Annual Report 2003-2004

National Research Centre for Onion and Garlic
Rajgurunagar - 410 505, Dist. Pune, Maharashtra

Annual Report 2003-2004

National Research Centre for Onion and Garlic
Indian Council of Agricultural Research
Rajgurunagar - 410 505, Dist. Pune, Maharashtra

NRCOG Annual Report 2003 -2004

Compiled & Edited by
Dr. Anil Khar
Ms. Asha Devi A
Dr. V.S.R. Krishnaprasad

Published
January 2005

Published by
Dr. K. E. Lawande
Director, NRCOG, Rajgurunagar

Address
Rajgurunagar, Dist. Pune, Maharashtra
Phone : (02135) 224056, 222026
Fax : (02135) 224056
Gram : Onionsearch
E-mail : nrcog@vsnl.net
Visit us at http://nrcog.mah.nic.in

Designed & Printed by
Anson Advertising & Marketing, Pune
Phone : (020) 24443244,
Telefax : (020) 24449013
Email : anson@vsnl.com

Executive Summary

Over the last four decades, onion and garlic research was focused mainly on development of high yielding varieties through selection, for meeting domestic demand as well as export. However, more recently, the research priorities have changed. The need of the hour is development of resistant varieties with sustained productivity to augment vertical growth. We also need varieties for different seasons, for export to traditional markets as well as European markets, for processing purpose and those having very good shelf life. Stress should be given to production with less chemical hazards. There is an urgent requirement to check colossal losses in storage and shipment. Making available genuine seed of different varieties is again a major priority. NRC for Onion and Garlic has set research priorities with sharp focus on the above requirements since inception i.e., 1998. In some areas, significant results have been achieved. The details are presented in the report.

In crop improvement, major focus is to develop high yielding varieties / hybrids in red and light red onion suitable for different seasons and resistant to biotic and abiotic stresses. NRCOG-1012 was identified as showing supremacy in yield with moderate resistant reaction against thrips and has good crop canopy. Based on the genetic diversity of the parents, lines have been identified for use in breeding programmes. Among the elite lines, NRCOG-1043, 1044, 1045, 597, 531, 609, 613, 546, 899, 571, 131, 935, 639, 704, 634 and Composite were identified as high yielders. In white onion, varieties suitable for processing and desirable horticultural traits with TSS above 18% have been identified. About 30 bulbs to row progeny gave mean TSS above 16% to 21%. In the project on development of hybrids in onion, 145 hybrids developed by using MS lines are being evaluated. In the case of garlic, development of high yielding genotypes is in progress. The accessions 50, 117 and variety G-41 were found to be stable with respect to marketable yield. In biotechnology, success has been achieved in callus culture and regeneration from seed explant of onion cv. B-780 and in garlic from root tip explant of cv. G-41. Keeping IPR and FR issues in view, the National Research Centre has taken up work on DNA fingerprinting of commercial varieties and elite germplasm possessing value addition attributes. In onion, out of 100 primers tried, 35 primers were found to be polymorphic. New research work was initiated on *in vitro* and *in vivo* screening of onion germplasm for salt tolerance.

In crop production, among different irrigation systems studied in onion, the drip irrigation method produced significantly higher yield than other methods and 27 % saving of water has been achieved in drip irrigation. Intercropping experiments in

sugarcane with vegetables revealed that sugarcane with onion cropping system coupled with drip irrigation is considered to be the best profitable option.

In crop protection, under IPM in onion, cultural control method viz., barrier cropping, blocked thrips up to 80% but caused shading effect. Therefore, refinement of this method was undertaken to avoid shading effect of barrier on onion. Under biocontrol, the feasibility of biological control of onion thrips through predator, *Chrysoperla* and efficacy of some insect pathogens is being evaluated against onion thrips. To minimize the insecticide inputs in onion trials like combined effect of neem and insecticides; management of thrips based on critical growth stages of onion are being conducted. Evaluation of some new insecticides against thrips is also being undertaken and efforts have also been made to understand the biochemical basis for thrips preference at different ages of onion plant. In screening for thrips resistance, lowest rating was observed for variety B-780.

In post harvest studies, assessment of storage losses through various factors is being worked out. The assessment of storage losses in late *kharif* onion revealed that the sprouting and black mould was very low in first four month of storage but it suddenly increases with increase in humidity levels. Use of *Trichoderma* as a pre harvest treatment failed to control rotting in storage. Micronutrient spray of $FeSO_4$ showed better bulb colour retention during storage. In garlic, effect of sulfur fumigation on storage life of garlic revealed no effect on rotting and black mould infection. Gamma irradiation and low temperature storage reduced losses in both onion and garlic. Irradiation treatment decreased sprouting irrespective of variety but rotting and black mould were higher in irradiation treatment after five months storage. The irradiation was found suitable in controlling sprouting at all storage environments.

Evaluation of performance of onion storage structures revealed that among the double row type of onion storage structures, bottom cum top ventilated mud plastered structure was found more efficient as compared to modified bottom ventilated storage structure. Among single row type storage structures, low cost thatched roof structure was found better over bottom ventilated Mangalore tiled storage structure and traditional Mangalore tiled storage structure.

Farm mechanisation was enhanced through the design and the fabrication of a motorized onion grader with higher efficiency and precision than the hand-operated grader, previously developed by the Centre. Performance evaluation test of this machine revealed that it could grade 1.5 to 2.0 tons per hour per person.

Biochemical analysis of domestic garlic lines and Chinese garlic revealed that both purple as well as white domestic garlic was comparatively richer than its Chinese counterpart in most of the constituents tested viz., Phosphorous, Potash, Protein, moisture, dry matter and TSS except Nitrogen. Amongst the various indigenous lines, NRCOG - 55 showed highest Nitrogen, Phosphorous, dry matter and TSS than all other lines. Percentage of moisture was lowest in G-1, whereas, potassium content was significantly higher in Agrifound Parvati. NRCOG- 335 was found significantly superior in protein content than all other tested cultivars of garlic during both the years.

A survey of onion storage structures was conducted in Gujarat and Karnataka. The survey results revealed that in Gujarat 22.54 % onion storage structures are temporary type while 14.0% of the structures are semi-permanent type. Whereas, in Karnataka, 37.14% storage structures were temporary type while 64.29% structures were semi-permanent.

Contents

INTRODUCTION

About the centre

The onion and garlic as vegetable spice form an important constituent diet for large section of Indian population. Besides culinary purpose, these are considered as valuable medicinal items also. Though, India stands second in respect of area in the world, it occupies second and third position in terms of production of onion and garlic, respectively. However, productivity per unit area is much lower as compared to other countries. Over last four decades, research work in onion and garlic has led to the development of many improved varieties. But, hybrids of onion and large cloved garlic are still elusive. Moreover, no standard variety with total resistance to major pests and diseases exists. In order to augur a profit oriented prospect, for onion farmers in terms of productivity, to masses in terms of quality and to exporters in terms of trade, concrete steps towards the goal with a mission mode research is a must. While contemplating these constraints, Indian Council of Agricultural Research sanctioned the National Research Centre for Onion and Garlic during VIII Plan and it was established in the year 1994 with its headquarters at Nasik. Presently, the centre has been shifted to Rajgurunagar, 43 km away from Pune on Pune-Nasik highway and started functioning from June 1998. Since establishment in new place, efforts were being made for developing infrastructure facilities and launching sound research programme for resolving major constraints in production of onion and garlic.

Location and weather

The centre is located at 18.32° N (latitude) and 73.51° E (longitude) at 553.8 mtr. above m.s.l with a temperature range of 5.5 °C - 42.0 °C having annual mean rainfall of 669 mm .

Mandate

- To collect, maintain and act as national repository for onion and garlic germplasm
- To develop hybrids/varieties suitable for domestic as well as export market coupled with resistance to biotic and abiotic stresses.
- To enhance and sustain productivity and quantity of seed as well as bulb crop through agronomic manipulations.
- To develop packages for post harvest handling and value addition.
- To act as clearing house of research and general information relating to onion and garlic.
- To study seed technology of onion
- To act as national trainers training centre for onion and garlic

Infrastructure

The centre has 55 acres research farm with perennial irrigation facilities handed over by CPRI, Shimla. The old structures were renovated and given a new face-lift. The irrigation facilities with modern approaches of micro irrigation have been created. The new administrative-cum-laboratory building have been completed and research laboratories such as horticulture, biotechnology, soil science, plant protection, post harvest technology are set up with need based modern equipments. Modern facilities such as Internet and e-mail connectivity have been created. The library has at present 461 books, 48 regulars journals, CD server, Hort-CD, Agris and Current Contents in CD and other relevant facilities.

Organogram

RESEARCH ACHIEVEMENTS

Crop Improvement

1.0 Development of High Yielding Varieties / Hybrids in Red And Light Red Onion Suitable for Different Seasons and Resistant to Biotic and Abiotic Stresses

1.1 Collection and evaluation of *kharif* onion germplasm

A total of 32 new lines of red, light red, and multiplier onion were collected from Karnataka and Maharashtra. A total of 115 lines dark red onion germplasm, including Arka Kalyan, B-780 were evaluated in three replications in a randomised block design in a plot size of one square meter. Observations were recorded on 13 growth, yield and quality attributes (plant height, No. of leaves, collar thickness, 5 bulb weight, neck thickness, polar diameter, equatorial diameter, weight of 'A' bulbs, weight of 'B' bulbs, weight of 'C' bulbs, TSS, marketable yield and total yield) on 5 competitive plants

Table 1: Performance of top 15 varieties in terms of yield and its related characters in *kharif* 2003

Sr no	Acc no.	MY (t/ha)	Acc No.	TY (t/ha)	Acc. No.	5BW (g)	Acc. No.	TSS (%)	Acc. No.	ED (cm)	Acc. No.	PD (cm)	Acc. No.	NT (cm)	Acc. No.	Earli-ness
1	1012	44.00	1012	44.90	925	0.36	AK	14	914	5.40	1004	4.55	966	0.24	933	96.
2	B-780	43.40	B-780	44.20	1033	0.36	MH-20 LR	13.1	991	5.24	914	4.28	879	0.26	930	96.
3	85	42.50	85	42.50	998	0.35	905	12.93	72 -1-R	5.22	925	4.27	924	0.28	923	98
4	975	39.80	1009	41.00	1032	0.34	991	12.86	1033	5.21	1009	4.26	923	0.29	948	98
5	1000	39.10	975	39.90	985	0.34	915	12.82	915	5.20	954	4.26	958	0.30	927	98
6	938	38.90	1000	39.50	ADR	0.34	1003	12.73	85	5.20	1001	4.22	1036	0.30	914	98
7	893	38.90	72-1-R	39.20	918	0.33	998	12.66	1009	5.19	991	4.21	904	0.30	910	98
8	1009	38.50	893	38.90	973	0.33	914	12.47	ADR	5.16	1033	4.17	696	0.31	971	98
9	N-53	38.20	938	38.90	AK	0.32	B-780	12.46	K-513 -SC	5.12	986	4.16	N-53	0.31	917	99.33
10	939	37.30	K-519 -R	39.60	940	0.32	999	12.46	AK	5.05	988	4.14	888	0.32	955	99.33
11	1001	36.80	N-53	38.50	B-780	0.32	918	12.34	918	5.03	976	4.13	976	0.33	952	99.33
12	985	36.40	985	38.20	K-513 -SC	0.31	995	12.33	B-780	5.02	1000	4.12	1000	0.33	954	99.33
13	980	36.40	950	37.80	975	0.31	121DR	12.33	940	5.00	999	4.12	964	0.33	998	99.33
14	AK	36.30	1001	37.40	1015	0.31	888	12.29	925	4.98	1006	4.08	925	0.34	919	99.33
15	K-519 -R	36.10	939	37.20	952	0.31	889	12.28	917	4.97 -R	K-519	4.06	927	0.34	944	99.33
16	911	35.60	973	37.10	N-53	0.31	1012	12.26	973	4.96	N-53	3.82	52	0.34	N-53	102
17	923	35.20	923	36.70	991	0.31	N-53	10.26	N-53	4.93	B-780	3.98	B-780	0.66	B-780	106
18	ADR	35.10	ADR	35.10	ADR	0.20	ADR	10.13	ADR	5.10	ADR	4.00	ADR	0.36	ADR	100.66
	G.M	**28.23**		**29.38**		**0.27**		**11.24**		**4.70**		**3.73**		**0.42**		

On perusal of results, top 15 germplasm lines performing superior in marketable yield, total yield, 5 bulb weight was selected. The results indicated that, the germplasm lines NRCOG-1012, B-780, NRCOG-85, 975, 1000, 938, 893, 1009, N-53, 985, K-519-R and 923 could be able to find place both in marketable and total yield. However, B-780 found place in all the attributes. The accession NRCOG-925, 1033, 998, 1032 and 985 found superior for 5-bulb weight, whereas NRCOG-966, 879, 924, 923 and 953 recorded minimum thickness. Further it is indicated that the variety B-780 continues to prove to be superior in terms of yield and growth attributes. However, NRCOG-1012 (44.9 t/ha) showed supremacy in yield with moderate resistant reaction against thrips and had good crop canopy, followed by B-780, NRCOG-85, NRCOG-1009 and NRCOG-975.

1.2 Genetic variation, association and diversity pattern in onion germplasm

The PCV was generally higher than all GCV indicates that selection of several of these characters may be effective. The heritability estimates ranged from 28.0-71.0 expected genetic advance as percent of mean varied from 7.85 for polar diameter to 65.05 weight of 'A' grade bulbs. Relatively very low values were recorded for polar diameter, equatorial diameter, TSS, no. of leaves and plant height. The results indicated that total yield had significant positive correlation with weight of 'A' grade and 'B' grade bulbs, and marketable yield and vice versa. Further, it is also noticed that 5 bulbs weight has significant positive association with equatorial diameter and plant height and had high and significant positive association with no. of leaves. A wide genetic base with acceptable level of productivity and high general combining ability to yield superior segregants are essential in the parental selection. Selection of parents in onion has been on the basis of *per se* performance is a good index. The majority of the breeders have restricted their selection to known material and made intensive effort for local adaptation, as a result of which certain gene blocks were rapidly fixed along with correlated response, which in many cases has been in the adverse direction. Keeping it in view, the data collected from the experiment of entire 115 landraces of onion were subjected to multivariate analysis. A total of 6555 D^2 values corresponding to all the 115 possible pairs of entries were computed as per method suggested by Rao (1952). A total of 10 clusters have been formed with no. of landraces in each cluster from 1(cluster X) to 22 (cluster I). The results indicated that cluster IX (28) had maximum number of genotypes followed by cluster I (22), cluster III (18), cluster IV (15). The variety Agrifound Dark Red and NRCOG-1037 fell in separate clusters. A combination of 8 entries of high yielding lines along with B-780 and Behary red fell in cluster VIII. The intra cluster distances ranged from 0.00 (cluster V &X) to 25.41 (cluster II). The inter cluster distance between cluster V and X was maximum followed by V &VIII and I & IV with 2, 9 and 23 germplasm lines respectively. The selection of parents on large phenotypic differences may be useful but there are several instances, where a single gene can provide large-scale differences in plant height, maturity and disease resistance. Therefore measures on genetic criteria, quantifying diversity have become an important tool in classifying the material, commonly used by the breeders.

Table 2: Distribution of 115 landraces of *kharif* onion

Cluster Number	No. of landraces in each cluster	Landraces in each cluster
I	22	NRCOG-048, 993, K-513-5C, 910, 889, 905, 940, 1016, 953, 1033, 918, 995, 915, 988, 999, 991, 998, 1003, Arka Kalyan, 121-DR, MH-20-LR, 981
II	2	NRCOG-696, 879
III	18	NRCOG-064, 966, 946, 956, 954, 924, 1020, 958, 972, 949, 934, 1008, 960, 941, 970, 919, 996, 1021.
IV	15	NRCOG-922, 974, 930, 971, 943, 931, 942, 964, 932, 944, 1010, 1022, 961, 975, 1036
V	1	NRCOG-1037
VI	12	NRCOG-891, 907, 1035, 955, 1019, 906, 950, 893, 945, 938, 939, 1025
VII	8	NRCOG-904, 948, 888, 911, 917,903, 914, 72-1-R
VIII	8	NRCOG-987, 990, 986, Behary Red, 1009, 1012, 085, B-780
IX	28	NRCOG-901, 976, 983, 992, 1015, 1032, 925, 1001, 1004, 1006, 994, 1005, 72-1-DR, 26-OP-DR, 900, K-519-R, 909, 937, 933, 921, 952, 973, 985,923, N-53, 927, 1000, 980
X	1	Agrifound Dark Red

On perusal of results, weight of 'B' grade bulbs and TSS contributed maximum towards divergence followed by marketable yield, plant height, and neck thickness. The cluster mean per plot yield was maximum in cluster IX , followed by cluster VIII, VII, VI. Minimum yield was observed in cluster II. Only five clusters recorded above mean values both in marketable yield and total yield. The divergent lines with high yield potential and some degree of resistance to disease will be identified for formulating sound breeding programme.

Late *Kharif*

1.3 Evaluation of late *kharif* onion germplasm

In order to identify suitable onion lines, a total of 209 germplasm lines of both red and light red colour were evaluated in three replications with a plot size 1 m^2 for yield, growth and quality parameters. Data were recorded on attributes namely plant height, no. of leaves, collar thickness, 5 bulbs weight, neck thickness, polar diameter, equatorial diameter, weight of 'A' , 'B' and 'C' grade bulbs, percent bolters, TSS, marketable yield and total yield. Maximum range was observed for plant height, collar thickness, neck thickness, polar and equatorial diameter, weight of 'A' grade bulbs, TSS, marketable yield and total yield. Higher coefficient of variation was observed for percent bolters, weight of 'A' and 'C' grade bulbs. On perusal of results it is indicated that, 127 superior genotypes in terms of total yield, 98 for marketable yield, 91 for TSS, 109 for neck thickness, 96 for 5 bulbs weight, 94 for more number of leaves and 80 for plant height were identified and are subjected to further evaluation in late *kharif* season of 2004.

1.4 Performance of high yielding germplasm lines

A total of 15 entries i.e. NRCOG-1043, 1044, 1045, Composite, 597, 531, 609, 613, 546, 899, 571, 131, 935, 639, 704, 634 were identified as high yielder and recorded above 45 t/ha and maximum of 62.5 t/ha. The check varieties B-780 and N-53 recorded 62.4 and 39.9 t/ha respectively.

Table 3: Performance of top 15 varieties in terms of yield & its related characters in late *kharif* 2003-04

Sr no	Acc no.	MY (t/ha)	Acc No.	TY (t/ha)	Acc. No.	5BW (g)	Acc. No.	TSS (%)	Acc. No.	ED (cm)	Acc. No.	PD (cm)	Acc. No.	NT (cm)	Acc. No.	Earli-ness
1	1043	62.50	Comp	72.00	1043	0.47	687	16.04	744	5.70	744	5.76	MH-37	0.35	885	106
2	B-780	62.40	B-780	64.90	546	0.44	720	15.56	1043	5.67	1007	4.90	1012	0.39	957	109
3	1044	55.10	1043	64.40	B-780	0.42	623	14.44	967	5.56	614	4.82	892	0.40	923	109
4	1045	51.90	546	64.00	Comp	0.42	M-15	14.41	1007	5.48	995-DR	4.73	LR 1014	0.41	900	109
5	Comp	51.70	1007	60.50	1007	0.42	85	14.33	597	5.44	85	4.72	970	0.41	899	109
6	597	50.90	1044	58.70	597	0.41	609	14.29	Comp	5.40	732	4.72	965	0.42	906	109
7	531	50.80	ALR	58.60	609	0.41	65	14.28	883	5.38	B-780	4.70	922	0.42	996	109
8	609	49.70	980	58.00	744	0.41	660	14.24	914	5.38	Comp	4.68	696	0.42	965	109
9	613	48.50	1045	57.10	612	0.41	1046	14.20	926	5.37	1034	4.68	925	0.42	966	109
10	546	48.00	N-2-4-1	57.00	881	0.41	70	14.12	966	5.34	546	4.66	967	0.43	925	109
11	899	46.50	634	57.00	914	0.41	546	14.10	908	5.34	880	4.66	912	0.43	924	109
12	571	46.50	609	56.40	980	0.41	704	14.10	732	5.34	999	4.64	848	0.43	913	109
13	131	45.90	976	56.10	35	0.41	651	14.08	880	5.33	1043	4.64	655	0.44	956	109
14	935	45.80	531	55.80	732	0.40	208	14.02	N-53	5.31	974	4.62	1006	0.44	898	109
15	639	45.50	881	55.20	880	0.40	N-2-4-1	14.01	893	5.30	651	4.61	966	0.44	995	111.33
16	704	45.30	613	54.20	639	0.40	Comp	13.74	546	5.30	989	4.60	Comp	0.54	Comp	126
17	634	44.90	M-20	54.20	1046	0.40	N-53	11.44	612	5.30	N-53	4.08	N-53	0.53	N-53	113.66
18	N-53	39.90	N-53	51.10	N-53	0.40	B-780	13.05	B-780	5.04	B-780	4.43	B-780	0.58	B-780	124
	G.M.	3.09		4.18		0.35		12.57		4.96		4.23		0.58		

The entries i.e. NRCOG-1043, 1044, 1045, Composite and B-780 recorded higher marketable yield as well as total yield. Further, there is no much difference in total yield and marketable yield in the lines NRCOG 1044, 1045, Composite, 609,613,546. However, some germplasm lines performed well by registering very high in terms of total yield but not marketable yield as in NRCOG-546, 1007, ALR, 98, N-2-4-1, 634, 976, 531, 881and M-20. These results indicates that there is a good scope in improvement of these lines for higher marketable yield. Inspite of the fact that N-53 recorded higher total yield (51.10 t/ha) but it recorded less marketable yield (39.9 t/ha). This yield gap can be reduced by exercising selection pressure in successive generations as this variety is commonly grown by farmers of this region and other parts of the country. High TSS was recorded in two accessions namely; NRCOG-687 (16.04 %) and NRCOG-720 (15.56 %) and these can be used in further breeding programme to increase TSS. Two entries namely MH-37 and NRCOG 1012 recorded minimum neck thickness of 0.35 and 0.39 cm respectively.

1.5 Genetic variation, association and diversity pattern in late *kharif* germplasm

On perusal of results, it is indicated that, high heritability estimates were reported for total yield, marketable yield, TSS, weight of 'A' and 'B' grade bulbs and plant height. However, high heritability coupled with high genetic advance present in the characters i.e. total yield, marketable yield, weight of 'A' and 'B' grade bulbs revealed that selection pressure can be exercised profitably for improvement in these characters so as to increase the genetic potentiality of some of the promising lines. Correlation coefficient between the attributes revealed that wt. of 'A' and 'B' grade bulbs had direct positive significant association with marketable yield and total yield. Similarly marketable yield also had positive and significant association with total yield. The entire data generated from evaluation trial of 209 germplasm lines were subjected to multivariate analysis. A total of 21,736 D^2 values corresponding to all the 209 possible pairs of lines were computed as per the method suggested by Rao (1952). The intra cluster distance was maximum in cluster IV in which maximum number of genotypes (35) were grouped followed by cluster VIII (26). The inter cluster distance was maximum between III and VI (37.22) followed II & VI (34.63) and I & VI (32.29).

