	1.64	6.31	6.46	5.06	5.18
N_1 - 100 Kg ha^{-1}	5.18	5.58	2.72	2.98	6.65	6.78	5.41	5.52
N_2 - 150 Kg ha^{-1}	6.07	6.43	3.51	3.89	6.81	7.00	5.53	5.68
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.13	0.13	0.20	0.14	0.03	0.03	0.01	0.01
CD at 5%	0.36	0.38	0.58	0.39	0.08	0.08	0.03	0.04
Phosphorus (P)								
P_0 - 0 Kg ha^{-1}	4.12	4.61	2.10	2.38	6.42	6.55	5.18	5.29
P_1 - 50 Kg ha^{-1}	5.04	5.21	2.75	2.98	6.62	6.80	5.38	5.52
P_2 - 75 Kg ha^{-1}	5.40	5.72	2.94	3.14	6.73	6.89	5.45	5.57
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.13	0.13	0.20	0.14	0.03	0.03	0.01	0.01
CD at 5%	0.36	0.38	0.58	0.39	0.08	0.08	0.03	0.04
Potassium (K)								
K_0 - 0 Kg ha^{-1}	4.29	4.38	2.15	2.41	5.96	6.09	4.80	4.91
K_1 - 50 Kg ha^{-1}	5.19	5.64	2.89	3.07	6.82	6.99	5.55	5.68
K_2 - 75 Kg ha^{-1}	5.07	5.52	2.75	3.03	7.00	7.16	5.66	5.79
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.13	0.13	0.20	0.14	0.03	0.03	0.01	0.01
CD at 5%	0.36	0.38	0.58	0.39	0.08	0.08	0.03	0.04
Interaction (N X P)								
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.22	0.23	0.35	0.24	0.05	0.05	0.02	0.03
CD at 5%	-	-	-	-	-	-	-	-
Interaction (N X K)								
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.22	0.23	0.35	0.24	0.05	0.05	0.02	0.03
CD at 5%	-	-	-	-	-	-	-	-
Interaction (P X K)								
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.22	0.23	0.35	0.24	0.05	0.05	0.02	0.03
CD at 5%	-	-	-	-	-	-	-	-
Interaction (N X P X K)								
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.38	0.40	0.61	0.42	0.09	0.08	0.04	0.04
CD at 5%	-	-	-	-	-	-	-	-

Table 2 (a). Effect of nitrogen, phosphorus and potassium levels on yield attributing character of onion

Treatments	Seeds per primary umbel			Seeds per secondary umbel			Seed weight per plant (g)			Seed yield per hectare (q)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Nitrogen (N)												
N_0 - 0 Kg ha^{-1}	494.35	529.41	511.88	351.67	371.86	361.77	20.84	21.24	21.04	9.06	9.82	9.44
N_1 - 100 Kg ha^{-1}	616.19	658.68	637.43	451.75	477.73	464.74	24.99	25.55	25.27	12.44	12.70	12.57
N_2 - 150 Kg ha^{-1}	690.31	739.02	713.17	512.51	541.08	526.80	27.47	28.22	27.85	12.76	13.13	12.94
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	2.29	2.63	2.43	2.17	2.16	2.14	0.08	0.09	0.07	0.02	0.05	0.03
CD at 5%	6.50	7.47	6.89	6.17	6.12	6.07	0.24	0.25	0.21	0.05	0.15	0.08
Phosphorus (P)												
P_0 - 0 Kg ha^{-1}	564.03	603.28	583.66	409.71	432.37	421.04	23.21	23.81	23.51	10.34	11.02	10.68
P_1 - 50 Kg ha^{-1}	607.09	648.02	627.56	443.38	469.01	456.19	24.65	25.15	24.90	11.86	12.20	12.03
P_2 - 75 Kg ha^{-1}	629.73	672.80	651.27	462.84	489.30	476.07	25.44	25.74	25.75	12.08	12.42	12.25
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	2.29	2.63	2.43	2.17	2.16	2.14	0.08	0.09	0.07	0.02	0.05	0.03
CD at 5%	6.50	7.47	6.89	6.17	6.12	6.07	0.24	0.25	0.21	0.05	0.15	0.08
Potassium (K)												
K_0 - 0 Kg ha^{-1}	549.90	587.38	568.64	397.21	419.34	408.28	22.70	23.14	22.92	10.76	11.31	11.04
K_1 - 50 Kg ha^{-1}	631.35	674.50	652.93	464.18	490.69	477.44	25.50	26.14	25.82	11.86	12.27	12.06
K_2 - 75 Kg ha^{-1}	619.60	662.23	640.91	454.54	480.65	467.59	25.10	25.74	25.42	11.65	12.06	11.86
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	2.29	2.63	2.43	2.17	2.16	2.14	0.08	0.09	0.07	0.02	0.05	0.03
CD at 5%	6.50	7.47	6.89	6.17	6.12	6.07	0.24	0.25	0.21	0.05	0.15	0.08
Interaction (N X P)												
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	3.97	4.56	4.21	3.77	3.73	3.70	0.15	0.16	0.12	0.03	0.09	0.05
CD at 5%	11.25	12.94	11.94	10.69	10.60	10.51	0.42	0.44	0.34	0.08	0.26	0.14
Interaction (N X K)												
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	3.97	4.56	4.21	3.77	3.73	3.70	0.15	0.16	0.12	0.03	0.09	0.05
CD at 5%	11.25	12.94	11.94	10.69	10.60	10.51	0.42	0.44	0.34	0.08	0.26	0.14
Interaction (P X K)												
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	3.97	4.56	4.21	3.77	3.73	3.70	0.15	0.16	0.12	0.03	0.09	0.05
CD at 5%	11.25	12.94	11.94	10.69	10.60	10.51	0.42	0.44	0.34	0.08	0.26	0.14
Interaction (N X P X K)												
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	6.87	7.90	7.28	6.52	6.52	6.41	0.25	0.27	0.21	0.05	0.16	0.09
CD at 5%	19.49	22.41	20.67	18.51	18.51	18.20	0.72	0.76	0.59	0.14	0.44	0.25

Table 2(b). Interaction effect between nitrogen and phosphorus levels on number of seeds per primary and secondary umbel

N x P	Seeds per primary umbel									Seeds per secondary umbel								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
P_0	459.89	572.84	659.37	492.67	613.44	703.73	476.28	593.14	681.55	325.77	416.21	487.14	341.78	440.68	514.64	333.78	428.44	500.89
P_1	496.74	630.14	694.40	530.55	673.23	740.29	513.65	651.68	717.35	351.09	463.18	515.87	372.80	489.65	544.58	361.94	476.42	530.22
P_2	526.42	645.60	717.16	565.00	689.36	764.04	545.71	667.48	740.60	378.15	475.86	534.53	401.01	502.87	564.03	389.58	489.36	549.28
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	3.97			4.56			4.21			3.77			3.73			3.70		
CD at 5%	11.25			12.94			11.94			10.69			10.60			10.51		

Table 2(c). Interaction effect between nitrogen and potassium levels on number of seeds per primary secondary umbel

N x K	Seeds per primary umbel									Seeds per secondary umbel								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
K_0	434.33	553.06	662.32	462.52	592.80	706.81	448.42	572.93	684.57	302.08	400.00	489.56	317.08	423.78	517.16	309.58	411.89	503.36
K_1	509.04	643.97	705.78	546.86	687.67	752.17	527.95	665.82	728.98	363.90	474.52	525.20	386.16	501.48	554.30	375.03	488.00	539.75
K_2	539.69	651.54	702.83	578.85	695.56	749.09	559.27	673.55	725.96	389.03	480.72	522.77	412.36	507.94	551.78	400.69	494.33	537.28
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	3.97			4.56			4.21			3.77			3.73			3.70		
CD at 5%	11.25			12.94			11.94			10.69			10.60			10.51		

Table 2(d). Interaction effect between phosphorus and potassium levels on number of seeds per primary and secondary umbel

P x K	Seeds per primary umbel									Seeds per secondary umbel								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2
K_0	496.69	574.21	578.81	531.07	611.39	619.67	513.88	592.80	599.24	355.94	414.60	421.10	373.23	439.01	445.79	364.58	426.81	433.44
K_1	592.12	612.39	654.29	633.55	654.71	698.44	612.83	633.55	676.36	432.01	448.63	482.98	457.16	474.48	510.30	444.58	461.56	496.64
K_2	603.30	634.68	656.08	645.22	677.97	700.31	624.26	656.33	678.19	441.17	466.91	484.45	466.71	493.54	511.83	453.94	480.22	498.14
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	3.97			4.56			4.21			3.77			3.73			3.70		
CD at 5%	11.25			12.94			11.94			10.69			10.60			10.51		

Table 2(e). Interaction effect between nitrogen, phosphorus and potassium levels on number of seeds per primary and secondary umbel

N x P x K	Seeds per primary umbel									Seeds per secondary umbel								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
P_0K_0	425.87	446.50	617.69	451.37	481.60	660.25	438.62	464.05	638.97	302.20	312.63	452.98	307.95	332.70	479.02	305.08	322.67	466.00
P_0K_1	468.49	630.93	676.92	504.55	674.06	722.05	486.52	652.50	699.48	330.66	463.83	501.53	351.51	490.33	529.64	341.08	477.08	515.58
P_0K_2	485.32	641.08	683.49	522.10	684.66	728.90	503.71	662.87	706.20	344.45	472.16	506.92	365.88	499.01	535.25	355.17	485.58	521.08
P_1K_0	432.51	605.75	684.38	456.56	647.78	729.84	444.54	626.77	707.11	292.96	443.19	507.65	312.20	468.81	536.02	302.58	456.00	521.83
P_1K_1	496.56	641.38	699.21	533.84	684.97	745.31	515.20	663.18	722.26	353.67	472.40	519.81	375.49	499.27	548.69	364.58	485.83	534.25
P_1K_2	561.16	643.28	699.61	601.25	686.94	745.73	581.20	665.11	722.67	406.63	473.95	520.14	430.70	500.88	549.03	418.67	487.42	534.58
P_2K_0	444.61	606.94	684.88	479.62	649.03	730.36	462.12	627.99	707.62	311.08	444.17	508.06	331.09	469.83	536.44	321.08	457.00	522.25
P_2K_1	562.06	659.60	741.21	602.19	703.97	789.15	582.12	681.79	765.18	407.36	487.33	554.25	431.47	514.83	584.59	419.42	501.08	569.42
P_2K_2	572.61	670.25	725.39	613.20	715.09	772.63	592.90	692.67	749.01	416.01	496.07	541.27	440.49	523.93	571.06	428.25	510.00	556.17
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	6.87			7.90			7.28			6.52			6.47			6.41		
CD at 5%	19.49			22.41			20.67			18.51			18.36			18.20		

Table 2(f). Interaction effect between nitrogen and phosphorus levels on seed weight per plant (g) and seed yield per hectare (q)

N x P	Seed weight per plant (g)									Seed yield per hectare (q)								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
P_0	19.66	23.54	26.44	20.05	24.07	27.32	19.85	23.80	26.88	7.31	11.70	12.00	8.87	11.86	12.34	8.09	11.78	12.17
P_1	20.88	25.46	27.61	21.27	25.96	28.22	21.08	25.71	27.92	9.66	12.84	13.07	10.00	13.15	13.45	9.83	13.00	13.26
P_2	21.98	25.97	28.37	22.42	26.64	29.13	22.20	26.31	28.75	10.22	12.80	13.22	10.58	13.09	13.60	10.40	12.94	13.41
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	0.15			0.16			0.12			0.03			0.09			0.05		
CD at 5%	0.42			0.44			0.34			0.08			0.26			0.14		

Table 2(g). Interaction effect between nitrogen and potassium levels on seed weight per plant (g) and seed yield per hectare (q)

N x K	Seed weight per plant (g)									Seed yield per hectare (q)								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
K_0	18.69	22.88	26.53	19.02	23.30	27.11	18.86	23.09	26.82	7.99	11.93	12.36	9.07	12.19	12.69	8.53	12.06	12.52
K_1	21.40	25.92	27.99	21.86	26.54	28.83	21.63	26.23	28.41	9.55	12.86	13.15	10.12	13.16	13.54	9.83	13.01	13.35
K_2	22.43	26.17	27.89	22.85	26.83	28.74	22.64	26.50	28.31	9.65	12.54	12.77	10.28	12.75	13.16	9.96	12.64	12.96
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	0.15			0.16			0.12			0.03			0.09			0.05		
CD at 5%	0.42			0.44			0.34			0.08			0.26			0.14		

Table 2(h). Interaction effect between phosphorus and potassium levels on seed weight per plant (g) and seed yield per hectare (q)

P x K	Seed weight per plant (g)									Seed yield per hectare (q)								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2
K_0	20.89	23.47	23.74	21.39	23.80	24.24	21.14	23.64	23.99	9.71	11.36	11.22	10.55	11.75	11.64	10.13	11.55	11.43
K_1	24.18	24.86	26.33	24.82	25.41	27.00	24.50	25.14	26.64	10.62	12.23	12.72	11.21	12.57	13.04	10.92	12.40	12.88
K_2	24.56	25.61	26.27	25.22	26.24	26.96	24.89	25.92	26.63	10.67	11.98	12.30	11.32	12.28	12.59	10.99	12.13	12.44
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	0.15			0.16			0.12			0.03			0.09			0.05		
CD at 5%	0.42			0.44			0.34			0.08			0.26			0.14		

Table 2(i). Interaction effect between nitrogen, phosphorus and potassium levels on seed weight per plant (g) and seed yield per hectare (q)

N x P x K	Seed weight per plant (g)									Seed yield per hectare (q)								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
P_0K_0	18.34	19.31	25.04	18.59	19.84	25.74	18.47	19.57	25.39	6.20	11.21	11.73	8.16	11.43	12.05	7.18	11.32	11.89
P_0K_1	20.04	25.48	27.02	20.41	25.99	28.06	20.23	25.74	27.54	7.81	12.14	11.92	9.01	12.38	12.26	8.41	12.26	12.09
P_0K_2	20.61	25.82	27.24	21.13	26.37	28.16	20.87	26.10	27.70	7.93	11.75	12.33	9.45	11.79	12.71	8.69	11.77	12.52
P_1K_0	18.50	24.64	27.27	18.91	24.76	27.73	18.71	24.70	27.50	9.18	12.30	12.59	9.72	12.58	12.95	9.45	12.44	12.77
P_1K_1	20.98	25.83	27.77	21.48	26.42	28.33	21.23	26.13	28.05	9.81	13.23	13.64	10.06	13.62	14.02	9.94	13.42	13.83
P_1K_2	23.15	25.90	27.78	23.43	26.69	28.60	23.29	26.29	28.19	9.99	12.99	12.97	10.23	13.26	13.36	10.11	13.12	13.17
P_2K_0	19.24	24.68	27.29	19.56	25.30	27.84	19.40	24.99	27.57	8.59	12.30	12.76	9.32	12.56	13.06	8.95	12.43	12.91
P_2K_1	23.18	26.44	29.18	23.69	27.20	30.11	23.43	26.82	29.64	11.04	13.22	13.89	11.28	13.49	14.34	11.16	13.36	14.12
P_2K_2	23.53	26.80	28.65	24.00	27.42	29.45	23.76	27.11	29.05	11.02	12.87	13.00	11.16	13.21	13.41	11.09	13.04	13.20
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	0.25			0.27			0.21			0.05			0.16			0.09		
CD at 5%	0.72			0.76			0.59			0.14			0.45			0.25		

Yield and quality parameters of onion as influenced by dates and methods of sowing in North Gujarat Agro climatic condition

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ABSTARCT

A field experiment was conducted during *kharif* season of 2003-2004 on loamy sand soil of Sardarkrushinagar to study the response of direct seeded and transplanted onion (*Allium cepa* L.) to dates of sowing commenced from 18th August, 28th August, 7th September and 17th September. Early sowing on 18th August surpassed the later dates of sowing and recording maximum values of diameter of bulb, weight of bulb per plant, bulb yield (qha^{-1}), TSS(%), Bulb grades (A, B and C), dry matter (%), Dry matter yield (qha^{-1}). Early sowing on 18th August produced significantly highest bulb yield of 303.3 qha^{-1} followed by second dates of sowing (28th August) with 290.3 qha^{-1}. Maximum net realization of ` 90977 ha$^{-1}$ was obtained from early sowing on 18th August where as the lowest net realization of ` 41715 ha^{-1} from the last date of sowing *i.e.* 17th September. Among the methods of sowing transplanting of seedlings was found better than direct seeding, recording higher value of diameter of bulb, weight of bulb, bulb yield, Bulb grades (A, B and C), TSS, dry matter per cent and Dry matter yield. Transplanting of seedlings realized the additional net profit of ` 21091 ha^{-1} over direct seeding.

Keywords: Dates and methods of sowing, TSS, Dry matter (%), Dry matter yield, Gross and net realization.

INTRODUCTION

Onion (*Allium cepa* L.) is an important spice crop often grown outdoors in all climates as an annual crop because of its adaptability to varying weather conditions. It is an underground vegetable which varies in size, colour, firmness and strength of flavour. Onion is often called “poor man’s orange” because it is a good source of vitamins, particularly Vitamin A and C. It is also a rich source of minerals such as iron, thiamine, niacin and manganese contents. Area under this crop is increasing due to its year round demand in the market and comparatively high price. Initiation of onion cultivation in *kharif* to catch early market has led to advocate the farmers for proper time of sowing especially in North Gujarat.

The choice of planting time is crucial, since each cultivar has its own degree of susceptibility to bolting, whose intensity also depends on seasonal time when the conditions for induction occur. Planting time also affects the mean weight and grade of bulbs as well as marketable yield: the values of these parameters gradually decrease when the planting is delayed from mid-August to late-September, as a consequence of crop length reduction which shortens the time available for synthesis and storage of

metabolites into the bulbs. Currently, onion is one of the most important crops grown in the world (Kumar *et. al.* 2007), with total cultivated surface of about 4.4 million ha and 85.8 Mt production in 2013. Asia produces 66.8% of the world onion, China being the major producer with 22.3 Mt, followed by India with 19.3 Mt. Therefore, the main objective of this study is to investigate the optimal sowing/transplanting date and method for vegetative growth, yield and quality of Agri-found dark Red onion cultivar in *kharif* season.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *kharif* 2003-04. Eight treatment combinations consisting of four dates of sowing *viz.*, (18^{th} August, 28^{th} August, 7^{th} September and 17^{th} September) and two methods of sowing (Direct seeding and transplanting) were tried in factorial randomized block design with four replications.

The soil was loamy sand in texture, having pH 7.6; and was low in organic carbon (0.19%) and available nitrogen (168.30 kg ha^{-1}), while medium in available phosphorus (49.35 kg ha^{-1}) and potash (271.49 kg ha^{-1}). The seeds of onion variety Agri-found dark red were sown directly on 18^{th} August, 28^{th} August, 7^{th} September and 17^{th} September 2003 in respective beds, keeping the seed rate 10 kg ha^{-1}. For transplanting method, the seed were sown on 18^{th} August, 28^{th} August, 7^{th} September and 17^{th} September 2003, respectively to raise the required number of seedlings for transplanting. After 40 days, when the seedlings become ready, those were used for transplanting on 27^{th} September, 7^{th} October, 17^{th} October and 27^{th} October 2003. The entire quantity of phosphorus (50 kg P ha^{-1}) and potash (50 kg K ha^{-1}) was applied as basal dose at the time of sowing/transplanting in form of diammonium phosphate and muriate of potash, respectively whereas Nitrogen (100 kg N ha^{-1}) was top-dressed in three equal splits at 25 DAS/DATP, 45 DAS/DATP and 60 DAS/DATP. Growth, yield attributes and yield were recorded at harvest. The maturity days were calculated from the dates of sowing/transplanting of seedling to maturity date.

RESULT AND DISCUSSION

Effect of dates and methods of sowing on yield and yield attributes of onion

Maximum diameter of bulb was observed under first date of sowing D_1 (18^{th} August) and decreased with subsequent dates of sowing (Table 1). Same trend was observed in case of weight of bulb per plant. The magnitude of increase in weight of bulb per plant under D_1 (18^{th} August) was to the tune of 8.92, 13.77 and 19.42 per cent over D_2 (28^{th} August), D_3 (7^{th} September) and D_4 (17^{th} September), respectively. Bhamburkar *et al.* (1993) also reported that significant increase in bulb size and weight under earlier planting and decreased with successive delay in sowing.

Sowing date (18^{th} August) produced the highest bulb yield (Table 1) of onion 303.3 qha^{-1}. The magnitude of increase in bulb yield of onion with sowing date D_1 (18^{th} August) was 20.64 per cent, over

sowing date D_4 (17^{th} September). Prevalence of favourable weather conditions at sowing time and during growth period might have helped to increasing yield attributes in early sown crop and ultimately higher bulb yield of onion. Pandey and Tripathi (1992) found that highest yield was obtained with earlier (1^{st} July) sowing as compared to later sowing dates.

Transplanting recorded significantly higher diameter of bulb as well as weight of bulb per plant over direct seeding (Table 1). This might be due to maintenance of optimum plant stand and spacing under transplanting method. Sukhdia *et al.* (2002) reported the maintenance of optimum plant stand and spacing under transplanting helped for more vegetative growth and bulb development and ultimately an increasing in diameter of bulb.

Transplanting registered higher bulb yield of onion (288.4 q ha^{-1}) over direct seedling in accounted 7.04 per cent (Table 1). The availability of optimum plant geometry might have helped to improve yield, yield attributes under transplanting method and also the increasing bulb yield. Khokhar *et al*. (1990), Movalia (1996) and Sukhadia *et al.* (2002) also observed that transplanting method gave higher bulb yield as compared to direct seeing method.

Effect of dates and methods of sowing on quality parameters

Total Soluble solids (Per cent)

The data presented in Table 2 revealed that the total soluble solids per cent were not significantly influenced by dates of sowing and methods of sowing (Table 2).

Grades of Onion bulb (q ha^{-1})

A grade onion bulb yield (> 5.5 cm diameter)

Among different dates D_1 (18^{th} August), D_2 (28^{th} August) and D_3 (7^{th} September) remained at par in terms of production of A grade bulbs. The last date of sowing D_4 (27^{th} September) produced significantly the lowest yield of A grade bulbs. Significantly higher yield of A grade bulbs was found under treatment S_2 (transplanting) than S_1 (direct seeding) (Table 2).

B grade onion bulb yield (4.5 cm to 5.5 cm diameter)

Among different dates D_1 (18^{th} August) recorded significantly highest B grade bulbs and the last date of sowing D_4 (27^{th} September) produced significantly the lowest yield of B grade bulbs. Significantly higher yield of B grade bulbs was found under treatment S_2 (transplanting) than S_1 (direct seeding) (Table 2).

C grade onion bulb yield (<4.5 cm diameter)

Among different dates D_1 (18^{th} August) recorded significantly highest C grade bulbs and the remaining at par with all date of sowing. Significantly higher yield of C grade bulbs was found under treatment S_1 (direct seeding) than S_2 (transplanting) (Table 2).

Dry matter per cent and dry matter yield (q ha^{-1})

Significantly the highest dry matter per cent (15.9) and dry matter yield (48.4 qha^{-1}) was recorded with treatment D_1 (18th August) than rest of the dates of sowing (Table 2). Significantly the lowest dry matter per cent (13.2) and dry matter yield of (31.7 q ha^{-1}) was produced by treatment D_4 (27th September). Significantly higher dry matter yield was recorded with treatment S_2 (transplanting) as compared to S_1 (direct seeding). Treatment S_2 (transplanting) produced 13.4 per cent higher dry matter yield than S_1 (direct seeding).

Economics

The maximum net realization (Table 3) of ` 90977 ha$^{-1}$ realizes when crop was sown on 18$^{th}$ August where as the lowest net realization of ` 41715 ha^{-1} from the last date of sowing *i.e.* 17th September. Early sowing (18th August) realized the additional net profit of ` 49262 ha$^{-1}$ over late sowing (27$^{th}$ September). Maximum net realization (Table 3) of ` 78,123 ha^{-1} accrued from transplanting as compared to direct seeding (`57122 ha$^{-1}$). Transplanting of seedlings realized the additional net profit of ` 21091 ha^{-1} over direct seeding.

REFERENCES

Bhamburkar AS, Deshmukh CM, Deshmukh PP and Kulwal LV (1993). Effect of different dates of sowing/planting on growth and yield of some varieties of onion. *P.K.V. Research Journal*.**17** (2):119-122.

Khokhar KM, Mahmood T, Husaain SI and Qureshi KM (1990). Effect of different sowing dates, direct seeding and transplanting of seedlings on maturation, bulb weight and yield in onion cultivation. (1990). *Indian Journal of Agricultural Sciences*. **60**(10):668-671.

Kumar S, Imtiyaz M, Kumar A, Singh R (2007). Response of onion (*Allium cepa* L.) to different levels of irrigation water. *Agricultural Water Management*. **89**: 161–166.

Movalia A.G. (1996). Comparative performance of direct seeded and transplanted onion (*Allium cepa* L.) under varying dates of sowing and nitrogen levels. M.Sc. (Agri) Thesis, Submitted to Gujarat Agricultural University, Sardarkrushinagar.

Pandey VB and Tripathi SP (1992). Effect of time of sowing on yield and quality of small onion. *A.A.D.F. News letter.* **12**(3):1-2.

Sukhdia NM, Ramani BB and Dudhatra MG (2002). Response of rainy season onion (*Allium cepa* L.) to sowing methods and weed management practices. *Indian Journal of Agrono*my. **47** (2):278-283.

Table 1: Effect of dates and methods of sowing on yield attributes and yield

Treatment	Diameter of bulb (cm)	Wt. of bulb/plant (g)	Bulb yield (qha^{-1})
Dates of sowing			
D_1: 18th August	5.78	76.2	303.3
D_2: 28th August	5.37	69.4	290.3
D_3: 7th September	4.99	65.7	278.7
D_4: 17th September	4.45	61.4	240.6
S. Em. ±	0.15	2.2	3.6
C.D. at 5 %	0.44	6.3	10.4
Methods of sowing			
S_1: Direct seeding	4.65	57.5	268.1
S_2: Transplanting	5.64	78.6	288.4
S. Em. ±	0.11	1.5	2.5
C.D. at 5 %	0.31	4.5	7.3
C.V. %	8.07	9.0	3.6
Interaction			
D × S	NS	NS	NS

Table 2: Effect of dates and methods of sowing on quality parameters

Treatment	Total soluble solids (%)	Yield of bulb grade			Dry matter (%)	Dry matter yield (qha^{-1})
		Grade A (>5.5 cm)	Grade B (4.5-5.5 cm)	Grade C (<4.5 cm)		
Dates of sowing						
D_1: 18th August	15.2	83.9	192.1	34.0	15.9	48.4
D_2: 28th August	15.6	84.2	200.0	24.9	14.4	41.8
D_3: 7th September	14.2	72.5	180.6	26.5	13.3	37.2
D_4: 17th September	14.2	48.7	158.0	25.5	13.2	31.7
S. Em. ±	0.6	4.1	6.8	1.9	0.4	1.2

C.D. at 5 %	NS	12.1	19.8	5.0	1.0	3.6
Methods of sowing						
S_1: Direct seeding	15.0	64.9	174.2	32.6	13.9	37.2
S_2: Transplanting	14.7	79.9	191.0	22.8	14.5	42.2
S. Em. ±	0.4	2.9	4.8	1.2	0.3	0.9
C.D. at 5 %	NS	8.5	14.4	3.5	NS	2.6
C.V. %	12.0	16.1	10.5	17.2	6.9	8.7
Interaction						
D × S	NS	NS	NS	NS	NS	NS

Table 3: Effect of dates and methods of sowing on Economics

Treatment	Bulb yield (qha^{-1})	Gross realization (` ha^{-1})	Total cost of cultivation (` ha^{-1})	Net realization (` ha^{-1})	B:C ratio
Dates of sowing					
D_1: 18th August	303.34	121336	30059	90977	1:4.0
D_2: 28th August	290.29	116116	30059	86057	1:3.9
D_3: 7th September	278.69	83607	30459	53148	1:2.8
D_4: 17th September	240.58	72174	30459	41715	1:2.4
Methods of sowing					
S_1: Direct seeding	268.40	80490	23368	57122	1:3.4
S_2: Transplanting	288.40	115360	37147	78213	1:3.1
Note: The selling price of onion bulbs (D_1: ` 400 $q^{-1}$, $D_2$: ` 400 q^{-1} , D_3: ` 300 $q^{-1}$ $D_4$: ` 300 q^{-1} , S_1: ` 300 $q^{-1}$ $S_2$: ` 400 q^{-1} ,					

Nutrient Management in Onion (*Allium cepa* L.)

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Abstract

Onion cultivation differs from season to season and variety to variety. During *kharif* season (June-July-August) the varieties *viz*., Baswant-780, Agrifound Dark Red, N-53, Phule Samarth etc will be grown while during late *kharif* (Sept.-Oct.) Baswant-780, N-2-4-1, Phule Samarth etc. and *rabi/* summer (Nov.-Dec.) N-2-4-1, Agrifound Light Red, Pusa Red etc will be grown. The experiments utilizing various techniques were conducted in different onion growing seasons along with suitable cultivars at different research stations and State Agriculture Universities to study yield potential and net return (income). Nutrient management plays key and vital role for maximum bulb yield in onion. Application of bio-fertilizers in combination with inorganic fertilizers and organic manures offers a great opportunity to increase nutrient uptake thereby increasing onion bulb yield. Wherein, full dose of phosphorus, potassium and the half dose of nitrogen are to be applied as basal doze and rest nitrogen 30 and 45 days after transplanting equally. Whereas, for *rabi* onion sulphur is to be mixed into soil 15 days before transplanting. Along with the recommended dose of fertilizers foliar spray of 0.5 to 1 per cent 19:19:19 (5-10 g/ l of water) at 15, 30 and

45 days after transplanting and 1 per cent 13:00:45 (multi key) at 60, 75 and 90 days after transplanting gave higher bulb yield from onion cv. Agrifound Light Red.

Keywords: Onion, varieties, seasons, fertilizer dose and INM.

Introduction

India is second largest producer of Horticultural crops like fruit and vegetables in the world. The production of Horticultural crops of India was 311.71 million tons from an area of 25.43 million hectare. Fruit production was 97.36 million tonnes from an area 6.5 million hectare wherein, vegetables production was 184.39 million tonnes from an area 10.26 million hectares (Anon, 2017-18). Among the various vegetables, onion plays key and vital role in export. India was exported 158899 thousand tonnes of onion in 2017-18 having value of Rs. 3088822 lakhs (Anon, 2018). In India, onion was grown on an area of 1.09 million hectare with production of 23.26 million tonnes and average productivity of 18.1 t/ ha. Maharashtra is major onion growing state in India and it was grown on an area of 508 thousand hectares with production 8854 thousand tons (Anon, 2017-18). Onion is a high value crop where its yield and quality are important economic considerations. The onion production depends on careful nutrient management and other management practices, insect pest and diseases and even climatic factors also influences on its yield. However, the onion cultivation differs from season to season and variety to variety. During *kharif* season (June-July-August) the varieties *viz*., Baswant-780, Agrifound Dark Red, N-53, Phule Samarth etc will be grown while during late *kharif* (Sept.-Oct.) Baswant-780, N-2-4-1, Phule Samarth etc. and *rabi/* summer (Nov.-Dec.) N-2-4-1, Agrifound Light Red, Pusa Red etc will be grown.

Onion is a highly nutrient responsive crop. A conventional method of nutrient management seems incapable for giving higher bulb yields over the long-term. Integrated nutrient management offers an effective strategy (Dhakad *et al*., 2019). A gradual shift from using purely organic sources to introducing some proportion of inorganic fertilization is gaining acceptance. This shift has formed the basis for Integrated Nutrient Managment, which could involve two nutrient sources: inorganic fertilizer and manures. Wherein, integrated nutrient management further prescribes that selected nutrient inputs be used judiciously to ensure optimum supply of all essential nutrients for sustained crop production. In this chapter effects of different nutrients and integrated nutrient management practices on onion yield and economics were discussed.

Effect of different nutrients on yield and economics of onion

Onion yield and economics of its cultivation depends upon the affordable techniques of nutrient management. The bulb yield can be increased by adopting integrated nutrient management in onion crop. However, onion bulb yield can differs season to season and variety to variety. Well decomposed organic manures at 25- 30 t, nitrogen 100 kg, phosphorus 50 kg and potassium 50 kg per hectare gave higher bulb yield (29.20 t/ ha) and B: C ratio (7.81) in *kharif* onion cv. Nashik Red (Sable *et al*., 2013 and Sable and

Sonpure, 2020). Full dose of organic manure, phosphorus, potassium and ½ nitrogen is to be applied as basal dose wherein, rest of nitrogen into two equal splits at 30 and 45 days after transplanting. Similarly, manures and fertilizers dose along with sulphur at 45 kg/ ha mixed into the soil at 15 days before transplanting gave maximum bulb yield (56.34 t/ ha) and B: C ratio (6.42) from *rabi* onion cv. N-2-4-1. Sulphur (application through gypsum) has synergistic effect along with other nutrients like nitrogen in increasing bulb yield (563.43 q/ ha) and B:C ratio (6.42) as reported by Bhalekar *et al*., 2018.

Effect of integrated nutrients management practices on yield and economics of onion

Along with the recommended dose of fertilizers foliar spray of 0.5 to 1 per cent 19:19:19 (5-10 g/ l of water) at 15, 30 and 45 days after transplanting (Fig 1) and 1 per cent 13:00:45 (multi key) at 60, 75 and 90 days after transplanting (Fig 2 & 3) gave higher bulb yield from onion cv. Agrifound Light Red (Sable and Sonpure, 2020 and Devi, 2016). Whereas, foliar spay of micronutrients like zinc sulphate, manganese sulphate each at 1 g/ l of water and ferrous sulphate at 2.5 g/ l of water along with recommended dose of fertilizers is to be sprayed to achieve higher onion bulb yield (Sable and Sonpure, 2020). Integrated nutrient management practice such as application of the bio-fertilizers like *Azospirillum* and Posphate Solubalizing Bacteria at 5 kg each along with 7.5 t farm yard manure, 2.5 t poultry manure (PM), 2.5 t vermi-compost is to be applied at the time of transplanting. Application of half nitrogen (55 kg/ ha), full dose of phosphorus (40 kg), potash (60 kg) and sulphur (40 kg) per hectare is found beneficial for higher N, P, K and S uptake by *rabi* onion cv. N-2-4-1 which reflects into higher bulb yields (50.38 t/ ha). Whereas, the rest half dose of nitrogen (55 kg/ ha) is to be applied 30 days after transplanting (Bhalekar, 2018). Harvesting of onion bulb can begin with its top naturally fall over and become brownish or yellowish. This is usually 90-120 days after transplanting and also depends on cultivars, soil types, climatic conditions etc. Best time to harvest *rabi* onion is one week after 50 per cent tops have fallen over. In *kharif* season since tops do not fall, soon after the colour of leaves changes to slightly yellow and tops start drying, red pigmentation on bulbs develop and also true shape and size develops and bulbs are harvested (Fig 4) . After uprooting of onion plants, bulbs are to be covered by its top and left in the field for curing up to 3-4 days. The neck with its leaf is to be cut leaving about 2-2.5 cm top above the bulb. If tops are cut too close, the neck does not close well and decay organisms have easy access to the bulb. Early harvesting results in sprouting of bulbs while, late harvesting results into formation of secondary roots during storage. In *kharif* season late harvesting results in doubles and bolting (Sable *et al*., 2020).

Fig.1 Foliar spray of one per cent 19:19:19 (NPK) at 15, 30 and 45 days after transplanting

Fig. 2 Foliar spray of 1 per cent 13:00:45 (NPK) at 60 and 75 days after transplanting

Fig. 3 Foliar spray of 1 per cent 13:00:45 (NPK) at 90 days after transplanting

Fig. 4 Harvesting stage of Onion cv. Agrifound Light Red

Conclusion:

Onion is daily consumable vegetable and grown all over the world. So, to increase its bulb yield and maximum net returns, judicious supply of nutrients at appropriate crop growth stage and adoption of integrated nutrient management techniques are essential.

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References

Anonymous (2019). *Krushidarshini*, Mahatma Phule Krishi Vidyapeeth, Rahuri (www.mpkv.ac.in)

Anonymous (2018). Horticultural statistics at a glance 2018.

Anonymous (2017-18). Area and production of Horticulture crops all India (final) (internet)

Bhalekar, M. N., Shinde, K. G., Rathod D. H. and Patil B.T. (2018). Impact of sources and levels of sulphur application on growth, yield and quality of onion (*Allium cepa* L.). *J. of Allium Res*. 1 (1): 71-77.

Dhakad, R., Chudasama, V.R., Jitendra V., Gosae, J., Dhaked M., (2019). Effect of INM in Onion (*Allium cepa* L.) with respect to growth and yield under North Gujarat Condition. *Int. J. Curr. Microbiol. App. Sci.* 8(4): 1618-1622

Devi N. D. (2016). Responds of vegetable crops to foliar feeding of water soluble fertilizer, *The Asian J of Hort.*, 11 (1): 242-251.

Sable, P. A. and Sushma, S.(2020). Nutrient, weed and pest and disease management in summer onion. *Shetakari magazine*, Feb., 2020. pp 41-42.

Sable P. A., Sushma S, and Chandaragi M. K. (2020). Nutrient, weed and pest and disease management in summer onion. *Shetakari magazine*, Feb., 2020. pp 41-42.

Sable P. A., Purane A. B. and Jadhav S. N. (2014). Spices crops of India (2nd edition book), *Jaya Publishing House*, Delhi. pp 136

Effect of plant bioregulators on growth, yield, biochemical and storage attributes of onion (*Allium cepa*)

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Abstract

The experiment was carried out with a view to study the response of plant bioregulators on growth parameters and plant growth analysis of onion at Regional Horticultural Research Station of Navsari Agricultural University, Navsari (Gujarat) during *Rabi* 2019. Among the treatments, GA_3 25 mg l^{-1} recorded highest number of leaves $plant^{-1}$ (9.42), bulb yield per net plot (19.97 kg), total bulb yield (47.55 t ha^{-1}), Chlorophyll content of leaves (2.32 mg $100g^{-1}$), phenols (61.77 mg 100 g^{-1}), proteins (1072.54 mg 100 g^{-1}) and the minimum loss of PLW was observed 4.0 % at 30 days after storage. The maximum dry matter content (21.36 %) was observed with the treatment combination of GA_3 25 mg l^{-1} + NAA 25 mg l^{-1}. Whereas, The maximum moisture content and bulb (83.98 %) was recorded with NAA 75 mg l^{-1}.

Key Words: Bioregulators, GA_3, NAA, Growth, Yield, Storage and Onion *etc*.

Introduction

Onion (*Allium cepa* L.) is an important and indispensable item in every kitchen as condiment cum vegetable in India. It is one of the important underground bulbous vegetable crops of Alliaceae family and is said to be native of Central Asia and Mediterranean region. Plant bioregulators called as magic chemicals are new generation agrochemicals, when added in small quantity, modify the natural growth regulatory systems right from seed germination to senescence in several vegetable crops and also regulate and modify various physiological processes within the plant and they help to increase the yield.

Materials and Methods

The field experiment was carried out at the vegetable research scheme, Regional Horticultural Research Station of the Navsari Agricultural University, Navsari, Gujarat, India during *Rabi* on cv. Gujarat Junagadh Red Onion 11 to investigate the response of plant bioregulators on onion. The experiment was conducted in Randomized Block Design (RBD) with three replications, which included 12 treatments

namely, T_1: GA_3 25 mg l^{-1}, T_2: GA_3 50 mg l^{-1}, T_3: GA_3 75 mg l^{-1}, T_4: NAA 25 mg l^{-1}, T_5: NAA 50 mg l^{-1}, T_6: NAA 75 mg l^{-1}, T_7: GA_3 25 mg l^{-1} + NAA 25 mg l^{-1}, T_8: GA_3 25 mg l^{-1} + NAA 50 mg l^{-1}, T_9: GA_3 25 mg l^{-1} + NAA 75 mg l^{-1}, T_{10}: GA_3 50 mg l^{-1} + NAA 50 mg l^{-1}, T_{11}: GA_3 75 mg l^{-1} + NAA 75 mg l^{-1} and T_{12}: Control. The foliar sprays were made at 30, 45 and 60 days after transplanting during morning hours to avoid the dehydration effect.

Results

At 90 DATP, the plant height was found non-significant. The application of GA_3 25 mg l^{-1} (T_1) recorded the maximum number of leaves $plant^{-1}$ (9.42) and was at par with the treatments T_{11} and T_8. The less number of leaves per plant was observed with the treatment control.

Application of GA_3 25 mg l^{-1} (T_1) recorded maximum bulb yield per net plot (19.97 kg) and it was superior over rest of the treatments followed by T_{10} (GA_3 50 mg l^{-1}+ NAA 50 mg l^{-1}). The minimum bulb yield per net plot (14.22 kg) was recorded with T_{11} (GA_3 75 mg l^{-1} + NAA 75 mg l^{-1}). Whereas, data showed that the plants treated with GA_3 25 mg l^{-1} (T_1) found maximum total bulb yield (47.55 t ha^{-1}) which was significantly superior over rest of the treatments followed by T_{10}. The lowest total bulb yield (33.85 t ha^{-1}) was recorded with T_{11} (GA_3 75 mg l^{-1} + NAA 75 mg l^{-1}).

The significantly maximum dry matter content of bulb (21.36 %) was observed with the treatment T_7 (GA_3 25 mg l^{-1} + NAA 25 mg l^{-1}). Whereas the lowest dry matter content was observed with the treatment T_6 NAA 75 mg l^{-1}. As well as, the maximum moisture content (83.98 %) was obtained with T_6 (NAA 75 mg l^{-1}) which was significantly at par with the treatments T_5, T_8, T_{11}, T1 and T_{10}. The minimum moisture content (78.81 %) was noted in control (T_{12}).

In case of biochemical parameters, maximum chlorophyll content (2.32 mg $100g^{-1}$) was observed with the treatment GA_3 25 mgl^{-1} superior over rest of the treatments. The minimum chlorophyll content (1.37 mg 100 g^{-1}) was recorded with the treatment NAA 25 mg l^{-1}. As well as results of TSS were found non-significant with the different treatments. The results of percent total phenols under different treatments showed significant. The maximum phenol content (61.77 mg) observed with the treatment T_1 (GA_3 25 mg l^{-1}) which was significantly at par with T_{12}. The minimum phenol content (51.53 mg) observed with the treatment T_3.Whereas, the maximum protein content (1072.54 mg) observed with T_1 (GA_3 25 mg l^{-1}) followed by the treatment T_{10} (GA_3 50 mg l^{-1} + NAA 50 mg l^{-1}). Whereas, GA_3 75 mg l^{-1} + NAA 75 mg l^{-1} (T_{11}) recorded minimum protein content (866.82 mg). The results of bulb pH were found non-significant.

In storage studies, the results showed significant at 30 days after storage and non-significant at 60 days after storage (DAS). At 30 DAS, the minimum PLW (4.00 %) was noted in T_1 (GA_3 25 mg l^{-1}) which was remained at par with the treatment T_{10}. Whereas, the maximum weight loss (7.17 %) was observed with

the treatment T_2 and T_4. As well as spoilage loss (%), Rotting (%) and sprouting (%) was not noticed during the storage.

Table 1: Effect of different plant bioregulators on growth, yield, biochemical and storage attributes of onion

	Plant height (cm) at 90 DATP	No. of leaves at 90 DATP	Yield/ net plot (kg)	Total bulb yield (t/ha)	Dry matter (%)	Moisture (%)	Chlorophyll (mg/100g) at 90 DATP	TSS (%)	Phenols (mg/100 g)	Proteins (mg/100 g)	Bulb pH	PLW at 30 DAS	PLW at 60 DAS
T_1: GA_3 25 mg l^{-1}	73.83	9.42	19.97	47.55	18.41	81.60	2.32	15.68	61.77	072.54	4.55	4.00	6.17
T_2: GA_3 50 mg l^{-1}	73.61	8.75	17.17	40.88	19.06	80.94	1.93	13.42	55.67	915.41	4.62	7.17	10.17
T_3: GA_3 75 mg l^{-1}	72.61	8.72	17.05	40.62	18.51	81.50	2.07	13.72	51.53	883.36	4.75	7.00	8.83
T_4: NAA 25 mg l^{-1}	71.65	8.57	16.97	40.40	19.86	79.08	1.37	14.85	54.77	868.89	4.59	7.17	10.00
T_5: NAA 50 mg l^{-1}	72.25	8.78	16.62	39.58	17.01	83.49	1.72	14.68	52.96	888.01	4.71	7.00	9.33
T_6: NAA 75 mg l^{-1}	71.52	8.72	16.42	39.08	16.35	83.98	2.02	14.99	53.11	909.20	4.76	6.33	8.17
T_7: GA_3 25 mg l^{-1} + NAA 25 mg l^{-1}	69.53	8.53	15.76	37.52	21.36	79.92	2.06	15.10	53.59	913.34	4.65	5.67	8.00
T_8: GA_3 25 mg l^{-1} + NAA 50 mg l^{-1}	73.67	9.13	15.29	36.41	17.47	82.69	2.04	14.81	55.27	870.96	4.59	5.50	8.17
T_9: GA_3 25 mg l^{-1} + NAA 75 mg l^{-1}	71.30	8.70	15.08	35.91	19.29	80.71	1.80	15.18	55.80	908.18	4.64	7.00	8.33
T_{10}: GA_3 50 mg l^{-1} + NAA 50 mg l^{-1}	73.20	8.82	17.49	41.64	18.42	81.59	1.96	14.58	59.43	983.13	4.65	5.83	8.50
T_{11}: GA_3 75 mg l^{-1} + NAA 75 mg l^{-1}	72.39	9.22	14.22	33.85	17.63	82.37	1.46	14.78	55.73	866.82	4.74	5.17	7.67
T_{12}: Control	70.10	8.47	15.61	37.17	20.97	78.81	1.41	14.37	60.55	886.46	4.57	6.67	9.50
Year Mean	72.14	8.82	16.47	39.22	18.69	81.39	1.85	14.68	55.85	913.86	4.65	6.21	8.57
S. Em. ±	1.67	0.18	0.62	1.49	0.81	0.86	0.03	0.43	0.67	17.77	0.07	0.47	0.81
C.D. at 5 %	NS	0.51	1.77	4.22	2.29	2.44	0.10	NS	1.91	50.38	NS	1.33	NS

Discussion

Effect of foliar spray of plant growth regulators on plant height (cm) at 90 DATP was found non-significant for pooled analysis. The highest plant height was obtained under the treatment of T_1 (GA_3 25 mg l^{-1}) might be due to increasing cell wall extensibility by GA_3. The bioregulators are efficiently involve in enhancing metabolic activity specially photosynthetic activity, efficient assimilation of photosynthates which results rapid cell division and enlargement in growing portion of the plant. Similar findings were reported for onion (Saleh and Abed, 1989; Shakhda and Gajipara, 1998; Sharma *et al.*, 1998; Bhople *et al.,* 1999; Shaikh *et al*., 2002; Tiwari *et al.,* 2003; Suseela *et al.,* 2005; Singh, 2006)

Significantly higher value for number of leaves plant^{-1} at 90 DATP was noticed with the treatment T_1 (GA_3 25 mg l^{-1}). The increase in number of leaves per plant is mainly due to enhanced cell elongation and cell division. It enhanced the photosynthesis, respiration and catalyse activities in plant, hence enhanced the number of leaves per plant. The increase in leaf number due to application of GA_3 was also reported earlier in onion (Singh *et al.,* 1983; Shishido and Saito, 1984; Salah *et al.,* 1989; Shakhda and Gajipara, 1998; Hye *et al.,* 2002, Shaikh *et al*., 2002; Subimal *et al.,* 2003; Tiwari *et al.,* 2003; Suseela *et al.,* 2005; Patel *et al*., 2010; Rashid, 2010; Kumar *et al.,* 2017).

The increase in bulb yield was mainly attributed due to increase in bulb weight per plant and bulb diameter. Increase in bulb yield with GA_3 application might be due to the fact that GA_3 initiate the physiological process and permeability of cell to produce more food for reserve. Growth regulators influenced plant of height, number of leaves which produces maximum number of scales per bulb thus increasing in the size of bulb and ultimately having maximum marketable bulb yield per hectare. It can be concluded that GA_3 was found most effective in enhancing the yield. Similar results observed by Nirmal *et al.* (1994), Singh *et al*. (1995) and Maurya and Lal (1987), Shakhda and Gajipara (1998), Anant and Maurya (2001), Hye *et al.* (2002), Tiwari *et al.* (2003), Das *et al*. (2006), Islam *et al.* (2007), Tyagi and Yadav (2007) in onion.

The results indicated that there was increase in chlorophyll content due to foliar application of gibberellic acid (GA_3) induces enhancement of ultra structural morphogenesis of plastids, which coupled with retention of chlorophyll, delay plant senescence (Ouzounidu and Ilias, 2005; Shah *et al.*, 2007; Ouzounidu *et al*., 2011). This increase undoubtedly might have helped to improve the photosynthetic efficiency. The increase in TSS may be accounted due to the hydrolysis of polysaccharides. Conversion of organic acids in to soluble sugars and enhanced solubilisation of insoluble starch and pectin present in the cell wall and middle lamella. The increase in TSS content due to growth regulators found from the results of several workers (Tiwari *et al*., 2003; and Patel *et al.,* 2010). The moisture content showed significant results with NAA. Similar results with Govind *et al.* (2015) in garlic.

