Annual Report 2005-2006

National Research Centre for Onion and Garlic
Rajgurunagar - 410 505, Dist. Pune (M.S.)

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

NRCOG Annual Report 2005 -06

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Published
December 2006

Published by
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Designed & Printed by
Anson Advertising & Marketing, Pune
Phone : 020- 24313244, Telefax : 020- 24210013
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कार्यकारी सारांश

राष्ट्रीय प्याज एवं लहसुन अनुसंधान केन्द्र को प्याज व लहसुन तथा इनकी जंगली जातियों के कृषि सम्बन्धी मुद्दों को सुलझाने का कार्य सौपा गया है। इन मुद्दों को ध्यान में रखते हुए ही केन्द्र का अधिदेश बनाया गया है। तद्नुसार, रिपोर्ट वर्ष में, इन फसलों के उन्नयन के मोर्चे पर अनेक महत्वपूर्ण उपलब्धियाँ हासिल की गयी, कुछ महत्वपूर्ण उपलब्धियाँ निम्नवत हैं।

✦ वर्ष 2004-05 के दौरान, प्याज के अस्सी नये जनन द्रव्य संग्रह में बढाये गये। इनमें महाराष्ट्र, कर्नाटक तथा तमिलनाडु से संग्रहित लाल, हल्के लाल, चपटे, गोल आदि सम्मिलित है। राष्ट्रीय पादप आंनुवशिकी संसाधन से प्याज के 12 तथा लहसुन के 152 जनन द्रव्य मूल्यांकन, रखरखाव तथा वृद्धि के लिए प्राप्त किये गये।

✦ राष्ट्रीय प्याज एवं लहसुन अनुसंधान केन्द्र ने राष्ट्रीय पादप आंनुवशिकी संसाधन ब्यूरो के सहयोग से अगस्त 21 से सितम्बर 9, 2005 तक हिमाचल प्रदेश के लाहौल, स्पीति व पांगी क्षेत्रों के उच्च पर्वतीय क्षेत्रों मे अन्वेषण अभियान चलाया । इस दौरान प्याज, लहसुन तथा उनकी जंगली जातियों के 47 नमूने इकटठे लिए गये तथा उन्हें जीनपूल में सम्मिलित किया गया।

✦ सभी मौसम में खेती के लिए चयनित 16 पंक्तियों मे, विपणन योग्य उपज के लिए बसवन्त-780 और एन-53 लगातार उत्तम पाये गये । खरीफ प्याज के उन्नयन के लिए, मासिंग लाइनों तथा बल्ब टू रो, सन्ततियों का मूल्यांकन किया गया। मासिंग लाइन के एच-985-03 और बल्ब टू रो, सन्ततियाँ, एनआरसीओजी-1010-4 और एनआरसीओजी-९२७-४ विपणन योग्य उपज के सन्दर्भ में उत्तम पायी गयी । रबी मौसम में, दो पंक्तियाँ, एनआरसीओजी-1051 और एनआरसीओजी-571, में 40 टन प्रति हे से अधिक कुल उपज और विपणन योग्य उपज प्राप्त हुई।

✦ केन्द्र द्वारा विकसित प्याज की एडवान्स लाइनो यथा B-780-5-3-1 तथा B-780-5-2-2 का अ.भा.स.स.प. प्रयोगों में उत्तम प्रदर्शन जारी रहा।

✦ सफेद प्याज में खरीफ मौसम में कुछ पंक्तियाँ अधिक विपणन योग्य उपज तथा सम्पूर्ण धुलनशील पदार्थ के लिए चेक किस्म फुले सफेद से अच्छी पायी गयी।

पद्धेती खरीफ मौसम में तेरह पंक्तियों में चेक किस्मों-पूसा व्हाइट तथा फुले सफेद से अधिक विपणन योग्य उपज प्राप्त की गयी। रबी मौसम में, चार इलाइट पंक्तियों ने फुले सफेद से अधिक विपणन योग्य उपज प्रदान की।

✦ लहसुन में 6 जननद्रव्य, जी-41 से उपज के दृष्टीकोण से उत्तम पाये गये जबकि 5 पंक्तियाँ जी-41 की समान उपज देती पायी गयी, जी-41 कुछ विभिन्न रसायनो से उत्पर्वतित पंक्तियाँ (एम-3 पीढी) को जी-41 की सन्तति के औसतकन्द भार से औसत अधिक कन्द भार के आधार पर चिन्हित किया गया।

✦ डीयूएस के अन्तर्गत राजगुरूनगर में बारह किस्मों का परीक्षण किया गया और यह पाया गया कि इन सभी मे सभी परीक्षण गुणों के लिए विभिन्नताएं थी। केवल पांच जननद्रव्यों ने विपणन योग उपज के लिए उत्तम प्रदर्शित की। प्याज व लहसुन के लिए दृश्य ग्राफिक्स युक्त डीयूएस परीक्षण मानदण्ड विकसित किये गये। दोनो फसलों के लिए चित्र पुस्तकालय विकसित किया गया। रबी और खरीफ दोनो मौसमों के परीक्षण राजगुरूनगर, करवाल, मुदुकुर व श्रीनगर में किये गये। इन आकड़ों को संकलित कर रिपोर्ट के रूप में प्रस्तुत किया गया।

✦ प्याज व लहसुन दोनो में प्ररोह गुणन तथा अपरोक्ष ओरगोने जेनिसिस दोनो विधियों से सूक्ष्म प्रवर्धन का प्रोटोकोल विकसित किया गया। आरएपीडी विधि से तेईस लहसुन पंक्तियों के साथ प्याज की एक किस्म की आनुवंशिक विभिन्नताओं का आकलन किया गया। यह पाया गया कि लहसुन की विभिन्न पंक्तियों के मध्य 44% विभिन्ताएँ पायी गयी जबकि प्याज के लिए केवल 33 प्रतिशत समानता पायी गयी।

✦ उत्पादन प्रौद्योगिकी मे सोर्स-सिन्क सम्बन्ध के बदलाव के लिए लिहोसिन के प्रयोग का परीक्षण किया गया और यह पाया गया कि रोपाई के बाद 60 और 75 दिनों पर लिहोसिन के दो छिड़काव तथा रोपाई के 75 व 90 दिनों पर एक-एक छिड़काव ने अधिक संख्या में 'ए' श्रेणी कन्दों के साथ अधिक उपज दी।

✦ विभिन्न सिंचाई प्रणालियों के तुलनात्मक अध्ययन से यह ज्ञात हुआ कि टपक सिंचाई प्रणाली से अधिक संख्या में ए श्रेणी के कन्दों के साथ अधिक उपज प्राप्त हुई साथ-साथ पानी की लगभग 36% की बचत हुई। उर्वचाई प्रयोगों मे तीन वर्षो के प्रयोग के आधार पर यह निष्कर्ष निकला कि प्याज में नः फाः पोः 50:50:80 किग्रा/हे आधारीय और 100 किग्रा नत्रजन टपक सिंचाई द्वारा सात बराबर भागों में देने से तथा लहसुन में न. फ.पो. 50:50:50 किग्रा/हे आधारीय 50 कि ग्रा नत्रजत टपक की सिंचाई द्वारा सात बराबर भागों में देना उपज तथा लाभः खर्च अनुपात के लिए सर्वोत्तम पाया गया इससे सतही सिंचाई की तुलना में पानी की 30 से 40 % बचत भी हुई।

✦ प्याज आधारित फसल-चक्रों पर पांच वर्षो के प्रयोग से यह निष्कर्ष निकला कि दलहनी फसलों युक्त फसल-चक्र जैसे-मूगफली-प्याज (पद्धेती खरीफ) और सोयाबीन-प्याज (रबी) ने प्याज मे अधिक विपणन योग्य उपज दी। लहसुन में इसी प्रकार के एक अध्ययन में दो वर्षो के प्रयोगों से यह ज्ञात हुआ कि अधिकतम विपणन योग्य उपज मटर-लहसुन फसल-चक्र में प्राप्त हुई जबकि अधिक लाभः खर्च अनुपात सोयाबीन-लहसुन फसल चक्र में प्राप्त हुआ।

✦ प्याज व लहसुन में समेकित पोषक तथा अवशोषण प्रयोग में यह पाया गया कि सोयाबीन को पिछली फसल के तौर पर उगाने से मृदा उर्वरकता सम्बन्धी परिमाणों में सुधार होता है। विभिन्न स.पो.प्र. मोड्यूलों में गोबरकी खाद व 50% संस्तुत उर्वरक वाले मोड्यूल में सर्वाधिक विपणन योग्य उपज प्राप्त हुई।

✦ बसवन्त-780 मे किये बीज अंकुरण और ओज के प्रयोगों से यह ज्ञात हुआ कि भण्डारण के 18 माह बाद भी डेसीकेटर मे रखे बीज की अंकुरण क्षमता तथा ओज अन्य उपचारों की तुलना में अधिक पाया गया।

✦ बीज नमी तथा सवेष्ठन सामग्री पर किये प्रयोगों से ज्ञात हुआ कि 5% नमी वाले बीजों को अल्यूमीनियम -लेमीनेटेड थेली मे निर्वात ने साथ सम्वेष्ठित करने के 15 महीने बाद अधिक अंकुरण तथा ओज पाया गया।

✦ बाधा फसल (मक्का तथा गेहू) लगाने से 80% थ्रिप्स को रोकने में सहायता मिली। इस प्रौद्योगिकी के प्रयोग से अधिकतम लाभः खर्च अनुपात प्राप्त हुआ तथा प्याज में कीटनाशकों के प्रयोग को घटाने में सहायता मिली। कीट परभक्षियों को थ्रिप्स की संख्या घटाने के उद्देश्य से प्रयोग किया गया। थ्रिप्स की संख्या को इ टी एल से नीचे लाने में असमर्थ रहे। जैवनियंत्रण तरीकों के अन्तर्गत प्राकृतिक परभक्षियों को आकर्षित करने के लिए कुछ पौधों पर प्रयोग किये गये। यह पाया गया कि कुछ परभक्षी जैसे -लेडीवर्ड वीटल, तथा चीलो मीनस सेक्समाकुलाटा और सूक्ष्म पाइरेट वग (ओरियस टेन्टिलस) सूर्यमूखी तथा मक्का की फसलों द्वारा आकर्षित किये गये।

✦ प्याज व लहसुन के सस्योत्तर प्रबन्धन मे यह पाया गया कि गन्धक द्वारा धूमन से प्याज में काली फफूद के प्रकोप में कमी आयी जबकि गन्धक का धूमन लहसुन में सड़न कम करने मे सहायक सिध्द हुआ। प्याज की किस्मों के गामा-विकिरण के प्रयोग में यह पाया गया कि विकिरण सभी मौसमों तथा रंगों के प्याज में अंकुरण घटाने में लाभदायक पाया गया। विभिन्न भण्डारण गृहों के प्याज की भण्डारण क्षमता पर असर पर किये गये प्रयोग से ज्ञात हुआ कि एक्जोस्ट पंखे से हवा प्रवाहित करने से नुकसान सबसे कम था जबकि विभिन्न सम्वेष्ठन सामग्रियों मे टाट के बोरे मे नुकसान सबसे कम था।

✦ केन्द्र पर भारतीय मसाला सोसायटी, कलीकट, राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर तथा भारतीय कृषि अनुसंधान परिषद, नई दिल्ली के संयुक्त तत्वाधान में दिनांक 25 से 27 नवम्बर 2005 तक एक तीन दिवसीय सेमिनार " करेन्ट ट्रेन्ड इन ओनियन, गार्लिक, चिलीज एण्ड सीड स्पाईसेज-प्रोडक्सन, मार्केटिंग एण्ड यूटीलाइजेशन " का आयोजन किया गया।

उपरोक्त मुख्य उपलब्धियों के मद्देनजर विभिन्न क्षेत्रों में अनुसंधान तथा कमियाँ चिन्हित की गई। साथ ही साथ ही साथ एस आर सी में हुए बहसों तथा आर-ए-सी की संस्तुतियों को ध्यान मे रखते हुए नये प्रयोग बनाये गये तथा इन दोनो फसलों के उन्नयन के लिए उन्हे कार्यान्वित किया जा रहा है।

Executive summary

The National Research Centre for Onion and Garlic, Rajgurunagar is entrusted with the job of addressing all agricultural related issues of both the crops including the wild species. The mandate of the Centre has been formulated keeping in view these issues. Accordingly, during the year under report, many significant achievements have been made on the research front towards improvement of onion and garlic. Some of the major achievements are listed below:

- Eighty new germplasm accessions of onion were added to the gene pool. These included red, light red, flat, round etc. from Maharashtra, Karnataka and Tamil Nadu. Twelve accessions of onion and 152 accessions of garlic have also been obtained from NBPGR for evaluation, maintenance and multiplication.

- An expedition trip to the high mountains of Lahaul and Spiti and Pangi region of Himachal Pradesh was carried out in collaboration with NBPGR, Shimla. A total of forty-seven accessions comprising of onion, garlic and wild *Allium* species were collected and added to the wild germplasm gene pool.

- Amongst the sixteen lines selected for all season cultivation, B-780 and N-53 continued to be superior in terms of total as well as marketable yield during *kharif* 2005. For improvement of *kharif* onion, massing lines and bulb to row progeny was evaluated. Massing line Kh-985-03 and bulb to row progenies. NRCOG-1010-4 and NRCOG-927-4 showed superior performance in terms of marketable yield. In *rabi*, two lines NRCOG-1051 and NRCOG-571 recorded more than 40 t/ha in both total and marketable yield.

- Advanced onion lines developed by the Centre *viz*., B-780-5-3-1 and B-780-5-2-2 continued to showed superior performances in AICVIP trials.

- In white onion, a few lines were identified having higher marketable yield and TSS than the check Phule Safed for *kharif*. Thirteen lines gave significantly higher marketable yield over the

best check Pusa White Round and Phule Safed in late *kharif*. In *rabi*, four elite lines gave significantly higher marketable yield than check Phule Safed.

✦ In garlic, 6 germplasm lines showed significantly superior yield over G-41, whereas, five elite lines showed yields at par with G-41. Few mutated lines from G-41 (M3 generation) having significantly higher mean bulb weight over progeny mean of control G-41 has been identified using different chemical mutagens.

✦ Under DUS, twelve varieties were tested at Rajgurunagar Centre and it was observed that there were significant differences in almost all the attributes. Only five genotypes showed superior performance in terms of marketable yield. DUS National Test Guidelines for onion and garlic with visual graphics has been developed. A photo library for both the crops was developed. Both *kharif* and *rabi* trials were conducted at Rajgurunagar, Karnal, Mydukur and Srinagar, data compiled along with digital form and presented in the report.

✦ Protocol for micropropagation in both onion and garlic lines have been standardized *via* shoot multiplication and indirect organogenesis. Twenty-three garlic lines were assessed for genetic diversity using RAPD. It was noted that variation amongst the garlic accessions were about 44%, whereas, with onion it showed a similarity of only 33%.

✦ In production technology, effect of lihocin was tried for alteration of source sink relationship and it was found that two sprays of lihocin (6ml/l) at 60 and 75 days after transplanting and single application at 75 days and at 90 days after transplanting gave significantly higher yields with higher number of A grade bulbs.

✦ Comparison of different irrigation systems showed that drip irrigation gave better yield with highest percentage of A grade bulbs and about 38% water saving. Fertigation studies, based on the last three year's results showed that NPK 50:50:80 kg /ha as basal +100 kg N in seven splits through drip irrigation for onion and NPK 50:50:80 kg /ha as basal + 50kg N in seven splits through drip irrigation in the case of garlic was best for higher yield and benefit - cost ratio. This also resulted in 30-40% water saving compared to surface irrigation.

✦ Based on a five year study on onion based cropping systems, it was finalized that legume based cropping sequences *viz.*, groundnut-onion (late *kharif*) and soybean-onion (*rabi*) resulted in higher marketable bulb yields in onion. A similar study in garlic, for the last two years, showed that higher marketable yield was obtained in pea-garlic sequence, whereas, higher B:C ratio was seen in soybean-garlic pattern.

✦ In integrated nutrient management, it was observed that soybean as preceding crop had significantly improved the soil fertility parameters. Amongst the different INM modules tried, the module having FYM + 50% RDF + S recorded the highest marketable yield.

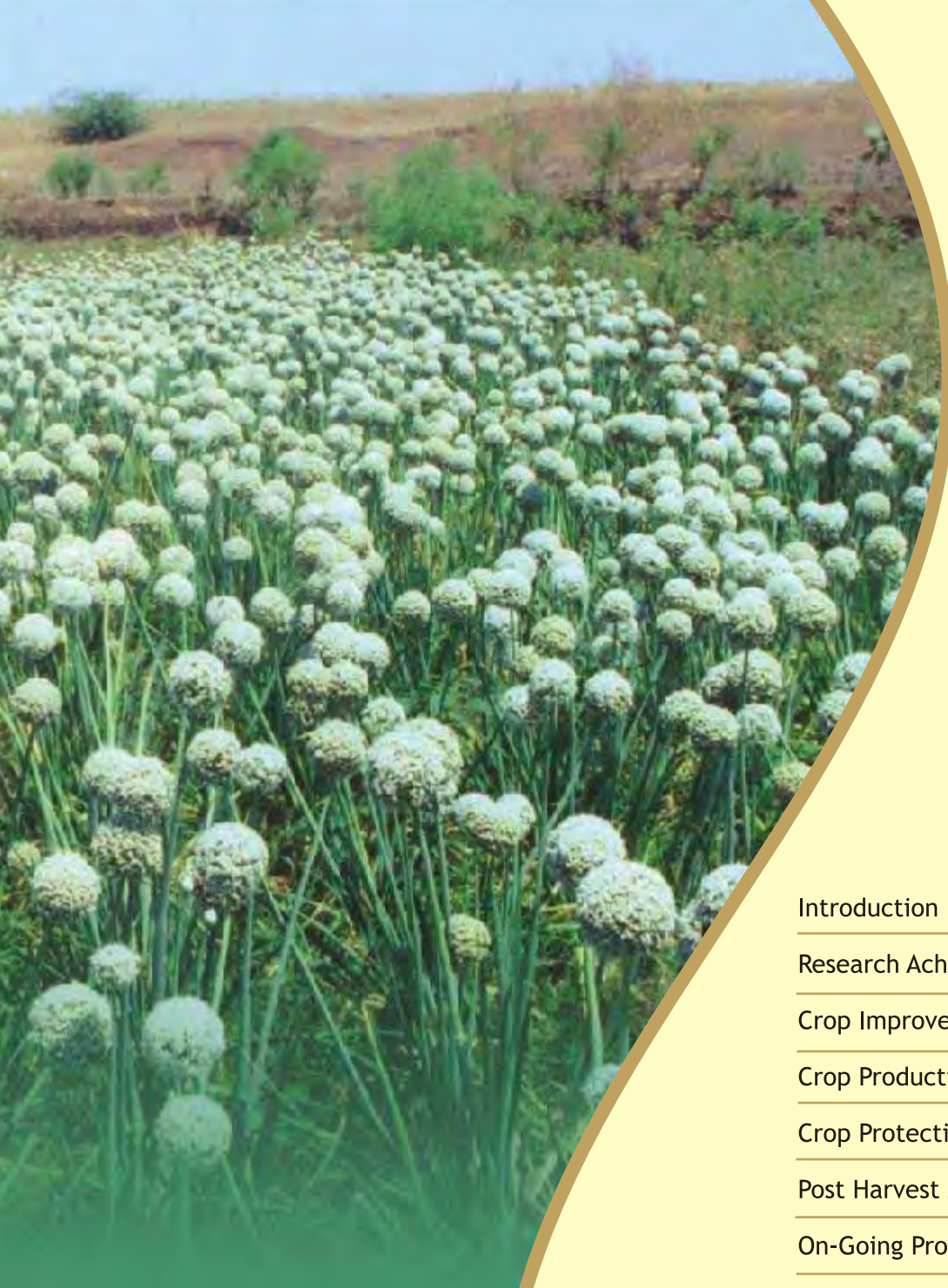
✦ In the experiment on seed viability and vigour in B-780, it was seen that seeds stored in desiccator showed the highest percentage of germination and seed vigour index after 18 months of storage. With regards to seed moisture and packing material, highest germination percentage and seed vigour index was noted in seeds(ALR and ADR) having 5% moisture packed in laminated aluminium bags with vacuum packing after 15 months of storage.