Table 4: Cluster means for 14 attributes of 209 landraces of short day onion grown in late *kharif*

Sr no	PH (cm)	NL	CT (cm)	5BW (kg)	NT (cm)	PD (cm)	ED (cm)	Wt. 'A'(kg)	Wt. 'B'(kg)	Wt. 'C'(kg)	Bolters (%)	TSS (%)	MY (kg)	TY (kg)
1.	56.64	9.19	1.36	0.35	0.62	4.20	4.97	1.05	1.74	0.79	0.19	13.65	3.58	4.33
2.	63.79	10.06	1.57	0.38	0.68	4.47	5.06	1.80	1.79	0.61	0.19	13.67	4.21	5.21
3.	65.77	10.36	1.53	0.38	0.64	4.19	5.09	1.85	1.64	0.50	0.28	13.40	4.00	5.07
4.	60.82	9.55	1.43	0.34	0.58	4.15	4.91	0.93	1.03	0.30	0.60	13.32	2.27	3.35
5.	54.53	10.20	1.43	0.34	0.52	4.09	4.68	1.02	0.95	0.42	0.10	13.38	2.40	3.04
6.	59.44	10.14	1.38	0.31	0.65	4.33	4.86	0.77	0.62	0.28	0.10	12.64	1.68	2.24
7.	56.28	8.92	1.25	0.34	0.57	4.29	4.82	1.23	1.55	0.44	0.15	12.26	3.23	3.83
8.	54.55	9.91	1.25	0.34	0.55	4.31	4.92	1.44	1.59	0.36	0.33	11.63	3.40	4.43
9.	54.63	9.73	1.23	0.36	0.59	4.29	4.99	1.88	1.28	0.28	0.47	11.70	3.45	4.68
10.	51.04	8.91	1.19	0.37	0.51	4.23	5.25	1.44	1.53	0.47	0.19	11.57	3.46	4.53
11.	51.84	8.89	1.19	0.34	0.52	4.20	4.93	1.19	1.41	0.33	0.35	12.23	2.93	4.66
12.	51.32	9.26	1.22	0.34	0.50	4.05	4.96	1.09	1.21	0.36	0.25	11.67	2.67	4.44
Mean	56.84	9.60	1.34	0.35	0.58	4.23	4.96	4.96	1.35	0.42	0.27	12.57	3.09	4.18

On perusal of mean data it is revealed that, cluster II recorded maximum total yield and marketable yield followed by cluster III, cluster IX and cluster XI. Thus it is indicated that the entries present in cluster I & II were the high yielders with divergent background and can also be employed in breeding programme for production of F_1 hybrids and as well as transgressive segregants. The results of divergent analysis further strengthened the identification of 15 top performing lines for yield and other attributes. It is revealed that the attribute TSS has contributed maximum towards genetic divergence followed by total yield, weight of 'B' grade bulbs and weight of 'A' grade bulbs. However, the marketable yield contributed to minimum divergence.

1.6 Performance of elite lines for yield and other quality parameters

On perusal of results, it is indicated that, the check variety B-780, showed supremacy in yield followed by Agrifound Dark Red, NRCOG-670, NRCOG-595 and Composite. 11 entries in total yield, 8 in marketable yield, 10 in ten bulb weight, 9 each in 'A' and 'B' grade bulbs, TSS, equatorial diameter, 10 each in polar diameter, collar thickness, neck thickness and 6 each in number of leaves and plant height showed superior performance in respective attributes. Further, it is indicated that, significant yield losses were observed from total yield to marketable yield. It ranged from 15.73 % (B-780) to 112.35 % (N-53) Maximum yield loss was observed in N-53 followed by NRCOG-546 (74.46), N-2-4-1 (59.12), NRCOG-571 (47.0), Agrifound dark red (45.76%) and NRCOG-650 (41.07). Further, it is indicated that there is need for improvement in terms of reducing losses in these varieties, so as to achieve the genetic potentiality of these lines for commercial exploitation.

Rabi

1.7 Performance of 195 lines of *rabi* germplasm for yield and quality

195 lines of *rabi* germplasm were evaluated in 3 replications in RBD. Results revealed that, significant differences were observed among the genotypes tested for all the characters. NRCOG-1096 (35 t/ha) showed supremacy in the total yield followed by 639 (32.1 t/ha), 1099 (30.0 t/ha), Composite (25.0 t/ha) and 870 (24.2 t/ha). For marketable yield NRCOG-639 (31.4 t/ha) showed supremacy in yield followed by 1099 (24.3 t/ha), 870 (21.8 t/ha) and Composite (21.6 t/ha).

Table 5: Performance of top 10 lines in *rabi* 2003-04

		1	2	3	4	5	6	7	8	9	10	GM
TY (Kg)	Acc	1096	639	1099	COMP	870	131	595	1015	651	571	
	Mean	3.50	3.21	3.00	2.50	2.42	2.42	2.40	2.30	2.29	2.29	1.31
MY (Kg)	Acc	639	1099	870	COMP	571	1096	294	711	650	131	
	Mean	3.14	2.43	2.18	2.16	2.14	2.13	2.10	2.10	2.06	2.04	1.08
BW(g)	Acc	COMP	1096	1099	201	732	696	N-2-4-1	205	651	711	
	Mean	56.33	52.00	49.00	48.66	48.33	48.00	47.33	46.00	46.00	45.00	30.95
ED(cm)	Acc	1096	873	N-2-4-1	COMP	1099	1002	696	201	202	179	
	Mean	4.89	4.69	4.64	4.62	4.61	4.54	4.54	4.52	4.52	4.52	3.77
PD (cm)	Acc	1096	COMP	1022	873	571	ALR	1013	1099	131	179	
	Mean	4.49	4.33	4.23	4.22	4.12	4.07	4.04	4.02	4.01	4.01	3.16
DM	Acc	704	899DR	530	893	894	895	896	206	929	951	
	Mean	110.00	115.00	115.00	115.00	115.00	115.00	115.00	115.33	116.33	117.33	126.53
CT (cm)	Acc	906	905	954	530	916	941	923	981	958DR	733	
	Mean	0.71	0.71	0.71	0.71	0.72	0.72	0.72	0.72	0.72	0.73	0.82
NT(cm)	Acc	992	972	981	912	874	900	907	63	908	121-DR	
	Mean	0.19	0.20	0.21	0.21	0.22	0.22	0.23	0.24	0.24	0.24	0.33
TSS (%)	Acc	687	K-519-R	710	N-2-4-1	COMP	ALR	444	613	83	734	
	Mean	15.48	14.64	14.16	13.76	13.66	13.62	13.56	13.46	13.18	13.13	11.45
NL	Acc	976	K-519-R	595	1046	709	1017	1041	1096	1099	988	
	Mean	10.20	9.80	9.60	9.50	9.40	9.40	9.30	9.20	9.20	9.10	7.76
PH (cm)	Acc	1041	COMP	872	Pusa Madhavi	1046	168	DR-Local	1015	Pusa Red	687	
	Mean	49.32	46.58	46.20	45.99	45.51	45.25	44.64	44.58	44.55	44.26	38.26

Wide yield gap between total yield and marketable yield was present in accessions NRCOG-1096 and 1099. Accession NRCOG-704, 899DR, 530, 893, 894, 895, 896, 206 and 929 came to maturity in 110-116 days. Neck thickness was minimum in 10 accessions viz. NRCOG-992, 972, 981, 912, 874, 900, 907, 63, 908 and 121-DR. TSS was high in NRCOG-689 (15.48%) and K-519-R (14.64%). However eight accessions registered TSS between 13 to 14.

1.8 Identification of onion germplasm lines suitable for growing in all the three seasons

44 genotypes have been identified from the germplasm grown in *kharif* (115 lines), late *kharif* (209 lines) and *rabi* (195 lines), which are grown in all the three seasons in order to identify suitable lines with high yield potential grown in all the three seasons. The data was analyzed and results revealed that significant differences were observed for all the characters studied in 44 genotypes. The perusal of results revealed that, outof 15 genotypes, 11 genotypes performed well in both total yield and marketable yield. A wide variation from total yield to marketable yield was observed in the lines NRCOG-906, 910, 958 and 954. Stability analysis of experimental data revealed that, the genotypes NRCOG-888, 910, 922, 944 and 946 are found to be stable in performance with respect to marketable yield, recorded below unit regression coefficient with minimum deviation from regression, indicating their stability in unfavourable environments and suitable for cultivation in all the three seasons.

Table 6: Performance of superior genotypes grown in all the three seasons

Sr. No	Lines	TY (kg)	Lines	MY (kg)	Lines	5 BW (kg)	Lines	ED (cm)	Lines	PD (cm)	Lines	TSS (%)	Lines	NT (cm)	Lines	NL (cm)	Lines	PH (cm)
1	NRCOG-893	3.55	893	3.36	85	0.31	85	5.22	85	4.30	1012	12.42	956	0.40	85	9.83	85	53.87
2	NRCOG- 938	3.27	938	3.16	696	0.29	1012	4.89	995	4.00	85	12.22	941	0.41	906	9.15	1012	53.37
3	NRCOG-944	3.24	911	3.06	1012	0.28	952	4.75	925	3.89	888	12.19	996	0.41	938	9.10	955	50.13
4	NRCOG-901	3.06	950	2.99	940	0.28	888	4.65	952	3.88	905	11.87	946	0.41	955	8.96	905	49.45
5	NRCOG-85	3.05	944	2.91	901	0.27	893	4.64	938	3.87	914	11.84	943	0.41	995	8.80	893	49.03
6	NRCOG-906	3.04	927	2.87	893	0.27	954	4.61	1012	3.86	918	11.74	952	0.41	954	8.77	906	47.76
7	NRCOG-925	3.02	85	2.87	925	0.27	995	4.60	944	3.85	995	11.72	901	0.42	893	8.68	961	47.51
8	NRCOG-950	3.02	923	2.84	952	0.26	925	4.60	888	3.81	996	11.71	893	0.42	901	8.67	995	46.90
9	NRCOG-994	2.98	888	2.83	938	0.26	938	4.58	940	3.75	940	11.65	905	0.42	994	8.66	940	46.78
10	NRCOG-888	2.97	905	2.82	905	0.26	940	4.57	954	3.72	954	11.63	961	0.43	1012	8.60	901	46.77
11	NRCOG-910	2.95	1012	2.82	955	0.26	905	4.52	994	3.72	915	11.63	911	0.43	940	8.55	914	46.62
12	NRCOG-905	2.94	915	2.79	888	0.26	944	4.50	996	3.71	909	11.59	958	0.44	950	8.42	918	46.40
13	NRCOG-915	2.93	952	2.78	950	0.26	996	4.50	958	3.68	969	11.57	955	0.44	961	8.42	907	46.13
14	NRCOG-958	2.92	901	2.77	911	0.25	915	4.49	914	3.67	910	11.56	938	0.44	907	8.37	938	46.08
15	NRCOG-954	2.92	925	2.77	918	0.25	950	4.47	893	3.65	950	11.54	940	0.44	958	8.32	954	46.07
	GM	2.87		2.74		0.25		4.48		3.64		11.41		0.42		8.23		46.01

On perusal of results, it is indicated that, 19 genotypes each in total yield and marketable yield, 14 in 5 bulb weight, 20 in equatorial diameter and 16 in polar diameter, 22 in TSS, 18 in plant height and 20 each in neck thickness and number of leaves showed the regression coefficient less than unity. A genotype is considered to be stable in performance, if it has high mean performance, unit regression coefficient and least deviation from regression. A total of 8 genotypes recorded higher yield >30.0 t/ha of total yield in all the three seasons (NRCOG-85, 893,901,906,925,938 and 950) and 28 genotypes registered >25.0 t/ha for marketable yield for all the three seasons indicating that there is an ample scope to identify stable onion genotypes which could be cultivated for all the seasons. Four germplasm (NRCOG-85, 893, 901 and 944) recorded high total yield, marketable yield and 5-bulb weight with below unit regression coefficient. The germplasm lines NRCOG-906, 925, 938 and 950, even though they recorded high yield, but the regression coefficient is very high for yield attributes. However, these entries registered less than unit regression coefficient for growth attributes such as plant height, number of leaves and neck thickness. Similarly, in case of marketable yield, a total of 8 genotypes (NRCOG-888, 910, 911, 922, 927, 944, 946 and 1012 recorded the bulb yield of >25.0 t/ha with unit regression coefficient. Among all the entries, NRCOG-888, 910, 922, 944, 946, and 1012 registered unit regression coefficient for total yield, marketable yield, 5 bulb weight with minimum deviation from regressions. These entries registered unit regression coefficient coupled with low values of ecovalence indicating that these lines can be successfully cultivated for all the three seasons.

The NRCOG-910 recorded minimum regression coefficient and stable performance with respect to equatorial and polar diameter and TSS. As such the NRCOG-910 can be used in breeding programmes to increase bulb size. In general there is a great demand for onion bulbs possessing globe shape, minimum neck thickness, moderate 5 bulb weight coupled with good TSS. The genotypes NRCOG-888, 901, 905, 911, 930 can be successfully used in breeding programme with an objective to increase polar diameter of the bulb, as these are stable with minimum ecovalence in expression of the attributes and in different cropping season. Further results indicated that the genotypes NRCOG-888 (xi=28.3 t/ha, bi=0.83, s^2di=0.11 and wi=0.20), NRCOG-910 (xi=27.5 t/ha, bi=0.91, S^2di=-0.05 and wi=0.15), NRCOG-922 (xi=27.3 t/ha, bi=0.86, s^2di=0.16 and wi=0.10), NRCOG-944 (xi=29.2 t/ha, bi=0.92, s^2di=0.02 and wi=0.22) and NRCOG-946 (xi=25.9 t/ha, bi=0.93, s^2di=0.36 and wi=0.54) showed superior and stable performance in all the three seasons and as such these lines can be suitable under unfavorable experimental conditions.

1.9 Evaluation of elite lines in *rabi*

11 elite lines along with 5 checks were evaluated in 6 m^2 plots in 3 replications during *rabi* 2003-04. Results revealed that significant differences were observed in the elite lines for the characters total yield, marketable yield, Wt. of 'A' 'B' and 'C' grade bulbs, polar and equatorial diameter, days to maturity, neck thickness and plant height.

On perusal of results, it is indicated that NRCOG-595 (32.2 t/ha) showed supremacy in yield followed by NRCOG-597 (30.9 t/ha), NRCOG-670 (30.5 t/ha), NRCOG-571 (30.0 t/ha), NRCOG-654 (29.7 t/ha) and NRCOG-546 (29.6 t/ha). In case of marketable yield, NRCOG-595 (28.6 t/ha) recorded maximum yield followed by NRCOG-597 (28.3 t/ha), NRCOG-654 (26.9 t/ha) and NRCOG-546 (26.2 t/ha).

Table 7: Performance of elite lines in *rabi* 2003-04

	NRCOG																
Acc. no.	592	671	546	571	651	597	595	670	650	654	Comp osite	ADR	B-780	A. Kalyan	N-53	N-2-4-1	GM
TY (kg)	13.31	13.46	17.80	18.04	15.88	18.61	19.36	18.34	16.14	17.84	9.31	12.62	15.08	14.13	12.66	15.22	15.49
TY (t/ha)	22.1	22.4	29.6	30.0	26.4	30.9	32.2	30.5	26.8	29.7	15.5	21.0	25.1	23.5	21.0	25.35	25.75
MY (kg))	12.25	12.15	15.75	15.46	13.33	17.03	17.18	14.73	14.83	16.91	8.47	10.17	14.68	12.74	11.18	14.05	13.76
MY (t/ha)	20.4	20.2	26.21	25.7	22.2	28.3	28.6	24.5	24.7	26.9	14.1	16.9	24.4	21.2	18.6	23.4	22.89
5BW (kg)	0.20	0.19	0.18	0.18	0.18	0.18	0.18	0.17	0.17	0.20	0.18	0.21	0.21	0.20	0.21	0.20	0.19
'A'BW (kg)	1.33	2.25	3.40	4.26	3.25	3.36	3.26	2.93	4.03	3.13	2.86	0.77	2.85	2.71	1.15	3.2	2.79
'B'BW (kg)	07.03	6.12	8.63	7.68	6.91	9.61	10.55	7.63	7.81	9.03	4.51	5.12	7.32	2.67	6.11	3.70	6.90
'C'BW (kg)	3.88	3.78	3.71	3.51	3.16	4.05	3.36	4.16	2.98	4.09	0.95	4.28	4.63	7.35	3.91	7.15	4.06
ED (cm)	5.04	4.61	4.54	4.56	4.58	4.77	5.19	4.92	4.56	4.49	4.54	3.76	4.20	3.92	4.11	3.98	4.48
PD (cm)	4.66	3.71	3.92	3.88	3.58	4.19	4.54	4.38	3.60	3.58	3.55	3.14	3.50	3.44	3.50	3.25	3.78
DM	124.00	122.00	126.00	126.00	122.00	125.00	126.00	128.00	122.00	124.00	123.00	118.66	118.66	116.00	116.00	116.00	122.10
CT (cm)	0.98	0.82	1.01	0.98	0.90	1.05	1.01	0.93	1.01	1.07	0.93	0.77	0.87	0.91	0.86	1.13	0.95
NT (cm)	0.35	0.46	0.41	0.41	0.52	0.38	0.36	0.32	0.54	0.47	0.56	0.544	0.50	0.50	0.44	0.54	0.45
TSS (%)	11.81	12.66	12.13	13.08	12.49	12.14	12.05	11.88	12.37	12.09	12.17	11.21	11.40	11.07	11.81	11.76	12.01
NL	8.76	8.53	9.23	8.83	8.70	8.93	8.73	8.00	8.73	8.96	8.26	8.36	8.23	8.63	8.03	9.05	8.68
PH (cm)	54.84	49.58	54.52	56.08	55.71	56.37	57.27	55.49	57.68	53.32	55.11	43.74	45.12	48.21	42.40	58.80	52.76

However, weight of 'A' grade bulbs was maximum in NRCOG-571 (4.26 kg) and NRCOG-650 (4.03kg). In spite of the fact that the lines NRCOG-595 and 597 showed supremacy in total and marketable yield, weight of 'A' grade bulbs (3.26 and 3.36 kg) were very less but weight of 'B' grade bulbs was maximum. Hence there is a need for improvement for increasing 'A' grade bulbs in these two elite lines.

All the elite lines showed maturity between 122-128 days whereas checks varieties came to maturity between 116-118 days. Neck thickness is minimum in elite lines compared to check varieties. Similarly TSS is in the range of 12.00-13.00 whereas TSS is 11.00 in check varieties.

2.0 Breeding White Onions for Processing and Desirable Horticultural Traits

Rabi 2002-03

2.1 Evaluation of white onion germplasm during *rabi* 2002-03

343 germplasm collected from various parts of the country were evaluated during *rabi* 02-03. The crop was transplanted on 1.1.03 in three replications (Table 8 & 9).

Table 8: *Rabi* White Onion Germplasm 2002-2003

Characters	Range	Values	No of entries
NT	0.3- 0.87	Below 0.5 cm	152
'A (%)	0.0 80.80	Above 40%	128
D (%)	0.0- 68.09	Below 5% , 0% Share	121 55
Bolt (%)	0.0- 10.52	Below 1% , 0% Share	282 258
Harvest (%)	27.86-100.0	Above 85% Above 90%	332 304
Marketable (%)	28.14-100.0	Above 75%	281
Equ./ Polar ratio	1.04-1.59	Below1.2	49
DM	109- 129	109 days (Earliest maturity)	1
TSS (%)	8.3- 13.55	Sig. Sup Over P. S.	31
MY (t/ha)	3.17- 60.14	Sig. Sup Over P. S	103
TY (t/ha)	8.33- 65.76	Sig. Sup Over P. S	148

Table 9: Top 10 white onion germplasm during *rabi* 02-03 (out of 343 entries)

	TSS %		Mkt bulbs (%)		MY (t/ha)		TY (t/ha)		DM
P-6	13.55	W-002	100.00	W-141	60.14	W-407	65.76	W-227	109.00
W-023	13.50	W-115	100.00	W-078	54.43	W-411	63.50	W-135	110.67
W-052	13.48	W-315	100.00	W-407	53.33	W-141	60.98	W-247	110.67
W-070	13.40	W-439	99.85	W-363	53.12	W-075	59.10	W-254	110.67
W-029	13.30	W-417	99.78	W-003	51.35	W-078	58.45	W-067	111.00
W-074	13.30	W-173	99.54	W-088	50.98	W-421	58.24	W-113	111.00
W-048	13.28	W-199	99.47	W-404	49.38	W-088	57.60	W-117	111.00
W-047	13.20	W-354	99.44	W-421	49.31	W-103	57.05	W-139	111.00
W-295	13.15	W-337	99.26	W-351	49.16	W-003	56.69	W-146	111.00
W-237	13.14	W-361	99.25	W-337	49.13	W-363	56.12	W-176	111.00
W-231	13.10	W-312	99.18	W-077	48.90	W-433	55.28	W-198	111.00
P. Safed	11.2	P. Safed	95.55	P. Safed	28.52	P. Safed	29.69	P. Safed	124.00

Significantly higher marketable yields (60.14 to 35.07 t/ha) were recorded in 103 entries over P. Safed (28.5 t/ha) and 148 entries gave significantly higher total yield (65.76 to 37.02 t/ha) over P. Safed (29.69 t/ha). Marketable and total yield ranged between 3.17 to 60.14 t/ha and 8.33 to 65.76 t/ha, respectively. 18 entries recorded significantly higher TSS (13.55 to 12.72%) over rest of the entries. 31 entries had TSS in the range of 13.55 to 12.25%, significantly higher than P. Safed (11.42%). Early maturity between 109 to 113 days after planting was recorded in 38 entries, while in P. Safed and PKV White matured in 124 DAP and AFW matured in 122 DAP. Marketable yield ranged between 28.14 to 100%. 281 entries had more than 75% marketable bulbs. 121 entries had doubles less than 5% and no doubles in 55 entries.

2.2 Performance of bulb to row progeny for high TSS in white onion during *rabi* 2002-03

More than 100 individual bulbs were selected for high TSS from germplasm and were multiplied separately. The bulb to row progenies of these bulbs were raised during *rabi* and harvested during May 03. These bulbs were kept in storage and TSS of all the bulbs in the progenies were recorded and mean TSS of the progeny was calculated.

The results were quite encouraging. About 30 bulbs to row progeny gave mean TSS above 16% to 20.81%. High TSS bulbs above 17% were selected and planted in massing cages in different groups i.e. the bulbs having 17 to 19% TSS within the progeny were grouped in one massing net and bulbs above 19% TSS were grouped in another cage for further multiplication and selection. One of the line had original TSS of 23% and mean TSS of its progeny from 70 bulbs was 20.81. More than 17% mean TSS was recorded in 20 bulb to row progenies.

