National Research Centre for Onion and Garlic

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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 2004 -2005

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कार्यकारी सारांश

राष्ट्रीय प्याज एवं लहसुन अनुसंधान केन्द्र का अधिदेय इन फसलों के वृद्धि में बाधक सभी मुद्दों का समाधान करना है। तद्नुसार अनुसंधान प्राथमिकताएं निर्धारित की गयी तथा इन पर कार्य किया जा रहा है। रिपोर्ट अवधि के दौरान प्याज व लहसुन के मात्रात्मक तथा गुणात्मक दोनों प्रकार के सुधार में महत्वपूर्ण उपलब्धियाँ हासिल की। विभिन्न प्रभागों में इन फसलों पर मुख्य उपलब्धियाँ निम्नाकिंत हैं ।

- लाल प्याज में खरीफ मौसम के लिए के-519 तथा एनआरसीओजी - 905 तथा पछेती खरीफ के लिए प्रवृष्टि 1067 तथा 1012 विपणन योग्य उपज के लिए उत्तम पायी गयी।
- बारह लाल पंक्तियों को उपज के लिए उत्तम प्रदर्शन के लिए वर्षभर खेती के लिए चयनित किया गया।
- लाल उन्नत पंक्तियों में एनआरसीओजी-654 तथा 597 को खरीफ मौसम में उपज व गुणवत्ता के लिए उत्तम पाया गया।
- उन्नत लाल प्याज की पंक्तियों में बी-780-5-3-3 तथा बी-780-5-2-2 अ.भा.स.स.सु.प. तथा हमारे केन्द्र के मूल्यांकन परीक्षणों में उत्तम प्रदर्शन करती पायी गयी।
- पूर्व में विकसित चार संकर संयोग उन्नत प्रदर्शन दे रहे हैं तथा समन्वित कार्यक्रम में परीक्षणार्थ हैं।
- सफेद प्याज में कुछ प्रवृष्टियाँ अधिक विपणन योग्य उपज, शीघ्र परिपक्वता तथा सम्पूर्ण घुलनशील पदार्थ (>17%) के लिए चिन्हिंत की गयी।
- लहसुन में, दो पंक्तियों यथा -221-5-2 तथा 103-4-1 में सर्वोत्तम मापक किस्म (जी-41) से अधिक उपज अंकित की गयी।
- अ.भा.स.स.सु.प. के अन्तर्गत प्रयोगों में दो प्रवृष्टियाँ (एनआरसीओजी-50 तथा 200)अधिक उपज दे रही हैं।

- प्याज व लहसुन में मृदूतक सम्वर्धन तथा पुरूद्भवन के आदिलेख का मानकीकरण किया गया। साथ ही साथ लहसुन में विभिन्न जनन द्रव्यों के बहुप्ररोह समावेशन के मूललेख का मानकीकरण किया गया।
- लहसुन में कुछ इरियोफिड माइट अवरोधिता सम्बन्धी आर.ए.पी.डी. चिन्हकों की पहिचान की गयी।
- प्याज व लहसुन अधिक उपज, पोषक मात्रा तथा भण्डारण क्षमता के लिए विभिन्न स. पो. प. मोड्यूलों की तथा उनकी मृदा की उर्वरता पर प्रभाव की पहिचान की गयी।
- गमले में प्रयोग के आधार पर प्याज की फसल में पोषक तत्वों के कमी के लक्षण की पहिचान की गयी।
- खरीफ प्याज के लिए प्रभावी उत्पादन प्रौद्योगिकी विकसित करने के लिए विभिन्न परिमानों यथा-छाया, समय तथा लगाने की विधि, किस्मों, रसायनों तथा खरपतवार प्रबन्ध का मानकीकरण किया गया।
- जैविक उत्पादन प्रयोगों में, मुर्गी की खाद सर्वोत्तम पायी गयी परन्तु कुल मिलाकर संस्तुति उर्वरक तथा कीटनाशकों वाले संयोग की तुलना में उपज में 25-40% की कमी तथा कन्दों के आकार में कमी पायी गयी।
- प्याज व लहसुन में उर्वरचाई प्रयोग सें ज्ञात हुआ कि जल-घुलनशील उर्वरकों का टपक सिंचाई द्वारा प्रयोग से उपज तथा उपज सम्बन्धी परिमानों में सुधार हुआ।
- टपक विधि में प्याज के लिए न:फा:पो:50:50:80 किग्रा/हे. आधारीय तथा 100 किग्रा नत्रजन प्रति हे. सात विभाजित मात्रा में तथा लहसुन के लिए 50:50:50 किग्रा/हे. तथा 50 किग्रा नत्रजन प्रति हे. सात विभाजित मात्रा में टपक विधि से देना, उपज तथा अधिकतम लागतः लाभ अनुपात के अनुसार सर्वोत्तम उपचार पाया गया। साथ-साथ टपक विधि से सतहीय सिचाई की तुलना में पानी की 20 से 30 प्रतिशत बचत पायी गयी।
- प्याज आधरित फसल तन्त्र पर किए अध्ययन से ज्ञात हुआ कि प्याज की अधिक उपज, दलहनी फसलों युक्त फसलक्रमों जैसे-मूंगफली-प्याज, तद्परान्त सोयाबीन-प्याज, में प्राप्त हुई।
- प्याज में भण्डारण नुकसान के आकलन पर किये प्रयोग संकेत देते हैं कि सी श्रेणी के प्याजों में भण्डारण नुकसान अधिक होते हैं। खेत में सुखाने, सुहागा, फेरस सल्फेट, 2 व 4 ग्राम/लि. कार्बन्डाजिम तथा ट्राइकोडर्मा का प्रयोग भण्डारण नुकसानों के प्रबन्धन में सहायक सिध्द होते हैं।
- गामा विकिरण द्वारा विभिन्न रंगों की प्याज की किस्मों में भण्डारण नुकसान के नियंत्रण में प्रभावी अन्तर पाया गया।
- विभिन्न भण्डारगृहों के मूल्यांकन में, मिट्टी के प्लास्टरवाला हवादार भण्डारगृह, पछेती खरीफ तथा रबी प्याज में वजन में कमी से होनेवाले नुकसान को कम करने में असरदार पाया गया। लेकिन लहसुन में विभिन्न भण्डारगृहों को कोई प्रभाव नही देखा गया।
- बाधा फसल द्वारा प्याज के थ्रिप्स प्रबन्धन में यह पाया गया कि मक्का की दो पंक्तियाँ सबसे प्रभावी पायी गयी। इस बाद बाहर मक्का तथा अन्दर गेहूँ की एक-एक पंक्ति वाले उपचार का स्थान था। इसके साथ-साथ बाधा फसलों से प्याज में पीड़कनाशक के प्रकोप को कम में सहायता मिली और 4-5 छिड़कावों के स्थान पर 1-2 छिड़काव पर्याप्त पाये गये।
- यह भी पाया गया कि 60 से 75 दिन की प्याज की फसल थ्रिप्स के प्रकोप के लिए सर्वाधिक सुग्राही होती है।
- कन्द बनाने के दौरान कम फिनोल, अधिक प्रोटीन, शर्करा तथा अमीनो अम्ल थ्रिप्स की अधिक संख्या के लिए जिम्मेदार पाये गये।
- कुल मिलाकर कीट परजीवी प्रारूपों यथा-वर्टीसिलियम लेकानी, बेवेरिया वेसिआना, पेसिलोमाइसिज तथा स्पिनोसेड, में प्रभावी अन्तर नही पाया गया तथा ये थ्रिप्स नियंत्रण के लिए कीटनाशक (कार्बोसल्फान) के तुलना में निम्न पाये गये।
- थ्रिप्स संख्या के कम करने के लिए प्रयुक्त तेरह कीट परजीवी अनियंत्रित दशा की तुलना में उच्चतर पाये गये लेकिन ये कीटों की संख्या को ई.टी.एल से नीचे लाने में असफल रहे।
- प्याज व लहसुन दोनों में एक नया पीड़क, लाल मकड़ी माइट, जो टेट्रानिकस सिनाबारिनस (यूरडिल) (एकेरी:ट्रेटानिकिडी), पहली बार रिपोर्ट किया गया।