✦ Barrier cropping with maize + wheat was found to be effective in blocking 80% of thrips. This technology has the advantage of the highest B:C ratio as well as it minimizes the insecticide applications by half in onion. Few insect pathogen strains were tested for their efficiency in bringing down the thrips population. However, it was noted that though the thrips population was reduced, they failed in bringing down the population to below ETL. Role of insectory plants to attract natural enemies in onion and garlic was studied as a part of biocontrol measures and it was observed that few predators namely, ladybird beetle *viz., Cheilomenes sexmaculata* and minute pirate bug, *Orius tantillus* were found to be attracted by sunflower and maize significantly.

✦ In the area of post harvest studies in onion and garlic, sulphur fumigation was found to reduce black mould infection in stored onions, whereas in garlic, fumigation resulted in reduced rotting of bulbs. Effect of gamma irradiation on a few onion varieties indicated that sprouting was effectively checked irrespective of season or colour. Effect of different storage structures on shelf life of onion showed that forced ventilation with exhaust fan recorded the minimum losses. And of the different packing materials used, hessian cloth bag resulted in the least losses.

✦ A three day National Symposium was organized at the Centre in association with Indian Society for Spices, Calicut, NRC for Seed Spices, Ajmer and Indian Council of Agricultural Research, New Delhi on "Current trends in onion, garlic, chillies and seed spices production, marketing and utilization" during 25-27 November 2005.

Keeping in view all the major achievements in the various fields of research and the gaps / constraints identified and also taking into consideration the discussions in the SRC and recommendations of the RAC, new trials have been formulated and are been implemented for the further improvement of these two crops.



Contents

Introduction

The Centre

The Indian Council of Agricultural Research (ICAR) established the National Research Centre for Onion and Garlic in the year 1994 and sanctioned the same during VIII plan with its headquarters at Nasik. Though the centre was initially located in Nasik, it was shifted to Rajgurunagar, 43 km away from Pune on Pune-Nasik highway and started functioning at the new location from June 1998.

Location and Weather

The centre is located at 18.32^0 N and 73.51^0 E at 553.8 m above m.s.l. with a temperature range of 5.5 ^{0}C - 42.0 ^{0}C having an annual average rainfall of 669 mm.

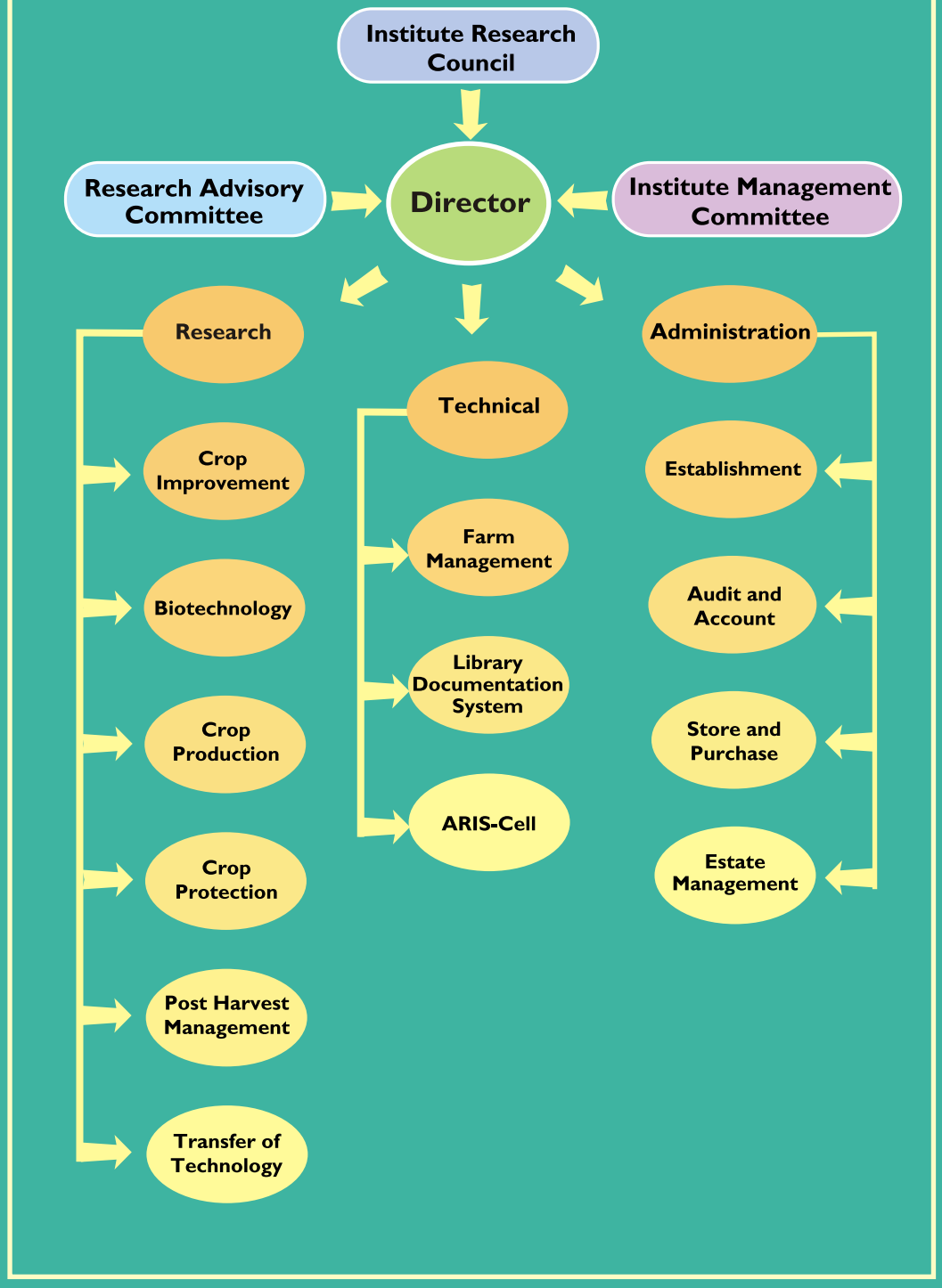
Mandate

* To collect, maintain and act as national repository for onion and garlic.
* To develop varieties/hybrids suitable for domestic and export market coupled with resistance to biotic and abiotic stresses.
* To enhance and sustain productivity and production of quality seed as well as bulb crop through agronomic innovations.
* To develop integrated pest and disease management for high bulb and seed yield.
* To develop technologies for post harvest handling of onion and garlic.
* To act as a clearing-house for research and technical know-how related to onion and garlic.
* To act as national trainers training centre for technology dissemination of onion and garlic.

Infrastructure

The Centre has 55 acres of research farm with perennial irrigation facilities at Rajgurunagar, 25 acres at Kalus and 10 acres at Manjri. Research laboratories of horticulture biotechnology, soil science, plant protection and post harvest technology were further strengthened with modern equipments. The facilities for Internet and e-mail connectivity have been created. The library is having 508 books, 18 national and 5 international journals, CD server, Hort-CD and other relevant facilities.

Organogram


Institute Research Council
Research Advisory Committee
Director
Institute Management Committee
Research
Crop Improvement
Biotechnology
Crop Production
Crop Protection
Post Harvest Management
Transfer of Technology
Technical
Farm Management
Library Documentation System
ARIS-Cell
Administration
Establishment
Audit and Account
Store and Purchase
Estate Management

Research Achievements

Crop Improvement

Development of onion (red and light red) varieties/hybrids suitable for different seasons and resistance to biotic and abiotic stresses

Germplasm collection, evaluation and maintenance

During the year 2004-05 eighty new germplasm accessions were added to the gene pool. This includes dark red, light red, with round, flat, flattish round shapes from Maharashtra, Karnataka and Tamil Nadu. Twelve accessions have also been introduced from NBPGR. All the accessions are being maintained through seed production in cages.

Post harvest performance of late *kharif* and *rabi* (2003-04) germplasm

Results revealed that, after 120 days of storage 17 entries *viz.*, NRCOG-158, 711, ALR, 577, 677, 1045, 465, 612, 634, Pusa Red, 547, 632, 619, 657, 674, B-780 and 746 showed less than 20% weight loss. 39 accessions recorded percent weight loss between 20-30% and 27 entries recorded between 30-40% weight loss. The lines with less than 20% weight loss having high yield could be considered for further evaluation.

In case of *rabi* germplasm under storage 10 lines *viz.*, NRCOG-158, 205, 450, 711, 1044, 14-2, 168, 465, 687, 1017 recorded less than 30 % weight loss. The three elite lines NRCOG-571, 597 (Fig.1) and Composite recorded 30-40 % weight loss. Standard varieties N-2-4-1, ALR, Arka Niketan recorded 40-50 % weight loss. Pusa Red and Pusa Madhavi varieties recorded more than 50 % weight loss after 120 days of storage.

Fig.1

Elite lines grown in late *kharif* 2005

Two elite lines *viz.*, Composite and NRCOG-671 recorded minimum weight loss of 35.8 and 36.6 % respectively, followed by NRCOG-595 and 597 with weight loss of 40.6 and 42.3 % respectively.

Evaluation of *kharif* (2005) germplasm for yield and quality

Among the 83 lines evaluated, variety B-780 (35.83 t/ha) continued to be superior in terms of yield followed by K-519 and NRCOG-985. The 5 bulb weight was maximum in NRCOG-923 (0.28 kg) followed by NRCOG-1025

(0.27 kg) and N-53 (0.26 kg), whereas it was minimum in B-780 (0.24 kg), NRCOG-948, 985 and 930. Arka Kalyan and B-780 recorded higher TSS of 12.72 and 12.75 % respectively. The shape index was maximum in NRCOG-879 (0.94) and Arka Kalyan (0.91) and NRCOG-905 (0.90). The accessions NRCOG-992 and 906 recorded minimum neck thickness whereas NRCOG-966 and 999 recorded minimum pseudostem diameter. Majority of the accessions recorded 10-12 leaves per plant with a height of 65-70 cm.

Evaluation of superior germplasm lines suitable for year round cultivation in *kharif* 2005

On perusal of results it is indicated that 12 lines (NRCOG-901, ADR, 1012, 939, 938(Fig.2), 905, 940, 909, 925 (Fig.3), 914, 923 and 888) showed superior performance (range: 17.2-24.33 t/ha). However the wide range in yield gap between total yield and marketable yield is evident in the lines NRCOG-939 (31.7/21.6 t/ha), 901(31.7/24.33 t/ha), 1012(31.6/21.3 t/ha), 925(29.2/18.6 t/ha), 950(28.3/16.88 t/ha), 914(28.0/18.0 t/ha) and 940(28.0/19.0 t/ha) and requires immediate attention for exercising selection pressure for quality bulbs.

Fig.2

Fig.3

Performance of advanced breeding line in *kharif* 2005

The massing line developed from Kh-985-03 showed superior performance (58.3 t/ha) in terms of marketable yield followed by N-53-03 (31.7 t/ha) and Kh-930-03 (18.3 t/ha) and 976-03 (17.3 t/ha). The desirable attributes have been achieved with globe shape and deep red colour in massing lines kh-993-03, 931-03, 988-03 and globe-03. However there is a need for improvement for yield in all the massing lines except 986-03, which has recorded 15.6 t/ha yield.

The lines developed through bulb to row method for *kharif* showed superior performance in terms of marketable yield to the tune of 22.7 t/ha in NRCOG-1010-4 and 70.0 t/ha in NRCOG- 927-4. Desirable quality and shape were observed in four bulb to row progenies of 925-2, 925-5, 927-3 and 994-1. Minimum neck thickness was recorded in a good number of bulb to row progenies with desirable shape. The selection pressure was exercised for quality bulbs for advancing the generation.

Combining ability and heterosis

Significant differences were observed for the characters, plant height, collar thickness, polar diameter, plot yield and marketable yield for all the crosses tested. Further, pooled analysis revealed that, significant differences were observed among the parents for characters *viz.*, plant height, number of leaves, collar thickness, plot yield and marketable yield. However, only three attributes showed significant difference

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Performance of elite lines in *rabi*, 2004-05

It is indicated that elite lines and Composite recorded maximum total yield and marketable yield followed by EL-654 (34.93). 10 bulb weight was recorded maximum in EL-597 (1.00 kg) followed by EL-595 (Fig 5) (0.9 kg) and Composite (0.89 kg). However, EL-654 (8.19 kg) recorded maximum 'A' grade bulbs followed by Composite (6.8 kg) and EL-595 (6.43 kg). 'B' grade bulbs were maximum in composite (8.21 kg) followed by EL-597 (7.67 kg) and EL-650 (7.32 kg). TSS was maximum in EL-671 (13.06%).

Fig. 5

Performance of parents and hybrids in *kharif*, 2005

A total of 8 parents and 17 crosses have been evaluated in row trial to see the potentiality of hybrids in *kharif* season. On perusal of results, the parent NRCOG-938 recorded maximum total yield (29.2 t/ha) and marketable yield (25.8 t/ha) followed by B-780 (18.9 and 18.2 t/ha) and NRCOG-925 (16.2 and 14.8 t/ha). Among the crosses, NRCOG-938 X ADR (51.1 t/ha) recorded the highest total yield followed by NRCOG-937 X B-780 (47.2 t/ha), NRCOG-985 X B-780 (43.8 t/ha), B-780 X AK (28.5 t/ha) and ADR X AK (23.7 t/ha) Selected crosses will be utilized for seed production to raise transgressive segregants.

Evaluation of F1 hybrids in *kharif*, 2005

18 hybrid combinations were evaluated in row trial to study the growth and yield parameters. The study revealed, which only three hybrid combinations *viz.*, MS-65A X NRCOG-905; MS-48A X NRCOG-1005 and MS-65A X AK, which recorded 50.8 and 31.8, 27.0 and 23.5, 27.1 and 25.4 t/ha of total and marketable yield respectively. There were no significant differences in expression of other attributes. However, 5 bulb weight was minimum in all the combinations. The TSS ranged from 10.28 to 12.12 %.

Performance of F_2 population in *kharif*,2005

10 F_2 crosses were evaluated in row trial for growth and yield. On perusal of results, higher yield was recorded in MS-48A X 1009 (32.3 t/ha) followed by MS-48A X 1010 (28.4 t/ha) and MS-65A X 974 (20.3 t/ha). Selection pressure was exercised from these crosses for selecting the bulbs in advancement of generation.

Evaluation of back cross population in *kharif*, 2005

9 back cross population were evaluated for growth and yield parameters. Superior performance was registered in the combination of MS-65A x 889 BC_1 (29.8 t/ha), MS-48A x 742 BC_1 (24.5 t/ha) and MS-65A x 1000 BC_1 (22.8 and 21.0 t/ha). The bulbs were planted to raise BC_2 population.

Among the lines, Kh-976-03 (34.0 t/ha) showed supremacy in total yield followed by Kh-993-03 (31.5 t/ha) and Kh-985-03 (22.0 t/ha). The average among all the massing lines being 23.4 t/ha, weight of 'A' grade bulbs was maximum in Kh-519-R-m-02 (0.98 kg). All the massing lines were forwarded to next generation after exercising selection pressure for desirable qualities.

Evaluation of bulb to row population in *kharif*, 2005

27 desirable quality bulbs were selected in order to raise population through bulb-to-row programme. During the first cycle, the seeds were produced by planting the selected bulbs. Plants raised from the first cycle were evaluated for growth and yield parameters in order to exercise selection pressure for selecting the desirable quality bulbs.

On perusal of results, it is indicated that NRCOG-974-5 (50.0 t/ha) showed supremacy in both total and marketable yield followed by NRCOG-980-5 (38.5 t/ha), Rose onion (35.7 t/ha), 1014 (33.8 t/ha) and 1009-5 (31.2 t/ha). The study further revealed that high TSS *kharif* lines can be identified through bulb to row method as it was evident in the Rose onion (15.32 and 14.0%) followed by NRCOG-980-5 (13.2%), NRCOG-980-3(12.80%) and NRCOG-1008-2 (12.80%). However, the 5-bulb weight was maximum in all the populations.

Performance of 29 germplasm lines grown in *kharif*, 2005

On perusal of results it is indicated that NRCOG-973 (24.8 t/ha) recorded superior performance followed by ADR (24.1 t/ha), B-780 (23.9 t/ha) and NRCOG-1163 (22.4 t/ha). The check variety N-53 recorded 16.4 t/ha. All superior performing lines recorded less marketable yield and needs improvement. B-780 (22.0 t/ha) recorded maximum yield. The average mean recorded for 5-bulb weight is 0.21 kg only. The range for days to maturity was 115 to 125 days and the average neck thickness recorded was 0.71 cm. The maximum TSS was recorded in Rose onion (16.0%) followed by NRCOG-1031 (14.0%), NRCOG- 1036 and NRCOG-1093 (12.5%).