Kharif 03-04

2.3 Evaluation of white onion germplasm during *kharif* 2003-04

Overall 335 white onion germplasm lines collected from different parts of M.P., Maharashtra and Gujarat were evaluated during *kharif* season 2003 along with 6 white check varieties viz. Phule Safed, P-6, AFW, Udaipur-102, JNDWO-85 and PKV white. The crop was planted on 22 July 2003 and came to harvest after 91 to 115 days of planting.

Table 10: Performance of white onion entries during *kharif* 2003 for various characters

Characters	Range during 2003	Values	No of entries 2003
A grade bulbs (%)	0.0-59.74	Above 40%	20
D grade bulbs (%)	0.0 57.10	Below 5% , 0% Share	83 13
Marketable (%)	32.82- 97.99	Above 75%	195
DM	91-115	91 days (Earliest maturity)	2
TSS (%)	8.53-13.96	Sig. Sup Over P. S.	254
MY (t/ha)	1.33-42.78	Sig. Sup Over P. S	7

Table 11: Top ten entries of white onion germplasm during *kharif* 03-04 for various characters in descending order out of 332 germplasm

Entries	MY (t/ha)	Entries	TY (t/ha)	Entries	DM	Entries	% pl stand
w-355	42.78	w-355	43.67	w-112	91.00	w-160	96.67
w-366	39.63	w-366	43.59	w-135	91.00	w-286	96.67
w-448	36.12	w-448	42.19	w-113	92.67	w-314	95.67
w-397	35.14	w-174	41.87	w-118	92.67	w-041	94.67
w-302	34.52	w-397	41.76	w-203	92.67	w-393	94.33
w-174	33.94	w-302	41.28	w-212	92.67	w-139	93.67
w-352	33.59	P. Safed	40.99	w-011	93.00	w-229	93.67
w-361	33.55	w-021	39.39	w-179	93.00	w-355	93.33
w-306	33.10	w-030	39.06	w-198	93.67	w-459	93.33
P. Safed	32.89	w-041	38.93	w-185	94.00	P. Safed	93.33
P. Safed	32.89	P. Safed	40.99	P. Safed	109.33	P. Safed	93.33

Neck thickness before harvesting was recorded which ranged between 0.80 to 1.71 cm. 88 entries showed at par and significantly smaller neck thickness ranging between 0.80 to 1.08 cm, whereas, it was 1.48 cm in Phule Safed, 1.33 in Udaipur-102 and 1.19 in AFW. TSS during *kharif* season varied fron 13.96 to 8.53%. 5 entries gave significantly higher and at par TSS than rest of the entries (13.96 to 13.19%). Among varieties, AFW had 13.92% TSS, while Phule Safed had 9.99%. 254 number of germplasm (13.96 to 11.01%) gave significantly higher TSS than P. Safed. Marketable percent were high in 107 entries ranging between 97.99 to 78.22, whereas, in Phule safed, AFW and PKV White it was 80.36, 59.33 and 64.67%, respectively. In case of marketable yield, 2 germplasm viz. w-355 (42.76 t/ha) and w-366 (39.63 t/ha) gave highest at par marketable yield than rest of the entries and checks. 24 entries were at par with Phule Safed (32.89 t/ha). Marketable yield ranged between 42.78 to 1.33 t/ha. 15 entries recorded at par and significantly highest total yield (43.67 to 36.49 t/ha) than rest of the entries including P.Safed (40.99 t/ha) and 20 entries gave at par yield with P. Safed. Days to harvest varied between 91 to 115 days after transplanting. 87 entries were earliest in maturity and ranged between 91 to 99 days after transplanting, while P.Safed took 109 days after planting. Percent plant stand were highest in 75 accessions ranged from 96.67 to 81.33%.

2.4 Evaluation of white onion germplasm during *kharif* season (being evaluated since 2001-04)

50 white onion germplasm including white check Phule Safed, were evaluated during *kharif* 2003 which were also evaluated during *kharif* 2001 & 2002. The crop was planted on 22 July 2003 in a randomised block design with three replications and harvested after 91 to 115 days of planting.

Table 12: Performance of *Kharif* White Onion Germplasm 2003-04 from w-393 to w-445

Characters	Range	Values	No of entries
NT (after harvest)	0.42- 0.81	Below 0.5 cm	2
NT (Before harvest)	0.89- 4.52	Below 1.0 cm	6
A Grade bulbs (%)	0.0 44.54	Above 40%	4
D Grade bulbs (%)	1.83- 55.16	Below 5% , 0% Share	13 0
Marketable bulbs (%)	40.47- 94.65	Above 75%	25
DM	95- 115	95 days (Earliest maturity)	3
TSS (%)	9.99- 13.92	Sig. Sup Over P. S.	41
MY (t/ha)	6.89- 35.14	At par with P. S	4
TY (t/ha)	10.09- 41.76	At par with P. S	4

This year P. Safed gave higher total and marketable yield 40.99 and 22.89 t/ha, respectively. While in previous *kharif* season the marketable yield was 3.20 and 14.56 t/ha and total yield 8.70 and 24.03 t/ha in *kharif* 2001 and 2002, respectively. Accession w-397, w-408, w-411, w-418 and w-404 gave total yield of 41.76 to 32.75 t/ha during 2003. Marketable yield was also high in accession w- 397 (35.14 t/ha). Marketable yield over three years pooled data ranged between 23.95 to 4.31 t/ha. 3 entries w-397, w-404 and w-393 gave higher yield of 23.95 to 17.50 t/ha over P. Safed (16.88 t/ha). Total mean yield over three years was high in w-397, w-408, w-418, w-393, w-404 and w-411 ranged between 31.23 to 24.70 t/ha, whereas, it was 24.57 t/ha in P.Safed. TSS in these germplasm ranged between 11.92 to 9.90%. Variety PKV White recorded highest TSS 11.92%. 8 entries had pooled TSS between 11.03 to 11.92% during 2001 to 2003, while it was 10.68% in P. Safed.

Table 13: Top ten *kharif* white onion germplasm out of 50 entries in descending order (Mean of three years 2001-04)

	MY (t/ha)		TY (t/ha)		TSS %
w-397	23.95	w-397	31.23	PKV white	11.92
w-404	18.37	PKV white	28.95	w-406	11.91
w-393	17.50	w-408	27.22	w-410	11.53
P. Safed	16.88	w-418	27.01	w-427	11.34
w-418	16.78	w-393	25.02	w-411	11.27
w-419	15.43	w-404	24.91	w-425	11.23
w-411	15.28	w-411	24.70	w-409	11.19
w-415	15.04	P. Safed	24.57	w-400	11.05
w-421	14.90	w-421	24.40	w-399	11.03
w-408	14.89	w-419	24.24	w-418	10.90
w-413	14.08	w-415	23.97	w-426	10.90

2.5 Evaluation of white onion elite lines during *kharif* season 2003-04

Nine elite lines were identified from 52 germplasm evaluated for two seasons and planted on 25 July in randomised block design with three replications in a plot size of 6 sq. m. on raised bed along with 4 checks.

Table 14: Performance of white elite lines during *kharif* 2003

Entries	TSS (%)	Entries	Mrk bulbs (%)	Entries	MY (t/ha)	Entries	TY (t/ha)	Entries	DM
AFW	13.96	w-448	82.79	w-397	32.92	w-397	38.36	w-420	112.00
w-420	11.96	w-397	82.23	w-448	30.36	w-448	37.43	Udaipur -102	113.67
w-421	11.90	Udaipur -102	80.59	P. Safed	28.47	P. Safed	34.82	w-404	115.33
PKV White	11.87	P. Safed	80.20	w-404	25.01	w-404	33.14	w-419	115.33
w-397	11.76	w-404	77.93	Mean	23.31	w-411	31.28	w-421	115.33
w-419	11.42	w-420	69.19	w-419	21.13	w-419	28.88	P. Safed	115.33
Udaipur-102	11.33	w-419	67.04	w-411	19.84	w-421	28.59	w-418	117.00
w-408	11.32	w-411	64.47	w-420	18.55	w-408	28.57	w-448	117.00
w-418	11.31	w-421	61.37	Udaipur -102	17.90	w-418	28.38	PKV White	117.00
w-411	11.24	w-408	60.33	w-421	17.88	w-420	27.80	w-408	118.67
w-404	11.21	w-418	58.44	w-408	16.34	PKV White	25.25	AFW	118.67
w-448	10.08	PKV White	53.10	w-418	15.26	Udaipur -102	21.59	w-397	122.00
P. Safed	9.99	AFW	50.87	PKV White	13.56	AFW	14.74	w-411	122.00

Marketable yield was statistically at par in three entries viz. W-397 (32.92 t/ha), w-448 (30 t/ha) and w-404 (25.01 t/ha) with P. Safed (28.47 t/ha). Total yield was also at par in 4 entries viz. W-397 (38.36 t/ha), w-404 (33.14 t/ha), w-448 (37.73 t/ha) and w-411 (31.28 t/ha) with P. Safed (34.82 t/ha). In previous two years i.e. 2001 and 2002 *kharif* season, P. Safed yielded poor marketable yield of 3.20 & 14.56 t/ha and total yield of 8.70 & 24.03 t/ha, respectively. Good yield during this year may be due to less rainfall as compared to previous years. Total yields in varieties PKV White, Udaipur-102 and AFW was 25.25, 21.59 and 14.74 t/ha, respectively. Percentage marketable bulbs were highest in w-448 (82.79%) followed by w-397 (82.23%), whereas, it was 53.10 and 50.87% in PKV White and AFW, respectively. Eight entries had significantly higher TSS (ranging between 11.21 to 11.96%) over P. Safed (9.99%). TSS in AFW was high 13.96%, but yield was very less (7.98 t/ha). Neck thickness (before harvest) was maximum in P. Safed (1.58 cm) whereas, in these lines it varied between 1.19 to 1.44 cm.

2.6 Evaluation of white onion massing lines during *kharif* 2003-04

45 massing lines selected on the basis of one-year yield performance and round shape of bulbs were evaluated during *kharif* season. These were planted in three replications in plot size of 1.05 sq. m.

Table 15: Performance of top 15 white onion selected massing lines during *kharif*

Acc. no.	TY (t/ha)	Acc. no.	MY (t/ha)
w-448	47.27	w-448	40.71
P.Safed	46.52	w-306	38.65
w-314	46.11	W-448 (Sc & cc)	37.26
W-448 (Sc & cc)	44.02	w-174	35.89
w-306	43.08	w-397	35.76
w-174	41.89	w-314	34.94
w-397	41.40	P. Safed	34.76
w-021	40.49	w-009	33.67
w-411	37.84	w-411	32.54
w-017	37.62	w-160	30.27
w-011	36.25	w-168	29.11
w-307	35.86	w-011	28.89
w-021 (pink)	35.79	w-017	28.38
w-009	35.60	w-307	27.55
w-031	35.33	w-319	26.78

8 massing lines showed at par total yield (ranging between 47.27 to 40.49 t/ha) with P. Safed (46.52 t/ha) and 13 lines for marketable yield (40.7 to 27.55 t/ha) with P. Safed (34.76 t/ha). Days to maturity were significantly earlier i.e. less than 103 days after transplanting (upto 97 DAT) in 10 entries over P. Safed, which took 110 for maturity after transplanting. Marketable yield was at par in massing line w-168 (29.11 t/ha) with P. Safed (34.76t/ha), but it was 9 days earlier in maturity than P. Safed.

2.7 Evaluation of white onion germplasm during late *kharif* 2003-04

273 white onion germplasm were evaluated including checks during late *kharif*. Highest total yield of 81.50 t/ha was recorded in w-418, which was significantly superior over Phule Safed (70.17 t/ha) and at par with w-415 (76.94 t/ha) and w-036 (74.02 t/ha), which was followed by w-408 (71.17 t/ha). Total yield above 50 t/ha was recorded in 127 entries. Marketable yield was significantly superior over Phule Safed (45.81 t/ha) in 7 entries. Marketable yield above 40 t/ha was recorded in 71 entries. Percentage marketable yield ranged from 98.81% to 11.24% in the germplasm lines. Though the total yield was highest in w-418, w-415 and w-036 but marketable yield was only 36.94, 28.06 and 36.13 t/ha, respectively. There is lot of scope to exploit yield potential of these germplasm by making thorough selections over generations and the work is in progress.

Days to maturity in the germplasm varied from 108 to 135 days after transplanting. 21 germplasm were 13 to 20 days earlier in maturity with higher marketable/ total yield above 40 and 45 t/ha, respectively. Germplasm w-011, w-393, w-025, w-026, w-245, w-021, w-197, w-433, w-042, w-208, w-008, w-024, w-209, w-039, w-189 and w-434 had total yield more than 50 t/ha with maturity in 118 days or even less than 118 days after planting.

Bolters ranged between 0 to 70.38% in late *kharif*. 61 germplasm recorded no bolters and 4 germplasm had no doubles. Less than 10% doubles were recorded in 49 entries. TSS during late *kharif* varied from 14.74 to 10.66%. 43 germplasm had significantly higher TSS ranging between 14.74 to 12.76 % over Phule Safed (11.86%). Germplasm w-406, w-322 and w-340 had at par and highest TSS (14.74 to 13.85%) over all the entries. TSS above 13% was recorded in 19 germplasm, but total yield above 50 t/ha with TSS above 13% was recorded in 6 entries. Marketable yield (35.24 to 53.61 t/ha) along with TSS (more than 13%) were also high in 6 entries.

Table 16: Performance of white onion germplasm during late *kharif* 2003-04 for various characters

Characters	Range	Values	No of entries
A Grade Bulbs (%)	0.00-81.00	Above 40%	123
D Grade Bulbs (%)	0.00-82.88	Below 10% , 5% Share	49 17
Bolters (%)	0.00-70.38	Below 5% , 0% Share	178 61
DM	108-135	Earliest maturity	12 (108 days)
TSS (%)	10.66-14.74	Sig. Sup Over P. S.	44
MY (t/ha)	5.00-56.55	Yield above 40 (t/ha)	71
TY (t/ha)	20.14-81.50	Yield above 50 (t/ha)	128

2.8 Evaluation of white onion germplasm above w-393 for three years during late *kharif* (2001-04)

49 germplasm were evaluated for three years during late *kharif*. On the basis of mean total yield, more than 10% yield over Phule Safed (52.01 t/ha) was recorded in 6 germplasm viz. w-415, w-418, w-421, w-404, w-419 and w-408 which ranged from 67.32 to 57.35 t/ha. Marketable yield more than 10% over Phule Safed was recorded in 5 lines (w-429, w-417, w-434, w-396 and w-393). Those germplasm lines having high yield potential but less marketable yield can be exploited after selection over generations. And those germplasm have higher marketable yield can be tested in large trials. TSS in w-406 was highest (14.10%) which was followed by w-410 (13.44%) and w-423 (13.40%).

Table 17: Top 10 entries based on mean of three years during late *kharif* 01-04 in entries from Acc. No w-393 to w-445

Lines	MY (t/ha)	Lines	TY (t/ha)	Lines	TSS %
w-429	43.69	w-415	67.32	w-406	14.10
w-417	36.37	w-418	65.91	w-410	13.44
w-434	36.33	w-421	59.34	w-423	13.40
w-396	34.58	w-404	58.50	w-427	13.29
w-393	34.25	w-419	57.70	w-395	13.19
w-422	33.29	w-408	57.35	w-425	12.96
w-440	32.63	w-394	56.99	w-426	12.79
w-435	31.77	w-420	55.21	w-444	12.79
w-432	31.44	w-407	54.56	w-416	12.77
w-439	31.20	w-401	54.04	w-429	12.73
P. Safed	30.44	P. Safed	52.01	P. Safed	11.61

2.9 Evaluation of white elite lines during late *kharif* 2003-04

Nine elite lines were selected on the basis of two years of performance and evaluated in bigger plots along with checks on drip irrigation system. Total yield was significantly higher in w-429 (40.49 t/ha) and marketable yield in two elite lines viz. w-429 (31.92 t/ha) and w-393 26.13 t/ha) over Phule Safed (34.37 t/ha and 20.14 t/ha, respectively). Though the total yield of AFW and PKV White were significantly high but marketable yields were only 18.66 and 10.50 t/ha, respectively. High yielding lines also matured in 128 days after transplanting (DAT) as compared with AFW (131 DAT), Phule Safed (133 DAT) and PKV White (138 DAT). More than 70% marketable bulbs were recorded in 4 lines. Marketable bulbs were quite less in Phule Safed (58.11%), AFW (38.67%) and PKV White (31.37%). Less than 10% bolters were recorded in 6 elite lines. All the varieties recorded more than 25% bolters during late *kharif*. PKV White recorded maximum bolters of 41.16%. Less than 10% doubles were recorded on w-440 and 4-417. Doubles in Phule Safed was 13.701, PKV White 17.73%, AFW 25.17% and Pusa White 28.08%. Significantly high TSS were recorded in two elite lines and two varieties (ranging between 13.77 to 13.32%), but marketable yield of these varieties (PKV White and AFW) were very less as compared with these elite lines.

Table 18: Performance of white elite lines during late *kharif* 2003-04

Lines	D(%)	Lines	Bolters (%)	Lines	MY (t/ha)	Lines	TY (t/ha)
W-440	7.91	W-396	3.01	w-429	31.92	w-429	40.49
W-417	8.43	w-429	3.64	w-393	26.13	AFW	38.20
w-393	11.32	W-417	5.41	W-440	23.46	w-393	36.85
w-429	12.22	W-440	5.89	W-422	21.79	w-418	36.42
P. Safed	13.70	W-422	8.99	W-396	20.87	P. Safed	34.37
w-444	14.16	w-393	9.89	P. Safed	20.14	W-440	33.55
W-422	14.91	w-418	13.67	w-418	19.36	PKV White	33.14
w-413	15.12	w-444	23.55	W-417	18.86	w-413	32.50
W-396	15.84	P. Safed	24.95	AFW	18.66	W-422	32.27
PKV White	17.73	P. White	26.53	w-444	15.30	W-396	30.93
w-418	23.77	AFW	27.31	w-413	12.00	w-444	27.63
AFW	25.17	w-413	28.79	PKV White	10.50	P. White	26.31
P. White	28.08	PKV White	41.16	P. White	9.26	W-417	25.02

2.10 Evaluation of white massing lines and individual bulb to row progeny during late *kharif* 2003-04

Individual bulbs were selected in previous years and progeny were raised and in second year again selected bulbs were planted in massing cages or bulbs were selected from the germplasm on the basis of desirable characters and planted for seed production. Total yield in 18 massing lines ranged from 59.26 t/ha in w-302-5-3-1(LR)-4/M-Kh to 16.83 t/ha in w-334-2/M-LK. Some of the lines were massed in second generation after single bulb selection, thus showed inbreeding depression in some of the lines. Marketable yield ranged from 48.07 t/ha to 8.11 t/ha. Bolters and doubles were quite less in these massing lines as compared with check Phule Safed (7.25 and 15.90%, respectively). Doubles were not recorded in 4 massing lines and no bolters in 5 lines. TSS ranged between 13.83 to 11.59%.

Five single bulbs selected on the basis of shape and size was selfed. The progenies were evaluated and inbreeding depression was observed in first generation. Bulbs will be further selected and massed in next season. Total yield and marketable yield was less than the check Phule Safed. But percentage of marketable yield was quite high i.e. more than 80% than Phule Safed (76.35%) and AFW (74.33%). Similarly percent doubles and bolters were also less in these lines, whereas, percent doubles in Phule Safed and AFW was 15.90 and 25.44%, respectively.

Table 19: Performance of massing lines in white onion during late *kharif* 03-04

Lines	MY (t/ha)	Lines	TY (t/ha)	Lines	DM
W-302-5-3-1-LR-4/M-Kh	48.07	W-302-5-3-1-LR-4/M-Kh	59.26	AFW	114
W-429/M-LK	46.26	W-473/M-LK	57.24	W-429/M-LK	119
P. Safed	43.33	P. Safed	56.81	w-417/M-LK	121
w-417/M-LK	43.33	W-448-2/M-LK	54.76	W-302-SC/M-LK	123
W-448-2/M-LK	42.26	W-429/M-LK	50.43	W-348-1/M-LK	123
W-366-1/M-LK	38.81	w-417/M-LK	50.38	W-422-13/M-LK	124
W-348-3/M-LK	38.61	W-343-3/M-LK	49.38	P. Safed	125
Udaipur-102	37.90	W-302-SC/M-LK	47.43	Udaipur-102	125
W-343-3/M-LK	37.71	Udaipur-102	46.79	W-311-2/M-LK	125
W-350-3/M-LK	37.28	W-348-3/M-LK	45.94	W-334-2/M-LK	125

Table 20: Performance of bulb to row progeny during late *kharif* 03-04

Lines	MY (t/ha)	Lines	TY (t/ha)	Lines	DM
Udaipur-102	37.90	W-429-7/S-LK	43.14	AFW	114
W-311-2-1/S-LK	38.62	Udaipur-102	46.79	W-429-7/S-LK	113
W-362-1-1/S-LK	37.81	W-311-2-1/S-LK	39.48	W-431-14/S-LK	117
W-429-7/S-LK	36.39	W-362-1-1/S-LK	38.05	W-311-2-1/S-LK	121
AFW	27.86	AFW	37.69	Udaipur-102	125
W-431-14/S-LK	25.56	W-417-27/S-LK	37.56	W-362-1-1/S-LK	125
W-417-27/S-LK	25.44	W-431-14/S-LK	27.44	W-417-27/S-LK	128
P. Safed	43.33	P. Safed	56.81	P. Safed	125

White elite lines were selected based on two years performance in all the three seasons for yield and storage, which will be evaluated in large trials.

Table 21: White elite lines based on two years performance during *kharif*, late *kharif* & *rabi* (above germplasm W-393 w-445 evaluated for two years)

Sr. No.	Acc. No.	*Kharif*	Acc. No.	*Rangda*	Acc. No.	*Rabi*
1	w-393	TSS	w-395	s	w-394	s
2	w-397	y	w-396	y	w-398	s
3	w-404	y	w-404	y	w-401	ys
4	w-405	y	w-407	ys	w-402	y
5	w-406	y	w-411	ys	w-404	ys
6	w-408	y	w-415	y	w-405	y
7	w-418	y	w-417	y	w-407	y
8	w-419	y	w-418	y	w-408	ys
9	w-420	y	w-419	ys	w-411	ys
10	w-421	y	w-420	ys	w-415	ys
11			w-421	ys	w-418	y
12			w-422	y	w-419	y
13			w-423	s	w-421	y
14			w-429	y	w-422	s
15			w-432	s	w-432	s
16					w-437	s

3.0 Development of Hybrids in Onion

3.1 Evaluation of onion hybrids during *rabi* 2003-04

Out of 73 crosses we made between inbred lines and MS 48A and 72 crosses with MS65A during May 03 only 48 F1's with MS48A and 32 F1's with MS65A has been planted on 25 December, 03 in replications and being evaluated during *rabi* 03-04 along with 4 checks and all the parents. Heterosis over better parent and percent superiority over check varieties will be worked out. Seeds were produced in exotic hybrids (by forcing) and planted for bulb production for further selection and seeds obtained from the crosses made with Indian varieties were also planted. The trial is in progress.