उपरोक्त अर्जित उपलब्धियों तथा प्याज व लहसुन अनुसंधान के समक्ष समस्याओं तथा क्यू.आर.टी. की संस्तुतियों को ध्यान में रखते हुए नये प्रयोग बनाये गये हैं तथा इन दोनों फसलों के सुधार के लिए कार्य किये जा रहे हैं।

Executive Summary

National Research Centre for Onion and Garlic is mandated to address all the issues that hinder the growth of these crops and accordingly the research priorities were fixed and are being executed. During the year under report, on the research front, significant achievements have been made towards the improvement of onion and garlic, both qualitatively as well as quantitatively. Major achievements in these crops under various sections are given hereunder:

- Among red onion, K-519, NRCOG-985 in *kharif* season and accessions 1067 and 1012 in late *kharif*/*rangda* were found to be superior in terms of marketable yield.
- Twelve red lines, selected for year round cultivation, showed superior performance in terms of yield.
- Among red elite lines NRCOG-654 and 597 were found to be superior in terms of yield and quality in *kharif* season.
- Advanced lines of red onion B-780-5-3-1 and B-780-5-2-2 are showing superior performance under AICVIP and evaluation trials at our Centre.
- Previously developed four hybrid combinations are giving superior performance and are being tested in co-ordinated programme.
- In white onion, some accessions with higher marketable yield, early maturity and TSS (>17%) have been identified.
- In garlic, two lines *viz.*, 221-5-2 and 183-4-1 recorded significantly superior yield over the best check variety (G-41).
- Under AICVIP trial, two accessions (NRCOG-50 and 200) are giving better yield performance.

- Protocol has been standardized for callus culture and regeneration in onion and garlic, whereas, protocol for multiple shoot induction in different genotypes of garlic has also been standardized.
- Some RAPD markers linked to eriophyid mite resistance in garlic were identified.
- Different INM modules in onion and garlic for increasing yield, nutrient content and storability and their effect on soil fertility were identified.
- In onion crop, work on identification of nutrient hunger signs was done under pot culture experiments.
- Different parameters viz., shading, date and method of planting, varieties, chemicals and weed management were standardized for development of an effective production technology in *kharif* onion.
- In organic production trials, poultry manure treatment was found to be best but the overall yields were 25-40% lower with reduced bulb size than the recommended fertilizer and pesticide treatment.
- Fertigation studies in onion and garlic revealed that the application of water soluble fertilizers through drip irrigation improved the yield and yield contributing characters of both onion and garlic.
- Use of NPK 50:50:80 kg/ha as basal plus 100 kg N in seven splits for onion and 50:50:50 kg/ha basal and 50 kg N through seven splits for garlic through drip irrigation was adjudged as best treatment in terms of yield and cost:benefit ratio. Moreover, there was 20-30% water saving in drip fertigation over surface irrigation method.
- Studies on onion based cropping systems revealed higher marketable bulb yield of onion in legume based cropping sequences like groundnut followed by onion and soybean onion cropping sequence.
- Assessment of storage losses in onion indicated that C grade bulbs had higher storage losses and combination of field curing treatment, application of borax, ferrous sulphate, carbendazim @ 2 and 4g/l and use of *Trichoderma* as drenching helps in effective management of storage losses.
- Use of irradiation showed significant differences in controlling storage losses among different coloured varieties.
- Among the different storage structures evaluated, mud plastered top and bottom ventilated storage structure was found more efficient in reducing physiological loss of weight in both late *kharif* and *rabi* onion. Whereas, no effect of different storage structures was observed in garlic.
- In barrier cropping for onion thrips management, it was observed that blocking efficiency was highest in two rows of maize followed by an outer row of maize and an inner row of wheat. Further, barrier cropping also reduced the pesticide load on onion by restricting the sprays to one or two as compared to 4-5 in regular schedule.
- It was also found that 60-75 days old onion crop is more susceptible to the thrips infestation.
- Low phenols, high protein content, reducing sugars and amino acids were found to be responsible for the higher infestation of thrips during bulbing stage
- Overall efficacy of insect pathogen formulations namely, *Verticilium lecani*, *Beauveria bassiana*, *Paecilomyces* and Spinosad did not differ significantly amongst themselves and were inferior to insecticide (carbosulfan) spray for the control of thrips.
- Thirteen insect pathogen strains, used to minimize the thrips population, were significantly superior as compared to control but they failed to bring down the thrips population below ETL at any instance.
- A new pest, red spider mite identified as *Tetranychus cinnabarinus* (= *urdicae*) (Acari: Tetranychidae) was reported for the first time in both onion and garlic.

Keeping in view all the achievements made and problems being faced in onion and garlic research and on the basis of RAC recommendations, new trials have been formulated and are being carried out for the improvement of both these crops.

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Introduction

National Research Centre for Onion and Garlic was sanctioned by the Indian Council of Agricultural Research during VIII Plan and it was established in the year 1994 with its headquarters at Nasik. In June 1998, the Centre was shifted to Rajgurunagar, 43 km away from Pune on Pune-Nasik highway and started its functioning from June 1998 onwards. It is located at 18.32^{0}N (latitude) and 73.51^{0} E (longitude) at 553.8 mtr. above m.s.l with a temperature range of 5.5 ^{0}C - 42.0 ^{0}C having annual mean rainfall of 669 mm .The Centre has 55 acres research farm at Rajgurunagar. Besides this, 10 acres has been acquired at Hadapsar, Pune for commercial seed production of onion and garlic and also to conduct various multilocation trials.