Effect of various treatments showed significant difference in the physiological loss in weight during the storage of bulbs at 30 and 60 DAS. In first 30 days of storage, the weight loss was lowest in bulbs sprayed with GA_3 @ 25 ppm. At 60 DAS, the weight loss was highest in control whereas low rate of weight loss in bulbs treated with GA_3 @ 25 ppm. Shoemaker (1947) reported that thick neck bulbs are more prone to sprouting due to greater access of oxygen and moisture to central growing point which ultimately lead to loss in marketable quality of bulb.

Conclusion

From the foregoing discussion, It was concluded that the application of GA_3 25 mg l^{-1} on onion plants at 30, 45 and 60 days after transplanting showed highest yield per net plot, total bulb yield and as well as in quality parameters.

References

Anant B. and Maurya, V. N. (2001). Effect of GA_3 and foliar feeding of urea on bulb production of onion (*Allium cepa* L.). *Veg. Sci.,* **28** (1): 90-91.

Bhople S. R., Dod V. N., Bharad S. G., Gholap S. V. and Jadhao B. J. (1999). Seed production of onion as influenced by the application of growth regulators. *J. Soils Crops,* **9** (1): 78-79.

Das B. C., Maji S., Singha S., Dutta P. and Dhua R. S. (2006). Growth regulators in controlling fruit drop of rose apple (*Syzygium jambos* L. Aston) grown in West

Bengal. Proceedings of national symposium on production, utilization and export of underutilized fruits with commercial potentialities. 22-24 November, 2006. pp. 168-173.

Govind Maji S., Kumawa, R., Pal A., Kumar S. and Saha S. (2015). Improvement of growth, yield and quality of garlic (*Allium sativum* L.) cv. G-282 through a novel approach. *Bioscan.,* **10** (1) : 23-27.

Hye A. M., Shahidul Haque M. and Abdul Karim M. (2002). Influence of growth regulators and their time of application on yield of onion. *Pakistan J. Biol. Sci*., **5** (10): 1021-1023.

Islam M. S., Islam M. O., Alam M. N., Ali M. K. and Rahman M. A. (2007). Effect of growth regulator on growth, yield and yield components of onion. *Asian J. Pl. Sci.,* **6** (5): 849-853.

Kumar S., Maji S. and Kamal Ram M. (2017). Effect of plant bio-regulators on the growth, yield and physico - chemical characteristics of onion (*Allium cepa* L.). *Asian J. Hort*., **12** (1): 121-126.

Maurya C. P. and Lal, H. (1987). Effect of IAA, NAA and GA on growth and yield of onion (*Allium cepa* L.) and vetable chilli (*Capsicum annum* L.) *Prog. Hort*., **19** (3-4): 203-206.

Nirmal S. V., Deore B. P. and Patil R. C. (1994). Effect of growth substances on yield and yield contributing traits in onion. *J. Maharashtra Agric. Univ.,* **19** (1): 136-137.

Ouzounidou G., Giannakoula A., Asfi M. and Ilias I. (2011). Differential responses of onion and garlic against plant growth regulators. *Pakistan J. Bot.,* **43** (4): 2051-2057.

Ouzounidu G. and Ilias I. (2005). Hormone induced protection of sunflower photosynthetic apparatus against Cu toxicity. *Biologia Plantarum,* 49: 223-228.

Patel M. J., Patel H. C. and Chavda J. C. (2010). Influence of plant growth regulators and their application methods on yield and quality of onion (*Allium cepa* L.). *Asian J. Hort.,* **5** (2): 263-265.

Rashid M. H. A. (2010). Effect of sulphur and GA_3 on the growth and yield of onion. *Prog. Agric*., **21** (1 & 2): 57 – 63.

Salah M. M. S. and Abed D. J. (1989). Effect of gibberellic acid and naphthalene acetic acid on growth, yield and quality of onion. *Disrat.,* 16: 39-51.

Salah M. M. S. and Abed D. J. (1989). Effect of gibberellic acid and naphthalene acetic acid on growth, yield and quality of onion. *Disrat.,* 16: 39-51.

Shah S. H., Ahmad I. and Saimullah. (2007). Respones of Nigella sativa to foliar application of gibberellic acid and kinetin. *Biologia Plantarum,* 51: 563-566.

Shaikh A. M., Vyakaranahal B. S., Shekhargouda M. and Dharmatti P. R. (2002). Influence of bulb size and growth regulators on growth, seed yield and quality of onion cv. Nashik Red. *Seed Res.,* **30** (2): 223-229.

Shakhda V. P. and Gajipara N. N. (1998). A note on influence of IAA, IBA and GA_3 on growth and yield of onion (*Allium cepa* L.). *Veg. Sci.,* **25** (2): 185-186.

Sharma N., Kaur N. and Gupta A. K. (1998). Effect of gibberellic acid chlorocholine chloride on tuberisation and growth of potato (*Solanum tuberosum* L.). *J. Sci. Food Agric.,* **78** (4): 466-470.)

Shishido Y. and Saito T. (1984). Effect of plant growth regulators on low temperature induction of flower buds in onion plants. *J. Japanese Soc. Hort. Sci.,* 53: 45-51.

Shoemaker J. S. (1947). "*Vegetable growing*." John Willey and Sons. Inc., New York.

Singh A. R., Pankaj S. L. and Singh G. N. (1983). Effect of growth regulators on growth, yield and quality of onion. *Punjab Hort. J.,* 23: 100-104.

Singh M. (2006). Response of growth regulators on bulb yield of onion (*Allium cepa* L.). *Int. J. Agric. Sci.*, **2** (2): 589-590.

Singh S., Singh K. and Singh S. P. (1995). Effect of hormones on growth and yield characters of seed crop of *kharif* onion (*Allium cepa* L.). *Indian J. Pl. Physiol*., **38** (3): 193-196.

Suseela T., Ravisankar C. and Rao B. V. (2005). Effect of growth regulators and method of application on growth and yield of onion cv. N-53. *J. Res. ANGRAU*, **33** (4): 110-113.

Tiwari R. S. Ankur A. and Sengar S. C. (2003). Effect of bioregulators on growth, bulb yield, quality and storability of onion cv. Pusa Red. *Indian J. Pl. Physiol*., **8** (4): 411-413.

Tyagi A. K. and Yadav S. K. (2007). Effct of growth regulators on growth and yield of onion (*Allium cepa* L.) cv. Pusa Red. *Pl. Archives,* **7** (1): 371-372.

Onion harvesting, curing, grading and storage: A Review Study

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Abstract

Onion (*Allium cepa* L.) is one of the oldest bulb crops, known to mankind and consumed worldwide. It is one of the most important commercial vegetable crops grown in India and believed to be originated in Central Asia. It is valued for its distinct pungent flavour and is an essential ingredient for the cuisine of many regions. Onion is the queen of kitchen. Despite the achievements in production technology, the post-harvest losses still pose a great problem due to lack of scientific knowledge. Therefore, in this paper an effort is made to collect information regarding the important aspects of onion harvesting, curing, grading and storage.

Keywords: Onion, harvesting, curing, grading, storage

Introduction

Onion (*Allium cepa* L.) is one of the oldest bulb crops, known to mankind and consumed worldwide. It is one of the most important commercial vegetable crops grown in India and believed to be originated in Central Asia. It is valued for its distinct pungent flavour and is an essential ingredient for the cuisine of many regions. Onion is the queen of kitchen. Despite the achievements in production technology, the post-harvest losses still pose a great problem due to lack of scientific knowledge. A number of harvesting equipment had been designed and fabricated. There are manual harvesting equipment that works on the principle of loosening of soil adhering to the root zone of onion and afterwards uprooting the plants. But these types of equipment are widely used in developing countries while automated types are widely used in developed countries. After harvesting the onion bulbs are kept for curing. This process removes excess moisture from the outer layers of the bulb prior to storage.

The dried skin provides a surface barrier to water loss and microbial infection, thereby preserving the main edible tissue in a fresh state. The removal of moisture also reduces shrinkage during its post harvest handling and storage. Various experiments have been carried out on effect of different curing methods on storage life of onions. To increase the market value onion graders have also been designed and developed. The drudgery of human labour involved for grading of onion has been reduced by hand operated as well as motorized onion grader developed by NRCOG, PUNE. In India, the farmers practice different storage methods. The onions are bulk stored in special structures with thatched roof and side walls are made up with bamboo sticks or wire mesh for ventilation. Modern structures are also there for their storage. Despite the achievements in production techniques, significant reduction in post-harvest losses is still a goal to be achieved.

Onion harvesting technology:

Manual harvesting is the most common practice in developing countries. This is normally carried out by levering the bulbs with a fork to loosen them and pulling the tops by hand. In developed countries, especially on large scale farms, mechanical harvesting is commonly used. The harvesting techniques adopted are influenced by weather condition at harvest time.

Khura *et al*.(2011) designed digger for onion crop, lifting the soil and onion with leaves from the field and subsequently transferring the dugout onion onto a separation unit for removing soil mass from onion and finally windrowing clean onions in the rear for manually picking up with minimum damage to the onion bulbs and leaves. The main components of the harvester were digging, conveying and separating units. Six different shape digging blades were evaluated for the digging efficiency. The minimum mean draft of 625.6N was observed for inverted V- shaped blade. The optimal design values of variables like length, speed ratio and slope of the elevator were determined as 1.2 m, 1.25:1 and 15°, respectively. During the field evaluation, the prototype onion digger, with the above design values, performed as per the recommended standards with digging efficiency 97.7%, separation index 79.1%, bulb damage 3.5%, fuel consumption 4.1 litre/ha (12.81 litre/ha) and draft 10.78kN.The saving in cost of harvesting is 1170 Rs/ha with developed digger as compared to manual harvesting.

Mahesh Chand Singh (2014) developed and evaluated digger performance at a speed of 4 km/h in first high gear with minimum losses at a field capacity of 0.46 ha/h . Depth control wheels were effective to control the depth of cut by blade. The average operational depth of 7.62 cm of the developed digger was suitable with practically no damage to the onion bulbs. Lift percentage, mean digger efficiency and damage percentage were 94.9, 89.8 and 5.1%, respectively.

Omar O.A.*et al*.(2018) developed onion- harvester consists of frame, lifting device (blade and collected roller), elevator and collecting device. The results indicated that, the maximum field capacity was 0.180 fed/h at speed of 1.125km/h and the maximum field efficiency was 73.9 % at speed of 0.720km/h, it was recorded at depth of 4cm, compared with manual method which recorded the field capacity and field efficiency were 0.125 fed/h and 84.26%, respectively.The maximum lifting efficiency and minimum total losses were 99.2% and 1.9% obtained with the use of the developed onion harvester, compared with manual method which recorded 98.1 % and 2.5%, respectively. The minimum power and energy consumed were 10.112 kW and 59.5 kW.h/fed at depth of 4cm and forward speed of 0.720km/h obtained under onion harvester, compared with manual method which recorded 0.759 kW and 6.072 kW.h/fed, respectively. The criterion cost for manual harvesting was 2400 LE/fed. It was recommended to operate the developed harvester for harvesting onion crop at a depth harvesting of 10 cm and a forward speed of 0.720 km/h where the lowest criterion cost was 674.33 LE/fed, the lowest losses was 1.9%, and the least energy consumed was 59.5 kW.h / fed . [L.E. means Egyptian pound]

Onion Curing:

Curing remove excess moisture from the outer layers of the bulb prior to storage. The dried skin provides a surface barrier to water loss and microbial infection, thereby preserving the main edible tissue in a fresh state. Drying also reduces shrinkage during subsequent handling, reduces the occurrence of sprouting, and allows the crop to ripen before fresh consumption or long-term storage.

The experiment on effect of different curing methods on storage life of onions was conducted at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. In the treatment T1, field cured bulbs were kept under 50 per cent shade for 12 days and tops removed immediately after harvesting. In the treatment T1, field cured bulbs were kept under 50 per cent shade for 12 days and tops removed

immediately after harvesting. In treatments T2, T3, T4 and T5 field cured bulbs were kept under 50 per cent shade for 15 days with topping on 3rd, 5th, 10th and 15th day after harvesting, respectively. In treatment T6, field cured bulbs were kept under 100 per cent shade for 15 days with topping on 15th day after harvest. In treatment T7 and T8, field cured bulbs were kept on tarpaulin under 50 per cent and 100 per cent shade for 15 days, respectively with topping on 7th day after harvest. T9 was control (method usually adopted by the farmers). It was found that post-harvest curing significantly reduced the storage losses. Among the different curing methods, field cured bulbs kept under 50 per cent shade for 15 days and tops removed 15 days after harvest (T5) was found superior with minimum storage losses. The minimum physiological loss in weight (12.24%), sprouting (3.2%), rotting (6.9%) and incidence of black mould (7.80%) with maximum marketable bulbs (82.10%) was noted in this treatment. The curing operation resulted in colour development of onion bulb and highest score (7.4) was recorded in the same treatment.

Onion Grader

The drudgery of human labour involved for grading of onion has been reduced by hand operated as well as motorized onion grader developed by NRCOG, PUNE. The cost of grading with machine is around Rs. 26/t as compared to Rs. 80/t in hand grading. The precision of grading achieved by grader was 98% as against 50% in hand grading.

Gayathri, G *et al.(*2016) designed, developed and evaluated a manually operated onion grader at I.I.H.R., Bangalore for Rose onion verities commonly cultivated in Bangalore into three grades based on geometric dimensions of the selected variety. The statistical analysis showed that the standardized parameters were slope 4°, length wise swing direction and feed gate at full opening. The grader has a grading capacity 1105 kg/h at overall grading efficiency 75 per cent and required grading efficiency 75 per cent. The operation cost of machine was 6 times less than manual operation cost.

A manually operated prototype tubular on-farm onion grader was developed using locally available material and tested for its grading performance for the three onion genotypes namely, SataraGarva, ArkaKalyan and Bangalore Rose onion. Provision was made for slope and clearance adjustment. The effects of grading slope (13°, 15°& 18°) and feed rate (300, 450 and 600 kg/h) on grading effectiveness, bulb

damage and grading capacity of the developed grader were studied. For optimum grading performance in the developed grader, 13o grading slope and 300 kg/h feed rate were found to be optimum for tested onion varieties. The cost of grading onion for the developed grader was Rs. 130 per tone and the Cost: Benefit Ratio was worked out to be 1.00: 7.69. The developed prototype was found to be good for on-farm grading of selected onion genotypes. (Karthik S. K. *et al*.2018)

Dabhi M. N (2016).Design and developed divergent-type principle power driven onion bulb grading machine to increase the output and save time of labour. The best combination of roller speed and roller inclination was found to be 13 rpm and 8^{o}, respectively, for efficiency of 79.95% at capacity of 598.58 kg.h−1. The machine cost of grader was Rs. 40680/-(without electric motor).

Gunathilakea *et al*.(2016) tested size grading machine for onion. Machine performance was maximum at 3^{o} inclined angle of the grading cylinder against horizontal axis and 15 rpm rotating speed of the grading cylinder. Maximum grading qualities/efficiencies under optimized machine adjustments for small, medium and large sizes were reported 84.47%, 93.46% and 90.14 respectively. The capacity of the grading machine was 630 kg/hour under the optimized operational conditions.

Onion peeler

A batch type peeling machine suitable for farm-level operation was designed and tested for multiplier onion. The equipment consisted of a cast aluminium drum seated over a rotating disc. Inner surface of the drum and top surface of the lower disc are covered with corrugated rubber sheet which aids in the peeling process. The multiplier onion needs to have the ends cut with a sharp knife and soaked in clean water for a period of 10 min to assist the loosening of peel followed by air drying for 1-2 min to remove the surface water. Major operational parameters: Speeds of operation and abrasive surface on the drum were optimized for peeling efficiency, damage to the bulb and other per formance parameters. The capacity of the peeler was about 50-60 kg/h. The peeling efficiency was about 92 percent with unpeeled and damaged percentage being 6 and 2 percent, respectively. The cost economics study revealed that the equipment had a saving in labour and cost to a tune of about 68 and 69 percent, respectively, with a payback period of 1.40 years.(NaikRavindra*et al*. 2013)

An onion peeling machine was designed, manufactured, developed and evaluated to suit the small and medium processing units. The onion peeling machine consists of seven parts, main frame, peeling drum, inlet and outlet openings, collection basin, water and air supplying systems, and power transmission. The machine was evaluated using different onion bulb sizes (small, medium & large). A mixed sample of different sizes was also tested. The evaluation process was conducted under three different drum rotational speeds (30, 40 and 50 rpm), three different peeling residence times (1, 2 and 3mins) and three different batch loads (18, 24 and 30kg). The optimum peeling efficiency of 74.9, 65.24, 80.08 and 85.45% were obtained at 24kg batch load (0.36 ton/h.), 2min peeling residence time and 40 rpm for small, medium, mixed and large sizes respectively. Water pump and air compressor were added to the peeler to improve the peeling efficiency, and it was tested under the previous conditions. The corresponding values of peeling efficiency for the machine with pump water at water pressure of 400kPa were 76.73, 83.06, 99.20 and 87.49 %, respectively. While they were 76.33, 72.87, 87.530 and 88.37%, respectively for air pumping at pressure of 500kPa. The estimated costs of onions peeling machine were 28.47, 29.56 and33.75 L.E/ton for the machine only, machine with water pump and machine with air compressor respectively. These values of estimated costs using the developed machine are very competitive with the cost of manual peeling process which approached about 75 L.E/ton.

Storage Methods/structures / conditions

In India, the farmers practice different storage methods. The onions are bulk stored in special houses with thatched roof and side walls are made up with bamboo sticks or wire mesh for good air circulation. In North India, the sides are also covered with gunny cloth. Onions are stored in these sheds by spreading them on dry and damp proof floor or racks. Periodical turning of bulbs or removal of rotten, damaged and sprouted bulbs should be done. Well-ventilated improved storage structures with racks or tiers having two or three layers of bulbs would be desirable for proper storage. Storage losses of *rabi* harvest onions range from 30 % to 60 %. Major loss in storage is physiological loss of weight about 25 – 30 % followed by 10 – 15 % in sprouting of bulbs and finally microbial decay or rotting accounts for 10 – 15 %.

Despite the achievements in production technology, the post-harvest losses during storage still pose a great problem. Several researchers attempted to find solution of preventing the post-harvest losses of onion.

Singh and Singh (1973) found that tat storage with brick base was comparatively better than other local methods of onion storage. Storage in crates at room temperature and storage in tat with ground base was not economical. The onion bulbs stored in a shed lost 25.75 per cent after 90 days of storage compared to 48.42 per cent in onion stored in room without ventilation and also found that with increase in ventilation by partitioned the 'tat' the per cent of loss in weight was decreased as compared to the completely filled tat without gap (Khurana and Singh, 1984).

Iordachescu*et al*. (1983) studied six methods of onion storage with the cv. Staltgart Giant. In the variants under natural ventilation, the storage period lasted five months with storage losses of 4.18 to 4.71 per cent, whereas in forced ventilation, the storage period was extended to eight months with 2.21 to 2.25 per cent losses.

Khurana and Singh (1984) reported that onion bulbs stored in a shed lost 25.75 per cent after 90 days of storage compared to 48.42 per cent in onion stored in room without ventilation and also found that with increase in ventilation by partitioned the 'tat', the per cent of loss in weight was decreased as compared to the completely filled tat without gap.

Mahadevswamy (1984) observed that maleic hydrazide @ 800 ppm sprayed bulbs stored in polyethylene bags recorded lower rotting (15.8%) as compared with the untreated bulbs (17.6%). The same treatment recorded less sprouting and sprout length as compared with control. The curing method of storage was the best method of storing onion under ambient condition followed by the hanging method.

Thomas *et al*. (1986) studied the storage trials at pimpalgaon in Maharashtra in a traditional storage shed known as chawl and model stores in rabi onion and revealed that after five months storage period, the storage losses were 70 per cent in poorly ventilated chawl compared with 50 per cent in bitter ventilated model store. In India, different storage methods are practiced by the farmers. Among those, split bamboo storage structure with central hallow was found better and the extent losses by way of spoilage, sprouting were minimum during storage (Krishnamurthy et al., 1987).

The total storage loss at the end of five months in Nasik type storage structure was 21 per cent in cv. Ballary Red which was considered acceptable. The total cost of the structure was Rs. 5000 (Murthy *et al*., 1988).

The combination of CA storage (5% CO2, 3% O2) and refrigerated storage (1°C) also resulted in 99% of the onion bulbs considered marketable after 7 months storage; however, 9% weight loss occurred (Smittle, 1989).

In ventilated bamboo storage structure for onion, the total losses reduced to 39.23 per cent compared to conventional storage structure having 53 per cent after five months storage (Subbaram et al. 1990).

Arora*et al*. (1993) reported that the minimum sprouting (60.5%), rotting (15.0%) and total loss (35.0%) in wire mesh shed storage compared to ordinary room storage of onion bulbs (77.5, 20.5 and 72.7%, respectively).

In Sudan, mud or straw cottage was used for storing onions. Straw cottage was constructed in such a way that, they were ventilated by the prevailing wind passing through them. After five months of storage by this method, 50 to 60 per cent of bulbs were marketable. The higher temperature of 30 and 35°C caused less sprouting but higher rotting and loss in weight was observed compared to lower temperature (20-25°C) (Maini and Chakrabarti, 2000).

Ranpise *et al.* (2001) used the conventional onion storage structure called chawl which has no aeration at bottom and onion can be stored upto 1.5 to 2.0 metre height with resulting into lot of bruising and decay, and also reported onion stored in modified improved storage structure with bottom and central ventilation with raised floor (60 cm) of structure above ground reduced the storage losses from 99.2 to 70.0 per cent during five months storage. The storage temperature of 15°C along with relative humidity of 50 to 70 per cent could be helpful to reduce the rotting and desiccation to a desired level to lengthen the storage life of onion bulbs in storage.

Tripathi and Lawande (2003) reported that the total losses in low cost bottom ventilated structure are much lower (35.17%) than recommended bottom ventilated structure (44.96%). The sprouting and black mould infection was also lower in low cost storage structure.

Vengayapattarai is constructed in levelled fields by placing equal sized rectangular stones to act as load barrier kept at a distance of 2 feet in-between each stones. The custom made neem wooden board are placed over the stones and all three

sides are covered with manually woven bamboo sheets. The structure is filled with onions and the fourth side is either be covered with jute gunny bags or bamboo sheets as per convenience of the farmer. The top portion of the pattarai is covered with coconut thatches to prevent from rainfall, excess sunlight, also facilitates ventilation to the stored onions (Karthikeyan et al. 2009).

Hang on string method

Roof over Pattarai

Low cost storage structure

Forced air onion storage

Plate: Storage structures for onion

Directorate of onion and garlic research developed 2 structures for onion storage. 'Bottom and side ventilated two row structures for the storage capacity of 25 – 50 tonnes and 'Bottom and side ventilated single row low cost storage structure' for 5 – 10 tonnes capacity. Some storage structures for onion are shown in figure.

Salient features of these storage structures are given below

- Construction of structure on raised platform to prevent moisture contact and dampness.
- Use of Mangalore tiled roof or other suitable material to prevent build-up, high temperature inside.
- Providing bottom ventilation for free and faster air circulation to avoid formation of hot and humid pockets between the onion layers.

- Avoid direct sunlight on onion bulbs to reduce sunscald, fading of colour and quality deterioration.
- Restriction on width of each stack to 60-75 cm for hot and humid weather, 75 - 90 cm for mild and humid weather and 90-120 cm for mild and dry weather conditions.
- Maintenance of stacking height to 100 cm for small and multiplier onions and hot weather and 120 cm for mild weather and for big onions to avoid pressure bruising.
- Providing cubicles instead of continuous stack and sufficient space for ventilation from all sides. One cubic meter area of store accommodates about 750 kg onions. Accordingly construction of godown for required capacity and construction of more units instead of single big structure and in zigzag manner when constructed in more rows to have better aeration.
- Providing 2-tier if space available is insufficient.
- Periodical disinfection of structures and premises to check rottage.
- The cost-efficient of structures is based on locally - available materials and labour

Plate: Cost effective structures for onion

References

Arora, S.K., Randhawa, K.S., Mohan, S. and Gupta, A.K. (1993). Influence of different chemicals on the storage of onion (Allium cepa L.). Maharashtra Journal of Horticulture, 7(2): 93-99.

Dabhi M. N., and Patel N. C.(2016). Design and Development of Onion Grader. Journal of Agricultural Engineering.Volume : 53, Issue : 1: 27- 32

D.M.C.C. Gunathilakea, W.M.C.B Wasalaa , K.B. Palipane(2016). Design, development and evaluation of a size grading machine for Onion cited from https://www.researchgate.net/publication/299522546 on 24/04/2020.

El-Ghobashy, H; Adel H. Bahnasawy; Samir A. Ali; M. T. Afify; and Z. Emara (2011).Development and evaluation of an onion peeling machine. MSAE, 29(2):663-682.

Gayathri, G., Harshanjali, K.V., Rupavathi, K., Kumar, D. Vijay, Kumaran, G. Senthil, Kumari, A. CarolinRathina and Ramana, M.V. (2016). Design, development and evaluation of a manually operated onion grader for Rose onion.Internat. J. Agric. Engg., 9(2) : 121-129

Iordachescu, C.S. and Nihailescu, N. (1983). Studies on the improvement of technology of onion storage in large stores. Journal of Fructerlo, 10(1): 31-37.

Khurana, S.C. and Singh, C.B. (1984). A note on loss in weight during storage of onion bulbs. Haryana Journal of Horticultural Science, 13(3-4): 186-188.

Krishnamurthy, K.C., Viswanath, A.P., Babu, C.K. and Subramany, S., (1987), Bulletin on harvest and post-harvest Technology of onion. University of Agricultural Sciences Research Bulletin, No. UAS/HPST/87/5.

Karthikeyan, C., Veeraragavathatham D., Karpagam D. and AyishaFirdous, S. (2009). Indian Journal of Traditional Knowledge. 8(2): 225-229

Khura T K, Indra Mani and Srivastava A P. 2011 Design and development of tractor-drawn onion (Allium cepa) harvester. Indian Journal of Agricultural Sciences 81 (6): 528–32.

Karthik S. K., Palanimuthu V. and Satishkumar (2018). Design and Development of On-Farm Onion Grader. International Journal of Current Microbiology and Applied Sciences. ISSN: 2319-7692 Special Issue-6 pp. 2907-2914.

Mahadevaswamy K.L., (1984), Studies on the simple storage techniques for onion cv. Ballaryred with pre-harvest treatment of maleic hydrazide. M.Sc. Thesis, University of Agricultural Sciences, Bangalore.

Mahesh C.S. (2014). Development and performance evaluation of a digger for harvesting onion (Allium Cepa L.). International Journal of Agric. Eng. 7(10): 391- 394.

Maini, S.B. and Chakrabarti, A.K., (2000), Post-harvest management of onions and garlic.Souvenir, National Symposium on Onion and Garlic Production and Postharvest Management: Challenges and Strategies, 19-21 November 2000, National Research Centre for Onion and Garlic, Rajgurunagar, Nasik, pp. 25-32.

Murthy, K.C., Vishwanath, A.P., Babu, C.K. and Ramakumar, M.V., (1988), Onion storage in Nasik type structure. Current Research, 17(11): 149-151.

NaikRavindra ,Annamalai, S.J.K.,Ambrose, Dawn (2013.)Development of Batch Type Multiplier Onion (Onion Aggregatum) Peeler with Centrifugal Discharge. Agricultural Mechanization in Asia, Africa and Latin America 44(3):25-30.

O.A. Omar ,Soha G. Abdel Hamid and G.A. El-Termzy Development of an onion-crop harvesterMisr J. Ag. Eng., 35 (1): 39 – 56.

Ranpise, S.A., Birade, R.M., Patil, B.T. and Sawant, S.V. (2001). Factors affecting the storage of onion: A Review. The Orissa Journal of Horticulture, 29(1): 1-12.

Singh, K. and Singh, D. (1973). Effects of various methods of storage on the keeping quality of onion bulbs. Haryana Journal of Horticultural Science, 2(3-4): 116-122.

Smittle, D.A. (1989). Controlled atmosphere storage of Vidalia onions. Proceedings of the Fifth International Controlled Atmosphere Research Conference, Wenatchee, Washington, USA, 14–16 June, 2:171–177.

Subbaram, M., Singaravelu, T., Thangaraj and Irulappan, I. (1990). Ventilated bamboo structure for onion storage. Onion Newsletter for the Tropics, 2: 38-41

Thomas, P., Padwal, Desai, S.R., Srirangarajan, A.N., Joshi, M.R., Janave, M.T., Bhonde, S.R. and Quadri, S.M.H. (1986). Pilot scale storage tests on the efficacy of gamma irradiation for sprout inhibition of onion under commercial storage conditions. Journal of Food Science and Technology, 23(2): 79-84.

Tripathi, P.C. and Lawande, K.E. (2003). Onion storage structure for small and marginal farmers. ICAR News, A Science and Technoogy Newsletter, 9(4): 18-19.

VU Raut, NehaChopde, PT Bhaisare and RS Wankhede. Effect of different curing methods on storability of onion bulbs. International Journal of Chemical Studies. 2018; 6(1): 1788-1790.

Insect Pests, Diseases and Physiological Disorders and Their Management in Tomato (*Lycopersicon esculentum* Mill.)

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Abstract: Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and commercially grown vegetable crops cultivated throughout the India. There are various factors *viz*., insect pests fruit borer (*Harmigera* Hubner Hub.), whitefly (*Bemisia tabaci* Gennadius), leaf miners (*Liriomyza trifoli* Burgess) and leaf miner (*Tuta absoluta* Myr.) and aphids (*Myzus persicae* Sulzer) diseases like Damping off (*Pythium aphanidermatum*), leaf spot (*Septoria lycopersici*) leaf curl virus, fusarium wilt (*Fusarium oxysporum f. sp. Lycopersici*) early blight (*Alternaria solani*) and late blight (*Phytophthora infestans*) disease and physiological disorders *viz*., blossom end rot, fruit cracking and sun scald, blotchy ripening (gray wall)/ yellow shoulder, cat face are the important constrains in the production of tomato in recent years. Hence, in this chapter the above mentioned insect pests, diseases, physiological disorders and their management strategies are discussed.

Introduction

Tomato (*Solanum lycopersicum* Mill.) belongs to the family Solanaceae and it is one of the most important and nutritive rich popular vegetable crop grown in India. It is grown over an area of 0.81 m ha with 19.39 m t production. Tomato is cultivated in a broad range of climatic conditions and major Tomato producing states in the country are Andhra Pradesh, Madhya Pradesh, Karnataka, Gujarat, Odisha, West Bengal, Chhattisgarh, Bihar, Telangana, Tamil Nadu, Uttar Pradesh, Maharashtra,

Haryana and Himachal Pradesh. These states are account for about 90 per cent of the total production of the country (Anon, 2019).

Nutritive value

Tomato is one most popular fruits of the earth. Tomato is categorized as a vegetable but in botanical terms, the tomato is the fruit born on a vine. Hence, tomato is actually not a vegetable but a fruit. Water content of tomato is quite high and is about 93-95%. The solid matter content of tomato ranges from 5.5-9.5% of which about 1% is seed and skin (on fresh weight basis). Variation in solids percentage in tomato composition may be due to its variety, soil characteristics, rainfall and irrigation etc. factors (Bhowmik *et al.*, 2012)

Tomato is considered as very healthy and nutritious due t its rich nutritional profile especially rich in various vitamins and also in antioxidants. Raw tomato contains average 93.1 % moisture and rich in moisture as other vegetables. It has 1.9 g protein and 0.6 g of minerals. Tomato are very low calorie as it contains only 23 Kcal, 0.1 g of fat, 3.6 g of carbohydrates. Both Raw and ripe tomatoes are free food for those who are on calorie restricted diet. Looking to the mineral content, it contains, 20mg of calcium, 36 mg of phosphorus and 1.8 mg of iron. Ripe tomatoes are laso full of moisture and contains average of 94.0g of moisture, 0.9g protein, 0.2 g fat, 0.5 g crude fibre. It contains 0.64 mg of iron, 48mg calcium and 20 mg phosphorus. Ripe tomatoes are also contains very low calorie and provides only 20 Kcal (Gopalan *et al.*, 2012). Iron is one of the important mineral of tomato. Though tomato is not a rich source of iron, but iron present in tomato is more bioavailable because of its ascorbic acid content. Ascorbic acid makes iron in reduced form which is easier for absorption and utilization in body. A glass of tomato juice can meet 10-20 % of recommended daily allowance of iron. Cirtic acid is one of the important acid in tomato which is present in form of citric monohydrate. Other acids like succinic, oxalic and tartaric acid are also present in small amount. Destruction of ascorbic acid is observed in tomato products during processing due to oxidation reaction by heat and light. (Nasir *et al*., 2015). Tomato is rich in various carotenoid contents especially rich in lycopene which is about 85% of total carotenoids. Lycopene is a carotenoid which is not synthesized in animals and synthesized by plants only lycopene showed that lycopene is quite stable in tomato processing and storage (Leoni and Jongen, 2002). There is a

strong relationship between tomato intake and plasma/serum lycopene concentrations. Lycopene is well known for its impact on cancer protection. Numbers of studies showed an inverse relation between plasma lycopene level and cancer. Lycopene is the major carotenoid found in the lungs (Schmitz, 1991 and Ganji and Kafai, 2005). Antioxidants that are present in tomatoes are vitamin C (160-240mg/kg), provitamin A carotenes (6-9mg/kg), lycopene (30-200mg/kg), phenolic compounds like flavonoids (5-50mg/kg) and phenolic acids (10-50mg/kg) (Davies *et al.*, 1981). Tomato are fairly good in oxalic acid (5.3 mg / 100 g). Oxolic acid forms insoluble calcium salts in form of calcium oxalate which may cause kidney stone. (Bhowmik *et al.*, 2012)

Tomato contains good amount of potassium. Potassium is helpful in lowering blood pressure, reduce the adverse effect of excess sodium intake on blood pressure, reduce the risk of kidney stones, and possibly reduce age-related bone loss. (Freeman and Reimers, 2011). Tomato is considered beneficial for high blood pressure patients. The total sugar content of tomato varies from 2.19-3.55%. Tomato contains almost negligible amount of sucrose which is almost 0.1 %. But it contains glucose and fructose as main reducing sugars which are almost 50-65% of tomato solids. Fructose sugar is higher than glucose in tomatoes (54:46) (Gould, 1992). This sugar combination makes tomato low glycemic index food. Hence, tomato is safe for diabetics and it does not raise post prandial blood sugar level.

There are a number of reasons behind this varied range of solids percentage in tomato composition, like variety, rainfall, soil characteristics and irrigation. The insoluble solids in tomato juice ranges from 15-20% of total solids and mainly composed of lignin cellulose and pectin. Polysaccharides present in tomatoes are mainly xylan, pectin, cellulose, arabinoxylan and arabinogalactan which consist of about 0.7% of tomato juice (Leoni, 1993).

Production of tomato has been increased over the years while, its yield continue to be low due to several production constraints like insect pests, diseases and influence of climatic factors (Bley 2005). The occurrence of different insect pests, diseases and some physiological disorders might vary from season to season and crop growth stages. Several insect pests reportedly feed on tomato, right from germination to harvesting stage and cause reduction in yield and quality. The important insect pests attacking tomato are fruit borer *Helicoverpa armigera* Hubner (Lepidoptera:

Noctuidae), whitefly *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae), thrips *Frankliniella occidentalis* Trybom (Thysanoptera: Thripidae), red spider mites *Tetranychus evansi* Baker (Acarina: Tetranychidae), leaf miners *Liriomyza trifoli* Burgess (Diptera: Agromyzidae), cutworm *Agrotis segetum* Denis and Schiffermuller (Lepidoptera: Noctuidae) and aphids *Aphis gossypii* Glover (Hemiptera: Aphididae) (Sam *et al.,* 2014). The diseases like Damping off (*Pythium aphanidermatum*), leaf spot (*Septoria lycopersici*) leaf curl virus, fusarium wilt *(Fusarium oxysporum f. sp. Lycopersici)* and early (*Alternaria solani*) and late blight (*Phytophthora infestans*) disease and some important physiological disorders *viz*., blossom end rot, fruit cracking and sun scald, blotchy ripening (gray wall)/ Yellow shoulder, cat face and causes of these disorders and their management practices are discussed in brief.

Important Insect Pests of tomato

Fruit borer (*Helicoverpa armigera* Hub.)**:** Fruit borer is one of the most important insect pests of tomato, limiting production and market value of crop produce. The fruit borer, *Helicoverpa armigera* (Hubner) is the most destructive and severe pest of tomato, generally known as gram pod borer, American bollworm and tomato fruit borer and causes 40-50 percent damage to the tomato crop (Pareek and Bhargava, 2003).

Damaging stage: Full grown caterpillars

Damaging Symptoms

- Young larvae scrap and feed on tender foliage while later stage larvae bore circular holes, feeds on internal contents of the fruit and thrust its head inside the fruit, leaving rest of its body outside.

Integrated pest management

Integrated management of fruit Borer (according to Plant Protection Division, IIVR, Varanasi)

- Grow marigold as trap crop (1:14). Marigold seedlings should be 15 days older than tomato seedlings
- Set up pheromone traps at 5/ acre at flowering stage for early detection
- Release of *T. brassiliensis* at 2,50,000 eggs/ha at fruit initiation
- Spray HaNPV at 1 ml / l of water at evening time.
- Erecting of bird perches @ 20/acre for encouraging predatory birds such as King crow, common mynah etc.

- Spray 5 per cent neem extract or azadirachtin @ 3000 ppm
- Application of chlorantraniliprole 18.5 % SC at 0.3 ml/ l of water for 2-3 spray at an interval of 8-10 days (Anon, 2018).
- Spray with indoxacarb 14.5% SC @ 160-200 ml in 120-240 l of water/acre or flubendiamide 20% WG @ 40 g in 150-200 l of water/acre or flubendiamide 39.35% M/M SC @ 40 ml in 15 00 l of water/acre (Anon, 2014)


Marigold flowers as trap crops for fruit borer

Source: TNAU, Portal

Serpentine leaf miner: *Liriomyza trifoli* Burgess , Family: Agromyzidae

Damaging stage: Maggots

Damaging Symptoms: Feeding results in to serpentine mines on the leaf. Heavy infestation causes large whitish blotches , drying and dropping of the affected leaf

Management:

- Judicious use of nitrogen fertilizers
- Intercrop with bean reduces leaf miner attack
- Cyantraniliprole 10.26% OD @ 360 ml in 200 l water/acre (Anon, 2014)

Whitefly (*Bemisia tabaci* Gennadius), Family: Aleyrodidae

Damaging stage: Nymphs and Adults

Damaging Symptoms: Nymphs and adults suck the sap on the ventral surface of leaves. Downward curling and wrinkling of affected leaves. This white fly also act as vector of leaf curl disease in tomato

Management

- Cover nursery with nylon net for protection
- Install yellow sticky traps @ 12 / ha to attract the adults
- Remove alternate weed hosts

- Dimethoate 30 % EC 20 ml/ 10 l of water, Thiamethoxam 25 % WG 4 ml/ 10 l of water at 10 days interval


White fly (Source: TNAU, Portal)

Aphids (*Myzus persicae*) Family: Aphididae)

Damaging stage: Nymphs and Adults

Damaging Symptoms: Nymphs and adults suck the sap from leaves. Black sooty mould develop on honey substance secreted by aphids on leaves

Management

- Thiomethoxam 25 % WG 25 g a. i./ ha. (Plant Protection Division, IIVR, Varanasi).
- Imidacloprid 17.8 % SL 0.5 ml/ l of water (Anon, 2018)

Leaf minor, *Tuta absolutan* (Meyrick) Family: Gelechiidae

A South American tomato pinworm, *T. absoluta* also called as the tomato leaf miner is one of the destructive invasive pest observed for the first time infesting tomato crop in Maharashtra, India. This pest has been classified as the most serious menace for tomato production worldwide. The pest has spread from South America to several parts of Europe, entire Africa and has now spread to India. Plants are damaged by direct feeding on leaves, stems, buds, calyces, young fruit, or ripe fruit and by the invasion of secondary pathogens which enter through the wounds made by the pest. It can cause up to 90 per cent loss of yield and fruit quality under greenhouses and field conditions (https://icar.org.in/node/6084). The destructive nature of the pest, multivoltine character, short life cycle, its high reproductive potential and increased resistance to insecticide use are the reasons for its key pest status in the new localities (IRAC, 2014, Desneux *et al*., 2010).

Damaging stage: Larvae/maggots

Damaging Symptoms: The white long circular mines on the old leaves. The incidence is first noticed at nursery stage. Plant showing leaf blotch symptoms and irregular

galleries and mines on the leaf (Chandish *et al.*,2016). In tomato, it attacks all plant parts and crop developmental stages, although the larvae prefer apical buds, tender new leaflets, flowers, and green fruits and can cause up to cent percent crop destruction (https://irac-online.org/pests/tuta-absoluta)

Integrated pest management strategies of leaf miner in polyhouse as suggested by IIHR Bengaluru given below.

- Use of incandescent bulb at one bulb/150 m^2
- Use of one pheromone trap/300 m^2
- Need based spray of spinosad 45 SC at 0.25 ml or flubendiamide @ 0.20 ml/l in rotation at 3 weeks interval.
- Spray with decamethrin 2.5 EC at 1 ml/l coinciding with the peak *Tuta* adult emergence
- Light traps are to be kept before transplanting of the crop itself.
- Spray of insecticides *viz*., cyazypyr at 1.8 ml/l, rynaxypyr @ 0.3 ml/l and indoxacarb at 1 ml/l (recorded least fruit damage) according to Bhut *et al*., 2017)

Leaf minor attack (Source: TNAU, Portal)

Important diseases of tomato

Damping off (*Pythium aphanidermatum*)

Damaging Symptoms: This is one of the most severe disease of tomato occurs at nursery stage. In pre-emergence stage seedlings are killed just before they reach the soil surface. The young radical and the plumule are killed and there is complete rotting of the seedlings. The post-emergence phase is characterized by the infection of the young, juvenile tissues of the collar at the ground level. The infected tissues become soft and water soaked. The seedlings topple over or collapse

Management

- Seeds treatment with *Trichoderma viride at* 4 g/kg or *Pseudomonas fluorescens* 10 g / kg of seed 24 hours before sowing.
- Soil application of *Pseudomonas fluorescens* at 2.5 kg / ha mixed with 50 kg of FYM.
- Water stagnation should be avoided.
- Drenching of copper oxy chloride at 2.5 g / l of water (4 lit /m^2) (POP, TNAU)

Damping off

Leaf curl

Leaf spot (*Septoria lycopersici*)

Damaging symptoms: This disease is attacked at any stage of plant growth and characterized by numerous, small, grey, circular leaf spots having dark border.

Management

- Removal and destruction of the affected plant parts
- Seed treatment with Thiram or Dithane M-45 (2 g/kg seed) is useful in checking seed borne infection.
- Spray with Dithane Z-78 (0.2%) effectively manages the disease under field condition (http://nhb.gov.in/pdf/vegetable/tomato/tom002.pdf)

Fusarium wilt (*Fusarium oxysporum* sp *lycopersici*)

Damaging symptoms: Veinlets clearing and chlorosis of the leaves appears first. The younger leaves die in succession and the entire leaves wilt and die in few days. Soon the petiole and the leaves droop and wilt. Under field condition yellowing of the lower leaves first and affected leaflets wilt and die.

Management

- Soil solarization before preparation of nursery bed
- Seed treatment with *Pseudomonas fluorescens* (PF) @ 10 g / kg of seed
- Nursery application of *Pseudomonas fluorescens* (PF) @ 20 g / m^2

- Seedling dipping in the solution of *Pseudomonas fluorescens* (PF) @ 5 g /l water along with soil application of *Pseudomonas fluorescens at* 2.5 kg mixed with 50 kg FYM /ha at 30 days of transplanting (POP, TNAU)


Fusarium wilt (*Fusarium oxysporum* sp *lycopersici*)

Leaf curl (*Tomato Yellow Leaf Curl Virus/ TYLCV*)

Damaging Symptoms: It is one of the major disease of tomato which is transmitted by whitefly. The disease is characterized by severe stunting of the plants with downward rolling and crinkling of the leaves. Reduced flower, fruit setting and older curled leaves become leathery and brittle. The infected plant appears as pale and produces more lateral branches giving a bushy appearance

Management

- The disease spread can be minimized by cultural practices like use of border or barrier cropping. (Barrier crops like maize, sorghum, pearl millet etc) Five or six rows of these crops all around the main tomato plot should be sown at least 50-60 days before transplanting of tomato (http://nhb.gov.in/pdf/vegetable/tomato/tom002.pdf)
- Spray systemic insecticides like dimethoate at 2 ml /l or Imidacloprid 17.8 SL 0.5 ml/ l of water to minimize the vector (POP, TNAU)

Tomato blight

Early blight (*Alternaria solani)*

Damaging Symptoms: Small black spots on leaves and get enlarged gradually. Yellow halo around the black spots, leaf falling at severe stage and infection may occur on all the plant parts.

Late blight (*Phytophthora infestans*)

Damaging Symptoms:: Late blight disease may occur at any stage of crop. Characterized by Brown, purple or black spots may occur on any plant parts. Yellow

halo appears around the black spot. Petiole becomes black and persistent soil moisture increases the incidence of the disease.

Management

- For late and early blight spray mancozeb 2.5 g or copper oxy chloride 2.5 g/ l of water 2-3 time alternatively at 10 days interval.
- For late blight spray copper oxy chloride 2.5 g/ l of water 2-3 time alternatively at 10 days interval (Anon, 2018).


Early blight (*Alternaria solani* L.)


Late blight (*Phytophthora infestans)*

Physiological disorders in Tomato

Physiological disorders are abnormalities in fruit color or appearance that are not caused by any pest and diseases. It is caused due to abotic factors. These disorders may be caused due to nutrient deficiencies, physical-chemical or herbicide injury and environmental factors**.** Important physiological disorders of tomatoes are *viz*. blossom end rot, sunscald, catface, growth cracks, yellow shoulder, chemical injury and adventitious root *etc.*

Blossom End Rot (BER)

Symptoms: It is common on immature and ripe tomatoes. Fruit shows water-soaked lesion then becomes enlarged which turn black at final stage. Initially BER causes local injury to fruit, favours secondary organism infection which causes rotting at the blossom end of the fruit. It often occurs on rapidly developing fruit in hot and dry weather condition. BER causes greatest impact in the earliest maturing fruit (Anon, 2014)

Causes: Blossom end rot in tomato caused by multiple factors *viz*., High salinity, high $MgSO_4$, NH_4 or K concentration. A localized calcium deficiency at distal end of the fruit results in BER. Calcium is immobile element which deficiency can occur with fluctuated water. Reduced calcium uptake by the plant causes BER. Accelerated plant growth rate, unfavorable moisture relationships.

Management

- Polyethylene mulching to maintain adequate soil moisture.
- Misting/ fogging in protected condition to reduce its incidence.
- Proper fertilization management.
- Adequate water management.
- Selections of blossom end rot tolerant varieties.
- Soil analysis to recommend calcium requirement.
- Foliar spray of calcium nitrate ($CaNO_3$) 0.5-1 per cent at fruit development
- Foliar spray of $CaCl_2$ 0.5 per cent at fruit development (Verma, 2018).

Fruit Cracking

Symptoms: Fruit cracking is common in tomato. Two types cracking are found in tomato such as concentric and radical cracking. In former type, splitting of the epidermis in circular pattern around the pedicel scar is found wherein, in radial cracking splitting toward the blossom end from the pedicel scar is found. Probably, cracks occur at fully ripe stage as compared to mature green or breaker stage. Less susceptible cultivars do not crack till the breaker stage, more tolerant cultivars do not crack till they are red ripe and resistant cultivars rarely cracks (Anon, 2014).

Causes : This physiological disorder is coincides with rapid fruit development and wide fluctuations in water availability to the plant. Sudden water availability causes rapid fruit expansion leading to fruit cracking. Fruit ripening during dry weather may show considerable cracking if the dry period is followed by heavy rain (Anon, 2014). The high temperature and light intensity also may induce fruit cracking. Some cultivars crack more than other because of genotypic differences. Boron deficiency (especially calcareous soil) also leads to fruit cracking. Fruit exposed to sunlight leads to more concentric cracking (Varma, 2018)

Management

- Selection of cultivars tolerant to cracking.
- Proper water management.
- Adequate nutrient management.
- Avoid defoliation (foliar diseases at fruit maturity) to save fruit from heat exposure.
- Soil application of borax @ 5 kg/ha at 7^{th}, 30^{th}, 60^{th}, and 90^{th} days after transplanting, equally (Tupakar, 2017).
- Two to 3 foliar spary of borax 0.25 per cent during fruiting - ripening stage (Varma, 2018).
- Foliar application of 0.2 per cent boric acid (Anon, 2018 b)
- Protected condition tomato cultivation.

Sunscald

Symptoms: In this disorder, yellow coloured patch appears on the side of tomato fruit when it ripens. When, green fruit exposed to direct sunlight get into ripe unevenly. So

that, probably symptoms appears at the mature green to breaker stage of fruit development. Initially fruit becomes whitish with shiny area. The killed tissues gradually converted into slightly sunken area that become pale yellowish and wrinkled at fruit ripening. Such portion immediately infected by secondary infection of organisms and the fruits are get spoiled. The extent of the injury is more serious during periods of abnormally high temperatures.

Causes: Pruning in tomato suddenly exposes fruit to hot heat from sun. Natural spreading of the plant caused due to heavy fruit load or loss of foliage due to heavy disease attack. In hot sun light, surface temperature may be 10 ^{O}C more the air temperature.

Management

- Careful pruning and harvesting.
- Foliar disease control.
- Cultivate cvs with good foliage cover.

Blotchy ripening (gray wall)/ Yellow shoulder

Symptoms: In this disorder, the shoulders of tomato fruit exposed to the sun. Chlorophyll in this area is slowly break down at ripening which could reflects into either green or yellow patches but not red. The affected area remains green or yellow nearly at the stem end of the tomato fruit. The outer pericarp of the affected area becomes hard and white.