Performance of improved lines for all season cultivation in *kharif*, 2005

16 improved lines have been evaluated in two replications for all growth and yield parameters. The analysis of variance indicated that significant differences were observed among the entries tested for the characters: total yield, marketable yield, 5-bulb wt., equatorial diameter, no. of leaves and plant height. On perusal of results the check varieties B-780 and N-53 continued to prove superior in terms of total yield and marketable yield. However, among entries, NRCOG-923 (19.4 t/ha) recorded maximum yield followed by NRCOG-922 (17.8 t/ha) and produced attractive dark red bulbs. The TSS ranged from 9 to 12%. All the lines came to maturity between 114 to 126 days.

Performance of elite lines in respect of 6 seed yield characters

On perusal of results it is indicated that EL-654 (74.26 cm) recorded maximum scape length followed by EL-595 (73.95 cm), EL-597 (73.55 cm) and EL-671 (73.34 cm). The scape diameter was maximum in EL-592 (1.73 cm) followed EL-671 (1.57 cm) and EL 546 (1.56 cm). However the umbel diameter was maximum in EL-592 (8.69) followed by EL-597 (8.58 cm) and EL-546 (8.52 cm). 1000 seed weight was maximum in EL-651 (4.93 g), EL-651 (4.88 g) and EL-595 (4.83 g). The seed yield was maximum in EL-546 (20.82 g) followed by EL-671 (19.64 g). However, in general the reduction in seed yield was due to heavy infection of Iris yellow spot virus disease. Association of components revealed that scape length had significant positive association with umbel diameter, while 1000 seed weight had significant positive association with seed yield.

Line X Tester analysis for *kharif* onion

On perusal of results, it is indicated that, only three parents i.e. B-780 (1.31**), NRCOG-914 (0.44**), NRCOG-1005 (0.16*) and among the lines MS-65A (0.07**) showed positive and significant GCA effects for total yield. One parent for weight of 'A' grade bulbs, 2 for TSS, 5 for equatorial diameter, 7 for polar diameter and 2 for number of leaves showed positive and significant GCA effects. Whereas, negative and significant GCA effects were recorded in 4 parents for neck thickness and 6 for pseudostem diameter.

On perusal of results, it was indicated that, variance due to SCA effects for all the characters were higher than the GCA effects for all the characters suggesting that, yield components are observed predominantly governed by non additive gene action. Further results indicated that positive significant differences among the SCA effects were observed in one cross each in plant height and number of leaves, 2 for polar diameter and 3 for weight of 'A' grade bulbs.

These results inferred that, the cross combination of MS-48A x B-780, MS-65A x B-780, MS-65A x NRCOG-914 and MS-65A x AK may be tested further for durable heterosis in *kharif* season.

Genotype × Environment interaction for all season cultivation

On perusal of results it is indicated that, NRCOG-905 (Fig.6) (xi=3.41; bi=0.003 and s^2di=0.13), (xi=2.65; bi=0.001 s^2di=0.11) recorded maximum of both total and marketable yield, with less than unit regression coefficient and minimum deviation from regressions. As such NRCOG-905 is suitable for *kharif*, late *kharif* and *rabi* conditions. Further the results indicated that eight lines each for total and marketable yield, ten for neck thickness, five for TSS, eight for polar diameter, seven for equatorial diameter, eight for 5 bulb weight, eight for days to maturity and seven each for plant height and number of leaves showed superior performance by recording higher mean values.

Fig.6

DUS Characterization

- National Test Guidelines for onion and garlic along with visual presentation have been developed.
- Both *kharif* and *rabi* trials were conducted at Rajgurunagar, Karnal, Mydukur and Srinagar. The data were compiled along with digital form and presented in the report.
- Photo library of onion and garlic as per National Test Guidelines has been prepared.
- Annual Report of DUS is in progress.

Development of onion (white and yellow) varieties/ hybrids for processing, export and resistance to biotic and abiotic stress

Evaluation of white onion germplasm during *kharif* , 2005

Sixty five white onion germplasm accessions were evaluated during *kharif, 20*05 in three replications on raised beds with drip irrigation. Maximum plant height and number of leaves were recorded up to 61.39 cm and 11.20 per plant, respectively while minimum being 22.11 cm and 5.70/plant, respectively. Collar thickness ranged from 0.69 to 1.52 cm and neck thickness from 0.51 to 1.34 cm. TSS was maximum (13.32%) in w-066 but its total yield was very less i.e. 3.72 t/ha. Marketable yield and TSS was higher than check Phule Safed in w-056 and w-448-BR-2 (Fig.7) (18.17 t/ha and 11.38% and 20.78 t/ha and 11.66%, respectively). Maturity was earliest in w-203 (113 days after planting). Line w-118 matured in 120 days after planting with 17.78 t/ha total yield as compared with Phule Safed, which took 127 for maturity with 15.33 t/ha total yield. Percent A grade bulb was very less in the germplasm and ranged from 0 to 7.22%. It was 0.98% in Phule Safed and 1.66% in AFW. Among the lines, marketable yield and total yield was maximum (20.78 and 23.33 t/ha, respectively), against best check Phule Safed (10.39 and 15.33 t/ha). Four germplasm lines gave significantly higher total yield (20.56 to 23.33 t/ha) over Phule Safed (15.33 t/ha). Ten lines gave significantly high marketable yield (13.71 to 20.78 t/ha) over check Phule Safed.

Fig.7

Evaluation of white onion elite lines during *kharif* , 2005

Seven elite lines were evaluated in plots of 1 x 6 m area per replication during *kharif*. Despite heavy rains and disease incidence, two lines w-009Kh (12.23 t/ha) and w-302Kh (12.45 t/ha) gave significantly higher total yield over check Phule Safed (9.15 t/ha). Marketable yield was also higher in w-009Kh (9.96 t/ha) and w-302Kh (9.71 t/ha) against check P.Safed (7.63 t/ha). Collar thickness (1.06 cm) and neck thickness (0.82cm) was lesser in w-302Kh whereas, it recorded minimum of 0.68 cm in w-448-BR-2 and AFW. Percent A grade bulbs were highest in w-397Kh (43.73%) followed by w-302Kh (39.41%), w-448BR-2 (31.89%) and w-009Kh (28.01%) compared to check Phule Safed (26.89%). Percent doubles were lowest in w-009Kh (4.74%) followed by w-448BR-2 (6.23%). In varieties it ranged from 7.52 to 10.9%. Percent marketable bulbs in varieties ranged from 64.48% in JNDWO-85 to 84.04% in Phule Safed. In high yielding germplasm *viz.*, w-009Kh (Fig. 8) (81.59%), w-302 Kh (77.5%), w-397Kh (Fig. 9) (75.35%) and w-448BR-2 (86.8%), there is scope for further selection to increase percent marketable bulbs. Line w-009Kh and w-302Kh were selected from red segregating populations. In IV generation of w-009Kh, bulb colour segregation was reduced to 3.95% and in second generation of w-302Kh the colour segregation reduced to 22.56%. Thus w-302kh can further be purified and will be suitable for *kharif* season.

Fig.8

Fig.9

Evaluation of white onion breeding lines during *kharif*, 2005

Out of 44 breeding lines selected for *kharif* season, only 7 lines could be evaluated in replicated trial due to production of less seeds. Only one line w-021/M-2Kh yielded significantly higher for total yield (25.64 t/ha) and marketable yield (15.0 t/ha) over Phule Safed, which recorded 13.67 and 10.67 t/ha, respectively. Line w-355/M-2 Kh recorded the highest TSS of 13.61% with marketable yield 7.78 t/ha over Phule Safed. There is a scope for further improvement of w-021/M-2 Kh as doubles were 32.37% thus reducing the percent marketable bulbs (55.55%) against 79.24% in Phule Safed. Rest of the lines was planted for multiplication and further selection. There are chances of inbreeding depression due to strict selection and development of poor umbels due to viral disease affecting seed yield. These lines after purification can be multiplied in large cages and utilized for the development of composites and as parental lines.

Evaluation of white onion germplasm during late *kharif*, 2004-05

Forty eight lines were evaluated in three replications during late *kharif*. 13 lines gave significantly higher marketable yield (31.56 to 47.75 t/ha) over best check Pusa White Round (25.67 t/ha) and Phule Safed (24.05 t/ha). Total yield ranged from 18.24 to 66.5 t/ha in germplasm lines while, it was 33.0 to 37.12 t/ha in five white varieties. TSS varied from 9.96 to 11.67% in the germplasm lines and in varieties it was 10.76 to 11.54%. Days to harvest were significantly earlier (102 to 106 days after planting) in 16 lines, over the checks,

which took 120 to 123 days to harvest. Five lines *viz.*, w-422, w-222, w-197, w-193 and w-442 recorded higher yield and early maturity (102 to 106 DAP) than the checks. Bolters ranged from 0 to 34.72% in the germplasm whereas, in varieties it was 5.59 to 25.58%. 9 lines recorded no bolters and 20 entries recorded less than 5.0% bolters. Doubles were 2.09 to 61.54% in germplasm and in varieties it was 11.76 to 44.45%. Less than 5.0% doubles were recorded in 3 entries.

Evaluation of white onion breeding lines during late *kharif*, 2004-05

Ten breeding lines were evaluated in replicated trial during late *kharif*. Total yield was higher in massing lines w-127Kh/02M, w-174Kh/02M and w-429/M, which ranged from 41.17 to 46.11 t/ha against checks Phule Safed (34.0 t/ha) and PWR (35.24 t/ha). Marketable yield was significantly higher in 5 massing lines (30.48 to 38.0 t/ha) against check Phule Safed (23.05 t/ha) and PWR (24.38 t/ha). In varieties, total yield ranged from 28.05 to 35.24 t/ha and marketable yield from 13.10 to 24.38 t/ha. Percent marketable bulbs in the lines with higher total yield were 73.0%-87.0% indicating the scope for further improvement. Percent marketable bulbs were highest (94.3%) in w-444/M that recorded maximum marketable yield (38.0 t/ha). There was no significant difference for TSS, which ranged from 10.0 to 11.4% in these lines. In three lines bolters were not found and doubles were less than 5.0%. Lines *viz.*, w-444/M, w-429/M, w-174Kh/02M matured 7 to 15 days earlier than checks, which took 114 to 120 days to harvest.

Evaluation of exotic onion hybrids during late *kharif*, 2004-05

20 exotic hybrids along with 5 varieties were evaluated during late *kharif*. Total yield was significantly higher in Hy. Excalibar (31.29 t/ha) followed by Hy. Early Supreme White (31.17 t/ha) over checks B-780 (24.4 t/ha), N-2-4-1 (24.68 t/ha) and ALR (22.14 t/ha). Marketable yield was also higher in three hybrids *viz.*, Hy. Excalibar (30.81 t/ha), Hy. Early Supreme White (28.92 t/ha) and Lexus 15549-1 (24.74 t/ha) over best check B-780 that yielded 20.54 t/ha. Percent TSS varied widely from 5.98% in Hy. Early Supreme White to 14.25% in Hy. Pune Red against the varieties, which had a range from 10.35 to 11.95%. Percent marketable bulbs were as high as 98.48% to a minimum of 56.55% in these hybrids. 10 hybrids recorded more than 90% marketable bulbs over the varieties, which had 34.34 to 78.13% marketable bulbs. No bolting was noticed in 18 hybrids except Hy. Lucifer and Hy. Pune Red, which had 15.79 and 17.46% bolters, respectively. Bolters in the varieties was minimum (10.15%) in B-780 and maximum (39.39%) in Phule Suwarna. Double bulbs were 0 to 25.10% in the hybrids against 0.42 to 16.49% in the varieties. No doubles were recorded in 7 hybrids and less than 5.0% in 17 hybrids. Hy. Lucifer was earliest in maturity (137 DAP) and most of the hybrids came to harvest from 140 to 146 DAP.

Evaluation of white onion germplasm during *rabi*, 2004-05

88 lines were evaluated during *rabi* in replicated trial. Marketable yield in the germplasm ranged from 4.05 to 33.89 t/ha, whereas total yield ranged from 7.95 to 44.82 t/ha. Two lines *viz.*, w-420 and w-332 gave higher marketable yield of 33.89 and 29.69 t/ha, respectively. Accession w-401 (44.82 t/ha), w-420 (36.47 t/ha), w-332 (33.39 t/ha) and w-355 (32.64 t/ha) gave significantly high total yield than the best check Phule Safed (28.65 t/ha). TSS in the germplasm ranged from 10.17 to 13.02% whereas in checks it was less than 10.87%. 18 germplasm lines had significantly higher TSS than the checks. Days to maturity varied from 118 to 133 days after planting. 14 germplasm lines were 8 to 10 days earlier than check varieties, which took 130 days to harvest. Percent doubles ranged from 0 to 42.14% and 30 lines recorded no doubles and bolters. Percent doubles in high yielding germplasm was 3.47% in w-420, 4.24% in w-355, 5.95% in w-332 and 31.7% in w-401. There is scope for further improvement in the germplasm w-401, which recorded highest total yield of 44.82 t/ha.

Evaluation of white onion elite line during *rabi*, 2004-05

12 elite lines were evaluated during rabi in 3 replications. 4 lines gave significantly higher total yield ranging between 22.05 to 26.21 t/ha than check variety Phule Safed (17.06 t/ha). Marketable yield was significantly high in 3 germplasm lines *viz.*, w-302 (Fig. 10) (24.58 t/ha), w-404 (21.55 t/ha) and w-411 (20.61 t/ha) against check Phule Safed (16.53 t/ha). Days to maturity in these lines ranged between 136 to 140 days after planting. TSS in w-394 was maximum (11.32%) while in Phule Safed it was 10.43 and in AFW it was 10.52%. Percent doubles were nil in w-302, w-422 and Phule Safed and it was 4.67%, 5.45% and 12.6% in high yielding lines *viz.*, w-411, w-404 and w-394, respectively. Lines w-302, w-404, w-411 and w-394 are better for most of the desirable characters except w-394 for doubles, which will be improved further.

Fig.10

Evaluation of white onion breeding lines during *rabi*, 2004-05

38 breeding lines were evaluated in three replication during *rabi*. Total yield ranged from 8.98 to 36.92 t/ha in these lines, whereas in varieties it varied from 18.71 to 20.61 t/ha. 8 lines gave significantly high total yield from 25.30 to 36.92 t/ha and marketable yield from 22.24 to 34.80 t/ha, against checks PWR (20.61 and 17.69 t/ha, respectively) and Phule Safed (19.15 and 17.48 t/ha, respectively). Marketable yield in these lines varied from 7.28 to 34.80 t/ha and in varieties it was 11.76 to 18.40 t/ha. TSS ranged from 9.88% to 11.86% in these lines and in varieties it was 11.60% in Udaipur-102 to 12.24% in Phule Safed. Two lines (w-043/M and w-411/M) were earliest in maturity (126 DAP) with more than 21 t/ha marketable yield having TSS 11.0% against check Phule Safed that took 130 days to harvest with 17.48 t/ha marketable yield. There were no bolters and double bulbs were very less in these lines. No doubles were recorded in 20 lines while in varieties it ranged from 1.10% in JNDWO-85 to 27.62% in Udaipur-102. Percent A grade bulbs were more than 40% in three lines. Hence bulbs from these will be selected for multiplication and will be evaluated for

Evaluation of white onion high TSS lines during *rabi*, 2004-05

101 high TSS bulbs were selected in 2000-01 having TSS more than 15% out of about 7000 bulbs from 300 germplasm lines and selfed in 2001-02. TSS of all the bulbs in the progeny was recorded during 2002-03 and 114 high TSS massing groups were made from the bulbs having TSS more than 15%.These bulbs were planted for seed production during 2003-04 and the massed progeny was evaluated during 2004-05. Out of 114 massing groups planted for seed production, seeds were produced from 21 groups only due to heavy incidence of IYSV. Total yield was maximum (12.0 t/ha) in w-275-18/Ht-1MRb, whereas in white varieties it ranged from 12.3 to 15.4 t/ha. Average percentage of TSS in these lines was maximum (18.8%) and in varieties it was 11.3%. In line w-293-02/Ht-5M-Rb, 84% bulbs recorded TSS more than 15% and 62% bulbs recorded more than 17% TSS. Percent number of bulbs having TSS more than 15% ranged from 84% to 10% and more than 17% from 62 to 3%, whereas in varieties no bulbs recorded TSS more than 15%. Among the 21 high TSS lines, TSS of single bulb (mother bulb) ranged between 15 to 23%. In first generation selfed progeny, mean TSS ranged from 14 to 20% and in first generation massing progeny it ranged from 13.6 to 19.6%. Further, high TSS bulbs from these segregating populations were selected and planted in massing cages for multiplication to obtain second-generation massing progeny.

Evaluation of late *kharif* white onion germplasm and breeding lines for storage studies

36 late *kharif* germplasm lines were stored up to 3 months and total storage losses were recorded. Storage losses after 1, 2 and 3 months of storage ranged from 2.27 to 25%, 19.39 to 40.08% and 34.30 to 67.47% in these lines, while the losses in Phule Safed was 15.94%, 33.67% and 67.47%, respectively. After two months of storage, losses in 10 lines were less than 25% against check Phule Safed (33.67%). Losses in line w-197 was lowest, up to 34.33% against check Phule Safed (67.47%) after 3 months of storage and 4 lines recorded storage losses less than 40%.

12 late *kharif* breeding lines were stored up to 3 months and total storage losses were recorded. After 2 and 3 months of storage, losses ranged from 22.98 to 36.74% and 39.08 to 62.82% in these lines, while the losses in Phule Safed was 32.42% and 69.81%, respectively. After two months, storage losses in w-311Lk-2/02M, w-473/02, w-127 Kh/02M and w-435/M were up to 25.0% against the check Phule Safed (32.42%). Losses in line w-435/M, w-311Lk-2, w-444/M were up to 44.94% after 3 months against check Phule Safed (69.81%). Lines w-444/M and w-127Kh/02M were also high yielders besides having comparatively better storage life than the check.

Evaluation of *rabi* (2004-05) white onion germplasm, elite lines and breeding lines for storage studies

123 *rabi* white onion germplasm lines were evaluated for storage life along with 3 white and 2 red checks. Percent total loss was recorded from 2 to 5 months of storage. Percent total loss after 2, 3, 4 and 5 months of storage ranged from 5.79 to 39.58%, 11.56 to 53.43%, 22.25 to 78.70% and 25.27 to 85.46% in the germplasm, respectively. In white varieties, it ranged from 65.21 to 75.60% total loss after 5 months of storage, while in red varieties it was 25.27% in N-2-4-1 and 56.32% in ALR. Less than 30% losses after 4 months and less than 40% losses after 5 months of storage were recorded in 8 germplasm which were nearer to ALR and N-2-4-1 having better storage life. However, white varieties had losses more than 48.8% after 4 months and 65.2% after 5 months of storage.