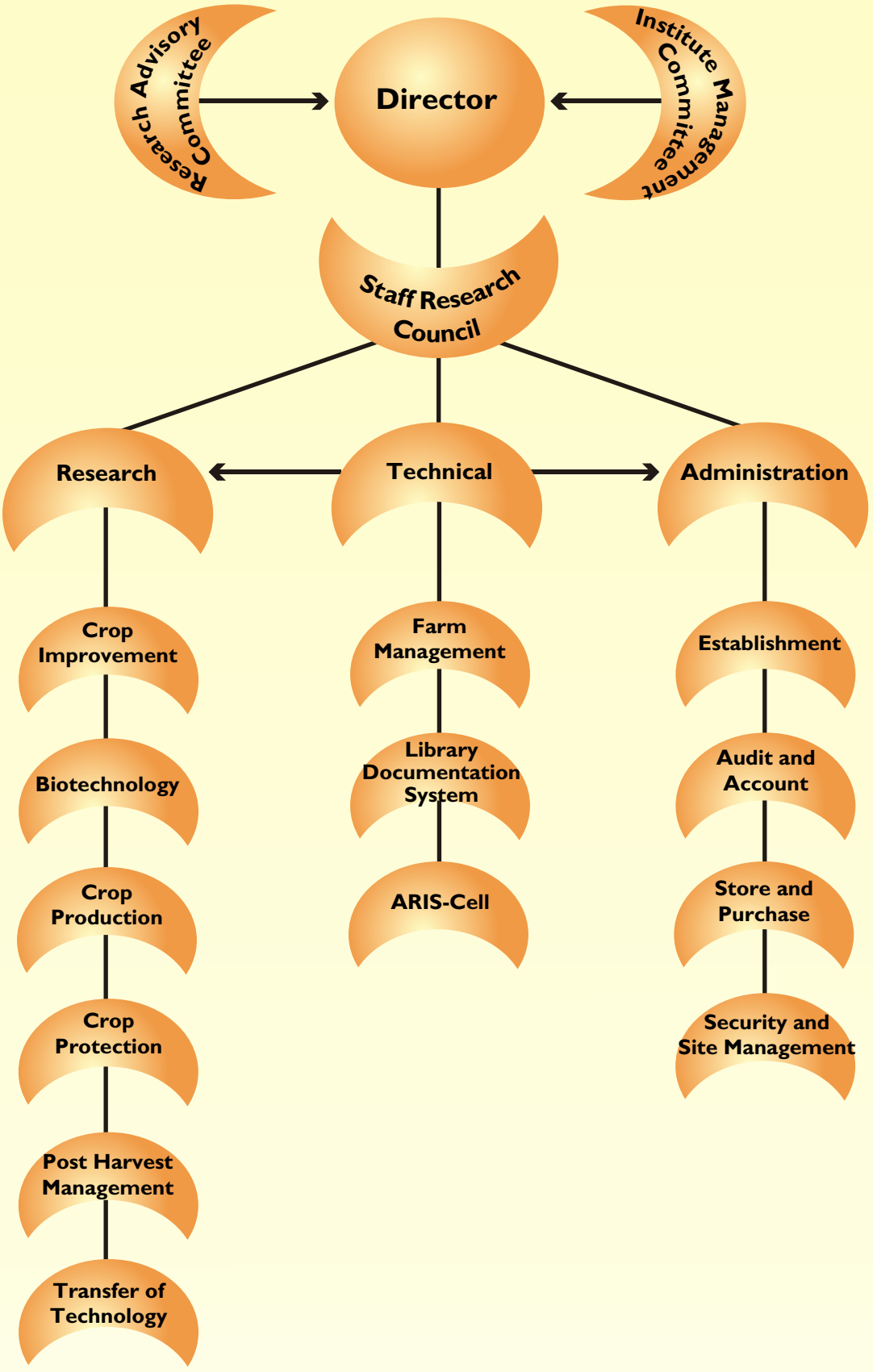
Mandate

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

Infrastructure facilities

The centre has five well equipped laboratories *viz.*, Biotechnology, Soil Science, Entomology, Horticulture and Post harvest management with all the latest equipments for research activities. A meteorology observatory is also functional at the centre for daily recordings of temperature, relative humidity, rainfall etc. The institute has a state of art communication facility with an EPABX system and LAN. Modern facilities such as internet and e-mail connectivity through V-SAT have been created for all the scientists and officers. The institute has its own web server. Entire network, administration of computers, internet and website management is looked after by the ARIS cell. A technical cell keeps record of all the research and technology projects and co-ordinates information management both within the institute as well as with outside agencies. The library has at present 471 books and 51 regulars journals including six international journals. It also maintains a CD ROM server with bibliographic database from Hort -CD, Agris, Agricola and Current Contents which are accessible on the desktop of all the scientists through LAN.

Organogram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Administration
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Biotechnology
Crop Production
Crop Protection
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Transfer of Technology
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Library Documentation System
ARIS-Cell
Establishment
Audit and Account
Store and Purchase
Security and Site Management

Research Achievements

Crop Improvement

Genetic Improvement of Red Onion

Germplasm collection and conservation : Conservation of onion germplasm is the main task of this National Research Centre ever since its inception. These genetic resources contain valuable genes that are of immense genetic value in breeding programmes using conventional methods and modern biotechnological tools. These genetic resources will play a unique role in the development of new cultivars, strains and hybrids and also in restructuring of the existing varieties. NRCO&G has conducted number of explorations in the onion growing states *i.e.*, Maharashtra, Gujarat, Karnataka, Andhra Pradesh and Tamil Nadu and collected number of germplasm lines and these are being maintained regularly through seed production in protected cages. As such nearly 450 lines of diverse genotypes are being maintained. Thus germplasm is also being maintained regularly through gene pool management to preserve the favourable genes of different genotypes, which can be exploited in future breeding programmes.

Kharif 2004

Evaluation of kharif germplasm : During the year 2004-05, eighty new germplasm accessions of red and light red onion of round, flat, flattish round shape were collected and seeds produced in cages. Evaluation of 83 germplasm lines in *kharif* season revealed that the check variety B-780 (35.83 t/ha) was superior in terms of marketable yield followed by K-519 (32.20 t/ha) and NRCOG-985 (26.30 t/ha) (Table 1). The five bulb weight was found to be maximum in NRCOG-923 (0.28 kg) followed by NRCOG-1025 (0.27 kg) and N-53 (0.26 kg) whereas the check variety B-780 (0.24 kg) recorded the minimum. Check varieties B-780 and Arka Kalyan recorded high TSS (12.72 and 12.75%, respectively).