4.0 Varietal Evaluation Trials at the centre and under AICVIP

4.1 Evaluation of advanced lines during *rabi* 2002-03

Five advanced lines were evaluated during *rabi* along with 7 other varieties. The crop was transplanted on raised bed under drip irrigation system on 4.1.03 in RBD with 3 replication. The plot size was 8 sq. m. per entry per replication.

Table 22: Evaluation of advance lines during *rabi* 2002-03

Lines	TSS (%)	A Bulbs (%)	B Bulbs (%)	C Bulbs (%)	D Bulbs (%)	MY (%)	MY (t/ha)	TY (t/ha)
B-780-5-2-1	10.98	43.86	33.77	20.50	0.40	99.05	32.69	33.12
B-780-5-2-2	10.52	34.73	39.52	21.55	0.29	97.72	31.86	32.24
B-780-5-3-1(Red)	10.69	40.24	42.41	15.11	0.07	99.43	37.35	37.63
B-780-5-3-1(L.Red)	10.87	40.65	36.65	17.50	0.50	99.28	37.57	37.97
ALR (NRCOG)	12.26	38.83	37.14	23.66	0.75	99.25	33.71	34.02
B-780 (SC)	9.97	39.47	34.07	19.96	0.68	99.32	33.82	34.16
B-780	10.36	40.70	38.28	16.76	0.19	99.54	34.85	35.08
N-2-4-1	11.96	31.22	39.89	20.03	1.20	98.40	35.07	35.58
A. Niketan	12.44	33.19	34.30	28.28	2.64	95.77	28.69	30.43
A. Kalyan	12.16	34.31	40.77	22.97	1.25	98.06	33.66	34.45
PKV White	11.32	34.97	31.84	18.25	13.77	85.72	31.82	37.86
P. Safed	10.68	31.89	33.73	18.14	14.67	82.89	29.32	36.29

Marketable yields were significantly higher in B-780-5-3-1 (LR) (37.57 t/ha) and B-780-5-3-1 (R) (37.35 t/ha), over N-2-4-1 (35.07 t/ha). Total yield was highest in B-780-5-3-1 (LR) (37.97 t/ha) followed by PKV White (37.86 t/ha) and B-780-5-3-1 (R) (37.63 t/ha). More than 40% A grade bulbs were recorded in B-780-5-2-1 (43.86 t/ha), B-780 (40.70 t/ha), B-780-5-3-1 (LR) (40.65 t/ha) and B-780-5-3-1 (R) (40.24 t/ha). Percentage A grade bulb was lowest in N-2-4-1 (31.22%). Total soluble solids during *rabi* ranged between 12.44% (A. Niketan) to 9.97% (B-780 (SC)). Comparing these advance lines in three seasons var. B-780-5-3-1 (R) gave highest mean marketable and total yield of 46.17 t/ha and 48.51 t/ha, respectively.

4.2 Evaluation of advanced lines during *kharif* 2003-04

Five advanced lines selected from B-780 were evaluated during *kharif* season 2002 with other varieties to see the performance of selected materials. The crop was planted on 25 July 2002 and harvested after 99 days of planting.

Table 23: Evaluation of advance lines during *kharif* 2003

Varities	TSS (%)	A (%)	B (%)	C (%)	D (%)	Rot (%)	MY (%)	MY (t/ha)	TY (t/ha)	DM
B-780-5-2-1	11.28	40.70	38.18	17.79	0.82	1.37	96.67	37.06	38.35	120.33
B-780-5-2-2	11.67	38.27	37.20	17.49	0.13	5.03	92.96	37.51	40.32	122.00
B-780-5-3-1(Red)	11.12	48.06	36.50	11.91	0.36	2.46	96.46	42.54	44.03	122.00
B-780-5-3-1(L.Red)	12.17	33.78	41.94	18.10	0.78	3.16	93.83	29.20	31.13	122.00
B-780 (SC)	10.79	48.13	35.28	13.30	0.30	1.98	96.71	41.01	42.34	120.33
N-2-4-1 (720)	11.61	36.93	30.68	15.56	6.16	8.27	83.17	21.50	25.97	112.00
B-780	11.01	37.37	39.27	18.79	0.62	2.36	95.44	34.25	35.85	122.00
ADR	10.72	35.39	33.40	15.32	1.57	12.74	84.10	27.08	32.34	113.67
N-53	10.72	48.25	29.07	10.10	1.05	10.13	87.42	34.22	39.34	113.67
A. Niketan	11.77	35.94	38.36	14.22	5.91	2.96	88.52	25.41	28.72	113.67
A. Kalyan	11.92	33.94	37.56	21.18	2.94	1.36	92.67	26.00	28.04	112.00

Marketable and total yield were significantly highest in B-780-5-3-1(Red) 42.54 t/ha and 44.03 t/ha, respectively over check B-780 (34.25 & 35.85 t/ha, respectively), which was followed by B-780 (SC) and B-780-5-2-2. Arka Niketan & N-2-4-1 (720) gave less marketable and total yield. All the advanced lines including B-780 took 120 -122 days after planting except N-2-4-1 (720). Rest of the varieties took 112 to 114 days to harvest. More than 95% marketable yield was recorded in B-780 (SC) (96.71%), B-780-5-2-1 (96.67%) and B780-3-1(R) (96.46%). Marketable yield percentage in varieties A.Niketan, N-53, ADR and N-2-4-1 (720) ranged between 83.17 to 88.52%. Percentage of A grade bulbs were more in N-53 (48.25%), B-780 (SC) (48.13%) and B-780-3-3-1 (Red) (48.06%). Total soluble solids in these varieties ranged between 12.17 in B-780-5-2-1 (L. Red) to 10.72 in N-53.

4.3 Evaluation of advanced lines during late *kharif* 2003-04

Six advanced lines were evaluated during late *kharif* on drip irrigation along with check varieties. B-780-5-2-1 gave highest total yield of 44.85 t/ha which was followed by B-780-5-3-1(R) (43.02 t/ha) and B-780 (42.73 t/ha). All these lines were significantly superior over check variety ALR (27.26 t/ha). Marketable yield was highest in line B-780-5-3-1 (R) (40.21 t/ha) which was followed by B-780-5-2-1 (39t/ha) as compared with ALR (29.83 t/ha), A. Niketan (27.53 t/ha), N-2-4-1 (30.28 t/ha), ADR (24.27 t/ha) and N-53 (22.94 t/ha). Percentage of marketable yield was highest in B-780-5-3-1 (R) (93.51%) followed by B-780-5-2-2 (92.51%), whereas in check varieties it was less than 80%. N-53 recorded lowest marketable percentage of 59.79%. Less than 5% bolters were observed in B-780-5-2-2 (1.65%) and B-780-5-3-1 (R) (3.14%) whereas, in varieties it was maximum up to 24.63% in N-53 followed by ALR (16.86%) and A. Niketan (14.98%). There were no doubles in B-780 (SC), B-780-5-3-1 (LR) and B-780-5-3-1 (R) whereas, it was less than 0.5% in B-780 selections. In varieties, bolters ranged from 3.61 in A. Kalyan to 11.70% in N-53. TSS ranged between 13.79% in A. Niketan to 11.84% in N-53.

Table 24: Evaluation of advanced lines during late *kharif*

Lines	TSS (%)	A (%)	B (%)	C (%)	D (%)	Bolt (%)	MY (%)	MY (t/ha)	TY (t/ha)	DM
A. Kalyan	13.15	23.78	38.38	14.57	3.61	12.96	76.73	19.85	28.40	138
A.Niketan	13.79	34.64	21.34	7.41	7.03	14.98	63.40	27.53	41.13	138
ADR	11.93	44.89	19.74	6.44	8.86	11.81	71.07	24.27	41.93	128
ALR	13.04	29.78	22.65	15.40	9.15	16.86	67.83	29.83	37.26	136
B-780	12.55	46.83	28.71	11.66	0.26	7.96	87.20	37.28	42.73	133
B-780 SC	12.90	50.63	22.81	13.88	0.00	6.37	87.32	34.21	39.11	136
B-780-5-2-1	12.88	46.46	28.31	12.08	0.21	6.67	86.85	39.00	44.85	133
B-780-5-2-2	12.50	47.13	30.01	15.38	0.35	1.65	92.51	33.08	35.64	131
B-780-5-3-1 LR	13.07	23.85	49.46	14.89	0.00	7.04	88.19	35.50	40.27	133
B-780-5-3-1 RED	12.61	42.05	36.84	14.62	0.00	3.14	93.51	40.21	43.02	131
N-2-4-1	13.21	41.31	27.18	6.44	6.03	11.97	74.93	30.28	40.46	138
N-2-4-1 (720)	12.59	39.75	23.78	15.68	6.55	5.40	79.21	24.33	30.62	138
N-53	11.84	39.15	13.04	7.59	11.70	24.63	59.79	22.94	38.04	128

4.4 Evaluation of varieties during *rabi* 2002- 03

Ten varieties were evaluated during *rabi* season. The crop was transplanted on 3 January in flat bed of 6 sq. m. size in randomised block design replicated thrice.

Table 25: Evaluation of varieties during *rabi* 2002-03

Varieties	TSS (%)	A (%)	B (%)	C (%)	D (%)	MY (%)	MY (t/ha)	TY (t/ha)
ADR	11.05	24.80	48.02	18.18	7.15	90.99	31.22	34.27
ALR	11.85	39.99	36.99	19.92	1.31	96.90	36.44	37.54
A.Niketan	11.95	34.51	43.39	20.46	0.42	98.36	36.44	37.03
A.Kalyan	12.35	22.15	52.66	22.83	0.97	97.64	33.56	34.38
N-2-4-1	11.96	31.42	48.08	18.59	1.66	98.09	37.00	37.76
B-780	10.90	40.65	36.94	19.40	0.18	96.99	33.08	34.13
P. Safed	11.42	26.17	45.89	21.87	4.41	93.93	32.96	35.08
AFW	12.06	20.79	27.69	17.39	33.51	65.86	21.68	32.93
PKV White	11.32	32.31	36.06	14.13	16.10	82.50	33.92	41.17

Variety N-2-4-1 gave highest marketable yield (37 t/ha). Seven varieties were significantly superior (ranging between 37 to 32.96 t/ha) over ADR (31.22 t/ha) and AFW (21.68 t/ha) for marketable yield. PKV White gave highest total yield of 41.17 t/ha followed by N-2-4-1 (37.76 t/ha), ALR (37.54 t/ha) and A. Niketan (37.03 t/ha). All the varieties were statistically at par compared with N-2-4-1 except AFW for total yield. Percentage of marketable bulbs ranged between 98.36 to 65.86%. AFW and PKV White had less marketable bulbs (65.86 and 82.50%, respectively). Percent doubles were high in AFW (33.51%) and PKV White (16.10%). Rest of the varieties had less than 5% doubles except ADR (7.15%). Total soluble solids in these varieties ranged between 12.35 to 10.90%.

4.5 Evaluation of varieties during *kharif* 2003-04

Performance of 12 varieties was studied during *kharif* season. The crop was transplanted on 25 July in randomised block design in plot size of 6 sq. m. on raised bed under drip irrigation system with 3 replication.

Table 26: Evaluation of varieties during *kharif* 2003-04

Varieties	TSS (%)	A (%)	B (%)	C (%)	D (%)	MY (%)	MY (t/ha)	TY (t/ha)
B-780	11.01	37.37	39.27	18.79	0.62	95.44	34.25	35.85
ADR	10.72	35.39	33.40	15.32	1.57	84.10	27.08	32.34
ALR	12.35	23.85	33.04	21.50	4.72	78.40	17.26	21.97
N-2-4-1	11.89	28.03	32.82	25.65	3.92	86.50	18.57	21.42
N-53	10.72	48.25	29.07	10.10	1.05	87.42	34.22	39.34
A. Niketan	11.77	35.94	38.36	14.22	5.91	88.52	25.41	28.72
A. Kalyan	11.92	33.94	37.56	21.18	2.94	92.67	26.00	28.04
Udaipur-102	11.33	28.41	30.04	22.14	5.80	80.59	15.73	19.36
PKV White	11.87	18.23	24.20	10.66	34.44	53.10	12.72	24.28
AFW	13.96	13.87	16.78	20.22	13.07	50.87	6.71	13.23
P. Safed	9.99	35.23	33.86	11.11	11.60	80.20	26.91	33.82
P. Suwarna	11.85	32.85	31.45	15.51	4.08	79.81	20.53	25.80

Total yield and marketable yield were high in B-780 and N-53. Marketable yield ranged between 34.25 t/ha (B-780) to 6.71 t/ha (AFW). Marketable yield was statistically at par and significantly superior over rest of the varieties in B-780 (34.25 t/ha) and N-53 (34.22 t/ha). Percentage marketable bulbs were above 90 per cent in B-780 (95.44%) and A. Kalyan (92.67%). Less than 5% doubles were recorded in 5 varieties. Percentage doubles was lowest 0.62% in variety B-780 followed by 1.05% in N-53. Total soluble solids in these varieties ranged between 13.96 to 9.99.

4.6 Evaluation of varieties during late *kharif* 2003-04

15 varieties were evaluated during late *kharif* season on drip irrigation during 03-04. Total yield was statistically at par in 10 varieties ranging from 42.73t/ha in B-780 to 37.26 t/ha in ALR. Marketable yield was significantly high in B-780 (37.28 t/ha) over all the varieties. It was followed by N-2-4-1 (30.28 t/ha) and ALR (29.83 t/ha). Marketable percentage in B-780 was also significantly higher (87.20%) than the rest of the varieties. Percent marketable bulbs ranged from 87.20 to 31.37% in these varieties. Per cent bolters during late *kharif* ranged from 7.96 (B-780) to 48.27% (A. Bindu OP). Percent bolters were statistically at par in 7 varieties i.e. 7.96% in B-780 to 14.98% in A. Niketan. Percent doubles in these varieties ranged from 0.29 (B-780) to 28.08 (PKV White). Percent bolters were quite less in 5 varieties. TSS in these varieties ranged from 14.13 to 11.84%.

Table 27: Evaluation of varieties during late *kharif* 2003-04

Varieties	A (%)	B (%)	C (%)	D (%)	Bolt (%)	MY (%)	MY (t/ha)	TY (t/ha)	DM
A. Bindu (OP)	12.3	11.0	8.2	19.9	48.2	31.6	8.5	27.98	133
A.Kalyan	23.7	38.3	14.5	3.6	12.9	76.7	19.8	28.4	138
A.Niketan	34.6	21.3	7.4	7.0	14.9	63.4	27.5	41.1	138
ADR	44.8	19.7	6.4	8.8	11.8	71.0	24.2	41.9	128
AFW	15.0	15.2	8.3	25.1	27.3	38.6	18.6	38.2	131
ALR	29.7	22.6	15.4	9.1	16.8	67.8	29.8	37.2	136
B-780	46.8	28.7	11.6	0.2	7.9	87.2	37.2	42.7	133
JNDWO-85	36.6	23.0	9.6	15.9	11.1	69.3	28.7	41.3	136
N-2-4-1	41.3	27.1	6.4	6.0	11.9	74.9	30.2	40.4	138
N-53	39.1	13.0	7.5	11.7	24.6	59.7	22.9	38.0	128
P. Suwarna	21.0	33.6	14.1	8.1	18.3	68.7	17.4	25.6	128
P. White	8.8	18.0	10.4	28.0	26.5	37.2	9.2	26.3	138
P. Safed	26.0	23.7	8.3	13.7	24.9	58.1	20.1	34.3	133
PKV White	13.3	12.3	5.6	17.7	41.1	31.3	10.5	33.1	138
Udaipur-102	31.8	25.2	12.0	7.4	8.1	69.1	27.1	38.9	133

4.7 Evaluation of onion & garlic varieties under AICVIP during *rabi* 2003-04.

Onion

Out of seven entries received under AICVIP varietal evaluation trial in onion, 4 entries were in IET i.e. B-780-5-3-1, B-780-5-2-2, RHR-O-S-1 and RO-59 and 3 entries viz. HOS-1, HOS-2 and L-28 were received for AVT-I, were planted along with check A. Niketan and ALR on 26 December 04 and the trial is in progress.

Garlic

In garlic six varieties were received for IET and 3 varieties for AVT-I along with 4 checks. The cloves were planted on 18 October 03. The experiment is in progress.

5.0 Collection, Characterisation, Evaluation and Maintenance of Garlic (*Allium sativum L.*) Germplasm

5.1 Evaluation of garlic germplasm

During *rabi* 2003-04, a total of 110 lines of white garlic germplasm were planted along with the commercially released varieties viz., G-1, G-41, GG-2 and GG-3. The experiment was laid out in randomised block design in three replications in a plot size of 1m x 1m. Observations on important and desirable horticultural traits will be taken.

5.2 Evaluation of elite lines of garlic germplasm

During rabi season 2003-04, a total of 11 elite lines along with four check varieties are being evaluated for yield and yield related attributes. The experiment was laid out in randomised block design in three replications in a plot size of 3m x 2m. Observations on important and desirable horticultural traits will be taken.

5.3 Evaluation of purple coloured garlic germplasm

Garlic germplasm was divided on the basis of bulb colour. A total of 108 lines of purple garlic germplasm are being evaluated along with the commercially released varieties and one purple check variety Godavari. The experiment is in progress.

5.4 Genotype x Environment interaction in garlic

A total of 38 lines planted in 2000-01, 2001-02 and 2002-03 were analyzed for stability in their marketable yield. It was found that Acc. 50, 117 and variety G-41 were stable as is evident from their mean value greater than average population mean, non-significant S^2di and bi nearer to one.

Table 28: Stability analysis in elite lines of garlic

Acc.	Env. 1	Env. 2	Env. 3	Mean	S^2di	βi
50	13.1	11.7	8.93	11.24	1.72	0.87
117	13	10.1	7.64	10.25	0.64	1.24
G - 41	16.9	12.5	13.75	14.36	0.93	1.01

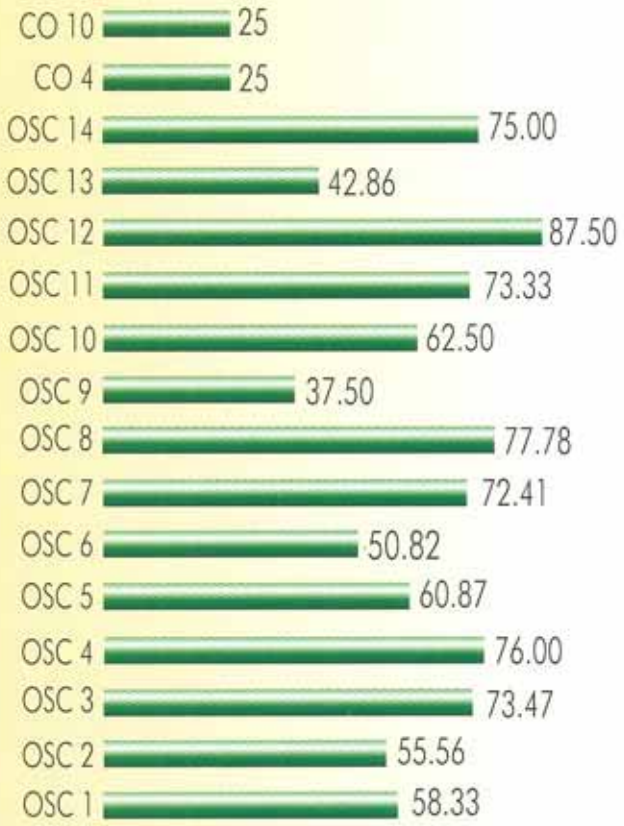
5.5 Evaluation of bulb to row garlic germplasm

Progenies having bulb weight more than 20-25 g/bulb were again selected from previous bulb to row germplasm and evaluated for identifying superior genotypes. The experiment was laid out in single replication in an augmented block design along with checks G-41, G-1, G-50 and Godavari.

6.0 Creation of Variability in Garlic through Mutation

Lethal dose for various mutagens (viz. EMS, Colchicine and Sodium Azide at 6 hours and 12 hours of treatment at different concentrations) were recorded in previous season and bulbs were multiplied in M2 generation for further evaluation. 600 individual bulb to row progenies were planted during October 03-04 and observations are in progress.

7.0 Use of Biotechnological Approaches for Onion and Garlic Improvement



Percent response for callus formation in onion seed explant

7.1 Standardization of protocol in onion for indirect organogenesis and shoot multiplication

Work was initiated to study the callus formation in seed and shoot tip explant of onion. MS medium was used as the basal media. Different concentrations of auxins alone and in combination with cytokinins were used for callus initiation. It was found that medium OSC 12 gave good callus formation from seed explant of onion. Callus regeneration was observed when callus initiated in OSC 1 medium was transferred onto regeneration medium OR3. Callus derived in OSC 2 also gave good regeneration in the same regeneration medium, but this was associated with more root formation. OSC 5 and OSC 6 derived callus showed regeneration upon transfer to regeneration medium OR 6.

In multiple shoot induction studies from shoot tips of onion, preliminary observation showed that kinetin and BA alone leads to multiple shoot formation. But the results obtained were not very efficient for multiple shoot induction. The rate of recovery of multiple shoots was low.

Callus formation from seed explant in onion

Callus formation from shoot tip explant in onion

7.2 Standardization of protocol in garlic for indirect organogenesis

An experiment was initiated to study the callus induction and later plant regeneration in garlic var. G-41. Root segments from the *in vitro* grown plants were used as the experiment material. Effect of auxins alone and in combination with cytokinins were studied for callus induction. It was found that 2,4-D at lower concentrations and picloram at higher concentrations were suitable for efficient callus formation from the root tips. Callus was obtained from the apical portions only from 2,4-D treatment whereas, picloram led to callus formation throughout the root segment except the non apical portion. Callus regeneration was observed in BA containing medium. The protocol, thus developed, will pave way for the development of a suitable and cultivar independent regeneration system in garlic, which in turn will aid for creation of variability through somaclonal variations and genetic transformation studies in Indian garlic.

7.3 DNA fingerprinting in onion and garlic varieties

Work on DNA fingerprinting on onion and garlic through RAPD has been initiated. In onion, out of 100 primers, 35 primers previously found to be polymorphic are being checked again to validate their reproducibility, whereas, in garlic DNA isolation of commercial cultivars has been completed. Now work on genotyping of commercial cultivars of onion and garlic has been initiated.

7.4 Salinity tolerance studies in onion through *in vitro* shoot tip culture

A project has been formulated for *in vitro* and *in vivo* screening of onion genotypes with the following objectives:

- Standardization of critical dose (CD_{50}) for salinity under *in vitro* conditions for onion genotypes
- Selection for salinity tolerance in onion genotypes under *in vitro* (direct as well as indirect organogenesis) and *in vivo* conditions
- DNA fingerprinting (RAPD) of the selected salt tolerant and sensitive onion lines

Observations on bulb diameter, shoot length, root length, number of roots, fresh root and shoot weight and number of roots have been recorded in variety B-780. In addition to this, biochemical properties viz., Na and K concentration and proline content will also be evaluated in control versus stressed plants.