12 *rabi* white onion elite lines were evaluated for storage life upto 5 months of storage. Losses after 4 months and 5 months of storage ranged from 48.68 to 85.31% and 58.81 to 91.06%, respectively. In white varieties, it was minimum (62.09%) and in red varieties, it was 36.37%, after 5 months of storage. Losses in Phule Safed went upto 83.81%. Line w-437 recorded lowest losses upto 48.68% after 4 months and 58.81% after 5 months of storage, which was better among the white varieties as compared to Phule Safed and it was near to ALR, which recorded 44.99 and 47.36% losses, respectively.

10 high TSS *rabi* white onion lines were also evaluated for storage life upto 5 months of storage. Losses after 5 months of storage ranged from 31.1 to 78.3% while the lowest was in w-293-02/HT-4MRb followed by w-HT/M-Rb (33.1%). Top 5 lines recorded storage losses from 31.1 to 45.4% against check Phule Safed (78.3%) after 5 months of storage and it showed a minimum of 50.2% in JNDWO-85, among white varieties .

Evaluation of yellow onion germplasm during *rabi*, 2004-05

Out of 13 accessions evaluated during *rabi*, total yield ranged from 3.85 to 20.50 t/ha in the germplasm whereas in check it was 12.86 t/ha. Three accessions y-004 (20.50 t/ha), y-003 (15.87 t/ha) and y-009 (13.98 t/ha) gave higher total yield over check. Marketable yield was also high in these lines and it was 14.37 t/ha in y-004, 14.05 t/ha in y-003 and 11.55 t/ha in y-009 over check P. Suwarna (10.01 t/ha). Percent Marketable bulbs ranged from 30.99 to 93.75% and doubles from 0 to 25.35%. Days to maturity was from 119 to 137 DAP.

Development of hybrids in onion during *rabi*, 2004-05

Four hybrids were developed using male sterile line MS65A and one with MS48A at NRCOG and evaluated along with 2 hybrids, one developed by IARI (Hybrid-44) and one by Indo-American Seed Co. (Hy. Syn-3) and 2 *rabi* varieties as checks. Percent A grade bulbs were more in the hybrids as compared with the checks. It ranged from 38.45 to 56.38% in the NRCOG hybrids and it was 52.92% in Hy. Syn-3 and 27.64% in Hy. 44, against the check N-2-4-1 (33.97%) and ALR (39.03%). Percent double bulbs in the crosses was also less (1.14 to 5.36%) against the check varieties N-2-4-1 (4.79%) and ALR (13.94%). Percent marketable bulbs were more in the hybrids as compared with the checks. Marketable yield of NRCOG hybrids ranged from 27.1 to 31.8 t/ha, while it was 26.9 t/ha in Hy.Syn.-3 and 16.33 t/ha in Hy. 44. Total yield in ALR and N-2-4-1 was 26.92 and 25.89 t/ha and marketable yield was 22.59 and 23.44 t/ha, respectively. Percent heterosis ranged between 7.83 to 21.52% over better parent and percent superiority was 18.89 to 26.29% over best check for marketable yield and it was 8.46 to 19.86% for total yield over best check.

Varietal evaluation trial under AICRP project

Varietal evaluation trial of onion-IET, AVT-I and AVT-II during *rabi*, 2004-05

Seven entries along with two checks were received and evaluated during *rabi* 2004-05. PKV White Sel. gave significantly higher total yield (32.7 t/ha) but marketable yield was quite less (23.8 t/ha), with only 72% marketable bulbs. It was followed by Syn-3 (27.5 t/ha) for total yield. Marketable yield was significantly high in Syn-3 (26.9 t/ha) than both the checks. Percentage of doubles was very high in Punjab White (34%) followed by Sel-383 (28%) and PKV White Sel (23%). Rest of the varieties were not superior over both the checks.

Four entries along with two checks were evaluated during *rabi* 2004-05 in AVT-I. Total yield was significantly high in variety B-780-5-3-1 (30.0 t/ha). It was followed by B-780-5-2-2 (26.2 t/ha), which was at par with check ALR (26.0 t/ha). Marketable yield was significantly higher in B-780-5-3-1 (29.2 t/ha) and B-780-5-2-2 (24.6 t/ha) than the best check ALR (22.0 t/ha). Marketable percentage in ALR was 84.7% whereas, in B-780-5-3-1, B-780-5-2-2 and RHR-O-S-1 it was above 93%. Percent doubles were nil in B-780-5-3-1 and it was only 0.2% in B-780-5-2-2, which was followed by RHR-O-S-1 (1.7%) against check ALR (12.1%). Variety B-780-5-3-1, RHR-O-S-1 and check Arka Niketan was earliest in maturity and took 129 days after planting against the check ALR (137 days to mature). In AVT-II, three entries along with two checks were evaluated and none of the entries gave higher marketable and total yield than both the checks under Rajgurunagar conditions.

Onion improvement through biotechnological approaches

Micropropagation of onion *via* shoot multiplication

Nine different onion varieties *viz.*, N-2-4-1, B-780, Phule Safed, Arka Niketan, ALR, ADR, N-53 (Fig.11) and Agrifound white were used for studying the effect of genotype and different hormones on shoot multiplication. Different combinations and concentrations of plant growth regulators *viz.*, BA (0.5-2 mg/l), Kin (2-10 mg/l) alone and in combination with NAA (0.5 mg/l) were used to achieve multiple shoots from shoot tip explant (from axenic seedling). Apart from ALR and ADR, all other lines gave shoot multiplication and the best media was those containing BA (1-2 mg/l).

Fig.11

Indirect organogenesis

Indirect organogenesis was achieved in two varieties, B-780 and Phule Safed using eleven different callus induction medium (MS based). Callus initiated was transferred to four different regeneration medium consisting of different concentrations of BA / Kin (1-2 mg/l). Both the varieties responded well to regeneration and induced on an average 12-14 and 17-20 shoots, respectively. These shoots were shifted to basal MS medium for further proliferation and rooting. Rooted plantlets were transferred to the field condition, where they established well and also flowered normally.

Induction of haploids through gynogenesis

Seven different varieties using 41 different hormonal combinations were tried for induction of haploids in MS based media. After inoculating > 8600 flower buds of each variety, it was observed that one combination consisting of BA was able to induce a single plant from variety N-53. This plant was multiplied and rooted in basal MS medium and an attempt was made to analyse the root tip for ploidy. However, owing to the very delicate nature of the roots, cytological analysis was not possible. Hence, the plantlets were shifted to bulblet induction medium and these bulblets will be transferred to the field. Roots will be taken upon plant maturity for cytological analysis. Similarly, in var. N-2-4-1, two other combinations consisting of BA + IAA resulted in the induction of plants from the ovary. After multiplication these were also transferred to the bulblet induction media. A part from this, a field study was formulated for induction of haploids.

DNA profiling of onion varieties and advanced lines using RAPD

DNA was isolated using CTAB method from 18 onion varieties as well as four advanced lines, quantified using λ-DNA and used along with two garlic lines (out groups) for DNA profiling using RAPD technique. 56 random primers (Operon Technologies, USA), found in preliminary experiments to amplify onion were screened again for repeatability and around 40 were found to be effective and hence used for further profiling studies. RAPD products were resolved using 1.5% agarose gel (SRL,India). Results were documented in GelDoc 2000 (BioRad, USA) and analysed using the software, Quantity One. Further experiment is in progress.

Garlic improvement through conventional and biotechnological approaches

Collection of germplasm

A total of 152 accessions were received from NBPGR for maintenance and multiplication at our Center during 2005-06.

Evaluation of *rabi* germplasm 2004-05

Out of a total of 124 white lines evaluated, 94 were subjected to RBD analysis in 2 replications. Of these, acc. No. 74-5, 183-4-1, 201-7-1, 74-4, 219-7-1 and 316-11-1 were found to be significantly superior to the best check G-41. In addition to this, 24 accessions were found to be at par with G-41.

A total of 115 pink coloured lines were subjected to evaluation during *rabi* 2004-05. Of these only 102 coloured lines were analysed using RBD in 2 replications. The results indicated that acc. No. 310 and 316-8-3 recorded highest marketable yield than the check variety but were not found to be significantly superior than G-41. In addition to these, 7 other accessions were found to be at par with G-41.

Out of 32 lines evaluated for desirable horticultural traits, it was observed that acc. No. IC-32871 recorded highest yield of 4.3 t/ha followed by Godavari (3.9 t/ha) and G-41 (3.8 t/ha). No other line was found to be at par with best check Godavari or G-41. Of the 27 lines obtained from NBPGR (new collection), all the lines were found to be at par with G-41 with 10 lines recording higher marketable yield than the check variety G-41.

Evaluation of elite lines of garlic

A total of 11 elite lines were evaluated and it was found that acc. No. 183, 200, 221, 316 and 201 recorded yield at par with G-41.

Clonal selection through bulb to row method in garlic

74 clonal selections made on the basis of their superior performance, were evaluated and it was observed that accessions 316-1A, 316-10-2, 73-4, 316-12-2, 200-10-2, 221-1-1, 221-3-2, 316-12-1, 201-12, 201-3, 316-8-4, 174-8-1 and 321-2-1 recorded significantly superior yield than G-41. In addition to this, all lines except three were found to be at par with the check variety G-41.

Creation of variability in garlic through mutation

Cloves of variety G-41 were treated with different doses of chemical mutagens SA, EMS and Colchicin for 6 hours and 12 hrs. The bulbs were multiplied in M1 and M2 generations and 548 individual bulbs were selected and bulb to row progenies were planted in M3 generations along with three checks *viz.*, G-1, G-41 and G-50 in augmented block design. Maximum bulb weight of 36.6 g was obtained in the M3 progeny in Colchicine 0.25% treatment, 38.5 g obtained from 0.01% of Sodium Azide treatment. Among different concentration of colchicine treatments, 65 progenies out of 212 progenies gave significantly higher mean bulb weight than the progeny mean of G-41. 40 progenies out of 137 in M3 generation yielded significantly higher than the check G-41 (11.5 g) in the treatments with different concentrations of Sodium Azide. The effect of EMS was less as compared with Sodium Azide and Colchicine treatments. Only 18 progenies gave significantly higher yield than check G-41. In Colchicin 0.08%, 6hrs and SA 0.01% 12 hrs treatments, 59% progenies had significantly higher mean bulb weight than the best check G-41 progenies followed by 57% progenies from Colchicin 0.55% 12hrs treatment. In case of EMS, 26.3 and 20 % progenies from the EMS treatment of 0.55% concentration at 6 and 12 hours, respectively, gave significantly higher yield than the best check G-41.

Varietal evaluation trial under AICRP at NRCOG

Varietal evaluation trial of garlic under AVT-I and AVT-II during *rabi*, 2004-05

In AVT-1 trial, six accessions were evaluated in four replications. Acc. RAUG-5 recorded highest yield and was at par with AC-200, rest of the accessions were significantly inferior to these accessions. Accession SKAUG-151 was not able to develop bulbs under our conditions since this is purely a temperate cultivar.

In AVT-II trials, four accessions were evaluated in four replications under RBD. Acc. G-323 recorded highest yield and was at par with G-1. Rest other accessions were significantly inferior to these accessions.

Garlic biotechnology

Indirect organogenesis

An experiment was initiated to study the effect of different short day garlic genotypes towards callus induction and regeneration. Callus was raised from root tip explant of three garlic genotypes (G - 41, GG - 3 and Godavari) in two MS based induction media fortified with two combinations of 2,4-D and BA. Both the induction media resulted in the formation of 70-100% callus induction. Upon transfer to regeneration media, containing BA (1-2.25 mg/l), regeneration of shoots was observed. However, genotypic differences were evident during callus regeneration. Of the three genotypes studied, G - 41 (18-20 shoots / g callus) and GG- 3 (8 -10 shoots / g callus) induced shoots, whereas, Godavari failed to induce shoots.

Preliminary screening of garlic varieties and breeding lines using RAPD

In preliminary screening of garlic varieties through RAPD technique, 100 decamer primers (Operon Technologies, USA) were screened in duplicate for assessing polymorphism. Fourteen of these primers were selected on the basis of clear polymorphic bands, for further testing on all the 24 cultivars, consisting of 10 varieties, 12 breeding lines and one exotic line along with an onion breeding line (an out-group to check the reliability of the primer). Analysis of the RAPD data exhibited that garlic and onion showed a low degree of similarity ranging from 0.37 - 0.27 with an average of 0.32. From the resultant dendrogram (Fig.12), it was observed that four clusters were formed. Cluster I was the biggest one with 14 genotypes, Cluster II consisted of only one genotype, SKAUG 151, Cluster III was the second biggest one with 8 genotypes whereas Cluster IV showed the single onion genotype (the out group). Variation amongst the garlic accessions was about 44%, whereas, with onion it showed a dissimilarity of 77%. The range of similarities for the 23 garlic cultivars investigated varied from 66 to 98 %, which indicates a high level of genetic variation between the varieties. Onion cultivar (GWO-1) showed a 30% similarity between this species and the cluster of garlic cultivars. Thus garlic cultivars appear to be closely linked when compared with *A. cepa*.

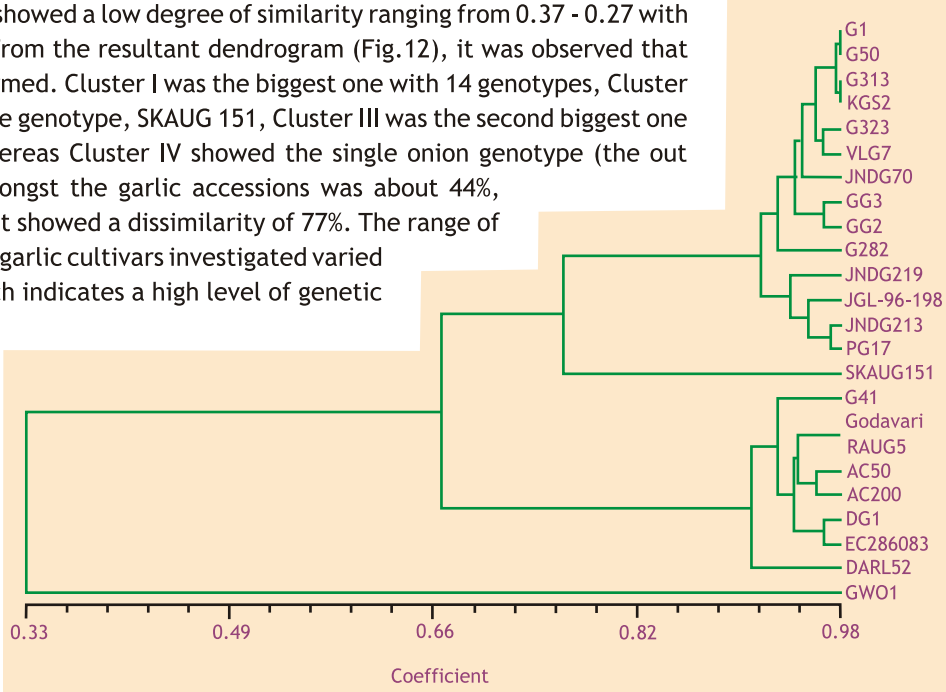


Fig. 12: Dendrogram generated using unweighted pair group method with arithmetic average analysis, showing relationships between 23 garlic and one onion genotype using RAPD data

Collection and maintenance of wild species

An expedition trip to the high mountains of Lahaul & Spiti and Pangi region of Himachal Pradesh was carried out in collaboration with NBPGR, Shimla during 29 August to 9 September 2005. A total of 47 accessions comprising of onion, garlic and wild *Allium* species were collected (Fig 13 a-b). The live samples were kept at NBPGR, Shimla for maintenance whereas seeds collected were sent to NBPGR, New Delhi for maintenance and distribution. Variability was observed and collected in wild *Allium* species for plant height, number of leaves, leaf shape, leaf colour, inflorescence shape, colour, bulb shape, scale colour and presence or absence of leaf odour.

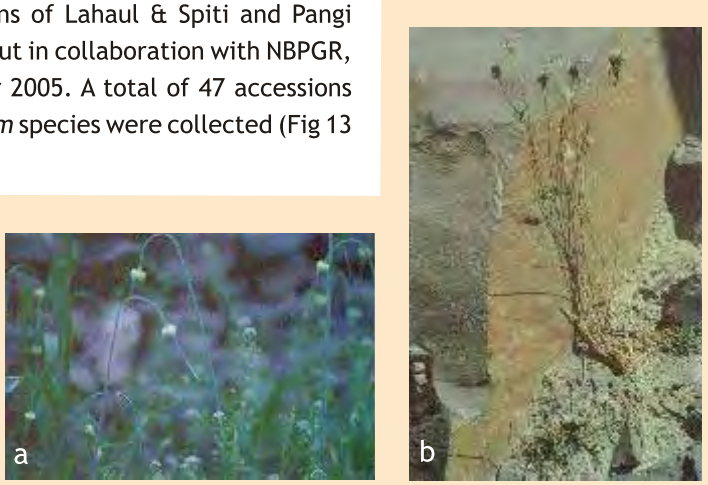


Fig 13 (a-b) Wild *Allium* spp.in their natural habitat

Crop Production

Onion and garlic production technology

Effect of direct sowing

Various direct sowing methods such as manual sowing, Pune seed drill (with out filler), Pune seed drill (with vermicompost) and windhrock planter were tried during late *kharif* season, 2004-05 and were compared with transplanted crop. It was found that highest yield (24.38 t/ha) was found in manually sown crop and it was at par with transplanted onion (23.89 t/ha) and crop sown by single row planter (22.86 t/ha). The percentage of A grade bulb was higher in transplanted crop. The storage losses in direct sown onion was also recorded. The results reveal that there was no difference in different types of losses in onion produced in transplanted and direct sown methods.

Onion seed was sown in lines at 15 cm distance in the field in *kharif*, 2005 using different methods such as manual sowing, Pune drill and onion seed drill. These were compared with the transplanted onion. The direct sown onion took lesser duration than the combined duration of nursery and transplanted crop. The final stand was higher in transplanted crop and manual sowing than other methods. The highest yield was recorded in transplanted crop but it was statistically at par with other treatments. The percentage of A grade bulbs and equatorial diameter of bulbs was higher in seed drill sown onion crop. The total soluble solids were higher in the direct sown crop.