Table 1 : Performance of high yielding genotypes in *kharif*

Entry	MY (t/ha)	5 BW (kg)	TSS (%)	NT (cm)	PH (cm)
B-780	35.83	0.24	12.57	0.37	67.42
K-519	32.20	0.26	11.60	0.67	61.42
NRCOG-985	27.10	0.24	11.40	0.38	66.53
NRCOG-1005	26.30	0.22	11.64	0.38	62.63

Evaluation of promising lines for year round cultivation : Onion bulbing is promoted by long photoperiods and varieties differ in the photoperiod requirement to induce bulb development. The rate of bulb development increases and the time from the start of bulb initiation to maturity decreases, as photoperiod increases. Accordingly, the varieties suitable for *kharif* cultivation (July-August planting) are not suitable for *rabi* cultivation (October-November planting) and vice versa. Varieties produce more bolters under unfavorable conditions resulting into poor quality and less marketable returns.

Keeping these implications in view, research was initiated to identify / develop lines suitable for all the seasons. Out of 44 lines identified for year round cultivation, twenty four lines were tested for yield and other quality attributes during *kharif* season. Results revealed that 12 lines viz., NRCOG-901, Agrifound Dark Red, 1012, 939, 938, 905, 940, 909, 925, 914, 923 and 888 showed superior performance in terms of yield (17.2 - 24.30 t/ha). Further, it was also observed that there is a wide gap between total yield and marketable yield in some promising lines *viz.*, NRCOG - 939, 901, 1012, 925, 950, 914 and 940, which requires immediate attention by exercising selection pressure for decreasing this gap (Table 2).

Table 2 : Performance of lines suitable for year round cultivation

Lines	TY (t/ha)	MY (t/ha)	5BW (kg)	TSS (%)	SI
NRCOG-939	31.7	21.2	0.22	12.16	0.84
NRCOG-901	31.6	24.3	0.22	10.91	0.81
NRCOG-1012	31.6	21.2	0.24	11.72	0.83
NRCOG-925	29.2	19.0	0.21	11.46	0.81
NRCOG-950	28.3	16.8	0.22	11.09	0.79
NRCOG-914	28.0	18.6	0.25	11.57	0.80
NRCOG-940	27.9	19.2	0.22	11.40	0.83

As a result of continued research and subsequent exercise of selection pressure, we identified 11 elite lines having required shape, colour, yield, and quality suitable mainly for *rabi* cultivation.

Evaluation of elite lines : In order to identify the lines suitable for *kharif* cultivation, only two elite lines *viz.*, NRCOG-654 and NRCOG-597 were found to be superior in terms of yield and quality (Table 3). However, the popular varieties *viz.* N-53 and B-780 continued to show superior performance in terms of total yield. There is a wide variation between total and marketable yield mainly due to bulb size and rotting.

Table 3 : Performance of elite lines in *kharif* season

Lines	TY (t/ha)	MY (t/ha)	5BW (kg)	TSS (%)	NT (cm)
NRCOG-654	29.7	19.6	0.25	11.0	0.35
NRCOG-597	27.8	19.3	0.26	11.7	0.39
B-780	32.7	24.1	0.28	11.0	0.41
N-53	38.1	27.1	0.26	10.7	0.40

Late *kharif* 2004-05

Evaluation of onion germplasm : Ninety accessions were evaluated and results revealed that there were significant differences among the entries tested for all characters except neck thickness and pseudostem diameter.

Ten accessions (NRCOG-1067, 1012, 1047, 1048, B-780, 609, N-2-4-1, 1015, 1095, 670) recorded >45.0 t/ha and marketable yield ranged from 45.0 to 51.7 t/ha. Results revealed that NRCOG-1067 (51.7 t/ha) showed supremacy in marketable yield followed by NRCOG-1012 (51.2 t/ha), NRCOG-1047 (49.8 t/ha), NRCOG-1048 (48.5 t/ha) and NRCOG-B-780 (46.3 t/ha.). Percent A grade bulbs were maximum in NRCOG-1012 (3.81 kg) followed by NRCOG-1047 (3.10 kg), NRCOG-B-780 (3.08 kg) and NRCOG-1048 (2.83 kg). High TSS (11.2-11.8 %) was recorded in 10 genotypes and neck thickness was minimum in NRCOG-945 (0.29 cm) followed by NRCOG-1092 (0.30 cm) and NRCOG-897 (0.31 cm). Superior genotype NRCOG-1067 also recorded the maximum number of leaves and maximum plant height (Table 4).

Table 4 : Top performing genotypes in respective characters

Lines	MY (t/ha)	Lines	5 BW (kg)	Lines	TSS (%)	Lines	NT (cm)	Lines	NOL	Lines	PH (cm)
1067	51.7	914	0.52	650	11.8	945	0.29	1067	11.83	650	70.4
1012	51.2	135	0.39	597	11.6	1092	0.30	650	11.60	1067	69.4
1047	49.8	911	0.38	1067	11.4	898	0.31	1095	11.33	1095	67.9
1048	48.3	1095	0.38	131	11.4	906	0.32	1015	11.26	609	67.8
B-780	46.3	943	0.38	ALR	11.4	85	0.32	Comp.	11.13	Comp.	65.5
609	46.0	988	0.38	609	11.4	923	0.32	1012	10.86	531	65.2

Performance of elite lines : Results of thirteen elite lines evaluated during the late *kharif* season revealed that there were significant differences in percent of A grade bulb, 10 bulb weight, pseudostem diameter and plant height.

There were no differences among the total yield and marketable yield (Table 5). Variety N-53 (23.3 t/ha) recorded maximum total yield followed by B-780 (22.43 t/ha), ALR (20.57 t/ha) and NRCOG-597 (20.52 t/ha). However, the marketable yield was very high in B-780 (20.43 t/ha) followed by NRCOG-597 (18.70 t/ha), NRCOG-595 (17.96 t/ha) and NRCOG-571 (16.93 t/ha). Further, results revealed that there is need for improvement in Composite and ALR as there is a wide gap between total yield and marketable yield. High TSS (11.0-12.26 %) was recorded among the elite lines while the check varieties recorded in between 10.3-10.6%.

Table 5 : Performance of elite lines

Lines	MY (t/ha)	Lines	AGB (kg)	Lines	TSS (%)	Lines	NT (cm)	Lines	NOL	Lines	PH (cm)
B-780	20.43	B-780	9.67	671	12.26	592	0.36	597	10.20	597	70.96
597	18.70	597	6.96	650	12.06	595	0.36	670	9.73	592	69.10
595	17.96	592	6.86	670	11.66	ALR	0.36	N-53	9.53	546	69.10
571	16.93	546	6.56	597	11.43	571	0.36	ALR	9.46	595	67.13
546	16.48	N-53	6.41	571	11.33	670	0.38	592	9.33	650	66.80
ALR	11.71	670	6.06	651	11.10	651	0.39	B-780	9.26	571	66.33

Evaluation of massing lines : A number of breeding methods exist to improve onion yield, quality and required shape and colour, of which massing technique is one of the dependable method for improving the desirable characters. The experimental results revealed that the massing line kh-985-03 (58.3 t/ha) showed superior performance in terms of marketable yield followed by kh-N-53-03 (31.7 t/ha) in *kharif* cultivation (Table 6).