CROP PRODUCTION

8.0 Onion Based Cropping System

The crop sequence has a considerable effect on crop yield, soil fertility and occurrence of diseases and pests etc. In recent years soil fertility-fertilizer use research is focused on cropping sequences. Fertilizer recommendations are made for cropping sequence as a whole taking into account the yield of preceeding crop and their residual effect. Studies on sequential cropping of well-delineated agro ecological zone would help for optimization of nutrient inputs, thereby, minimizing the external inputs. However, the available information on these aspects of onion is very less. Thus a long-term trial was started in 2000 to find out the best cropping sequence for onion under western Maharashtra conditions. Among the various sequences evaluated, during summer season, the yields obtained in groundnut and cucumber crops during summer season were 0.57 t/ha and 14.0 t/ha respectively, which was lower than the previous years. During *kharif* season, the yield of potato, marigold and aster was lower than the previous years while bajra gave higher yield than last year. This may be due to the effect of low rainfall and higher temperature (Table 29). The yield of onion cv. B-780 during late *kharif* season was very good in both the cropping sequences. In groundnut-onion sequence the yield was 48.46 t/ha while in cucumber-onion combination it was 43.11 t/ha despite reducing 30% nitrogen application. The yield of onion in *rabi* season was lower as compared to last season as the crop was severely affected by diseases and mites and the yield ranged between 22 to 27 t/ha in all 8 sequences. There was no difference in yield and size of onion bulbs among the various sequences evaluated. Further studies on the uptake of plant and soil nutrients and its correlation with yield and yield contributing characters are also in progress.

Table 29: Yield of various crops in summer 03, *kharif* 03 and late *kharif* 03-04

Cropping Sequences	Summer (Feb-May) 03		*Kharif* (June-Sept.) 03		Late *kharif*	
	Crops	Yield (t/ha)	Crops	Yield (t/ha)	Crops	Yield (t/ha)
S1	-		Aster	0.93lakhs bundles	-	-
S2	-		Marigold	4.7	-	-
S3	-		Potato	6.67	-	-
S4	-		Potato	6.53	-	-
S5	-		Groundnut	1.23	-	-
S6	-		Soybean	1.89	-	-
S7	-		Bajra	3.03	-	-
S8	-		Bajra	3.29	-	-
S9	-		Onion	20.44	-	-
S10	Groundnut	0.57	-	-	Onion	48.46
S11	Cucumber	14.0	-	-	Onion	43.19
S12	-		Onion	21.28	-	-

9.0 Irrigation studies in onion and garlic

Different irrigation systems viz. drip, sprinkler, rain gun and surface were used to test their efficacy in onion during *rabi* season 2002-03.The results revealed that the drip irrigation method produced significantly higher yield than other methods. The lowest yield was recorded in rain gun system of irrigation, which seems to be the effect of uneven distribution of water as there was more zoning in this system (Table 30).

Table 30: Effect of different methods of irrigation on growth and yield of onion cv. N-2-4-1

Treatments	TY (t/ha)	MY (t/ha)	Net-planted area (%)
T1-Surface irrigation	36.75	33.47	64
T2-Drip irrigation 100 %PE	45.62	42.15	72
T3-Sprinkler irrigation 100 %PE	40.15	36.18	72
T4-Rain gun irrigation 100 %PE	20.53	19.68	96

9.1 Fertigation trial in onion and garlic (AICRP-VC TRIAL)

The fertigation trial in onion and garlic was started in the year 2002 with the objective of maximizing fertilizer use efficiency. The data reveals that bulb yield of onion in T1, T2, T3 and T8 was statistically similar during *rabi* 02-03. The reduction in fertilizer dose by 30 and 40% significantly reduces bulb yield. As far as the marketable yield is concerned, all treatments except T7 were higher than control (T8). The percentage of 'A' grade bulbs was more in all soluble fertilizer treatments than control T8 and T7.The percentage of double bulbs was very high in T8 (Control) as compared to other treatments (Table 31). There was no impact of fertigation treatments on total soluble solids and bulb diameter. As far as the water saving is concerned, there was around 27 % saving of water in drip irrigation treatments over surface irrigation.

Table 31: Effect of soluble fertilizers on growth and yield of onion cv N-2-4-1

Treatments	Yield (t/ha)	A grade (%)	B grade (%)	C grade (%)
T1-100% NPK as WS through drip	35.16	60.57	21.33	9.75
T2- 90% NPK as WS through drip	35.25	55.21	25.76	10.11
T3- 80% NPK as WS through drip	35.74	63.20	22.27	8.03
T4- 70% NPK as WS through drip	31.67	54.09	28.37	11.7
T5- 60% NPK as WS through drip	32.42	57.69	25.99	11.7
T6- NPK 150:50:50 Kg/ha +50 kg N in 7 splits drip	33.85	55.26	23.80	7.24
T7- NPK150:50:50 Kg/ha as basal and 50 kg N in 2 splits	25.75	47.46	31.28	17.63
T8- Surface irrigation-150:50:50Kg/ha NPK as basal and 50 kg N in 2 splits	36.68	43.62	26.60	4.95

The yield of garlic during 02-03 was highest in T1 and T8. The reduction in fertilizer dose significantly reduces the bulb yield. The percentage of 'A' grade bulbs was higher in T1 than T8 but all other treatments were lower than control (T8)(Table32). As far as water saving is concerned, there was around 17.13 % saving of water in drip irrigation over surface irrigation.

Table 32: Effect of soluble fertilizers on growth and yield of garlic cv. G-41.

Treatments	Yield (t/ha)	A grade (%)	B grade (%)	C grade (%)
T1-100% NPK as WS through drip	9.57	50.07	37.11	10.61
T2- 90% NPK as WS through drip	7.69	38.89	42.69	16.69
T3- 80% NPK as WS through drip	7.31	39.86	39.37	19.76
T4- 70% NPK as WS through drip	7.29	40.04	39.96	20.52
T5- 60% NPK as WS through drip	7.36	39.96	39.44	20.30
T6- NPK 50:50:50 kg/ha +50 kg N in 7 splits through drip	8.54	41.11	32.27	21.26
T7- NPK 50:50:50 kg/ha as basal and 50 kg N in 2 splits	7.88	37.41	36.57	20.79
T8- Surface irrigation-50: 50:50 kg/ha NPK as basal and 50 kg N in 2 splits	9.02	43.21	37.46	19.33

9.2 Intercropping of onion and garlic in sugarcane with modern irrigation systems

The concept of intercropping in sugarcane with vegetables is gaining popularity among the farmers to get additional income in initial months and to maximize the use of all available resources. The crops like onion and garlic are very much suited to intercropping in sugarcane (Nov.-Dec planting). Since these crops are shallow rooted bulb crops having low canopy, they do not compete with deep-rooted long duration crop like sugarcane. The emphasis is now being given on the paired row planting of sugarcane for better cane thickness and sugar recovery. Further the use of micro irrigation particularly drip irrigation is now becoming essential to save water and increase the water use efficiency. These factors provide opportunities for intercropping of short duration vegetable crops in sugarcane during initial months. The marketable yield of onion and garlic was higher in pair row planting with drip and sprinkler irrigation than ridges and furrow method. Although the total yield was higher in ridges and furrow method but due to more percentage of bolters and doubles the marketable yield was less. Onion has performed well in all treatments except ridges and furrows where the doubles were very high. The marketable yield of potato and cabbage was much higher in sprinkler and ridge and furrow planting method (Table 33). Sugarcane yield was higher in drip and sprinkler irrigation despite less number of plants. The number of cane per hills and cane thickness was more in pair row planting method (Table 34). There was 28% water saving in pair row with surface than ridges and furrows, while paired row planting, drip irrigation recorded 44 per cent water saving than ridges and furrows (Table 35). Paired row planting of sugarcane with drip or sprinkler and onion as intercrop appeared to be most economically profitable combinations. These combinations recorded 276 t/ha yield of sugarcane and 34 t/ha yield of onion in drip and 279 t/ha yield of sugarcane and37.7 t /ha of onion in sprinkler.

Table 33: Marketable yield of intercrops (t/ha)

Treatments	Intercrops			
	Onion	Garlic	Potato	Cabbage
Drip irrigation with paired row planting	34.4	5.1	16.2	43.5
Sprinkler irrigation with paired row planting	37.7	5.1	20.5	45.0
Surface irrigation with paired row planting	29.1	3.9	12.7	32.3
Surface irrigation with ridges & furrow planting	22.5	3.0	13.0	44.1

Table 34: Yield of sugarcane

Treatments	Yield (t/ha)	No. of milleable canes/ha(In lakhs)
Drip irrigation with paired row planting	276	1.79
Sprinkler irrigation with paired row planting	279	1.77
Surface irrigation with paired row planting	209	1.76
Surface irrigation with ridges & furrow planting	210	1.84

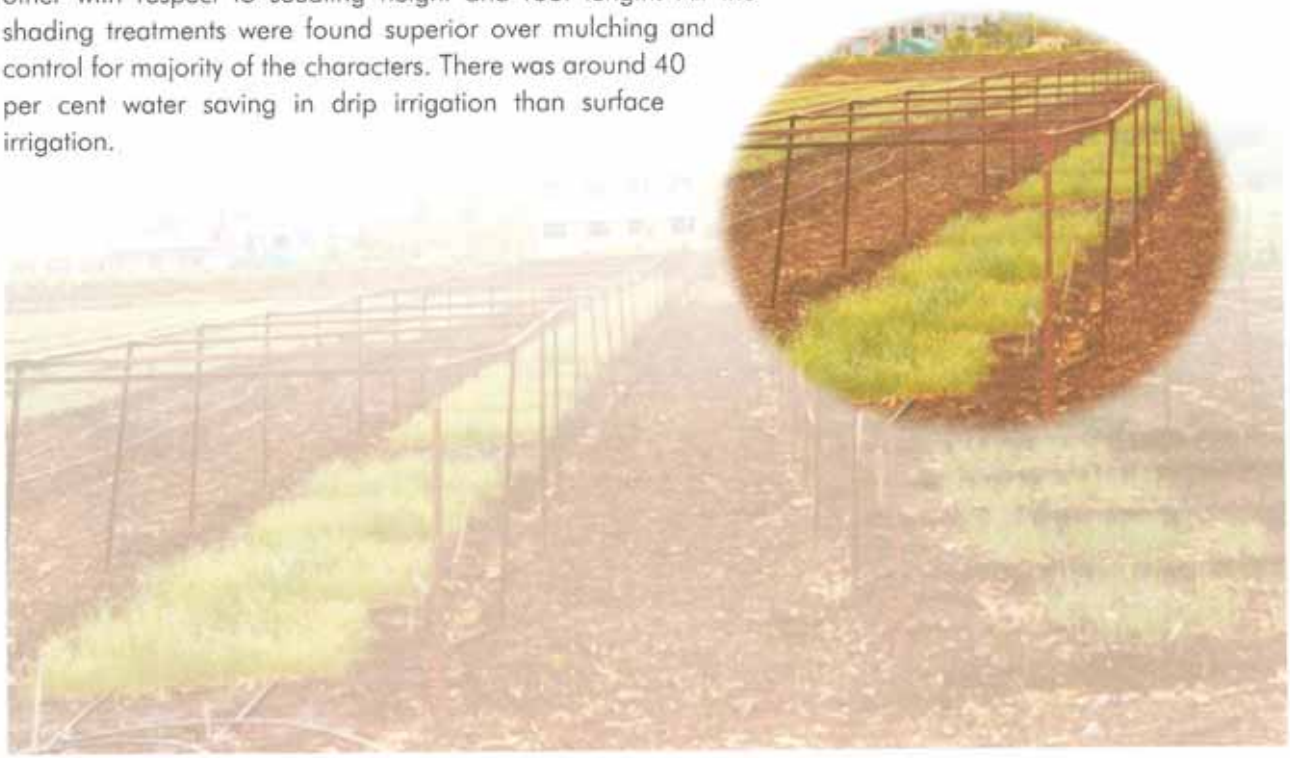
Table 35: Water requirement of sugarcane along with intercrops

Treatments	Amount of Water applied (ha cm)	% Water Saving over ridge & furrow method
Drip irrigation with paired row planting	137	44
Sprinkler irrigation with paired row planting	156	28
Surface irrigation with paired row planting	157	28
Surface irrigation with ridges & furrow planting	200	-

10.0 Production Technology for *Kharif* Onion

10.1 Effect of shading on nursery production in *kharif*

Different shading material i.e. Agro shade net 50%, 75%, Hessian cloth and mulching were tried for nursery production during summer under two methods of irrigation i.e. surface and drip. The days to germinate, final stand (%), seedling height, number and length of roots were significantly higher in drip irrigation. Among the various shading treatments, hessian cloth shading was found better than other with respect to seedling height and root length. All the shading treatments were found superior over mulching and control for majority of the characters. There was around 40 per cent water saving in drip irrigation than surface irrigation.



10.2 Effect of date and method of planting on yield of *kharif* onion

Among the four dates of planting i.e. June 1, June 15, July 1, and July 15, the second and fourth dates produced higher yield than first and third dates. Among the methods of planting, flat beds and BBF with drip irrigation produced higher yield as compared to other method of planting (Table 36).

Table 36: Effect of date and method of planting on yield of *kharif* onion cv. B-780

Date of Planting	Total marketable yield (t/ha)				
	Flatbed	Raised bed	R & F	BBF	Av.
01.06.03	28.63	26.18	29.53	29.33	28.41
15.06.03	33.26	28.25	26.42	32.84	29.44
01.07.03	32.84	22.32	27.84	31.79	28.70
15.07.03	33.69	24.85	34.21	33.63	31.60
Average	32.11	25.40	29.50	31.89	-

10.3 Effect of variety and method of planting

Two varieties of onion i.e. Baswant-780 and N-53 were planted under four method of planting during *kharif* season 2003.Onion cv. Baswant-780 was found statistically superior to N-53 with respect to plant height, number of leaves, plant stand (%), total yield and percentage of A and B grade bulbs. Among the planting methods, BBF was found better than others for plant height, number of leaves, plant stand (%), total yield and percentage A and B grade bulbs. The percentage of rotted bulbs was lower in BBF method (Table 37)

Table 37: Effect of variety and method of planting on yield of *kharif* onion cv. B-780

Date of Planting	Total marketable yield (t/ha)		
	B-780	N-53	Av.
Flat bed	33.70	24.64	29.17
Raised bed	26.11	24.25	25.18
Ridges & Furrow	34.21	27.03	30.62
BBF	33.66	31.73	32.69
Average	31.92	26.91	-

10.4 Effect of direct seeding on growth and yield of onion

Onion seed was directly sown in the field either manually or with different type of seed drills during *kharif* season 2003. The plant height was higher in transplanted crop but total yield, marketable yield, percentage A&B, grade bulbs were higher in direct sown crops. Among various seed sowing methods, manual sowing and Pune seed drill produced higher yield (Table38).

Table 38: Effect of direct sowing in onion in *kharif* onion

Treatments	Marketable yield (t/ha)
Transplanted	24.32
Manual sowing	34.34
Single row seed drill (wind rock planter)	30.93
Pune seed drill (without vermi compost mixing	34.56
Pune seed drill (with vermi compost mixing	30.28

10.5 Effect of lihocin

The foliar application of 2500 ppm lihocin was done at 45,60,75 and 90days after planting individually or in combination during *kharif* 2003. There was no beneficial effect of this chemical on yield of onion. But the percentage of A grade bulbs was higher in some treatments but that was not statistically significant. The late application and repeated application even reduce the bulb size. During late *kharif* season 03-04, the application of 2500 ppm lihocin at 75 and 90 days significantly increased the yield of onion. The percentage of A grade bulbs was higher in these treatments. But there was no effect on percent doubles and bolters. The application of lihocin also failed to increase neck fall in onion (Table 39).

Table 39: Effect of lihocin on growth and yield of *kharif* onion cv. Baswant-780

Treatments	*Kharif* MY (t/ha)	Late *kharif* MY (t/ha)
Control	40.06	54.89
2500ppm lihocin spray at 45 days of transplanting	42.85	55.70
2500ppm lihocin spray at 60 days of transplanting	42.02	53.92
2500ppm lihocin spray at 75 days of transplanting	42.77	58.17
2500ppm lihocin spray at 90 days of transplanting	43.45	59.37
2500ppm lihocin spray at 45 & 60 days of transplanting	41.11	54.93
2500ppm lihocin spray at 45, 60, 75 days of transplanting	40.15	52.72
2500ppm lihocin spray at 45, 60, 75, 90 days of transplanting	39.73	53.44

10.6 Effect of curing

The various treatments were tried for curing of *kharif* onion. The results reveals that highest PLW was recorded in no curing treatments while lower losses were recorded in pit curing (soori method). There was no effect of these treatments on rotting and sprouting per cent.

11.0 Production Technology for Onion during Late *Kharif*

11.1 Effect of trimming of seedlings before transplanting on yield of onion during late *kharif* 2003-04

Effect of trimming the seedling in variety B-780 from same day of planting to seven days before planting was studied along with seedling planted without trimming. The initial results showed that total and marketable yield were highest in the seedlings planted without trimming (65.6 and 62.7 t/ha, respectively). It was significantly at par with the treatments where the seedlings were trimmed two days before planting (62.6 and 59.6 t/ha, respectively) as compared with the seedlings trimmed at same day of planting (55.2 and 53.1 t/ha, respectively). Per cent plant stand increased up to the seedlings trimmed one day before planting (99.2%) and later it reduced gradually up to the seedlings trimmed 7 days before planting.

Table 40: Effect of trimming of seedlings before transplanting on yield of onion

Treatments	MY (t/ha)	TY (t/ ha)	Plant stand (%)	MY (%)
T-1(7 Days trimming before planting)	51.6	53.6	91.4	96.1
T-2(6 Days trimming before planting)	54.6	56.8	92.1	96.2
T-3(5 Days trimming before planting)	50.5	52.0	95.0	97.2
T-4(4 Days trimming before planting)	41.4	43.3	95.0	95.5
T-5(3 Days trimming before planting)	53.5	54.6	95.7	97.9
T-6(2 Days trimming before planting)	59.6	62.6	97.8	95.1
T-7(1 Day trimming before planting)	50.8	52.6	99.2	96.5
T-8(same Day trimming before planting)	53.4	55.5	96.4	96.2
T-9(without trimming before planting)	62.7	65.6	95.7	95.6

11.2 Effect of days to uprooting the seedlings before planting on yield during late *kharif* 2003-04

Seedlings of B-780 were uprooted from 7 days before planting up to the same day of planting at regular intervals to see the establishment and yield of onion, which will help in maintenance of germplasm or for long distance transport. This experiment will give information on how long we can keep the uprooted seedlings under normal conditions and their effect on the yield. It was observed that seedling uprooted on the same day of planting gave highest total yield of 62.65 t/ha. As the duration of uprooting the seedlings increases there is decrease in the yield. From statistical analysis it was revealed that there was no significant difference on yield from the seedlings uprooted on the same day of planting to seedling uprooted before 3 days of planting. Yield was drastically reduced after uprooting the seedlings 5 days before planting. Plant stand was also high in seedling uprooted one day before (99.29%) or on the same day of planting (95%).

Table 41: Effect of days to uprooting the seedlings before planting on yield

Treatments	MY (t/ha)	TY (t/ ha)	Plant stand (%)	MY (%)
T-1(7 Days trimming before planting)	51.60	53.60	91.40	96.10
T-10 (7 Days uprooting before planting)	36.43	37.26	67.14	97.94
T-11 (6 Days uprooting before planting)	38.33	41.60	68.57	92.00
T-12 (5 Days uprooting before planting)	46.55	47.57	82.14	97.86
T-13 (4 Days uprooting before planting)	51.43	53.76	85.71	95.73
T-14 (3 Days uprooting before planting)	57.98	58.93	82.14	98.36
T-15 (2 Days uprooting before planting)	58.81	61.48	90.00	95.66
T-16 (1 Day uprooting before planting)	58.88	60.43	99.29	97.44
T-17 (Uprooting on same day before planting)	60.48	62.64	95.00	96.45

12.0 Organic Cultivation Trial In Onion And Garlic

A new trial on organic cultivation of onion and garlic have been started in 2003. There were four preceeding crops i.e. mung bean, french bean, pearl millet and soybean in *kharif* season. There were three manures i.e. poultry manures, FYM and their combinations and one recommended fertilizer treatment in each crop sequence. Onion was planted in late *kharif* season under drip irrigation system. The preceeding crops were sown in *kharif* season in the organic cultivation trial in onion. The mung bean and cowpea crops were severely damaged by the pest and diseases with the results of poor yield. The yield of French bean crop was also low. But the yield of soybean was good (Table 42).

Table 42: Yield of preceeding crops during *kharif* season

Treatments	*Kharif* season	
	Crops	Yield (t/ha)
C1	Mungbean	9.9
C2	French bean	49.2
C3	Cowpea	0.0
C4	Soybean	258.7

During late *kharif* season, onion cv. Baswant-780 was planted in two crop sequences. There was no effect of preceeding crops i.e. green gram and French bean on growth and yield of onion but there was significant difference in various fertilizer treatments. The highest yield (28.26 t/ha) was recorded in recommended dose of NPK and plant protection measures. This was almost double of all other treatments. Among the organic manures highest yield (16.93 t/ha) was recorded in Poultry manure followed by Farmyard manure and poultry manure combination. The lowest yield was recorded in Farmyard manure application. Similar trends were observed for percent A grade bulbs, percent B grade bulbs and bulb size (Table 43).

Table 43: Effect of preceeding crops and fertilizers on yield of late *kharif* onion cv. B-780

Treatments	TY (t/ha)			Total MY (t/ha)		
	Mung bean	French bean	Av.	Mung bean	French bean	Av.
FYM(20t/ha)	10.20	10.07	10.14	9.88	7.57	8.73
Poultry manure (10t/ha)	17.15	16.7	16.93	16.93	14.00	15.18
FYM(10t/ha)+PM(5t/ha)	12.94	14.57	13.75	12.41	11.78	12.10
Rec. NPK	22.99	23.52	28.26	19.87	21.12	20.50
Average	15.82	16.22		14.63	13.62	

In garlic, the preceeding crops were sown in *kharif* season in the organic cultivation trial in garlic. The mung bean and cowpea crops were severely damaged by the diseases and insects. This resulted in very poor or no yield of these crops. The yield of french bean crop was also low. But the yield of soybean crop was good (Table 44).

In *rabi* season, garlic cv. G-41 was planted in all four-crop sequences. In contrary to onion there was significant difference in preceeding crops with respect to growth and yield of garlic. The highest yield was recorded in Green bean followed by cowpea. The percent A and B grade bulbs and bulb size were higher in Mung bean sequence. Among the fertilizer treatments highest yield was recorded in recommended dose of NPK and plant protection measures. The percent A and B grade bulbs were also higher in this treatment .In general the yield of garlic was low in all treatments (Table 45).