Effect of lihocin on growth and yield of onion *cv.* B-780 in late *kharif*

To check the excess vegetative growth and hasten the bulb development, an experiment was conducted in late *kharif* season with plant growth regulator (Lihocin). It was applied as foliar spray to onion *cv.* Baswant - 780 at 45, 60, 75 and 90 days after planting either alone or in combinations. The results indicated that higher yield (32.14 t/ha) was recorded with two sprays of lihocin (6ml/l) at 60 and 75 days after transplanting and it was at par with single application of lihocin (6ml/l) at 75 days (31.34 t/ha) and at 90 days (31.55 t/ha) after transplanting. These treatments gave significantly higher yields than control (25.0 t/ha). The percentage of A-grade bulb was also higher in these treatments. There was no effect of lihocin on storage losses.

Comparison of irrigation systems in onion

Four methods of irrigation *i.e.* drip, big sprinkler (12 m radius), medi sprinkler (6m radius) and surface irrigation were evaluated for their performance in *rabi* onion *cv.* N-2-4-1.The results show that significantly higher yield was recorded in drip method (41.17 t/ha) followed by big sprinkler (31.62 t/ha). The lowest

yield was recorded in surface irrigation (20.29 t/ha). The yield in surface and medi sprinkler was statistically similar. The percentage of A grade bulbs was highest in drip irrigation method. As far as total quantity of water applied is concerned, it was highest in surface irrigation method and lowest in drip irrigation. There was around 38 % water saving in drip irrigation over surface irrigation, while it was 15 % and 1 % in medi sprinkler and big sprinkler, respectively. The net-planted area was highest in big sprinkler and highest gross plot yield was also obtained in this treatment.

As far as storage losses are concerned, the total losses were highest in onion irrigated with bigger sprinkler (53.78 %) after four months. The lower losses were found in drip irrigation (34.19 %), which was closely followed by surface irrigation (37.41%).

Organic cultivation trial in onion and garlic

Onion *cv.* Baswant 780 was planted after two preceding crops *i.e.* mungbean and french bean and with four fertilizer/manure combinations in late *kharif* season, 2004-05. The results revealed that there was no difference in plant height and number of leaves among crop sequences and manure/fertilizer treatments. As far as yield is concerned, the total and marketable yield was significantly higher in recommended practices. Almost 40-50% lesser yield was recorded in organic treatments. Among the organic treatments, highest yield (15.44 t/ha) was recorded with poultry manure treatment followed by poultry manure + farmyard manure, which was 14.03 t/ha. The percentage of A grade (>60 mm size) bulbs was higher in recommended practices while the percentage of B grade and C grade bulbs was higher in organic treatments. The equatorial diameter of bulbs was higher in recommended practice treatment while polar diameter and neck thickness was similar in all treatments.

As far as the storage losses are concerned, the total losses were statistically same in all the treatment combinations and preceding crops. The weight loss (PLW), rotting and black mould infection was similar in all treatments while sprouting was higher in recommended practices treatment.

The preceding crops *i.e.* green gram, french bean, pearl millet, soybean were sown in *kharif, 20*05 in the organic cultivation trial in onion. The green gram *cv.* ML-818, french bean *cv.* Varun, pearl millet (bajra) *cv.* Ankur-2226 and soybean *cv.* MACS-450 were used for the experiment. The green gram, french bean and pearl millet crops were completely damaged by heavy rains and no yield was recorded in these crops. While the soyabean crop was partially affected by rain and higher yield (17.41 q/ha) was recorded in recommended fertilizer treatment. This was followed by farmyard manure treatment (16.48 q/ha).

In garlic, *cv.* G-41 was planted after four preceding crops *i.e.* mungbean, french bean, bajra and soyabean with four fertilizer/manure combinations in October 2004.The results revealed that the crop sequences and the fertilizer/manure treatment did not show any statistical difference for height and number of leaves per plant. The bulb yield was significantly higher (5.03 t/ha) in recommended practices than organic treatment combinations. All the organic treatments were statistically similar for yield. Similar was the case for preceding crops. The percentage of A-grade bulbs was higher in recommended practice than all other treatments. The percentage of bulbs having damaged root discs was also higher in recommended practice.

As far as the storage losses are concerned, the losses were between 12 to 14 percent after 6 months and there was no significant difference among various treatment combinations.

The preceding crops, same as in onion trial, was sown in *kharif* 2005. The green gram, french bean, pearl millet crops was completely damaged by heavy rains and there was no grain yield. The soybean crop survived and higher yield of 16.94 q/ha was recorded in recommended fertilizer treatment. This was followed by application of farmyard manure (16.81 q/ha).

Onion based cropping systems

Based on the pooled mean data for five years (Table 1), among the various cropping sequences evaluated in onion, results indicated that the higher marketable bulb yield of onion was noticed in legume based cropping sequences like groundnut-onion, and soybean followed by onion. The highest average marketable bulb yield of 36.1 t/ha was recorded in sequence consisting of preceding groundnut followed by onion in late *kharif* season.

In *rabi* season, the higher marketable mean bulb yield of 28.9 t/ha. was noticed in soybean-onion sequence. The increase in yield could be attributed to preceding crop of soybean and groundnut and their residual effect. The highest C:B ratio of 1:2.42 was obtained in soybean onion cropping system.

There was tremendous improvement in physical and chemical properties of soil in legume based cropping sequences particularly available N content of the soil. Apart from this, improvement was noticed in organic carbon, organic matter, soil available N, P and K content in legume based cropping systems like soyabean (*kharif*) followed by onion (*rabi*) and groundnut (summer) followed by onion (*rabi*) than any other sequences evaluated.

Table1 : Best three onion based cropping systems

Particulars	Soyabean (kharif)-Onion (rabi) sequence	Groundnut (summer)-Onion (late kharif) sequence	Aster (kharif)-Onion (rabi) sequence
Yield (t/ha)	Soybean 2.23 Onion 28.9	Groundnut 4.10 Onion 36.1	Aster 198220 bundles Onion - 27.2
B:C ratio	2.42	2.39	2.37
Organic carbon improvement (%)	0.58 - 0.62	0.50 - 0.55	0.56 - 0.56
Organic matter improvement (%)	10.0 - 11.4	8.6 - 10.0	9.7-9.8
Soil available N improvement (kg/ha)	219.1 -250.0	216.2- 251.3	217.4 -231.8
Soil available P improvement (kg/ha)	37.5 - 48.9	43.6- 49.1	37.6 -39.7
Soil available K improvement(kg/ha)	396.4 -415.2	394.5 -413.2	395.5 -411.2

Garlic based cropping systems

Among the sequences evaluated, higher marketable bulb yield was noticed in pea-garlic sequence (Table 2). In *kharif*, 2005, different crops like bajra, groundnut, green gram, pea, soybean and potato were grown. The observations on yield and yield contributing characters were recorded. The yield of groundnut, bajra, green gram, potato and pea were very low than average yield. This may be due to high rainfall coupled with higher incidence of pest and diseases. During the summer season, yield of crops like cucumber, bajra and groundnut was found very good.

Based on the last two years data, higher marketable bulb yield (6.65 t/ha) was found in the sequence consisting of pea in *kharif* season followed by garlic in *rabi* season. But, the higher B: C ratio was noticed under soybean -garlic-cropping pattern (2.53). Further studies on the uptake of plant and soil nutrients and its correlation with yield and yield contributing characters are to be evaluated for consecutive years.

Table 2 : Bulb yield of garlic

Treatments	Cropping sequences	2003-04 (t/ha)	2004-05 (t/ha)	Mean (t/ha)
S1	Bajra (*kharif*) -Garlic (*rabi*)	5.62	5.36	5.49
S2	Potato (*kharif*) - Garlic (*rabi*)	6.12	4.97	5.55
S3	Mungbean (*kharif*) - Garlic (*rabi*)	6.57	4.78	5.68
S4	Soybean (*kharif*) - Garlic (*rabi*)	6.37	3.77	5.07
S5	Ground nut (*kharif*) - Garlic (*rabi*)	6.29	3.37	4.83
S6	Cucumber (summer) - Garlic (*rabi*)	6.31	4.73	5.52
S7	Bajra (summer) - Garlic (*rabi*)	5.53	4.71	5.12
S8	Groundnut (summer) - Garlic (*rabi*)	5.51	4.93	5.22
S9	Pea (*kharif*) - Garlic (*rabi*)	5.46	7.84	6.65

Fertigation studies in onion and garlic (AICVIP)

The studies were conducted in onion and garlic during 2002-2005 to find out optimum nutrient requirement of onion and garlic through drip fertigation. The results revealed that water-soluble fertilizers through drip irrigation improved the yield and yield contributing characters of both the crops(Table 3). The percentage of A grade bulbs was more in 100 % of recommended dose of fertilizers as water soluble than conventional application. The reduction in fertilizer dose significantly reduced the marketable bulb yield of onion and garlic. The data indicated that when fertilizer dose increased from 60-100 percent, the value of additional yield was less than the additional cost of fertilizer incurred. While calculating the benefit - cost ratio, the treatment of NPK 50:50:80 kg /ha as basal +100 kg N in seven splits gave higher net income per unit area in both the crops. Based on the last three years results, it is concluded that NPK 50:50:80 kg /ha as basal +100 kg N in seven splits through drip irrigation for onion and NPK 50:50:80 kg /ha as basal + 50kg N in seven splits through drip irrigation in the case of garlic was adjudged the best treatment for higher yield and benefit - cost ratio. As far as water saving is concerned 30-40% water was saved through drip fertigation over surface irrigation.

Table 3 : Pooled analysis data of fertigation studies in onion and garlic (2002-2005)

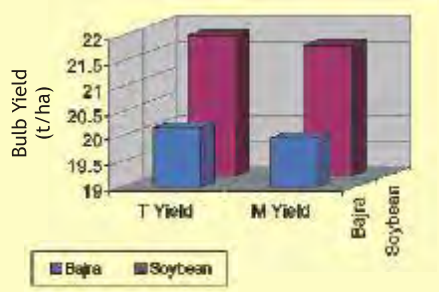
Treatments	Onion			Garlic		
	MY (t/ha)	AGB (%)	B:C ratio	MY (t/ha)	AGB (%)	B:C ratio
T1	30.1	35.15	1.30	8.77	42.08	2.62
T2	29.0	32.23	1.29	8.10	35.81	2.48
T3	29.4	34.56	1.35	7.72	31.88	2.43
T6	29.6	32.09	1.63	7.91	39.02	2.95
T8 (control)	24.3	27.51	1.30	8.06	42.60	2.93

Integrated nutrient management and uptake studies in onion and garlic

Evaluation of integrated nutrient management (INM)modules in onion *cv.* N- 2- 4-1

Seven INM modules were evaluated during *rabi* season in the year 2004-05 in onion cv N-2-4-1. The effect of preceding crops and INM modules had significant effect on the total and marketable bulb yield of onion. The results showed that soybean as preceding crop had significantly improved the soil fertility parameters by which the bulb yield was increased significantly when compared to bajra as preceding crop. In onion, yield was increased by 7.6 % when soybean was preceding crop compared to over bajra (Fig. 14).

Fig .14 Total and marketable yield of onion due to preceding crops



Among the seven modules, M-4 (FYM+50% RDF +S) had recorded superior bulb yield. Highest marketable yield of 22.9 t/ha of onion over absolute control (M-1) was noticed.

The soil fertility parameters namely, available nitrogen, phosphorus and potassium were analyzed in the soil samples after the harvest of onion crop to study the changes brought in by the two preceding crops under different INM modules. The results revealed that preceding crops had significantly improved the available N, P and K status in the soil.

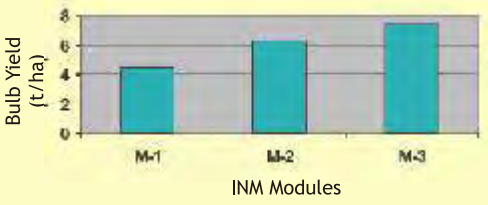
The concentration of above nutrients in onion bulbs and tops was significantly improved due to soybean as preceding crop in comparison to bajra. Among the modules, M-4 and M-5 receiving organic manures without bio-fertilizers and M-6 receiving organic manures with bio-fertilizer had recorded higher contents of N, P and K than M-2 (only NPK) and M-3 (NPK + S). Combined effect of soybean and M-5 (50% NPK+ poultry manure @10 t/ha) recorded highest N, P and K contents in the bulbs.

Low storage losses (38.0%) of onion bulbs during a period of 6 month was noticed due to soybean as preceding crop. Among the modules, M-3 (NPK +30 S) showed minimum losses (32.5%) followed by M-1 < M-6 < M-4 < M-5. The interaction effect of preceding crop bajra and M-3 recorded losses of 34.5% while the minimum losses of 30.5% was noticed due to soybean with M-3. The effect of preceding crop, INM modules and their interaction was significant in improvement of pyruvic acid concentration in the onion bulbs. The highest amount of pyruvic acid was noticed in the module M-6 (only organic manures + bio-fertilizer+ S). Similarly, M-3, M-5 and M-4 recorded higher amounts, as these modules received 50% nutrients through organic manures.

Evaluation of integrated nutrient management modules in garlic *cv.* G-41

The bulb yield was superior in the block where previous crop was soybean in *kharif* season than bajra. An increase in yield by 17.2 % was observed due to soybean as preceding crop over bajra. Among the INM modules, yield of M-3(RDF - 100:50:50 Kg NPK/ha +30 S)> M-4 (50% RDF+ FYM)> M-5 (50% RDF+ PM) . The data in Fig. 15 depicts the highest yield, which was produced in M-3 with 63.7% increase over the absolute control (M-1) and 16% over RDF (M-2).

Fig .15 Performane of INM Modules on Garlic Yield



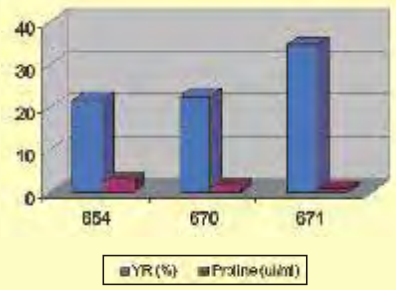
The changes in the soil fertility parameters were evaluated after the harvest of garlic crop. Here also, soybean as preceding crop improved the nitrogen available status of soil. All the INM modules had improved the fertility of soil, in which the effect of M-6 was more prominent. Interaction effect of preceding crop and INM modules showed significant effect on available status of soil N, P and K. The soil available micronutrient status was also improved. Substantial build up of available Zn, Cu, Fe and Mn was noticed in soil in soybean block. Similarly, the modules receiving organic manures had recorded greater amounts of these micronutrients in both soybean and bajra blocks. The zinc status was below critical level in bajra block with M-1 module.

The nutrient concentration of the bulbs was also improved. Module M-5 and M-6 along with soybean as preceding crop had produced the best effect on the concentration of N, P and K, which in turn affected the bulb yield. Preceding crops, INM modules and their interaction effect had significantly improved the sulphur content, pyruvic acid concentration and the shelf life of bulbs during the storage period of 6 months. It was seen from the results that sulphur concentration in bulbs was highest in modules in the following descending order M-5>M-4>M-3> M-6. The concentration of pyruvic acid significantly improved in all modules. The increase was directly related to the increased sulphur concentration in bulbs. Modules receiving farmyard manure as organic manure recorded lower storage losses.

Screening of onion germplasm against drought

A two factorial RBD trial was conducted in *rabi* season, 2004-05 with 33 onion accessios (factor 1) to screen against drought under different irrigation interval (factor 2). The performance of following germplasm lines, 654, 670 and 671 was best against different irrigation intervals (Fig.16).

Fig .16 Performane of onion lines at 24 day irrigation interval



These three lines recorded minimum reduction in bulb weight per bed in comparison to the yields at 8-day irrigation interval. The percent yield reduction (%YR) due to different irrigation intervals increased with increase in the period. The 24- day interval recorded highest reduction (54%). The estimation of proline concentration in leaves of these lines showed that they contain high amounts than other germplasm lines. Some of the varieties tested in the experiment proved to show tolerance to the drought stress are Agrifound Rose, Gujarat white, N-2-4-1 Selection, Hissar 2 and Udaipur-102. Correspondingly these varieties had produced high amounts of proline in their leaves.

Onion seed production and storage technology

Increasing the seed viability and vigour in onion

The experiment on seed viability and vigour in onion was conducted with *cv.* Baswant-780 with four treatments *viz.*, ambient temperature storage, storage in dessicator, treatment with para amino benzoic acid and Oxalic acid treatment. The treated seeds were stored for 18 months and observations on seed viability and vigour were recorded after every three months. The results revealed that seed germination was statistically at par in all the treatments for the first six month period. The seed germination was 68 percent after 18 months of storage in seed stored in desiccator while germination was less than 10 percent in all other treatments including control. The seed vigour index in desiccator stored onion seed was also higher

than other treatments. For confirmation of results, the trial was repeated in 2005. Initial results revealed that seed germination and seed vigour index were higher in seed stored in desiccator than other treatments after 6 months

Effect of seed priming treatment on viability and vigour of onion seeds

The onion seed *cv.* Baswant 780 was primed with several chemicals such as para amino benzoic acid, potassium nitrate, di potassium hydrogen phosphate and poly ethylene glycol in different concentrations. These seeds were dried and packed in 400 gauge polyethylene bags and stored at ambient temperature. The results reveals that seed germination was more than 70 percent in all the treatment 15 months after treatment and there was no significant difference among the treatments with respect to percent germination and seed vigour index.

Effect of seed moisture and packing material on viability and vigour of onion seed

The onion seeds of *cvs*. Agrifound Dark Red and Agrifound Light Red of different moisture levels *viz.*, 5,6,7 and 8 percent were packed in various packing materials like cloth bags, polyethylene bags, laminated aluminium bags and laminated aluminium bags with vacuum packing. These bags were stored at ambient condition. The percent germination and viability of seed was recorded after 12 months and 15 months. The results indicated that in onion *cv.* Agrifound Dark Red, seed germination (74.98%) and seed vigour index (582) were higher in seed stored at 5.0 % moisture than other moisture levels after 12 months. The lowest seed germination (63.65 %) and seed vigour index (439) was recorded in seed having 8 % moisture. As far as packing material is concerned, the highest seed germination (87.43 %) and seed vigour index (580) was recorded in laminated aluminum bags with vacuum packing while the lowest seed germination (38.75 %) and seed vigour index (347) was recorded in cotton cloth bags. Among the various treatment combinations, highest germination and seed vigour index was recorded in seed having 5.0 % moisture stored in laminated aluminum bags with vacuum packing. While lowest germination and seed vigour index was recorded with seed having 8% moisture and packed in cotton cloth bags. After 15 month of storage the trend was same but the seed germination and seed vigour in cotton cloth was further reduced to 5.0 %. Similar results were recorded with the seed of onion *cv.*, Agrifound Light Red.