Table 6 : Performance of massing lines for yield and other desirable characters

Massing lines	MY (t/ha)	NT (cm)	SI	NOL
Kh-985-03	58.3	0.30	0.87	10.0
Kh-(N)-53-03	31.7	0.26	0.93	11.0
Kh-993-03	-	0.18	1.06	8.2
Kh-931-03	-	0.15	1.03	8.8
Kh-988-03	-	0.28	0.95	9.4
Kh-globe-03	-	0.40	0.91	8.4

Performance of these two lines is quite satisfactory as 50-60% increase in yield in *kharif* onion was observed than the existing varieties. Further, desirable attributes such as globose shape and deep red colour were also achieved in massing lines of kh-993-03, kh-931-03, kh-888-03 and kh-globe-03.

Evaluation of bulb to row progenies : In order to achieve improvement in yield and desirable attributes, 32 bulb to row progenies have been developed and evaluated. The results revealed that eight progenies showed superior performance in terms of marketable yield. NRCOG-1010-4 recorded marketable yield to the tune of 22.7 t/ha whereas NRCOG-927-4 recorded 70 t/ha yield. Desirable quality and shape were observed in four progenies viz., NRCOG-925-2, NRCOG-925-5, NRCOG-927-3 and NRCOG-994-1 (Table 7).

Table 7 : Performance of bulb to row progenies for yield and desirable attributes

Progenies	MY (t/ha)	NT (cm)	SI	NOL	PH (cm)
NRCOG-1010-4	22.7	0.30	0.87	8.6	62.5
NRCOG-927-4	70.0	0.20	0.87	11.0	49.2
NRCOG-925-2	17.5	0.30	1.30	8.5	47.4
NRCOG-925-5	25.6	0.41	1.19	8.7	50.9
NRCOG-927-3	17.0	0.36	1.30	10.5	55.1
NRCOG-994-1	15.3	0.25	1.22	7.0	49.6

Post harvest performance of red onion germplasm : Storability is one of the main objectives for onion improvement programme in late *kharif* & *rabi* varieties. 206 germplasm lines were studied for their post harvest performance over a period of 120 days for physiological weight loss and rotting. The results revealed that 17 entries *viz.*, NRCOG-158, 711, Agrifound light red, 577, 677, 1045, 465, 612, 634, Pusa red, 547, 632, 619, 657, 674, B-780 & 746 recorded less than 20% weight loss and can be considered for further evaluation in order to identify the lines for storability coupled with yield. Similarly 195 *rabi* germplasm were evaluated for post harvest performance after 120 days. Lines NRCOG-158, 205, 450, 711, 1044, 14-2, 168, 465, 687, 1017 recorded 30% weight loss whereas standard

var. N-2-4-1, Agrifound light red, Arka Niketan recorded 40-50% weight loss and Pusa Red and Pusa Madhavi recorded more than 50% weight loss. Hence there is a good scope for storability suitable for *rabi* conditions. NRCOG-597 recorded minimum physiological weight loss of 26.7% after 120 days of storage. As such there is good scope for improvement of onion for yield as well as high storability.

Heterosis breeding

Rabi 2003-04

Development of new hybrid combinations : By utilizing the available male sterile lines we have developed a good number of hybrids which are being evaluated. Experimental results indicated three successful hybrid combinations in red and light red onion. Hybrid vigor was evident in the crosses MS-48A x 900 (55.3 t/ha), MS-48A x 1000 (34.3 t/ha) and MS-48A x 974 (25.5 t/ha). Further, to reduce the neck thickness, a qualitative character, a good number of combiners have been identified.

Evaluation of onion hybrids : Out of 145 crosses made between inbred lines and two male sterile lines during 02-03 only 80 F1's were evaluated during *rabi* 03-04 along with 4 checks and all the parents. Total yield in the parent ranged from 4.2 to 24.1 t/ha, whereas marketable yield ranged from 0.6 to 22.7 t/ha. Nineteen inbred lines recorded at par total yield with best check N-2-4-1 (19.3 t/ha). Similarly nineteen lines, six varieties and both the male sterile lines had at par marketable yields (10.2 - 22.7 t/ha) as compared with the best check ALR (16.6 t/ha). Total yield in F1 hybrids with MS65 ranged from 3.3 to 39.2 t/ha. Five crosses gave significantly superior yield (24.2 - 39.2 t/ha) over best check ALR (16.6 t/ha). None of the crosses were superior over best check with MS48. F1 hybrids received from IARI had total and marketable yield of 20.0 and 11.7 t/ha, respectively. Total yield in the crosses with MS48A ranged from 5.3 to 22.8 t/ha and marketable yield from 3.14 to 22.0 t/ha, respectively.


Hybrid of MS65A X 444 along with parents

Heterosis studies : Heterosis over better parent and percent superiority over check varieties were worked out. It was observed that F1's made with MS48A showed very less heterosis as compared with the F1's made with MS65A. Only one cross made with MS48A gave significant heterosis over better parent (54.5%). Percent superiority in the F1's of MS48A over varieties *viz.* B-780 and A. Niketan was significantly higher (92.8 and 8.3%, respectively). Heterosis over better parent was recorded in 10 crosses made with MS 48A (5.7 to 44.8%), but it was non significant. Heterosis in crosses between inbred lines and MS65 was quite high as compared to the F1's with MS48 (Table 8). 20 crosses showed heterosis over better parent which ranged from 1.3 to 278.6%, but heterosis over better parent was significantly high in 10 crosses only (18.6 to 278.6%). Percent superiority in five crosses was significantly high over N-2-4-1 (56.8 to 153.0 %), 11 crosses over B-780 (62.9 to 257.7 %), 5 crosses with ALR (56.6 to 136.4 %) and 9 crosses with A.Niketan (59.1 to 234.5 %). Heterosis in the previous year was compared and it was observed that trend in the crosses performed this year was somewhat same. But heterosis this year was very high up to 278.6% over better parent and 136.4% superiority over best check (ALR). This year the unfavorable climatic conditions, resulted in very less yield of the parents than the F1 hybrids with MS65A, resulting in a very high amount of heterosis. The yield of better parent in one of the F1's with MS65A was 10.4 t/ha and the resultant F1's was 39.2 t/ha which resulted in high heterosis of 278.6% (Table 9). Three inbred lines with MS65A gave significantly higher heterosis (108, 83.4 and 75.4%) in the previous year. Similarly heterosis in F1 hybrids with MS65A during this year was 278.6, 150.8 and 72.4% with the same inbreds.