Causes : Fruit exposure to high temperature during fruit maturation and ripening. Potassium deficiency also causes this disorder.

Management

- Balanced fertilizer management.
- Adjust planting date to achieve favorable light intensity for fruit development.
- Avoid fruit exposure to the sun.
- Picking of fruit at the breaker stage.
- Allow fruit to ripe at room temperature.

Cat face

Symptoms: Fruit deformity is usually occurred at the blossom end of the fruit hence fruit becomes unmarketable. It is commonly observed in first harvest. The fruit becomes misshapen with enlarged scars and holes at the blossom end of the fruit.

Causes : Cold weather at the time of blossom setting (before anthesis) which kills certain cells that could develop into fruit.

Management

- Maintenance of sufficient soil moisture balance.

- Protected cultivation (heating to reduce cold temperature during anthesis).

References:

Anonymous (2018). Directorate of Extension Education, *Krushidarshani*, MPKV, Rahuri

Anon, 2014, Area based IPM package, Department of Agriculture and Co-operation, Government of India, pp-18.

Anon, (2014 b). Physiological disorders of tomato. Report on plant disesses,

Department of Crop Sciences, University of Illinois at Urbana-Champaign, **RPD No. 981,** December, 2014.

Bhowmik D., Sampath K.P., Paswan S., Srivastava S. 2012. Tomato-A Natural Medicine and Its

Health Benefits. Journal of Pharmacognosy and Phytochemistry. **1**(1): 24.

Bhat, P. S., Saroja, S. Prasad, B. S. R. and Ranganath, H. R. 2017. Efficacy of newer molecules for the management of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) - an invasive pest on tomato. Pest Management in Horticultural Ecosystems., **23(2)**: 170-173

Blay, E. Commercial tomato production in Ghana. In: Kyofa-Boamah, M., Blay, E., Braun, M. and Kuehn, A. (eds.). Handbook of crop protection in Ghana: An IPM Approach. 2005; **5:**139-156

Chandish R Ballal., Ankita Gupta, M. Mohan, Y. Lalitha and Abraham Verghese, 2016. The new invasive pest *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in India and its natural enemies along with evaluation of Trichogrammatids for its biological control, Current Science. **110(11)**:2155-2159 Pareek, P.L and Bhargava, M. C., 2003. Estimation of avoidable losses in vegetables caused by borers under semi arid condition of Rajasthan. *Insect Envioronment.* **9:**59-60.

Davies J. N., Hobson G. E., McGlasson W. B. 1981. The constituents of tomato fruit-the influence of environment, nutrition, and genotype. Critical Reviews in Food Science and Nutrition., **15**:205-80.

Desneux N, Wajnberg E, Wyckhuys KAG, Burgio G, Arpaia S, Narva'ez-Vasquez CA, 2010. A Biological invasion of European tomato crops by Tuta absoluta:

ecology history of invasion and prospects for biological control. *Journal of Pest Science*. **84:**403-408.

Freeman B. B., Reimers K. J., 2011. Tomato Consumption and Health: Emerging Benefits. American Journal of Lifestyle Medicine.

Ganji V, Kafai MR. Population determinants of serum lycopene concentrations in the United States: data from the Third National Health and Nutrition Examination Survey, 1988-1994. *J Nutr*. 2005;135:567-572.

Giovannucci E. 1999. Tomatoes, tomato-based products, lycopene, and cancer: review of the epidemiologic literature. Journal of National Cancer Institute. **91**:317-31.

Gopalan C. Rama Shastri B. V., Balasubramanian S. C., 2012. Nutritive Value of Indian Foods, NIN, ICMR.

Gould W. A. 1992. Tomato production, Processing and Technology Baltimore, USA: CTI Publications.

IRAC 2014 - The Insecticide Resistance Action Committee *Tuta absoluta* – The Tomato Leafminer or Tomato Borer Recommendations for Sustainable and Effective Resistance Management

Leoni C. I. 1993. Derivati Industriali del pomodoro. Parma, Stazione Sperimentale per I'Industria delle conserve alimentary. Leoni C, Jongen W. 2002. Improving the nutritional quality of processed fruits and vegetables: the case of tomatoes. Fruit and vegetable processing: improving quality, 52-66.

Nasir M. U. , Hussain S., Jabbar S. 2015. Tomato processing, lycopene and health benefits: A review. Science letters., **3** (1) : 1-5.

Tupkar Gajanan (2017). Tomato farming. *Agrowon news paper (Marathi),* Maharashra, **20, December**, 2017

Schmitz H.H., Poor C. L., Wellman R., Erdman Jr. J. W. 1991. Concentrations of selected carotenoids and vitamin A in human liver, kidney and lung tissue. Journal of Nutrition., **121**:1613-21.

Sam, G. A, Osekre, E.A., Mochiah, M.B., Kwoseh, C., 2014, Evaluation of insecticides for the management of insect pests of tomato, *Solanum lycopersicon* L. *Journal of Biology, Agriculture and Healthcare*; **4(5)**:49-57

Verma Lalit Kumar (2018). Physiological disorders in tomato fruit. *Krishijagran magazine* (Source: Internet Krishijagran.com), **27 September**, 2018.

Zanoni B, Peri C, Nani R, Lavelli V. 1998. Oxidative heat damage of tomato halves as affected by drying. Food Research International. **31**:395-401.

Effect of organic, inorganic and biofertilizer on growth and yield of onion (*Allium cepa* L.) cv. GJRO-11

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Abstract: Present investigation was conducted the year 2018-19 in *Rabi* season at Horticultural Research Farm, College of Horticulture, AAU, Anand, Gujarat with ten treatments in a simple RBD with three replications. The soil application of 50% RDF (50: 37.5: 37.5 NPK kg/ha) + 25% N from vermicompost + 5 ml Bio-NPK consortium was most effective treatment and which was recorded significantly maximum on growth and yield parameters *viz.,* plant height (70.11 and 86.70 cm at 45 and 90 DAT respectively), minimum bolting per cent (4.38), average bulb weight (129.30 g), bulb volume (136.70 cc), neck thickness (1.11 cm), bulb yield (24.18 kg/plot and 497.60 q/ha), maximum A and B grade bulb yield (395.98 q/ha and 91.50 q/ha, respectively) and TSS (13.47 ^{o}Brix). While number of leaves per plant was non-significant.

Key words: Onion, Organic, inorganic, biofertilizer, growth and yield

Introduction

Onion (*Allium cepa* L.) is one of the most important vegetable bulbous crops grown in India from ancient time. Onion is the "Queen of the kitchen". The edible portion is a modified stem which is known as 'bulb' and develops underground. Onion is preferred mainly because of its green leaves, immature and mature bulbs are either eaten raw or cooked as vegetables. It is popular as salad crop and mature onion bulbs are widely used as a cooked vegetable in soaps stews and casseroles in addition to a flavoring agent in many additional dishes. It is one of the few versatile vegetable crops that can be kept for a fairly long period and can safely withstand the hazards of rough handling including long distance transportation.

In world, India ranks 2nd in area and production of onion. India is prominent in the production and export of onion in the world. Onion is being grown in area of 1285000 ha with total bulb production of 23262000 MT (Anon., 2018). In Gujarat,

onion occupied an area of about (54488 ha) with total bulb production of 1416602 MT (Anon., 2018). The major onion growing districts are Bhavnagar, Rajkot, Amreli, Junagadh, Jamnagar, Porbandar, Kutch, Mehsana, Surat and Anand. Bhavanagar is a leading district for onion cultivation of 32,000 ha area and 870400 MT production. (Anon., 2018).

As regard with the productivity the combined application of organic manures and inorganic fertilizers to increase yield but has paramount importance in ameliorating the yield. Use of inorganic fertilizers now a day is costly affair and increases cost of cultivation. Secondly the sole application of inorganic fertilizers deteriorates soil fertility level day by day, which affect the production, economics of production and human health, while organic manure and bio-fertilizers are cheap, easily available and eco-friendly, giving quality produce, improving keeping quality, T.S.S. and pungency. It improves the physiochemical properties like soil structure, infiltration rate, porosity, water holding capacity, bulk density, etc. and also very useful for the sustainable crop production as well as soil fertility and productivity.

Material and methods

A field experiment entitle “Effect of organic, inorganic and biofertilizer on growth and yield of onion (*Allium cepa* L.) cv. GJRO-11” was laid out during the year of 2018-19 at Horticultural Research Farm, College of Horticulture and Laboratory work was carried out in the Department of Horticulture as well as Department of Microbiology, B. A. College of Agriculture, Anand Agriculture University, Anand.

There were ten treatments *i.e.* T_1 -100 % RDF (control), T_2 - 75 % RDF + 25 % N from FYM, T_3 - 75 % RDF + 25 % N from vermicompost, T_4 - 75 % RDF + 25 % N from castor cake, T_5 - 50 % RDF + 50% N from FYM, T_6 - 50 % RDF + 50% N from vermicompost, T_7 - 50 % RDF + 50% N from castor cake, T_8 - 50 % RDF + 25 % N from FYM + 5 ml Bio-NPK Consortium, T_9 - 50 % RDF + 25 % N from vermicompost + 5 ml Bio-NPK Consortium and T_{10} - 50 % RDF + 25 % N from castorcake + 5 ml Bio-NPK Consortium in a Randomized block design with three replication with plot size of 3 x 2 m. The soil of the experimental field was light alluvial having sandy loam texture with the soil pH of 7.5, 0.25 % organic carbon 220.25 kg/ha available nitrogen determined by alkaline potassium permanganate method, 28.22 kg/ha available phosphorus estimated with Olson's extraction method,

258.32 kg/ha available potassium determined with Flame photometer and microbial count of soil at initial and after harvest the crop was counted by colony forming unit machine. Onion seeds were sown on 11th October, 2018. About six weeks old seedlings was transplanted on 4th December, 2018 at row to row distance of 15 cm and plant to plant distance of 10 cm. Common dose of FYM 20 t/ha applied one month before the transplanting. The organic manures (Farm yard manure, Vermicompost, and Castor cake) were applied at the time of field preparation and half of the nitrogen (N) and full dose of phosphorus (P) and potassium (K) were applied before transplanting and remaining nitrogen (N) were applied one month after transplanting. Observations were recorded for different traits. The recommended dose of fertilizer was done as NPK @100:75:75 kg/ha and Bio-fertilizers applied as a root dipping treatment (3-5 ml/l water for 10-15 minutes). Plant height was measuring by measuring scale. Bulb diameter and neck thickness measuring by Vernier Calipers. Bulb weight measure by weighing balance. TSS determined by digital rafractro meter. For observation of plant five-five plants per plot was selected at random for the purpose in each observation at different stages of plant growth as mentioned earlier and after that the average value was calculated. Recording growth parameter like plant height (cm), number of leaves, bolting percent and yield parameter like average bulb weight (g), bulb volume (cc), neck thickness (cm), bulb yield (kg/plot and q/ha), grading of bulb (A grade > 65 g, B grade 45-65 g, C grade < 45 g) and TSS (^{o}Brix). The bulbs were harvested on 30th March, 2019 when 70% tops started falling over. The tops were removed two days after field curing leaving 2.5 cm top with the bulb. The data were analyzed statistically as per standard procedure.

Result and discussion

Growth parameters

Growth of onion crop was evaluated in terms of plant height, number of leaves and bolting percent. The result of the effect of various combination of organic, inorganic and biofertilizer found that the maximum plant height (70.11 and 86.70 cm at 45 and 90 DAT respectively) and minimum bolting per cent (4.38). While number of leaves per plant at 45 and 90 DAT was non-significant in treatment T_9 (50% RDF + 25% N from VC + 5 ml Bio-NPK Consortium) which was at par with T_{10} (50% RDF + 25% N from CC + 5 ml Bio-NPK Consortium), T_8 (50% RDF + 25% N from FYM

+ 5 ml Bio-NPK Consortium) and T_6 (50% RDF + 50% N from VC) and minimum in T_2 (75% RDF + 25% N from FYM). Higher plant height, number of leaves and minimum bolting percent due to application of biofertilizer improve nitrogen status of soil because it is free nitrogen fixer, thereby increase the nitrogen level and ultimately increase plant growth and development and also vermicompost along with NPK which increase physical and biological condition of soil which helps to increase plant growth parameter and suppress bolting percent. Similar result finding were also reported by Jayathilake *et al.* (2003), Jayathilake *et al.* (2006), Chuda *et al.* (2009), Maneesh kumar (2015), Jat *et al.* (2018) Singh and Singh (2018) in onion.

Table 1: Effect of organic, inorganic and biofertilizers on growth parameters of onion cv. GJRO-11

Treatment No.	Plant height (cm)		No. of leaves/plant		Bolting (%)
	45 DAT	90 DAT	45 DAT	90 DAT	
T_1	61.75	77.57	7.73	10.40	5.29
T_2	54.21	71.19	7.27	9.53	5.48
T_3	56.71	75.67	7.53	10.13	5.33
T_4	55.47	74.77	7.40	10.07	5.46
T_5	57.07	75.93	7.63	10.20	6.20
T_6	67.67	83.53	8.00	10.73	4.77
T_7	62.19	77.70	7.93	10.47	5.09
T_8	68.03	84.57	8.07	10.90	4.53
T_9	70.11	86.70	8.13	11.07	4.38
T_{10}	68.57	85.73	8.07	11.00	4.38
S.Em. ±	2.54	3.38	0.28	0.32	0.15
C. D. at 5%	7.56	10.05	NS	NS	0.44
C.V. %	7.09	7.38	6.29	5.23	5.08

Yield parameters

The result of the effect of various combination of organic, inorganic and biofertilizer found that the maximum average bulb weight (129.30 g), bulb volume (136.70 cc), neck thickness (1.11 cm), pollar diameter (5.56 cm), equatorial diameter

(6.91 cm), bulb yield (24.18 kg/plot and 497.60 q/ha), maximum A and B grade bulb yield (395.98 q/ha and 91.50 q/ha, respectively) and TSS (13.47 ^{o}Brix) in treatment T_9 (50% RDF + 25% N from VC + 5 ml Bio-NPK Consortium) which was at par with T_{10} (50% RDF + 25% N from CC + 5 ml Bio-NPK Consortium), T_8 (50% RDF + 25% N from FYM + 5 ml Bio-NPK Consortium) and T_6 (50% RDF + 50% N from VC) and minimum in T_2 (75% RDF + 25% N from FYM). Because of application of biofertilizer improve nitrogen status of soil and also it is free nitrogen fixer, thereby increase the nitrogen level, major nutrient avaibility is supplied by inorganic fertilizer will be utilized quickly and other essential secondary nutrient slowly released by organic substance and also vermicompost increase physical and biological condition of soil which helps to increase vegetative growth of plant & due to high rate of photosynthesis, chlorophyll synthesis & translocation of more photosynthates to the storage organ resulting good bulb yield. Similar result finding were also reported by Krishnamurthy (2005), Mahanthesh *et al.* (2005) and Chuda *et al.* (2009), Kumar *et al.* (2011), Mandal *et al.* (2013), Singh *et al.* (2015), Rabari *et al.* (2016) in onion.

Conclusion

On the basis of the present investigation study, it could be concluded that treatment T_9 -50% RDF (50: 37.5: 37.5 NPK kg/ha) + 25% N from vermicompost + 5 ml Bio-NPK consortium was found superior in respect to growth parameter and yield of onion cv. GJRO-11 under Middle Gujarat condition.

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Table 2: Effect of organic, inorganic and biofertilizers on yield parameters and yield of onion cv. GJRO-11

Treatment No.	Average bulb weight (g)	Bulb volume (cc)	Neck thickness (cm)	Bulb diameter (cm)		Bulb yield		Grading of bulbs			TSS (^{o}Brix)
				Pollar diameter	Equatorial diameter	Kg/plot	q/ha	A grade	B grade	C grade	
T_1	116.60	120.17	0.84	5.16	6.22	19.39	398.97	327.37	46.84	24.69	12.48
T_2	105.07	107.07	0.69	4.58	5.83	16.30	335.39	270.03	28.81	36.69	11.71
T_3	111.13	117.53	0.81	5.01	6.08	18.06	371.60	298.77	41.02	31.96	12.47
T_4	110.80	116.67	0.84	4.87	5.98	17.07	351.17	287.79	29.42	34.02	12.28
T_5	113.33	119.23	0.84	5.10	6.16	18.52	381.00	307.89	44.92	28.33	12.51
T_6	123.64	128.40	0.96	5.36	6.44	21.84	449.31	353.37	83.88	12.21	13.15
T_7	117.93	123.07	0.86	5.21	6.30	20.42	420.10	342.11	61.80	16.19	12.96
T_8	123.73	128.87	0.97	5.44	6.49	22.60	465.02	369.00	84.43	11.66	13.18
T_9	134.30	136.70	1.11	5.56	6.91	24.18	497.60	395.98	91.50	10.01	13.48
T_{10}	126.13	131.80	1.07	5.48	6.73	23.01	473.39	371.67	90.88	10.77	13.37
S.Em. ±	4.86	2.90	0.05	0.11	0.16	0.95	19.60	14.56	3.05	1.05	0.33
C. D. at 5%	14.45	8.61	0.16	0.34	0.47	2.83	58.23	43.26	9.06	3.13	0.98
C.V. %	7.12	4.08	10.40	3.82	4.31	8.19	8.19	7.59	8.75	8.43	4.47

References

Adagale, S. V., Masalkar, S. D., & Pandure, B. S. (2009). Effect of integrated nutrient management on growth and yield of onion seed production. *Asian Journal of Horticulture*, 4 (2), 484-487.

Anonymous (2018). Directorate of Horticulture, Gujarat State, Gandhinagar.

Anonymous (2018). Indian Horticuture Database, National Horticulture Board, Ministry of Agriculture, Government of India.

Chuda, K., Kanaujia, S. P., Singh, V. B., & Singh, A. K. (2009). Effect of integrated nutrient management on growth, yield and quality of *kharif* onion under terraced condition of Nagaland. *Environment and Ecology*, 27(4), 1511-1513.

Dilpreet, T., Singh, K., Varinder, S., & Singh, J. (2016). Growth, yield and quality of onion as influenced by integrated nutrient management. *International Journal of Agriculture Sciences*, 8 (51), 2295-2298.

Gajbhiye, R. P., Sharmar, R. R., & Tewari, R. N. (2003). Effect of biofertilizers on growth and yield parameters of tomato. *Indian Journal of Horticulture*, 60(4), 368-371.

Geetha, K., Raju, A. S., & Shanti, M. (1999). Effect of farm yard manure and potassium on yield of onion at different stages of growth. *Journal Research ANGRAU*, 27(1-2), 18-23.

Jat, K. P., Garhwal, O. P., & Singh, S. P. (2018). Influence of organic, inorganic fertilizers and biofertilizers on growth, yield and quality of onion. *IJCS*, 6(3), 01-06.

Jawadagi, R. S., Basavaraj, N., Naik, B. H., Patil, B. N., & Channappagoudar, B. B. (2012). Effect of planting geometry and organic sources of nutrients on growth, yield and quality of *rabi* onion Cv. Bellary Red. *Karnataka Journal of Agricultural Sciences*, 25 (2), 232-235.

Jayathilake, P. K. S., Reddy, I. P., Srihari, D., & Reddy, K. R. (2006). Productivity and soil fertility status as influenced by integrated use of N-fixing biofertilizers, organic manures and inorganic fertilizers in onion. *Journal of Agricultural Sciences*, 2(1), 46 58.

Jayathilake, P. K. S., Reddy, I. P., Srihari, D., Reddy, K. R., & Neeraja, G. (2003). Integrated nutrient management in onion (*Allium cepa* L.).*Tropical Agricultural Research*, 15, 1-9.

Krishnamurthy, D., Sharanappa, M., Umesh, R., & Chandrashekhar, C. (2009). Effect of integrated nutrient management on soil nutrient status and balance in onion production under irrigated condition. *Crop Research*, 37(1, 2 and 3), 124-128.

Kumar, M. (2015). Studies of integrated nutrient management on growth, yield and quality traits of onion (*Allium cepa* L.) (Doctoral dissertation, JNKVV).

Kumar, S., Anoop Kumar & Yadav, Y. C. (2011). Efficacy of bio-fertilizers with NPK on growth and yield of onion (*Allium cepa* L.) cv. Nasik Red. *Asian J. Hort*. 6(1), 256-258.

Mahanthesh, Ravi Prasad Sajjan, M., Harshavardhan, M., Vishnuvardhana., & Janardhan, G. (2008) .influence of inorganic and biofertilizers on dry matter production and yield of rainy season onion cv. Bellary Red. *The Asian J of Hort*, 4 (1), 59 -62

Mandal, J., Ghosh, C., & Chattopadhyay, G. N. (2013). Proportional substitution of chemical fertilizers with vermicompost on growth and production potential of onion (*Allium cepa* L.). *International Journal of Bio-resource and Stress Management*, 4(2), 356-357.

Mandloi, K. S., Bose, U. S., & Deshmukh, K. S. (2008). Effect of organic manures and inorganic fertilizers on growth and yield of onion (*Allium cepa* L.). *Asian Journal of Horticulture*. 3 (2), 238-240.

Patel, K. (2007). Combined effect of nitrogen, organic manures and biofertilizer on growth, yield and quality of onion (*Allium cepa* L.) varieties. (Doctoral Dissertation, Anand Agricultural University).

Rabari, K.V., Patel, M.V., & Umale, A. A. (2016). Effect of nutrient management on growth, TSS content, bulb yield and net realization from onion bulb. *Biosciences Biotechnology Research Asia*, 13(1), 557-559.

Singh Shalini & Sharma Richa (2018). Efficacy of farmyard manure for growth and yield of onion (*Allium cepa* L.) cv. N-53. *Journal of Pharmacognosy and Phytochemistry*, 7(4), 2771-2775.

Singh, A., Ram, R. B., & Meena, M. L. (2015). Efficacy of different sources of nutrient and biofertilizer on growth, yield, quality of onion. *International Research Journal of Natural and Applied Sciences*, 2 (10), 64-70.

Singh, D., & Singh, B. (2018). A study of integrated nutrient management on growth and yield of onion (*Allium Cepa* L.) Cv. Nasik red. *The Pharma Innovation Journal*, 7(5, Part G), 473.

Somashekar, G. (2014). Effect of different combinations of organic manures and supplementation of bio-fertilizers on growth, yield and quality of onion (*Allium cepa* L.). (Doctoral Dissertation, Dr. Ysr Horticultural University).

Yadav, D., Prasad, V. M., & Gujar, K. D. (2005). Effect of different biofertilizers in association with phosphorus on growth and yield of onion (*Allium cepa* L.), a white onion var. JNDWO. *New Agriculture*, 16 (1/2): 87-89.

Yogita & Ram (2012). Effect of chemical and biofertilizers on quality of onion. *Hort Flora Research Spectrum*, 1 (4), 367-370.

Integrated Nutrient Management and Nutrient Uptake in Pumpkin

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Abstract

An experiment entitled "Integrated nutrient management studies in pumpkin" was carried out during summer season of 2011 at Horticulture Farm, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment conducted in Randomized Block Design with three replications using cv. Arka chandan, with ten treatments, two kinds of organic manures (FYM and Vermicompost) alone and in combination with two kinds of bio-fertilizers (Azotobacter and PSB) and reduced doses of chemical fertilizers were tested in comparison with RDF.

On the basis of results, the application of 50:25:25 Kg NPK ha^{-1} + FYM 25 t ha^{-1} + seed treatment with PSB to the crop found to be sound integrated practice. The integrated use of inorganic fertilizers, organic manures and bio-fertilizers had a significant effect on nutrient uptake. The highest uptake of Nitrogen, Phosphorus, and Potash by pumpkin vine was recorded maximum in the treatment 50 kg N, 25 kg P_2O_5, 25 kg K_2O ha^{-1} dose of fertilizers in combination with FYM 25 t ha^{-1} and seed treatment with PSB 25 g kg^{-1} of seed. i.e. T_4. Available Nitrogen, Phosphorus and Potash in the soil after harvest of pumpkin crop were highest in the treatment with application of inorganic fertilizers 50 kg N, 25 kg P_2O_5, 25 kg K_2O ha^{-1} in combination with FYM 25 t ha^{-1} and seed treatment with PSB 25 g kg^{-1} of seed. i.e. T_4 recorded maximum Nitrogen, Phosphorus, Potash (190.23, 27.97, 386.91 kg ha^{-1} respectively).

Key words: Pumpkin, INM, Arka Chandan, Vermicompost, FYM

Introduction

Cucurbitaceae is one of the largest family in vegetable kingdom consisting of largest number of edible type species. Pumpkin (*Cucurbita moschata Poir.)* is one such important vegetable belongs to family Cucurbitaceae. Pumpkin fruits are extensively used as vegetables both in immature and mature stage. The yellow and orange fleshed fruits are very rich in carotene (3,332 IU), which is precursor of Vitamin-A with fair quantities of vitamins B and C (Prem Nath et al., 1973). In modern agriculture, chemical fertilizers constitute the major portion of total cost of seed production. As the cultivation of pumpkin is fast expanding, the growers often come across one or the other problems that limit its fullest expressions of growth and productivity. Hence, these problems could be overcome partially or completely by using different agrochemicals like mineral nutrients and growth regulators. The optimum doses of nitrogen, phosphorus and potassium vary greatly with the length of growing season, fertility status of soil, soil type, cultivar, geographical location and the environmental factors. These factors will have marked effect on the growth and yield parameters of pumpkin.

Material and Methods

The experiment entitled "Integrated Nutrient Management studies in Pumpkin" was conducted at Horticulture farm, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2011. Sowing of pumpkin seed on medium black soil, it was free from weeds and disease infection. In order to know the chemical properties of soil a representative soil sample was collected from experimental site by using appropriate soil sampling technique. The treatments detail are as follow as, T_1 - 50:25:0 kg NPK (RDF) + FYM @25t/ha, T_2 -50:25:25 kg NPK + FYM@25t/ha, T_3- 25:25:25 kg NPK + Seed treatment with Azotobacter @ 25 g/kg seed + FYM@25t/ha, T_4 - 50:25:25 kg NPK + Seed treatment with PSB @ 25 g/kg seed + FYM@25t/ha, T_5 - 25:25:25 kg NPK +Seed treatment with Azotobacter and PSB @ 25 g/kg seed + FYM@25t/ha, T_6- Seed treatment with Azotobacter and PSB @ 25 g/kg seed + FYM@25t/ha, T_7- Seed treatment with Azotobacter and PSB @ 25 g/kg seed + Vermicompost 2 t/ha + FYM@25t/ha**,** T_8 - 50:25:0 kg NPK + Seed treatment with PSB@ 25 g/kg seed +FYM@25t/ha, T_9 - 50:25:0 kg NPK + Seed treatment with Azotobacter and PSB @ 25 g/kg seed + FYM@25t/ha, T_{10}- 25:25:25 kg NPK + Seed treatment with Azotobacter and PSB @ 25 g/kg seed + vermicompost 2 t/ha + FYM @25t/ha. The experiment was laid out in Randomized Block Design with Three replications and Ten treatments. Variety used was Arka

Chandan for Pumpkin. Five plants were selected at random in each plot to record the observations on Flesh colour of fruit, Thickness of flesh (cm), Number of seeds per fruit, Total Soluble Solids (%),Yield per hectare (q), Nutrient uptake (%) by vine, Final nutrient status after harvest(kg ha^{-1}).

Table 1. Effect of integrated nutrient management on total nitrogen, total phosphorus and total potassium content of the vine and Available soil Nitrogen, Phosphorus and potassium after harvest (kg ha^{-1}) as influenced by integrated nutrient management

Treatments	**Number of seeds/fruit**	**Thickness of flesh (cm)**	**TSS (%)**	**Flesh colour of fruit**	**Yield / ha (q)**	**Nutrient uptake (%) by vine**			**Final nutrient status after harvest(kg ha^{-1})**		
						N	**P**	**K**	**N**	**P**	**K**
T_1	223.33	1.90	11.30	Yellow	80.28	3.88	0.37	0.23	186.76	21.15	335.32
T_2	318.58	2.03	7.76	Pale yellow	106.66	3.93	0.36	0.27	188.84	24.30	367.43
T_3	302.47	2.00	9.90	Yellow	137.14	4.03	0.35	0.24	178.13	24.24	364.08
T_4	380.12	2.67	11.76	Yellow	210.95	4.23	0.42	0.39	190.23	27.97	386.81
T_5	361.67	2.37	9.26	Pale yellow	161.90	3.40	0.38	0.35	189.75	27.09	359.49
T_6	354.25	2.20	11.50	Pale yellow	159.52	3.32	0.41	0.29	162.75	27.68	362.08
T_7	365.82	2.07	9.06	Yellow	94.28	3.60	0.28	0.28	174.91	26.67	360.14
T_8	342.08	2.17	8.36	Yellow	117.61	3.89	0.38	0.32	182.03	26.91	358.96
T_9	309.33	2.07	8.80	Yellow	90.95	3.97	0.33	0.28	190.21	27.94	364.08
T_{10}	291.67	2.03	8.93	Yellow	144.76	3.62	0.39	0.28	180.08	25.67	368.31
'F' Test	Sig.	Sig.	Sig.	-	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)±	9.208	0.10	0.54	-	14.69	0.049	0.02	0.01	2.14	1.20	1.54
C.D. at 5%	27.36	0.31	1.61	-	43.66	0.14	0.06	0.04	6.37	3.58	4.59

Result and discussion

The number of seeds per fruit was recorded maximum in treatment T_4 (380.12) followed by T_7, T_5 and T_6 were found at par with each other. Minimum (223.33) number of seeds was recorded in treatment T_1.In respect of thickness of flesh showed significant influence over INM. The treatment T_4 recorded maximum (2.67cm) thickness of flesh, which was at par with the treatment T_5. Whereas, minimum (1.90cm) thickness of flesh was recorded in the treatment T_1. The maximum (11.76%) TSS percentage was recorded significantly in the treatment T_8. The minimum (7.56 %) TSS percentage was recorded in the treatment T_2. The results of present investigation are in agreement with the finding of Randhawa *et.al.* (1981). The observation on

the effect of INM on flesh colour of pumpkin fruit was recorded. Basically, pumpkin produces fruit with yellowish flesh colour. Observation were recorded by eye estimation, most of the fruit did not show variation regarding flesh colour. In respect to the yield of fruit per hectare treatment T_4 produced maximum (210.95q/ha), which is significantly superior over all other remaining treatments followed by T_5, T_6, T_3, T_{10}, T_8 and T_2. The minimum (80.28q/ha) yield per hectare was recorded in T_1.

Nutrient uptake by vine for nitrogen reveals that, maximum (4.23kg) nitrogen uptake by vine was found in treatment T_4, which was at par with treatment T_3. Minimum (3.32kg) uptake of nitrogen was recorded in T_6. Phosphorous uptake by vine was recorded Maximum (0.42%) in treatment T_4 and the treatment T_7 recorded minimum (0.28%) uptake of total phosphorus. Potassium uptake by vine indicated that, the treatment T_4 recorded maximum (0.39%) amount of total potash content and it was found to be at par with the treatment T_5 (0.35%). The treatment T_1 recorded minimum (0.23%) uptake amount of total potash.In general, overall trend of the data revealed that integrated use of inorganic fertilizers along with application of organic manures and biofertilizers resulted in increased N uptake compared to sole application of organic manures or inorganic fertilizers. The results are in conformity with the findings of Balemi, (2003), Mali et al., (2003). The maximum total uptake of P by plant was recorded in T_4-50:25:25 NPK kg ha^{-1} + 25 t FYM ha^{-1} and seed treatment of PSB which was significantly superior over other treatments. These findings are in conformity with the results obtained by Subbaiah (1994) which revealed that application of biofertilizers increased P uptake along with increasing uptake of N in pumpkin. The phosphate activity and phosphorus content (shinde et al. 1992) was more in vermicompost than FYM, resulted in higher uptake and availability of phosphorus after harvest. The same trend in increasing K_2O uptake by pumpkin plants. This may be due to fact that favorable effect of higher uptake of N influenced the faster growth of plant that increases the demand for K_2O in soil.

Available soil Nitrogen after harvest (kg ha^{-1}) as influenced by integrated nutrient management

The data presented in Table 1 revealed that, various combinations of inorganic fertilizers, organic manures and biofertilizers significantly influenced the nutrient status of

Nitrogen, Phosphorus and Potash in the soil after harvest in integrated nutrient management system.

The significantly maximum (190.23 kg ha^{-1}) nitrogen was observed in the soil with the treatment T_4 receiving application of 50:25:25(NPK kg ha^{-1}) recommended dose of fertilizers in combination with FYM 25 t ha^{-1} and seed treatment of PSB with 25gm kg^{-1} of seed, which was at par with T_9, T_5, T_2, followed by treatment T_1, T_8, T_{10} at par with each other. Minimum (162.75 kg ha^{-1}) nitrogen was recorded in the soil after harvest in the treatment T_6 where no use of chemical fertilizer was done. In respect of Phosphorus status in the soil after harvest, various combinations of inorganic fertilizers, organic manures and biofertilizers significantly influenced it. Significantly maximum (27.97 kg ha^{-1}) phosphorus was recorded in the treatment T_4 which was at par with T_9, T_6, T_5 and T_3. Whereas, minimum phosphorus was recorded in the treatment T_1 (21.15 kg ha^{-1}). Potash status in the soil after harvest was significantly influenced by various treatments of integrated nutrient management. Significantly maximum (386.81kg ha^{-1}) potash was recorded in the treatment T_4 with the 50:25:25 (NPK kg ha^{-1}) dose of fertilizers in combination with FYM 25 t ha^{-1} and seed treatment of PSB, which was significantly superior over other treatments. The minimum (335.35 kg ha^{-1}) Potash was recorded in treatment T_1.

There was an overall increase in the available NPK in soil with the combined application of inorganic fertilizers, organic manures and Biofertilizers. Improvement in the status of available nutrients in the soil after harvest of the crop was due to addition of these nutrients through application of organic manures, inorganic fertilizers and biofertilizers. This may be attributed to direct application of inorganic fertilizers and slow release of N through Vermicompost or FYM and biological fixation of N by bacteria. Vermicompost is a better source of N and a good carrier material for Azotobacter and PSB (Ismael, 1995) over the FYM (Shinde *et al*., 1992). Vermicompost may brought up the population of Azotobacter and PSB which resulted in higher available in the soils.

LITERATURE CITED

Balemi, T., 2003. Onion for Azotobacter inoculation in integrated nutrient management: Agri Topia, 18:1/2, 1-2. 5 ref.

Bose, T.K., 2002. Vegetable Crops Vol.1.

Das, R. C. and S. C. Swain, 1977. Effect of growth substances and nitrogen on growth, yield and quality of pumpkin (*Cucurbita moschata Dychesne*). Indian J. Hort., 34 (1): 51

Gupta, A. and K. Srinivas, 1976. Response of pumpkin to nitrogen and phosphorus fertilization. Indian J. of Hort. 12: 289-293.

Ismail. S. 1995. Earth worms in soil fertility management in Organic agriculture (Ed:P.K.Thampan) Peekay tree crops development foundation, cochin pp.78-95Karuthamani, M., S. Natarajan. and S. Thamburaj, 1995. Effect of inorganic and biofertilizers on growth, flowering and yield of pumpkin(*Cucurbita moschata*) cv. Co-2. S. Indian Hort. 43: 134-136.

Mali, M.D., 2004. Effect of organic manures on yield quality of cucumber (*Cucumis sativus L*.). Cv. Himangi. M.Sc.(Agri.) Thesis unpublished submitted to M.P.K.V., Rahuri.

Obiagwu C.J. and N.I. Odiaka, 1995. Fertilizer schedule for yield of fresh fluted pumpkin (*Telfairia occidentalis*) grown in lower benue river basin of Nigeria. Indian J. of Agric. Sci. 65(2): 98-101.

Prabhakar, B.S., Srinivas. K. and V. Shukla, 1985. Yield and quality of muskmelon cv. Hara Madhu in relation to spacing and fertilization. Progressive Hort., 17(1): 51-55.

Randhawa, K.S., D.S. Cheema and K.S. Sandhu, 1981. The effect of nitrogen, phosphorus and potassium on growth, yield and quality of new muskmelon varieties. Haryana J. Hort. Sci. 10(1-2): 88-94.

Sreenivas, C.H., S. Muralidhar, and M. Singarao, 2000. Yield and quality of ridgegourd fruits as influenced by different levels of inorganic fertilizer and vermicompost. Ann. of Agric. Res. 21(2): 262-266.

Shinde, P.H., R.L. Naik, R.B. Nazikar, Kanndam and Khaire,1992. Evaluation of vermicompost ,Proceedings of national seminar organic farming M.P.K.V.,Pune.

Onion yellow dwarf virus: A threat to onion farmers

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Abstract

Onion yellow dwarf virus (OYDV; Family- Potyviridae; Genus- Potyvirus) is a major virus infecting onion. The symptom includes stunting in onion and shallot. Leaves show irregular yellow striping to almost complete yellowing and also downward curling, flattening and crinkling. Also deterioration during storage and premature sprouting of bulbs may occur. Generally leek does appear to be resistant. OYD virus is transmitted by over 50 aphid species in a non-persistent manner and by mechanical inoculation. Seed transmission is not reported in *Onion yellow dwarf virus*. The main route of natural spread is by vector transmission and through vegetative propagation of infected hosts. Detection is mainly done through ELISA and virus specific antisera. Virus indexing against the virus is a must for production of healthy planting materials. High quality viral antibody with less contamination of host (plant) proteins is an essential pre requisite for virus indexing.

Keywords: *Onion yellow dwarf virus,* serology, virus indexing, vector.

Introduction

Onion (*Allium cepa*), herbaceous biennial plant comes under the family Amaryllidaceae, rise for the edible bulb. The onion is likely originated from southwestern Asia but is now grown throughout the world, mostly in the temperate zones. Onions are not sounded with nutrients but are prized for their flavour and are used widely in kitchen purpose (Anonymous, 2018; Anonymous, 2019). Onions are among the world's hoariest domesticated plants. 'Onion', the name is probably derived from a Latin word '*unus'*, which represents the world, meaning 'one'.

It was among the first crops found to suffer from a damaging 'mosaic disease', but the identity of the causal agent remained uncertain until the recent researches.

Major Allium viruses that have international concern are *Garlic common latent carlavirus*, *Garlic dwarf reovirus*, *Leek yellow stripe potyvirus*, *Mite-borne filamentous viruses*, *Onion yellow dwarf virus* (OYDV), *Shallot latent carlavirus* and *Shallot yellow stripe potyvirus*. Pathological perspective, *Onion yellow dwarf virus*, a *Potyvirus* has prime concern and has a narrow host range (onions, garlic, shallots and a few ornamental *Alliums* sp.). It is flexious filamentous virus having 775 nm. length. It survives in bulbs and setts, and therefore can be transmitted during vegetative propagation. The disease is caused by a virus that is transmitted by various aphid species like *Myzus persicae* (green peach aphid), or mechanically to onions and other crops such as garlic, leek and some other species. The virus can also survive in volunteer onions. Although the virus is not spread to the seed, seed from infected plants is of poor quality.

Based on sequence homology, occurrence of three distinct groups of Potyviruses infecting *Allium* spp. has been proposed (Delecolle *et al*., 1981). Two individual virus species have been denoted OYDV, *Onion yellow dwarf virus* (Fa: Potyviridae; genera Potyvirus; Garlic [G] and Onion [O] strains) and LYSV, *Leek yellow stripe virus* (Fa: Potyviridae; genera: Potyvirus). Some of the virus diseases of Allium crops can be easily controlled through hygienic measures, but others may require breeding for resistance. Promising results have been obtained in freeing garlic from virus(es) by tissue culture. Application of these techniques is used for virus free seedlings.

Symptoms of virus infection

Onion is a sterile plant. During generations of cultivation, a multitude of diseases have infected this crop, causing yield and quality reduction (Sable et al., 2020). Stunting is the major symptom associated with the virus. On leaves it shows yellow stripes, which varies with respect to isolate of the virus and cultivar of host. The infected crop lag behind in growth with the healthy one along with reduced bulb size (Melhus *et al*., 1929). The infection may lead to severe in complex virus attack. The virus is cosmopolitan in nature. In young onions, first symptom of onion yellow dwarf is the appearance of yellow streaks at the bases of the first true leaves. After

this initial symptom, all developing leaves show symptoms ranging from yellow streaks to complete yellowing of the leaves. Leaves are sometimes crinkled, flattened and tend to fall over; bulb size get reduced. In case of complex viral infection, it probably contributes to mosaic symptoms. In many cases, onion plants are infected with a variety of viruses, but elimination of these viruses is difficult because this crop is propagated through bulbs. Potyviruses, carlaviruses, and allexiviruses have been detected in diseased plants. Among these, *Onion yellow dwarf virus* (OYDV) is important viral pathogens of onion. Virus diseases of onion are widespread in the world, causing serious damage to yields and quality of the crop.

Generally the plant appears dwarf and effect a wilted appearance. Do not confuse virus symptoms with those of normal-shaped leaves with alternate yellow or green bands caused by genetic or vegetative mutations. Infected bulbs (transplants, volunteers) always produce diseased plants and serve as sources of contamination for following seasons, especially when aphid populations are high. Therefore, disease-free transplants and non-host rotation result elimination of the virus from field. Other disease management recommendations include isolation from other susceptible crops or volunteer onions, and insect control is also effetive. Infected leaves may crinkle and flop over. Symptoms are more pronounced on leaves that develop from an infected bulb or transplant, and the yellow streaks begin at the base of the first leaves and successive leaves as they emerge. Later, there is more pronounced yellowing, and leaves crinkle, flatten, twist, and fall to the ground. Flower stems are shortened, streaked with yellow, and twisted.

Generally, viruses and virus strains could not be transmitted to any Allium species other than their natural host, except to the highly susceptible crow garlic (*A. vineale*). This species, and other predominantly vegetatively propagating wild *Allium* spp. (field garlic, *A. oleraceum*; *A. ursinum;* sand leek), were found not to be reservoirs of viruses that might infect Allium crops. Streaking in vegetative propagated wild leeks (*A. ampeloprasum* and closely related species) originating from the Mediterranean area and Asia was due to an undescribed mite-borne virus. Some studies confirmed that spread of potyviruses in Allium crops in the Netherlands is from planting sets, and from a neighboring crop only if of the same species (Dijk, 1993).

Serology based detection of Allium viruses

Recent studies provided strong evidence that the majority of vegetatively propagated *Allium* spp. are commonly infected by several distinct viruses. Former attempts to characterize viruses infecting *Allium* spp. often led to confusing results and to an inappropriate naming of viruses, for example *Garlic yellow stripe virus*, *Garlic yellow streak virus* and *Garlic mosaic virus* (GMV). Later studies showed that researchers coining these names had actually worked on mixtures of some of the now formally described viruses. This was also the reason that many antisera produced in the former studies against virus preparations from naturally infected *Allium* spp. contained antibodies to a range of different viruses, rendering them unsuitable for the identification of Allium viruses. In any case, gave that these antisera don't respond with host component (and cryptic viruses) and, above all, have been inspected for their sensitivity to a portion of the major viruses in vegetative propagated *Allium* spp., they can be utilized for virus indexing in a virus elimination program, in connection with antisera and monoclonal antibodies to Allium viruses not recognized by the oligospecific antisera. Classification and nomenclature of these viruses has been widely confused due to use of cross reactive antisera, the relatively low sensitivity of serological methods, and the lack of plants infected by a single, positively identified virus needed to complete Koch's postulates. More confusion was added after the initiation of molecular methods by the use of the identical names for different viruses, such as GMV for *Carlavirus* and *Potyvirus*. Of the Potyviridae, only one viruses has been identified to be infected in Allium genera *i.e*., *Onion yellow dwarf virus* (OYDV) (Kobayashi et al.,1996). Even so, most of the certified propagation material available commercially is probably infected with low-titre of virus (Dijk *et al*., 1991).

Management protocols of the virus

The general recommendation for controlling Allium viruses has given by Asian Vegetable Research and Development Center. Germplasm should be obtained from the safest source possible. If available, true seed of germplasm should be preferred for the movement of Allium germplasm since seed poses a minimal risk of moving and introducing pests. Germplasm for which true seed is not available should be moved as pathogen-tested in vitro cures. If this is not possible, full quarantine measures must be taken until the vegetative material or seed is cultured in vitro. In vitro material should be tested for viruses known to affect Allium in the

country of origin of the germplasm. Electron microscopy will allow the detection of all virus particles, including those not yet described. The transfer of germplasm should be carefully planned in consultation with plant quarantine authorities and the relevant indexing laboratory.

Chemicals interfering nucleic acid replication can be used as anti-viral chemical. It result little effect as it damage the host tissues also. Chemicals such as 5-flurouracil (5-FU) and 6-azoguanine (6-AG) are toxic towards both virus and the host. These toxins also result environmental issues, thus not recommended for field application. Use true onion seed (rather than sets) and virus-free planting stock is widely recommended prophylactic measures against plant viruses. In garlic, indexing for the virus and meristem tip culture eliminates the virus. Rouging of infected plants is commonly practiced by the farmers in infected field. No pesticides control is found to be effective against this disease. Controlling aphids also does not prevent the disease because they retain the virus for a very short period of time and quickly transmit the virus as they move through the crop in search of preferred hosts.

Conclusion

Allium Spp. propagated from virus free bulbs shows a yield increment of half or increasingly over the yield of the untreated plants (Lot et al., 1998). The increase in yield results from more vigorous plant growth, which in turn results in larger cloves and bulbs. In economic terms, the increase in revenues may be even greater than the weight increase suggests, since the larger bulbs fetch a higher price per unit weight compared with small ones. In this manner, the utilization of infection free propagating materials give an improved horticultural practice to onion cropping, even when the price of the propagation material is higher than that of the traditional planting material. The use of ‘virus-free’ propagules is spreading fast. This can just happen, however, where huge plots, local coordination and improved field management are rehearsed as fundamental strides for diminishing the risk of immediate re inoculation and expanding the opportunity of accomplishment. Growers of virus-free propagules have to adopt a complete change in management, including an absolute separation between the production of propagation material and the cultivation of the commercial crop. Many growers throughout the world use part of the commercial crop as propagation material. Adaptation to virus free production implies that reproduction is done only by specialized growers/companies, and annual

purchase of propagation material from these sources is required. Since re infestation quickly occurs from neighbouring fields or wild plants (Sosa *et al*., 1997), it is imperative to have regional cooperation in cultivation, sanitary controls (both of pests and of weeds, which may serve as hosts for vectors and/or garlic viruses) and management.

REFERECE

Anonymous (2018). Horticultural Statistics at a glance 2018.

Anonymous (2019). *Krushidarshini*, Mahatma Phule Krishi Vidyapeeth, Rahuri (www.mpkv.ac.in)

Delecolle, B. and H. Lot. (1981). Viroses de l ail. I. Miseen évidence et essais de caractérisation parimmunoelectomicroscopie d'un complexe de trois virus chez différentes populations d'ailatteintes de mosaïque. *Agronomie* **1(1)**:763-769.

Kobayashi, K., Rabinowicz, P., Bravo-Almonacid, F., Helguera, M., Conci, V., Lot, H. and Mentaberry, A. (1996). Coat protein gene sequences of garlic and onion isolates of the onion yellow dwarf potyvirus (OYDV). *Archives of virology*, **141(12)**:2277-2287.

Lot, H., Chovelon, V., Souche, S. and Delecolle, B. (1998). Effects of onion yellow dwarf and leek yellow stripe viruses on symptomatology and yield loss of three French garlic cultivars. *Plant Disease*. **82**. 1381–1385.

Melhus, I.E., C.S. Reddy, W.J. Henderson and E.Vestal. (1929). A new virus disease epidemic on onions. Phytopathology **19**:73-77.

Sable P.A., Mrs. Sushma Sonpure and M.K. Chandaragi (2020). Nutrient, weed, pest and disease management in summer onion. Shetakari magazine, **Feb., 2020**. 41-42

Sosa, C., Munoz, J., Navelino, P. and Gonzalez, H. (1997). Evaluation of re-infection by virus in virus free garlic 'Rosado Paraguayo' grown in Cordoba. Survey of vectors. *Acta Horticulturae* **433**: 601–605.

Van Dijk, P. (1993). Survey and characterization of potyviruses and their strains of Allium species. *Netherlands J. of Plant Pathol.* **99(2)**:1-48.

Van Dijk, P., Verbeek, M. and Bos, I. (1991). Mite-borne virus isolates from cultivated Allium species, and their classification into two new rymoviruses in the family Potyviridae. *Netherlands J. of Plant Pathol.* **97(6)**: 381-399.

Post harvest activities from bulb uprooting from the farm land to warehouse

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Abstract

Post harvest activities after harvesting of onion bulbs widely practiced to their cultural practices, adoptive methods are inherited from traditional knowledge and commonly practiced to avoid sprouting and rotting after harvest in due course of bulb storage, it could lead to the extend the storage period of the onions. Suitable curing temperatures, airflow, moisture loss, and field heat could results post harvest loss of onions at all stages after harvesting.

Keywords: Onion, Cultural Practice, Curing, Post Harvest Activities.

Introduction

Onion (*Allium cepa* L.) is a high volume and high value vegetable crop belongs to the family *alliaceae*, and it is a prime member of the genus *Allium.* The daily dietary demand of onion has been increasing within and outside the country, due to the nutritional and medicinal

values. Onion is under extensive cultivation by the large, medium, small and marginal farmers across the country mainly from the states of Maharashtra (6.80 mt), Madhya Pradesh (3.30 mt) and Karnataka (2.80 mt). It is an important foreign exchange earning crop of India, the export value was in the order of 3106.50 crores by exporting 2.42 million metric tons of onion bulbs, which contributes up to 70.00 per cent share of export earnings among the vegetable commodities. India (21.56 mt) is the leader in onion production after China (22.61 mt). Contrarily, the productivity of India (16.10 MT/ha) has pretty low compared to USA (55.95 MT/ha), Netherlands (49.70 MT/ha), Iran (36.93 MT/ha) and Egypt (36.58 MT/ha) (NHB, 2017).