Table 44: Yield of preceeding crops during *kharif* season

Treatments	*Kharif* season	
	Crops	Yield (t/ha)
C1	Mungbean	9.7
C2	French bean	32.7
C3	Cowpea	0.0
C4	Soybean	251.3

Table 45: Effect of preceeding crop and fertilizers on yield of garlic cv. G-41

Treatments	Yield (t/ha)				
	Mung bean	French	Cowpea	Soybean	Av.
FYM (20t/ha)	5.76	3.42	3.42	4.49	4.27
Poultry manure (10t/ha)	5.76	3.66	4.94	3.57	4.48
FYM(10t/ha) + PM (5t/ha)	3.60	2.57	4.09	3.22	3.37
Rec. NPK	5.65	4.59	5.26	4.69	5.12

13.0 Garlic Based Cropping Sequence

A new project on garlic based cropping sequence was started in 2003 with the objectives of identifying and establishing garlic based economically feasible cropping sequence and to study the effect of garlic rotation on aflatoxins in ground nut. The results showed that there was no significant difference in yield of garlic in different crop sequences during summer season. The yield level of garlic was lower in all the treatments due to higher infection of diseases during Dec-Feb. There was difference in percentage A, B, C grade bulbs in different crop sequences.

14.0 Influence of Seed Pelleting and Planting Methods in Onion Production (AICRP-VC Trial)

Various seed pelleting materials such as DAP, Borax, $ZnSO_4$, Bavistin, *Azospirillum*, *Trichoderma*, micronutrient mixture, karanj leaf and kernal powder mixed with gum acacia were used for seed pelleting. The well dried pelleted seeds were sown in raised and flat beds during *kharif* season 03.The results reveals that there as no effect of these treatment on bulb yield .The seeds sown on raised beds gave significantly higher yield than flat beds. The percent A grade bulbs were also higher in raised beds. (Table 46)

Table 46: Influence of seed pelleting and planting methods on growth and yield of onion during *kharif* season

Treatments	MY (t/ha)		
	Flat Bed	Raised Bed	Av.
DAP (30g /kg of seed)	31.2	22.8	27.0
Borax (0.1 g / kg of seed)	35.0	26.3	30.7
$ZnSO_4$ (0.3 g/ kg of seed),	38.3	31.8	35.0
Bavistin (3 g/ kg of seed)	37.3	31.9	34.6
DAP + Borax+ Bavistin,	35.9	31.8	33.9
DAP + ZnSo4 + Bavistin,	38.0	32.0	35.0
Azospirillum (100g kg of seed)	35.0	29.9	32.4
Trichoderma viride (4g / kg of seed)	34.5	31.1	32.8
Commercial micronutrient mixture (20g/kg of seed)	32.8	27.7	30.2
Karanj Leaf Powder (500 g / kg of seed)	34.0	29.7	31.9
Karanj Seed Kernel Powder (500g / kg seed),	37.1	31.8	34.5
Control	37.9	34.4	36.2
Average	35.6	30.1	32.8

15.0 Development of Integrated Nutrient Management Module in Onion and Garlic

15.1 Evaluation of onion varieties for nutrient uptake in *kharif* season

A field trial was conducted to evaluate the onion varieties for the nutrient uptake studies during *kharif* 2003. The results of five best performing varieties out of 11 are as follows:

Stage 1:- 40 Day after transplanting:

The growth of onion at 40 days is vigorous, having crossed juvenile stage the seedlings establish into soil. And at 40 days, bulb initiation and development also begins. To know what is the nutrient content in the plants, it becomes essential to work out the demand of different varieties. Whole plant samples (5/variety/replication) were collected for the analysis of nutrient concentrations on dry weight basis. Among the 5 varieties, the content of nutrients at 40 day growth stage w.r.t nitrogen, phosphorus and potassium followed the descending order: N-53> ADR> B-780>Udaipur> Agrifound dark red. The performance of above varieties reflects that they must be best suited for *kharif* season.

Table 47: Nutrient composition in whole plant sample at 40 DAT in onion varieties

Variety	N (g/100g)	P (g/100g)	K (g/100g)
Arka Kalyan	1.8	0.24	2.25
N-53	2.4	0.38	2.55
B-780	2.2	0.39	1.85
Udaipur-102	2.1	0.41	2.39
Agrifound Dark Red	2.3	0.32	1.78

Stage 2:- 65 Day after transplanting:

Most of the annual crops show maximum metabolic activity at 60 days of its growth. At this stage the foliage development is at its peak. Hence the concentration of N, P and K was determined in tops and bulbs separately. Data presented in table 2 shows the percentage content of N, P and K in tops and bulb at 65 days of growth for 5 onion varieties. It was seen that greater quantity of nutrient was present in dry matter of bulbs than in tops. This indicated assimilation of nutrient in the sink (bulb) from source (leaves/tops) has begun. Also at this stage maximum bulb development might have taken. It was noticed that highest nutrient content was found in Udaipur, B-780, and N-53 varieties than others at this stage.

Table 48: Nutrient composition in leaf and bulb samples at 65 DAT in onion varieties

Variety	Leaf dry matter			Bulb dry matter		
	N (g/100g)	P (g/100g)	K (g/100g)	N (g/100g)	P (g/100g)	K (g/100g)
Arka Kalyan	1.02	0.09	1.39	1.41	0.55	0.89
N-53	1.15	0.16	1.17	2.08	0.60	1.12
B-780	1.17	0.14	1.00	1.93	0.56	1.36
Udaipur-102	1.26	0.18	1.62	2.54	0.54	1.52
Agrifound Dark Red	0.99	0.09	1.78	1.80	0.56	1.54

Stage 3:- 90 Day after transplanting:

Most of the short day onions attain maturity at 90 days of growth. Maximum photosynthates might have translocated to sink. Hence this stage was preferred to determine the nutrient concentration in both the tops and the bulb dry matter. It was seen that concentration of nutrients was quite higher in bulbs than tops (Table 3). The pattern of greater concentration amongst the 5 varieties followed the following descending order: B-780> N-53> ADR. This order was worked out based on dry matter weight of sample size of 5 plants per variety.

Table 49: Nutrient compositions in leaf and bulb samples at 90 DAT in onion varieties

Variety	Leaf dry matter			Bulb dry matter		
	N (g/100g)	P (g/100g)	K (g/100g)	N (g/100g)	P (g/100g)	K (g/100g)
Arka Kalyan	0.83	0.09	0.38	1.63	0.58	1.13
N-53	1.16	0.12	0.79	1.71	0.64	1.48
B-780	0.75	0.11	0.98	1.76	0.59	1.23
Udaipur-102	0.78	0.12	1.58	1.45	0.53	1.57
Agrifound Dark Red	0.90	0.11	0.81	1.70	0.63	1.67

Stage 4:- 115 Day after transplanting:

After 110 days the onion crop passes the stage of full maturity and the phenomenon of neck fall is observed. Each variety was harvested to record the total bulb yield. Random bulbs (5 numbers) were collected per variety for chemical analysis and recording dry matter yield. On the basis of dry matter, nutrient concentration in bulbs and total bulb yield, the uptake value for N, P and K was worked out for 5 onion varieties (Table 4). The results showed that varieties producing maximum yield had removed maximum nutrients from soil. The demand for NPK is more in case of N-53 than other varieties grown during *kharif* season.

Table 50: Nutrient compositions and uptake in plants samples at 115 DAT (harvest) of onion varieties

Variety	Plant Sample			Bulb Yield (t/ha)	Uptake (kg/ha)		
	N (g/100g)	P (g/100g)	K (g/100g)		N	P	K
Arka Kalyan	1.44	0.56	1.17	28.04	82.02	29.70	47.32
N-53	1.56	0.63	1.51	39.34	108.9	46.84	71.92
B-780	1.45	0.62	1.27	35.85	103.02	38.93	66.05
Udaipur-102	1.41	0.52	1.60	19.35	49.01	21.33	40.84
Agrifound Dark Red	1.45	0.63	1.71	32.34	104.59	46.38	59.57

CROP PROTECTION

16.0 Integrated Pest Management In Onion

Under IPM in onion, various field trials were laid out during *rabi* 2003-04 for the management of thrips through employing different tactics. Cultural control method like barrier cropping can block thrips up to 80% but caused shading in previous years. Therefore refinement of this method was under taken to avoid shading effect of barrier on onion. Under biocontrol, the feasibility of biological control of onion thrips through predator, *Chrysoperla* and efficacy of some insect pathogens are being evaluated against onion thrips. To minimize the insecticide inputs in onion, trials like combined effect of neem and insecticides; management of thrips based on critical growth stages of onion are being conducted. Evaluation of some new insecticides against thrips was also undertaken. Besides the above trials a field and laboratory experiment was carried to understand the biochemical basis for thrips preference at different ages of onion plant. Results of the above trials are awaited.

16.1 Screening of onion germplasm for thrips resistance

Till date, thrips management in onion is dependent on insecticides. This practice is unsafe in long run and non-judicious use of chemicals results in environmental pollution. Host plant resistance is enduring and safer. At present there is no promising source for resistance in onion (*Allium cepa*) against thrips. It is imperative to screen onion germplasm to identify the resistant lines against thrips.

In *kharif* season, 30 lines of white onion lines and 85 lines of red onion were screened for thrips resistance. The entries were planted in Randomised block design with 2 replication on 26 July 2003.

Thrips incidence occurred in the initial stage of the crop only and crop recovered in the later stage. As a result only curling symptoms were observed on the plants. Therefore injury in terms of leaf curling was recorded.

LCR on 1-5 scale: 1= erect leaves; 2=90° curling; 3=180° curling; 4=all leaves showing 180° curling and/or leaves showing distortion and moderate twisting; 5=plant with complete curling and twisting.

Based on the LCR, in white onion the curling was in the range of 1.3 to 2.8. The lowest rating was recorded in W-080-26. However, the highest yield was obtained in Phule Safed (NRC). In case of red onion, the lowest rating was recorded in B-780 (2.0) and the same was yielded highest bulbs (1.24kg/3rows) followed by accession 1009 (0.71kg/3rows). The lower marketable yield in many lines is due to poor plant stand and rotting.

POST HARVEST TECHNOLOGY

17.0 Post Harvest Studies In Onion

17.1 Assessment of storage losses

17.1.1 Seasonal variation

The assessment of storage losses in late *kharif* onion cv. Baswant 780 reveals that the sprouting and black mould was very low in first four month of storage but it suddenly increased to 20% with increase in humidity levels. The storage losses in *rabi* season were less than late *kharif* season. The physiological weight loss in *rabi* onion was 13.92% after 120 days of storage, while the rotting and sprouting after 120 days of storage in *rabi* onion were 10.35% and 3.21% , respectively, which were lesser than late *kharif* onion. The sprouting losses increased rapidly after 120 days storage. The storage losses in November harvested *kharif* onion were around 82 % after 120 days of storage. The major portion was contributed by sprouting (54.85%) followed by physiological loss in weight i.e. PLW (23.45 %) (Table 51). The storage losses in September harvest *kharif* onion were around 90% during 75 days of storage. The PLW and sprouting loss, both were higher in September harvest onion.

Table 51: Assessment of storage losses in onion after 120 days after storage

Losses (%)		Late *kharif*	*Rabi*	*Kharif*
Quantitative Losses	PLW	27.47	13.92	23.45
	Rotting	8.91	10.35	5.65
Qualitative Losses	Sprouting	1.49	3.21	54.85
	Black Mould	1.56	1.55	0.00

17.1.2 Effect of neck length of bulb

Onion having different neck length viz., with out neck, 4 cm, >4 cm, intact leaves were stored in different seasons .The results revealed that rotting losses were also lower in intact leaves onions. But black mould infection was higher in intact leaves in late *kharif* season. *Rabi* season onion also showed trend similar to late *kharif* onion. But the losses were comparatively lesser up to 150 days of storage. However, intact leaves didn't show any beneficial effect in long duration storage (8 months).

17.1.3 Effect of grades of onion on storage

Different grades of onion viz. A, B, C, Doubles and Bolters were stored during *rabi* season. There was no difference in PLW, sprouting and black mould, the rotting was higher in double bulbs.

17.2 Effect of pre harvest treatment

Late kharif

17.2.1 Effect of bio pesticide

Trichoderma was sprayed in different concentrations fifteen days before harvesting to reduce storage rot. Based on the results, it was found that *Trichoderma* failed to control rotting in storage.

17.2.2 Effect of chemicals

Various chemicals such as streptocyclin, bavistin, copper sulphate, salicylic acid, sodium thiosulphinate etc. were sprayed fifteen days before harvesting to control rotting and sprouting. But these chemicals failed to control sprouting and rotting in storage.

Rabi

17.2.3 Effect of chemicals

Various chemicals such as glycine, gallic acid, pyrogallol, cultar, borax, $FeSO_4$, salicylic acid, etc. were sprayed fifteen days before harvesting to control rotting and sprouting. But these chemicals failed to control sprouting and rotting in storage. But $FeSO_4$ showed better bulb colour retention during storage. Bavistin and Carbaryl were also tried for the same purpose, but it showed no effect.

Kharif

17.2.4 Effect of Lihocin

Lihocin (cycocel) was applied @ 2500 ppm at different intervals to onion crop. These onions were stored from November 03 to January 04. The results revealed that there was no effect of these sprays on PLW, sprouting and black mould infection, but rotting of bulbs was significantly lower in the bulbs sprayed with 2500 ppm Lihocin at 75 days and 90 days of transplanting.

17.2.5 Effect of Copper Sulphate

Copper Sulphate was sprayed on *kharif* onion crop at 90 and 100 days after transplanting for the purpose of forcing maturity of onion. These onions were stored from November to January and various storage losses were recorded. The results revealed that there was no effect of date of spraying on PLW but some treatments increased the PLW. As far as sprouting is concerned, it was significantly lower in second date of spray. Some concentrations showed significantly higher rotting in early stages.

17.2.6 Effect of chemicals

Various chemicals such as Paclobutrazol, TIBA, Bavistin, streptocyclin, and salicylic acid were sprayed on onion crop at two dates i.e. 75 and 90 days of transplanting. The results showed that there was no effect of these treatments on PLW, sprouting and black mould infection, but rotting was less at initial dates of spraying up to one half month.

17.3 Effect of post harvest treatments

17.3.1 Effect of irradiation and low temperature storage

An experiment was conducted combining the gamma irradiation treatment and low temperature storage in onion. The gamma irradiated bulbs of onion were stored at ambient (atmospheric) and low temperature (0-2° C temp. and 65-70% RH) for four months and storage losses after four month were recorded. Subsequently the losses were recorded at 15 days intervals to observe post cold storage behavior.

The result revealed that there were only 6.41% losses after 4 months of low temperature storage while the losses in ambient storage were33.35%. There were no sprouting and rotting losses in cold storage. When the low temperature stored non-irradiated onions were taken out and kept under ambient conditions, the sprouting losses increased rapidly and 43.3% onion were sprouted after one month and subsequently increased up to 67.77 per cent after 4 months. The sprouting in gamma irradiated and low temperature stored onion was only 4.7 % after one month and remained 4.7 % even after 4 months. As far as other losses *viz.*, physiological loss of weight, rotting and black mould is concerned, these were much less than control under low temperature storage.

17.3.2 Effect of varieties and irradiation

Different onion varieties were irradiated during *rabi* season. The results reveal that irradiation treatment decreased sprouting irrespective of variety. But rotting and black mould were higher in irradiation treatment, if onion was stored for more than five months.

17.3.3 Effect of Irradiation and storage environment

The irradiated and un-irradiated bulbs of onion cv. N-2-4-1 were stored under three storage temperatures *i.e.*, cold storage (0-2°C), air conditioned (AC) storage (15-20°C) and ambient storage for four months from June to October. The results revealed that PLW was very low at 0-2°C temperature while rotting was highest at ambient storage and AC storage. The sprouting losses were maximum under AC storage (Table 52). The irradiation was found suitable in control of sprouting at all storage environments.

Table 52: Effect of irradiation and storage environment on storage losses (%) in onion cv. N-2-4-1.

Type of Storage	Storage losses 120 days after storage											
	PLW			Rotting			Sprouting			Black mould		
	Un IR	IR	Mean	Un IR	IR	Mean	Un IR	IR	Mean	Un IR	IR	Mean
Ambient Storage	19.63	17.77	18.4	23.8	14.63	19.21	4.34	0.00	2.17	2.54	1.84	2.19
AC Storage	21.49	13.87	17.68	14.12	4.24	9.18	62.47	9.31	35.89	0.00	0.00	0.00
Cold Storage	4.66	5.12	4.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	15.26	12.05		12.64	6.29		22.27	3.10		0.84	0.61	

Two *kharif* onion cultivars namely, B-780 and N-53 were treated with irradiation and stored under two environmental conditions. The results showed that in onion cv-N-53, PLW was lower at low temperature. The rotting and sprouting losses were also higher at ambient temperature, but PLW, rotting and sprouting were also higher than *rabi* season variety. The onion cv. B-780 also showed similar trends but the weight loss and rotting were less than the onion cv. N-53.

17.4 Effect of curing treatments

17.4.1 *Rabi* onion

The *rabi* onion was cured in various poly tunnels for 3 days. The results revealed that there was no effect of curing on storage losses except PLW during storage. The PLW was higher in onions cured in both end closed poly tunnels. Also recommended curing method was compared with farmers traditional curing method.

17.4.2 *Kharif* onion

Kharif onion cv. B-780 was cured in various types of poly tunnels, pit curing and compared with no curing. The result reveals that PLW was highest in freshly cut onion, while it was significantly lower in all treatments. Sprouting, black mould and rotting were statistically similar in all treatments.

17.5 Evaluation of white onion germplasm in storage during *rabi* 2002-03

348 white onion germplasm along with four white varieties were studied for their storage losses. Bulbs were kept in storage after curing on 15 May in three replications in the crates. Three observations were recorded at interval of 2 months for number of bulbs, total weight loss, loss due to rotting + physiological loss and loss due to sprouting.

Table 53: Top 10 white onion *rabi* entries having good storage life over different varieties after six month of storage in crates (May to Nov.)

Sr. No.	% loss by Number		% Loss by weight		% Loss by Rot + PLW		% Loss by Sprout	
1	W-163	32.61	W-163	51.79	W-015	34.81	W-324	0.00
2	W-170	36.38	W-305	54.70	W-305	40.84	W-361	0.34
3	W-305	37.45	W-170	54.86	W-031	42.01	W-344	0.71
4	W-057	40.48	W-361	59.52	W-218	42.17	W-170	1.04
5	W-332	41.90	W-332	61.06	W-163	44.95	W-215	2.59
6	W-003	43.38	W-312	61.14	W-007	46.00	W-310	2.94
7	W-312	44.26	W-029	61.88	W-117	46.90	W-184	3.40
8	W-361	44.80	W-354	64.66	W-146	47.29	W-266	3.71
9	W-354	45.90	W-028	65.33	W-332	49.94	W-045	3.73
10	W-029	48.32	W-057	65.57	W-226	50.51	w-449	3.75
13	A. Niketan	59.33	A. Niketan	67.13	A. Niketan	60.16	A. Niketan	6.97
15	N-2-4-1	58.72	N-2-4-1	69.05	N-2-4-1	62.64	N-2-4-1	6.40
18	ALR	64.11	ALR	67.45	ALR	59.75	ALR	7.71
19	PKV white	88.97	PKV white	92.13	PKV white	87.78	PKV white	10.74
20	B-780	92.49	B-780	95.87	B-780	63.33	B-780	32.54
21	AFW	95.02	AFW	96.07	AFW	88.02	AFW	8.05
22	P. Safed	96.90	P. Safed	97.96	P. Safed	81.84	P. Safed	16.12
23	P-6	95.83	P-6	98.52	P-6	87.78	P-6	10.74

After two months of storage, percentage loss in number of bulbs was significantly less in 84 germplasm and ranged between 0 to 12.68%, whereas, losses by weight was significantly less in 78 germplasm (6.81 to 19.96%) over P. Safed (32.78% and 39.03%, respectively). Losses by number and weight after two months of storage ranged between 0.0 to 72.34% and 6.81 to 80.82%, respectively. Losses by number after 4 months of storage ranged from 14.47 to 98.28% and by weight it ranged from 25.01% to 98.80%. 167 germplasm by number (14.47 to 68.63% loss) and 110 germplasm by weight (25.01 to 68.67% loss) had significantly less loss over P. Safed (91.25% & 92.54% loss, respectively). Losses after 6 months of storage ranged from 32.61 to 100% by number and 51.79 to 100% by weight. 132 germplasm by number (32.61 to 81.39% loss) and 119 germplasm by weight (51.79 to 86.22% loss) had significantly less storage losses over P. Safed (96.90% & 97.96% loss, respectively). Among the varieties, per cent loss after 6 months of storage by weight in white varieties was 92.13% in PKV White, 96.07% in AFW, 97.96% in P. Safed and 98.52% in P-6, whereas, in red varieties it was 67.13% in A. Niketan, 67.45% in ALR, 69.05% in N-2-4-1 and 95.87% in B-780.

17.6 Effect of storage environment and packing material on total storage losses of onion cv N-2-4-1

The bulbs of onion cv. N-2-4-1 were packed in different packing materials i.e. staking, hessian cloth bags, lino-bags (Netlon) and plastic crates from May to September 03. The observations of various types of losses were recorded. The results revealed that PLW was more in crates but rotting was more in staking and hessian cloth bags. The occurrence of sprouting and black mold was less during 2003 than 2002, which may be due to weather conditions. (Table 54 and 55).

Table 54: Effect of storage environment and packing material on total storage losses of onion cv N-2-4-1

Type of onion storage structures	Packing material				Average
	Stake	Hessian cloth bag	Lino bag	Plastic crate	
Traditional double row storage structure with asbestos roof	51.06	46.27	49.41	44.80	47.89
Modified bottom ventilated double row storage structure with asbestos roof	52.04	38.19	41.07	35.83	41.78
Modified bottom cum top ventilated double row storage structure with asbestos roof	27.70	30.36	34.27	28.80	30.28
Bottom ventilated double row storage structure with asbestos roof and chain links on sides	37.42	39.26	42.56	41.23	40.12
Average	42.06	38.52	41.83	37.83	

Table 55: Effect of storage environment and packing material on net profit (Rs/t)

Type of onion storage structures	Packing material				Average
	Stake	Hessian cloth bag	Lino bag	Plastic crate	
Traditional double row storage structure with asbestos roof	1250	1123	937	729	1010
Modified bottom ventilated double row storage structure with asbestos roof	1249	1684	1552	1486	1493
Modified bottom cum top ventilated double row storage structure with asbestos roof	2560	2121	1886	1781	2087
Bottom ventilated double row storage structure with asbestos roof and chain links on sides	2003	1541	1394	1115	1513
Average	1766	1617	1442	1278	

17.7 Performance of onion storage structures

17.7.1 Storage losses in various onion storage structures

Among the double row type of onion storage structures, bottom cum top ventilated mud plastered was found more efficient in reducing physiological loss of weight (PLW) and rotting as compared to modified bottom ventilated storage structure. The losses in traditional type of storage structures were higher. Among single row type storage structures, low cost thatched roof structure was found better over bottom ventilated mangalore tiled storage structure and traditional mangalore tiled storage structure (Table 56).