Table 8 : Range values for some of the important characters in hybrids, parents and checks

Range	Parents	MS Lines	Check Variety	F1 Hybrid with 48A	F1 Hybrid with 65A
Total entries	54	2	4	48	32
AGB (%)	0.0 - 26.3	5.9 - 9.8	2.8 - 12.5	0.0 - 28.9	0.0 - 51.5
DGB (%)	0.0 - 27.6	0.0 - 0.0	0.0 - 4.3	0.0 - 7.2	0.0 - 18.3
Bolters (%)	0.0 - 11.0	0.0 - 0.7	0.0 - 0.0	0.0 - 6.5	0.0 - 9.0
MB (%)	9.6 - 94.4	79.7 - 81.3	71.2 - 88.8	43.8 - 100.0	42.3 - 97.8
MY (t/ha)	0.6 - 22.7	10.4 - 10.6	10.9 - 16.6	3.4 - 22.0	3.3 - 39.2
TY (t/ha)	4.2 - 24.0	12.9 - 13.0	14.6 - 19.3	5.8 - 22.8	6.0 - 40.0

Table 9 : Heterosis and percent superiority in F1 hybrids made with MS48A & MS65A

Details	MY (t/ha)	Percent heterosis over best parent	Percent superiority of F1's over check		
			N-2-4-1	ALR	A. Niketan
Inbreds and parents	0.6 to 22.7				
F1's with MS48A	3.4 to 22.0	-84.8 to 54.5	- 77.9 to 42.1	- 79.4 to 32.7	-70.9 to 87.9
F1's with MS65A	3.3 to 39.2	- 71.3 to 278.6	- 78.9 to 153.0	-80.3 to 136.4	- 72.2 to 234.5
Checks (4)	10.9 to16.6				
Heterosis in F1's in +ve direction					
With MS48A	out of 48 F1	11	3	2	10
With MS65A	out of 32 F1	20	12	12	19

Late *Kharif* / *Rangda* 2004-05

Evaluation of exotic hybrids : Nineteen exotic hybrids along with 4 varieties were planted during first week of November. Total soluble solids in these hybrids were quite less (6.6 to 9.9%) as compared to the varieties (10.6 - 11.7) except three hybrids, which ranged from 10.1 to 13.9%. In some of the hybrids, there was no bulb formation. No doubles were recorded in seven exotic hybrids and doubles less than 3% were observed in thirteen hybrids. Doubles in varieties were 0.6 to 16.7%. Except two hybrids, no bolters were recorded whereas in the Indian varieties bolters ranged from 6.8 to 29.6%. Percentage marketable bulbs were less than 80% in the varieties except B-780, while thirteen exotic hybrids gave more than 85% marketable bulbs. Despite of late receipt of the seed and unfavourable climatic conditions, marketable yield in hybrids ranged from 1.6 to 26.7 t/ha against the check varieties, which varied from 4.4 to 18.3 t/ha and six exotic hybrids yielded more than the check varieties (Table 10).

Table 10 : Range values for some of the characters in exotic onion hybrids

Character	Exotic Hybrids	Varieties
TSS (%)	6.6 - 13.9	10.6 - 11.7
Doubles (%)	0.0 - 14.6	0.60 - 16.7
Bolters (%)	0.0 - 11.5	6.78 - 29.6
MY (%)	51.0 - 97.8	34.1 - 83.0
MY (t/ha)	1.6 - 26.7	4.4 - 18.3

Evaluation of onion hybrids for storage : Onion hybrids developed using two male sterile lines were kept for storage studies during *rabi* 04. 50 hybrids made using MS48A and 26 hybrids with MS65A were stored along with the parents and the hybrid received from IARI. Losses in the hybrids with MS48A ranged between 20.0 to 63.7% and with MS65A it was 20.7 to 84.8% after 4 months of storage. Storage losses in the parents ranged from 22.3 to 95.7%. Percent superiority over check Arka Niketan and respective MS lines were worked out. Percent superiority in positive direction after 4 months of storage was recorded in twenty and five hybrids over Arka Niketan and MS48A ranged from 0.6-45.5% and 2.7-30.3, respectively with cross made with MS48A. Percent superiority in the crosses made with MS65A was 0.8-48.1 (11 hybrids) and 3.3-56.1% (19 hybrids) over Arka Niketan and MS65A, respectively. Similarly superiority in desired direction after 6 months of storage was noted in 20 and 14 hybrids made with MS48A, which ranged between 0.2 to 35.1% and 0.5 to 31.0% over Arka Niketan and MS48A and eight hybrids with MS65A ranged from 1.6 to 24.9% and 14 hybrids from 2.9 to 34.4% over Arka Niketan and MS65A, respectively. Top four entries with MS48A had 17.1 to 35.1% superiority over check variety Arka Niketan, which had 55.2% storage loss after 6 months of storage. Hybrid between MS48A and Arka Niketan had positive heterosis of 17.3% over the check variety. Losses in B-780 were 90.2% but F1 with MS48A recorded 61.8% losses. Percent superiority in positive direction in the hybrids with MS65A was more than 20% in 4 crosses over Arka Niketan (Table 11 & 12).

Table 11 : Range values of storage losses in onion hybrids

Hybrids	Entries	Percent storage losses	
		4 months	6 months
With 48A	50	20.0 - 63.7	35.8 - 83.3
With 65A	26	20.7 - 84.8	41.4 - 94.3
Parents	52	22.3 - 93.3	43.2 - 97.6
Checks	5	36.6 - 95.7	55.2 - 99.2

Table 12 : Range of percent superiority in storage losses in onion hybrids

	Percent superiority in hybrids with MS48A over A. Niketan	Percent superiority in hybrids with MS65A over A.Niketan
Percent superiority after 4 months		
No. of entries	20	11
(Range in +ve side)	(0.6-45.5)	(0.8-48.1)
Percent superiority after 6 month		
No. of entries	20	8
(Range in +ve side)	(0.2 - 35.1)	(1.6 - 24.9)

Evaluation of varieties under AICRP (Vegetables)

Rabi 2003-04

Onion varietal evaluation in IET and AVT-I : Seven entries were received under AICVIP varietal evaluation trial in onion, four entries in IET *i.e.,* B-780-5-3-1, B-780-5-2-2, RHR-O-S-1 and RO-59 and three entries *viz.*, HOS-1, HOS-2 and L-28 for AVT-I & were planted along with check A. Niketan and ALR. Total yield was highest

in check ALR (Light Red) (23.77 t/ha) which was at par with B-780-5-3-1 (22.57 t/ha) and A. Niketan (21.18 t/ha). Marketable yield was highest in line B-780-5-3-1 (21.47 t/ha) and was at par with both the checks. Percentage marketable yield in both the advanced lines was very high. In B-780-5-3-1, marketable bulbs were 94.95% and in B-780-5-2-2 it was 92.09%, whereas in check A.Niketan and ALR it was 88.84 and 78.94%, respectively. Percent doubles in advanced lines were less than 1% *i.e.* B-780-5-2-2 (0.52%) and B-780-5-3-1 (0.56%) as compared with the check A. Niketan (5.53%) and ALR (17.70%). TSS was at par in all the varieties. Maturity in B-780-5-3-1 was 10 days earlier than ALR.