Despite of the achievements in onion production, the post-harvest losses still pose a great problem in onion. Significant losses in quality and quantity of onion occur after harvesting till marketing after storage; therefore it is become a serious problem in the India. The post-harvest losses namely Sun scald, sprouting and rotting are great problem annual storage losses were over 40% and between 40 to 60% in India (Bhagachandani *et al.,* 1980; Maini *et al.,* 1984). It was estimated that the production of 41 lakh tonnes of onion lost due to desiccation, decay and sprouting loss could cause value of Rs 600 crores (Kukanoor, 2005). This results in raise in their price. In this view, we could review literature of possible methods to reduce the onion post harvest losses.

Results and Discussion

Harvesting followed handling of onion bulbs in field

Harvesting preferably varied across the areas (Table 1), hence it is carried out during dry weather, Harvesting after a rainfall or immediately or soon after irrigation could lead to susceptibility to post-harvest disease. After harvesting keep firm bulbs with mature necks and scales, and bulb of good size. Defective bulbs like insect damaged, sun scalded, and green bruised should be discarded for better utility.

Field Curing

After uprooting of crop in the farm a layer of onion bulbs were covered by onion tops in such a way that the bulbs protected from direct sun light for one to two days. Field curing is part of biomass drying intended to dry off the bulb neck and outer scales to prevent the loss of excess moisture and decay during storage by pathogens. Filed heat, good air ventilation and low humidity are prime factors for field curing. The bulb outer layer contaminated by soil dirt's and adherent materials falls during field curing. This field curing would cause of loss 3-5% of onion bulb weight by tight neck with outer scales one or two dry scales. Onions dried in the field were cut the tops by leaving 1 to 2 cm bulb necks.

Shade Curing

Trimmed bulbs after field curing shifted to shade curing with well-ventilated shades. Curing in shade is advisable because it improves bulb colour and reduces significantly losses during storage. Curing is the removal of excess moisture from the outer skin and neck portion of onion which helps in reducing the infection of diseases. Curing decreases the incidence of neck rot, reduces water loss during storage, prevents microbial infection, and is desirable for development of good scale colour and onions must be promptly stored after curing. Pre-mature sprouting in onions reduces marketing potential; Curing heals wounds and strengthens general skin condition of the bulbs (Moude *et al.*, 1984). The principal biological factors leading to onion bulb deterioration are respiration, resumption of growth and pathogen attack (Abdallah and Mann, 2000). The onion bulb quality can be maintained longer by curing with foliage intact followed by storage. Significantly quality and storage life achieved by mud rooms storage, when cold storage facility cannot be availed (Ghulam *et al.,* 2013). Air at approximately 35°c was blown through the onions for 6 days, after which treated onions, together with samples from the same crops taken after field curing reduces post harvest loss (Harrow and Harris, 1969)

Onion bulb sorting by grading

The onion bulbs are classified based on size into three grades namely A grade (> 80 mm), B grade (50-80 mm) and C grade (30-50 mm). In India, onions were manually before storage or before marketing, it is unwieldy process and laborious. The mechanization reduces labor intensiveness, labor charges and also increases precision. Directorate of Onion and Garlic

Research has developed manual and motorized machines for grading (Plate 1 & 2). The efficiency of manual operated grading machine is five times of the manual grading while the efficiency is almost 20 times with motorized grading machine. The accuracy of grading of onion with grading machine is around 90 % as against 70% with manual grading, these grading machines helps for bettor sorting of uniform bulbs for better post harvesting activities like packaging and storage (DOGR Agropedia, 2020).

Plate 1: Motorized onion grader

Plate 2: Hand operated manual grader

Table 1: Seasonal calendar time lines of Indian onion cultivation

Area and Seasons	Sowing/Nursery	Transplanting	Harvest
Maharashtra/Gujarat			
Kharif	May-June	July-August	September-December
Late *kharif*	August-September	September-October	January-March
Rabi	October-November	December-January	April-May
Tamil Nadu/ Karnataka/ Andra Pradesh			
Kharif	March-April	April-May	July-August
Late *kharif*	May-June	June-August	October-November
Rabi	September-October	November-December	March-April
Rajasthan/Uttar Pradesh/Bihar/Haryana/Punjab			
Kharif	May-June	July-August	November-December
Rabi	October-Novemebr	December-January	May-June
West Bengal/Orissa			

Kharif	June-July	Auguest-September	November-December
Rabi	August-September	October-December	February-March
Mountains/Hills			
Rabi	September-October	October-November	June-July
Summer (Long-day type)	November-December	February-March	August-September

References

Abdallah A.A. and Mann L.K. (2000). Bulb development in the onion (Allium cepa L.) and the effect of storage temperature and bulb rest. *Agricultural Sciences,* **26:** 56-61.

Bhagachandani P.M., Pal N, Singh N. and Chaudhary B. (1980). White onion for dehydration. *Indian Hort.*, **24(4):** 7-9

DOGR Agropedia (2020). https://dogr.icar.gov.in/index.php?option=com_content& view=article&id =122&Itemid=194&lang=en

Ghulam N., Abdur R., Muhammad S., Farhatullah and Imran A. (2013). Influence of curing methods and storage conditions on the post-harvest quality of onion bulbs. *Pakistan J. Botany*, **45(2):** 455-460.

Harrow K.M. and Harris S. (1969). Artificial curing of onions for control of neck rot (*Botrytis allii* Munn), *New Zealand J. Agri. Res.,* **12(3):** 592-604,

Kukanoor. (2005). Post–harvest studies in onion cv. N-53. Ph.D. Thesis. University of Agricultural Sciences, Dharwad.

Maini S.B., Diwan B. and Anand J.C. (1984), Storage behaviour and drying characteristics of commercial cultivars of onion. *J Food Sci. Tech.,* **21(6):** 417.

NHB. (2017). **Horticultural Statistics at a Glance-2017, pp.209–407,** http://nhb.gov.in/statistics/Publication/Horticulture%20At%20a%20Glance%202017%20for%20net%20uplod%20(2).pdf

Economics, Fertility Status and Microbial count on soil of onion (*Allium cepa* L.) cv. GJRO-11 as influenced by organic, inorganic and biofertilizer

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Abstract: Present investigation was conducted the year 2018-19 in *Rabi* season at Horticultural Research Farm, College of Horticulture, AAU, Anand, Gujarat with ten treatments in a simple RBD with three replications. The soil application of 50 % RDF + 50 % N from FYM was significantly maximum avaibility of N, P_2O_5, K_2O and Organic carbon (369, 44.67, 331 kg/ha and 0.39 %, respectively) and application of 50 % RDF + 25 % N through FYM + 5 ml Bio-NPK consortium recorded maximum *Azotobacter, Azopirillum*, PSB, KMB and Total count of bacteria. Among the different treatments; T_9 - 50% RDF (50: 37.5: 37.5 NPK kg/ha) + 25% N from vermicompost + 5 ml Bio-NPK consortium registered the highest net realization 306569.38 `/ha with BCR value of 3.35 as compared to rest of the treatments.

Key words: Onion, Organic, inorganic, biofertilizer, Economics, Fertility status

Introduction

Onion (*Allium cepa* L.) is one of the most important vegetable bulbous crops grown in India from ancient time. Onion is the “Queen of the kitchen”. The edible portion is a modified stem which is known as ‘bulb’ and develops underground. Onion is preferred mainly because of its green leaves, immature and mature bulbs are either eaten raw or cooked as vegetables. It is

popular as salad crop and mature onion bulbs are widely used as a cooked vegetable in soaps stews and casseroles in addition to a flavoring agent in many additional dishes. It is one of the few versatile vegetable crops that can be kept for a fairly long period and can safely withstand the hazards of rough handling including long distance transportation.

In world, India ranks 2nd in area and production of onion. India is prominent in the production and export of onion in the world. Onion is being grown in area of 1285000 ha with total bulb production of 23262000 MT (Anon., 2018). In Gujarat, onion occupied an area of about (54488 ha) with total bulb production of 1416602 MT (Anon., 2018). The major onion growing districts are Bhavnagar, Rajkot, Amreli, Junagadh, Jamnagar, Porbandar, Kutch, Mehsana, Surat and Anand. Bhavanagar is a leading district for onion cultivation of 32,000 ha area and 870400 MT production. (Anon., 2018).

As regard with the productivity the combined application of organic manures and inorganic fertilizers to increase yield but has paramount importance in ameliorating the yield. Use of inorganic fertilizers now a day is costly affair and increases cost of cultivation. Secondly the sole application of inorganic fertilizers deteriorates soil fertility level day by day, which affect the production, economics of production and human health, while organic manure and bio-fertilizers are cheap, easily available and eco-friendly. It improves the physiochemical properties like soil structure, infiltration rate, porosity, water holding capacity, bulk density, etc. and also very useful for the sustainable crop production as well as soil fertility and productivity. Organic manures acts as a buffering agents and supplies food for beneficial living organisms. Organic manures helps to control the plant parasitic nematodes and fungi up to some extend by altering the balance of micro-organisms and increase organic carbon in the soil. In recent years, biofertilizer NPK consortium are gaining much popularity. Bio-NPK consortium contain five strains of agriculturally beneficial microorganism (two Nitrogen fixer, two Phosphate solubilizer and one potash mobilizer) is the one time solution for all the macronutrient (N, P, and K) requirement of crop. Use of Bio-NPK consortium @ 3-5 ml for root dipping treatment can save up to 25% N, P, K chemical fertilizer with increase in growth and yield with reduction of soil, water and air pollution.

Material and methods

A field experiment entitle “Effect of organic, inorganic and biofertilizer on growth and yield of onion (*Allium cepa* L.) cv. GJRO-11” was laid out during the year of 2018-19 at Horticultural Research Farm, College of Horticulture and Laboratory work was carried out in the Department of Horticulture as well as Department of Microbiology, B. A. College of Agriculture, Anand Agriculture University, Anand.

There were ten treatments *i.e.* T_1 -100 % RDF (control), T_2 - 75 % RDF + 25 % N from FYM, T_3 - 75 % RDF + 25 % N from vermicompost, T_4 - 75 % RDF + 25 % N from castor cake, T_5 - 50 % RDF + 50% N from FYM, T_6 - 50 % RDF + 50% N from vermicompost, T_7 - 50 % RDF + 50% N from castor cake, T_8 - 50 % RDF + 25 % N from FYM + 5 ml Bio-NPK Consortium, T_9 - 50 % RDF + 25 % N from vermicompost + 5 ml Bio-NPK Consortium and T_{10} - 50 % RDF + 25 % N from castorcake + 5 ml Bio-NPK Consortium in a Randomized block design with three replication with plot size of 3 x 2 m. The soil of the experimental field was light alluvial having sandy loam texture with the soil pH of 7.5, 0.25 % organic carbon 220.25 kg/ha available nitrogen determined by alkaline potassium permanganate method, 28.22 kg/ha available phosphorus estimated with Olson's extraction method, 258.32 kg/ha available potassium determined with Flame photometer and microbial count of soil at initial and after harvest the crop was counted by colony forming unit machine. Onion seeds were sown on 11th October, 2018. About six weeks old seedlings was transplanted on 4th December, 2018 at row to row distance of 15 cm and plant to plant distance of 10 cm. Common dose of FYM 20 t/ha applied one month before the transplanting. The organic manures (Farm yard manure, Vermicompost, and Castor cake) were applied at the time of field preparation and half of the nitrogen (N) and full dose of phosphorus (P) and potassium (K) were applied before transplanting and remaining nitrogen (N) were applied one month after transplanting. Observations were recorded for different traits. The recommended dose of fertilizer was done as NPK @100:75:75 kg/ha and Bio-fertilizers applied as a root dipping treatment (3-5 ml/l water for 10-15 minutes). The bulbs were harvested on 30th March, 2019 when 70% tops started falling over. The tops were removed two days after field curing leaving 2.5 cm top with the bulb. The data were analyzed statistically as per standard procedure. The economic study of the crop was done by computing the cost of cultivation and net profit in rupees per hectare on the basis of prevailing rate of inputs and outputs obtained from the local market. Nutrient status and

microbial of soil at initial and after harvest the crop is determined by different method of estimation.

Result and discussion

Economics

The result of the effect of various combination of organic, inorganic and biofertilizer found that the highest net realization 306569.38 `/ha with BCR value of 3.35 in treatment T_9 (50% RDF + 25% N from VC + 5 ml Bio-NPK Consortium) as compared to rest of the treatments and minimum in T_2 (75% RDF + 25% N from FYM). Similar result finding were also reported by Dilpreet *et al.* (2017) in onion.

Table 1: Effect of organic, inorganic and biofertilizers on economics of onion cv. GJRO-11

Treatment No.	Yield (kg/ha)	Gross realization (`/ha)	Total cost of production (`/ha)	Net realization (`/ha)	BCR
T_1	39897	319176	87893.13	231282.87	2.63
T_2	33539	268312	91561.68	176750.32	1.93
T_3	37160	297280	92949.18	204330.82	2.20
T_4	35117	280936	92255.43	188680.57	2.05
T_5	38100	304800	95229.12	209570.88	2.20
T_6	44931	359448	98004.12	261443.88	2.67
T_7	42010	336080	96616.62	239463.38	2.48
T_8	46502	372016	90123.12	281892.88	3.13
T_9	49760	398080	91510.62	306569.38	3.35
T_{10}	47339	378712	90816.87	287895.13	3.17

Nutrient status of soil

The result of the effect of various combination of organic, inorganic and biofertilizer found that the soil application of 50 % RDF + 50 % N from FYM was significantly maximum avaibility of N, P_2O_5, K_2O and Organic carbon (369, 44.67, 331 kg/ha and 0.39 %, respectively). While in organic carbon and available phosphorus in T_6 (50% RDF + 50% N from VC) and T_7 (50% RDF + 50% N from CC) at par with T_5 (50% RDF + 50% N from FYM) and available nitrogen and potash in T_6 (50% RDF + 50% N from VC), T_7 (50% RDF + 50% N from CC), T_8 (50% RDF + 25% N from FYM + 5 ml Bio-NPK Consortium) and T_{10} (50% RDF + 25% N from CC + 5 ml Bio-NPK Consortium) at par with T_5 and minimum in T_1 (control). Similar result finding were also reported by Jayathilake *et al.* (2006), Singh and Pandey (2006), Sharma *et al.* (2009), Nainwal *et al.* (2015), Thangasamy and Lawande (2015) and Shinha *et al.* (2017) in onion.

Table 2: Effect of organic, inorganic and biofertilizers on available nutrient status of the soil at initial and after harvest the crop

Treatment No.	Organic Carbon (%)	Available Nutrient status of the soil		
		Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potash (kg/ha)
Initial	0.25	220.25	28.22	258.32
T_1	0.25	254.33	33.00	266.00
T_2	0.26	282.67	36.67	296.00
T_3	0.29	260.00	34.33	280.33
T_4	0.27	271.00	35.33	291.00
T_5	0.39	369.00	44.67	331.00
T_6	0.36	350.67	41.67	324.33
T_7	0.36	357.33	42.33	326.67
T_8	0.30	340.00	39.67	323.67
T_9	0.34	293.00	37.33	302.67
T_{10}	0.33	327.67	39.00	321.67
S.Em. ±	0.01	14.66	1.38	5.39
C. D. at 5%	0.03	43.55	4.11	16.01

C.V. %	6.26	8.17	6.25	3.05

Microbial count of soil

The data presented in Table 3 revealed that among the different combination of treatments, T_8 (50 % RDF + 25 % N through FYM + 5 ml Bio-NPK consortium) recorded maximum Azotobacter, Azopirrilum, PSB, KMB and Total count of bacteria. Whereas, the minimum Azotobacter, Azopirrilum, PSB, KMB and Total count of bacteria in Control. FYM treatments improved the microbial count at harvesting time as compared to other biofertilizer treatments. It might be due to slow releasing of nutrients from FYM. Farm yard manure is a carrier of organic carbon and organic dry matter. Due to this reason, organic carbon and microbial count improved in onion with the application of FYM alone or in combination with biofertilizers. Similar trends of results were reported Dilpreet *et al*. (2017).

Table 3: Effect of organic, inorganic and biofertilizers on microbial count of soil at initial and after harvest the crop

Treatment No.	Microbial count (cfu/g) of soil				
	Azotobacter	Azopirillum	PSB	KMB	Total count
Initial	2.4×10^3	2.1×10^3	1.9×10^3	2.9×10^3	4.0×10^7
T_1	2.8×10^3	6.1×10^4	4.3×10^4	2.8×10^4	4.5×10^7
T_2	4.8×10^4	3.5×10^4	2.4×10^5	3.9×10^5	5.6×10^8
T_3	3.9×10^4	3.0×10^4	2.1×10^5	3.4×10^5	4.9×10^8
T_4	3.1×10^4	2.5×10^4	1.8×10^5	2.9×10^5	4.1×10^8
T_5	5.2×10^4	3.9×10^4	3.3×10^5	5.0×10^5	6.2×10^8
T_6	4.4×10^4	3.2×10^4	2.7×10^5	4.5×10^5	5.7×10^8
T_7	3.8×10^4	2.8×10^4	2.5×10^5	4.0×10^5	5.1×10^8
T_8	7.1×10^5	6.1×10^5	4.7×10^5	6.2×10^5	7.3×10^9
T9	6.0×10^5	5.5×10^5	4.2×10^5	5.8×10^5	6.9×10^9
T10	4.1×10^5	4.4×10^5	3.5×10^5	5.1×10^5	6.3×10^9

Conclusion

On the basis of the present investigation study, it could be concluded that treatment T_9 -50% RDF (50: 37.5: 37.5 NPK kg/ha) + 25% N from vermicompost + 5 ml Bio-NPK consortium was registered the highest net realization 306569.38 `/ha with BCR value of 3.35 as compared to rest of the treatments for onion cv. GJRO-11 under Middle Gujarat condition.

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References

Anonymous (2018). Directorate of Horticulture, Gujarat State, Gandhinagar.

Anonymous (2018). Indian Horticuture Database, National Horticulture Board, Ministry of Agriculture, Government of India.

Dilpreet, T., Singh, K., Varinder, S., & Singh, J. (2016). Growth, yield and quality of onion as influenced by integrated nutrient management. *International Journal of Agriculture Sciences,* 8 (51), 2295-2298.

Jayathilake, P. K. S., Reddy, I. P., Srihari, D., & Reddy, K. R. (2006). Productivity and soil fertility status as influenced by integrated use of N-fixing biofertilizers, organic manures and inorganic fertilizers in onion. *Journal of Agricultural Sciences*, 2(1), 46 58.

Nainwal, R. C., Singh, D., Katiyar, R. S., Sharma, L., & Tewari, S.K. (2015). Response of garlic to integrated nutrient management practices in a sodic soil of Uttar Pradesh, India. *Journal of Spices and Aromatic Crops*, 24(1), 33–36.

Patel, K. M. (2007). Combined effect of nitrogen, organic manures and biofertilizer on growth, yield and quality of onion (*Allium cepa* L.) varieties. (Doctoral Dissertation, Anand Agricultural University).

Sharma, R. P., Datt, N., & Chander, G. (2009). Effect of Vermicompost, FYM and Chemical fertilizers on yield, nutrient uptake and soil fertility in okra (*Abelmoschus esculentus* (L.) Moench) – onion (*Allium cepa*) sequence in wet temperate zone of Himachal Pradesh. *J. of Indian Society of soil Science*, 57(3), 357-361.

Singh, V., & Pandey, M. (2006). Effect of integrated nutrient management on yield of and nutrient uptake by onion and on soil fertility. *Journal of the Indian Society of Soil Science*, 54(3), 365-367.

Sinha, S. K., Verma, R. B., Singh, V. K., Patel, V. B., Panwar, G. S., Bharati, D. K., Amit Kumar., & Ravi Kumar. (2017). Integrated Nutrient Management Approach for Increasing Growth, Yield and Economics of Onion. *Current Journal of Applied Science and Technology*, 25(1), 1-6.

Thangasamy, A., & Lawande, K. E. (2015). Integrated nutrient management for sustainable onion production. *Ind. J. Hort*. 72(3), 347-352.

Vachan, R., & Tripathi, S. M. (2018). Study on the effect of bio-fertilizer with chemical fertilizer on plant growth, Yield and economics of *rabi* season onion (*Allium cepa* L.) cv. NHRDF Red. *Journal of Pharmacognosy and Phytochemistry*, 6(5), 1496-1499.

Status and Scope of Onion Production and processing in Madhya Pradesh

(*Allium cepa* L.*)*

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Abstract

Onion is an important crop of almost all landmasses and is commercially cultivated in several countries. Madhya Pradesh is the second largest onion producing state in the country. It produces about 36,83,097 Metric ton of onion from 1,49,843 hectare area with productivity 24.53 tons / hectare . In the state cultivation and storage of onion is promoted by providing assistance through state as well as central schemes. State is also focusing on making market linkages with the big companies so that farmers can get best return of their produce. Madhya Pradesh being a lead producer of so many fruits and vegetables in the country, still the food processing capacity in the state is very low indicating huge scope of investment in the sector.

Ketwords: Onion, varieties, food processing, value addition

Introduction

Madhya Pradesh is one of the leading states in the production of most of the Horticultural crops because of its various special schemes, technologies, Government approaches, policies etc. In vegetable production, Madhya Pradesh ranks 3rd among all other states of India (Horticulture at a glance-2018). Tomato, Onion, Chilly, Green peas and Garlic are the main vegetables grown in Madhya Pradesh.

Onion is an important crop of almost all landmasses and is commercially cultivated in several countries. It is an essential item in every kitchenette as vegetable and condiment in India. As a culinary ingredient it adds to the taste and flavour in a wide range of food preparations and it is also used as a salad. It is also used for medical purpose. Presently India is the second largest producer of onion in the world (Horticultural Statistics, 2018). The major onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Rajasthan, Bihar, Haryana, Andhra Pradesh, Tamil Nadu, and West Bengal.

Status of Onion Production in Madhya Pradesh

Madhya Pradesh is the second largest onion producing state in the country. It produces about 36,83,097 Metric ton of onion from 1,49,843 hectare area with productivity 24.53 tons / hectare . The major onion varieties grown in MP are AFDR, AFLR, Bhima light red, Bhima dark red, Bhima super, Bhima shakti, Early grano, Pusa white round, Arka kirtiman. In Madhya Pradesh onion grows in three seasons namely Kharif, Late Kharif and Rabi. The transplanting period of Kharif onion in Madhya Pradesh is July to August and it is harvested during October to December. The Late Kharif onion is transplanted during October to November and harvested during January to March. The farmers of Madhya Pradesh initiate transplanting of Rabi onion in December and complete it in January. The Rabi onion harvesting commence by the end of March and continues up to May end. In Madhya Pradesh Indore, Dewas, Ujjain, Rewa, Dhar, Shajapur, Sagar, Ratlam Khandwa, Rajgarh, Shivpuri, and AgarMalwa are the major onion producing districts. (Table : 01)

Scope of Processing and Value addition

Madhya Pradesh produces about 36,83,097 Metric tons of onion in a year, but consumes only half of it. Surplus availability of onion in Madhya Pradesh is about 2687906 MT. Hardly 02 percent of perishable horticultural produce is processed to value added products. Hence, there is huge scope for Canning (thermal processing), Refrigeration, Freezing, Drying, Paste, Powder, Dehydration, Frying, Extrusion, Irradiation, UV, Pulsed Light, etc. At the same time, there is market glut during harvesting season and farmers are forced to sell their produce at throw away prices. Therefore, food processing industries can help farmers to get sure income for their produce and also avoid market glut. Due to abundant production in last 2-3 years, the onion prices have fallen to bare minimum Rs. 2 / kg resulting in farmer's distress across the state. Since lack of awareness and publicity about preserving onions, the bumper crop is getting rotten. If we would have had food processing units catering to onions then farmers can able to sell their produce at any time.

India stands as the second largest food producer in the world after China. The primary reason behind this achievement is the marginal surplus in production and success in attaining self-sufficiency in food. Currently Food processing sector accounts for about 1/3rd of total food

market in India. The food processing industry is valued at US$258 billion, and is the fifth largest industry domestically in terms of production, consumption, export, and expected growth in the country. It contributes to around 14% of manufacturing Gross Domestic Product (GDP) and 13 % of India's total food exports.

On account of rapid urbanization, hectic schedules and rising working population, the demand for processed onion products is witnessing a tremendous growth, particularly in India. In order to save time, consumers are not willing to indulge in difficult cooking procedures such as chopping onions. Apart from this, food processing represents one of the largest sectors in India which is bolstering the demand for onion powder.

Onion can be processed in the form of Paste, Powder, Flakes, Cut onion rings, etc. These products can be manufactured in small and medium scale industry format. Minimally processed ready to use or ready to cook fresh onions, onion paste, dehydrated onion flakes, onion powder, onion oil, onion vinegar, onion sauce, pickled onion, onion wine and beverage etc are in huge demand and these demand for the processed products are increasing day by day due to its convenience to handle and use.

The Government of Madhya Pradesh along with Ministry of Food Processing Industries (MoFPI) are also taking all necessary steps to boost investments in the food processing sector. At present 8 Food Parks, 2 Mega Food Parks, and 1 logistic park are working in Madhya Pradesh for food processing activities.

Department of Horticulture & Food Processing is providing 25% subsidy with maximum assistance of upto Rs 2.5 Crores for setting up of food processing industries in the state. Whereas, Ministry of Food processing Industries, GOI have providing financial assistance for setting up of food processing industries under Pradhan Mantri Kisan Sampada Yojana (PMKSY). It helps to boost the growth of food processing sector in the country. The major schemes under SAMPADA are Mega Food Parks, Integrated Cold Chain and Value Addition Infrastructure, Creation/ Expansion of food processing and preservation capacities, Infrastructure for Agro-processing clusters, Creation of Backward and Forward Linkages, Food Safety and quality assurance infrastructure, Operation greens etc.

Challenges:

The fragmented supply chain, lack of adequate storage and perishable nature of onion, high marketing margins, and dominance of few traders, small scale and season wise operating processing unit are significant challenges for the onion cultivators of Madhya pradesh.

Conclusion:

It may be concluded that Madhya Pradesh has huge potential in onion processing due to its high productivity, that is 24.53 tons / hectare which is larger than the average onion productivity worldwide. Madhya Pradesh being a leading producer of so many fruits and vegetables in the country, still the food processing capacity in the state is very low indicating huge scope of investment in the sector.

Table 1. Details of major Onion growing Districts of Madhya Pradesh
(HAPIS, 2018-19, Final Estimate)

S.No.	Name of the Crop	Total Cultivated Area (Ha)	Total Production (MT)	Major Vegetables Growing Districts		
				Districts	Area (Ha)	Production (MT)
1	Onion	1,49,843	36,83,097	Indore	13,146	4,20,672
				Dewas	13,003	3,98,021
				Ujjain	14,645	3,31,855
				Rewa	8,014	2,08,364
				Dhar	7,980	2,04,228
				Shajapur	8,790	2,197,50
				Sagar	9,025	1,80,503
				Ratlam	7,027	1,756,75
				Khandwa	6,740	1,36,500
				Rajgarh	6,090	1,23,018

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this information to the students, researchers, teachers and readers also. We would also like to thank all the readers in advance and wish this review article will be useful to them

References:

Madhya Pradesh production data- Department of Horticulture and Food Processing, MP (2018-19 Final Estimate)

National production data-Horticulture Statistics At a Glance-2018

http://www.mphorticulture.gov.in/en

https://www.investindia.gov.in/sector/food-processing

Pest management approaches towards organic cultivation in Onion (*Allium cepa* L.).

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Abstract

Onion (*Allium cepa* L.; Family: Amaryllidaceae) is one of the most substantial commercial vegetables. Organic cultivation is a comprehensive system intended to upsurge the productivity and fitness of people. During the last two decades, there has been a momentous sensitization of the global community towards environmental safeguarding and assuring of food quality. The advocates of organic farming consider that it can meet both these demands and become the mean for far-reaching development of rural areas. At present, onion is grown solely under the inorganic condition with fertilizer and insecticide regimes. Bulbs that are organically grown are free of pesticide residue, contribute to value addition and fetch a premium price in international markets. Recent studies indicate the incidence of pest and total yield is on par with both inorganic and organically raised onion. Organic cultivation practices in Onion will withstand environmental sustainability as well as ecological balance.

Key words: Organic cultivation, Insect-pest, Crop rotation, Food quality, Onion.

Introduction

Onion (*Allium cepa* L.; Family: Amaryllidaceae) is one of the most significant commercial vegetables. It is grown in Maharashtra, Gujarat, Uttar Pradesh, Orissa, Karnataka, Tamil Nadu, Madhya Pradesh, Andhra Pradesh and Bihar, in India. Nowadays, organic cultivation is being embraced by the mainstream and displays great potential commercially, socially and environmentally. The indemnities caused by insect-pests are highly alarmed by farmers nowadays. Recently, the precedence has been given to uphold the health of the

ecosystem thus enabling plant to become resistant to the occurrence by insect-pests and diseases. Plant size, shape, colouration, leaf hairs, and natural chemicals (both attractants and repellents) are distressing the effect of insect-crop colonization.

The current organic drive is drastically diverse from its original custom. Now it is having environmental sustainability at its core in addition to the founder's concerns for healthy soil, healthy food and healthy people. The pest and disease management options in organic farming are heavily dependent on preventive measures rather than curative practices which are based on the ecologically safer management methods. The precedence has been given to sustain the health of the ecosystem thus permitting plant to become resistance to attack by insect pests. Broad management of ecosystem through a little amendment in the cultural practices such as crop rotation, soil quality management through the addition of organic amendments establish the preliminary defence against the attack of insect-pests and diseases trailed by use of the curative methods like use of predators, parasitoids and plant products forms the next line of defence against the insect pests of onion for enhancement organic cultivation.

Major pests infesting onion

The major threat to onion farmers, due to insect and mite pests are well recognised. Some of these have national significance and have a high economic concern. Onion thrips: *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), Onion maggot: *Delia antiqua* Meigen (Diptera: Anthomyiidae), Bulb mite: *Rhizoglyphus robini* Claparédè (Sarcoptiformes: Acaridae), Eriophyid mite: *Aceria tulipae* (Keifer) (Prostigmata: Eriophyidae), Red spider mite: *Tetranychus cinnabarinus* (Boisduval) (Trombidiformes: Tetranychidae). Constant surveillance and timely action play an inevitable role in organic-based management of these pests. The status of their ability to cause economic damage to crop is regularly altering due to climate change and other factors. In this scenario, the adoption of novel technologies and a combination of further organic practices are desired

Insect pest management strategies for organic onion cultivation

Broad management of ecosystem through little adjustment in the cultural practices such as crop rotation, soil quality management through the addition of organic amendments constitute the preliminary defence against the attack of insect-pests of onion trailed by use of the remedial approaches like the use of predators, parasitoids, plant products and ecologically safer chemicals form the next line of defence against the insect pests and diseases. For ease of considerate and

their effective application for management of insect pests and diseases under organic farming, pest management approaches of onion are classified into the following categories;

1. Modification of cultural practices
2. The conservation practices to reinstate the natural enemies
3. Use of biological control agents such as insect predators, parasitoids, insect pathogens by applying or releasing the agents through inoculating and inundated methods.
4. Use of botanicals and their mixtures such as Panchagavya, Dasagavya and mineral oils as curative control measures.
5. Use of organic pesticides

1. Modification of cultural practices

Cultural practices are among the oldest systems used for pest destruction and many of the preventive practices used in conventional and organic farming today have their roots in traditional agriculture. A slight modification in the cultural practices will have an impact on the whole ecosystem. These practices can augment the agricultural biodiversity and thus have a greater role to play in the management of insect pests in onion. However, these methods have certain limitations as they have to be planned well in progress and these are preventive thus not helpful in case of a severe outbreak of insect pests of onion.

Plant breeders traditionally have sited more focus on creating pests-resistant varieties. Where they are available, however, insect-resistant varieties can be an operative defence. It is vital to invent about the mechanism of insect resistance in a crop variety because genetically modified crops (GMOs, transgenic crops) are not allowed in organic production systems. Even when insect-resistant cultivars are not available, some varieties may be less attractive to pest species or tolerate more damage than others. Plant size, shape, colouration, leaf hairs, and natural chemicals (both attractants and repellents) are upsetting the outcome of insect crop colonization. In onion crop, with the wider leaf angle and round leaves support less number of thrips incidence (Patil *et al.,* 1988). Moreover, plants with glossy foliage are more resistant to onion thrips (Molenaar, 1984). Note that changing cultivars to diminish pests can also reduce beneficial insects either directly or indirectly. Although resistant varieties and natural controls generally work together to suppress pests, some exemptions have also been documented.

Crop rotation or sequence is intended to present a no-host crop to pest insects. Convincingly, rotations are likely to have little effect on highly mobile foliar

insects.However,Marigold, *Chrysanthemum* spp., *Sesbania* spp., *Crotalaria* spp., *Gaillardia* spp. , castor and *Desmodium* spp., can be crop rotating with onion crop to reduce the pest infestation especially, concerning the mite attack (Raj, M. *et.al*, 2014).

The stage of crop development can have a profound outcome on a crop's attractiveness to pest insects. A research study is conducted by Salem and Aref (2019) to evaluate the response of thrips population towards transplanting date as well as to evaluate insect development and onion productivity. Results can be employed in the management of insect population through a transplanting of onion seedlings in early date to reduce insect population particularly thrips population by average 50 or 100% at least, in comparing with middle or late date; and increase onion yield productivity by 30 or 42%, respectively this benefit can be obtained without using any pesticides.

Decisions about plant densities are dictated more by the growing characteristics of the crop, weed management, and harvest requirements than by pest insect management. In general, if increasing the population density of a crop increases beneficial insects, it can lead to a decrease in pest insects. Aboukhadrah *et. al,* (2017) resulted from that response of Onion yield to plant density up to 45 plants/m2 significantly increased most vegetative growth characteristics, total and marketable bulbs yield.

Organic production does not allow synthetic fertilizers or sewage sludge. Although crop plants must grow vigorously to withstand pest and disease damage because overly lush plants often attract more pest and disease and experience more damage than other plants. Over fertilized plants may give visual clues to insects and disease of onion crop and become targets of attack.

Infrequent disruption of soils in natural systems preserves food webs and diversity of organisms and habitats. The regular disturbance of agricultural soils disrupts ecological linkages and allows adapted pest species to increase without the diminishing effects of natural controls. Nevertheless, tillage can also destroy insects overwintering in the soil as eggs, pupae, or adults, and reduce pest problems. Organic producers usually rely on tillage to control weeds and to prepare the soil for planting. Reduction of tillage alters pest insect of onion dynamics considerably. Onion thrips cause fewer problems in reduced till systems.

Mulching systems fall into various categories, including plastic and natural materials. Although, the use of plastic mulch is frequently discouraged by organic certification agencies

because it depends on a non-renewable resource. Biodegradable plastic mulches are being developed and may disturb pests in a similar way to that of conventional, non-biodegradable mulches. Organic farmers of onion often use straw mulch because it is readily accessible and delivers good weed suppression. All mulches suppress insect pest of onion in comparison to bare soil.

Trap crops attract pest species away from the cash crop to be protected and into a specific area where they can be devastated. Depending on the target pest and the cash crop, trap crops can be planted with or around the perimeter of the cash crop field. The size and configuration of the trap-crop area usually are not centred on the size of the cash crop area but on the number of pests of onion, which is anticipated.

2. Conservation practices to restore the natural enemies

Along with onion cultivation, conservation of natural enemies involves the manipulation of the environment to enhance the survival, fecundity, longevity, and performance of natural enemies to increase their effectiveness. Such conservation efforts may be directed at mitigating harmful conditions or enhancing favourable ones. Conservation practices can be further categorized as those that focus on reducing mortality, providing supplementary resources, controlling secondary enemies, or manipulating host plant attributes to the benefit of natural enemies.

Keeping beneficial insects in and around annual crops may be achieved by intercropping, which involves placing a crop plant and another plant within proximity to promote insect interaction. It is one part of a comprehensive conservation plan to manipulate habitats in ways that enhance natural control. The resources provided to natural enemies include pollen, nectar, alternate prey or hosts. Many organic farms are already intercropped to maximize land use and to conquer weeds in the crop area.

3. Use of biological control agents

Inundative and inoculative release or applying biological control agents such as insect predators, parasitoids and insect pathogens will have a greater role to play in suppressing the insect pests in an insecticide-free environment. These agents can be used as curative control methods in case of a sudden outbreak in the insect population of onion.

4. Use of botanicals and their mixtures

The use of botanicals and other insecticides of mineral origin for the control insect pests were used as last options in organic agriculture if all the earlier methods have been failed. Strict regulation of the chemicals that are allowed for pest management in organic cultivation is supervised by NPOP (National Programme for Organic Production) for India and similar organizations existed in different countries to look after registration of chemicals for use in organic cultivation of the crops. The crude extracts, as well as commercial formulations from plants like neem, pongamia, and tobacco that showed efficacy in conventional agriculture for the management of insect pests, were permitted in organic farming because of their less residual action and ecological safety. Panchagavya, Dasagavya and mineral oils are curative control measures, which is well known effective against insect pest management of onion.

5. Use of organic pesticides and other pesticides

When nonchemical practices documented in the organic system plan are not sufficient to prevent or control populations of insect pests from rising above an economically damaging level, a biological or botanical material or a substance included on the national list of synthetic substances allowed for use in organic crop production may be applied to prevent, suppress, or control pests of onion.

Conclusion

For any given combination of onion, crop location, labour and capital availability circumstances there are hypothetically several optimum crop protection tactics. Different crop production and protection approaches include schedule-based prevention, integrated pest management, organic, traditional, biodynamic, biological or ecological applies. Alternate strategies may depend on fundamentally different conceptual methods, yet also function as feasible suites of best management follows for crop production. In organic cultivation of Onion, the various strategies supporting pest management can be coordinated to effect reliable and sustainable yield of crops by reducing the pest infestation below the economic injury level. It seeks to combine tactics except for chemicals, will sustain economic viability and environmental stability in Onion cultivation. This will sustain the future perspective cultivation strategies various crops including Onion.

Reference

Aboukhadrah, S. & Alsayed, Abdul & Sobhy, Labib & Abdelmasieh, William. (2017). The response of Onion Yield and Quality To Different Planting Date, Methods and Density. *Egyptian Journal of Agronomy*. **39**: 203-219.

Mishra, Raj & R., K. & Kumar, Dharmendra & Saabale, Pr & A., Singh. (2014). Management of major diseases and insect pests of onion and garlic: A comprehensive review. *Journal of Plant Breeding and Crop Science*. **6**: 160-170.

Molenaar N D. 1984. Genetics, thrips (*Thrips tabaci* L.) resistance and epicuticular wax characteristics of non-glossy and glossy onion, *Allium cepa* L. *Dissertation Abstracts International B-Sciences and Engineering* **45**: 1075.

Patil A P, Nawale R N, Azri D S and Moholkar P K. 1988. Field screening of onion cultivars for their reaction to thrips. *Indian Cocoa Arecanut* and *Spices Journal* **12**:10-11.

Salem, H., Aref, N (2019). Integration between transplanting date and cultivar type in management population of onion thrips (thysanoptera: thripidae) attacking onion plants in the field conditions. *Int. J. Agric. For. Life Sci*. **3**(1): 121-130.

TRAINING NEEDS OF ASSESSMENT OF FARMERS REGARDING ORGANIC FARMING IN NORTH GUJARAT

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ABSTRACT

Efficient management and maintenance of soil health is the key to accomplish sustainable higher productivity, food security and environmental safety. So, attention is being given to soil due to rapidly decline in agriculture land, soil fertility irrational and imbalance use of inputs etc. All these factors call for a shift in research away from maximum crop production to the "Sustainable crop production system" without degradation of soil health and environment. Development and adoption of an ideal management system which can conserve the natural resources is the urgent need of the era. Organic management system is one of the options to conserve natural resource. The present study was conducted in North Gujarat. All the Seven districts under SDAU jurisdiction namely viz; Mehsana, Patan, Sabarkantha, Aravalli, Gandhinagar, Kutch, and Banaskantha were selected. List of organic farmers were obtained from the DAOs of respective districts. Majority of the farmers had middle aged, educated up to primary to secondary level, farming along with animal husbandry as main occupation, possessed membership in two organizations. average size of land holding is large tube well was the main source of irrigation. and having medium annual income. Majority of farmers prefer to composting/ vermicomposting, green manuring / leaf manuring and crop rotations (Rank I,II and III) followed by Bio fertilizers technology. Majority of farmers had medium training need of organic farming. Social participation and animal posses were highly significant with training need of organic farming. While occupation, land holding, irrigation facilities and annual income were non-significantly related with training need of organic farming. While the age and education had negatively and highly significant relationship with training need of organic farming.

INTRODUCTION:-

Efficient management and maintenance of soil health is the key to accomplish sustainable higher productivity, food security and environmental safety. So, attention is being given to soil due to rapidly decline in agriculture land, soil fertility irrational and imbalance use of inputs etc. All these factors call for a shift in research away from maximum crop production to the "Sustainable crop production system" without degradation of soil health and environment. Development and adoption of an ideal management system which can conserve the natural resources is the urgent need of the era. Organic management system is one of the options to conserve natural resource. The Gujarat state has total 48518.91 hectares area under certified organic cultivation. Many farmers of the State are practicing organic farming and as a result about 0.5 per cent of land has been recorded under organic farming. It is important to know the training need assessment of the farmers towards organic farming technology. Considering the above view in mind, the study was carried out to know the "Training need assessment of farmers regarding organic farming in North Gujarat**"**

OBJECTIVES:-

1. To study the personal attributes of farmers
2. To assess the training need of the farmers regarding organic farming
3. To ascertain relationship between personal attributes of the farmer and their training need **.**

METHODOLOGY:-

The present study was conducted in North Gujarat. under SDAU jurisdiction. All the Seven districts namely viz: Mehsana, Patan, Sabarkantha, Arravalli, Gandhinagar, Kutch, and Banaskantha were selected purposively. List of organic farmers were obtained from the DAOs of respective Districts. All the 105 organic farmers were selected. The data were collected by personal interview. The interview schedule was prepared after thorough discussion with scientists and extension educationists. The data to be collected were tabulated, analyzed and interpreted in terms of objectives with appropriate statically procedures..

Selection of farmers :-

Sr.No	Name Districts	Name of the Villages	Selection of organic farmers
1	Banaskantha	Sundha	4
		Tetoda	4
		Kant	3
		Aseda	4
		Chandisar	4
		Rasana	3
		Kumbhasan	2
2	Patan	Bhalana	4
		Piluda	4
		Kamliwada	4
		Visol	3
		Mithivavdi	4
3	Sabarkantha	Ponaizojva	3
		Rudramala	3
		Vadali	3
		Khedbhrma	3
		Talod	3
4	Mehsana	Detojpura	3
		Linch	4
		Piludra	4
		Palodar	3
		Motidau	4
5	Gandhinagar	Vasnarathod	3
		Nandol	3
		Dehgham	2
6	Kutch	Chobari	3
		Mai	3
		Prakapar	3
		Jarpara	3
		Mota kapya	2
7	Aravali	Mauchapra	3
		Vejpur	4
		Total	**105**

FINDINGS AND DISCUSSION:-

Table:- 1. Distribution of the respondents according to their Age n=105

Sr.No.	Age Group	Number	Percent.
1	Young age (18-35 yrs.)	30	28.50
2	Middle age (36-50 yrs.)	50	47.50
3	Old age (Above 50yrs.)	25	24.00
	Total	**105**	**100.00**

The data depicted in table-1 show that majority (47.50percent) of the respondents were found in the middle age group followed by young age (28.50percent) and old age group (24.00percent) respectively. From the above discussion, it could be inferred that majority of the respondents belonged to middle age group. The probable reason might be that, old age and young age farmers has less interest in farming.

Table:- 2.Distribution of the respondents according to their Level ofEducation.

n=105

Sr.No.	Education	Number	Percent.
1.	Illiterate	14	13.30
2.	Primary level (1 to 8 std.)	57	54.10
3.	Secondary level (9 to 10 std.)	21	19.95
4.	Higher Secondary level (11 to 12 std.)	09	08.85
5.	College level & above	04	03.80
	Total	**105**	**100.00**

The data presented in table-2 reveal that (54.10 percent) of respondents were having primary level of education, followed by secondary level (19.95percent). Higher secondary level (08.85percent), college level and above 03.80percent) whereas (13.30percent) of the farmers were found illiterate. It can be thus concluded that majority of the respondents were having Primary level of educations .

Table:- 3. Distribution of the respondents according to their occupation. n=105

Sr.No.	Occupation	Number	Percent.
1.	Only Farming	12	11.40
2.	Farming+Animal husbandry	62	58.90

3.	Farming+Business	07	06.85
4.	Farming+Service	08	07.60
5.	Farming+Animal husbandry+Service	16	15.25
	Total	**105**	**100.00**

It is apparent from the above data that (58.95percent) farmers had farming+animal husbandry as their occupation followed by (15.25percent) who were earning from farming+animal husbandry+service. On the other hand (11.40percent) were earning only from farming.

Thus it can be concluded that majority of the farmers were earning from farming along with animal husbandry.

Table:4.Distribution of the respondents according to their Land holding. n=105

Sr.No.	Land holding	Number	Percent.
1.	Marginal (up to 1.0 ha)	05	04.75
2.	Small (1.01 to 2.0 ha)	15	14.25
3.	Medium (2.01 to 4.0 ha)	30	28.50
4.	Large(more than 4.0 ha)	55	52.50
	Total	**105**	**100.00**

The data in table-4 indicate that (52.50percent) of the farmers were large farmers followed by medium farmers(28.50percent) and small farmers (14.25percent). Only (04.75percent) of them were marginal farmers.thus, it can be concluded that majority of the farmers (52.50percent) owned land more than 4.0 hectares.

Table: - 5.Distribution of the respondents according to their Irrigation facility. n=105

Sr. No.	Irrigation facility	Number	Percent.
1.	No facility(Irrigated by Hire)	16	15.20
2.	Canal	08	06.85
3.	Well & Electric motor	07	06.65
4.	Tube Well	68	64.60

5.	Well +Tube Well	06	05.70
	Total	**105**	**100.00**

It can be seen from table-5 that majority of the farmers(64.60percent) had tube well irrigation facility. (15.20percent) farmers had no facility.Only (06.85percent). Remaining farmers have irrigated their crops through canal. It can be concluded that majority of the farmers had tube well irrigation facility.

Table: - 6.Distribution of the respondents according to their Annual income.n=105

Sr. No.	Annual income	Number	Percent.
1.	Low(Below Rs.50.000)	08	07.60
2.	Medium(Rs.50,001 to 2,50,000)	68	64.60
3.	High(Above Rs.2,50,000)	29	27.60
	Total	**105**	**100.00**

The data presented in table-6 indicate that (64.60percent) and (27.80percent) of the respondents had annual income of Rs.50, 000-/ to Rs.2, 50,000-/ and above Rs.2, 50,000-/ respectively. Only (07.60 percent)of the respondent were having the income below Rs.50, 000-/ per year. It can be concluded that majority of the farmers were having medium annual income.

Table: - 7.Distribution of the respondents according to their Social participation.

n=105

Sr.No.	Social participation	Number	Percent.
1.	No Participation	05	04.75
2.	Member in one Organization	08	07.60
3.	Member in two Organization	41	38.95
4.	Member in more than two Organization	45	43.00
5.	Office bearer	06	05.70
	Total	**105**	**100.00**

The data presented in table-7 clearly indicate that (43.00percent) respondents could associated with two organizations followed by (38.95percent) were associated with more than two organizations. Only (07.60percent) respondents were member in only one

organization. Further it was observed that only (05.70percent) respondents were found holding position in social organizations.

It is concluded that majority of the respondents were associated with two organizations. i-e milk Co-operative society and Co-operative society.

Table: 8 Distribution of the respondents according to their No. of Animal Possesses. n=105

Sr. No.	**No. of Animal Possesses**	Number	Percent.
1.	Not possessed animal	15	14.25
2.	possessed animal up to 5 animals	65	62.00
3.	possessed heard 6 to 10 animals	14	13.30
4.	possessed more 10 animals	11	10.45
	Total	**105**	**100.00**

Table 8 reveals that majority of respondents (62.00 percent) had animal up to 5. followed by (14.25) per cent who does not possessed animals. While (13.30per cent had heard size between 6 to 10 animals (10.45 per cent had more than 10 animals.

Table: - 9 .Distribution of the respondents overall of training need n=105

Sr.No.	Category	frequency	Percent.
1	Low(below 44 score)	15	14.50
2	Medium (44 to 49 score)	82	77.90
3	High(above 49 score)	08	07.60
	Total	**105**	**100.00**

x= 46.57, SD =02.58

The data in table -9 reveals that (77.90percent) of the farmers had medium training need. Remaining (14.50percent)and (07.60percent) farmers had low & high overall training need respectively.

Table: - 10 Distribution of the respondents according to their training need. n=105

Sr.No.	Training need	Mean Score	Rank.
1	Composting/ vermicomposting	2.69	I

2	Green manuring / greed/ leaf manuring	2.55	II
3	Crop rotations	2.51	III
4	Bio fertilizers technology	2.45	IV
5	Nutrient mangement	1.60	V
6	Bio logical method of pest control	2.29	VI
7	Record keeping & certification standards	2.25	VII
8	Grading/packing of marketing of organic produce	2.24	VIII
9	Soil management techniques	2.18	IX
10	Marketing information	2.14	X
11	process of certification developed by governments	1.96	XI
12	Bio rational pest management techniques	1.81	XII

Mean of mean score .— 2.45

The respondents were asked to opine about training need of various aspects related to organic farming at three points quantum i.e. mostly needed. Somewhat needed and not needed with a score of 3, 2 and 1 respectively. Based on the total training need score of all respondents, mean score for each practice was worked out.