Crop Protection

Integrated pest management in onion and garlic

Barrier cropping for management of onion thrips

Based on the previous years results the trial was laid out in *rabi* season to evaluate the efficiency of barrier crops to block thrips. Economics were worked out for adopting the technology. The barrier crops were compared with the check plots where regular insecticides were sprayed and also with an absolute control. Both the barriers effectively blocked the thrips by 80.0%. Thrips population was also significantly low in barrier plots.

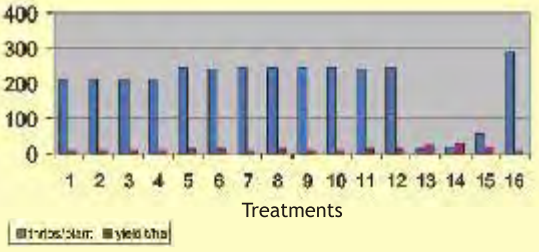
Highest marketable yield was recorded in the check plots and plots with maize + wheat followed by plots with 2 rows of maize. The major gain by adopting the barrier crops was the benefit: cost ratio. Highest BC ratio was obtained with Maize + wheat barrier followed by 2 rows of maize barrier. The study clearly suggested that the barrier maize + wheat could be adopted to get higher BC ratio, as well as to minimize the insecticide applications in onion.

Evaluation of insect pathogens for management of thrips

In all the sprays, barring two occasions the insect pathogens were found effective in controlling the thrips compared to control. But they could not bring down the thrips population to below ETL at any instance. The thrips infestation level was unusually high during the period of study compared to normal years. No insect pathogen strain had shown consistent performance in bringing down thrips population. After 10 days of the first spray, all the strains were at par except Bb-9. During second and third sprays, thrips infestation was severe and reached to 470 / plant in control. But in all the treatments thrips count was significantly less than control. No insect pathogen performed consistently in all the sprays. In fifth spray the thrips population decreased. The decrease is due to the weakening of the plants in control and other treatments except in insecticide sprayed plots.

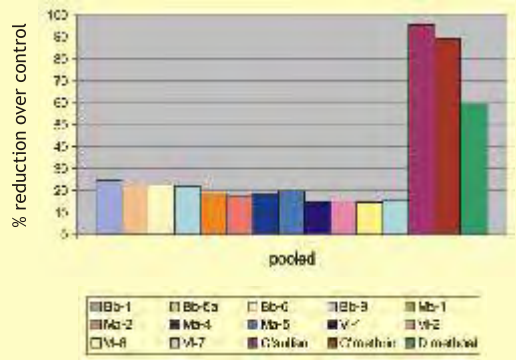
With regard to yield, both marketable and total yield was higher in cypermethrin and carbosulfan

Fig .17 Overall performance of insect pathogen strains against thrips in onion during late *kharif* 2004



1= *Beauveria bassiana* (Bb)-1; 2 = Bb-5a; 3= Bb6; 4= Bb-9
5= *Metarrhizium anisopliae* (Ma)-1; 6= Ma-2; 7= Ma-4;8= Ma-5
9= *Verticilium lecani* (Vl)-1; 10= Vl-2; 11=Vl-6; 12= Vl-7
13= carbosulfan; 14= cypermethrin; 15= dimethoate; 16= control

Fig .18 Performance (percent reduction over control) of insect pathogens in *rabi*, 2004-05



sprayed plots. Yields of all insect pathogens were found non-significant.

In conclusion, insect pathogen strains minimized the thrips population significantly as compared to control. However, they failed in bringing down the thrips population to below threshold levels. Insecticide sprays were found much effective in controlling thrips than any insect pathogen.

In *rabi* season, a total of six sprays were given at 10 day interval. All the treatments significantly reduced the thrips population over control in all the sprays. However, they were found significantly less effective than insecticide treatments. Among the insect pathogens, *B. bassiana* strains consistently reduced the thrips populations in all the sprays. At any instance, none of the pathogen strains could bring down the thrips population below ETL (30/plant). None of the pathogens reduced the thrips population by 25% compared to insecticides, which reduced thrips by 90.0% over control (Fig.18). Highest marketable yield was recorded in plots sprayed with carbosulfan followed by cypermethrin.

Insectary Planting: To attract natural enemies in onion-garlic ecosystem

The predators' diet is not limited to prey alone but also requires pollen and nectar from many flowering plants during adult stage. Therefore, role of insectary plants to enhance predators in onion and garlic ecosystem was explored during *rabi*, 2004-05. Many of these insectary plants significantly attracted predators namely ladybird beetles *viz.*, *Cheilomenes sexmaculata*, *Coccinella septumpunctata*, *Hippodamia variegata* and minute pirate bug, *Orius tantillus* (Fig. 19 a and b). Sunflower and maize significantly attracted *C. sexmaculata* and *O. tantillus*; coriander attracted *H. variegata and* mustard *C. septumpunctata*. Later on, *O. tantillus* migrated to garlic plants and was found to effectively feed on thrips. On an average their population was 2.2 bugs /garlic plant. Prominent species of coccinellidae found on garlic were *H. variegata* followed by *C. sexmaculata*. When garlic was harvested they migrated to onion. On an average 0.58 bugs / onion plant were recorded. Beside Sunflower, maize was noticed as a resource plant for both *Orius* and *C. sexmaculata*. A large number of *C. sexmaculata and* O. *tantillus* were recorded on maize.

Fig.19 Predators feeding thrips in garlic

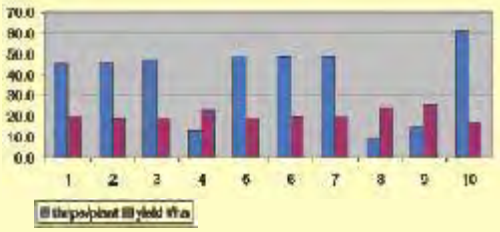
a) Orius tantillus

b) Cheilomenes sexmaculata

Evaluation of insecticides for the management of onion thrips during *rabi*, 2004-05

Four new insecticides, each at two doses were evaluated for their efficacy against *Thrips tabaci* during *rabi* on onion. Among all the insecticides tested, lambda cyhalothrin was found significantly effective in reducing the thrips population in all the four sprays followed by the same insecticide at lower dose (Fig.20). Although all other insecticides reduced the thrips population than control, their efficacy was poor compared to check treatment, monocrotophos. Even, significantly higher marketable and total yield were obtained with monocrotophos and lambda cyhalothrin at higher dose (1ml/l) followed by lambda cyhalothrin at lower dose.

Fig.20 Performance of insecticides against thrips during *rabi* 2004-05



1- Pegasus @600g ai/ha; 2-Actara @ 50 g ai/ha
3-Pride @40 g ai/ha; 4-Karate 25g ai/ha
5-Pegasus @850g ai/ha; 6-Actara @ 100 g ai/ha
7-Pride @80 g ai/ha; 8-Karate 50g ai/ha
9-Monocrotophos 10-control

Reaction of some wild *Alliums* to *Thrips tabaci*

Bio diversity in *Alliums* offers many sources of resistance to pests and diseases. The existing onion germplasm lacks resistance to thrips. Therefore, some of the wild species of *Alliums* were tested for their reaction against thrips.

After 96h, maximum numbers of thrips had settled on *A. cepa* and *A. fistulosum* followed by *A. vaviloviix A. cepa*. Significantly less thrips settled on *A. ampeloprasum, A. fistulosum* (EC 461753) and *A. galanthum*. Significantly higher multiplication of thrips was noticed on *A. cepa* in all the dates followed by *A.vavilovii x A.cepa*. Significantly low thrips were found on *A. ampeloprasum, A. galanthum and A. fistulosum* (except - 461748). Taking the averages over the dates, the highest number of thrips were found on *A. cepa* followed by *A.vavilovii x A.cepa*.

Post Harvest Management

Post harvest studies in onion and garlic

Effect of sulfur fumigation in onion

Well-cured bulbs of onion *cv.* N-2-4-1 were subjected to sulfur fumigation (50 g/m^3) for 1,2,3,4,5,6,7, and 8 hours durations in May 2005 to reduce disease infection. These fumigated onions were stored at ambient conditions till October and observations were recorded on various types of storage losses *i.e.* weight loss, sprouting, rotting and black mould at periodic intervals. It was found that fumigation of sulfur did not affect the weight loss, rotting and sprouting in storage. But black mould infection was significantly reduced to 2.5% in sulfur fumigation for more than 3 hours, which was less than the control (4.3 %).

Effect of irradiation on onion varieties

Twenty-three onion varieties *viz.*, Agrifound Dark Red, Baswant-780, Arka Kalyan, Arka Niketan, N-2-4-1, Agrifound Light Red, PKV white, Phule Safed, Pusa White Round, Phule Suwarna, Arka Pitamber and some elite lines of NRCOG were gamma - irradiated in the month of June 2005 and stored under ambient conditions for 5 months along with unirradiated onions and periodic observations on weight loss, rot, sprouting and black mould infection were recorded. The results revealed that gamma irradiation effectively checked sprouting in all onion varieties irrespective of season and colour. In general, rotting was not increased by the irradiation barring few *kharif* season varieties. There was no significant effect of irradiation on weight loss and black mould infection barring white colour varieties. The black mould infection was higher in white coloured varieties than red, light red and yellow varieties.

Effect of storage environment

Effect of size of heaps (stakes) on storage losses

The bulbs of late *kharif* onion *cv.* Baswant 780 were stored in heaps (stakes) of 6x1x1, 6x1x3, 6x1x5, 6x3x1, 6x3x3, 6x5x1 and 6x5x3 fit (LxWxH) sizes from Feb-June 2005 for studying the storage losses. It was found that less rotting was recorded in smaller heaps than bigger heaps. The total storage losses were 35.39% in 6x1x1 size heaps after 4 months while the storage losses in 6x5x3 size heap were 45.32% during the same period.

In *rabi* season the bulbs of *cv.* N-2-4-1 were stored in heaps (stakes) of 6x1x1, 6x1x3, 6x1x5, 6x3x1, 6x3x3, 6x3x5. 6x5x1, 6x5x3 and 6x5x5 fit (LxWxH) sizes from May - October 2005 and observations were recorded. The results revealed that the total storage losses were less in smaller heaps. The total storage losses in 6x1x1(LxWxH) size heap were only 27.67 % after 5 months while the losses in 6x5x5 size heaps were 45.32 %

45.32 % during the same period. It was found that the storage losses increased with increase in height or width of heaps. There was no effect of size of heap on PLW and sprouting but rotting and black mould infection was directly proportional to width and height of heaps.

Effect of forced ventilation on storage losses in onion

The bulbs of onion *cv.*, N-2-4-1 were packed in four different ways *i.e.* hessian cloth bags, netlon bags and plastic crates and stakes. These were kept under three storage environments *viz.*, naturally ventilated, forced ventilation with exhaust, forced ventilation with wind operated fan in modified bottom cum top ventilated double row storage structure from May-October 2005. The observations on different types of losses were recorded .The results revealed that lower losses (38.03%) were recorded in forced ventilation (1 $m^3/m/m^3$) with exhaust fan followed by forced ventilation with wind-operated fan (47.53%) compared to naturally ventilated compartment (51.86 %). The PLW, rotting, sprouting and black mould was less in forced ventilated compartment. Among the various packing materials the lowest losses were recorded in Hessian cloth bags (33.03%). Higher losses were found in stakes and netlon bags. Overall, lowest losses (26.97 %) after 5 month of storage were found in Hessian cloth bags stored under forced ventilated condition.

Assessment of storage losses in garlic

The garlic bulbs (*cv.* G-41) of A (>35mm size), B (25-35 mm size) and C grade (<25mm size) were stored under ambient condition to assess the storage losses. The results revealed that lower losses were recorded in small sized bulbs for initial 3 months of storage and thereafter storage losses increased rapidly in small size bulbs. Overall there was no difference in total storage losses among different grades of bulbs after 6 months of storage.

Effect of sulfur fumigation on storage losses in garlic

Garlic bulbs *cv.* G-41 were given sulfur fumigation (50g/m^3) for 1, 2, 3, 4, 5 and 8 hours after shade curing and cutting of leaves to reduce the disease infection. It was found that fumigation of sulfur reduced rotting of bulbs. It was between 8 and 9 percent in sulfur fumigation (> 3 hours), which was significantly lesser than control (12.4 %). Infection of black mould was very low and there was no significant difference among the treatments. Similarly the weight loss was also not effected by fumigation treatments.

Effect of size of heaps on storage losses in garlic

To assess the effect of heap size on storage losses in garlic, bulbs of garlic *cv.* G-41 along with the leaves were stored in circular heaps of 1x1, 2x2, 3x3, 4x4, 5x5 fit (DXH) sizes from April - October 2005 and observations on various type of storage losses were recorded. It was found that there was no effect of heap size on rotting, weight loss and black mould development and total storage losses in garlic.

On Going Projects

Project No.	Project Title	Scientists involved
NRCOG 1.1.1	Development of onion (red and light red) Varieties/hybrids suitable for different seasons and resistance to biotic and abiotic stresses	VSR Krishna Prasad V Mahajan, A Aziz Qureshi and PS Srinivas
1.1.2	Development of onion (white and yellow) varieties/hybrids for processing, export and resistance to biotic and abiotic stresses	V Mahajan, VSR Krishna Prasad, A Aziz Qureshi and PS Srinivas
1.1.3	Onion improvement through biotechnological approaches	Asha Devi A, Anil Khar and V Mahajan
1.1.4	Garlic improvement through conventional and biotechnological approaches	Anil Khar, Asha Devi A, V Mahajan, A Aziz Qureshi and PS Srinivas
1.2.5	Onion and garlic production technology	V.Sankar, PC Tripathi and A Aziz Qureshi
1.2.6	Integrated nutrient management and uptake studies in onion and garlic	A Aziz Qureshi
1.2.7	Post harvest studies in onion and garlic	PC Tripathi and V Sankar
1.2.8	Onion seed production and storage technology	PC Tripathi and V Sankar
1.2.9	Integrated pest management in onion and garlic	PS Srinivas and CR Ramesh
1.2.10	Integrated disease management in onion and garlic	CR Ramesh and PS Srinivas

Externally Funded Projects

Central Sector Scheme

Title	Scientists involved
Implementation of PVP and FR legislation and DUS testing in onion and garlic	VSR Krishna Prasad
Breeder seed production of onion	V Mahajan
Intercropping of onion and garlic in sugarcane with modern irrigation systems	KE Lawande and PC Tripathi
Comparison of chemical sprout suppressant and irradiation on storage life of onion under different storage conditions	KE Lawande and PC Tripathi

AP Cess Fund

Title	Scientists involved
Revolving scheme on onion seed production	KE Lawande and PC Tripathi
Evaluation of selenium status in Indian type onion and garlic- Studies on the nutritional behaviour of selenium and sulphur	AA Qureshi

Mega Seed Project, ICAR

Title	Scientists involved
Seed production in agricultural crops and fisheries	KE Lawande and PC Tripathi

List of Publications

Research papers

Khar A, A Asha Devi and KE Lawande 2005. Callus culture and regeneration from root tip of garlic (*Allium sativum* L.). *J. Spices and Aromatic Crops* 14 (1): 51-55.

Khar A, A Asha Devi, V Mahajan and KE Lawande 2005. Genotype x environment interactions and stability analysis in elite lines of garlic (*Allium sativum* L.). *J. Spices and Aromatic Crops* 14 (1):21-27.

Khar A, A Asha Devi, V Mahajan and KE Lawande 2006. Genetic diversity analysis in elite lines of late *kharif (rangda)* onion. *J. Maharashtra Agr. Univ.* 31(1): 49-52.

Khar A, V Mahajan, A Asha Devi and KE Lawande 2005. Genetical studies in elite lines of garlic (*Allium sativum* L.). *J. Maharashtra Agr. Univ.* 30 (3): 277-280.

Khar, A, A Asha Devi, V Mahajan and KE Lawande 2006. Genetic divergence analysis in elite lines of garlic (*Allium sativum* L.). *J. Maharashtra Agr. Univ.* 31(1): 52-55.

Krishna Prasad VSR, KE Lawande and V Mahajan 2004. Assessing and prediction of environmental response of short day onion (*Allium cepa* L) genotypes grown in three seasons of western India. *Indian J. of Hort.* 63 (3) : 270-275

Krishna Prasad VSR, KE Lawande and V Mahajan 2006. Performance and diversity pattern in the land races of *Allium cepa* L. *Indian J. of Pl. Gene. Res.* (In Press)

Qureshi AA and G Narayanasamy 2005. Residual effect of phosphate rocks on the dry matter yield and P uptake of mustard and wheat crops. *J. Indian Soc. Soil Sci.* 53 (1): 132-134.

Qureshi AA, G Narayanasamy, PK Chhonkar and VR Balasundaram 2005. Direct and residual effect of phosphate rocks in presence of phosphate solubilizers and FYM on available P, organic carbon and viable counts of phosphate solubilizers in soil after soybean, mustard and wheat crops. *J. Indian Soc. Soil Sci.* 53 (1): 97-100.

Sankar V, KE Lawande, AA Qureshi and PC Tripathi 2005. Effect of bio-power and bio-force application on growth and yield of onion. *Orissa Journal of Horticulture* 33(1): 4 -7.

Papers / Abstracts presented in conferences

Mahajan V, MJ Havey, J Jernej and KE Lawande 2005. Diversity studies using simple sequence repeats in onion varieties. In: Abstract, International Conference on Plant Genomics and Biotechnology: Challenges & Opportunities held at IGKV, Raipur from 26 28 October. Pp: 188.

Sankar V, D Veeraragavathatham and M Kannan 2005. Quality parameters and post harvest storage life of onion influenced by organic farming practices. In: Proceedings of International Conference on Plasticulture and Precision Farming held at New Delhi from November 17-20. Pp. 356.

Sankar V, D Veeraragavathatham, M Kannan, K Subbiah and V Prakasam 2005. Studies on organic farming practices in onion for the production of export quality bulbs. Ibid. Pp. 355.

Sankar V, PC Tripathi, KE Lawande and AA Qureshi 2005. Micro irrigation studies in onion and garlic. Ibid. Pp. 232.