17.7.2 Economics of storage structures

The calculation of cost: benefit ratio of onion storage in various type of storage structures reveals that net profit (Rs/t) was highest in bottom cum top ventilated mud-plastered structure (Rs. 2541/t). This is closely followed by low cost thatched storage structure (Rs 2473/t) than all other storage structures (Table 57).

17.8 Effect of low temperature storage

Onion cv N-2-4-1 was stored under ambient condition and low temperature conditions (0-2°C & 65-70% RH) from May to October. There was almost negligible losses in low temperature storage during 4-month storage but after taking out from cold store the losses due to sprouting increased rapidly. But the sprouting losses were significantly reduced by γ-irradiation treatment in low temperature stored onions.

Table 56: Performance of *rabi* onion cv. N-2-4-1 stored in various types of onion storage structures during May to Oct. 03

Type of onion storage structures	Quantitative losses (%)	Qualitative losses (%)
	Total	Total
Traditional double row storage structure with asbestos roof	52.06	2.0
Modified bottom ventilated double row storage structure with asbestos roof	46.57	6.02
Modified bottom cum top ventilated double row storage structure with asbestos roof	26.58	1.52
Bottom ventilated double row storage structure with asbestos roof and chain links on sides	34.89	2.28
Low cost bottom ventilated single row onion storage structure with thatched roof	28.03	2.45
Traditional single row storage structure with Mangalore tiles roof	42.66	2.10
Bottom ventilated single row storage structure with Mangalore tiles roof	41.05	4.74

Table 57: Economics of storage of *rabi* season onion cv. N-2-4-1 stored in different onion storage structures during May to October 03

Type of onion storage structures	Net Profit (Rs/t)
Modified bottom ventilated double row storage structure with asbestos roof	1228.0
Modified bottom cum top ventilated double row storage structure with asbestos roof	2541.0
Bottom ventilated double row storage structure with asbestos roof and chain links on sides	2070.0
Low cost bottom ventilated single row onion storage structure with thatched roof	2473.0
Traditional single row storage structure with Mangalore tiles roof	1452.0
Bottom ventilated single row storage structure with Mangalore tiles roof	1990.0

17.9 Development and evaluation of motorized onion grader

Hand operated grader is useful and affordable to farmers for on farm grading. However for traders, there is need for a grader with higher efficiency. Considering these requirements, NRCO&G has designed and fabricated motorized grader with higher efficiency and precision. The motorized grader has 2 sets of counter rotating double rollers, which grades onion on the basis of diameter. The grader has one 1HP motor for rotating the rollers. It has provision of grading onions in five grades i.e. <35mm, 35-50mm, 50-60mm, 60-80mm and >80mm. The grader is 7 feet in length and 4.0 feet wide.

Performance

17.9.1 Capacity

Performance evaluation test of the machine was done with onion variety Baswant-780 and it revealed that it can grade 1.5 to 2.0 tons per hour per person. The efficacy of the grader may vary with loading speed, bulb size etc. The range difference was only 1.8 % in A grade when onion cv. B-780 graded with grader in while range difference in manual grading was 25.3%. Similarly the range difference for B grade bulbs was 5.17% in grader and 19.34 % in manual grading.

17.9.2 Accuracy

The difference between repeated grading by grader was very less as compared to manual grading. When the graded A grade onion was passed through the grader it was found that it contained more than 90 % A grade bulbs. Similarly B grade contained 87.2% B grades onions. In C grade onion there were 90.4% in repeated grading.

17.9.3 Economics

The comprehensive production cost of the grader as per the specifications would be around Rs. 40,000/-. The working life of grader is at least ten years. During main harvesting season, assuming 60 working days, the grader can grade 1000 t annually. The calculation of interest on capital, depreciation and labour charges for running the grader reveals that the grading charges would be around Rs.15/t as compared to Rs.80 in manual grading.

17.10 Morphological changes in onion during growth and development

Periodic observations of growth characters of onion were recorded from 4 weeks till harvesting at weekly interval during *rabi* and *kharif* seasons. The results reveal that steep rise in weight and size of bulb was recorded after 6 weeks of transplanting. The number of leaves and plant height remain constant after 12 weeks of transplanting. *Kharif* onion showed similar trends. The direct sown onion showed steep rise in bulb weight and size after 12 weeks of sowing. The root length in direct sown crop was higher than transplanted crop.

18.0 Post Harvest Studies in Garlic

18.1 Effect of sulfur fumigation on storage life of garlic

The sulfur fumigation (50g/m3) was given to garlic bulbs for 1,2,3 & 4 hours during June 2003.The treated garlic were stored under ambient condition for 8 month. There was no effect of fumigation on rotting and black mould infection.

18.2 Performance of garlic stored in various types of onion storage structures

The garlic cv.G-41 was stored in different onion storage structures in heap (stakes) and in hessian cloth bags during April to October. There was no effect of these treatments on % PLW but disease infection (%) was lower in heaps (stakes) kept in modified bottom ventilated storage structure. The visual quality was better in garlic stored in stakes. The discolouration was also less in heaps (Table 58).

Table 58: Performance of garlic cv. G-41 stored in various types of onion storage structures during April to Oct. 02

Type of storage structures / Packing material	PLW (%)		Diseased bulbs (%)		Discoloration (%)*		Visual quality**	
	Stake	Hessian bags	Stake	Hessian bags	Stake	Hessian bags	Stake	Hessian bags
Traditional double row storage structure	12.14	12.50	31.13	29.43	2.48	2.33	6.65	5.06
Modified bottom ventilated double row storage structure	12.21	14.30	22.86	28.33	1.95	2.03	6.50	4.80
Bottom cum top ventilated double row storage structure	13.01	14.11	28.40	31.00	1.58	2.13	7.30	5.26
Bottom ventilated double row structure with chain links on sides	14.63	13.98	35.21	27.88	1.80	2.66	6.30	5.60
Average	13.00	13.70	29.40	29.20	1.95	2.29	6.69	5.18

*None-1, Slight-2, Moderate-3, Moderatly-4, Sever-5

**Visual quality: Excellant-9, Good-7, Fair-5, Poor-3 and Unsellable-1(Hedonic scale)

18.3 Effect of low temperature storage and γ-irradiation on storage losses in garlic

The bulbs of garlic cv G-41 were γ-irradiated and kept under ambient storage conditions and low temperature condition (0-2° C and 65-70% RH) in hessian cloth bags from May to October. The material was taken out from store after 5 months and kept under room temperature for post storage behavior studies. The result reveals that storage losses in cold storage were very low as compared to ambient storage. The total weight loss in cold stored material after 5 month was 6% as compared to 17 % under ambient storage conditions. The infection of soft rot was higher in ambient condition (24 %) as compared to low temperature condition (8%). There was no sprouting in all treatments. When the cold stored garlic was kept under room temperature, the un-irradiated garlic started sprouting and it increased to 12.63 %. But there was no sprouting in γ-irradiated garlic. The internal sprouting which is common in garlic after November was not found in γ-irradiated bulbs and bulbs were healthy till termination of the experiment i.e. upto January. Thus the irradiation combined with low temperature storage may be helpful in reducing the storage losses in garlic by 20-25%.

18.4 Biochemical analysis of domestic garlic lines and Chinese garlic

Various garlic varieties such as G-41, G-1, GG-2, G-50, Agri Found Parvati (Himachal produce), Agri Found Parvati (Karnal produce), and lines from NRCOG viz. No. 55, No. 61, No. 335 as well as Chinese garlic were tested for their biochemical constituents viz. ,%N, % P, % K, % Protein, % Moisture, % Dry matter, TSS (%) etc. during the year 2003 and 2004.

The results revealed that both purple as well as white domestic garlic showed higher content of all the above stated constituents than Chinese garlic except Nitrogen, which was at par with all cultivars except No. 335 and No. 55. The garlic line from NRCOG, No. 55 showed highest %N, %P, % Dry matter and TSS (%) than all other lines during 2003. Moisture content was lowest in G-1 consistently for both the years. Agri Found Parvati (Karnal produce) was found significantly superior in Potassium content, while No. 335 was found significantly superior in protein content than all other tested cultivars of garlic during both the years.

19.0 Survey Report

19.1 Survey of onion storage structures in Gujarat and Karnataka

19.1.1 Gujarat

The survey of post harvest handling and storage of onion was carried out in major onion growing areas of Gujarat. The survey results revealed that in Gujarat 22.54 % onion storage structures are temporary type while 14.0% of the structures are semi-permanent type. The majority of storage structures is permanent type (63.38%). The 82.22% permanent structures are bottom ventilated but the bottom ventilated type of structures are different of the recommended type. Majority of the temporary structures (75.8%) were up to 10 t capacity. While 42.56 % semi permanent structures were found to have less than 10 t capacity. Contrary to this majority of the permanent structures have more than 10 t capacity. The majority of permanent structures were constructed on raised platform. The 68.52 % semi permanent structures and 51.61 % temporary were constructed on raised platform. The floor of non-bottom ventilated unraised structures was kuchcha or filled with coarse sand. In bottom ventilated structures wooden logs or wooden bantams are the main construction materials in all type of structure. The majority of the temporary roofs were built with grasses / sugarcane leaves with or with out polyethylene covers. The Mangalore tiles were main roofing material in semi permanent structures, while galvanized iron sheets were main roofing material in permanent structures, which was followed by asbestos sheet and Mangalore tiles.

19.1.2 Karnataka

The survey of post harvest handling and storage of onion was carried out in major onion growing areas of Karnataka. The survey reveals that 37.14% storage structures were temporary type while 64.29% structures were semi-permanent. Only 8.57% structures were permanent. None of these structures was bottom ventilated. Majority of the temporary structures (75.8%) were up to 10 t capacity. While 42.56 % semi permanent structures were found to have less than 10 t capacity. Contrary to this, majority of the permanent structures have more than 10 t capacity. The temporary storage structures were found to have more length as compared to semi permanent and permanent structures. The 69.9% permanent structures and 40.0% semi permanent structures were 15 to 30 feet long while 67.74% temporary structures were more than 45 feet in length. Contrary to the length, 95% temporary structures were found to have less than 6 feet width. Similarly 65.11% semi permanent structure were less than 6 feet wide while more than 50 % permanent structure were more than 12 feet wide. The majority of permanent structures were constructed on raised platform. The 68.52 % semi permanent structures and 51.61 % temporary were constructed on raised platform. But the height of platform in majority of the semi permanent and temporary structures is less than 15 cm. The permanent structures have platform height of either 2 feet or more than 2 feet. As far as the bottom ventilation is concerned, only 38.1% permanent structures, 11.4 % semi permanent structures and 1.62 percent temporary structures were constructed with bottom ventilation facility. The floor of non-bottom ventilated un-raised structures was kuchcha or filled with coarse sand. In bottom ventilated structures wooden logs or wooden bantams are the main construction materials in all type of structures. The majority of the temporary roofs were built with grasses/ sugarcane leaves with or with out polyethylene covers. The Mangalore tiles were main roofing material in semi permanent structures, while galvanized iron sheets were main roofing material in permanent structures, which was followed by asbestos sheet and Mangalore tiles.

19.2 Season wise assessment of yield of onion at farmers field

In order to assess the yield, productivity, method of planting etc. at farmers' field, extensive surveys were conducted in the onion growing belts of Maharashtra during the harvesting season of late *kharif*, *rabi*, and *kharif* season. The survey was conducted in four districts of the state namely, Pune, Nasik, Satara and Ahmednagar.

The results reveals that most of the farmers are planting on flat beds in late *kharif* and *rabi* season, while 44% farmers have planted on ridges and furrows in *kharif* season. The yield levels of *kharif* season were lower (19.8 t/ha) than *rabi* (49.24 t/ha) and late *kharif* (31.4 t/ha) season. The percent A and B grade bulbs were 42.5 and 43.85 respectively during *rabi* and late *kharif* season, while in *kharif* it was only 14.3 %.

EDUCATION AND TRAINING

Lectures / Talks

Topic	Organiser	Venue	Date
Dr. K. E. Lawande, Director			
Onion and Garlic	Nirmal Seeds Pvt. Ltd.,	Pimpalgaon Baswant (Nashik)	12.04.2003
Onion and Garlic Cultivation, Problems and Management	Jansewa Foundation,	Pune	28.04.2003
Research Activities in Onion and Garlic of NRCOG	MSAMB, Pune	NRCOG, Rajgurunagar	30.06.2003
Onion Storage	Hindustan Agro Co-Op Ltd.	Navipeth, Rahuri, Dist. Ahmadnagar	10.08.2003
Onion and Garlic Production	IFFCO	Pune	21.09.2003
Onion and Garlic Production, Storage, Management and Control	Deepak Agro Solutions Ltd	Andursul, Yeola, Dist. Ahmadnagar	16.10.2003
Onion and Garlic Production, Storage, Management of Pests & Diseases	Deepak Fertilizers & Petrochemicals Corporation Ltd.,	Chinchoshi, Tal. Khed, Dist. Pune	21.11.2003
Onion and Garlic Production, Storage, Management and Control	Deepak Fertilizers & Petrochemicals Corporation Ltd.,	Mhaskewadi, Tal. Parner, Dist. Pune	25.11.2003
Onion and Garlic Production, Storage, Management and Control	KVK, Babhaleshwar and PKVSS Ltd., Pravaranagar	Babhaleshwar, Tal. Rahata, Dist. Ahmadnagar	16.12.2003
Production technology for quality seeds of onion and garlic	Winter School on 'Advances in Production and Evaluation of Quality Vegetable Seeds' IIVR, Varanasi	Varanasi	20.12.2003
Dr. V. Mahajan			
Onion & Potato cultivation and problems	Ambegaon Taluka Shetmal Prakriya Sahakari Sanstha Maryadit, Manchar and IFFCO, Pune	Manchar	11.06.2003
Breeding methods for improvement of crops	Department of Environmental Sciences, University of Pune	Pune University	29.10.03 to 18.11.03

Topic	Organiser	Venue	Date
Varietal development of onion	Tamil Nadu State Agrl. Dept	NRCOG, Rajgurunagar	5 to 7 Feb. 2004
Production technology of onion	Ambegaon Taluka Agrl. Produce Processing Co. Soc. and IFFCO, Pune.	Peth, Dist. Pune	11.6.2003
Scientific cultivation of onion	APMC, Chakan and MSAMB, Pune.	Chakan, Dist. Pune	
Production of quality onion for export and post harves handling.	Krishi utpanna bajar samiti, Shirur, MSAMB, Pune, M.S. Agrl. Dept. and NRCOG, Rajgurunagar	Shirur, Dist. Pune	27.9.2003
Onion production parisanwad	Deepak Fertilizers, Pune.	Talegaon, Dist. Pune	16.9.2003
Production of onion for storage export and storage	MSAMB, Pune.	Village Mahod	
Special programme on Cultivation of Onion	M.S. Agrl. Dept., Khed, NRCOG, Rajgurunagar, TATA Engineering & Locomotive Limited, Pune and Vandevi Agrl. Society, Shive	Village Shive	22.10.2003
Package of practice of onion crop	IFFCO, Pune	Village Patas	16.12.2003
Production of onion for export	MSAMB, Pune	Village Ottur	23.12.2003
Onion production technology	MSAMB, Pune.	Village Manchar	5.01.2004

Participation in exhibitions

Dr. V. Mahajan, S.B. Kadam and S.D. Waghmare participated in 'Agricultural Exhibition' at Captain Shivrampant Damle Sports Ground, Pune organized by SDAO, Rajgurunagar on 6 April 2003.

Dr. V. Mahajan, V.V. Patil, S.B. Kadam, H.M. Jadhav, P.R. Sonawane and Naim Shaikh participated in 'Agriculture Exhibition' at Vishal Junnar Nagar Dyaneshwar Grammonnati Mandal High School Ground, Aale, Tal. Junnar, Dist. Pune organized by Vishal Junnar Sahakari Patpedhi Maryadit, Mumbai and Srijan Marketing, Sinnar from 12-14 April 2003.

Dr. V. Mahajan, V.V. Patil, S.B. Kadam, H.M. Jadhav, P.R. Sonawane and Naim Shaikh participated in 'Kissan 2003" - Pune at Agriculture College Campus, Pune from 3-7 December 2003 organized by Deccan Exhibitors Pvt. Ltd, Pune.

Transfer of technology

Organized a three-day training programme on 'Onion and Garlic Production Technology' for the Officers (Horticulture/Agriculture) from Govt. of Tamil Nadu from 5-7 February 2004.

Participation in seminars/symposia/workshops/meetings

Name & Designation	Title of the meeting	Venue & Date
Dr VSR Krishna Prasad, Pr. Sci., (Hort.) Dr V Mahajan, Sr. Sci. (Hort.)	XX All India Coordinated Vegetable Group Meeting / Workshop held at Gujarat Agricultural University,	Anand, Gujarat May 2003
Dr K.E.Lawande, Director Dr VSR Krishnaprasad, Pr. Sci. (Hort.) Dr V Mahajan, Sr. Sci. (Hort.) Dr Anil Khar, Sci. (Hort.)	International Seminar on Sugarcane Genomics & Genetic Transformation, Vasantdada Sugar Institute, Manjari (BK), Pune.	Pune 28-29 August, 2003
Dr VSR Krishnaprasad, Pr. Sci. (Hort.) Dr V Mahajan, Sr. Sci. (Hort.)	International Workshop on Plant Growth Promoting Rhizobacteria	IISR, Calicut 5-10, October, 2003
Dr K.E.lawande, Director Dr VSR Krishnaprasad, Pr. Sci. (Hort.) Dr V Mahajan, Sr. Sci. (Hort.)	National Symposium on Harnessing Heterosis in Crop Plants	IIVR, Varanasi 13-15 March, 2004
Dr V Mahajan, Sr. Sci. (Hort.)	Financial workshop of NATP	College of Agriculture, Pune 21February, 2004

Trainings

Name and Designation	Training	Organised By	Venue & Duration
Dr. Anil Khar, Sci. (Hort.)	International training course on "Biotechnological tools for plant Improvement"	ICRO/UNESCO/EMBO/ KSRECT	Erode, Tamil Nadu, 7-20 Sep., 2003
Dr. P. S. Srinivas, Sci. SS (Ento)	Summer school on Forecasting in Agriculture	IASRI, New Delhi	IASRI, New Delhi 9-29 July 2003

PUBLICATIONS PRESENTATIONS

Papers/ Reviews

Khar A, Lawande KE and Asha Devi A. 2003. Biotechnological approaches in garlic *(Allium sativum* L.) - Past, present and future. *The Botanica*, Delhi University. 53 : 155-168.

Srinivas PS and Panwar VPS. 2003. Combined effects of intercropping maize with pulses and potash fertilizer on stem borer, *Chilo partellus* (Swinhoe) infestation in maize. *Ann. Agric. Res. New Series* 24(3): 461 465.

Srinivas PS and Panwar VPS. 2003. Efficacy of Neem and Bt formulations against *Chilo partellus* (Swinhoe) infestation in maize. *Pesticide Research Journal* 15(2): 131 132.

Papers Presented in Seminars / Symposia / Conferences

Mahajan V, Khar A, Kadam SB and Lawande KE. 2003. Varietal evaluation and storage studies in garlic. In *National Seminar on New Perspectives in Spices, Medicinal and Aromatic Plants*, ICAR Research Complex for Goa, Goa, 27-29 November 2003. P 16.

Khar A, Mahajan V, Asha Devi, Kadam SB and Lawande KE. 2003. Studies on heratibility, genetic advance, coefficient of variation and performance studies in some elite lines of garlic. In *National Seminar on New Perspectives in Spices, Medicinal and Aromatic Plants*, ICAR Research Complex for Goa, Goa, 27-29 November 2003. P 17.

Mahajan V, Khar A, Asha Devi, Kadam SB and Lawande KE. 2003. Determination of LD 50 for chemical mutagens in garlic variety G-41. *In National Seminar on New Perspectives in Spices, Medicinal and Aromatic Plants*, ICAR Research Complex for Goa, Goa, 27-29 November 2003. P 49.

Popular Articles

Lawande KE. 2003. Increasing export of onion and garlic from India. *Indian Horticulture*, October-December, 33-34.

Lawande KE. 2003. About NRC for Onion and Garlic Interview with Director. *In Agriculture & Industry Survey*, 13 (12) : 36-37

Lawande KE. 2003. Pungent profits. *Times Agriculture Journal*, Sept-Oct, 1-2.

Lawande KE. 2003. Interview about NRCOG Miliaey Unnat Kheti. *Unnat Kheti Sabji Visheshank*, March-April, 4-10.

Mahajan V and Lawande KE. 2004. Uttam Praticha Kanda Utpadan. *Shetkari*, June, 6-11.

Mahajan V and Lawande KE. 2004. Kanda Prakriya Va Sathavan. *Shetkari*, July, 8-9.

Lawande KE. 2004. Kanda Lagawad Tantra. *Dhanyalaxshmi*, July, pp: 57-82.

Lawande KE and Mahajan V. 2004. Rabi Hangamat Uttam Praticha Kanda Utpadan. *Baliraja*, Sept, pp: 46-52.

Mahajan V. 2003. Vagyanik paddhatidwara lasun utpadan. *Godwa*, October, 41-50.

Mahajan V. 2003. Rabbi Kanda- Rope vatika kashi Taiyar karavi? *Adarsh Sheti Udyog*, Nov, 16-18

Mahajan V. 2004. Kanda kadhani, sathawanuk aani Prakria. *Adarsh Sheti Udyog*, February, 24 27.

Papers Presented

Lawande KE. 2003. Diversification of agriculture through onion and garlic production and new technologies'. *In National Seminar on 'Diversification of Agriculture Through Horticultural Development'*. NHRDF, NHB and State Department of Horticulture, UP, Deoria, Nov. 15-16.

Lawande KE. 2003. Present status and prospects of garlic production An Indian perspective. In *National Seminar on 'New perspectives in Spices, Medicinal and Aromatic Plants'*. ISS-IISR, Calicut at ICAR Research Complex for Goa, Goa, Nov. 27-29.

Lawande KE. 2004. Recent trends in onion and garlic production with emphasis on organic farming and micro-irrigation. *In National Seminar on 'Vegetable Production with Special Reference to Onion and Garlic in Bihar and Scope for Diversification in Agriculture Through Vegetable Cultivation'*, Madhubani, Bihar, NHRDF, NHB and NAFED, March 2-4.

Lawande KE. 2004. Heterosis in Onion Prospects and Challenges. *In National Symposium on 'Harnessing Heterosis in Crop Plants'*, IIVR, Varanasi, March 13-15.

INSTITUTIONAL ACTIVITIES

Institutional Activities

MoU signed

The marketing right of the hand operated 'Onion Grader' developed by NRCOG were given to M/s. Pune District Onion Growers Cooperative Purchase & Sale Society Limited, Pune. A MoU was signed on 5 April 2003.

Institutional Meetings

Seventh SRC meeting was conducted from 10-11June 2004 under the chairmanship of Dr. K.E. Lawande, Director, NRCOG. Scientists presented progress of work and future programmes, which were thoroughly discussed.