The data presented in table-10 reveal that majority of farmers prefer to Composting/ vermicomposting and Green manuring / greed/ leaf manuring and Crop rotations (Rank I,II and III) followed by Bio fertilizers technology. The rest were as consider as least important various aspects related to organic farming by the farmers **.**

Table: -11.Relationship with characteristics of farmers & their training need. n=105

Sr.No.	**variable**	Training need coefficient of Correlation.(r-value)
1.	Age	-- 0.592**
2.	Education	0.558**
3.	Occupation	0.188
4.	Land Holding	0.086
5.	Irrigation facilities	0.192
6.	Annual Income	0.177
7.	Social Participation	0.367**

8	Animal posses	0.542**

** Significant at the level of the 0.01 level. * Significant at the level 0.05 level.

A perusal of data presented in table-10 revealed that the Education, Social participation and animal posses were highly significant with training need of organic farming. While occupation, land holding, irrigation facilities and annual income were non-significantly related with training need of organic farming. While the age had negatively and highly significant relationship with training need of organic farming.

1.1.6 CONCLUSIONS:-

- Majority of the visiting farmers had middle aged, educated up to primary to secondary level, farming along with animal husbandry as main occupation, possessed membership in two organizations. average size of land holding is more than 4.0 hectares, tube well was the main source of irrigation. and having medium annual income. (Rs.50,000/- to Rs.2,50,000/-)
- majority of farmers prefer to Composting/ vermicomposting and Green manuring / greed/ leaf manuring and Crop rotations (Rank I,II and III) followed by Bio fertilizers technology.
- Education Social participation and animal posses were highly significant with training need of organic farming. While occupation, land holding, irrigation facilities and annual income were non-significantly related with training need of organic farming. While the age had negatively and highly significant relationship with training need of organic farming.

REFERENCES

Bhatt, H. P. 2002 Impact of institutional training on farmwomen's' knowledge and adoption of whear production technology, M.Sc (Agri.) thesis (unpublished), (G,A,U,. S.K. Nagar

Garret, H.E.1967, Statistics in psychology education. Vakils peffer and simons pvt. Ltd., Bombay.

Siddaramaiah, B S. and Jalihal, K. A. 1983 Ascale to measure extension participation of farmers. IJEF, 19 (3&4) :74-76,

Subramonium, K. 1986. Communication behavior of farmers a system analysis M.Sc (Agri.) College agriculture vellayani.

Trivedi, M. S. and Patel, B. T. 1997. A knowledge test to measure Groundnut growers' knowledge about Groundnut production technology, GJEE 8&9 :109-110.

Influence of time and method of transplanting on different varieties of white onion (*Allium cepa* L.).

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ABSTRACT

Present study was undertaken for assessment of date of transplanting, method of cultivation and performance of different varieties on growth, yield and quality of white onion (*Allium cepa* L.). Results revealed that the higher plant height at 45 (34.99 cm) and 90 (64.28 cm), maximum number of leaves at 45 (6.07) and 90 DAT (8.74), minimum neck thickness at 45 (7.87) and 90 DAT (18.56), minimum days taken for maturity (135.36), minimum bolting percent (7.45) and the minimum incidence of purple blotch (27.33 %), maximum weight of bulb at harvest (113.19 g), marketable yield of bulb per plot (17.14 kg), minimum unmarketable yield of bulb per plot (0.09 kg), marketable yield of bulb per hectare (488.48 q), minimum unmarketable yield of bulb per hectare (2.81 q), higher total bulb yield per hectare (491.29 q) simultaneously, maximum diameter of bulb (5.28 cm), maximum neck thickness after curing (4.33 cm) and maximum total soluble solids (14.21˚Brix) was evaluated when planted on 17th December in flat bed cultivation with Agrifound White variety.

According to findings of research, the highest growth, yield and quality of white onion can be achieved by the growing of Agrifound White at 17th December in flat bed.

INTRODUCTION

Onion (*Allium cepa* L.) belongs to family Alliaceae.Onion is also designated as “queen of the kitchen” (Selvaraj, 1976).The Onion is preferred because of its green leaves, immature and mature bulbs are either eaten raw or cooked as vegetables and among them mild flavoured are often preferred for salads. The bulbs are indispensable part in several preparation like soups, sauces, condiments, spice, medicine, seasoning of many foods and now a days many value added products like powder & flakes are also available.

Onion has many uses as folk medicine and recent reports suggest that onion has several neutraceutical properties. Sharma (2014) has given detailed account of nutritional as well as medicinal richness of onion. It is very good source of different vitamins, minerals, dietary fibers,

flavonoids, antioxidant and sulphur containing compounds. In India two types of varieties are popular *viz*. red and white types. Among them red types are preferred for raw consumption at domestic level. While in export market and for processing, white onion have edge over others. During last few years the requirement of white onion for a flakes and powder processing industries and its export have increased.

There are several methods of planting like flat bed, raised bed, ridge and furrow etc. Kanwar and Akbar (2003) have concluded after comparing the different methods of planting that planting in onion in flat land produced statistically highest net bulb weight, bulb diameter, neck diameter and yield per ha in flat bed condition. Choice of method of planting depends upon several factors like type of soil, time of planting and climatic condition.

MATERIALS AND METHODS

An experiment was carried out to evaluate the different varieties, method of cultivation and date of transplanting on growth, yield and quality of white onion during 2014-15 at Horticulture Instructional Farm, Department of Horticulture, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar. It represents the North Gujarat Agro-climatic Zone IV. Experiment laid out in Split plot design (SPD) one main treatment factor and two sub plot treatment factor among Main plot treatment Date of transplanting (D) d_1 = 17th December, d_2 = 1st January, Sub plot treatment Methods of cultivation (M) m_1 = Flat bed, m_2 = Ridge bed and Varieties (V) v_1 = Agrifound White, v_2 = Akola Safed, v_3 = Gujarat White Onion-1 with three replications. Observations were made on different growth, yield and quality. The data were analyzed as suggested by Panse and Shukhatme.

RESULTS AND DISCUSSION

A. Growth attributes

In the present study various growth attributes viz., plant height, number of leaves, neck thickness of plant, days taken for maturity, bolting per cent, insect-pest and disease were result sowed that maximum plant height at 45 (34.99 cm) and 90 (64.28 cm), maximum number of leaves at 45 (6.07) and 90 (8.74), minimum neck thickness at45 (7.87) and 90 (18.56), minimum days taken for maturity (135.36), minimum bolting percent (7.45) and the minimum incidence of purple blotch (27.33 %) days of transplanting was recorded with treatment 17th December transplanting(D_1) and minimum plant height at 45 (31.32 cm) and 90 (57.15 cm), maximum incidence of purple blotch (30.21 %) days of transplanting was recorded under treatment 1st January transplanting(D_2).

Different dates of transplanting created difference in plant growth parameters which might be due moderate climatic condition in early date than late planting (Rahman *et al.*,2003). Abdulsalam *et al.*(2004) also repeated same findings in onion.

Data presented in table 1 revealed that method of cultivation created significant variation in plant height at 45 and 90 days of transplanting. Among the two methods of cultivation, the maximum plant height at 45 (35.40 cm) and 90 (64.26 cm), the maximum number of leaves at 45 (6.01) and 90 (8.57), neck thickness at 45 (8.99 cm) and 90 (21.02 cm), the minimum days taken for maturity (136.16), minimum bolting percent (6.71) and minimum incidence of purple blotch (25.35 %)days of transplanting were recorded in flat bed (M_1) method of cultivation while minimum plant height at 45 (30.91 cm) and 90 (57.18 cm), minimum neck thickness at 45 (7.91 cm) and 90 (18.23 cm), maximum bolting percent (10.70), maximum incidence of purple blotch (32.19 %) days of transplanting were recorded under ridge bed (M_2) cultivation.

As the onion is a shallow rooted crop it might have performed better in that flat bed than ridge bed (Kanwar and Ishfaq , 2013). Similar results were obtained by Arian *et al*. (2004) and Singh *et al*. (1992).

The performance of different varieties also differed significantly with respect to plant height (Table 1). The plant height at 45 and 90 days of transplanting was significantly varied. The maximum plant height at 45 (34.13 cm) and 90 (63.16 cm), maximum number of leavesat 90 (8.46), minimum bolting percent (7.44) and minimum incidence of purple blotch (26.33 %)days after transplanting was recorded in variety Agrifound White(V_1)which was statistically at par with Gujarat White Onion-1 (V_3) (33.68 cm and 60.40 cm at 45 and 90 day after transplanting respectively) whereas minimum plant height at 45 (31.65 cm) and 90 (58.06 cm), minimum days taken for maturity (135.41), minimum bolting percent (7.44), maximum incidence of purple blotch (31.87 %) days of transplanting was recorded in Akola Safed (V_2).

Varietal difference reported due to the genotypic difference was major cause of difference growth of onion. These findings are in corroborate with the findings of Jilani *et al*. (2002) and Khandhagale *et al*. (2005).

The development of bolters is a physiological phenomena which is highly influenced by environmental factors. A slight fluctuation in temperature, time of planting etc. may cause its emergence. Though to some extent it is a genetic character also. In the present study different environmental condition created by dates, soil condition created by method of planting and

difference in varieties might be responsible for difference in bolting per cent. Our result are close accordance with that of Ahmed and Hassan (1978), Bhamburkar*et al.*(1986), Pandey *et al.* (1990) and Gautam *et al.* (2006).

B. Yield attributes and yield

In the present study various yield and yield attributes *viz*., weight of bulb, marketable and unmarketable yield and total bulb yield were studied which have been tabulated 2 significantly maximum weight of bulb at harvest (113.19 g), marketable yield of bulb per plot (17.14 kg), minimum unmarketable yield of bulb per plot (0.09 kg), marketable yield of bulb per hectare (488.48 q), minimum unmarketable yield of bulb per hectare (2.81 q), higher total bulb yield per hectare (491.29 q) was recorded with in treatment which were transplanted on 17thDecember (D_1) while minimum marketable yield of bulb per plot (14.30 kg), yield of bulb per plot (0.12 kg), minimum marketable yield of bulb per hectare (407.45 q) was recorded under treatment of 1st January transplanting(D_2),

The significant variation in bulb weight under the influence of different dates of planting might be due to variation in temperature and humidity at different stages of plant growth by (Cheema *et al*. 2005). Gautam et al.(2006) and Ron (2010) have also repeated the similar result. Increase in unmarketable yield might be due to more number of bolters, splited bulbs, purple blotch and twins. Sharma *et al.* (2003) in onion and Gowada *et al.* (2007) in garlic.

Perusal of data in table 2 are maximum weight of bulb at harvest (109.43 g), maximum marketable yield of bulb per plot (17.49 kg), marketable yield of bulb per plot (13.95 kg), minimum unmarketable yield of bulb per plot (0.06 kg), maximum marketable yield of bulb per hectare of 498.50q, maximum total bulb yield per hectare (500.26 q), was recorded in flat bed (M_1) cultivation while minimum weight of bulb at harvest (98.72 g), unmarketable yield of bulb per plot (0.16 kg), maximum unmarketable yield of bulb per plot (0.16 kg), minimum marketable yield of bulb per hectare (397.43 q), minimum total bulb yield per hectare (402.04 q) was recorded under ridge bed (M_2) cultivation.

Planting in flat bed resulted in higher weight of bulb which might be due to the enhanced crop growth which further resulted in better utilization of photosynthates (Sharma et al., 2009). Result obtained in this investigation are in close accordance of Haque*et al.* (2002) and Arian *et al.* (2004).

Three varieties in the study differed significantly maximum weight of bulb at harvest (108.73 g), marketable yield of bulb per plot (17.31 kg), minimum unmarketable yield of bulb per plot (0.07 kg), maximum marketable yield of bulb per hectare (493.43 q), significantly minimum unmarketable yield of bulb per hectare (2.09 q), maximum total bulb yield per hectare (495.22 q) was recorded in Agrifound White(V_1)whereas minimum marketable yield of bulb per plot (13.62 kg) minimum weight of bulb at harvest 96.49 g, maximum unmarketable yield of bulb per plot (0.14 kg), minimum marketable yield of bulb per hectare (388.03 q), minimum total bulb yield per hectare (392.26 q) was recorded in Akola Safed(V_2).

Variation in varieties is a common and well known fact that every variety has its own genetic make up and our findings agreed with the findings of Khandhagale *et al.* (2005) and Gowda *et al.* (2007).

The vigorous vegetative growth resulted by more photosynthates and favourable weather conditions might have helped to increase the marketable yield of bulb. The increase in marketable yield of bulb due to its positive correlation with bulb diameter and bulb weight. As a matter of fact the better quality bulb have lesser lesser unmarketable quality. Present findings are close corroborate the findings of Singh *et al.* (2010) in garlic.

C. Quality attributes

In the present study various quality attributes viz., diameter of bulb, neck thickness after curing and total soluble solids studied, maximum diameter of bulb (5.28 cm), maximum neck thickness after curing (4.33 cm) and maximum total soluble solids (14.21˚Brix) was recorded with 17th December transplanting(D_1)while minimum diameter of bulb (4.57 cm), minimum neck thickness after curing (3.89 cm) and minimum total soluble solids (12.95˚Brix) was recorded under 1st January transplanting(D_2).

Representation of data in table 2 are self explanatory that method of cultivation created significant variation on diameter of bulb. Among the two methods of cultivation, the maximum diameter of bulb (5.13 cm), maximum neck thickness after curing (4.61 cm) and maximum total soluble solid (13.71˚Brix) was recorded in flat bed cultivation(M_1) which was significantly superior over ridge bed cultivation 4.71 cm, minimum neck thickness after curing (3.62 cm) and minimum total soluble solid (13.44˚Brix) was recorded under ridge bed cultivation (M_2).

The performance of three varieties was significantly different with respect to diameter of bulb (Table 2). The maximum diameter of bulb (5.11 cm), maximum neck thickness after curing

(4.31 cm) and maximum total soluble solid (13.68˚Brix) was recorded with treatment Agrifound White(V_1) while minimum diameter of bulb (4.65 cm), minimum neck thickness after curing (3.88 cm) and total soluble solid (13.37˚Brix) was recorded in Akola Safed(V_2). Though statistically Agrifound White was at par with Gujarat White Onion-1.

The diameter of bulb was directly influenced by size and length of bulb. Better size of bulbs is responsible for improved diameter of bulb because it is directly correlated to plant height, neck thickness and bulb weight. The results are in close accordance with findings of Kanwar and Akbar (2013) in onion and Haque *et al*. (2002) in garlic. Reason for variation in TSS may be attributed to the different treatments. TSS is a plant index which is affected by several factors like temperature, humidity, sun-light, supply of nutrients and other inputs, variety and even micro-climate of crop. This results in close accordance with findings of Singh *et al*. (2010) in garlic, Cheema *et al.* (2005), Kanwar *et al.* (2013) and Mohanty (2001) in onion.

Conclusion

According to findings of present investigation optimum growth, yield and quality of white onion can be achieved by the growing of Agrifound White at 17th December in flat bed.

REFERENCES

Abdulsalam A. L, M. A. and Hamaiel, A. F. (2004). Effect of planting dates and compared fertilizers on growth, yield and quality of Hassawi Onion under Al-Hassa Oasis condition. *Scientific Journal of King Faisal University., (Basic and Applied Sciences)* Vol. **5** (1): 1425.

Ahmed, M. K. and Hassan, M. S. (1978). Effects of land preparation and planting method on onion (*Allium cepa* L.) production in the Sudan Gezira. *Acta Horticulturae.,* **84**.

Arian, A. L., Khushk, A. M., Baloch, A. F. and Ahmed, Nasir (2004). Growth and yielding behavior of onion in response to essential nutrients. *Pakistan J. Agric. Res.,* Vol. **18** (1).

Bhamburkar, A. S., Rajput, J. M., Kulwal, L. V., Kale, P. B., Sadawarte, K. and Deshmukh, P. P. (1986). Bolting in onion as influenced by dates of planting, nitrogen and cultivars. *P. D. K.V. Res. J*., Vol. **10** (2): 115-118.

Gautam, I. P., Khatri, Bhogendra and Paudel, Govinda P. (2006). Evaluation of different varieties of onion and their transplanting times for off-season production in mid hills of Nepal. *Nepal Agric. Res. J*., Vol. **7:** 21-26.

Gowda, M. C., Baby, Madineni and Gowda, A.P.M. (2007). Evaluation of garlic (*Allium Sativum* L.) genotypes for growth, yield and quality. *Journal of Crop Research* (Hisar)., Vol. **33** (1/3): 141-143.

Haque, Md. S., Sattar, Md. A. and M, H. R. P. (2002). Land configuration and varietal effects on yield contributing traits and yield of garlic. *Pakistan Journal of Biological Science*., **5** (10): 1024-1027.

Jilani, M. S., Ghaffoor, A. (2002). Screening of local varieties of onion for bulb production. *International Journal of Agriculture and Biology.*, Vol. **5** : 57-69.

Kanwar, M. S. and Ishfaq Akbar, I. (2013). Effect of planting methods on performance of onion varieties under cold desert condition. *An International Quarterly Journal of Life Sciences, The Bio scan*. Vol. **8** (3): 911-913.

Khandagale S. S., Jogdande N. D., Gonge V.S., Warade A.D., Futane N.W. (2005). Varietal performance in onion (*Allium cepa* L.) *International Journal of agricultural Sciences*., Vol. **1** (1): 45-46.

Mohanty, B. K., and Prusti, A. M. (2001). Performance of common onion varieties in kharif seasons. *Journal of Tropical Agriculture*., Vol. **39** (1): 21-23.

Pandey, U. B., Singh Lallen and Rajkumar (1990). Studies on the dates of transplanting and levels of nitrogen on yield and quality of small onion (*Allium cepa* L.). *A.A.D.F., News letter*, **10** (3): 10-12.

Panse, V. G. and Sukhatme, P.V. (1978).Statistical Methods for Agricultural Workers, Indian Council of Agriculture Research Publication, New Delhi pp.369.

Rahman, M. S., Faruq, M. O., Alam, M. S. and Sharfudddin, A. F. N. (2003). Growth, yield and storage performance of onion as influenced by planting time and storage condition. *Pakistan J. of Biological Sciences*., Vol. **6** (13): 1179-1182.

Ron, Goldy (2010). Effect of five planting dates on yield of six sweet onion (*Allium Cepa* L.). *Midwest Vegetable Trial Report for* 2010.

Selvraj, S. (1976). Onion queen of kitchen. *Kisan Word*, **3** (12) : 32-34.

Shama, A. (2014). Market survey, G.B.P.U.A&T., Pantnagar, Uttarakhand. WWW. FFYMAG. COM

Sharma , A. K., Bhatia, R. S. and Raina, R. (2009). Effect of planting dates, size of setts and method of planting on kharif onion (*Allium cepa* L.). production under submountain low hills of Himachal Pradesh. Veg. Sci. **36** (1): 74-76.

Sharma, M. K., Kohli, V. K. and Sharma, S. K. (2003). Varietal performance of onion cultivars under mid hills condition of Himachal Pradesh. *Approaches for sustainable development of Onion and Garlic*., 150-151.

Singh, Lallan., Chauhan, K. P. S. and Singh, J. B. (1992). Effect of planting and size of cloves on yield and quality of garlic (*Allium Sativum* L.). *Newsletter, Associated Agricultural Development Foundation*. Vol. **12** (2): 7-8.

Singh, Pratibha., Naruka, I. S., Rathore, S. S., Shaktawat, R.P.S. and Singh, P. P. (2010). Response of garlic (*Allium Sativum* L.) cultivars to different date of sowing in Malwa region of Madhya Pradesh. *Indian Journal of Agricultural sciences* ., Vol. **80** (7): 645-648.

Table 1. Effect date of transplanting, method of cultivation and performance of different varieties on growth of white onion (*Allium cepa* L.)

Treatments	Plant height at 45 DAT (cm)	Plant height at 90 DAT (cm)	Number of leaves at 45 DAT	Number of leaves at 90 DAT	Neck thickness at 45 DAT (cm)	Neck thickness at 90 DAT (cm)	Days taken for maturity	Bolting per cent	Purple blotch (%)
D_1 (17th December)	34.99	64.28	6.07	8.74	9.04	20.69	141.64	7.45	27.33
D_2 (1st January)	31.32	57.15	5.41	7.81	7.87	18.56	135.36	9.96	30.21
S.Em. ±	0.59	1.08	0.09	0.15	0.13	0.32	0.70	0.13	0.47
C.D. at 5 %	3.63	6.58	0.59	0.91	0.82	1.95	4.29	0.81	2.88
C V %	7.64	7.56	7.24	7.68	6.82	6.94	2.16	6.48	6.98
M_1 (Flat bed)	35.40	64.26	6.01	8.57	8.99	21.02	140.85	6.71	25.35
M_2 (Ridge bed)	30.91	57.18	5.46	7.98	7.91	18.23	136.16	10.70	32.19
S.Em. ±	0.55	1.02	0.09	0.14	0.12	0.30	0.62	0.12	0.45
C.D. at 5 %	2.18	4.01	0.36	0.55	0.50	1.20	2.46	0.50	1.76
C V %	7.12	7.15	6.86	7.24	6.46	6.63	1.92	6.25	6.64
V_1 (Agrifound White)	34.13	63.16	5.88	8.46	8.84	20.75	141.51	7.44	26.23
V_2 (Akola Safed)	31.65	58.06	5.55	7.92	7.75	18.64	135.41	10.55	31.87
V_3 (Gujarat White Onion-1)	33.68	60.94	5.78	8.45	8.77	19.48	138.58	8.13	28.21
S.Em. ±	0.65	1.21	0.10	0.16	0.14	0.35	0.65	0.14	0.50
C.D. at 5 %	1.95	3.65	NS	0.48	0.44	1.06	1.97	0.44	1.52
C V %	6.80	6.95	6.23	6.82	6.12	6.28	1.65	5.88	6.11

Table 2. Effect date of transplanting, method of cultivation and performance of different varieties on yield and quality of white onion (*Allium cepa* L.)

Treatments	Weight of bulb at harvest (g)	Marketable yield of bulb per plot (kg)	Unmarketable yield of bulb per plot (kg)	Marketable yield of bulb per hectare (q)	Unmarketable yield of bulb per hectare (q)	Total bulb yield per hectare (q)	Diameter of bulb (cm)	Neck thickness after curing (cm)	Total soluble solids (°Brix)
D_1 (17th December)	113.19	17.14	0.09	488.48	2.81	491.29	5.28	4.33	14.21
D_2 (1st January)	94.96	14.30	0.12	407.45	3.55	411.00	4.57	3.89	12.95
S.Em. ±	2.81	0.45	0.003	13.00	0.09	13.07	0.11	0.07	0.06
C.D. at 5 %	17.11	2.77	0.02	79.14	0.55	79.55	0.69	0.44	0.37
C V %	11.47	12.31	12.20	12.32	12.21	12.29	9.86	7.45	1.92
M_1 (Flat bed)	109.43	17.49	0.06	498.50	1.76	500.26	5.13	4.61	13.71
M_2 (Ridge bed)	98.72	13.95	0.16	397.43	4.60	402.04	4.71	3.62	13.44
S.Em. ±	2.72	0.44	0.003	12.79	0.09	12.80	0.10	0.07	0.05
C.D. at 5 %	10.69	1.76	0.01	50.22	0.35	50.27	0.42	0.27	0.22
C V %	11.11	12.12	11.87	12.12	11.86	12.04	9.38	7.27	1.78
V_1 (Agrifound White)	108.73	17.31	0.07	493.43	2.09	495.52	5.11	4.31	13.68
V_2 (Akola Safed)	96.49	13.62	0.14	388.03	4.22	392.26	4.65	3.88	13.37
V_3 (Gujarat White Onion-1)	107.00	16.23	0.11	462.43	3.23	465.67	5.00	4.15	13.68
S.Em. ±	3.24	0.54	0.004	15.49	0.10	15.50	0.12	0.08	0.06
C.D. at 5 %	9.73	1.63	0.01	46.45	0.31	46.49	0.38	0.24	0.20
C V %	10.81	11.98	11.52	11.98	11.52	11.91	8.93	6.98	1.74

Organic nutrient management packages of green manuring-potato-groundnut sequence under North Gujarat condition

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Abstract

The field experiment was conducted during 2003-04 to 2014-15 at Centre for Research on Integrated Farming Systems, S.D. Agricultural University, Sardarkrushinagar (Gujarat) to study the "Organic nutrient management packages of green manuring-potato-groundnut sequence under North Gujarat condition". Application of 50 % recommended NPK+ 50% N from FYM+ inorganic sources of micronutrients as per soil test produced the significantly highest potato equivalent yield (47338 kg/ha) of potato as well as recorded the maximum net return (` 1,01,551), BCR (1.75), system productivity (130), system profitability (278) and agro energy K cal (38100), available N (246 kg/ha) and K (330 kg/ha).

Key words: Potato equivalent yield, Farm yard manure, Benefit cost ratio, potato-ground nut, organic production

Introduction

Awareness in health conscious has increased the demand of organic products at national as well as international level. The organic sources *viz;* bio fertilizers, FYM, castor cake, vermicompost and other highly concentrated organic manures are not easily available for nutrient management of high nutrient requiring crops like potato. Farmers of North Gujarat have been practicing *in-situ* green manuring and using organic manures for years to sustain the soil fertility and crop yield on long- term basis but persuasive confirmation of maintaining the comparable crop yield under organic, inorganic and integrated nutrient management systems is not adequate.

At present some of package of practice for individual crops are available which are not enough to sustain the production management system. Potato followed by summer groundnut is prominent cropping system of this region. Therefore information needs to be generated with respect to suitable combination of different

organic sources and green manuring to develop the suitable nutrient-management practices for this high-value organic cropping system for better quality and high-productive food as well as sustainability. Moreover, the information for partial elimination of inorganic nutrients for sequenced cropping is not available. Hence, this experiment was planned.

Material and Methods

The experiment was initiated during 2003-04 at Research Farm, Centre for Research on Integrated Farming Systems, SDAU, Sardarkrushinagar (Gujarat) to study the "Organic nutrient management packages of green manuring-potato-groundnut sequence". The soil at the experimental site was loamy sand with organic carbon (0.26 %), B.D. (1.502 g/cc), porosity (43.32 %), low available nitrogen (195 kg/ha), medium in available phosphorus (23.9 kg/ha) and high in available potassium (261 kg/ha). The experiment was non-replicated with plot size of 300 m^2. The experiment comprises of eight treatments as given in Table 1. The sequence was green manuring- potato - summer groundnut. Green manuring crop sannhemp was grown during *kharif* in 1st week of July and incorporated after 45 days after sowing. The potato crop was sown in last week of November and harvested in last week of February. The variety of potato was K. Badshah sown keeping 45 cm x 20 cm distance. The summer groundnut crop was sown in 1st week of March and harvested in middle of June. The variety of groundnut was GG 20 sown keeping 45 cm x 10 cm distance. Organic source viz., FYM, vermi-compost, castor cake and rock phosphate were analyzed for their NPK composition and applied at the time of sowing according the treatments. Nutrients contents of each organic material are given in Table 2. Seed rate of each crop viz. sunhemp (60 kg/ha), potato (2,500 kg/ha) and groundnut (120 kg/ha) were as per recommendation of North Gujarat. The seeds were treated as per treatment with *Rhizobium* and PSB culture and were dried under shade before sowing for 3 hrs. The potato and groundnut were fertilized with 220-110-220 NPK kg/ha and 25:50:00 NPK kg/ha, respectively. Tuber & haulm yields of potato and pod & haulm yields of summer groundnut were recorded at the time of harvest of each crop. Equivalent yield of potato was calculated on the basis of market rate of each crop during March 2014 for potato and July 2014 for groundnut. On visual observation damage of insect & pest was not severe in all the crops.

Soil studies were carried out by taking soil samples from 0 to 22.5 cm depth at 8 different spots ascertained in a random manner. The samples were drawn before the application of fertilizers to the experimental field during the each year. Estimation of total nitrogen was done by modified Kjeldhal's method as described by Jackson (1973). Phosphorus was estimated by Olsen's method (Olsen *et al*., 1954). Estimation of potassium was made from acid extract by flame photometric method as described by Jackson (1973).

Table: 1 Treatments details

T_1	50% recommended NPK+ 50% N from FYM + inorganic sources of micronutrients as per soil test
T_2	Different organic sources each equivalent to 1/3 of recommended N (FYM + vermicompost + castor cake)
T_3	T_2 + Intercropping or trap crop (location specific in each season)
T_4	T_2 + Agronomic practices for weed and pest control (No chemical pesticides and herbicides)
T_5	50% N from FYM + Bio fertilizer for N (*Azatobactor/Rhizobium*)+ Rock phosphate to substitute P requirement crop + Phosphate solubilizing bacterial culture (PSB-16)
T_6	T_2 + Bio fertilizer containing N (*Azotobactor*) and P carriers (PSB-16)
T_7	100% NPK+ Secondary and micro-nutrients based on soil test

Results and Discussion

Effect on potato equivalent yield (PEY)

The result revealed that highest PEY of potato was significantly influenced due to different treatments. The treatment T_7 (100% NPK+ Secondary and micro-nutrients based on soil test) produced the highest potato equivalent yield of potato in 2003-04 to 2004-05. While the result revealed that the highest potato equivalent yield of potato was significantly influenced due to different treatments. The treatment T_6 (Different organic sources each equivalent to 1/3 of recommended N (FYM + vermi compost + castor cake) + bio fertilizer containing N (*Azotobactor*) and P carriers (PSB-16) produced the highest potato equivalent yield of Potato in 2005-06 to 2006-07.

After conversion period the result constantly revealed that the highest potato equivalent yield of potato was significantly influenced due to different treatments.

The treatment T_1 (50% recommended NPK+ 50% N from FYM+ inorganic sources of micronutrients as per soil test) produced the highest PEY of Potato in 2007-08 to 2014-15. This result in agreement with reports of Daniel, et al. (2008 who reported insufficiency of manure for optimum yield of crops in short period of time, regardless of the amount (low) they used. On the other hand, Rutunga and Neel (2006) reported that application of high rate of nutrient rich farmyard manure alone was sufficient to increase potato yield. Depending on fertilizer combinations, farmyard manure gave a potato tuber yield increase of 38 -82 % (Baniuniene 2008).

Pooled

The pooled results revealed that the highest potato equivalent yield of potato was significantly influenced due to different treatments. The treatment T_1 (50% recommended NPK+ 50% N from FYM+ inorganic sources of micronutrients as per soil test) produced the highest potato equivalent yield of potato. Moreover, potassium has stimulating effect on photosynthesis, phloem loading and translocation as well as synthesis of large molecular weight substances in storage organs, thereby contributing to the rapid bulking of the tubers (Singh, 1999).

Effect on soil properties

The highest content values of available N (246 kg/ha) and K (330 kg/ha) were recorded in treatment T_1 (50% recommended NPK+ 50% N from FYM+ inorganic sources of micronutrients as per soil test), P (31.06 kg/ha) was recorded in treatment T_5 (Different organic sources each equivalent to 1/3 of recommended N (FYM + vermi compost + castor cake) + Bio fertilizer containing N (*Azotobactor*) and P carriers (PSB-16). The highest values of organic carbon (0.37 %) was observed in T_2 Different organic sources each equivalent to 1/3 of recommended N (FYM + vermi compost + castor cake) and T_3 (T_2 + Intercropping or trap crop (location specific in each season). The result finding similar with Mahapatra (2009) and Willer (2008).

Economics:

Economic of different treatment was workout on the basis of selling price of tuber at the time of harvest market value of input. The data indicate that 50% recommended NPK+ 50% N from FYM+ inorganic sources of micronutrients as per soil test (T_1) recorded the maximum value of gross returns (` 236688) as well as maximum net return (` 101551).

REFERENCES

Baniuniene A., Zekaite V. (2008). The effect of mineral and organic fertilizers on potato tuber yield and quality. *Latvian Journal of Agronomy*, No.11.

Daniel, M. Pant, L. M. and Nigussie, D. (2008). Effect of integrated nutrient management on yield of potato and soil nutrient status of Bako, West Shoa *Ethiopian Journal of Natural Resources,* vol. 10, pp. 85-101.

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Mahapatra, B. S.; Ramasubramanian, T. and Chowdhury, H. (2009). Organic farming for sustainable agriculture: Global and Indian perspective. *Indian Journal of Agronomy* 54 (2): 178-185.

Olsen, S.R.; Cole, V.C.; Watanable, P.S. and Dean, L.A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate. U.S.D.A., Circ. No. 939.

Rutunga, V. and H. Neel, (2006). Yield trends in long-term crop rotation with organic and inorganic fertilizers on Alisols in Mata, Rwanda,*Biotechnol. Agron. Soc. Environ.*, vol. 10, pp. 217-228.

Singh JP (1999) Potassium fertilization of potatoes in north India. In, Proceedings of IPI workshop on Essential Role of Potassium in Diverse Cropping Systems, held at the 16th World Congress of Soil Science Montpellier, France, 20-26 August. *International Potash Research Institute*, Basel, Switzerland: 123-127.

Willer, H. 2008. Organic Agriculture Worldwide: Current Statistics. In: *The World of Organic Agriculture: Statistics and Emerging Trends 2008*. Willer, H., Yussefi-Menzler, M. And Sorensen, N. (Eds.). International Federation of Organic Agriculture Movements (IFOAM), Bonn, Germany and Research Institute of Organic Agriculture (FiBL), Frick, Switzerland, pp. 23-46.

Table: 3 Effect of different treatments on potato equivalent yield of sequence (2003-04 to 2014-15 and pooled)													
Treat.	Potato equivalent yield (kg/ha)												
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Pooled
T_1	30953	35932	39692	41790	44176	48520	44968	48899	48909	52238	64025	67926	47338
T_2	19168	30839	41838	42458	40140	43772	41822	45502	45459	49278	63267	62900	43869
T_3	17136	31048	41765	41040	40044	40097	37866	43190	42332	47482	62668	65113	42481
T_4	16549	31201	41911	41605	38313	42446	40732	44937	43782	47568	62362	64995	43033
T_5	14544	29090	38048	36382	33030	34002	32102	32039	31997	35922	47037	52438	34717
T_6	16446	32185	42323	42809	43040	45623	43935	47322	46389	51024	63190	66632	45073
T_7	32306	36144	42245	40342	40857	43003	41427	45078	44922	49442	59679	64790	45020
SEM $\pm$													779
CD (0.05)													2207
CV %													6.27

Table: 4 Effect of different treatments on economics, system productivity, system profitability and agro energy (pooled)							
Treatments	Gross return (`/ha)	Cost of cultivation (`/ha)	Net return (`/ha)	BCR	System productivity (kg/ha/day)	System profitability (`/ha/day)	Agro energy K cal
T_1	236688	135137	101551	1.75	130	278	38100
T_2	219343	155412	63931	1.41	120	175	34975
T_3	212407	158088	54319	1.34	116	149	33925
T_4	215162	154986	60177	1.39	118	165	34334
T_5	173584	134394	39191	1.29	95	107	27545
T_6	225364	155831	69534	1.45	123	191	35841
T_7	225100	128874	96226	1.75	123	264	36947

Calories/100 g : Ground nut: 567, Potato: 97

Particulars	Farm gate prices (`/kg) during 2014-15	Particulars	Farm gate prices (`/kg) during 2014-15
Potato Tuber	5.0	Ground nut pod	40
Potato haulm	0.5	Ground nut straw	3.0

Table: 5 Soil fertility status after 2014-15 as affected by different treatments of organic farming

Treat.	Available major nutrients (kg/ha)			Available secondary and micronutrient (mg/kg)					O.C. (%)	pH	EC (ds/m)	Bulk density (g/cc)	Porosity (%)
	N	P	K	S	Fe	Mn	Zn	Cu					
T_1	246	29.64	330	16.36	10.96	18.16	1.70	0.72	0.36	7.1	0.128	1.456	45.06
T_2	237	27.41	270	17.32	9.96	17.91	1.92	0.76	0.37	6.65	0.127	1.443	45.55
T_3	234	28.87	286	18.12	9.46	17.36	1.42	0.64	0.37	6.53	0.118	1.439	45.70
T_4	235	28.80	272	16.94	9.42	17.74	1.98	0.72	0.36	6.51	0.118	1.432	45.96
T_5	223	31.06	301	15.56	8.48	16.18	1.36	0.66	0.34	6.93	0.122	1.452	45.21
T_6	232	30.44	296	17.62	9.22	17.96	1.74	0.64	0.36	6.54	0.127	1.444	45.51
T_7	234	26.30	299	16.26	12.00	6.08	1.60	0.32	0.28	7.04	0.112	1.461	44.87
Initial	195	23.90	261	13.26	3.26	6.24	0.42	0.36	0.26	7.16	0.14	1.502	43.32

Organic Farming: A Review

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ABSTRACT

India produces a large variety of food crops including cereals, pulses and oilseeds. In the name of increased productivity, increased application of enormous quantity of chemical fertilizers is being followed keeping the health factor neglected. Hence an alternative method of farming that satisfy the needs of increased food production as well as providing a security soil health problem. Organic farming is a production management system excluding of all synthetic off-farm inputs but rely upon on-farm agronomic, biological and mechanical methods like crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection, etc which promotes and enhances biodiversity, biological cycles and agro-ecosystem health. Organic farming is beneficial for natural resources and the environment. Organic farming is a system that favors maximum use of organic materials and microbial fertilizers to improve soil health and to increase yield. Organic farming has a long history but show a recent and rapid rise. This article explains history, characteristics, components and advantages of organic farming

Keywords: organic farming, advantages, history

Introduction

Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. Agriculture remains the key sector for the economic development for most developing countries. It is critically important for ensuring food security, alleviating poverty and conserving the vital natural resources. Due to greater use of synthetic agro chemicals like fertilizers and pesticides, adoption of nutrient responsive, high-yielding varieties of crops has boosted the production output in most of cases. And continues use of these high energy inputs is leading to decline in production and productivity of various crops as well as deterioration of soil health and environments, destruction of soil structure, aeration and water holding capacity, reduction in soil

humus/organic matter. Therefore, for sustaining healthy ecosystem, there is need for adoption of an alternatives farming system like organic farming.

Organic Farming

Organic farming is a production management system excluding of all synthetic off-farm inputs but rely upon on-farm agronomic, biological and mechanical methods like crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection, etc which promotes and enhances biodiversity, biological cycles and agro-ecosystem health.

Characteristics of Organic Farming

1. sustainable use of local resources
2. Ensuring the basic biological functions of soil-water-nutrients-human continuum.
3. Maintaining a diversity of plant and animal species as a basis for ecological balance and economic stability.
4. Minimal use of purchased inputs, only as complementary to local resources
5. Increasing crop and animal intensity in the form of polycultures, agroforestry systems, integrated crop/livestock systems etc. to minimize risks.

Organic farming relies on crop rotation, crop residues, animal manures, legumes, green manures, off-farming organic wastes, agricultural cultivation, mineral bearing rocks and aspect of biological pest control to maintain soil productivity and tilth to supply plant nutrients and also to control insects, weeds and other pests (Lampkin 1990).

History of Organic Farming

Organic farming practice is known since ages. The ancient Indian manuscripts also describe the importance of dead and decaying matter in nourishment of life and soil fertility. Organic farming has been recognized worldwide for personal health, safe environment, food security and fight against global warming. The concept of organic farming was started 1,000 years back when ancient farmers started cultivation near the river belt depending on natural resources only. In fact, organic agriculture has its roots in traditional farming practices that evolved in countless villages. In Mahabharta (5500) mentions of Kamadhenu, the celestial cow and its role on human life and soil fertility. Organic agriculture began more or less simultaneously in Central Europe and India. The

British botanist Sir Albert Howard, often referred to as the father of modern organic agriculture, works as an agricultural adviser in Pusa, Bengal, (now in Bihar).

Need of Organic Farming

The recent decade has seen a serious concern over the issue of environmental degradation and an urgent need for its sustainability has been raised. Organic manures not only as a source of nutrients but also increase size biodiversity and activity of the microbial population in soil. Excessive applications of pesticides and fertilizers have caused damage to the soil and environment besides affecting the crop production. Thus, a natural balance needs to be maintained at all cost for the existence of life and property.

Principles of Organic Farming

Principle of health

Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Principle of ecology

Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

Principle of fairness

Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities. This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products. This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being.

Principle of care

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes. Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

Advantages of Organic Farming

1 Nutritional, poison free and tasty food-

The nutritional value of food is largely a function of its vitamin and mineral content. In this regard, organically grown food is dramatically superior in mineral content to that grown by modern conventional methods. A major benefit to consumers of organic food is that it is free of contamination with health harming chemicals such as pesticides, fungicides and herbicides. Also, less residues of pesticides and antibiotics are present (Huber and van de Vijver, 2009).

2. Lower growing cost :

The economics of organic farming is characterized by increasing profits via reduced water use, lower expenditure on fertilizer and energy, and increased retention of topsoil. To add to this the increased demand for organic produce makes organic farming a profitable option for farmers.

3. Enhances soil nourishment:

Organic farming effectively addresses soil management. Even damaged soil, subject to erosion and salinity, are able to feed on micro-nutrients via crop rotation, inter-cropping techniques and the extensive use of green manure. Also Agricultural productivity doubled with soil fertility techniques: compost application and introduction of leguminous plants into the crop sequence (Dobbs and Smolik, 1996; Drinkwater *et al*., 1998; Edwards, 2007).

4. More energy efficiency:

Growing organic rice was four times more energy efficient than the conventional method (Mendoza, 2002).

5. Environment -friendly practices:

The use of green pesticides such as neem, compost tea and spinosad is environment-friendly and non-toxic. These pesticides help in identifying and removing diseased and dying plants in time and subsequently, increasing crop defense systems. Organic agriculture reduces erosion caused by wind and water as well as by overgrazing (Pimentel *et al.,* 1995).

6. Organic farming is a source for productive labour:

Organic farming is a source for productive labour: Agriculture is the main employer in rural areas and wage labour provides an important source of income for the poor. Thus, by being labour intensive, organic agriculture creates not only employment but improves returns on labour.

Disadvantages of Organic Farming-

1. Lower productivity:

An organic farm cannot produce as much yield as a conventional or industrialized farm. Though this point is debatable as the productivity and soil quality of an industrialized farm decreases rapidly over the years.

2. Requires skill:

An organic farmer requires greater understanding of his crop and needs to keep a close watch on his crops as there are no quick fixes involved, like pesticides or chemical fertilizers. Sometimes it can be hard to meet all the strenuous requirements and the experience to carry out organic farming.

3. Time consuming:

Significant amounts of time and energy are required to execute the detailed methods and techniques that are required for a farm to be called an organic farm. Failure to comply with any of these requirements could result in loss of certification, which the farmer will not be able to regain in up to three years.

4. More labour intensive:

It can be more labor-intensive. For organic farming considers biological, cultural and mechanical responses to production challenges. It focuses on plant and soil health through proper aeration, drainage, fertility, structure and watering. So there's more above and below ground grunt work involved.

Conclusion

Organic farming works in harmony with nature rather than against it. A common belief within the organic movement is that natural products are good, whereas man-made chemicals are bad or at least not as good as natural ones. This idea may also be used to explain why organic farming avoids the use of synthetic fertilizers and pesticides etc. This involves using techniques to achieve good crop yields without harming the natural environment or the people who live and work in it. In another way organic farming is kind of agricultural that provide the consumers, with fresh, tasty and reliable food while regarding natural life cycle systems. An organic farming keeps biodiversity and reduce environmental pollutions such air, water and soil.

References

Dobbs, ThL and Smolik, J.D. 1996. Productivity and profitability of conventional and alternative farming systems: a long-term on-farm paired comparison. Journal of Sustinable Agriculture, 91(1): 63-79.

Drinkwate,r L.E., Wagoner, P. and Sarrantonio, M., 1998. Legume-based cropping systems have reduced carbon and nitrogen losses. Nature, 396: 262-265.

Edwards, S. 2007. The impact of compost use on crop yields in Tigray, Ethiopia. Institute for Sustainable Development (ISD). Proceedings of the International Conference on Orga nic Agriculture and Food Security FAO, Rome.

Huber, M. and van de Vijver, L. 2009. Overview of research linking organic production methods and health effects in the lab, in animals and in humans. Department of Health Care and Nutrition, Louis Bolk Institute, Netherlands.

Lampkin, N. 1990. Organic farming. Farming Press Book, IPSWICH.

Mendoza, T.C. 2002. An Evaluation study of plan international sustainable agriculture program in Calapan, Oriental Mindoro. Report submitted to Plan International Philippines, 6th Floor N & M Building Chino Roces Ave. Makati City, Philippines. 123 pp.

Pimentel, D, Harvey C, Resosudarmo, P. Sinclair, K,. Kurz, D., McNair, M., Crist, S, Shpritz, L., Fitton, L., Saffouri, R. and Blair, R. 1995. Environmental and economic costs of soil erosion and conservation benefits. *Science*, 267: 1117-1123.

Integrated Weed Management in Vegetables: A review

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Abstract:

A year's seeding is seven year's weeding and thus Indian agriculture has been defined as a confrontation with weeds. The welfare of mankind is highly dependent on farmer's ability to control the growth of weeds. Thus, it is necessary to concentrate more on weeding out the undesirables than for any other activity related to increasing agricultural production. No single herbicide is effective in controlling wide range of weed flora. Continuous use of same herbicide creates resistance in weed flora or causes shift in the flora. Only one method of weed control may lead to increase in population of particular weed. Many a time, a combination of these methods gives effective and economic control than a single method. So there is need of integrated weed management in vegetables for effective control of weeds.

Keywords: Vegetables, Integrated, Weed management, Herbicides.

Introduction:

Weeds pose most serious problem in vegetable crops because of the liberal use of farm yard manure, chemical fertilizers and frequent irrigations that help the weeds to grow vigorously. It has been well established that losses from weeds accounts for 45 per cent more than when compared to insect pests and diseases of about 30 and 20 per cent, respectively (Rao, 1983). Jain and Singh (2000) stated that an unchecked weed growth in cluster bean caused 47 per cent reduction in seed yield. Weeds can be categorized by their life-cycles and management strategies developed accordingly (Nwafor et al., 2010). Annual weeds complete their life-cycles in one year and reproduce

solely by seeds. Annuals are divided into summer and winter groups depending on when they grow. The perennial weeds live for more than two years and can reproduce by seed or vegetative structures such as stolons, rhizomes, tubers, bulbs and roots (Njoroge 1999). Hand weeding is a common practice of weed control but incessant rains in vertisols and unavailability and high labour wages at weeding peaks are the major constraints (Vyas and Kushwah, 2008). As we know hand weeding is a traditional and effective method of weed control. But untimely rains, unavailability of labour at peak time and increasing labour cost are the main limitations of manual weeding. Under such situations, the only alternative that needs to be explored is the use of suitable herbicides which may be effective and economically viable (Gupta 1984). Crop types and soil properties have greatest influence on the occurrence of weed species (Streibig et al., 1984 and Andreasen et al., 1991). Various other factors like type of irrigation, cropping pattern, weed control measures and environment also have a significant influence on the intensity and infestation of weeds (Saavedra et al., 1990). In most of the vegetables, the early growth period is the most critical stage at which stress of any kind affects the economic yield. Weed competition is such an important stress during this period. This growth period is often marked by weather conditions that do not permit the traditional methods of weed control. Besides, this period coincides with the season of peak labour activity leading to scarcity of labour for weeding. All this, add to high cost of production. Under such situations, use of integrated weed management practices needs to be explored as an effective and economical method of weed management in vegetables.

Integrated weed management (IWM) is a science-based decision-making process that coordinates the use of macro and micro-environment information, weed biology and ecology, and all available technologies to control weeds by the most economical and ecologically viable methods (Rao and Nagamani 2010). Integrated weed management combines different agronomic practices and herbicides use to manage weeds, so that the reliance on any one weed control technique is reduced (Reddy and Nagamani 2019). Objective of integrated weed management is to develop weed management program using a combination of preventive, cultural, mechanical, and chemical practices. It will help in minimize overall economic impact of weeds and reduce the use of herbicide. This

may reduce detrimental effects on the environment and human health cause due to high use of herbicides.