Lawande KE 2005. Onion improvement- Present status and future thrust In: Souvenir, National Symposium on Onion, Garlic, Chilli and Seed Spices Production, Marketing and Utilization held at Rajgurunagar during 25-27 November. Pp.1-11.

Lawande KE 2005. Post harvest handling and storage of onion and garlic. Ibid.Pp.105-108.

Srinivas P.S. 2005. Pest management in onion and garlic: Present and future strategies. Ibid. Pp.155-159

Asha Devi A, A Khar and KE Lawande 2005. Genotypic response of garlic (*Allium sativum* L.) genotypes for callus culture and regeneration. In: Abstracts and Posters, National Symposium on Onion, Garlic, Chilli and Seed Spices Production, Marketing and Utilization held at Rajgurunagar during 25-27 November. Pp. 32.

Asha Devi A, A Khar and KE Lawande 2005. *In vitro* shoot multiplication studies in onion var. B-780. Ibid. Pp. 35.

Khar A, A Asha Devi and KE Lawande 2005. Preliminary screening of garlic varieties through RAPD technique. Ibid. Pp. 35.

Khar A, PS Srinivas, S Tamhankar, L Cruze, A Asha Devi and KE Lawande 2005. Identification of RAPD marker for distinguishing eriophyid mite resistant vs. susceptible lines in garlic. Ibid. Pp. 92.

Krishna Prasad VSR and KE Lawande 2005. Differential performance of onion lines in different stability approaches. Ibid. Pp. 31.

Krishna Prasad VSR, KE Lawande, BS Mundhe, H Yewale and PP Gawande 2005. Component compensation for seed yield of onion (*Allium cepa* L.). Ibid. Pp. 29.

Krishna Prasad VSR, KE Lawande, BS Mundhe, H Yewale and PP Gawande 2005. Distinctness, Uniformity and Stability (DUS) characterization of released varieties of *kharif* onion (*Allium cepa* L.). Ibid. Pp.30.

Krishna Prasad VSR, KE Lawande, H Yewale and PP Gawande 2005. Distinctness, Uniformity and Stability (DUS) characterization of released varieties of *rabi* onion (*Allium cepa* L.). Ibid. Pp. 31.

Krishna Prasad VSR, V Mahajan and KE Lawande 2005. Development of F_1 hybrids through line x tester analysis for *kharif* onion production. Ibid. Pp. 29.

Krishna Prasad VSR, V Mahajan and KE Lawande 2005. Genetic variation and component association of yield and its attributes in onion (*Allium cepa* L.). Ibid. Pp. 28.

Krishna Prasad VSR, V Mahajan and KE Lawande 2005. Performance of onion (*Allium cepa* L.) germplasm for yield and quality attributes under the late *kharif* conditions. Ibid. Pp. 23.

Krishna Prasad VSR, V Mahajan, KE Lawande 2005. Diversity pattern and parental selection for onion (*Allium cepa* L.) improvement. Ibid. Pp. 24.

Mahajan V, A Khar and KE Lawande 2005. Studies on storage of garlic varieties stored with and without foliage. Ibid. Pp. 102.

Mahajan V, J Jakse, MJ Havey and KE Lawande 2005. Identification of male sterile cytoplasm in onion in Indian genotypes. Ibid. Pp. 21.

Mahajan V, PS Srinivas, VSR Krishna Prasad and KE Lawande 2005. Iris yellow spot virus- a new threat for onion seed production in India. Ibid. Pp. 94.

Mahajan V, V Sankar, PC Tripathi and KE Lawande 2005. Effect of trimming of seedlings and day to uprooting at the time of transplanting on yield of onion. Ibid. Pp.57.

Mahajan V, VSR Krishna Prasad and KE Lawande 2005. Screening of white onion germplasm for storage. Ibid. Pp. 58.

Qureshi AA and KE Lawande 2005. Effect of selective crops on activity of nitrogen enzymes and the changes in nitrogen content in rhizosphere and non-rhizosphere soils. Ibid. Pp. 41.

Qureshi AA, V Sankar and KE Lawande 2005. Evaluation of INM modules in onion and garlic crops. Ibid. Pp. 52.

Qureshi AA, VSR Krishna Prasad and KE Lawande 2005. Screening of onion germplasm against drought tolerance. Ibid. Pp. 22.

Sankar V and D Veeraragavathatham 2005. Studies on organoleptic evaluation of organically produced onion. Ibid. Pp. 105.

Sankar V, AA Qureshi, PC Tripathi and KE Lawande 2005. Production potential and economics of onion based cropping systems under Western Maharastra region. Ibid. Pp. 79.

Sankar V, D Veeraragavathatham and M Kannan 2005. Post harvest storage life of onion influenced by organic farming practices. Ibid. Pp.104-105.

Sankar V, PC Tripathi and KE Lawande 2005. Effect of seed pelleting and planting methods in *kharif* onion production. Ibid. Pp. 59.

Sankar V, PC Tripathi, AA Qureshi and KE Lawande 2005. Effect of fertigation on growth and yield of onion var. N-2-4-1. Ibid. Pp. 62.

Sankar V, PC Tripathi, AA Qureshi and KE Lawande 2005. Effect of seaweed based organic biostimulants on growth and yield of garlic. Ibid. Pp. 60.

Sankar V, PC Tripathi, AA Qureshi and KE Lawande 2005. Fertigation studies in garlic Ibid. Pp. 80.

Srinivas PS and KE Lawande 2005. Combined effect of neem with insecticides on onion thrips, *Thrips tabaci* Lindeman. Ibid. Pp. 93.

Srinivas PS and KE Lawande 2005. Insectary planting: To attract natural enemies to onion and garlic ecosystems. Ibid. Pp. 92.

Tripathi PC, SS Dhumal, HM Jadhav and KE Lawande 2005. Survey of method of planting, yield and productivity of onion. Ibid. Pp. 108.

Tripathi PC, SS Dhumal, HM Jadhav and KE Lawande 2005. Survey of onion storage structures in India. Ibid. Pp. 104.

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Lawande KE, A Khar and A Asha Devi 2006. *Allium* Biodiversity. In: Abstracts, National Conference on Agrobiodiversity organized by the National Biodiversity Authority held at Chennai from 12 15 February. Pp. 104 105.

Mahajan V 2006. *Pyaj avum lahasun ki kisme, utpadan, niryat avum prasanskaran*. In: *Smarika (Souvenir)*, National Seminar on Vegetable Production, Post Harvest Management and Marketing, from 4-6 March 2006 at Regional Research Station, Sinnar, Nashik. Pp. 11-18.

Tripathi PC 2006. Pyaj avam lahsun mai jal pravandhan. Ibid. Pp. 19-21.

Popular articles

Lawande KE and V Mahajan 2006. Kanda Beejoutpadan. *Shetakari* p. 26-32.

Mahajan V 2006. *Kandyachya vivid jatinchi chi lagwad*. *Shetakari* p. 10-14.

Mahajan V and KE Lawande 2005. Kandhyachi ropvatika kashi taiyar karavi? *Agro 1, Weekly Agriculture News Paper*.

Mahajan V and KE Lawande 2005. Rabbi kanda: Utpadan va Sathavan. *Shetakari* p. 23-28.

Sankar V, KE Lawande and PC Tripathi 2005. Mother clove selection in garlic - A review. *Spice India* 18 (9): 30.

Sankar V, Mahajan V and KE Lawande 2005. Prospects of garlic processing industry in India. *Spice India* 18 (10): 23-25.

Srinivas PS 2005. Garlic wards off pests and diseases. *Spice India* 18 (7): 27-28.

Tripathi PC 2006. Kanda lagwad tantra gyan, ketache va paniyanache niyoyan. *Shetkari Masik*, Feb: 8-9.

Tripathi PC and Lawande KE 2005. Pyaj shrenikaran yantra-ek labhadayak vikalpa. *Phal Phool* 27(2): 16-17.

A special issue of *Krishi Chayanika* (October December 2005) was published by DIPA, ICAR exclusively on onion and garlic. The issue contains detailed information of important aspects of the two crops *viz.*, medicinal properties of onion and garlic, its biotechnology, seed production in onion, etc. The following articles of the centre appeared in the special issue:

Asha Devi A, A Khar and KE Lawande 2005. Pyas aur lasun sudhar mein jaivapraudyogiki. *Krishi Chayanika* 45-46.

Khar A 2005. Lasun ki munafadayak kismem. *Krishi Chayanika* 24, 38.

Krishna Prasad VSR 2005. Bharat main vikasit pyas ki kismem. *Krishi Chayanika* 17-23, 47.

Lawande KE 2005. Pyaj aur lasun ka aushadhiya mahatvu. *Krishi Chayanika* 6.

Lawande KE 2005. Pyas aur lasun ka vipanan. *Krishi Chayanika* 28, 36-37.

Mahajan V and KE Lawande 2005. *Pyaj avam lahasoon se prasanskrit utpad. Krishi Chayanika* 7-10, 14.

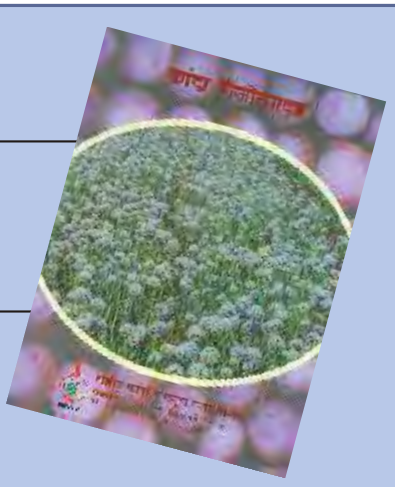
Tripathi PC and KE Lawande 2005. Pyaj bhandaran ke liye naveentam bhandargruh. *Krishi Chayanika* 32-35.

Tripathi PC and KE Lawande 2005. Pyaj ka sasyottar pravabdhan. *Krishi Chayanika* 25-27, 39-40.

Tripathi PCand KE Lawande 2005. Pyaj ki uannat kheti. *Krishi Chayanika* 11-14.

Tripathi PC and KE Lawande 2005. Pyaj shrenikaran yantra. *Krishi Chayanika* 29-31.

Research bulletins



Lawande KE and V Mahajan 2005. *Kanda beejoutpadan* (in Marathi). Research bulletin No.13. Published by National Research Centre for Onion and Garlic.

Tripathi PC and KE Lawande 2005. Intercropping of onion and garlic in sugarcane with modern irrigation systems. Research bulletin No.14. Published by National Research Centre for Onion and Garlic.

Tripathi PC and KE Lawande 2006. *Cold storage of onion and garlic*. Research bulletin No.15. Published by National Research Centre for Onion and Garlic.

Transfer of Technology

Lectures delivered

Topic	Organizer(s)	Venue	Date
Dr. Mahajan V			
Onion production for export, insect and pest management	Maharashtra State Agricultural Marketing Board, (MSAMB) Pune.	Indapur	6.7.05
Uttam praticha kandhyacha niryatisathi kadhni purva va kadhaninantarche tantragyan, sathavanuk	MSAMB, Pune; Agrl. Dept., Pune and APMC Lonand	Lonand, Satara	25.8.05
Uttam praticha kandhyacha niryatisathi kadhni purva va kadhaninantarche tantragyan, sathavanuk	MSAMB, Pune; Agrl. Dept., Pune and APMC, Neera	Morgaon, Baramati	30.8.05
Uttam praticha kandhyacha niryatisathi kadhni purva va kadhaninantarche tantragyan, sathavanuk	MSAMB, Pune; Agrl. Dept., Pune and APMC, Indapur	Babda, Indapur	14.9.05
Kanda utpadan tantragyan	RAWE students, College of Agriculture, Pune	Khadumbre	5.10.05
Kanda pikavaril vivid keed va rog tasech tyache niyantran	Zuari Industries Ltd., Pune	Avasari Phata	28.11.05
Kanda utpadan shashtrokta Paddhat	Hari Siddhi Farm, Bhagadi and Ambagaon Taluka Agricultural	Bhagadi	1.1.06

Topic	Organizer(s)	Venue	Date
Niryat kshyam Kanda lagwad, utpadan vaad, Ekatamak keed rog vyavasthapan, kadhni purva va kadhani nantarche tantragyan va sathavan	APMC, Junnar and MSAMB, Pune	Junnar	10.1.06
Niryat kshyam Kanda lagwad, utpadan vaad, Ekatamak keed rog vyavasthapan, kadhni purva va kadhani nantarche tantragyan va sathavan	APMC, Junnar; Sahakar Maharshi Shivajirao & Dadaso Kade Gramin Bigersheti PathSansthan, Otur; Ganesh Mandal Market Yard, Otur and MSAMB, Pune	Otur	13.1.06
Onion production technology	Bank of Maharashtra, Gramin Vikas Kendra, Hadapsar, Pune	Gramin Vikas Kendra, Bhigvan, Tal. Indapur	24.1.06
Sudharit kanda va lasun lagwad tantragyan, niryatkshamya kanda utpadan va sathavanuk	Department of Agriculture, Maharashtra	Chakan Market Yard	27.1.06
Niryat kshyam Kanda lagwad, utpadan vaad, Ekatamak keed rog vyavasthapan, kadhni purva va kadhani nantarche tantragyan va sathavan	APMC, Manchar, MSAMB, Pune and Dept. of Agriculture, Maharashtra	Shingve, Taluka Ambegaon	30.1.06
Kanda lagawad, niga va sathavan	APMC, Manchar, MSAMB, Pune and Dept. of Agriculture, Maharashtra	Shinoli, Taluka Ambegaon	31.1.06
Onion seed production technology	HTC, Pune	NRCOG, Rajgurunagar	8.2.06
Kanda va batata peek parisanwad	Zuari Industries Ltd., Pune & Agrl. Dept. Panchayat Samiti, Ambegaon, Maharashtra	Karegaon, Taluka Ambegaon	11.3.06
Sathavanuk khyamya kanda utpadan va sathavanuk	Govt. Polytechnique, Pune	Parinche, Tal. Purander	12.3.06

Participation in Exhibitions

Names	Organizer(s)	Venue	Period
V Mahajan; V Sankar; VV Patil; NL Gore; PS Takale; AP Trivedi; NH Shaikh; SD Waghmare; PR Sonawane; PK Tadge and MS Kale	Kisan Forum, Pune; Ministry of Agril.; NABARD & SBI	Kissan 2005, Moshi, Pune	14 - 18, December 2005
V Mahajan; VV Patil; Keskar; SD Waghmare; PR Sonawane; PK Tadge and MS Kale	Sangamner Taluka Agril. Produce Soc. and Dept. of Agril., Maharashtra	Agriculture & Food Processing Exhibition Sangamner.	12 - 15, January 2006
V Mahajan; VV Patil; SD Waghmare and PR Sonawane	Department of Agriculture, Maharashtra	Agriculture Exhibition Chakan	27 January 2006

Farmers' training

A three-day training programme was organized during 27-29 December 2006 on "Production, post harvest technology of onion and garlic" for farmers from Andhra Pradesh. Thirty five farmers attended the training programme. The trainees were exposed to improved technologies in production, pest management, storage, value addition and marketing through lectures and field visits. The farmers interacted with the growers and traders during field and market visits and acquired first hand information.

In collaboration with KVK, Nandurbar a three-day training programme was organized at NRCOG, from 23-25 Feb 2006 to onion growers from Nandurbar, Maharashtra. Fifty farmers were trained on all aspects of production, protection and post harvest handling through lectures and field and market visits.

Human Resource Development

Participation of scientists / staff in conferences / courses / meetings / seminars / symposia / workshops / trainings etc. during 2005-06

Title and Venue	Name	Period
All India Coordinated Research Project (Vegetable crops) Group meeting held at UAS, Dharwad, Karnataka	Dr. KE Lawande Dr. VSR Krishna Prasad Dr. PC Tripathi, Dr.V Mahajan Dr. AA Qureshi.	16-19 April 2005
Workshop on Bio-safety Measures held at Pune	Dr. PC Tripathi Dr. V Mahajan	20 August 2005
International Conference on Plant Genomics and Biotechnology: Challenges and Opportunities held at Indira Ghandhi Krishi Vidyapeeth, Raipur	Dr. V Mahajan	26- 28 October 2005
National Symposium on Current Trends in Onion,Garlic, Chillies and Spices Production, Marketing and Utilization, held at National Research Centre for Onion and Garlic, Rajgurunagar	All scientists and staff of NRCOG	25 - 27 November 2005
21 days training programme on "Human Resource Management" at National Academy of Agricultural Research Management, Rajendranagar, Hyderabad.	Dr. AA Qureshi	4 - 24 January 2006
National Conference on Agribiodiversity organised by National Biodiversity Authority, Chennai.	Dr. KE Lawande	12-15 February 2006
National Seminar on Vegetable Production, Post Harvest Management and Marketing held at Regional Research Station, Sinnar, Nasik	Dr. V Mahajan Dr. PC Tripathi	4-6 March 2006

Deputations / Visits abroad

Scientist	Purpose of visit	Place of visit	Period
Dr. Anil Khar	Received BOYSCAST fellowship from Department of Science and Technology, Government of India	USDA-ARS Dept. of Hort., University of Wisconsin, Madison, USA	One year w.e.f 30.3.06

Training programme on DUS

A training programme on "DUS testing of Onion and Garlic" was organized during 28-30 March 2006. 24 participants from State Agricultural University and ICAR Research Institutes participated in the above training.

National symposium, SYMSAC-II

NRC for onion and garlic organized the National Symposium, SYMSAC-II, on **"Current trends in onion, garlic, chillies and seed spices production, marketing and utilization"** during 25-27 November 2005 at Rajgurunagar, in collaboration with Indian Society for Spices, Calicut, NRC for Seed Spices, Ajmer and Indian Council of Agricultural Research, New Delhi.

Dr. G Kalloo, DDG (Hort.& Crop Sci.), ICAR inaugurated the Symposium. Dr. MR Thakur, Ex-VC, Dr. YS Parmar University of Horticulture and Forestry presided over the function. Dr. KE Lawande, Director NRCOG and Chairman of the SYMSAC-II welcomed the delegates. Dr. VS Korikanthimath, President, ISS briefed about the research activities of the society and Dr. T John Zachariah, Secretary, ISS introduced the technical sessions of the souvenir. On this occasion chief guest Dr. G Kalloo, DDG (Hort.& Crop Sci.) released publications of SYMSAC-II and presented JS Pruthi award for best paper published in Vol.13 (2004) of Journal of Spices and Aromatic Crops to Dr. Sasikumar *et al*. He also presented Premnath Foundation award to Dr. SK Malhotra, Senior Scientist for developing improved varieties in seed spices. Dr.VSR Krishna Prasad, Principal Scientist (Hort.) and Convener of SYMSAC-II proposed the vote of thanks. 175 delegates from all parts of the country attended the three-day symposium.