Sixth RAC meeting was held on 16-17 September 2003. Dr. Vishnu Swarup, Director, Indo-American Hybrid Seeds, New Delhi chaired the meeting. The members were Dr. K.E. Lawande, Director, NRCOG, Rajgurunagar, Dr. S.S. Kadam, Head, Dept. of Biotechnology, MPKV, Rahuri, Dr. S.H. Shinde, Dean, College of Agriculture, Kolhapur, Dr. S.J. Singh, Ex-Head, IARI Regional Station, Pune, Prof. R.P. Singh, Nalanda (Bihar), Mr. Dhananjaya Kumar, Patna and Dr. V. Mahajan, Sr. Scientist & Member Secretary. All the scientists presented their findings and RAC made appropriate suggestions for future research programmes.

Sixth, Seventh and Eighth IMC meeting was held on 7.10.2002, 30.5.2003 and 10.3.2004 under the chairmanship of Dr. K.E. Lawande, Director, NRCOG. The committee reviewed and approved the agenda items accordingly.

Hindi Pakhwara

The Centre organized Hindi Pakhawara from 7-14 September 2004 and conducted some activities/competition at this Centre like Hindi Typing, Essay, Scientific lectures, dictations, debate and poetry. The Centre also arranged a guest lecture of Mr. Raj Bahadur Saini, Hindi Officer, HEMRL, Pune and distributed prizes to the winners on 12 September 2003.

PERSONNEL

Staff Position

S. No.	Category	Sanctioned Post	Filled	Vacant
1.	RMP	01	01	00
2.	Scientific	10	08	02
3.	Technical	08	08	00
4.	Administrative	09	09	00
5.	Supporting	07	07	00
	Total	35	33	02

Name	Designation
Scientific	
Dr. K.E. Lawande	Director
Dr. V.S.R. Krishna Prasad	Principal Scientist (Horticulture)
Dr. P.C. Tripathi	Senior Scientist (Horticulture)
Dr. V. Mahajan	Senior Scientist (Horticulture)
Dr. A.A. Qureshi	Scientist Sr. Scale (Soil Science)
Dr. P.S. Srinivas	Scientist Sr. Scale (Entomology)
Ms. Asha Devi, A.	Scientist (Genetics) (on study leave w.e.f. 30.08.02)
Dr. Anil Khar	Scientist (Horticulture)
Mr. V. Sankar	Scientist (Horticulture) (on study leave w.e.f. 23.09.02

Technical

Mr. V.V. Patil	Technical Officer (T-5)
Mr. N.L. Gore	Technical Assistant T-4 (Field/Farm)
Mr. A.P. Trivedi	Technical Assistant T-4 (Field/Farm)
Mr. H.S.C. Shaikh	Computer Programmer T-4
Mr. D.M. Panchal	Technical Assistant T-2 (Field/Farm)
Mr. R.B. Baria	Technical Assistant T-2 (Field/Farm)
Mr. B.A. Dahale	Tractor Driver T-2
Mr. S.P. Yeole	Jeep Driver T-2

Administration

Mr. N. Gopal	Assistant Administrative Officer
Mr. D.B. Mundharikar	PA to Director
Mrs. S.S. Joshi	Assistant
Mr. S.P. Kandwal	Senior Clerk
Mr. P.S. Tanwar	Senior Clerk
Mrs. M.S. Salve	Senior Clerk
Mrs. N.R. Gaikwad	Hindi Typist
Mr. R.K. Dedge	Junior Clerk

Supporting

Mr. S.K. Said	S.S.Gr.III (Beldar)
Mr. P.R. Sonawane	S.S.Gr.II (Lab Attendant)
Mr. P.E. Tadge	S.S.Gr.II (Lab Attendant)
Mr. M.S. Kale	S.S.Gr.II (Lab Attendant)
Mr. R.S. Kulkarni	S.S.Gr.I (Lab Attendant)
Mr. S.D. Waghmare	S.S.Gr.I (Watchman)
Mr. N.H. Shaikh	S.S.Gr.I (Messenger)

DISTINGUISHED GUESTS

Name	Designation	Date
Dr. R.N Pal	Ex-DDG (Hort.), ICAR	29.04.2003
Mr. Harshawardhan Patil	Minister for Marketing & EGS, Mumbai	30.06.2003
Dr. S.K. Bhargava	Member, ICAR Governing Body, Agroman System, Mumbai	11.07.2003
Dr. A.S. Jadhav	Associate Dean (LAE), MPKV, Rahuri	23.07.2003
Dr. S.K. Dorge	Ex-Vice Chancellor, MPKV, Rahuri	16.08.2003
Dr. V.S. Korikanthimath	Director, ICAR Research Complex for Goa, Old Goa	29.08.2003
Mr. Ashokrao Mohol	Member of Parliament, Khed, Dist. Pune	20.09.2003
Dr. Yogendra S. Nerkar	Director (ARE), Vasantdada Sugar Institute, Pune	02.12.2003
Dr. Mangala Rai	Secretary (DARE) & Director General, ICAR, New Delhi	31.12.2003
Dr. G. Kalloo	DDG (Horticulture & Crop Sci.) ICAR, New Delhi	31.12.2003
Dr. Shanti Wilson Wijaratne	Chairman, Institute of Post Harvest Technology, Colombo, Sri Lanka	25.03.2004
Dr. Glen Rutten Cutter	Director, Seminis Veg Seeds, Woodland, CA, USA	30.03.2004
Mr. Antonio Carlos Pierro	Manager, Seminis Veg Seeds, Compinks, SP, Brazil	30.03.2004

Total number of farmers visited-3791

BUDGET

Financial Statement for the year 2003-2004

Head of Accounts	Rupees in Lakhs	
	Budget Grant	Expenditure
Non-Plan	82.00	67.74
Plan	110.00	104.32
KVK	Nil	Nil
NATP	16.82	12.94
AP Cess Fund Scheme	Nil	Nil
Pension & Retirement Benefits	Nil	Nil
'P' Loans & Advances	9.00	4.67
'R' Deposit Schemes	13.00	8.52
Revolving Fund Scheme	6.75	2.53
Total	237.57	200.72
Revenue receipt	4.50	-

ABBREVIATIONS

A. Bindu	-	Arka Bindu
A. Niketan	-	Arka Niketan
A.Kalyan	-	Arka Kalyan
ADR	-	Agrifound Dark Red
AFW	-	Agrifound White
AICRP-VC	-	All India Co-ordinated Research Project-Vegetable Crops
AICVIP	-	All India Co-ordinated Vegetable Improvement Project
AK	-	Arka Kalyan
ALR	-	Agrifound Light Red
BBF	-	Broad based furrow
cm	-	Centimetre
CT	-	Collar thickness
D	-	Doubles
DAP	-	Days after planting
DAT	-	Days after transplanting
DM	-	Days to maturity
ED	-	Equatorial diameter
FYM	-	Farm yard manure
GM	-	Grand mean
IET	-	Initial Evaluation Trial
IR	-	Irradiated
LCR	-	Leaf curl rating
m	-	metre
MY	-	Marketable yield
N	-	Nitrogen
NL	-	Number of leaves
NPK	-	Nitrogen Phosphorous Potassium
NT	-	Neck thickness
P. Safed	-	Phule Safed
P. Suwarna	-	Phule Suwarna
P. White	-	Pusa White
PD	-	Polar diameter
PH	-	Plant height
PLW	-	Physiological loss in weight
PM	-	Poultry manure
t/ha	-	Tonnes/hectare
TSS	-	Total soluble solids
TY	-	Total yield
WS	-	Water soluble
5BW	-	5 bulb weight

कार्यकारी सारांश

विगत् चार दशकों में प्याज व लहसुन अनुसंधान का लक्ष्य, मुख्यत: घरेलू तथा निर्यात हेतु चयन द्वारा अधिक उपज देने वाली किस्मों के विकास पर केन्द्रित रहा । अनुसंधान की बढती प्राथमिकताओं में अवरोधी किस्मों की आवश्यकता है जो उत्पादकता को बरकरार रखकर उर्ध्वाघर वृध्दि ला सके। हमें विभिन्न मौसमों, पारम्परिक निर्यात बाजारों तथा यूरोपीय बाजारों में निर्यात हेतु, प्रसंस्करण हेतु तथा अधिक भण्डारण क्षमता वाली किस्मों की जरुरत है । कम रसायनिक नुकसानों वाला प्याज उत्पादन करने की बात को महत्व देने की आवश्यकता है । साथ ही साथ भण्डारण तथा परिवहन में भारी मात्रा में होने वाले नुकसानों को कम करने की जरुरत है । विभिन्न किस्मों का पर्याप्त मात्रा में अच्छा बीज पैदा करने तथा उपलब्ध कराने की जरुरत है । राष्ट्रीय प्याज़ व लहसुन अनुसंधान केन्द्र ने अपनी स्थापना यथा-१९९८ से सही लक्ष्यों पर केन्द्रित अनुसंधान प्राथमिकताएं बना रखी है और कुछ क्षेत्रों में सराहनीय परिणाम प्राप्त किये गये है । जिनका विवरण इस प्रतिवेदन में दिया गया है ।

फ़सल उन्नयन के अन्तर्गत विभिन्न मौसमों तथा जैविक व अजैविक कारकों के प्रति अवरोधी लाल तथा हल्के लाल रंग की अधिक उपज देने वाली किस्मों/संकरों के विकास पर ध्यान दिया गया । अधिक उपज, थ्रिप्स के प्रति मध्यम अवरोधिता तथा अच्छे पौध आकार के आधार पर एनआरसीओजी-१०२ को चिन्हित किया गया । आनुवंशिक विषमताओं के आधार पर उन्नयन कार्यक्रमों के लिए मातृ पंक्तियो को चिन्हित किया गया । इनमें से एनआरसीओजी-१०४३, १०४४, १०४५, कम्पोजिट, ५९७, ५३१, ६०९, ६१३, ५४६, ८९९, ५७१, १३१, ९५५, ६३९, ७०४, ६३४ को अधिक उपज देने के लिए चिन्हित किया गया । ऐसे पाँच जननद्रव्यों की पहिचान की गयी जो तीनों मौसमों में उगायी जा सकते हैं । सफेद प्याज़ में प्रसंस्करण तथा वांछित औद्यानिक गुणों के साथ १८% से अधिक सम्पूर्ण घुलनशील पदार्थ वाली किस्मों की पहिचान की गयी । लगभग ३० कन्द से पंक्ति सन्ततियों में सम्पूर्ण घुलनशील पदार्थ १६ से २०.८१% था । प्याज़ में संकर विकसित करने की परियोजना में एम एस पंक्तियों के प्रयोग से विकसित १४५ संकर मूल्यांकित किये जा रहे है । लहसुन में अधिक उपज देने वालो जननद्रव्यों का कार्य प्रगति पर है । एसेशन-५०, ११७ तथा किस्म जी-४१ विपणन योग्य उपज के लिए स्थिर पायी गयी । जैवप्रौद्योगिकी में कॅलस सम्वर्धन तथा पुरुद्भवन प्याज़ के बीज तथा लहसुन के मूलाग्र से कॅलस सम्वर्धन तथा पुरुद्भवन में सफलता प्राप्त की गयी । आई.पी.आर. तथा एम आर के मुद्दों को ध्यान में रखते हुए व्यावसायिक किस्मों तथा मूल्य संवर्धन गुणों युक्त उन्नत जननद्रव्यों की डी.एन.ए. फिंगर प्रिंटींग का कार्य आरम्भ किया गया है । प्याज़ में प्रयोग में लाये १०० प्राइमरों में से ३५ प्राइमर पोलीमॉरफिक पाये गये । प्याज़ जननद्रव्य में लवण अवरोधिता के लिए इनविवो और इनविट्रो परीक्षण का कार्य आरम्भ किया गया है ।

फ़सल उत्पादन के अन्तर्गत विभिन्न सिंचाई प्रणालियों के अध्ययन से ज्ञात हुआ कि टपक सिंचाई प्रणाली से उपज में वृध्दि के साथ-साथ पानी की २७ प्रतिशत बचत होती है । गन्ने की अन्य सब्जियों के साथ अन्त:सस्यन पर किये प्रयोग के निष्कर्षो से ज्ञात हुआ कि टपक सिंचाई प्रणाली के साथ प्याज़ व गन्ने का अन्त:सस्यन सबसे अधिक लाभदायक है ।

प्याज़ तथा लहसुन के लिए समेकित पोषण प्रबन्धन पर किये प्रयोगों से ज्ञात हुआ कि नत्रजन, फासफोरस तथा पोटाश का अवशोषण ४० दिनों पर घटते क्रम में पाया गया । प्रयोग से यह भी परिणाम प्राप्त हुए कि अधिकतम उपज पर मिट्टी से अधिकतम मात्रा में पोषक तत्व अवशोषित किये जाते है । खरीफ मौसम में एन-५३ की नत्रजन, फासफोरस, पोटाश की माँग अन्य किस्मों की तुलना में अधिक पायी गयी ।

फ़सल संरक्षण में प्याज़ के समेकित पीड़क प्रबन्धन पर किये अध्ययन से यह पाया गया कि कर्षण क्रियाएं यथा अवरोधक फसलें थ्रिप्स को ८० प्रतिशत तक रोकती है परन्तु इसे पौधों पर छाया का असर होता है । इसलिए छाया के असर को कम करने के लिए संशोधित विधि का प्रयोग किया गया । जैवनियंत्रण के अन्तर्गत प्याज़ के थ्रिप्स के नियंत्रण के लिए क्राइसोपेटला परभक्षी तथा कुछ कीट परजीवियों पर प्रयोग किये जा रहे है । प्याज़ में कीटनाशकों के प्रयोग को कम करने के लिए नीम तथा कीटनाशकों के मिश्रण द्वारा, क्रान्तिक वृध्दि अवस्थाओं में कीटनाशकों के प्रयोग पर कार्य प्रगति पर हैं । कुछ नये कीटनाशकों का परीक्षण भी किया जा रहा है । वृध्दि की विभिन्न अवस्थाओं पर थ्रिप्स की प्राथमिकता के जीवरसायनिक कारणों पर भी अध्ययन किया जा रहा है । थ्रिप्स के प्रति अवरोधिता के प्रयोंगों में बसवन्त-७८० को कम रेटिंग पर पाया गया।

कटाई उपरान्त अध्ययनों में विभिन्न कारकों का भण्डारण नुकसानों पर प्रभाव जानने हेतु प्रयोग किये गये । पिछेती खरीफ मौसम के प्याज़ में प्रस्फुटन तथा काली फफूंदी रोग भण्डारण के पहले चार महीने तक बहुत कम पाये गये, परन्तु आर्द्रता बढने पर इनमें अचानक तीव्र वृध्दि देखी गयी । ट्राईकोडरमा का प्याज निकालने से पूर्व इस्तेमाल भण्डारण में सड़ने की समस्या को रोकने में विफल रहा । सूक्ष्म पोषक तत्वों, यथा फेरस सल्फेट का छिड़काव से भण्डारण में प्याज़ का रंग अधिक दिन तक टिका रहा । गन्धक के धूमन से लहसुन में सड़न तथा काली फफूंदी पर प्रभाव नही पडा । गामा विकिरण तथा कम तापमान पर भण्डारण से प्याज़ व लहसुन दोनो में भण्डारण नुकसान कम हुए । विकिरण से सभी किस्मों में प्रस्फुटन की समस्या कम हुई लेकिन कुछ मामलों से सड़न तथा काली फफूंदी अधिक देखी गयी । विकिरण सभी भण्डारण तापक्रमों पर प्रस्फुटन को नियंत्रित करने में प्रभावी रहा ।

विभिन्न भण्डारगृहों के मूल्यांकन से विदित हुआ कि कतारों वाले भण्डारगृहों में मिट्टी के प्लास्टर वाला भण्डारगृह, रुपान्तरित हवादार भण्डारगृह से अधिक उपयोगी था, जबकि एक कतार वाले भण्डारगृहों में घास की छत वाला कम लागत का हवादार भण्डारगृह, खपरैल वाले हवादार तथा खपरैल वाले परम्परागत भण्डारगृह से अधिक उपयुक्त पाया गया ।

यान्त्रिकीकरण के लिए एक मोटरचालित प्याज़ श्रेणीकरण यंत्र विकसित किया गया । जो केन्द्र द्वारा पहले विकसित हस्तचालित श्रेणीकरण यंत्र से अधिक क्षमता तथा अचूकता वाला है । इस यंत्र के परीक्षण से ज्ञात हुआ कि इससे १.५ से २.० टन प्याज़ प्रति घण्टा प्रति व्यक्ति श्रेणीकृत किया जा सकता है ।

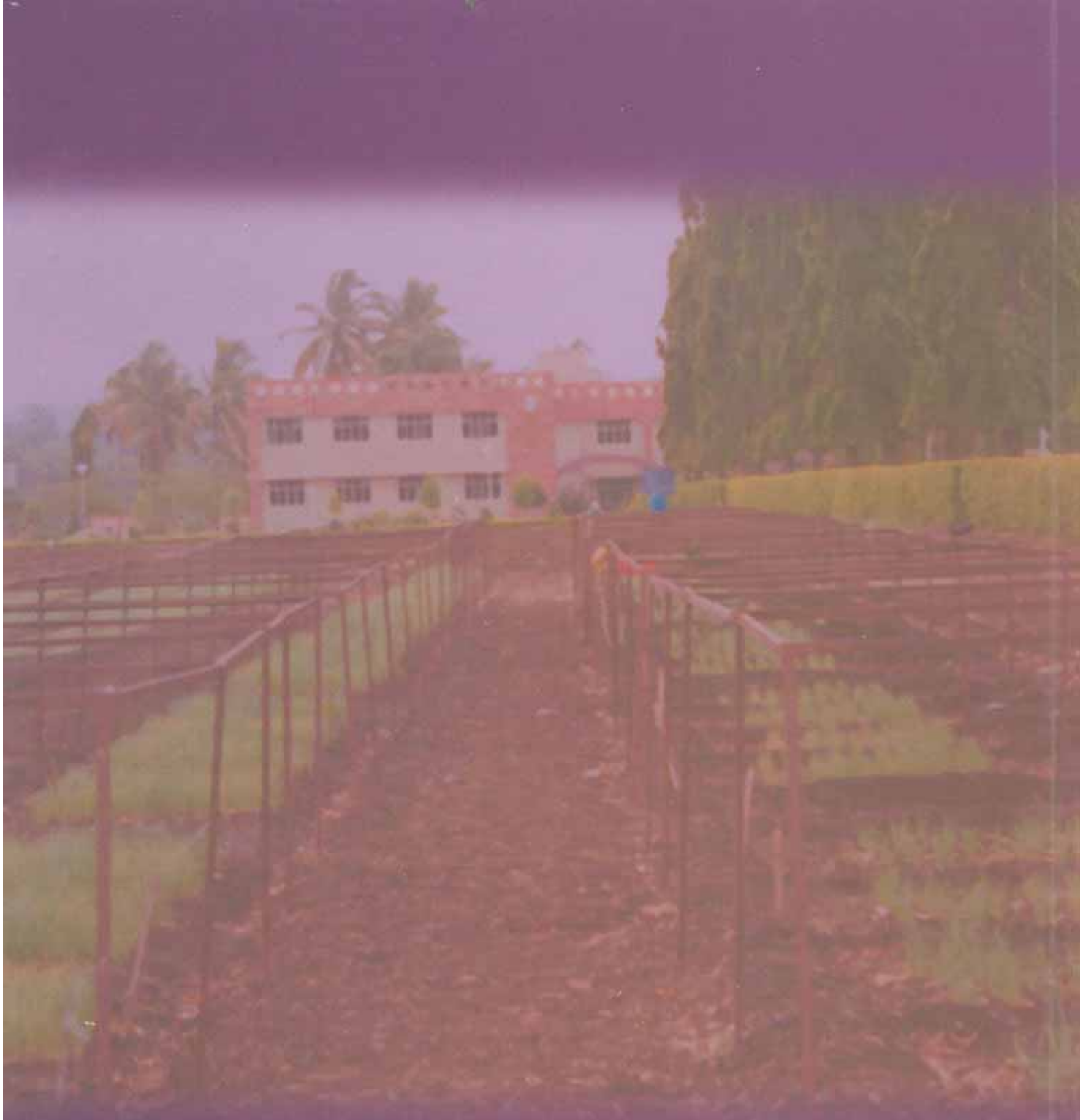
स्थानीय लहसुन तथा चीनी लहसुन के जैवरसायनिक परीक्षण से ज्ञात हुआ कि स्थानीय सफेद तथा बैंगनी दोनों लहसुन चीनी लहसुन से अधिक सम्पन्न है । इनमें अधिक फासफोरस, पोटाश, शुष्कभार, आदि अधिक प्रतिशत में पाये गये । विभिन्न लाइनों में एनआरसीओजी-५५ मे नत्रजन, फासफोरस, शुष्कभार, सम्पूर्ण घुलनशील पदार्थो की प्रतिशत मात्रा अन्य से अधिक पायी गयी । जी-४१ में सबसे कम नमी पायी गयी जबकि पोटाश की मात्रा एग्रीफाउण्ड पार्वती में सर्वाधिक थी, एनआरसीओजी-३३५ में दोनो वर्षो प्रोटीन की मात्रा सर्वाधिक पायी गयी ।

गुजरात तथा कर्नाटक राज्यों प्याज़ के भण्डारगृहों का सर्वेक्षण किया गया । सर्वेक्षण से ज्ञात हुआ कि गुजरात मे २२.५४% अस्थायी तथा १४.०% अर्ध्द स्थायी प्याज़ भण्डारगृह पाये गये जबकि कर्नाटक में ३७.१४% अस्थायी तथा ६४.२९% अर्ध्द स्थायी प्याज़ भण्डारगृह पाये गये ।

ANNEXURE 1

Meteorological data for the year 2003-04 at NRC for Onion and Garlic, Rajgurunagar

Month	Average				Total Rail fall (mm)	Average Sunshine (hr day^{-1})
	Max Temp (°C)	Min Temp (°C)	Max RH (%)	Min RH (%)		
April 2003	38.0	18.0	57	23	000.0	9.12
May 2003	38.1	20.5	65	33	000.0	10.06
June 2003	32.1	21.0	85	56	151.0	5.07
July 2003	28.4	21.4	87	79	45.5	2.20
August 2003	27.6	20.3	90	74	50.5	3.35
September 2003	28.8	19.3	89	65	42.5	4.34
October 2003	33.5	17.1	78	46	8.0	6.58
November 2003	31.7	14.3	80	36	6.0	8.43
December 2003	29.6	11.2	82	33	000.0	9.23
January 2004	29.2	10.3	84	32	000.0	9.02
February 2004	32.1	11.0	77	23	000.0	9.47
March 2004	32.7	14.1	70	16	000.0	9.20
Total					346.0	
Average	31.8	16.5	78.7	43.0	28.8	7.2



National Research Centre for Onion and Garlic
Rajgurunagar – 410 505, Dist. Pune, Maharashtra

Phone : 02135- 224056, 222026 Fax : 02135- 224056 Gram : Onionsearch
E-mail : nrcog@vsnl.net Visit us at http://nrcog.mah.nic.in