Conventional methods of weed control have become an expensive input in the cultivation of vegetable crops. Owing to high cost and non- availability of labour in time and no single method of weed control is adequate or cost effective. Integrated weed management is a systematic approach to minimize weed impacts and optimize the land use by the different weed management practices (Aldrich, 1984)

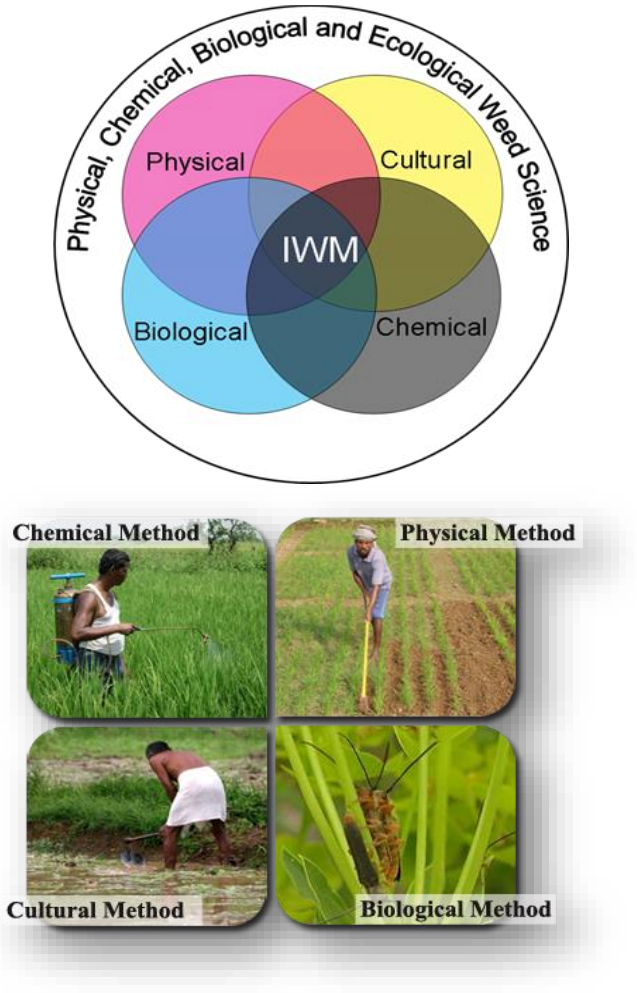

Figure 1. Different methods of weed management

Integrated weed management

Integrated weed management approaches are Prevention, Chemical weed control, Biological weed control, physical weed control and Cultural weed control (Singh et al,. 2019).

Prevention

As we know prevention is better than cure, avoid using crops that are infested with weed seeds for sowing. Avoid feeding screenings and other material containing weed seeds to the farm animals. Avoid adding weeds to the manure pits, Clean the farm machinery thoroughly before moving it from one field to another. Avoid the use of gravel sand and soil from weed-infested area. Inspect nursery stock regularly for the presence of weed seedlings, tubers, rhizomes, etc. Keep irrigation channels, fence-lines, and un-cropped areas clean. Inspect farm frequently for any strange looking weed seedlings. Destroy such patches of a new weed by digging deep and burning the weed along with its roots. Sterilize the spot with suitable chemical. Quarantine regulations are available in almost all countries to deny the entry of weed seeds and other propagules into a country through airports and shipyards. (*http://dx.doi.org/10.5772/55950*)

Chemical weed control

Using chemicals, generally referred as herbicides, for the control of weeds is called chemical weed control. In 1944 - discovery of 2,4-D Na salt as a land mark in herbicide usage (Reddy and Nagamani 2019). Herbicides work by blocking a fundamental growth process *viz*., by destroying chlorophyll, stop cell division, stop respiration which cause stunting, unnatural growth, and dry out the weed plant. Herbicides offer a great scope for minimizing the cost of weed control irrespective of the situation and offer a good weed control alternative to cultural or mechanical methods in horticultural crops (Bhullar et al., 2015) .

Biological weed control

Use of living organism's *viz*., insects, disease organisms, herbivorous fish, snails or even competitive plants for the control of weeds is called biological control. It is use of beneficial creatures such as insects or fungi that damage the weeds. Examples, Insects - *Uroplata giraldi* to control *Lantana camara*, mites to control prickly pear, Fish like

common carpc to control Aquatic weeds, Fungi *Rhizoctinia* blight to control Water hyacinth.

Physical weed control

Physical weed control includes, Hand weeding, tillage, digging, sickling and mowing, burning, flooding and hoeing. In market different mechanical weeders are available for example Dry land weeder, Power rotary weeder, and Tractor operated multi row rotary weeder.

Cultural weed control

Cultural weed control methods includes different cultural practices such as, Field preparation, Summer tillage, Maintenance of optimum plant population, Crop rotation, Growing of intercrops, Use of Mulching, Solarisation, Stale seedbed, Blind tillage, Crop management practices, Grazing *etc*. Mulching generally prevents the germination of light sensitive weeds like *Ageratum conyzoides*, *Portulaca oleraceae* etc. (Adeyemi and Olaniyi 2008).

Conclusion:

So it is concluded that integrated weed management considers all available weed control techniques and combines them to provide economic and sustainable weed management. A key component of managing for resistance is to avoid the repeated use of a single herbicide group with the same mechanism of action year after year. Cover crops serve important functions such as enriching soil organic matter, cycling nutrients, and protecting soil from water and wind erosion. To insure long term sustainability of benefits realized with use of herbicide tolerant crops, farmers must practice diversified integrated weed management. The farmer needs to define long and short-term goals for the farm's integrated weed management programme. Farmers need to look ahead and plan their weed control programme for as long as practical.

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References

Adeyemi, OR and Olaniyi, SM. 2008. Critical period for weed removal in garden egg (*Solanum gilo*). Nigerian Journal ofHorticultural Science 13: 82-90.

Aldrich, R.J. 1984. Weed crop ecology: Principles in weed management. Berton Publishers. Massachusetts. Pp. 375.

Andreasen, C., Streibig, J.C. and Hass, H. 1991. Soil properties affecting the distribution of 37 weed species in Danish fields. Weed Res., 31: 181-187.

Bhullar, Makhan Singh & Kaur, Tarundeep & Kaur, Simerjeet & Yadav, Ramawatar. 2015. Weed management in vegetable and flower crop-based systems. 47. 277-287.

Gupta, O.P. 1984. Critical Period of Weed Crop Competition Scientific Weed Management in the Tropics and Sub-tropics, Today and Tomorrow's Printers and Publishers, New Delhi.

http://dx.doi.org/10.5772/55950.

Jain, A.K. and Singh, S.K. 2000. Integrated weed management in cluster bean. Haryana J. Hort. Sci., 2: 146-149.

Njoroge, JM. 1999. Weeds and their vontrol in horticultural cropswith special reference to East Africa, pp. 65-71. In: 17thEast African Biennial Weed Science Conference Proceedings.

Nwafor, OE, Adepoju SO, Mba AA, Okonkwo MC, EmefieneM and Aminu K. 2010. Proceedings of 24 Annual NationalConference of Farm Management Association of Nigeria(FAMAN). Adamawa State University, Mubi. October11-14, 2010.

Rao, A. N. and Nagamani, A. 2010. Integrated Weed Management in India–Revisited. Indian J. Weed Sci., 42: 123-135.

Rao, V.S. 1983. Principles of weed science, Oxford and IBH Publiushing Co. New Delhi. pp. 24-42.

Reddy, S. R. and Nagamani, C. 2019. Principles of crop production, Kalyani Publishers. Noida. pp. 605

Saavedra, K.L., Torres, G., Bermejo, E.H. and Hildag, B. 1990. Influence of environmental factors on the weed flora in the Guadalquivir valley. Weed Res., 30: 363-374.

Singh Mandeep, Amit Kaul, Vivek Pandey and Avtar Singh Bimbraw. 2019. Weed Management in Vegetable Crops to Reduce the Yield Losses. Int.J.Curr.Microbiol.App.Sci. 8(07): 1241-1258.

Streibig, J.C., Gottshau, A., Dennis, B., Hass, H. and Molgaar, P. 1984. Soil properties affecting weed distribution. In: 7th Int. Symp. Weed Biol. Ecol. Systematics, Paris 10-12 Oct. pp.147-154.

Vyas, M.D. and Kushwah, S.S. 2008. Effect of cultural and chemical methods on growth and yield of soybean in Vindhynagar Plateau of Madhya Pradesh. Indian J. Weed Sci., 40 : 92-94.

Development of Juices Made From Pomogranate, Tomato and Rose Petal Extract and its Organoleptic Assessment

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Abstract

The current study was carried out for the development of juices made from pomegranate, tomato and rose petals extracts. Three formulation that contains different percentage of juices of pomegranate, tomato and rose petals extracts were used for the preparation of mix juice. Formulated, T1, T2 and T3 juices were analyzed for sensory evaluation. During sensory evaluation of three different juice ratios T1 90: 5:5 and T2 80:15:5 and T3 70:25:5 were selected and then the selected products were analyzed for the physic-chemical, phytochemical and storage stability during storage period of 28 days at every seven days interval. Looking to the sensory qualities T1 and T2 were found highly acceptable.

Keywords: Pomegranate, Tomato and rose petals extract juices, Sensory Evolution.

Introduction

Fruit juices are obtained from a single fruit or from different kinds of fruits and vegetables. It is one of the most popular drinks to go with breakfast in the morning (Franke *et al.,* 2005). Fruits are rich in functional components like minerals, vitamins, dietary fiber, antioxidant, and do not contain and dairy allergens that might prevent usage by certain segments of the population (Luckow and Delahunty, 2004). Consuming fruits promotes health, energy and quality of life. Fruit and vegetable juices have become important in recent years due to overall increase in natural juice consumption as an alternative to the traditional caffeine containing beverages such as coffee, tea, or

carbonated soft drinks (Rowshon *et al.*, 2014). Fruits and vegetables juice improve high phenol content correlate with reduced cardiovascular diseases and cancer mortality (Hertog *et al.,* 1997a,b). Phenol compounds may produce their beneficial effects by scavenging free radicals. In the past few years there has been an increasing interest in determining relevant dietary sources of antioxidant phenolics (Maria *et al.,* 2010).

Fruit and vegetable juices also prevent the formation of kidney and gall stones, due to their potassium salt richness. Are recommended in acidosis, diabetes, under nutrition, gout, and aging tissues. Recent scientific studies have also claimed that the antioxidant found in most fruits and vegetable juices can help lower a person's risks of developing Alzheimer disease (Delia *et al.,* 2011). Pomegranate juice contains higher levels of antioxidants than most other fruit juices. It also has three times more antioxidants than red wine and green tea. The antioxidants in pomegranate juice can help remove free radicals, protect cells from damage, and reduce inflammation. Pomegranate juice has become more popular because of the attribution of important biological actions (Maria *et al.,* 2010). Looking to the health benefits and popularity of mix fruit juices, the present study was planned to develop and evaluate pomegranate, tomato and rose petal juices in various combinations and to check for their sensory qualities during storage period.

Materials and methods

This study was conducted into three main phase

Phase I

1. Collection of materials
2. Preparation of juice
3. Standardization of juice

Phase II

Sensory Evaluation

Phase -I

The Study was initiated by gathering the knowledge regarding the pomegranate, and ingredients required for product development were procured from respective place.

The fresh pomegranate, tomato and rose petals were collected from the local market, Anand, Gujarat, India. Sugar (good life) was procured from grocery shop from anand local market. The Standardization of mix fruit and vegetable juice preparation which was very crucial stage of entire study. After the procurement of all ingredients required, developing a new product and the standardization of product was initiated.

Preparation mix fruit and vegetable juice

The preparation of mix fruit and vegetable juice was done by extraction juice from pomegranate, tomato, and rose petals. Rose petals juice was extracted by boiling them in water and then filtered with double muslin cloth. Sugar was added. No preservatives and food color were used. Then the boiled mixture was cooled and mixed according to ratios with other fruit juices.

The juices were prepared purely, without adding water by manual and electronic juicer machines. Then the juice was standardized in four sets of development and storage studies of juices made from pomegranate, tomato, and rose petals extract juices different ratios i.e. (pomegranate Juice : tomato Juice: rose petals extract Juice) where control juice was C (100:0:0) and three experimental juices were T1 (90:5:5) , T2 (80:15:5) and T3 (70:25:5). 10 gm sugar was added to each.

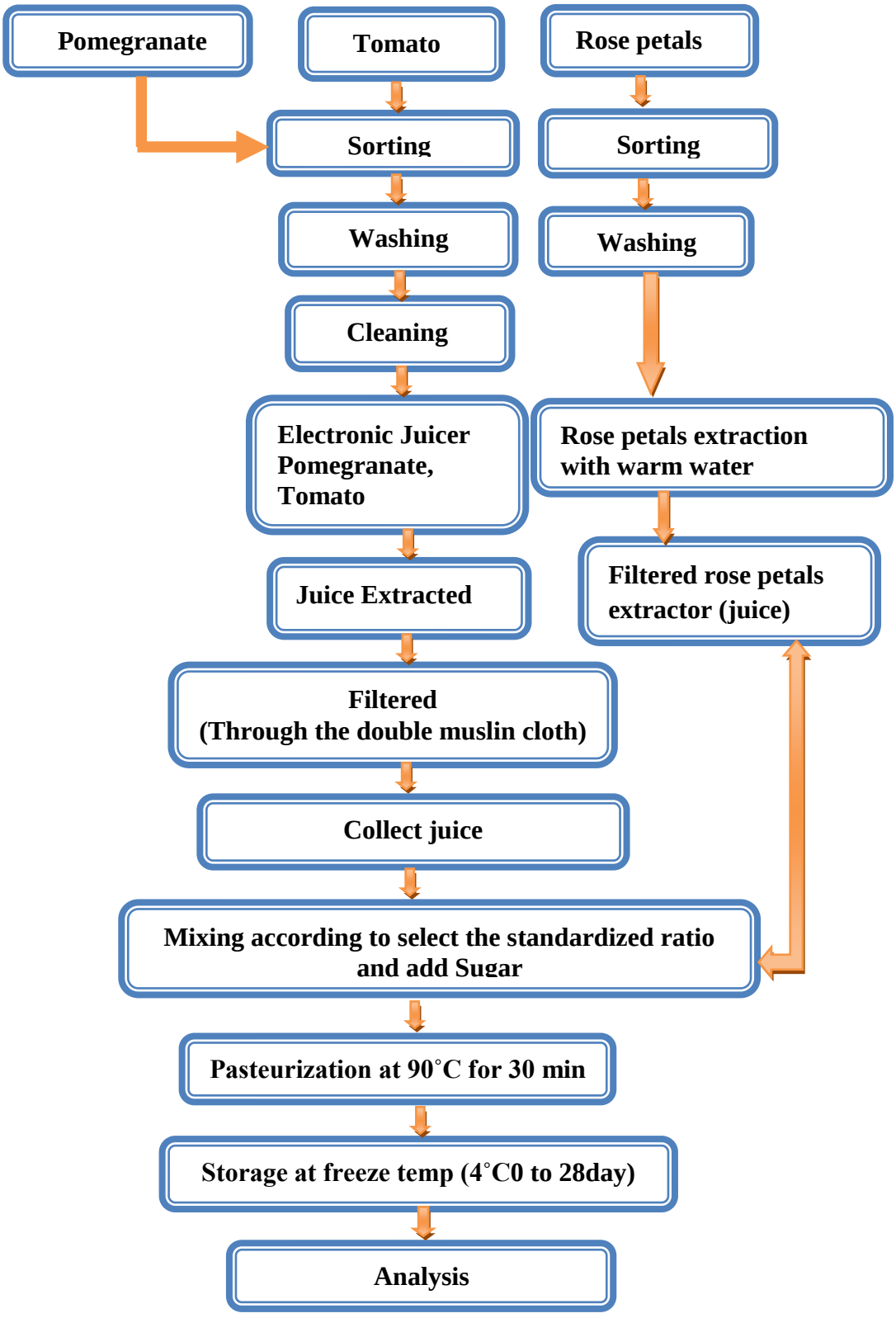

Figure no. 1 Preparation of Juice.

Sensory evaluation

When the quality of a food product is assessed by means of human organs, the evaluation is said to be sensory or subjective or organoleptic. Every time food is eaten is judgment is made. Sensory quality is a combination of different senses of perception coming into play in choosing and eating a food. Hedonic rating test was used to conduct sensory evaluation of prepared juices. The hedonic rating test is used to measure the consumer acceptability of the juice. Four juices were served to the panelists at one session and total three sessions were performed.

Rating scale

The tests were performed using 5 point hedonic rating scale, where the scales with score were:

- LVM – Like very much – 5
- LM – Like moderately – 4
- NLD – Nor like or dislike – 3
- DM – Dislike moderately – 2
- DVM – Dislike very much – 1

Statistical analysis

Statistical analysis of the data was carried out using single factor one way analysis of variance (ANOVA), (M S office excel) to determine the acceptability of the Development and storage studies of juices made from Pomegranate, Tomato and Rose Petals extract juices.. The significance level of $^{**}P \leq 0.01$ and $^{*}P \leq 0.05$ and F value were considered.

Results and discussion

Standardization of juice

Different combinations were used for standardization of juice mixtures. Out which four combinations were selected and compared with each other as shown in table 1.

Table 1: Composition of Control Juice and Experimental Juice

Samples	Ingredients of Juice	Ratio (100ml)	Sugar(gm)
Control (C)	Pomegranate	100 : 0 : 0	10 gm
Experimental-1 (T1)	Pomegranate : Tomato : Rose petals extract	90 : 5 : 5	10 gm
Experimental-2 (T2)	Pomegranate : Tomato : Rose petals extract	80 : 15 : 5	10 gm
Experimental-3 (T3)	Pomegranate : Tomato : Rose petals extract	70: 25 : 5	10 gm

Table 1 indicates the various combinations used during standardization of juices. The results of sensory evaluation was depicted in table 2.

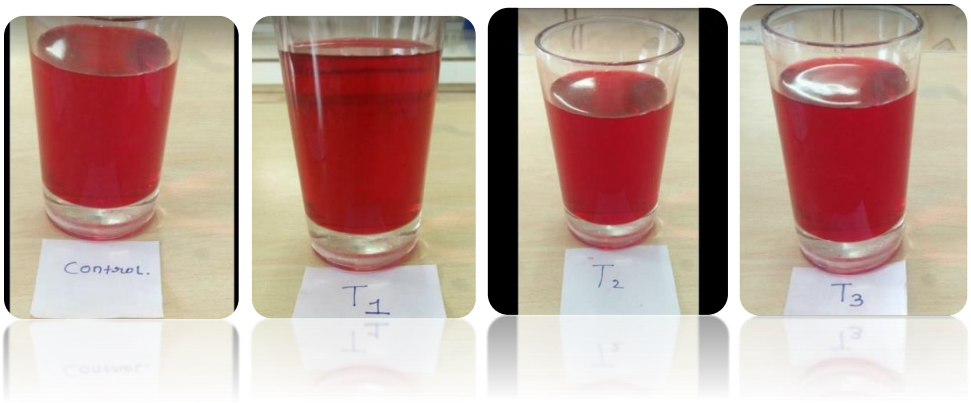

Plate 1: Control juice and experimental juice

Table 2: Sensory score of developed juices for various sensory qualities

Sample	Color	Flavor	Consistency	Taste	O.V
Control	8.37± 0.67	7.97± 0.76	7.80± 0.61	8.13± 0.82	8.13± 0.82
T1	8.30± 0.53	7.70± 0.75	7.93± 0.78	7.77± 0.77	7.80± 0.85
T2	8.23± 0.73	8.17± 0.79	8.13± 0.82	8.03± 0.93	8.23± 0.86
T3	7.77± 0.73	7.23± 0.82	7.50± 0.73	7.20± 0.71	7.37± 0.67
F-Value	4.95	8.01	3.86	7.95	7.13

P-Value	HS	HS	S	HS	HS

Table 2 shows the mean value of sensory qualities of control and experimental juices. The developed pomegranate, tomato and rose petals extract juices was evaluated for color, flavor, consistency, taste and over all acceptability through a taste testing panel consists of 10 untrained panelists. The panelists were briefed about the sample and then asked to score the sample in ascending order of 1-9 point showing their degree of preference in respect of color, flavor, consistency, taste and over all acceptability of the juices sample. The responses were recorded. It is observed from table that for color, flavor, consistency, taste and over all acceptability of all sample there are highly significance differences was observed among the samples. It was also observed that T2 was found the best one and ranked as like very much.

It was observed that control combination was found most acceptable. Colour of T1 (8.30± 0.53) was found most acceptable following the negligible difference with T2 (8.23± 0.73). T2 was found best in flavour (8.17± 0.79), consistency (8.13± 0.82), taste (8.03± 0.93) and in overall acceptability (8.23± 0.86). Combination T3 was found least acceptable amongst all.

Conclusion

From the present study, it was observed that acceptable juice formulation can be prepared from pomegranate, tomato and rose petals extracts. Experimental juice T2 made of Pomegranate : Tomato : Rose petals extract with 80:15:5 ratio, was found most acceptable. It showed good sensory value for colour, taste, flavour and overall acceptability.

References

Delia G. D., Nicoleta G. H., Camelia M., Diana N. R., Mirela V. P., Radoi B., (2011). Antioxidant activity of some fresh vegetables and fruits mjuices. *Journal of Agroalimentary Processes and Technologies.*, ***17*****(2),** 163-168.

Franke A. A., Cooney R.V., Henning S. M., Custers L.T., (2005). Bioavailability and antioxidant effects of orange juice components in humans. J *Agic. Chem.,* **53 (13)**: 5170-5178.

Hertog M. G. L., Sweetnam P. M., Fehily A. M., Elwood P. C., Kromhout D., (1997a). Antioxidant flavonols and ischaemic heart disease in a Welsh population of men. The Caerphilly study. *Am. J. Clin. Nutr.*, 65, 1489-1494.

Hertog M. G. L., van Poppel G.., Verhoeven D., (1997b). Potentially anti carcinogenic secondary metabolites from fruit and vegetables. In Phytochemistry of Fruit and Vegetables; Toma s., Barbera n. F. A., Robins R. J. E., Clarend on Press: Oxford, pp 313-329.

Luckow t., and Delahunty C., (2004). Which juice is healthier? A consumer study of prebiotic non-dairy drinks. *Food Quality and Preference.*, **(15)**:751-759.

Mira R., Nina V., Judith A., Riad M., Michael A., (2010). Consumption of Polyphenolic-rich beverages (mostly pomegranate and black currant juices) by healthy subjects for a short term increased serum antioxidant status, and the serum's ability to attenuate macrophage cholesterol accumulation. *Food Funct.,* 1, 99–109.

Munish G., Vinni A., (2015). Development and Evaluation of a Nutraceutical Herbal Summer Drink., *International Journal of Medical, Health Biomedical, Bioengineering and Pharmaceutical Engineering*., **9(7).**

Rowshon M. D., Habib A. I., (2014). Processing of mixed Vegetable Juice from Tomato, Cucumber and pumkin. *Food science and technology.,* **2(6)**: 83-91

Post harvest management, processing and preservation of vegetables : need of hour

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ABSTRACT

Horticulture is backbone of our country and greater population about 60-65% is directly or indirectly dependent on it. Horticulture produce also earns good in export earnings for the country. Unfortunately about 25-30% of horticulture produce gets wasted due to lack of post-harvest management of vegetables which resulted in huge loss of crores of rupees. A complex series of metabolic adjustments occur in vegetables after harvest which are influenced by dislocation of supply of nutrients, water and growth regulators from the parent plant to the harvested vegetables. The overall process leads to postharvest deterioration of the produce. To achieve the target of feeding the growing population and meeting the requirements of processing industry and export trade, increasing production and productivity will not be sufficient. Reduction in post-harvest losses is therefore need of the hour to feed growing population of country.

Keywords: Post-harvest techniques in vegetables. Post-harvest management, processing of vegetables

Introduction

India is a rich horticultural country producing wide variety of fruits, vegetables, spices, ornamental and medicinal plants. India is second largest producer of vegetables in the world. Unfortunately, having such a huge production a considerable postharvest loss to the tune of 10-25% of vegetables occur annually mainly due to inefficient postharvest management practices. These percentages are not acceptable and adversely affect the Indian economy. To prevent such amount of losses, different organizations in India have been trying to find solution for serious issue related to post-harvest.

Vegetables are highly perishable having moisture content of (80-90%). Food production has been steadily increased in India due to advancement in production technology, but

improper post-harvest management, processing, value addition and storage results in high losses in agricultural produces.

There are many technologies already developed in the past which are available in the literature but are not practiced may be due to either materials are not available locally, not much effective or the technology is more costly. By adoption of simple post-harvest management practices, processing and value addition operation viz., proper harvesting, sorting, grading, packaging, pulping, pickling, drying and dehydration at farmer's level during the peak season will help in minimization of post-harvest losses as well as doubling the farmer's income.

The optimum postharvest management of horticultural products is not the same for all products. Growers, wholesalers, exporters and retailers must all be aware of the specific needs of a product if the postharvest shelf life and quality is to be maximized. Reduction in post-harvest losses is therefore need of the hour to feed growing population of country. Processing of food products mainly as part of a cottage industry has been a long established traditional practice imbibed in many cultures of the country. However, with changing lifestyle patterns, increasing income, increasing preference toward, Ready to Eat and packaged foods, the significance of the Food Processing Industry has increased enormously

Table- Post harvest losses in major vegetables(Selvakumar2014)

Name of vegetable	**Post-harvest losses as percentage of production**
Beans & peas	7-12
Brinjal	10-13
Cabbage	7-15
Cauliflower	10-15
Garlic	1-3
Onion	15-30
Potato	15-20
Tomato	10-20

Post-harvest management practices

Post-harvest losses can be reduced by adopting breeding technologies for longer shelf life, improvement of pre-harvest factors and harvesting techniques, proper methods of handling, marketing, packaging, transportation and storage, development of appropriate processing technology

1. Selection of varieties: Varieties with better keeping and processing quality and lesser handling susceptibility should be bred and selected for different vegetables. A few examples of varieties with long shelf life are Arka Vishal, Pusa Gaurav (Tomato), Arka Nidhi and Arka Neelakandh (Brinjal).

2. Harvesting: Harvesting should be done at proper stage where there is minimum damage and loss, as rapidly as possible and at minimum cost. Harvesting should be done at early morning or late evening hours. A temperature of above 27 0C during harvesting should be avoided. The products that are to be send to distant markets are harvested in the evening and transported in the cool hours of night where as commodities for local markets are harvested early morning. Harvesting should not be done immediately after rain or irrigation. Harvesting at optimum stage of maturity ensures maximum quality and yield. Care must be taken to avoid mechanical injury to product.

3. Sorting/Grading: Sorting of harvested vegetable produce is done to remove diseased, damaged, mis -shapen, over mature, insect attacked and rotten vegetable. Disease/insect attacked should also be discarded to avoid any spread of infection to normal and healthy vegetable/fruit produce.

Systematic grading coupled with appropriate packaging and storage, will extend postharvest shelf life, wholesomeness, freshness, and quality, will substantially reduce losses and marketing cost. Horticultural produce must be sorted and graded on the basis of parameters such as maturity, size, shape, color, weight, freedom from insects and pests, pesticide residues and ripeness. Vegetables like onion, potato, tomato, chillies, okra and french beans are graded on the basis of size, shape, weight and maturity stage. Elimination of off-grade and diseased horticultural crops prevents the spread of diseases. Common horticultural crops are generally graded on the basis of size and weight (Nath, 2013).

4. Washing: The Produce is cleaned/washed to remove adhering dirt, dust, insects, mould and spray residues and to improve appearance. Onion, garlic, okra and mushrooms are not washed after harvest. Chemically mild detergent (soap solution), glacial acetic acid or Nacl (1%) can be used for surface decontamination. Chlorinated water (100 pp cholorine) is also effective in surface decontamination. Fruits and vegetables are to be rinsed again with clean wastes and excess water allowed to dry before packing.

5. Trimming: Trimming is done in crops like cabbage and lettuce etc. To remove unwanted, discoloured, rotten and damaged parts. Trimming enhances visual quality, reduces deterioration of produce, and facilitates handling packaging and transport.

6. Curing: Curing is a process of strengthening and wound periderm (skin) of root and tuber crops for a specified period under well-defined conditions of temperature and relative humidity which enhances shelf life of these crops by forming corky layer which protects against water loss and infections by decaying organisms. In bulb crops (onion &garlic).Curing is a drying process for toughening of outer skin and tightening of necks. Potato curing is most effective at about 200c and 80% relative humidity.

7. Waxing: Waxing is done mainly to minimize water loss and reduce shrivelling and wilting to enhance therefore storage life. Wax seals off the stem near the petiole and the pores on the surface of fruits which are the main routes of transpiration. Waxing on the surface of fruit or vegetable product which are the main routes of transpiration. Waxing also improves appearance of produce. Paraffin wax, Carnuba wax and various resins are common types of wax used for preparation of wax emulsion. Waxes are generally applied by foaming, spraying and brushing of which foaming is the best, since it leaves a very thin coating. Some of the common coating materials are semperfresh, prolong and waxol. Vegetables such as tomato, brinjal, sweet pepper, cucumber, muslmelon, carrot etc. are often waxed with a water emulsion by dipping or spraying to retard the moisture loss from the product and at the same time to improve their lustre. This practice of keeping the product sound and lustrous is generally not in vogue in our country.

Shelf life of fruits and vegetables may be extended by utilizing different plant based coating materials viz., neem extract, tulsi extract, aloe vera extract etc. (Nath *et al*. 2013) may be used locally which have anti fungal properties at farmers level so that more return will be generated from their agricultural produces.

8. Precooling: Pre-cooling is the process of removing field heat from the harvested commodity, particularly when harvested during hot weather. Pre-cooling helps in decreasing rate of transpiration and respiration delayed ripening and easing the load on the cooling system of transport or storage chambers. There are several methods of pre-cooling process as-

- Room cooling
- Hydro-cooling
- Contact icing
- Vaccum cooling

9. Post- Harvest Disease Control: Vegetables suffer significantly due to invasion of fungi and bacteria causing disease and resulting in huge postharvest losses. Succulence of vegetables makes them prone to infection by micro-organisms Mechanical injuries, contamination by diseases vegetables, heat and other environmental agencies pre-dispose products to diseases. Post-harvest diseases can be controlled by use fungicides as sprays or dips, incorporated in wax or impregnated in packaging materials.

10. Sprout inhibition: Tuber and bulb crops (onion & potato) enter a dormant stage at maturity, sprouting starts at the end of dormancy or rest period. Sprouting is a growth resumption process. Sprouting causes huge loss due to respiratory utlisation of substrates. Maleic hydrazide (MH-40), 3-Cholorisopropyly-N-Phynle Carbamate (CIPC), Methyl naphthalene acetic acid (MENA) and 2,3,4,6 tetra nitro benzene (TCNB) are commonly used as sprout inhibitors. Gamma irradiation at 0.02- 0.15 KGY is widely accepted by many countries for successful sprout inhibition of onion and potato without affecting other quality attributes.

11. Packaging: Packaging is a fundamental and necessary for management of highly perishable products. The main role of packaging is to assemble the produce into convenient units for handling and safeguard the produce during distribution, storage and marketing. Packaging materials are selected according to plant characteristics. It improves storage life of produce and provides greater attraction to the produce. An efficient package practices protects product from any physical, physiological and

pathological deterioration throughout storage, transport and marketing packaging material should provide cushioning to fresh produce as several types like bamboos baskets, sacks (mode of plastic or jute),wooden crates, corrugated fibre board (CFB) cartons are used. Vegetables mostly bamboo baskets, gunny bags, plastic crates are used for packaging purposes.

The use of polyethylene film bags for wrapping horticultural crops like capsicum, broccoli, assam lemon, tomatoes etc for transport, has been found to be most suitable for reducing wastage. Losses in first grade tomatoes can be reduced from 15 to 3% by using upright cone baskets together with dry grass as a packaging material between the layers of fruits. Packing of tomatoes in sealed unventilated polyethylene provides a modified atmosphere which extends storage life. Printed plastic bags are used to reduce light transmission to potato tubers. Plastic oven ventilated bags of 25 and 50 kg of capacity are used for onions and potatoes. Palletization and containerization will go a long way in establishing both internal and international trade on a firm footing (Nath, 2013).

12. Transport: Transport is an important linkage in postharvest handling, storage and distribution. Transport of horticultural produce from field to the distribution markets is done by rail, truck, airplane and ship. Large quantities of horticultural crops are transported in open trucks. Window type conical bamboo baskets designed for stacking and aeration have been developed by the CFTRI, Mysore for transportation of produce by rail. Serious losses take place due to improper handling, careless loading and unloading and use of improper containers. Transport of produce during cool hours of night, use of ventailated, insulated evaporative cooled or regrigerated vehicles ensures preservation of quality. Pallets are used in many developed countries for trading of horticultural produce. It is also important to introduce mechanical loading and unloading particulary with the use of fork lift trucks. In advanced countries refrigerated containers known as reefer containers produce. In India use of containers working on evaporative cooling techniques should be encouraged.

13. Pre-harvest sprays: Pre-harvest sprays of chemicals have been applied to reduce postharvest losses in different fruits and vegetables. Different chemicals, growth regulators and fungicides viz. calcium chloride, calcium nitrate**, g**ibberellic acid-3, 6-

BAP, carbendazim and benomyl (alone or in different combinations) may be used to minimize the post-harvest losses in fruits and vegetables.

14. Marketing System: Vegetable market is often suffering from several constraints due to their high perishable nature, season market and bulky nature. Assembling and subsequent marketing of the produce is further blocked due to lack of proper storage facilities and quick transport systems. Very often the products are formed to dispose of their produce at a very nominal price where there arises seasonal gluts due to these bottle necks. Another major defect in vegetable marketing is the in volovement of several intermediaries which dominate the trade and get huge profit. Consequently producer's margin in the consumer price becomes very low. It is therefore essential that organized effort for establishing co-operative system of marketing should be enforced at village and districxt levels to control activity of intermediaries and to regulate the vegetable marketing smoothly and in a streamlined system. Moreover, close co-ordination among Agricultural Marketing Board, National Horticulture Board and state department of agriculture/Horticulture should be ensured to formulate an action plan for regulating marketing of vegetables in a smooth and streamlined way.

15. Storage: Storage of vegetable produce an important for improving shelf life avoiding market glut and to ensure supply throughout the year and increase profit to the producers. The principle aim of storage is to reduce and control transpiration, respiration and disease infection at the same time maintaining life processes at the required level. Different methods of storage of vegetable produce are as:

a) Refrigerated storage: Highly perishable vegetable produce requires refrigerated vegetable storage since it retards the rate of metabolic change, moisture loss, respiratory heat products and spoilage caused by heat production and spoilage caused by micro-organisms and thereby enhances retaining life of vegetable produce. In this method, ambient air is cooled and then passed over the bulk grains via existing aeration system. Refrigerated aeration has been used for cooling dry grain in subtropical climates when ambient temperatures are too high.

b) Controlled/Modified atmosphere: The main purpose of controlled atmosphere (CA) or modified atmosphere is to adjust the atmosphere composition of gases surrounding the commodity by removal or addition of gases. Thus resulting in an atmospheric composition different from that of normal air. Modified atmosphere does not differ in principle from the controlled atmosphere storage except that the control of gas concentris less precise.

c) Hyobaric storage: Hyobaric storage is similar to controlled atmosphere storage in which produce is stored in partial vacumm. The vacumm is created by vacumm pump to a particular desired low pressure. The process of ripening and sencence is greatly reduced by decreasing rate of respiration and removal of ethylene.

d) Zero-energy cool chamber: In tropical areas like india, tremendous amount of quality deterioration take place immediately after harvest of produce due to lack of on farm storage facilties to overcome this problem, low cost environmental friendly zero energy cool chambers are developed by IARI New Delhi these chambers work on principle of evaporative cooling using locally available materials like brick sand and bamboos. The temperatures in these chambers are less than surrounding atmosphere. These chambers can be used for short term storage of products at the farmers field itself.

On farm storage is also required to reduce losses in highly perishable fresh horticultural produce. Low-cost, low-energy, environmental friendly cool chambers made from locally available materials and which utilize the principles of evaporative cooling have been therefore developed in response to this problem. These cool chambers (Fig. 1) are able to maintain temperatures at 10–15°C below ambient, as well as at a relative humidity of 90 per cent, depending on the season. Fruits and vegetables are stored in plastic crates within the chamber. The shelf life of the fruit and vegetables maintained in the cool chamber was reported to be increased from 3 days at room temperature to 90 days (Anon. 2006).

Fig 1: Zero Energy Cool Chamber for highly perishable fresh horticultural produce

(B) Examples of processing in different vegetables:

1.Instant Ginger Candy

Nath *et al* (2013) optimized quality attributes of instant ginger candy using different slice thickness and blanching time. Uniform size ginger rhizomes of six months old should be used for candy preparation. Materials should be washed thoroughly with clean water to remove dirt and other undesirable particles from the surface and also to reduce the microbial load causing contamination. After washing, rhizomes should be dried at room for few hours. Dried fresh rhizomes should be peeled manually, made slices with different slice thickness (5.0-25.0 mm) with the help of SS knife. Slices are to be blanched in boiling water for 25-30 minutes followed by dipping in 40°B and 75°B sugar solutions containing 2.0% citric acid for 1 and 2 hours at 95ºC, respectively. As soon as the retention time reached the predetermined level, the materials are to be taken out from the syrup and kept at laboratory tray drier at 60°C for 1 hour. Dried materials should be cooled at room temperature before being packed in air tight containers for further analyses.

Flow chart for preparation of instant ginger candy is shown below:

Freshly harvested uniform size ginger rhizomes
Washing with clean water

Peeling
Cutting into round shaped slices
Blanching in boiling water
(25-30 minutes with 2.0% citric acid)
Dipping in 40°Brix sugar syrup with 2.0% citric acid
(for 1 hr at 95ºC)
Dipping in 75°Brix sugar syrup with 2.0% citric acid
(for 2 hrs at 95ºC)
Draining and drying at 60 ºC for 1 hour
Cooling and packing

2. Preparation of Ginger Slice in Brine

This is the minimally processed fresh ginger product which may be stored for more than six months at ambient condition. Fresh and tender ginger rhizomes are generally used for preparation of this product. It should be prepared by peeling and cutting the rhizomes into slices of 5-10 mm thickness followed by blanching in boiling water for 5-10 minutes at 100 degree Celsius and filling into bottles or cans cover with brine solution (9.0% salt and 2.0% citric acid). Preservatives (50 ppm KMS + 50 ppm sodium benzoate) may be added in the brine solution for better shelf life. Seal the bottles and store in cool place.

Recipe for Ginger Slice in Brine Sl. No.	**Raw materials**	**Quantity**
1.	Sliced ginger (5mm thickness)	1.0 kg
2.	Water	1.0 liter
3	Salt	90.0 g
4.	Citric acid	20.0 g
5.	KMS	0.05 g
6.	Benzoic acid	0.05 g

The flowchart for the preparation of ginger slices in brine is given below:

Fresh Ginger
Peeling

Slicing
Blanching (5-10min at 100□C)
Filling into bottles/cans
Covering with brine solution
Sealing/seaming
Storage

3.Tomato Ketchup

It is made from strained tomato juice or pulp and spices, salt, sugar and vinegar, with or without onion and garlic, and contains not less than 12 per cent tomato solids and 25 per cent total solids. Different steps for preparation of tomato ketchup are shown below:

Processing Steps :

a) Wash tomatoes with clean water
b) Blanch in boiling water for 20 minutes
c) Remove the peel and extract the juice/pulp
d) Add one third quantity of sugar to the extracted tomato juice and start heating
e) Add all required ground spices tied in a muslin cloth (spice bag) into the pulp and continue heating
f) Heat the masses until the pulp volume reaches to one third of the original volume
g) Remove the spice bag and stop the heating
h) Add vinegar, salt and the rest of the sugar and mix thoroughly
i) Heat again slightly to mix the ingredients properly
j) Add calculated amount of sodium benzoate to the product
k) Fill the product in sterilized bottles and cool for sometimes to reach product temperature of about 400^0 C
l) Seal the bottles and label it&Store in dark and cool place

REFERENCES:

1. Anonymous. Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region. Food and Agriculture Organization of the United Nations

Agricultural and Food Engineering Technologies Service, Viale delle Terme di Caracalla, 00100 Rome, Italy, 2006. ©APO 2006, ISBN: 92-833-7051-1

2. Chaturvedi BK, Raj LCA. Agricultural Storage Infrastructure in India: An Overview. IOSR Journal of Business and Management, 2015; 17(5):37-43.
3. Nath A. Post-harvest Management and Value Addition in Horticultural Crops: Scope for Entrepreneurship Development with Special Reference to North-East India. Published in Horticulture for economic prosperity and nutritional security in 21st century.Edited by T. K. Hazarika and B.P. Nautiyal Published by Westville Publishing House, New Delhi. 2013, 207-219.
4. Nath A, Bagchi B, VK Verma, H Rymbai, AK Jha, BC Deka. Extension of Shelf Life of Tomato Using KMnO4 as Ethylene Absorbent. Indian Journal of Hill Farming. 2015; 28(1):77-80.
5. Nath A, Bagchi B, LK Misra, Bidyut C Deka. Changes in post-harvest phytochemical qualities of broccoli florets during ambient and refrigerated storage. Food Chemistry, 2011; 127:1510-1514.
6. Nath A, Deka BC, D Paul, LK Mishra. Ambient storage of capsicum under different packaging materials. Bioinfolet, 2010; 7(3):266-270.
7. Nath A, Deka Bidyut C, Ngachan SV. A process for producing tuity-fruity from Chow chow. The Patent Office Journal, 12/12/2014, 2014, 15201.
8. Nath A, K Barman, S Chandra, P Baiswar. Effect of plant extracts on quality of Khasi mandarin (Citrus reticulata Blanco) fruits during ambient storage. Food & Bioprocess Technology, 2013; 6(2):470-474.
9. Nath A, Mangaraj S, Goswami TK, Chauhan J. Post-harvest management and production of important horticultural crops. Scientific Publishers (India), Jodhpur, India. ISBN: 978-81-7233-948-7. 2016, 1-436.
10. Sel vakumar R, Glaustas Olericulture. New Vishal Publications West Patel Nagar, New Delhi, 2014, 944-945.
11. Singh PK. A decentralized and holistic approach for grain management in India Current Science, 2010; 99(9):1179-1180.

EFFECT OF METHOD OF HARVESTING AND TIME OF CURING ON YIELD AND STORAGE LIFE OF RABI ONION cv. AGRIFOUND LIGHT RED

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ABSTRACT

Onion is popular bulbous crop which is consumed round the year. Being perishable in nature, a considerable loss occurs during storage. As a matter of fact pre harvest and post-harvest crop operations influence the shelf life of horticultural produce. The present investigation is an attempt to examine the effect of last irrigation and curing on yield and post-harvest losses of rabi onion. Irrigation before harvesting affect the shelf life of all the crops especially for the underground crops. Moreover, in case of onion curing is much an important operation that may decide the storage capacity. Findings of present investigation, one of practical significance for onion growers to fetch the better price after a long storage. The results revealed that yield per hectare (363.61 q) and marketable yield

per hectare (339.95 q) were recorded with treatment of irrigate the crop before two days of harvesting (m_1). Maximum yield per hectare (368.88 q) and marketable yield per hectare (341.10 q) were recorded with c_5 (No curing), while the minimum unmarketable yield per hectare (10.38 q), maximum recovery of fresh onion after three month of storage life (14.856 kg), minimum weight of dry scales (0.014kg), weight of rotted and sprouted onion (1.081 kg) were recorded with c_2 (Four days curing in field condition).

KEYWORDS: Curing, harvesting, irrigation, onion, storage life and yield.

INTRODUCTION

Onion is an important part of our daily diet. The onion is a rich source of phosphorous, calcium, sulphur, sodium and fiber with no fat and is an important component of folk medicine (Nayerabi *et al*., 2001; Marwat *et al.,* 2011). Besides medicinally richness and usefulness, onion has an important role in national economy. Fresh onion has share in export of 18.6 per cent among all the horticultural produce. Moreover prices of onion are at important index to finalize the inflation rate. Prices of onion mainly depend upon the quantity and quality of stored onion at either grower's level or trader's level.

The onion crop cannot be stored safely under ambient conditions because of its perishable nature, yet considerable deterioration may occur during storage due to rotting, sprouting and physiological weight loss and storage losses could be as high as 66% (Biswas *et al*., 2010). Out of the total onion production, most of produce is stored for daily requirement is lean season. There are several factors or operations during crop raising in the field like withholding last irrigation and curing under field or shade greatly influence the storability of onion. Curing in the field or shade for the purpose of removal of excess moisture from the outer skin is the prime technology to obtain under sized skin for avoiding moisture loss, disease infection and degradation in quality. Though, irrigation before harvesting and curing after harvesting are very important factors of cultivation practices which finalize the fate of storage life of onion. Unfortunately these factors have not been touched by research workers. Looking significance of crop and it's storage present experiment was planned and executed at Department of Vegetable Science, College of

Horticulture, S. D. Agricultural University, Sardarkrushinagar. Very limited information on these aspects is available for agro-climatic conditions of Gujarat. However, the experiences gained in the previous experiments should also be kept as the base line of this trial.

MATERIAL AND METHODS

The trial was conducted at Department of Vegetable Science, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat). The soil of experimental site was loamy sand in texture having pH of 7.8, low in available N (149 kg/ha), medium in available P_2O_5 (26 kg/ha) and K_2O (287 kg/ha). The seeds of variety Agrifound Light Red were procured from NHRDF, Nashik (MH). Experiment consists of total fifteen treatment combinations with three methods of harvesting *viz*., irrigate the crop before two days of harvesting (m_1), irrigate the crop before three days of harvesting (m_2) and harvesting without irrigation (m_3) and five time of curing *viz*., two days curing in field condition (c_1), four days curing in field condition (c_2), two days curing in shade condition (c_3), four days curing in shade condition (c_4) and no curing (c_5).

The onion seedlings of 8 weeks of uniform size were transplanted at the spacing of 15cm x 10 cm and harvested in second week of May during the year. A uniform dose of 50 kg N, 50 kg P_2O_5 and 50 kg K_2O/ha was mixed in soil before transplanting and 50 kg N/ha was applied at 30, 45 and 60 days after planting in three equal splits. Last irrigation was applied as per treatments and after harvesting. Curing in open field and shade was done as per treatment and produce was stored for three months in ambient condition. The retention of onion bulb quality during storage depends on the bulb maturity and variety. 20 kg of onion in each treatment of uniform shape and size were selected for storage life. The mean data were subjected to statistical analysis following analysis of variance technique Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of methods of harvesting on yield

Data pertaining to yield of onion are presented in Table 1. The result revealed that the significantly maximum yield per hectare (363.60 q) and marketable yield per hectare (339.95 q) were recorded with treatment m_1. The leaves were drying very slowly and gradually and were not fully dried even at harvest time. The bases of foliage near the neck of bulbs were green. Hence, it may be predicted that the flow of photosyntates or substrates in the foliage continued to the bulbs. These results are in conformity with the findings of Trevisan *et al.* 1999 in onion. Minimum unmarketable yield per hectare (11.78 q) were recorded with treatment m_3, whereas maximum unmarketable yield per hectare (24.65 q) were recorded with treatment m_1.

Effect of curing on yield

Data presented in (Table. 1) further indicated that different time of curing was observed significant. The maximum yield per hectare (368.88 q) were recorded with treatment c_5, which was statistically at par with treatment c_3, while minimum yield per hectare (328.81 q) were recorded with treatment c_2. The maximum yield of bulb are due to excess moisture content in bulb without cured treatment and less moisture content in properly cured onion. This result is in close agreement with the findings of [10]; [9] and [11] in onion. Minimum unmarketable yield per hectare (10.38kg) were recorded with treatment c_2, whereas maximum unmarketable yield per hectare (27.77 q) were recorded with c_5. During this process excessive moisture is removed from the outer covering and neck of the bulbs. These findings are in close accordance with finding of [9] and [7] in onion.

Effect of methods of harvesting on storage behaviour

Data presented in table1 pertaining to yield and post harvest losses revealed that, significantly minimum (0.892 cm) and maximum (1.165cm) neck thickness of bulb was recorded with treatment m_3 and m_1 respectively. Maximum fresh weight of onion (14.541kg), minimum weight of dry scales after three month of storage life (0.023kg), Minimum weight of rotted and sprouted bulb after three months of storage life (1.095kg) were recorded with the treatment of harvesting without irrigation while minimum weight of fresh onion after three month of storage life

(11.647kg) , maximum weight of dry scales after three month of storage life (0.026kg), maximum weight of rotted and sprouted onion after three months of storage life (1.797kg) were recorded with treatment harvesting without irrigation.

The lowest rotting and sprouted loss in the control treatment may be due to the fact that control plots did not receive irrigation before harvesting that kept the bulbs less succulent and as a result less attacked by bacteria and fungi during storage. This result is in conformity with the findings of Trevisan *et al.* 1999 in onion. Minimum per cent weight loss of onion after three month of storage life (27.29%) were recorded with treatment m_3, while maximum per cent weight loss (41.76%) were recorded with treatment m_1. The temperature and humidity were high during storage that might be attributed to the higher weight loss of stored onion. Rotting and re-growth increase the rate of respiration, heat generation and consequently enhance moisture loss and reduce the shelf life are the major factors of deterioration in onion bulbs during storage Yawalkar and Har (2004). The results of the present study are close agreement with those of Sharma *et. al*. 2007; Kale *et al*. 1992; Pandey and Bhonde (1992) and Trevisan *et al.* 1999 in onion.

Effect time of curing on storage behaviour

Curing method significantly affected the storage behaviours of onion (table 2). Significantly minimum neck thickness was (0.952 cm) observed under treatment two days curing under field condition and maximum neck thickness of bulb was (1.104 cm) observed under treatment no curing further indicated that different time of curing was observed significant influences at the end of three month of storage. Maximum recovery of fresh onion after three month of storage life (14.856kg) was recorded with treatment four days field curing and minimum weight of fresh onion after three month of storage life (10.946kg) was recorded with no curing,. Significantly minimum weight of dry scales (0.014kg), weight of rotted and sprouted onion (1.081kg) was obtained with treatment four days field curing and maximum dry scales (0.044kg) and rotted and sprouted onion (1.789kg) were observed with treatment no curing at the end of three month of storage life.

Curing of onion after harvesting affects the neck thickness of bulb, due to thin neck of bulb protect from atmospheric high temperature and high humidity and ultimately promote the higher recovery of onion bulb during storage. These findings are in close accordance with the findings of Rao *et al.* 1967; Bhonde and Bhadauria (1995); Bhonde *et al*. (1996) and Chadha and Sidhu (1989) in onion. Influence of different time of curing were recorded at the end three month of storage life with respect to per cent weight loss was observed significant variation. Minimum per cent weight loss (25.72%) was observed with treatment c_2 and maximum (45.27%) was recorded with treatment c_5 at the end of three month of storage life. Minimum losses occur at the different stages of storage that is only due to proper cured bulb were put for storing. These findings are in close accordance with the findings of Chadha and Sidhu (1989); Rao *et al.* 1967; Bhonde and Bhadauria (1995) and Chauhan *et al*. (1995) in onion.