SYMSAC-II, National Symposium had been covered in the following theme areas in seven technical sessions

1. Biodiversity, Genetics, Breeding and Biotechnology (Crop Improvement)
2. Sustainable Production System (Crop Production)
3. Plant Protection
4. Processing and value addition

5-6. Trade and policy issues & farmers' interface.

7. Economics and Marketing

Dr. Kirti Singh, Ex-Chairman ASRB, Dr. Nawab Ali, DDG (Engg.), Dr. Nerkar, Ex-VC, MPKV, Rahuri & Director VSI, Pune, Dr. RK Chowdhury, OSD, Directorate of Seed Research Dr. Mathura Rai, Director, IIVR, Dr. KR Koundal, Project Director, NRC for Plant Biotechnology, Dr. PG Adsule, Director, NRC for Grapes, Dr. SJ Singh, Ex-Head, IARI Regional Station, Pune, Dr. VB Patil, Director of Horticulture, Pune, Dr. S Dave, Director, APEDA attended the symposium and participated in different technical sessions. During the sessions, the related issues were discussed in detail with good interaction among the scientists.

Dr. Alapatti Prasad Rao Best Poster Award was presented to the poster entitled "Gujarat Cumin-4, a new wilt resistant cumin variety having high yield potential and better seed quality in India" authored by KP Patel, NR Patel and AV Agalodiya, Main Spices Research Station, S.D. Agricultural University, Jagudan, Gujarat and to the poster entitled "Preliminary screening of garlic varieties through RAPD technique" authored by Dr. Anil Khar, Asha Devi and KE Lawande. Following salient recommendations emerged out of presentations and discussions.

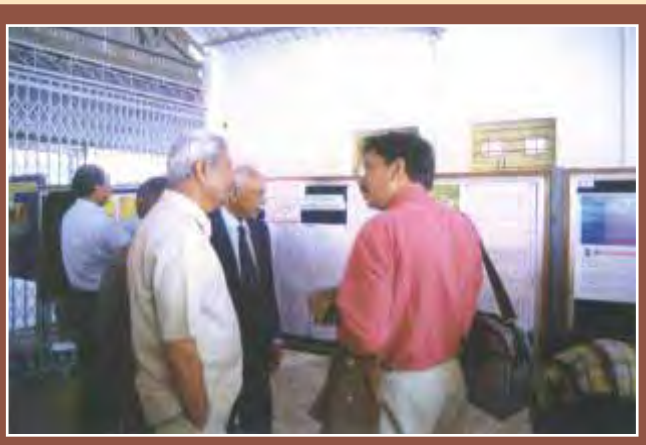
1. Re-orientation of research towards development of resistant varieties coupled with good storage in onion and garlic, low capsaicin and high oleoresins in chillies and more flavour in seed spices.
2. There is need for development of chilly varieties for processing with low capsaicin and high oleoresin content to exploit the great export potential.
3. Work on development of photo and thermo insensitive parental lines in spices must be taken up on priority and these can be exploited for the development of two line hybrids in these crops.
4. There is an urgent need for development of seed certification standards in seed spices.
5. Source of resistance for diseases in seed spices should be located and breeding for incorporation of resistant genes should be initiated.
6. Database on biochemical analysis of spice varieties must be developed on priority basis for establishment of brand name for export.
7. The use of drip irrigation with 100% PE was found useful for higher yield and quality with 35-40% water saving over surface irrigation in onion and garlic. The use of micro irrigation should also be tried in chillies and seed spices. The findings of micro irrigation should be demonstrated on large scale on farmers' field through frontline demonstration schemes.
8. The *kharif* onion plays an important role in price stabilization. There is need to do more research on various aspects of *kharif* onion such as planting system, direct sowing, curing *etc* in all the *kharif* growing belts of the country under a coordinated programme. Available results should be demonstrated in *kharif* onion growing areas of Maharashtra, Karnataka and Rajasthan.
9. Epidemiology of economically important diseases may be worked out and disease-forecasting models should be developed.
10. The work on survey and preparation of insect pest map of onion, garlic and seed spices in different agro climatic zones should be taken up.
11. A dynamic database on pathogens, insects, weather and cropping system must be developed for planning biotic stress free production.
12. Frontline demonstration of newly developed top and bottom ventilated mud thatched storage structure may be set up at the village level or with some progressive farmers to popularize the structures.
13. Since irradiation helps in hygenization of spices, irradiation facilities should be created in all agri-export zones.
14. Cost effective ventilated containers for transport of onion should be made available.
15. By adopting appropriate *kharif* onion production technology, Karnataka, Maharashtra and Rajasthan should boost *kharif* onion production to bridge the gap particularly during October and November.
16. NABARD may come forward to finance integrated training programmes to the farmers of major onion growing states in the field of production and post harvest handling of onion and refinance for agri-export zones.

Glimpses of
National symposium, SYMSAC-II

Dignitaries at the dais during the inaugural session

View of the participants

Presentation of best poster award



Delegates having discussion with experts during the poster session

A view of the poster session

A glimpse of the cultural event organized

Institutional Activities

Scientific and Management Meetings

Staff Research Council (SRC)

Chairman

Dr. KE Lawande,
Director, National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

Members

All Scientists of the Centre

Member-Secretary

Dr. VSR Krishna Prasad,
Principal Scientist,
National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

The Ninth SRC meeting was held on 20-22 February 2006 under the chairmanship of Dr. KE Lawande, Director. All the scientists presented the research achievements of their respective projects. The SRC reviewed all the research projects and offered suggestions for further strengthening of the projects.

Research Advisory Committee (RAC)

Chairman

Dr. MR Thakur
Ex-VC, Dr. YSPU of H and F,
Himachal Pradesh

Dr. VS Sheshadri
Ex-Head, Division of Vegetable Crops,
Indian Agricultural Research Institute,
New Delhi

Dr. SJ Singh
Ex-Head,
Indian Agricultural Research Institute (RS),
Pune, Maharashtra

Dr. SH Shinde
Ex Director of Research,
Mahatma Phule Krishi Vidyapeet,
Rahuri, Maharashtra

Shri. CB Holkar,
Chairman,
Vegetable & Fruit Co-operative Society,
Lasalgaon, Dist Nashik, Maharashtra

Dr. KE Lawande,
Director, National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

Dr. Nazeer Ahmed
Dean (Agri), FOA-cum-Prof. & Head
Sher-E-Kashmir University of Agricultural Sciences and Technology (K), Srinagar (J&K)

Dr. RB Jain
Managing Director, Jain Irrigation System Ltd.
Jalgaon, Maharashtra

Shri. Suryakant Palande
Ex-MLA & Progressive Farmer, Maharashtra

Dr. SN Pandey,
Asstt. Director General (Hort.)
Indian Council of Agriculture Research,
New Delhi

Member Secretary

Dr. VSR Krishna Prasad,
Principal Scientist (Hort.)
National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

The Ninth Research Advisory Committee meeting was held on 6-7 March 2006 under the Chairmanship of Dr. MR Thakur, Ex- Vice Chancellor, YSUH & F, Solan. The members, Dr. VS Sheshadri, Dr. Nazeer Ahmed, Shri Suryakand Palande, Dr. KE Lawande, Dr. VSR Krishna Prasad and all the Scientists attended the meeting.

Institute Management Committee (IMC)

Chairman

Dr. KE Lawande,
Director,
National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

Members

Asstt. Director General (VC)
Indian Council of Agriculture Research,
New Delhi

The Commissioner & Director of Hort.,
Govt. of Andhra Pradesh, Hyderabad

Shri. Suryakant Palande
Ex-MLA & Progressive Farmer Ghodnadi,
Tal - Shirur, Dist Pune, Maharashtra

The Finance & Accounts Officer,
Central Institute of Fisheries Education,
Mumbai

Dr. VSR Krishna Prasad,
Principal Scientist,
National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

Dr. R Veera Gowda,
Sr. Scientist,
Indian Institute of Horticultural Research,
Hessaraghatta, Bangalore, Karnataka

Dr. PC Tripathi,
Sr. Scientist,
National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

I/C Assistant Finance & Accounts Officer,
National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

Dr. VD Patil,
Director of Horticulture,
Govt. of Maharashtra, Shivajinagar, Pune

Dr. SS Kadam,
Vice-Chancellor,
M.A.U., Parbhani, Maharashtra

Shri. CB Holkar,
Chairman,
Vegetable & Fruit Co-Operative Society,
Lasalgaon, Dist Nashik, Maharashtra

Dr. Anurdha Upadhya,
Sr. Scientist,
National Research Centre for Grapes,
Manjri, Pune, Maharashtra.

The Assistant Administrative Officer,
National Research Centre for Onion and Garlic, Rajgurunagar, Pune, Maharashtra

The X Institute Management Committee meeting was held on 10, January 2006 under the chairmanship of Dr. KE Lawande, Director. The committee discussed the agenda in detail and gave recommendations accordingly.

Foundation day Celebration

The Foundation day of the National Research Centre for Onion and Garlic was celebrated on 16.06.2005. On the occasion, about 150 farmers from Rajgurunagar and nearby villages were invited for the function and they were trained on different aspects of onion and garlic cultivation, production and post harvest handling. Sh. Anantrao Dixit, Chief Editor Sakal was the chief guest for the occassion. Sh. UB Panday, Director, NHRDF and Sh. Suryakant Palande, RAC and IMC member, NRCOG also graced the occassion.

हिन्दी पखवाड़ा

राष्ट्रीय प्याज एवं लहसुन अनुसंधान केन्द्र पर दिनांक १४-०८-२००५ से २५.०५.०५ तक हिन्दी पखवाड़ा मनाया गया । इस दौरान टिप्पणी लेखन, सुलेखन, कविता पाठ, निबन्धलेखन, वादविवाद तथा टंकण प्रतियोगिताएं आयोजित की गयी। हिन्दी पखवाड़ा का समापन समारोह दिनांक २५.०५.०५ को आयोजित किया गया। इस कार्यक्रम की अध्यक्षता निदेशक महोदय ने की तथा डा. वी. एन. भालेराव सह प्राध्यापक, हिन्दी विभाग, पुणे विश्वविद्यालय इस कार्यक्रम के मुख्य अतिथि थे। निदेशक महोदय के उद्‌बोधन के पश्चात मुख्य अतिथि महोदय ने हिन्दी के महत्व पर सारगर्भित भाषा में प्रकाश डाला। मुख्य अतिथि के भाषण के पश्चात विजेता प्रतिभागियों को पुरस्कार वितरित किये गये।

Personnel

Degrees/Awards

Dr. Asha Devi A, Scientist Sr. Sc. (Genet.) was awarded Ph.D degree from University of Kerala on 12.05.2006 for the topic entitled 'Clonal propagation and analysis of fidelity of regenerants using molecular markers in garlic (*Allium sativum* L.)'.

Dr. Alapatti Prasada Rao award for Best Research Paper (Poster) was received by Drs. Khar A, Asha Devi A and Lawande KE for the poster entitled 'Preliminary screening of garlic varieties through RAPD technique' presented during SYMSAC-II: Current trends in Onion, Garlic, Chillies and seed spices- Production, Marketing and Utilisation held at NRCOG Rajgurunagar from 25-27 November 2005.

Promotions

1. Dr.V Sankar promoted to Scientist Sr.Scale w.e.f.18.11.2005.
2. Sh. NL Gore, promoted T-5 (Tech.Officer) w.e.f. 01.01.2005.

Transfers

Dr.CR Ramesh, Principal Scientist (Plant Pathology) was transferred from Indian Grassland and Folder Research Institute, Jhansi, Regional Station, Dharwad to NRCOG, Rajgurunagar w.e.f. 17.09.2005

Retirements

1. Sh.EDThorat, (T-4) (Technical Assistant), took Voluntary retirement w.e.f. 01.08.2005
2. Sh.MG Bhambure, SSGr.IV (Sr. Mali), took Voluntary retirement w.e.f. 01.11.2005

Staff Position

Sl. No	Category	Sanctioned Posts	Filled up posts	Vacant Posts
1.	RMP	01	01	Nil
2.	Scientific	11	09	02
3.	Technical	10	10	Nil
4.	Administrative	09	08	01
5.	Supporting	11	11	Nil
	Total	42	39	03

List of Staff

Scientific

Dr. KE Lawande
Director

Dr. CR Ramesh
Principal Scientist (Plant Patho.)

Dr. VSR Krishna Prasad
Principal Scientist (Hort.)

Dr. PC Tripathi
Senior Scientist (Hort.)

Dr. V Mahajan
Senior Scientist (Hort.)

Dr. AA Qureshi
Scientist Sr. Sc. (Soil Science)

Dr. PS Srinivas
Scientist Sr. Sc. (Ento.)

Dr. Anil Khar
Scientist Sr. Sc. (Hort.)

Dr. A Asha Devi
Scientist Sr. Sc. (Genet.)

Dr. V Sankar
Scientist Sr. Sc. (Hort.)

Technical

Mr. VV Patil
Technical Officer T-5

Mr. NL Gore
Technical Officer T-5

Mr. AP Trivedi
Technical Assistant T-4

Mr. ED Thorat
Technical Assistant T-4 (till 1.8.05)

Mr. HSC Shaikh
Computer Programmer T-4

Mr. P. S. Takale
Technical Assistant T-2

Mr. DM Panchal
Technical Assistant T-2 (Lab)

Mr. RB Baria
Technical Assistant T-2 (Field)

Mr. BA Dahale
Technical Assistant T-2 (Tractor Driver)

Mr. SP Yeole
Technical Assistant T-2 (Jeep Driver)

Administrative

Mr. N Gopal
Assistant Administrative Officer

Mrs. SS Joshi
Assistant

Mr. DB Mundarikar
PA to Director

Mr. SP Kandwal
Senior Clerk

Mr. PS Tanwar
Senior Clerk

Mrs. MS Salve
Senior Clerk

Mrs. NR Gaikwad
Hindi Typist

Mr. RK Dedge
Junior Clerk

Supporting Staff

Mr. AA Hole
SS Gr. IV (Sr. Mali)

Mr. MG Bhambure
SS Gr. IV (Lab Attendant) (till 1.11.05)

Mr. HS Shaikh
SS Gr. IV (Beldar)

Mr. SK Said
SS Gr. III (Beldar)

Mr. PK Khanna
SS Gr. III (Messenger)

Mr. PR Sonawane
SS Gr. II (Lab Attendant)

Mr. PE Tadge
SS Gr. II (Lab Attendant)

Mr. MS Kale
SS Gr. II (Messenger)

Mr. RS Kulkarni
SS Gr. I (Lab Attendant)

Mr. SD Waghmare
SS Gr. I (Watchman)

Mr. NH Shaikh
SS Gr. I (Messenger)

Distinguished Guests

Mr. Dadasaheb Kalamkar, Ex-MLA, Ahmednagar	06.04.2005
A Team of NABARD-World Bank Officers, Pune	13.05.2005
Mr. SK Joshi, Business Manager, DIPA, New Delhi	09.06.2005
Mr. Anantrao Dixit, Chief Editor, Sakal, Pune	14.06.2005
Dr. UB Pandey, Ex-Director, NHRDF, Nashik	14.06.2005
Mr. Suryakant Palande, Member RAC, NRCOG, Pune	14.06.2005
Mr. PV Phirke, JDA, Pune	29.06.2005
Dr. VS Korikanthimath, Director, ICAR-Res. Complex, Goa	06.07.2005
Dr. BB Vashishtha, Director, NRC-Seed Spices, Ajmer	06.07.2005
Mr. OP Gupta, MLA-UP, Lucknow	30.01.2006
Dr. AS Patil, Director (AE), VSI, Pune	13.02.2006
Mr. Gopal Reddy, IAS, MD-MSH&MPB, Pune	01.03.2006
Dr. SD Kulkarni, Director-CIAE, Bhopal	17.03.2006
Dr. RK Choudhary, PC-Seeds, IARI, New Delhi	28.03.2006

Total number of farmers visited	**5045**

Finance

Financial Statement for the year 2005-2006

Head of Accounts	Rupees in Lakhs	
	Budget Allocation	Expenditure
Non-Plan	89.00	86.98
Plan	200.00	169.35
KVK	Nil	Nil
NATP	Nil	Nil
AP-Cess Fund Scheme	4.00	4.40
Pension & Retirement	10.00	5.82
P-Loans & Advances	2.00	1.98
R-Deposit Scheme	47.56	35.50
Revolving Fund Scheme	7.25	6.24
Total	**359.81**	**310.27**
Revenue Receipt	**11.42**	

Abbreviations

ADR	Agrifound Dark Red
AFW	Agrifound White
AGB	A-grade bulb
AICRP	All India Coordinated Research Project
AICVIP	All India Co-ordinated Vegetable Improvement Project
ALR	Agrifound Light Red
AVT	Advanced Varietal Trial
B:C	Benefit cost ratio
DAP	Days after planting
DAT	Days after transplanting
ETL	Economic threshold level
IET	Initial Evaluation Trial
IYSV	Iris Yellow Spot Virus
MY	Marketable yield
NBPGR	National Bureau of Plant Genetic Resources
NRC	National Research Centre
P. Safed	Phule Safed
P. Suwarna	Phule Suwarna
PLW	Physiological loss of weight
PM	Poultry manure
PWR	Puse White Round
RAPD	Random Amplified Polymorphic DNA
RDF	Recommended dose of fertilizer
SA	Sodium azide
TSS	Total soluble solids

Annexure - I

Meteorological data for the year 2005-06 at NRC for Onion and Garlic, Rajgurunagar

Month	Temperature (°C)		RH (%)		Average sunshine per day (hrs.)	Total rain fall (mm)	Evaporation (mm)
	Max.	Min.	Max.	Min.			
April	36.9	18.9	61	22	7.8	00	7.0
May	34.0	19.5	63	29	9.1	00	8.4
June	32.4	22.8	79	55	6.5	172	3.8
July	27.2	22.1	80	69	1.2	267.6	2.8
August	26.6	21.4	86	76	3.4	161.2	3.6
September	27.5	21.3	88	74	2.4	240.4	4.0
October	30.5	18.7	79	40	6.7	107.7	3.3
November	30.3	12.9	67	24	10.2	00	2.1
December	28.5	11.6	71	28	9.6	00	2.3
January	29.4	9.8	69	28	10	00	2.9
February	33.2	13.2	65	19	10.4	00	5.3
March	34	15	58	29	9.9	00	6.2

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