Late *Kharif* / *Rangda* 2004-05

Evaluation of advanced lines : Four advanced lines were evaluated along with seven red and four white varieties. Percentage of A and B grade bulbs were quite high than all the varieties. Bolter is a major problem during late *kharif* and it was very less in these advanced lines against all the varieties. Doubles were negligible in all the advanced lines and marketable yield was more than 92 per cent. Marketable and total yield were also higher with two advanced lines recording significantly higher yields than all the varieties. Percentage of bolters and doubles were very less which resulted in higher marketable yield (Table 13).

Table 13 : Mean range values in advanced lines and different varieties

Characters	Advanced lines	Red varieties	White varieties	Yellow variety
Entries	4	7	5	1
AGB (%)	43.1- 56.5	16.8 - 45.4	11.6 - 24.5	19.0
BGB (%)	30.1 - 48.4	21.7 - 35.2	18.4 - 29.3	29.3
Doubles (%)	0.0 - 0.6	0.6 - 27.1	6.7 - 25.7	6.7
Bolters (%)	1.7 - 5.2	5.1 - 26.4	7.51 - 34.1	29.8
MY (%)	92.2 - 97.7	46.0 - 94.0	37.8 - 65.6	63.1
MY (t/ha)	35.0 - 40.5	13.5 - 35.7	11.6 - 18.7	18.5
TY (t/ha)	36.9 - 43.5	29.4 - 37.8	28.6 - 31.0	29.2

Genetic Improvement of White & Yellow Onion

White Onion:

Rabi 2003-04

Evaluation of white onion germplasm : 222 white onion germplasm were evaluated. Due to adverse climatic conditions, the yields were drastically reduced in germplasm as well as varieties. Even in such situation some accessions performed comparatively well, which will be identified and further evaluated. 9 lines gave significantly higher total yield between 24.3 to 26.7 t/ha over Phule Safed (21.2 t/ha). Two entries recorded significantly higher marketable yield of 26 and 26.3 t/ha against Phule Safed (20 t/ha). Days to harvest ranged from 112 to 137 days after planting. Bolters were very less in *rabi* but doubles were present. In 62 lines, doubles were not recorded. Three entries were 12 days earlier in maturity (in 125 DAP), with high marketable yield between 19.8 to 22.61 and total yield 22.9 to 25.1 t/ha, respectively (Table 14).

Forty seven lines were evaluated for three years (2000-03) during *rabi* . Mean total yield in these germplasm ranged from 20.5 to 57.4 t/ha and more than 40 t/ha mean total yield was recorded in eight germplasm against Phule Safed (31.5 t/ha). Marketable yield more than 20% over Phule Safed (28.6 t/ha) was recorded in seven germplasm, which ranged from 43.5 to 34.2 t/ha. Six lines had both high marketable and total yield than Phule Safed.

Table 14 : Range values for *rabi* white onion germplasm

Characters	Range	Values	No of entries
AGB (%)	0.0 - 43.7	Above 40%	2
Doubles (%)	0.0 - 47.9	0% Share	63
Bolters (%)	0.0 - 8.9	0% Share	187
MY (%)	28.3 - 98.5	Above 75%	135
TSS (%)	9.9 - 13.9	Sig. Sup over Check	11
MY (t/ha)	3.0 - 26.3	Yield above 20 t/ha	11
TY (t/ha)	4.0 - 26.9	Yield above 23 t/ha	13

Evaluation of white elite lines : Six elite lines were evaluated during *rabi* season along with check Phule Safed and AFW. Total yield was significantly superior in five elite lines over Phule Safed (25 t/ha) and two elite lines (31.1 and 32 t/ha t/ha) over AFW (28.2 t/ha). Four elite lines had significantly higher marketable yield (21.3 - 23.7 t/ha) over Phule Safed (19.7 t/ha) and all elite lines had significantly higher marketable yield over AFW (16.7 t/ha). No bolters were recorded in elite lines whereas in Phule Safed (0.6%) and AFW (2.8%) bolters were reported. Doubles were minimum (9.5%) in the elite lines as compared to Phule Safed (12.7%) and AFW (35.1%). High TSS up to 12.1% over Phule Safed (11.3%) and AFW (11.7%) was recorded.

Evaluation of white massing lines : 10 massing lines developed from germplasm were evaluated during *rabi* 03-04. Marketable and total yield in all the massing lines were higher than the original germplasm from which it was selected. Total yield in three lines was significantly superior (24.7 to 30.4 t/ha) than check Phule Safed (21.2 t/ha) and parent lines. Marketable yield was also superior in two lines (25.8 t/ha and 23.1 t/ha) over Phule Safed (20 t/ha) and parental lines. In some of the germplasm, total yield was high but due to more number of doubles it affected marketable yield. One line recorded no doubles. Days to maturity in 10 entries (117 - 130 DAP) were significantly earlier than Phule Safed (137 DAP). Seven entries were earliest in maturity and were at par with each other (117 - 121 DAP). One high yielding line was found to be 20 days earlier in maturity than Phule Safed.

Evaluation of white onion germplasm for storage : Bulbs of 220 germplasm were stored in plastic crates in the month of May 04. Storage losses were recorded in these entries up to November 04. Less than 30% losses were recorded in three entries and 25 entries had losses between 30 to 40% against the white check Phule Safed, which recorded 76% losses. After six months of storage, losses were more than 40% in all the entries whereas in Phule Safed storage losses were upto 86.8%. All the white checks recorded storage losses between 71.9 to 98.8% and N-2-4-1 among the red best check had storage losses up to 43.3%. Losses in top 10 white entries after 4 month of storage ranged between 24.8 to 35.2% and after 6 months of storage it was between 38.2 to 56.1%. While among *rabi* red checks it ranged from 25.1 to 38.3% and 43.3 to 54.8% after 4 & 6 months of storage, respectively (Table 15).

Evaluation of advance lines, white elite lines, breeding lines & varieties for storage :

Storage losses in four red, light red, white, six elite and ten breeding lines were studied during *rabi* season. Lowest losses of upto 43 % in red varieties, 28% in light red, 48 % in white and 46% among elite lines after 4 months of storage were observed. In white breeding lines lowest loss, after 4 months of storage, was 52% (Table 16).