Thus, on the basis of the data, it can be concluded that highest yield of onion was obtained by irrigate the crop before two days of harvesting (m_1) with no curing while four days field curing significantly improves storage life of onion and which helps to fetch higher market price.

REFERENCES

Bhonde, S. R. and Bhadauria, J. S., 1995. Effect of curing on keeping quality of small onion. National Horticultural Research and Development Foundation News letter, **15**(4):1-4.

Bhonde, S. R., Qadri, S. M. N., Pandey, V. B., Shrivastava, K. J. and Tiwari, B. K., 1996. Studies on onion storage of comparative performance of conventional various model godowns. National workshop on post-harvest Management of Fruits and Vegetables, 14-16 March, Bangalore.

Biswas, S.K., A. Khair, P.K. Sarkar and M.S. Alom. 2010. Yield and storability of onion (Allium cepa L.) as affected by varying levels of irrigation. Bangladesh J. Agric. Res., 35: 247-255.

Chadha, M.L. and Sidhu, A.S., 1989. Studies on post-harvest storage life of *kharif* onion under ambient conditions. Haryana Journal of Horticultural Science, **18**(1 and 2):150-151.

Chauhan, K.P.S., Singh, S.P. and Chougule, A.B., 1995. Studies on the effect of windrow curing, neck cut and shade curing on export quality of onion bulbs during storage. National Horticultural Research and Development Foundation Newsletter, **15**(4):5-7.

Gomez, K. A. and Gomez A. A. 1984. Statistical procedures for agricultural research, 2nd edition. John Wiley and Sons, New York, pp- 680.

Hazra, P., Chattopadhyay, A., Karmakar, K. and Dutta, S. 2011. Modern Technology in vegetable production, pp-264.

Kale, P. N., Warade, S. D. and Jagtap, K. B., 1992. A decade of research on storage of onion under ambient conditions. Maharashtra Journal of Horticulture, 6 (1):68-72.

Marwat, S.K., F. Rehman, M.A. Khan, M. Ahmad, M. Zafar and S. Ghulam. 2011. Medicinal folk recipes used as traditional phytotherapies in District Dera Ismail Khan. KPK. Pakistan. Pak. J. Bot., 43(3): 1453-1462.

Nayerabi, S.A.F. and A.H.M. Ahmed. 2001. The Commercial Vegetable of Pakistan Tropical Sci., 41: 95-99.

Pandey, U. B. and Bhonde, S. R. 1992. Shelf- life of *kharif* onion as influenced by curing and storage with foliage. *Associated Agricultural Development Foundation Newsletter*, **13**(1):5-8.

Rao, S.N., Rao, M.R. and Krishna marthy, G.G. 1967. Increasing yields and reducing storage losses of onion. Indian Farming, **17**:14-16.

Sharma, P. K., Yadav, G. L., Verma, R. and Gupta, A. 2007. Effect of last irrigation and field curing on yield and post-harvest losses of *rabi* onion (*Allium cepa*). *Annals of Biology* **23**(2):145-148.

Trevisan, J.N., G.A.K. Martins, S.J. Lopes and D.C. Garcia. 1999. Yield and post harvest storability of lowland grown onion genotypes. *Ciencia Rural*., **29**(3): 409-413.

Yawalkar, K. S. and Har, R. H. 2004. "Vegetable crops of India". Agro Horticultural publishing House, Nagpur, pp-250.

Table 1: Effect of methods of harvesting and time of curing on yield and storage life of onion

Treatment	Yield (q/ha)	Marketable yield (q/ha)	Unmarketable yield (q/ha)	Neck thickness at the time of storage (cm)	Weight of fresh (kg)	Weight of dry scales (kg)	Weight of rotted and sprouted (kg)	Per cent weight loss (%)
Methods of harvesting (M)								
m_1	363.60	339.95	24.65	1.165	11.647	0.026	1.797	41.76
m_2	348.64	333.07	15.57	0.995	12.605	0.025	1.651	36.97
m_3	328.47	316.69	11.78	0.892	14.541	0.023	1.095	27.29
S.Em ±	5.41	5.23	0.85	0.014	0.168	0.001	0.034	0.84
C.D. at 5 %	15.67	15.16	2.46	0.040	0.487	0.002	0.097	2.43
Time of curing (C)								
c_1	338.13	322.00	16.12	1.013	12.970	0.021	1.533	35.15
c_2	328.81	318.43	10.38	0.952	14.856	0.014	1.081	25.72
c_3	352.18	334.40	19.42	1.000	12.436	0.024	1.647	37.82
c_4	346.56	333.58	12.98	1.013	13.450	0.020	1.523	32.75
c_5	368.88	341.10	27.77	1.104	10.946	0.044	1.789	45.27
S.Em ±	6.99	6.76	1.10	0.018	0.217	0.001	0.043	1.08
C.D. at 5 %	20.24	NS	3.17	0.052	0.629	0.002	0.126	3.14
Interactions (M X C)								
S.Em ±	12.10	11.71	1.90	0.031	0.376	0.001	0.075	1.87
C.D. at 5 %	NS	NS	NS	0.091	NS	0.004	0.218	NS

Mathematical Modelling of Drying of Jamun (*Syzygiumcumini* (L.)) seeds

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Abstract

The drying kinetics of Jamun seeds in terms of moisture content, moisture ratio, drying time and drying rate was investigated. The sun and tray drying methods were used to employ to study the drying behaviour of Jamun seeds. The drying of Jamun seeds were carried out in sun drying at atmospheric condition and in tray dryer at 60 ^{0}C. The initial moisture content of fresh Jamun seeds was 58.13 % (w.b.). Ten mathematical models were fitted for prediction of drying kinetics. Among the drying models investigated diffusion approach model satisfactorily described the drying behaviour of Jamun seeds with highest coefficient of determination (R^2) and lowest chi-square (χ^2), root mean square error (RMSE) and mean bias error (MBE) values. The results showed that the values of highest coefficient of determination and lowest chi-square, root mean square error and mean bias error were 0.9944, 0.0005, 0.0042 and -0.0020 respectively. The moisture diffusivity was found in the range of 4.93×10^{-8} and 8.64×10^{-8} for sun and tray drying respectively. Study is very useful for commercial scale drying of Jamun seed to optimize drying process and to achieve superior quality of dried product.

Keywords: Jamun seed, Drying methods, Models, Drying kinetics

Introduction

Jamun (*Syzygium cumini* (L.)) is a very large evergreen tropical tree belonging to the family Myrtaceae (Sah and Verma 2011). The Jamun fruits are produced once in a year and its availability is possible in the month of June-July (Shrivastava and Kumar, 2009). Among several tropical fruits in India, Jamun a potentially important indigenous minor commercial fruit as well as have high medicinal uses (Ghose *et al.*, 2016). In India, the Jamun tree and its fruits are known variously as Jamun, Jambul, Jamoon. Worldwide, it is known by some other names Black Plum, Java Plum, Indian blackberry, Portuguese Plum, Jambolan Plum etc. (Kannan, 2013). Jamun is harvested

in monsoon season and its harvesting time is short and limits for 30 – 40 days. The seeds of Jamun encompass Glucoside, Jamboline and Ellagic acid, which have the ability to check the conversion of starch into sugar when there is excess production of glucose in body (Giri *et al*., 1985). The reviews revealed that the constituents that are reported in the seeds of *Syzgium cumini* are protein (6.3-8.5%), 1.18% fat, 16.9% crude fiber, 21.72% ash, 0.41% calcium, 0.17% phosphorus, fatty acids (palmitic, stearic, oleic and linoleic), starch (41%), dextrin (6.1%), a trace of phytosterol (β-sitosterol) and tannin (Ranjan *et al*., 2011). The volatile oil from the Jamun seeds can be extracted & used as an effective medicine against diabetes, heart & liver trouble. The seed powder of Jamun is used by the diabetic patients to control the blood sugar level naturally. Constituents of Syzgium cumini seeds are fatty oils (30 g/kg), including lauric (2.8%), myristic (31.7%), palmitic (4.7%), stearic (6.5%), oleic (32.2%), linoleic (16.1%), malvalic (1.2%), sterculic (1.8%) and vernolic acid (3%) and phytosterols such as β-sitosterol. Further constituents are tannins (6%), predominantly corilagin, ellagitannins, ellagic acid, galloyl-galactoside and gallic acid (Lock *et al*., 2009). Further constituents are tannins (6%), predominantly corilagin, ellagitannins, ellagic acid, galloyl-galactoside and gallic acid.

Jamun seeds also contains albumen, fat, glycosides, an alkaloid; jambosine3, resin, ellagic acid, quercetin, gallic acid as well as elements of zinc, vanadium, chromium, sodium and potassium. B sitoterol is present in unsaponifiable material of seed fat (Ali *et al.*, 2013)

Drying is basically defined as the decreasing of plant moisture content, aimed at preventing enzymatic and microbial activity, and consequently preserving the product for extend shelf life. The removal of moisture from foods retards many of the moisture-mediated deteriorative reactions and prevents the growth and reproduction of microorganisms (Dincer *et al.,* 2002). Drying of the Jamun seeds is essential to make the value added Jamun seed powder. Sun drying is a process which involves evaporation of water from produce assisted by movement of the surrounding air through the wind. The drying kinetics of food is a complex phenomenon and requires dependable models to predict drying behaviour. This needs experimental drying studies and application of simplified models for predicting drying behaviour (Pardeshi *et al.,* 2009). The effect of drying methods on the quality characteristics of Fenugreek (Trigonellafoenum-graecum) was studied by Naidu *et al.,* (2012). The three single

layer drying models (Exponential, Page, and Modified Page) tested showed excellent fit (R^2 is 0.92–0.99) for all three drying methods. Gawande *et al*. (2017) studied the modelling of convective drying of long pepper (*Piper Longum*L.). Ten mathematical models were fitted for prediction of drying kinetics. Among the drying models investigated page model satisfactorily described the drying behaviour long pepper with highest coefficient of determination (R^2) and lowest chi-square (χ^2), root mean square error (RMSE) and mean bias error (MBE) values.

Miranda *et al.* (2009) studied the Influence of temperature on the drying kinetics, physicochemical properties, and antioxidant capacity of *Aloe Vera* (*Aloe Barbadensis* Miller) gel. The drying kinetics of *Aloe vera* gel was modelled using the Wang–Singh equation, which provided a good fit for the experimental data.

Material and Methods

The experiments were conducted at the Department of Agricultural Process Engineering, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the drying behaviour of Jamun seeds. Jamun seed samples were dried at in tray dryer at 60 ^{0}C and in sun drying at atmospheric condition. The temperature of drying air was measured by mercury thermometer.

Drying Characteristics

Initial Moisture Content

The initial moisture content of fresh Jamun seeds samples were determined by the oven drying method (Raza *et al.*, 2015)

$$\text{M.C.(w.b.)}, \% = \frac{W_1 - W_2}{W_1} \text{ X } 100 \qquad \text{……..(1)}$$

Where,

M.C.(w.b.) =Moisture content, % (w.b.)

W_1= Initial weight of sample, g

W_2= Final weight of sample, g

Drying Rate

The moisture content data recorded during experiments were analysed to determine the moisture loss from Jamun seed in the particular time interval. The drying rate of sample was calculated by following equation.

$$R = \frac{\text{WML (kg)}}{\text{Time interval (min) x DM (kg)}} \qquad \text{…….(2)}$$

Where,

R = Drying rate at time θ, kg water/ kg dm min

WML = Initial weight of sample – Weight of sample after time θ

Moisture ratio

The moisture ratio (MR) at each moisture content level was determined by the following equation (Mohsenin, 1980).

$$MR = \frac{M - M_{\infty}}{M_o - M_{\infty}} \qquad \text{……..(3)}$$

where,

MR = Moisture ratio

M = Moisture content at any time (d.b.)

M_o = Initial moisture content (d.b.)

M_{∞} = Equilibrium moisture content (d.b.)

The EMC values were determined by drying Jamun seed samples in the sun and tray drying methods at the temperature levels as mentioned above untill the mass loss of the sample ceased. The final moisture content values were calculated from this constant weight and it was used as an EMC value for calculation of the moisture ratio.

Drying methods

Sun drying: Sun drying is the process in which drying can be done in natural atmospheric condition. For drying of Jamun seeds accurately 100 g of sample taken with three replications. The sample kept in the trays and placed where adequate amount of sunlight. During drying, the samples were weighed at an interval of 30 minutes until the samples attained constant moisture content. The sun drying of Jamun seeds was done during the month of May at 43-44 ^{o}C temperature.

Tray drying: A convective tray dryer is used in the drying experiment. The drying temperatures were taken as 60 ^{o}C at constant drying air velocity of 1.5 m/s in drying chamber. During drying, the samples were weighed at an interval of 30 minutes until the samples attained constant moisture content.

Plate 1. Tray dryer

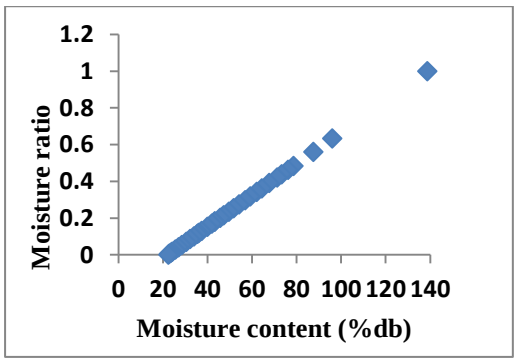

Fig 1. Moisture content verses moisture ratio in sun drying

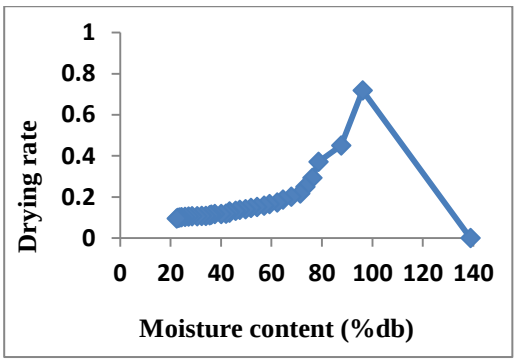

Fig 2. Moisture content verses drying rate in sun drying

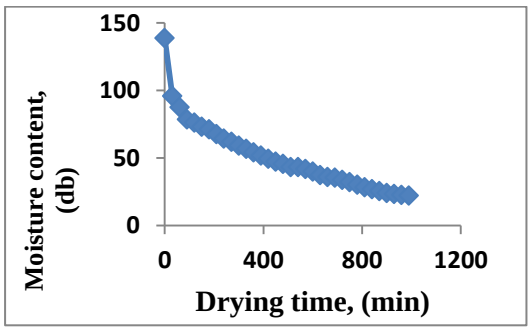

Fig 3. Moisture content verses drying time in sun drying

The typical curves showing variation in moisture content with moisture ratio, moisture content with drying rate and moisture content with drying time for drying of Jamun seeds by sun drying are shown in Fig. 1, Fig 2 and Fig. 3 respectively.

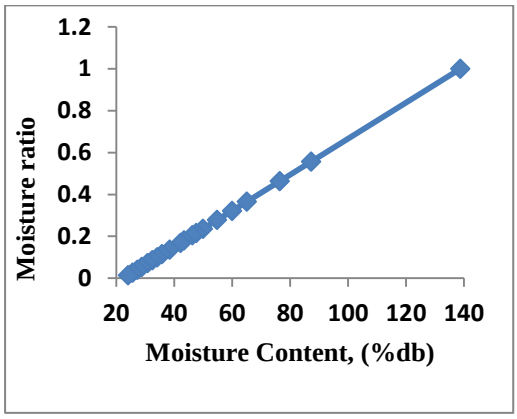

Fig. 4 Moisture content verses moisture ratio in tray drying

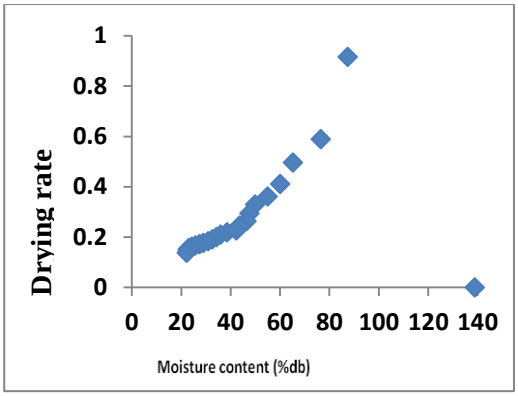

Fig. 5 Moisture content verses drying rate in tray drying

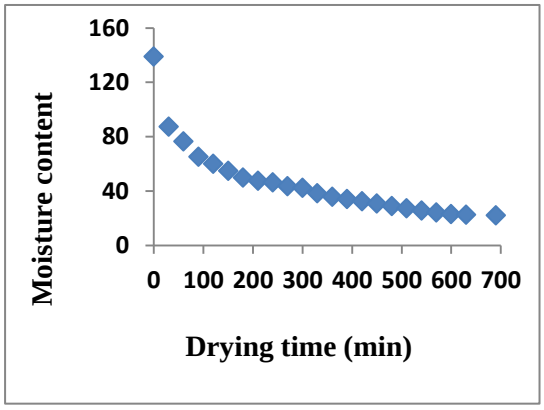

Fig. 6 Moisture content verses drying time in tray drying

The typical curves showing variation in moisture content with moisture ratio, moisture content with drying rate and moisture content with drying time for drying of Jamun seeds by tray drying are shown in Fig. 4, Fig 5 and Fig. 6 respectively.

Modelling of Convective Drying of Jamun seeds

To determine the most suitable drying equations, the experimental drying data were fitted in the various drying models (Table 1). For deciding acceptability and subsequently selecting the best equation. The coefficient of determination (R^2) was the main criteria. In addition to the coefficient of determination, the goodness of fit was determined by various statistical parameters such as reduced mean square of the deviation c2 and root mean square error *ERMS*, mean bias error (MBE). For quality fit, R^2 value should be higher or close to one and c2 and *ERMS* values should be lower (Pangavhane *et al.*, 1999; Togrul and Pehlivan, 2002; Erketin *et al*., 2004; Demir *et al.*, 2004). The above parameters were calculated as follows:

$$\chi^2 = \frac{\sum_{i=1}^{N}\left(M_{R,\exp,i} - M_{R,pre,i}\right)^2}{N - z} \quad \text{.....(4)}$$

$$MBE = \frac{1}{N}\sum_{i=1}^{N}\left(MR_{exp,i} - MR_{pre,i}\right) \quad \text{.....(5)}$$

Where,

$M_{R,exp,i}$ and $M_{R,pre,i}$ are the experimental and predicted dimension less moisture ratios, respectively,

N is the number of observations,

z is the number of drying *constants*.

Table 1. Mathematical model used

S.N.	Name of the model	Model /equation	References
1	Lewis/ Newtons' model	MR = exp(-kt)	Lewis 1921
2	Henderson and Pabis	MR = a exp(-kt)	Henderson and Pabis, 1961
3	Page model	MR = exp(-Kt^{y})	Zhang and Litchfield (1991)
4	Logarithmic	MR = a exp(-kt) +c	Yaldiz *et al*. (2001)
5	Two–term exponential	MR = a exp(-kt) + (1-a)exp(-kat)	Gunhan *et al.* 2004
6	Diffusion approach	MR = a exp(-kt) + (1-a)exp(-kbt)	Togrul and Pehlivan, (2003)
7	Verma *et al*	MR=a exp(kt) + (1- a) exp (-gt)	Verma *et al*. (1985)
8	Midilli	MR=a exp(-kt) +bt	Midilli *et al*. (2002)
9	Magee	MR=a + kt$^{1/2}$	Midilli *et al.* (2002)
10	Wang and sing	MR = 1+ at + bt^{2}	Ertekin and Yaldiz, (2004)

a, b, c, k and n = model coefficients, t = drying time, min and MR = moisture ratio

Moisture Diffusivity

In drying, diffusivity is used to indicate the flow of moisture or moisture out of material. In falling rate period of drying, moisture is transferred mainly by molecular diffusion. Diffusivity is influenced by shrinkage, case hardening during drying, moisture content and temperature of material.

The moisture diffusivity of the samples can be estimated by using the simplified mathematical Fick's second diffusion model. The solution of Fick's second law in slab geometry, with the assumption that moisture migration is caused by diffusion, negligible shrinkage, constant diffusion coefficients and temperature can be obtained as follows (Crank, 1975):

$$M_R = \frac{M - M_e}{M_0 - M_e} = \frac{8}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{(2n+1)^2} \exp\left[\frac{-(2n+1)^2 \pi^2 D_{eff} t}{4H^2} \right] \qquad \text{..... (6)}$$

For long drying periods, the Eqn can be further simplified to only the first term of the series as,

$$\ln\left(\frac{M-M_e}{M_0-M_e}\right)=\ln\frac{8}{\pi^2}-\left(\frac{\pi^2 D_{eff}\,t}{4H^2}\right) \qquad \text{..... (7)}$$

Where,

M_R= Moisture ratio, dimensionless

M = Moisture content at any time, g water / g dry matter

M_0 = Initial moisture content, g water/g dry matter

M_e = Equilibrium moisture content, g H_2O/g dry matter

D_{eff} = Effective diffusivity in m^2/s

H = Half thickness of piper longum in, m

n = Positive Integer

t = Time (s).

A general form of Eqn in semi-logarithmic form, as follows.

$$\ln(M_R)=A-Bt \qquad \text{….. (8)}$$

Where,

A is constant and B is slope.

a plot of ln (M_R) versus the drying time gives a straight line with a slope of B as,

$$Slope=\frac{\pi^2 D_{eff}}{4H^2} \qquad \text{….. (9)}$$

The effective diffusivity was determined by substituting value of slope B and the half thickness of H.

The effective diffusivity was determined by substituting value of slope B and the half thickness of H.

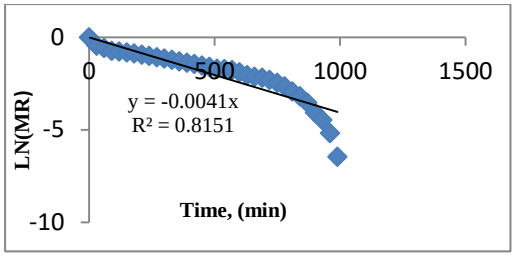

Fig. 8 ln(MR) during Jamun seed drying in sun drying

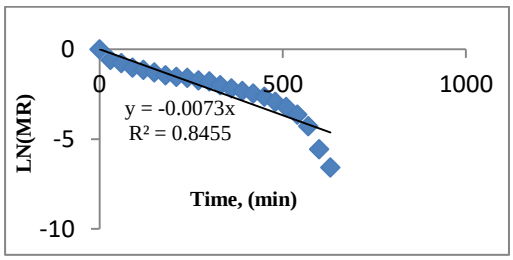

Fig. 8 ln(MR) during Jamun seed drying in tray drying

4. Results and Discussion

Table 2. Overall values for statistical parameters used in drying of Jamun seed

SN	Model	R^2	c^2	MBE	RMSE
1	Lewis	0.9012	0.0088	0.0030	0.0171
2	Logarithmic	0.9570	0.0039	0.0000	0.0114
3	Two term exponential	0.9431	0.0052	-0.0009	0.0131
4	Diffusion approach	0.9944	0.0005	-0.0020	0.0042
5	Henderson and pabis	0.9554	0.0041	0.0023	0.0116
6	Wang and singh	0.7630	0.0194	-0.0412	0.0255
7	Magee	0.9687	0.0029	0.0000	0.0097
8	Middili	0.0000	0.0501	0.0749	0.0324
9	Page	0.4908	0.0028	-0.0033	0.3097
10	Verma	0.9012	0.0056	-0.0014	0.0134

Table 2. Diffusivity in sun and tray drying methods

Drying Methods	Drying Temp.(^{o}C)	Ko	Equation	R^2	D_{eff}
Sun Drying	43 to 44 ^{o}C	-0.004	y = -0.004x	R^2 = 0.815	4.93×10^{-8}
Tray Drying	60 ^{o}C	-0.007	y = -0.007x	R^2 = 0.845	8.64×10^{-8}

The moisture diffusivity D_{eff} values during drying of Jamun seed were obtained by the modified method of slopes. The average effective moisture diffusivity $(D_{eff})_{avg}$ values of Jamun seed varied considerably with moisture content and air drying temperature. The moisture diffusivity was found in the range of 4.93×10^{-8} and 8.64×10^{-8} for sun and tray drying respectively.

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References

Dincer MM, Hussain, Sahin, AZ, Yilbas BS (2002) Development of a new moisture transfer (Bi–Re) correlation for food drying applications. International Journal of Heat and Mass Transfer. 45:1749–1755.

Demir V, Gunhan T, Yagcioglu AK and Degirmencioglu A (2004) Mathematical modelling and the determination of some quality parameters of air-dried bay leaves. Biosystems Engineering, 88(3):325-335.

Erketin S, Gulaboglu MS, and Gultekin S (2004) The thin-layer drying characteristics of rosehip. Biosystems Engineering, **89**(2):159–166.

Gawande AB, Patil BN and Deshmukh SD (2016) Effect of different drying Methods on Long Pepper (Piper Longum L.) International Journal of Research in Engineering, Science and Technology.1(6):32-38.

Giri J, Sathidevi T and Dushyanth N (1985) Effect of Jamun seed extract on alloxan induced diabetes in rats.J. Diabetic Assoc. India. 25:115-119.

Ghosh P, Pradhan RC, Mishra S, Patel AS and Kar A (2016) Physicochemical and nutritional characterization of Jamun (*Syzygium Cuminii*). current research in food and nutrition.

GornickiK, Kaleta, (2007) A. Drying curve modeling of blanched carrot cubes under natural convention condition. Journal of Food Engineering. 82: 160–170.

Gunhan T, Demir V, Hancioglu E, Hepbasli A (2004) Mathematical modeling of drying of bay leaves. Energy Conversion and Management, In Press, Corrected Proof.

Henderson SM and Pabis S (1961) Grain drying theory I. Temperature effect on drying coefficient. Journal of Agricultural Engineering Research., 6(3):169–174.

Kannan A and Puraikalan YD (2013) Development and organoleptic evaluation of Jamun juice. International journal of science and research 4(3).

Lewis WK (1921) The rate of drying of solids materials. J. Ind. Engin. Chem.13(5):427-432.

Lock K, Stuckler D, Charlesworth K and McKee M (2009) Potential uses and health effects of Indian raspberry. British Homeopathic J. 339:459-452.

Mohseni NN (1980) Physical Properties of Plant and Animal Materials. Gordon and Breach science publishers, New York.

Midilli A, Kucuk H and Yaper Z (2002) A new model for thin layer drying. Drying Tech. 20:1503–1513.

Naidu MM, Khanum H, Sulochanamma G, Sowbhagya HB, Hebbar UH, Prakash M and Srinivas P (2012) Effect of Drying Methods on the Quality Characteristics of Fenugreek (Trigonella foenum-graecum) Greens. Drying Technology, 30: 808–816.

Pangavhane DR, Sawhney RL and Sarsavadia PN (1999) Effect of various dipping pre-treatment on drying kinetics of Thompson seedless grapes. Journal of Food Engineering., 39(3):211-216.

Pardeshi IL, Arora S and Borker PA (2009) Thin-Layer drying of green peas and selection of a suitable thin-layer drying model. Drying Technology, 27: 288–295.

Ranjan A, Jaiswal A and Raja B (2011) Enhancement of Syzygium cumini (Indian Jamun) active constituents by ultra-violet (UV) irradiation method. Sci. Res. Essays. 6:2457-2464.

Raza A, Ali MU and Nisar T (2015) Proximate composition of Jamun (syzygium cumini) fruit and seed.Americal- Eurasian J. Agric. and Environ. Sci., 15(7): 1221-1223.

Shrivastava RP and Kumar S (2009) Fruit and vegetable preservation. Principles and practices, IBDC, New Delhi.

Sah AK and Verma VK (2011) Syzygium cumini: An overview.J. Chem. Pharm. Res,

Togrul IT and Pehlivan D (2002) Mathematical modeling of solar drying of apricots in thin layers. Journal of Food Engineering. 55: 209 216.

Togrul IT and Pehlivan D (2003) Modelling of drying kinetics of single apricot. J.Food Eng. 58: 23-32.

Verma LR, Buckling RA, Endan JB, and Wratten FT (1985) Effects on drying air parameters on rice drying models. Transaction of the ASAE, 28: 296- 301.

Yaldiz O, Ertekin C, Uzun HI (2001) Mathematical modelling of thin Layer solar drying of Sultana grapes.26, 457-465.

Zhang Q and Litchfield JB (1991) An optimization of intermittent corn drying in a laboratory scale thin layer dryer. Drying Technology. 9:383–395.

Infestation of Giant African Snail, *Achatina fulica* Ferussac in Vegetable Crops: A Review

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Abstract: Giant African Snail, *Achatina fulica* Ferussac is world's most damaging 100th invasive alien species and it is one of the largest terrestrial gastropods, easily adapted to life in regions outside the natural environment and most damaging species for the agriculture and horticulture in the country. *Achatina fulica* is active during the night and during day time it is hiding on the trees or often buried beneath the ground. Highly congenial condition for activity of snail is rain fall, lower temperature and higher humidity. It is reported to feed on 500 different plants species. Especially, vegetable crops like cabbage and cauliflower are highly prepared by giant African snail due to succulent nature of these crops. Hence, to know its origin, population dynamics, effect of weather parameters, different host plants and its infestation in vegetable crops and crop loss are discussed here under.

Introduction:

Achatina fulica Ferussac belongs to phylum: Mollusca, Class: Gastropoda, Order: Stylommatophora and family: Achatinidae. The snail is popularly called as giant African snail because of its big size and nativity. It is known for its destructive nature on cultivated plants wherever it occurs and is one of the world's largest and most damaging land snail pests. It has spread to most of the Indo-Pacific areas including India, Sri Lanka, Malaysia, China, Taiwan, Japan, Philippines, Hawaii, Samoa, Tahiti, New Guinea and Indonesia (Anon., 2000). It is world's most damaging 100th invasive alien species (Lowe *et al.,* 2000). It has now spread throughout much of the tropics by human activity and with such a wide distribution and often high densities, this pest species is likely to be the most global biomass of any land snail. It is a big sized, nocturnal, bisexual land snail reached most of the continents mainly through horticultural trade (Srivastava, 1973). Now, it has assumed a pest status in all the ornamental nurseries in almost all the states of India. In addition, mucus and the excreta falling on the economic plant parts will decrease the marketability. Serious damage was recorded in planted young cuttings by feeding on the sprouted buds and

affected the standing betel vine. Even though *A. fulica* prefer and thrive in more humid and warm conditions, they are highly adaptable to dry and cooler climates. They hibernate 10 to 15 cm deep in soft soil during less favorable conditions for up to one year. The herbivore diet includes over 500 different plant species, including breadfruit, cocoa, papaya, peanut, rubber and most types of beans, peas, cucumbers and melons. In Karnataka this snail was reported for the first time causing damage to ornamental plants and vegetables in Bangalore (Veeresh *et al*., 1979). Likewise, many authors (Subramanya,1982), Basavaraju *et al*. (2000), Ravikumar (2005), Javaregouda (2006), Shree *et al*. (2006), Basavaraju *et al*. (2010), Sridhar *et al*. (2013) and Rafee *et al*. (2013) reported infestation of giant African snail in different agriculture and horticulture crops in Karnataka. It is known to infest many crops like cereals, commercial crops, vegetables, fruits and ornamentals. The damage is seen in most of the districts of Karnataka on field and horticultural crops. Many times re-sowing of groundnut, soybean and some vegetables were taken up due to severe attack by this pest in early crop stage. Hence, in this chapter its origin, population dynamics, host plants and crop loss in vegetable crops have been discussed.

Origin

Giant African snail is present naturally from Natal and Mozambique in the south to Kenya and Italian Somaliland in the North. It extends 250 to 830 km from the coast, going farthest inland in the northern section of the range (Mead, 1949). Giant African snail is a serious pest of vegetables and considered to be a major problem in kitchen home gardens. Many farmers complained that they could not grow nursery-raised vegetables by transplanting them into the fields because they are immediately eaten by *A. fulica.* They completely wiped out vegetable crops such as cauliflower, potato, cabbage, pumpkin, cucumber, bottle gourd, white gourd, spinach, radish and tomato. Pulses and cereals such as hyacinth bean, cowpea, black gram, maize and millet and fruits *viz*., banana, guava, papaya and jack fruit are all considered to be vulnerable. They also reported that 500 recently transplanted cauliflower and cabbage plants were completely destroyed within just one night (Prem and Naggs, 2008).

Population Dynamics

Raut and Ghose (1984) studied the distribution of *A. fulica* in West Bengal and noted its spread from Kolkata (Balurghat) to Coochbehar. The population varied from 8.12/m^2 in Balurghat to 32.68/m^2 in Coochbehar (West Bengal). In the North-eastern region of India snail infested pockets were studied in nine locations namely Silonijan, East Sarani, Golaghat, Jhalukbari, Lachitnagar, Panbazar, Tezpur, Ulubari

and Jorhat in Assam. The population ranged from 8/m^2 at Silonijan to 26/m^2 at Jorhat. In Nagaland, snail infested pockets located at two places *i.e.*, Chumukedima (4.12/m^2) and Dimapur (24/m^2). In Meghalaya at Nongpoh, in Tripura at Kumarghat, in Manipur at Imphal snail infested pockets were located with the average populations of 11, 17.22 and 13/m^2, respectively. In Bihar, GAS was noticed in large number of places which were spread over 32 places (From Telecocolony to Chaibasa) and the average population ranged from 6 /m^2 at Telecocolony to 38/m^2 at Chaibasa. Further, GAS was also reported from Kerala, Tamil Nadu and Karnataka states. In Utter Pradesh at Bijnor, Dhampur and Moradabad, the average population recorded were 19.22, 27.32 and 34.40/m^2, respectively. The snail was in Malappuram, Palghat and Calicut in Kerala, the average population being 15, 24 and 34/m^2 respectively. It has been recorded from Madras, Annamalai Nagar, Pollachi and Tambaram, the average population recorded was 15.12, 22.11, 22.44 and 34/m^2, respectively. With regards to Karnataka, there is record of snail infested pocket from Bangalore only, the average population being 9/m^2.

Effect of weather parameters on incidence

The snails were generally active during the rainy season from dusk to dawn. The seasonal variation of population at Port Blair indicated that snail population recorded in a 25 m^2 plots was maximum during August (153.50/week) and September (121.25/week) while minimum during January (14.00/week), February (3.00/week) and March (1.00/week) and nil during April months (Gupta and Doharey, 1985). It is reported from Odisha in Anandapur, Baliapal, Balasore and Baripada, the average population of snails was 22.32, 25, 27 and 32/m^2, respectively (Srivastava, 1992). Thakur (1998) from Bihar reported that infestation of *A. fulica* commenced with the onset of monsoon rains and remained active throughout rainy season and started declining gradually from middle of November. Thakur and Kumari (1998) in Bihar, noticed maximum population during August and September (28.15 and 28.00 snails / week) and minimum during February (2.25 snails/week) and practically nil in January in an area of 54 $m^{2.}$ Rainfall had highly significant positive relationship with snail population in betelvine and arecanut ecosystem (Chandaragi 2014, Chandaragi and Patil, 2014).

Infestation in vegetable crops

Reddy and Sreedharan (2006) reported that severe damage was noticed on crops like banana, beans, cabbage, cucumber, cauliflower, tomato and chillies. The

damage was more pronounced in young seedlings in the field and nursery of these crops in Arakuvalley zone. Highest population of 620 snails/100 sq.feet in coconut garden followed by 431 on elephant foot yam, 102 on ginger, 89 on mulberry, 104 on cowpea, 82 on field bean at Tamalapur village of Hassan taluk. In Channarayapattan taluk, Nagaranavile village snails were found feeding on cowpea, field bean, maize and other cultivated plants (Basavaraju *et al.* 2010).

Mead (1979) stated that damage is characteristically localized and restricted to vegetable and flower gardens. The greatest damage caused by *A. fulica* is found either in new infestation sites or at the crest of expanding populations with the amount of damage decreasing proportionately towards the epicentre. Even with the great numbers characteristic of young populations, however, the damage is fairly localized and not catastrophic or devastating on a broad scale. It has been recorded on a large number of plants including most of the ornamentals, vegetables and leguminous cover crops. The list of vegetables host plants of giant African snail were given in the table.1. Onion (*Allium cepa* L.), garlic (*Allium sativum* L.), yam-beans (*Pachyrhizus tuberosus* (de Lamarck) Sprengel) and betelvine (*Piper betle* L.) are particularly remarkable among crop species in that they are evidently immune to the attentions of *A. fulica.* Bitter gourd (*Momordica charantia* L.) being grown free from *A. fulica* herbivory in the Andamans and yet there have been records of some damage to this crop species in various provinces in India (Srivastava, 1992).

Table 1. Host plants of vegetable crops of *Achatina fulica* Ferussac in World and India

Comon name	Scientific name	Country	References
1.World			
Amaranthus	*Amaranthus* spp.	Saipan	Lange (1950) and Weel (1948)
Beans	*Phaseolus radiates* L.	Hawaii	Weber (1954)
Bitter gourd	*Momordica charantia* L.	Philippines	Pangga (1949)
Cabbage	*Brassica* spp.	Philippines	Pangga (1949)
		Saipan	Lange (1950)
Carrot	*Daucus carota* L.	Saipan	Lange (1950)
Chili peppers	*Capsicum annuum* L.	Sumatra	Heubel (1937)
		Saipan	Lange (1950)
		Philippines	Pangga (1949)
Cucumber	*Cucumis sativus* L.	Saipan	Lange (1950)
		Philippines	Pangga (1949)

Cowpea	*Vigna sinensis* L.	Srilanka	Bertrand (1928)
		Sumatra	Heubel (1937, 1938)
		Hawaii	Weber (1954)
Egg plant	*Solanum melongena* L.	Saipan	Lange (1950)
		Philippines	Pangga (1949)
Melons	*Cucumis melo* L. *Citrullus vulgaris* (Thunb.)	Hawaiian Islands	Mead (1961)
		Philippines	Pangga (1949)
		Saipan	Lange (1950)
Okra	*Abelmoschus esculentus* (L.) Moench	Srilanka	Chamberlin (1952)
		Saipan	Lange (1950)
Passion flower	*Passiflora* spp.	Hawaii	Mead (1961),
		Saipan	Lange (1950)
Peanut	*Arachis hypogaea* L.	Sumatra	Heubel (1937, 1938)
umpkin	*Cucurbita pepo* L.	Srilanka	Green (1910)
		Saipan	Lange (1950)
Radish	*Raphanus sativus* L.	Sumatra	Heubel (1937, 1938)
		Saipan	Lange (1950)
Tomato	*Lycopersicon esculentum* Mill.	Guam	Mead (1961)
2. INDIA			
Amaranthus	*Amaranthus* spp.	Kolkata	Raut and Ghose (1984)
		Bihar	Singh and Roy (1979)
Bean	*Phaseolus* spp.	Bihar	Sharma and Agarwal (1989)
		Kolkata	Raut (1991)
Beans	*Lablab purpureus* L.	Kolkata	Raut and Ghose (1984)
Bitter gourd	*Momordica charantia* L.	Andaman	Srivastava (1973)
Broccoli	*Brassica oleracea* var.*botrytis* L.	Tamil Nadu	Balasubramanian and Kalayanasundaram (1973)
Cabbage	*Brassica oleracea var.capitata* L.	Kolkata	Raut and Ghose (1984)
		Tamil Nadu	Balasubramanian and Kalayanasundaram (1973),
		Bihar	Sharma and Agarwal (1989)
		Orissa	Behura (1955)
Cauliflower	*Brassica oleracea var.botrytis* L.	Andaman	Srivastava (1973)
		Kolkata	Raut and Ghose (1984)
Chilli	*Capsicum annum* L.	Kolkata	Raut and Ghose (1984)

		Bihar	Singh and Roy (1979)
			Sharma and Agarwal (1989)
		Andaman	Srivastava (1966)
		Bihar	Sharma and Agarwal (1989)
Garlic	*Allium sativum* L.	Andaman	Srivastava (1973)
Malabar spinach	*Basella rubra* L.	Kolkata	Raut (1982)
Mung bean	*Phaseolus aureus*, *Vigna radiate* (L.) R. Wilczek	Tamil Nadu	Balasubramanian and Kalayanasundaram (1973),
		Kolkata	Raut and Barker (2002)
Onion	*Allium cepa* L.	Bihar	Sharma and Agarwal (1989)
		Andaman	Srivastava (1973)
Orange	*Citrus sinensis* (L.) Osbeck	Kolkata	Raut and Barker (2002)
Pointed gourd	*Trichosanthes dioica* Roxb.	Bihar	Singh and Roy (1977)
Pumpkin	*Cucurbita maxima* Duchesne	Andaman	Srivastava (1973)
		Kolkata	Raut and Ghose (1984)
Radish	*Raphanus sativus* L.	Kolkata	Raut and Ghose (1984)
Ridge gourd	*Luffa acutangala* L.	Andaman	Srivastava (1973)
		Kolkata	Raut and Ghose (1984)
		Bihar	Singh and Roy (1979)
		Kolkata	Raut (1982)
Sponge gourd	*Luffa aegyptica* Mill.	Kolkata	Raut and Ghose (1984)
Sugar beet	*Beta vulgaris* var. *rapa* Retz	Bihar	Singh and Roy (1977)
Tomato	*Lycopersicum esculantum* Mill.	Bihar	Raut and Ghose (1984)
Winter squash	*Cucurbita maxima* Duchesne	Bihar	Singh and Roy (1979)
		Kolkata	Raut (1982)
		Bihar	Sharma and Agarwal (1989)

Crop Loss

The crop loss due to African snail in vegetable crops very meager, hence studies related to other snails also included. One study by Sharma and Agarwal (1989) who reported that giant African snail a serious pest on many fruits and vegetables *viz.*, banana, beans, brinjal, cabbage, cauliflower, chilli, coconut, coffee, all cucurbits, garlic, knolkhol, okra, lettuce, onion, papaya, tomato and other crops like maize, paddy, sorghum and sugarcane. However, small seedlings were

completely eaten by the snail. While, study conducted by Giraddi *et al.* (1996) reported that the damage of crops by snail, *Cryptozona semirugata* at Dharwad, Karnataka. The damage of 30.6, 27.4, 25.4, 10.5, 20.7 and 4.3 per cent in chilli (capsicum), sunflower, bhendi (okra), soybean, cotton and groundnut seedlings, respectively**.**

References

Anonymous, 2000, DPI notes on giant African snail, Animal and Plant Health Service, DPT, Queens land, pp. 1-9.

Balasubramanian, M. and Kalayanasundaram, P., 1973, A note on the incidence of giant African snail, *Achatina fulica* Bowdich. *Auara*, 4/5 : 217.

Basavaraju, S. B., Kulapati, H., Gowda, C. C., Sharanappa, J., Murthy, N. K. and Hipparagi K, J. S., 2000, Preliminary survey on the incidence of *Achatina fulica* Bowdich in Davanagere District. *Curr. Res*., 29 (7-8) : 129.

Behura, B. K., 1955, Depredations of the giant African land snail, *Achatina fulica* (Ferussac) in Balasore (Orissa), *J. Bombay Nat. Hist. Soc.*, 54: 287.

Chandaragi, 2014, Integreted management of Giant African Snail, *Achatina fulica* Ferussac in Agriculture and Horticulture Ecosystems. Ph.D Thesis, Univ. Agric. Sci. Dharwad, Karnataka , India.

Chandaragi, M and Patil, R. K. Population dynamics of giant African snail, *Achatina fulica* Bowdich (Stylommatophora: Achatinidae) in betelvine ecosystem. J Exp. Zool. India. 2014; 17(1):285-288.

Chemberlin, I. J., 1952, Final report on an ecology and population study of the giant African snail on Tinian, Marianas Islands. Pacific Science Board of the National research Council. Invertebrate Consultants committee for the pacific, p. 27.

Giraddi, R. S., Kulkarni, K. A. and Manjunath, M., 1996, Outbreak of snail, *Cryptozona semirugata* (Beck) on field crops. *Karnataka J. Agric. Sci*., 9 (3) : 533-534.

Gupta, G. P. and Doharey, K. L., 1985, Non insect pest and predators, All India Scientific Writers Society, New Delhi.

Heubel, G. A., 1937, Enkele gegevens over de agaatslak (*Achatina fulica* Fer.) in de Lampongsche Districten. *De Bergcultures*, 11 (47) : 1667-70.

Heubel, G. Ad., 1938, As Heube. *Ibid*., II. 12 (14) : 400-401.

Javaregouda, 2006, Incidence of snail, *Achatina fulica (*Bowdich) in betelvine and its management. *Pest Manag. Hort. Ecosys.*, 12 (1) : 41- 46.

Lange, W. H., 1950, Life history and feeding habits of the giant African snail on Saipan, *Pac.*

Lowe, S., Browne, M., Boudjelas, S. and De, P. M., 2000, *100 of the world's worst invasive alien species: a selection from the global invasive species database*. Published by the Invasive Species Specialist Group a specialist group of the Species Survival

Mead, A. R., 1949, The giant snails. *Atlantic*, 184 (2) : 38-42.

Mead, A. R., 1961, The Giant African Snail : A Problem in Economic Malacology. The University of Chicago Press, USA, p. 257.

Mead, A. R., 1969, *Aeromonas liquefaciens* in the leucodermia syndrome of *Achatina fulica*. *Malacol.*, 9 : 43.

Mead, A. R., 1979, Economic malacology with particular reference to *Achatina fulica*. In : *Pulmonates*, Ed. Fretter, V. and Peake, J., Academic Press, London, p. 150.

Pangga, G. A., 1949, A preliminary report on the biology, ecology and control of the giant African snail (*Achatina fulica* Fer.). *Philippine J. Agric*., 14 (4) : 337-47.

Prem, B. B. and Naggs, F., 2008, The giant African land snail *LissAchatina fulica* (Bowdich) in Nepal, *The Malacol.*, 50 : 19-21.

Rafee, C. M., Patil, R.R., Goud, K. B., Patil, R. K., Krishna Naik, L. and Patil, R. H., 2013a, Survey for infestation of giant African snail in Hubli taluka. Paper presented In: *10th National Symposium on Soil Biology and Ecology- soil biota and social insects for sustainable agriculture*, Uni. Agric. Sci., Bangaluru, December 19 -21, p.155.

Raut S.K., 1986, Snails and slugs in relation to human diseases. *Env. Ecol., 4:* 130-137.

Raut, S. K. and Barker, G. M., 2002, *Achatina fulica* Bowdich and Other Achatinidae as Pests in Tropical Agriculture. In: Molluscs as Crop Pests ,

Ed. Barker, G. M., CABI Publishing, Hamilton, New Zealand, pp. 55-114.

Raut, S. K. and Ghose, K. C., 1984, Pestiferous land snails of India. Zoological Survey of India, Bani Press, Calcutta, p. 151.

Raut, S. K., 1991, Population dynamics of the pestiferous snail *Achatina fulica* (Gastropoda : Achatinidae). *Malacol. Rev.*, 24 : 79-106.

Ravikumara, 2005, Bioecology and management of giant African snail, *Achatina fulica* Bowdich (Achatinidae: Gastropoda) in areca ecosystem. *M. Sc. (Agri.) Thesis*, Univ. Agril. Sci., Bangalore.

Reddy, K. B. and Sreedharan, K., 2006, Record of giant African snail, *Achatina fulica* Bowdich on coffee in Visakha agency areas, Andhra Pradesh. *Indian Coffee*, 70 (12) : 17-19.

Sharma, D. D. and Agarwal. M. L., 1989, Save your crops from giant African snail. *Indian Farm*., 38 : 15-22.

Shree, M. P., Ravi Kumar, K. and Nagaveni, V., 2006, Infestation of giant African snail on Mulberry. *Indian Silk*, 45 (6) : 14-16.

Singh, S. N. and Roy, C. S., 1977, Host records of *Achatina fulica* Bowdich, the giant African snail. *Entomol. Newslett.*, 7 : 10-11.

Singh, S. N. and Roy, C. S., 1979, Growth, reproductive behaviour and biology of the Giant African snail, *Achatina fulica* Bowdich (Pulmonata: Achatinidae) in Bihar. *Bull. Entomol*., 20 : 40-47.

Sridhar, V., Jayashankar, M., Vinesh, L. S. and Abraham, V., 2013, Severe occurrence of the giant African snail, *Achatina fulica* (Bowdich) (Stylommatophora: Achatinidae) in Kolar District, Karnataka. *Pest Manag. Hort. Ecosys*., 18(2): 228-230.

Srivastava, P. D., 1966, Leucodermia like disease in the culture of giant African snail, *Achatina fulica* Bowdich. *Indian J. Ent*., 28 : 412-413.

Srivastava, P. D., 1973, The giant African snail and its control. *Indian Farm.*, 33-36.

Srivastava, P. D., 1992, Problem of land snail pests in agriculture: A study of the giant African Snail. Concept Publishing Company, New Delhi, p. 234.

Subramanya, K. B., 1982, Studies on the snails with special reference to giant African snail, *Achatina fulica* (Bowdich) (Gastropoda : Achatinidae), *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Bangalore, Karnataka (India).

Thakur, S. and Kumari, R., 1998, Seasonal behavior of giant African snail, *Achatina fulica* in Bihar. *J. Ecotox. Environ. Monitor.*, 8 : 153-160.

Thakur, S., 1998, Studies on food preference and biology of giant African snail, *Achatina fulica* in Bihar. *J. Ecobiol*., 10 (2) : 103-108.

Veeresh, G. K., Rajagopal, D. and Puttarudraiah, M., 1979, First record of African giant snail, *Achatina fulica* Bowdich (Mollusca : Gastropoda) as a serious pest of ornamental crops in Bangalore. *Curr. Res.,* 8 : 202-204.

Weber, P. W., 1954, Studies on the giant African snail. *Ibid*., 15 (2) : 363-67.

Weel, P. B. V., 1948, Some notes on the African giant snail, *Achatina fulica* Fer. I. On its spread in the Asiatic tropics. II. On its economical significance. III. Observations on its biology. IV. On its biological balance and means of destruction. *Ckronica Naturae,* 104 (8/9) : 241-43, (10) : 278-80, (12) : 335-36; 105 (1) : 25-27.

Anti-Diabetic Potential Of Onion: A Review

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Abstract

Onion (*Allium cepa*) is one of the most important horticultural crops having extensive application as food and medicine. Onion is a multipurpose plant used in traditional medicines for centuries due to its excellent nutritional and health promoting effects. Onions are of great value as an important source of several phytonutrients as flavanoids, anthocyanins, phenolic acid and flavanolsfructooligosaccharides (FOS), thiosulfinates ,other organosulfur compounds, vitamins and some minerals. The secondary metabolites found in onions, phenolics, have antioxidant activity besides beneficial effects against different degenerative pathologies like cardiovascular and neurological diseases, dysfunctions based on oxidative stress and are can scavenge radicals by three major mechanisms: hydrogen atom transfer, electron transfer, and combination of both these transfers. *S*-methyl-L-cysteine sulfoxide isolated from onion has anti-diabetic, antioxidant and anti-hypolipidemic effects in alloxan diabetic rats. Fructans (polysaccharides) are the principal storage carbohydrates in onions with fructooligosacharide as the main component. The extract of onion bulb, *Allium cepa* is found to be strongly lowered high blood glucose (sugar) and total cholesterol levels.

Introduction

Onion (*Allium cepa*) is one of the most important horticultural crops having extensive application as food and medicine. After tomato, it is the second most commonly and widely cultivated vegetable grown commercially in over 175 countries worldwide with an approximated production of 97.40 million tons annually covering 5.2 million hectares of cultivable land (Bindu and Podikunju, 2015; FAOSTAT, 2017). As per the report of FAO, 2018, China with a production of 23,839,053 tons and India with 19,415,425 tons are the primary onion growing countries in the world followed by USA, Egypt, Iran, Pakistan, Turkey, Bangladesh, Russian Federation and Mexico (FAO, 2018). Among the Indian states Karnataka, Gujarat, Andhra Pradesh, Orissa and Madhya Pradesh are leading producers of onion

(Mahajan *et al., 2017)*. Being an essential food item, its demand in not only limited to domestic market but also have tremendous export potential. Onion is a biennial vegetable crop belonging to family Liliaceae. The genus *Allium* is by far the largest genus of onion containing more than 780 species (Burnie *et al.,* 1999).

The onion plant comprises of adventitious fibrous roots (Ranjitkar, 2003), bulb and tubular leaves. The bulb of onion is composed of concentric, fleshy and enlarged leaf bases. Gradually the outer leaf bases loose moisture and become thin and scaly forming a protective coat, while the inner leaves thicken as the bulb develops (Lim, 2015). Onion bulb is the most consumed part of onion followed by onion leaves. An edible onion bulb can grow up to 10 cm diameter with shape varying from flat to globular or oblong (Fritsch, 2005). Many onion cultivars are known to have developed worldwide which may be red, white or yellow in colour grown for dry bulbs, salads and pickling (Pareek *et al.,* 20017). It is an integral component of Indian culinary and have received tremendous attention since decades for their therapeutic value. Onion is the main component of condiments used in all households around the year. The bulbs are boiled and used in soups and stews, fried or eaten raw. They are also preserved in the form of pickles. Onion leaves are also used in salads and soups (FAO, 2009). Although onions have a siby71gnificant nutritional and medicinal value to the human diet, they are primarily consumed for their unique flavour and for their ability to enhance the flavour of other foods (Kopsell and Randle, 1997). Small bulbs of onions are pickled in vinegar and are used for making various seasonings, sauces and soups.

Nutritional and health benefits of onion

Onion is a multipurpose plant used in traditional medicines for centuries due to its excellent nutritional and health promoting effects. The nutritional composition of onion is very complex.Ascorbic acid is the most abundant vitamin found in the onion bulb, with a concentration of 1mg/g dry weight (Breu, 1996). Onion contains steroidal saponins (Carotenuto *et al.,* 1999), which prevent absorption of cholesterol in the intestine. Fructans (polysaccharides) are the principal storage carbohydrates in onions with fructooligosacharide as the main component.In a study of Roberford, 2007, onions were reported to have the highest quantity of fructans and had potential to decrease bacterial population.

Onions are of great value as an important source of several phytonutrients as flavanoids, anthocyanins, phenolic acid and flavanolsfructooligosaccharides (FOS), thiosulfinates ,other organosulfur compounds, vitamins and some minerals (Hertog *et al.,* 1993; Kamal and Daoud, 2002; Campos *et al.,* 2003; Gabler*et al.,* 2003; Yang *et al.,* 2004; USDA, 2008; Paul, 2006; Upadhyay, 2016; Slimestad, *et al.,* 2007).The Flavonoids is major phenolics compound in onions and are present in different forms like flavones, flavanones, flavonols, isoflavones, flavanonols, flavanols, chalcones, and anthocyanins . These favonols are present as their glycosides, that is, quercetin and kaempferoland isorhamnetin (Perez-Gregorio *et al.,* 2010. Santas, *et al* 2010. Prakash *et al.*,2007). Anthocyanins, belonging to anthocyanidins, are mainly present in red onions while a composition rich in flavonols as yellow onions (Vries*et al.*,1998; De Ancos *et al.,* 2015.). The secondary metabolites found in onions, phenolics, have antioxidant activity (Nuutila *et al.,* 2003; Yang *et al.,* 2004; Slimestad, et.al., 2007) besides beneficial effects against different degenerative pathologies like cardiovascular and neurological diseases, dysfunctions based on oxidative stress (Griffiths, 2002.) and are can scavenge radicals by three major mechanisms: hydrogen atom transfer, electron transfer, and combination of both these transfers (Prior *et. al.,* 2005). Studies have found that the quercetin derived from onion consumption is absorbed and accumulated in the form of quercetin conjugate in human plasma (Loku, 2002; Arai *et al.,* 2000) which plays vital role in preventing the oxidation of low density lipoprotein by scavenging the action of reactive oxygen species. Onion has proved to be effective in preventing coronary heart mortality due to the ability of quercetin to hinder platelet aggregation (Hollman *et al.,* 1996; Janssen *et al,* 1998; Bonaccorsi *et al.,* 2008, Benítez *et al.,*2011). Level of quercetin and DPPH radical scavenging action of onion increases from core of onion bulb to skin (Nutila *et al.,* 2002; Nutila *et al.,* 2003; Ly *et al.,* 2005).

Another source of phytochemicals in onions bulbs is the FOS in the form of inulin, kestose, nystose, and fructofuranosylnystose. The prebiotic effect of these FOS have been widely reported in the past years for health benefits (Benıtez *et al.,* 2011.)

Sulfur-containing compounds in onion may be volatiles and non-volatiles. In onions, sulfur compounds such as dialk(en)yldisulfides and dialk(en)yltrisulfides are responsible for typical odour and flavour through the action of alliinase (Lancaster

and Kelly 1983; Block 1996). Non-volatile cysteine sulfoxides (such as *S*-methyl-L-cysteine sulfoxide, *S*-propyl-L-cysteine sulfoxide and *S*-allyl-L-cysteine sulfoxide) are known as the precursors of the volatile compounds.

Allium vegetables have long been known for their antimicrobial activity against various microorganisms such as gram positive and gram negative bacteria (Zohri *et al.,* 1995; Colli and Amling, 2005) . Several products prepared by application of onion extracts proved to longer shelf life due to antioxidant potential of onion (Cao *et al.,* 2013) due to its antimicrobial action against a range of microbes (Pszczola, 2002) .Organosulfur compounds and phenolic compounds have been reported to be involved in the antimicrobial activity of onion (Takahama and Hirota, 2000; Grifith *et al.,* 2002; Kim *et al.,* 2004). Other compounds such as peptide Allicepin isolated from onion bulb also have shown antimicrobial property (Wang and Ng, 2004). Quercetin oxidation products have also shown antimicrobial property against *Helicobcter pylori a*nd multi drug resistant Methicillin-resistant *Staphylococcus aureus* (Ramos *et al.,* 2006).They also have inhibitory effects on proliferation cancer cells and adipocytes via inhibiting fatty acid synthase (FAS) (Zhou *et al.,* 2011).

It maintains dehydration of body in hot summer ad provide protection against excessive heat losses (Mitra *et al.,* 2012). It reduces the risk of preterm delivery (Myhre *et al.,* 2013; Samuel *et al.,* 2019; Englund-Ogge *et al.,* 2014), satiety and glycemia (Anderson *et al.,* 2013; Ozougwu, 2011; Kim *et al.,* 2011; Eldin *et al.,* 2010). Excess uses of onions have been found to lower the risk for carcinoma (Corzomartinezand Villamiel, 2007; Micheal, 2006; Wang *et al.,* 2012; Lai *et al.,* 2013). Individuals with high consumption of onion are 50 per cent less likely to suffer from cancers of the alimentary, stomach and respiratory tracts (Vecchia, 2015; Zhou *et al.,* 2011; Jenwitheesuk *et al.,* 2012l). Renal and colon carcinogenesis are inhibited by organosulfur compounds such as S-methylcysteine (SMC), diallyl disulfide (DDS), and S-allylcysteine (SAC) (Fukushima *et al.,* 1997; Hatono, *et al.,* 1996).

Quercetin content of onion is known to inhibit migration and invasion of SAS human oral cancer cells through inhibition of NF-κB and MMP-2/-9 signaling pathways (Yu *et al.,*2010). Onion extract shows inhibition of mutagenesis/carcinogenesis, (Herman-Antosiewicz *et al.,* 2004), modulation of

enzyme and cell signaling pathways (Gonzalez-Pena *et al.,*2013), free-radical scavenging, (Galluzzo *et al.,* 2009; Wang *et al.,* 2012; Lai *et al.,* 2013) apoptosis, immunomodulatory (Niukian *et al.,* 1987; Prasanna and Venkatesh , 2015) and other effects on cell proliferation and tumor growth in in-vitro studies (Hung, 2007).

Studies suggest that flavonoids have been known to be very effective against viruses for a long time. Many scientists have proved that flavonoids have antiviral activity, and can inhibit or kill viruses (Bakay *et al.,* 1968; Tripathi and Rastogi, 1981; Tsuchiya *et al.,* 1985; Hayashi *et al.,* 1993). The mechanism of inhibiting viral growth lies in blocking and destroying the synthesis of viral protein and nucleic acids (Castrillo and Carrasco, 1987; Vrijsen *et al.,* 1987; Zandi *et al.,* 2011). A study in the year 2003 showed that hydrophilic ethanolic extract of onion inhibited osteoclast activity and increased the bone formation process (Muhlbauer *et al.,* 2003). In addition, it has been shown recently that the oral intake of fresh onion juice had both spermatogenesis and anti-protozoal effects in Toxoplasma gondii infected rats (Khaki *et al.,* 2011; Gharadaghi *et al.,* 2012). Also there was an evidence of possible anti-inflammatory effect for onion extract (Alpsoy *et al.,* 2011).

Inflammation is a process of complex biological response. It is generally initiated by factors such as pathogen infection, chemical irritation, injury in cells and tissues. Many animal models have been studied to demonstrate the role of flavonoids against inflammation, and it has been reported that quercetin and kaempferol have an active role as anti-inflammatory agents (Kim *et al.,* 1998; Jachak,2001; Nasri*et al.,* 2012; El-Ghorab, 2017).Similarly, it has been observed in vitro that quercetin has a role in the inhibition of different isotypes of immunoglobulins such as IgM, IgG, and IgA; all are mitogen stimulated (Cumella *et al.,* 1987).

Several epidemiological studies have reported the efficacy of onion in inhibiting platelet aggregation (Halbrugge *et al.,* 1990; Lawson *et al.,* 1992; Ali *et al.,* 1999; Moon *et al.,* 2000; Briggs *et al.,* 2001; Ro *et al.,* 2015). Studies on the antithrombotic action of onion have reported that its aqueous extracts inhibit formation of thromboxane, a potent inducer of platelet aggregation (Goldman *et al.,* 1996; Moon *et al.,* 2000). Several epidemiologic studies have reported that the anti-platelet activity of onions is considered to be a property of organosulfur compounds, more specifically a class of α-sulfinyl-disulfides (cepaenes), found in onion extracts (Block *et al.,* 1997; Ali *et al.,* 1999).

There are several evidences of onion playing vital role in lowering blood sugar level. The chemical constituents of onion have been found effective in modulating conditions responsible for diabetes. Study suggests that flavonoids results increased secretion of insulin by controlling hormonal release from pancreatic cells which in turn increases the glucose uptake by cell resulting controlled blood glucose levels (Vessal *et al.,* 2003). Several studies have also highlighted the beneficial effect of favonol, quercetin in controlling diabetes (Knekt *et al.,* 2002; Kobori *et al.,* 2009). The blood glucose lowering activity of onion also be due to sulphur-containing compound-allyl propyl disulfide (APDS) which lowers glucose level by competing with insulin (which is also a disulfide) for insulin-inactivating sites in the liver (Kumari *et al.,* 1995) resulting an increase in free insulin in the blood have also proved to possess anti-diabetic potential by stimulating secretion of insulin (Srinivasan, 2005). Several other studies have also reported that *A.cepa* lowers blood glucose level by facilitating better glycogen storage (Guo *et al.,* 2002) and improve oxidative status by increasing glutathione peroxidise (Helen *et al.,* 1999). There are evidence that natural flavanoids could be beneficial preventing several complications associated to diabetes such as advanced glycation of collagens leading to development of cardiovascular complications (Urios *et al.,* 2007).

Numerous studies have reported the beneficial role of various forms of onion. The extract of onion bulb, *Allium cepa* in strongly lowered high blood glucose (sugar) and total cholesterol levels in diabetic rats when given with the antidiabetic drug metformin, (Campos *et al.,*2003 ; El-Demerdash *et al*., 2005; Ojieh ,2015), dietary onions (Babu and Srinivasan, 1999; Jelodar*et al.,* 2005) and isolated or synthesized active compounds in onions (Kumari *et al.,* 1995; Sheela *et al.,* 1995; Kumari and Augusti, 2002).

The effect of onion extract, prepared by mashing and stirring skin of peeled onion in 1000 mL of 95% concentration of ethyl alcohol at 40 °C for 24 on increase in postprandial glucose level of Sprague-Dawley (SD) rats model were studied by Kim *et al.,* 2011. The administration of extract showed an inhibitory activity against rat intestinal α-glucosidases. The experiment revealed a significant reduction in spike of blood glucose level of rat fed with sucrose (259.60 ± 5.1mg/dl) than the rats where were not treated with onion extracts (283.10±19.2 mg/dL) indicating that onion extract may be beneficial in lowering the spike in blood glucose level due to

inhibition of sucrose in upper and middle part of intestine thereby delaying carbohydrate absorption.

Ogunmodede *et al.,* 2012 also demonstrated the effect of aqueous extract of *Allium cepa* administration on alloxan-induced diabetic rabbits. The study involved injection of alloxan monohydrate into peritoneum to rat to induce diabetes among them. The diabetes induced rats were then grouped into 3 groups in which first group were given 100 mg/Kg body weight of *Allium cepa* aqueous extract daily via oral route for thirty days. The second group received 300 mg/Kg body weight orally daily for 30 days and the third group of rabbit was given peanut oil instead of *A.cepa* extract to serve as diabetic control. The results showed a dose dependent significant lowering in blood glucose level of the diabetics rabbits after 30 days of treatment with *A.Cepa* when compared to the control rabbit. Rabbit administered with 100 mg/Kg body weight of *A. Cepa* aqueous extract showed 53.30 per cent reduction in fasting glucose level (300.20 to 140.10 mg/dL) and rabbit with 300 mg/Kg body weight of *A. Cepa* aqueous extract showed 73.30 per cent reduction in fasting blood glucose level i.e. from 300.20 mg/dL to 80.40 mg/dL.

Kumara *et al.* reported that *S*-methyl-L-cysteine sulfoxide isolated from onion has anti-diabetic, antioxidant and anti-hypolipidemic effects in alloxan diabetic rats (Kumari and Augutsi, 2002) Fructans (polysaccharides) are the principal storage carbohydrates in onions with fructooligosacharide as the main component. In a study of Roberford, 2007 onions were reported to have the highest quantity of fructans and had potential to decrease baterial population. The efficacy of onion extract prepared from red onion and quercetin alone on C57BL/6J mice was studied by Henagan *et al.,* 2015. Both quercetin and onion extracts were found to be effective in insulin resistance and to increase energy expenditure. The antidiabetic potential of the ethanolic extract and fractions from *A. cepa* was verified in STZ–induced diabetic rats (Baragob*et al.,* 2015). Samples induced a significant effect in blood glucose level in an acute antidiabetic study. The raw extract, particularly, caused a 66.0% decrease at 200 mg/kg per se after 24 h. The hypoglycaemic potential of the juice of onion bulbs was instead verified in the study of Wistar rats by Ojieh*et al.,* 2015 in STZ-induced diabetic male. Two groups of rat i.e. rat with normal blood glucose level and diabetic rats were treated with 0.4 g/100 g body weight and 0.6 g/100 g body weight of onion juice. The administration of 0.4 g/100

g body weight of juice reduced fasting blood glucose by 50 per cent. The anti-diabetic potential of ripe onion juice was also investigated by Lee *et al.,* 2013 on STZ-induced diabetic and normoglycemic rat and found onion juice to have anti-diabetic potentialities.

A comparative study on the average blood glucose levels in the alloxan induced diabetic mice treated with ethanol extract of cooked, dried and pulverized *A. Cepa* bulbs and untreated mice showed significant reduction blood glucose in a dose dependent manner indicating that even after cooking the onion bulb contains ingredients capable of treating diabetes. However the effect onion extract when compared to the standard drugs, glibenclamide and insulin, the anti-diabetic activity was found to be less (Sani and Yakubu, 2016). In another report onions have been found to be hypoglyceimic and allyl propyl disulphide is implicated to be the active principle it said to lower blood sugar levels by increasing the amounts of free insulin available (Sheela *et al.*,1995).

The effect of 3 per cent freeze dried onion powder containing diet was examined in albino rats injected with streptozotocin. The results of this study indicate that some of the abnormalities that accompany the development of diabetes mellitus in rats given streptozotocin are ameliorated by dietary onion. Diabetic rats maintained on onion diet in the absence of insulin treatment displayed improved metabolic parameters as compared to diabetic animals fed control diet which was marked decrease in hyperglycemia and a significant improvement in body weight gain (Babu and Srinivasan, 1997). Islam *et al.,* 2008 also investigated the effects of two dietary doses of freeze-dried onion powder on diabetes-related symptoms in a high-fat (HF) diet streptozotocin (STZ)-induced diabetes rat model and report significant antihyperglycemic of these onion interventions in alloxan- or STZ-induced diabetic rats.

While combination of onion with garlic in a study conducted by in the meta-analysis, the antidiabetic effects of onion extract and single components were significant for glucose concentration and body weight ($P < .05$), but the effects of garlic extract were not significant. The results of the meta-analysis suggested that the single component intake and onion extract intake may be effective for lowering plasma glucose concentrations and body weight (Kook *et al.,* 2009).

Conclusion

Onion is a plant with a long history of traditional medicinal uses. Several studies conducted on the anti-diabetic potential along with its other immense potentials in illness confirm the beneficial effects of onion and its fractions. Consumption of onion in form salad, soups or spice can ameliorate health of person suffering from diabetes. Onion enriched food and extracts and their hypoglycemic activity could be taken into account a protective mechanism against the hyperglycaemia characteristics of diabetes mellitus . Further studies on long term effect of its pharmaceutical significance and dose for prevention of diabetes are also in line.

References

Ali, M. Bordia, T. and Mustafa, T. (1999). Effect of raw versus boiled aqueous extract of garlic and onion on platelet aggregation. *Prostaglandins Leukotrients and Essential Fatty Acids*, **60**:43–47.

Alpsoy, S.; Aktas, C.; Uygur, R., Topcu, B.; Kanter, M.; Erboga, M.; Karakaya, O. and Gedikbasi, A. (2011) Antioxidant and anti-apoptotic effects of onion (Allium cepa) extract on doxorubicin-induced cardiotoxicity in rats. *Journal of Applied Toxicology,***13(**5): 258-266.

Anthony, Ojieh. (2015). Onion extract may improve high blood sugar and cholesterol The Endocrine Society March 6, 2015.

Arai, Y.; Watanabe, S.; Kimira, M.; Shimol, K., Mochizuki, R. and Kinae, N. (2000). Dietary intakes of flavonols, flavones and isoflavones by Japanese women and the inverse correlation between quercetin intake and plasma LDL cholesterol concentration. *The Journal of Nutrition,***130(**9):2243–2250.

Babu, P.S. and Srinivasan, K. (1999). Renal lesions in streptozotocin-induced diabetic rats maintained on onion and capsaicin containing diets. *Journal of Nutritional Biochemistry,***10**:477–483.

Bakay, M.; Mucsi. I.; Beladi, I. and Gabor, M. (1968): Effect of flavonoids and related substances. Antiviral effect of quercetin, dihydroquercetin and dihydrofisetin. *ActaMicrobiolAcadSci Hung*, **15**: 223–227.

Baragob, A.E.; Al-Wabel, N.A.; Ahmed, N.A.; Babiker, M.F.; Abdalkarim, A.S. and Elboshra, M.I. (2015). Study to investigate the pancreatic regeneration and

evaluation of the antidiabetic and antihyperlipidemic potential of aerial parts of Allium cepa. *Biochemical and Biotechnological Research,***23**: 19–29.

Benitez, V.; Molla, E., Martin-Cabrejas, M.A.; Aguilera, Y.; López-Andreu, F. J.; Cools, K., et al. (2011). Characterization of industrial onion wastes (*Allium cepa L.*): dietary fibre and bioactive compounds. *Plant foods for human nutrition,***66**(1): 48-57.

Benitez, V.; Molla, E.;. Martin-Cabrejasa, M.A. et al. (2011). Study of bioactive compound content in different onion sections. *Plant Foods for Human Nutrition,***66** (1): 48–57.

Benkeblia, N. and Varoquaux, P. (2003). Effect of gamma-irradiation, temperature and storage time on the status of the glucose, fructose and sucrose in onion bulbs *Allium cepa* L. *International Agrophysics*, **18**: 1–5.

Bindu, B. and Podikunju, B. (2015). Performance evaluation of onion (*Allium cepa* L. Var. Cepa) varieties for their suitability in kollam district. *International Journal of Research in Agricultural Sciences*, **1**(1): 18–20.

Breu, W. (1996). *Allium cepa* L. (onion): Chemistry and analysis. *Phytomedicine,***3**(3):293–306.

Briggs, W.H.; Folts, J.D.; Osman, H.E. and Goldman, I.L. (2001). Administration of raw onion inhibits platelet-mediated thrombosis in dogs. *Journal of Nutrition,***131**:2619–2622

Burnie, G.; Forrester, S.; Greig, D.; et al. (1999). Botanica: The Illustrated A-Z of over 10,000 Garden Plants, 3rd edn., Random House: New South Wales. p. 74.

Campos, K.E.; Diniz, Y.S.; Cataneo, A.C.; Faine, L.A.; Alves, M.J.Q.F. and Novelli, E.L.B. (2003). Hypoglycaemic and antioxidant effects of onion, Allium cepa: dietary onion addition, antioxidant activity and hypoglycaemic effects on diabetic rats. *International journal of food sciences and nutrition,***54**(3), 241-246.

Cao, Y.; Gu, W.; Zhang, J.; Chu, Y.; Ye, X.; Hu, Y. and Chen, J. (2013). Effects of chitosan, aqueous extract of ginger, onion and garlic on quality and shelf life of stewed-pork during refrigerated .*Food chemistry*,**141**(3):1655-1660.

Carotenuto, A.; Fattorusso, E.; Lanzotti, V. and Magno S. (1999). Spirostanolsaponins of *Allium porrum L.Phytochemistry*,**51**(8):1077–1082.

Castrillo, J.L. and Carrasco, L. 1987. Action of 3-methylquercetin on polio virus RNA replication. *Journal of virology*,**61**(10):3319–3321.

Colli, J.L. and Amling, C.L. (2009). Chemoprevention of prostate cancer: What can be recommended to patients? *Current Urology Reports*,**10**:165-71.

De Ancos, B.; Colina-Coca, C.; Gonzalex-Pena, D. and Sanchez-Moreno, C. (2015). Bioactive compounds from vegetable and fruits by-products. *Biotechnology of bioactive compounds*: 1-36.

de Vries, J.H.M.; Hollman, P.C.H.; Meyboom, S.; Buysman, M.N.C.P.; Zock, P. L.; Van Staveren, W. A. and Katan, M. B. (1998) Plasma concentrations and urinary excretion of the antioxidant flavonols quercetin and kaempferol as biomarkers for dietary intake. *American Journal of Clinical Nutrition*,**68**: 60–65.

El-Demerdash, F.M.; Yousef, M.I. and El-Naga, N.I. (2005). Biochemical study on the hypoglycemic effects of onion and garlic in alloxan-induced diabetic rats. *Food and Chemical Toxicology.* **43**:57–63.

Eldin, I.M.T.; Ahmed, E.M. and Abd, E.H. (2010). Preliminary study of the clinical hypoglycemic effects of *Allium cepa* (red onion) in type 1 and type 2 diabetic patients. *Environmental health insights*,**4:**5540.

El-Ghorab, A.H.; Nauman, M.; Anjum, F.M.; Hussain, S. and Nadeem, M.A. (2010). Comparative study on chemical composition and antioxidant activity of ginger (Zingiberofficinale) and cumin (Cuminumcyminum). *Journal of Agriculture and Food Chemistry*,**58:** 8231–8233

El-Meleigy, M.; Ahmed M.; Arafa, R.; Ebrahim, N. and El-Kholany, E. (2010): Cytotoxicity of four essential oils on some human and bacterial cells. *Journal of Applied Sciences in Environmental Sanitation*, **5**: 143-159.

Englund-Ögge, L.; Brantsæter, A. L.; Sengpiel, V.; Haugen, M.; Birgisdottir, B. E.; Myhre, R., et al. (2014). Maternal dietary patterns and preterm delivery: results from large prospective cohort study. *Bmj*,**348**: g1446.

Fritsch, R.M. (2005). Herkunft, taxonomie und geschichte von Allium. In: Zwiebelanbau, Handbuchfür Praxis und Wissenschaft, pp. 15–37. Pareek, S., Sagar, N.A.,

Fukushima, S.; Takada, N.; Hori, T.; Min, W. and Wanibuchi, H. (1997). Cancer prevention by organo-sulfur compounds from garlic and onion. Journal *of Cellular Biochemistry*, **27:** 100-105.

Gabler, N.K.E.; Ostrowska, R.B.; Jones, M. and M. Jois. (2003). Consumption of brown onion (*Allium cepa*) cultivars reduces the risk factors of cardiovascular

disease. Proc. Australian Postharvest Horticulture Conf., 1–3 Oct. 2003, Brisbane, Australia.

Galluzzo, P.; Martini, C.; Bulzomi, P.; Leone, S.; Bolli, A.; Pallottini, V. and Marino, M. (2009). Quercetin-induced apoptotic cascade in cancer cells: Antioxidant versus estrogen receptor α-dependent mechanisms. *Molecular Nutrition & Food Research*, **53**(6): 699–708.

Gharadaghi, Y.; Shojaee, S.; Khaki, A.; Fathiazad, F.; Khaki, A.F.; Ghdamkheir, E. and Rouhaninia, M. (2012). Antiprotozoal effect of *Allium cepa* on acute renal failure caused by Toxoplasma gondii. *African Journal of Pharmacy and Pharmacology*,**6**(10): 771-777.

Glasser, G.; Graefe, E.U.; Struck, F.; Veit, M. and Gebhardt, R. (2002). Comparison of antioxidative capacities and inhibitory effects on cholesterol biosynthesis of quercetin and potential metabolites. *Phytomedicine*,**9**:33-40.

Goldman, I.L. (1996). Elevated antiplatelet activity induced by extracts from onion umbels. *Horticultural Science*,**31**:874.

Block, E.; Gulati, H.; Putman, D.; Sha, D.; You, N. and Zhao, S.H. (1997). Allium chemistry: synthesis of 1 [alk(en)ylsulfinyl] propyl alk(en)yldisulfides (cepaenes), antithrombotic flavorants from homogenates of onion (Allium cepa). *Journal of Agricultural Food Chemistry*,**45**(11):4414–4422.

González-Pena, D.; Colina-Coca, C.; Char, C.D.; Cano, M.P. and de Ancos, B.A. et al. (2013). Hyaluronidase inhibiting activity and radical scavenging potential of flavonols in processed onion. *Journal of Agricultural and Food Chemistry*,**61(**20): 4862–4872.

Griffiths, G.; Trueman, L.; Crowther, T.; Thomas, B.; and Smith, B. (2002). Onions: a global benefit to health. *Phytotherapy research*,**16**(7): 603-615.

Guo, J.J.; Kuo, C.M.; Chuang, Y.C.; Hong, J.W.; Chou, R.L. and Chen, T.I. The effects of garlic-supplemented diets on antibacterial activity against Streptococcus iniae and on growth in orange-spotted grouper, *Epinepheluscoioides.Aquaculture*,**364**: 33-38

Halbrugge, M.; Friedrich, C.; Eigenthaler, M.; Schanzenbacher, P. and Walter, U. (1990) Stoichiometric and reversible phosphorylation of a 46-kDa protein in human platelets in response to cGMP- and cAMP-elevating vasodilators. *The Journal of Biological Chemistry*,**265**:3088–3093.

Hatono, S.; Jimenez, A. and Wargovich, M. J. (1996). Chemopreventive effect of S-allylcysteine and its relationship to the detoxification enzyme glutathione 1155 S-transferase. *Carcinogenesis,* **17**:1041–1044.

Hayashi, K.; Hayashi, T.; Arisawa, M. and Morita N. (1993). Antiviral agents of plant origin: antiherpetic activity of acacetin. *Antiviral Chemistry and Chemotherapy*, **4**(1):49–53.

Helen, A.; Krishnakumar, K.; Vijayammal, P.L.andAugusti, K.T. (2000).Antioxi dant effect of onion oil (*Alliumcepa.Linn*) on the damages induced by nicotine in rats as compared to alpha-tocopherol. *Toxicology letters*, **116**(1-2):61-8.

Henagan, T.M.; Cefalu, W.T.; Ribnicky, D.M.; Noland, R.C.; Dunville, K.; Campbell, W.W. et al. (2015). In vivo effects of dietary quercetin and quercetin-rich red onion extract on skeletal muscle mitochondria, metabolism, and insulin sensitivity. *Genes & nutrition,***10**(1): 2.

Herman-Antosiewicz, A. and Singh, S.V. (2004). Signal transduction pathways leading to cell cycle arrest and apoptosis induction in cancer cells by Allium vegetable-derived organosulfur compounds: A review. Mutation Research, Fundamental and Molecular Mechanisms of Mutagenesis, **555**(1-2): 121–131.

Hertog, M.G.L.; Hollman, P.C.H. and Putte, B. (1993). Content of potentially anti-carcinogenic flavonoids of tea infusions, wines, and fruit juices. *Journal of Agricultural and Food Chemistry.***41**: 1242 -1246.

Hollman, P.C.H.; Vantrijp, J.M.P. and Buysman, M.N.C.P. (1996): Fluorescence detection of favonols in HPLC by postcolumn chelation with aluminum. *Analytical Chemistry,* **68**: 3511 - 3515.

Hung, H. (2007) Dietary quercetin inhibits proliferation of lung carcinoma cells. *Forum Nutrition,* 60: 146–157.

Islam, M. A.; Shamsuddoha, A.T.M.; Bhuiyan, M.S.I. and Hasanuzzaman, M. 2008. Response of Summer Onion to Potash and its Application Methods. American-Eurasian *Journal of Agronomy*, **1** (1): 10-15.

Jachak, S.M. (2001). Natural products: potential source of COX inhibitors. CRIPS, **2**(1):12–15.

Janssen, K.P.L.T.M.; Mensink, R.P.; Cox, F.J.; Harryvan, J.L.; Hovenier, R.; Hollman, P. C. and Katan, M.B. (1998). Effects of the flavonoids quercetin and apigenin on hemostasis in healthy volunteers: results from an in vitro and a

dietary supplement study. *The American journal of clinical nutrition*, **67**(2): 255-262.

JelodarGholamali, A.; Maleki, M.; Motadayen, M.H. and Sirus, S. (2005). Effect of fenugreek, onion and garlic on blood glucose and histopathology of pancreas of alloxan-induced diabetic rats. *Indian Journal of Medical Science*,**59:** 64-69.

Jenwitheesuk, K.; Surakunprapha, P.; Jenwitheesuk, K.; Kuptarnond, C.; Prathanee, S. and Intanoo, W. (2012). Role of Silicone Derivative Plus Onion Extract Gel in Presternal Hypertrophic Scar Protection: A Prospective Randomized, Double Blinded, Controlled Trial. *International Wound Journal*,**9**: 397-402.

Jung, J.Y.; Lim, Y.; Moon, M.S.; Kim, J. Y. and Kwon, O. (2011). Onion peel extracts ameliorate hyperglycemia and insulin resistance in high fat diet/streptozotocin-induced diabetic rats. *Nutrition & Metabolism*,**8**(1): 18.

Kamal, A.M. and Daoud, J.R. (2002). Effect of onion and/or garlic as feed additives on blood, tissue constituents and growth performance in Muscovey ducks. Veterinary Medical Journal, Cairo University, Egypt.

Khaki, A.; Farzadi, L.; Ahmadi, S.H.; Ghadamkheir, E.; Saedeh, S.S. and Sahizadeh, R. (2011). Recovery of spermatogenesis by *Allium cepa* in Toxoplasma gondii infected rats. *African Journal of Pharmacy and Pharmacology*,**5**(7): 903-907.

Kim, H.P.; Mani, I.; Iversen, L. and Ziboh, V.A. (1998). Effects of naturally-occurring flavonoids and biflavonoids on epidermal cyclooxygenase and lipoxygenase from guinea-pigs. *Prostaglandins Leukotriens and Essential Fatty Acids*,**58**(1):17–24.

Kim, J.W.; Kim, Y.S. and Kyung, K.H. (2004). Inhibitory activity of essential oils of garlic and onion against bacteria and yeasts. *Journal of food protection*,**67**(3): 499-504.

Kim, S.H.; Jo, S.H.; Kwon, Y.I. and Hwang, J.K. (2011). Effects of onion (*Allium cepa* L.) extract administration on intestinal α-glucosidases activities and spikes in postprandial blood glucose levels in SD rats model. *International journal of molecular sciences*,**12**(6): 3757-3769.

Knekt, P.; Kumpulainen, J.; Järvinen, R.; et al. (2002). Flavonoid intake and risk of chronic diseases. *American Journal of Clinical Nutrition*,**76**(3):560–568.

Kobori, M.;, Masumoto, S.;, Akimoto, Y. and Takahashi, Y. (2009). Dietary quercetin alleviates diabetic symptoms and reduces streptozotocin-induced disturbance of hepatic gene expression in mice. *Molecular Nutrition and Food Research*,**53**(7):859–868.

Kopsell, A. and Randle, W. M. (1997). Short-day onion cultivars differ in bulb selenium and sulfur accumulation which can affect bulb pungency. *Euphytica*,**96**(3): 385-390.

Kook, S.; Kim, G.H. and Kiheon, C. (2009). The anti-diabrtic effect of onion and garlic in experimental rts: meta analysis. *Journal of medical food.* **12** (3): 552-560.

Kris-Etherton, P. M.; Hecker, K. D.; Bonanome, A.; Coval, S. M.; Binkoski, A. E.; Hilpert, K. F. et al. (2002). Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. *The American journal of medicine*,**113**(9), 71-88.

Kumari, K. and Augusti, K.T. (1995). Antidiabetic effects of S- methylcysteine sulfoxide on alloxan diabetes. *Planta Medica*,**61**:72–74.

Kumari, K. and Augusti, K.T. (2002). Antidiabetic and antioxidant effects of *S*-methyl cysteine sulfoxide isolated from onions (*Allium cepa* Linn) as compared to standard drugs in alloxan diabetic rats. *Indian Journal of Experimental Biology*, **40**:1005–1009.

Lai, W.W.; Hsu, S.C.; Chueh, F.S.; Chen, Y.Y.; Yang, J.S.; Lin, J.P., et al. (2013). Quercetin inhibits migration and invasion of SAS human oral cancer cells through inhibition of NF-κB and matrix metalloproteinase-2/-9 signaling pathways. *Anticancer Research*, **33**(5): 1941–1950.

Lawson, L.D.; Ransom, D.K. and Hughes, B.G. (1992). Inhibition of whole blood platelet aggregation by compounds in garlic clove extract and commercial garlic products. *Thrombosis Researh*, **65**:141–156.

Ly, T.N.; Hazama, C.; Shimoyamada, M.; Ando, H.; Kato, K. and Yamauchi, R. (2005). Antioxidative compounds from the outer scales of onion. *Journal of Agricultural and Food Chemistry*,**53**(21), 8183-8189.

Majewska-Wierzbicka, M. and Czeczot, H. (2012). Flavonoids in the prevention and treatment of cardiovascular diseases. Polskimerkuriuszlekarski: organ PolskiegoTowarzystwaLekarskiego, **32**(187), 50-54.

Mitra, J.; Shrivastava, S. Á. and Rao, P.S. (2012). Onion dehydration: a review. *Journal of food science and technology,* **49**(3): 267-277.
Mitra, J.; Shrivastava, S. Á. and Rao, P.S. (2012). Onion dehydration: a review. *Journal of food science and technology,* **49**(3): 267-277.
Moon, C.; Jung, Y.; Kim, M.; Lee, S.; Baik, E. and Park, S. (2000) Mechanism for antiplatelet effect of onion: AA release inhibition, thromboxane A2 synthase inhibition and TXA2/PGH2 receptor blockade. *Prostaglandins Leukotriensand Essential Fatty Acids,***62**:277–283.
Moon, C.; Jung, Y.; Kim, M.; Lee, S.; Baik, E. and Park, S. (2000) Mechanism for antiplatelet effect of onion: AA release inhibition, thromboxane A2 synthase inhibition and TXA2/PGH2 receptor blockade. *Prostaglandins Leukotriensand Essential Fatty Acids,***62**:277–283.
Muhlbauer, R.C.; Lozano, A.; Reinli, A. and Wetli, H. (2003). various vegetables, fruits,mushrooms and red wine residues inhibit bone resorption in rats. *Journal of Nutrition,***133**(11): 3592-3597.
Muhlbauer, R.C.; Lozano, A.; Reinli, A. and Wetli, H. (2003). various vegetables, fruits,mushrooms and red wine residues inhibit bone resorption in rats. *Journal of Nutrition,***133**(11): 3592-3597.
Myhre, R.; Brantsæter, A.L.; Myking, S.; Eggesbo, M.; Meltzer, H.M.; Haugen, M. et al. (2013). Intakes of garlic and dried fruits are associated with lower risk of spontaneous preterm delivery. *Journal of Nutrition,* **143**:1100-1108.

Nasri, S.; Anoush, M. and Khatami, N. (2012). Evaluation of analgesic and anti-inflammatory effects of fresh onion juice in experimental animals. *African journal of pharmacy and pharmacology,***6**(23): 1679-1684.

Niukian, K.; Schwartz, J. and Shklar, G. (1987). Effects of onion extract on the development of hamster buccal pouch carcinomas as expressed in tumor burden. *Nutrition and cancer,* **9**:171-176.

Nuutila, A. M.; Puupponen-Pimia, R.; Aarni, M. and Oksman-Caldentey, K. M. (2003). Comparison of antioxidant activities of onion and garlic extracts by inhibition of lipid peroxidation and radical scavenging activity. *Food Chemistry,***81**: 485-493.

Nuutila, A.M.; Kammiovirta, K.; Oskman-Caldentey, K.M. (2002). Comparison of methods for the hydrolysis of flavonoids and phenolic acids from onion and spinach for HPLC analysis. *Food Chemistry,***76**: 519-525.

Ogunmodede, O.S.; Saalu, L.C.; Ogunlade, B.; Akunna, G.G. and Oyewopo, A.O. (2012). An evaluation of the hypoglycemic, antioxidant and hepatoprotective potentials of onion (*Allium cepa* L.) on alloxan-induced diabetic rabbits. *International journal of pharmacology*,**8**(1): 21-29.

Ojieh, A.E.; Adegor, E.C.; Okolo, A.C.; Ewhre, O.L.; Njoku, I.P.; Onyekpe, C.U. (2015). Hypoglycaemic and hypolipidaemic effect of *Allium cepa* in streptozotocin-induced diabetes. *International Journal of Scientific and Engineering Research,* **6**, 23–29.

Ozougwu, J.C. (2011). Anti-diabetic effects of *Allium cepa* (onions) aqueous extracts on alloxan-induced diabetic Rattusnovergicus. *Journal of Medicinal Plants Research*,**5**(7): 1134-1139.

P. Rose.; Whiteman, M.; Moore, P.K. and Zhu, Y. Z. (2005). "Bioactive S-alk(en)yl cysteine sulfoxide metabolites in the genus *Allium*: the chemistry of potential therapeutic agents," Natural Product Reports, vol. 22, no. 3, pp. 351–368.

Paul, S. (2006). Mineral and Trace Elements. Human Nutrition. Eleventh Edition, Elsevier Churchill Livingstone. Netherlands. pp. 231-249.

Perez-Gregorio, R.M.; Garcia-Falcon, M. S. J.; Rodrigues, A.S. and Almeida, D.P.F. (2010). Identification and quantification of flavonoids in traditional cultivars of red and white onions at harvest. *Journal of Food Composition and Analysis*,**23**(6):592–598, 2010.

Prakash, D.; Singh, B.N. and Upadhyay, G. (2007). Antioxidant and free radical scavenging activities of phenols from onion (Allium cepa). *Food Chemistry,* **102**(4): 1389–1393.

Prasanna, V.K. and Venkatesh, Y.P. (2015). Characterization of onion lectin (*Allium cepa* agglutinin) as an immunomodulatory protein inducing Th1- type immune response in vitro. *International Immunopharmacology*,**26**(2): 304–313.

Prior L.R.; Wu X. and Schaich K. (2005): Standard methods for the determination of antioxidant capacity and phenolics in foods and dietary supplements. *Journal of Agricultural and Food Chemistry,***53**: 4290–4302.

Pszczola, D.E. (2002). Antimicrobials: setting up additional hurdles to ensure food safety. *Food Technology*,**56**(6): 99–107.

Ramos, F.A.; Takaishi, Y.; Shirotori, M.; Kawaguchi, Y.; Tsuchiya, K.; Shibata, H. et al. (2006). Antibacterial and antioxidant activities of quercetin oxidation

products from yellow onion (Allium cepa) skin. *Journal of agricultural and food chemistry,***54**(10): 3551-3557.

Ranjitkar, H.D. (2003). A Handbook of Practical Botany. Arun Kumar Ranjitkar: Kathmandu.

Ro, J. Y.; Ryu, J.H.; Park, H.J. and Cho, H.J. (2015). Onion (*Allium cepa* L.) peel extract has anti-platelet effects in rat platelets. *SpringerPlus,***4**(1): 17.

Roberford, M.B. 2007. Inulin-type fructans: functional food ingredients. *Journal of Nutrition,***137**(11):2493S–2502S.

Rose, P.; Whiteman, M.; Moore, P.K. and, Zhu, Y.Z. (2005). Bioactive S-alk(en)yl cysteine sulfoxide metabolites in the genus Allium: the chemistry of potential therapeutic agents. *National Production Report*, **22**:351–368.

Samuel, T.M.; Sakwinska, O.; Makinen, K.; Burdge, G.C.; Godfrey, K.M. and Silva-Zolezzi, I. (2019). Preterm Birth: A Narrative Review of the Current Evidence on Nutritional and Bioactive Solutions for Risk Reduction. *Nutrients,***11**(8): 1811.

Sani, U.M. and Yakubu, Y. (2016). Phytochemical screening and anti-diabetic potential of ethanol extracts of cooked *Allium cepa L.* (onion). *The Pharmaceutical and Chemical Journal,***3**(4): 61-67.

Santas, J.; Almajano, M.P. and Carbo, R. (2010). Antimicrobial and ´ antioxidant activity of crude onion (Allium cepa, L.) extracts. *International Journal of Food Science and Technology,***45**(2): 403–409, 2010.

Sheela, C.G.; Kumud, K. and Augusti, K.T. (1995). Anti-diabetic effects of onion and garlic sulfoxide amino acids in rats. *Planta Medica,***61**(04): 356-357

Slimestad, R.; Fossen, T. and Vagen, I. M. (2007). Onions: a source of unique dietary flavonoids. *Journal of Agricultural and Food Chemistry.*,**55**(25): 10067-10080.

Slimestad, R.; Fossen, T. and Vagen, I.M. (2007). Reviews. Onions: a ˚ source of unique dietary flavonoids. *Journal of Agricultural and Food Chemistry*,**55** (25): 10067–10080.

Srinivasan, K. (2005). Plants food in the management of diabetes mellitus: spices as beneficial antidiabetic food adjuncts. *International Journal of Food Science and Nutrition,***56**:399–414.

Takahama, U. and Hirota, S. (2000). Deglucosidation of quercetin glucosides to the aglycone and formation of antifungal agents by peroxidase-dependent

oxidation of quercetin on browning of onion scales. *Plant and Cell Physiology*,**41**(9): 1021-1029.

Tripathi, V.D. and Rastogi, R.P. (1981). In vitro anti-HIV activity of flavonoids isolated from Garcinia multifolia. *Journal of Scientific and Industrial Research*, **40**:116–121.

Tsuchiya, Y.; Shimizu, M. and Hiyama, Y. (1985). Inhibitory effect of flavonoids on fungal diseases. *Chemical and Pharmaceutical Bulletin*,**33**:3881–3890.

United State Dietary Allowance (USDA). (2008). National Nutrient Database for Standard Reference. Retrieved from https://www.nal.usda.gov/fnic/foodcomp on 27th April, 2020.

Upadhyay, R. K. (2016). Nutraceutical, pharmaceutical and therapeutic uses of *Allium cepa*: A review. *International Journal of Green Pharmacy*, **10**(1): 46-64.

Urios, P.; Grigorova-Borsos, A.M. and Sternberg, M. (2007). Flavonoids inhibit the formation of the cross-linking AGE pentosidine in collagen incubated with glucose, according to their structure. *Eurpean Journal of Nutrition*,**46**:139–146.

Vessal, M.; Hemmati, M. and Vasei, M. (2003). Antidiabetic effects of quercetin in streptozocin-induced diabetic rats. Comparative Biochemistry and Physiology Part C: *Toxicology & Pharmacology*,**135**(3): 357-364.

Vrijsen, R.; Everaert, L.; Van Hoof, L.M.; Vlietinck, A.J.; Berghe, D.V. and Boeye, A. (1987). The poliovirus-induced shut-off of cellular protein synthesis persists in the presence of 3- methylquercetin, a flavonoid which blocks viral protein and RNA synthesis. *Antiviral Research*,**7**(1):35–42.

Wang, H.X. and Ng, T.B. (2004). Isolation allicepin, a novel antifungal peptide from onion (Allium cepa) bulbs. *Journal of Peptide Science*,**10**: 173–177.

Wang, Y.; Tian, W.X. and Ma, X.F. (2012). Inhibitory effects of onion (*Allium cepa* L.) extract on proliferation of cancer cells and adipocytes via inhibiting fatty acid synthase. *Asian PacificJournal of Cancer Prevention*, **13**(11): 5573–5579.

Yang, J.; Meyers, K.J.; Van Der Heide, J. and Liu, R.H. (2004). Varietal differences in phenolic content and antioxidant and antiproliferative activities of onions. *Journal of Agricultural and Food Chemistry*,**52**(22): 6787 6793.

Yu, C.S.; Lai, K.C.; Yang, J.S.; Chiang, J.H.; Lu, C. C.; Wu, C.L. et al. (2010). Quercetin inhibited murine leukemia WEHI-3 cells in vivo and promoted

immune response. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluationof Natural Product Derivatives, **24**(2): 163–168

Yu, K.; Wei, J.; Ma, Q.; Yu, D. and Li, J. (2009). Senescence of aerial parts is impeded by exogenous gibberellic acid in herbaceous perennial Paris polyphylla. *Journal of Plant Physiology,***166**(8):819-830.

Zandi, K.; Teoh, B.T.; Sam, S.S.; Wong, P.F.; Mustafa, M.R. and Abu Bakar, S. (2011). Antiviral activity of four types of bioflavonoid against dengue virus type-2. *Virology Journal*, **8**:560.

Zhou, Y.; Zhuang, W.; Hu, W.; Liu, G.J.; Wu, T.X. and Wu, X.T. (2011). Consumption of large amounts of allium vegetables reduces risk for gastric cancer in a meta-analysis. *Gastroenterology,***141**:80–89.

Zohri, A.N.; Abdel-Gawad, K. and Saber, S. (1995). Antibacterial, antidermatophytic and antitoxigenic activities of onion (*Allium cepa* L.) oil. *Microbiological research,***150**(2): 167-172.