Table 15 : Range value for percent storage losses after 4 and 6 months of storage

	No. of entries after	
	4 months	6 months
Less than 30%	3	0
30 - 40%	25	0
40 - 50%	48	3
50 - 60%	49	19
60 - 70%	41	47
70 - 80%	26	55
Above 80%	38	96

Table 16 : Mean range values in different lines

	Entries	Percent storage losses after 4 months
Red varieties	4	43 - 89
Light red varieties	4	28 - 50
White varieties	4	48 - 87
White elite lines	6	46 - 62
White breeding lines	10	52 - 95

Kharif 2004

Evaluation of white onion germplasm : One hundred and fifty lines of white onion germplasm were evaluated during *kharif* 04. Six entries recorded collar thickness below 1 cm while twenty entries had neck thickness below 0.5 cm. No doubles were recorded in eleven entries. Phule Safed took 110 days for maturity whereas fifteen entries recorded early maturity *i.e.*, below 92 days. TSS was significantly higher in eight entries over check Phule Safed (10.9%). Nine entries recorded significantly higher yield over best check Phule Safed. Among 4 checks, maximum total yield (24.3 t/ha) in Phule Safed and minimum (17.9 t/ha) in JNDWO-85 was recorded (Table 17). Based on three years of evaluation, 81 entries recorded total yield more than 20 t/ha during *kharif* season.

Table 17 : Range values for various characters in white onion germplasm

Characters	Range	Values	Entries
AGB (%)	0.0 - 59.3	Above 30%	22
Doubles (%)	0.0 - 41.8	Below 5%,	74
MY (%)	36.9 - 99.7	Above 75%	101
TSS (%)	8.6 - 13.9	Sig. superior over check	15
MY (t/ha)	3.6 - 34.0	Sig. superior over check	3
TY (t/ha)	5.7 - 36.2	Sig. superior over check	9

Evaluation of white onion elite lines : Ten white elite lines, selected on the basis of two years performance, were evaluated along wih 5 checks. Eight lines recorded higher total yield (27.1 to 35.6 t/ha) over best check Phule Safed (27 t/ha). Six lines were earlier in maturity (102 to 104 days) over Phule Safed (110 days). Four lines had higher marketable yield (25.3 to 33.0 t/ha) besides higher total yield and earliness in maturity over check. Six lines recorded higher percentage of A grade bulbs (46.3 to 30.1 %) over Phule Safed (29%). TSS in all these lines ranged from 9.4 to 11.5% whereas in check it was 10.9%.

Evaluation of white onion breeding lines : Breeding lines in white onion are being developed, on the basis of desirable characters, and such 60 lines are being purified. 30 lines were evaluated and rest of the lines were planted for further multiplication. Percentage doubles were quite less in these lines and no doubles were recorded in thirteen lines and less than 5% doubles were recorded in twenty lines and were having high marketable percentage. 24 entries had more than 75% marketable bulbs whereas maturity in less than 95 days was recorded in seven lines. Marketable yield in three lines (29.8 to 33.0 t/ha) was significantly superior over Phule Safed (22.5 /ha). One line matured 12 days earlier than Phule Safed, which took 110 days to harvest (Table 18).

Table 18 : Range values for various characters in white onion breeding lines

Characters	Range	Values	Entries
AGB (%)	0.0 - 59.1	Above 30%	4
Doubles (%)	0.00 - 21.1	Below 5%	20
MY (%)	47.4 - 100	Above 75%	24
TSS (%)	9.5 - 12.5	Sig. superior over check	1
MY (t/ha)	5 - 33	Sig. superior over check	3
TY (t/ha)	7 - 35.9	Sig. superior over check	3

Late *Kharif* 04-05

Evaluation of onion germplasm : Out of 48 germplasm evaluated, 15 lines had more than 35 percent A grade bulbs against white varieties, which had maximum of 26% A grade bulbs. Less than 10% doubles were recorded in eight lines. No bolters were recorded in thirteen lines and 28 entries had less than 5% bolters against Phule Safed (13.8%). More than 80% marketable bulbs were observed in twelve entries (Table 19). Significantly higher marketable and total yields than the check Phule Safed (21.6 & 30.5 t/ha) was recorded in 25 and 22 germplasm, respectively.

Table 19 : Mean values in onion germplasm during late *kharif* 04-05

Characters	P.Safed (Control)	Range in germplasm	Values	Entries
AGB (%)	18.96	3.2 - 59.8	>35%	15
Doubles (%)	9.6	0.0 - 68	<10%	8
Bolters (%)	13.8	0.0 - 39.4	<5%	28
MY (%)	73.3	22.2 - 96.9	>80%	12
TSS (%)	11.2	9.8 - 11.8	>11.5%	5
MY (t/ha)	21.6	6.4 - 38.8	Sig. superior over check	25
TY (t/ha)	30.5	17.2 - 58.6	Sig. superior over check	22

Evaluation of breeding lines : Bulbs of white onion were selected on the basis of desirable bulb characters and yield and 14 lines being developed for late *kharif* were evaluated. Seven lines recorded more than 35% A grade bulbs against the check Phule Safed (27.1%). Less than 10% doubles were recorded in six lines. Four lines had less than 5% bolters against the check (20.9%). Percentage of marketable bulbs in the check Phule Safed was 66.8% whereas 5 lines recorded more than 80% marketable bulbs (Table 20). Significantly higher marketable yield was recorded in six lines and total yield in four lines against the check varieties.

Table 20 : Mean range values in breeding lines

Characters	Best Check	Germplasm	Values	Entries
AGB (%)	27.1	9.8 - 50.8	>35%	7
Doubles (%)	11.5	1.7 - 58.0	<10%	6
Bolters (%)	20.9	0.0 - 24.9	<5%	4
MY (%)	66.8	27.2 - 94.2	>80%	5
TSS (%)	10.9	9.2 - 11.3	> 11%	1
MY (t/ha)	23.1	5.6 - 33.6	Sig. superior over check	6
TY (t/ha)	34.3	20.9 - 42.3	Sig. superior over check	4

Yellow onion

Rabi 2003-04

Evaluation of onion germplasm : Out of 25 yellow germplasm evaluated, nine entries gave significantly higher total yield (14.7 to 19.3 t/ha) over Phule Suwarna (12.4 t/ha) and also marketable yield (10.9 to 16.3 t/ha) over Phule Suwarna (8.90 t/ha). One entry matured earlier (106 days) than Phule Suwarna (112 days) and had higher total (14.7 t/ha) and marketable yield (11.4 t/ha). Six lines had both marketable and total yield higher than Phule Suwarna. More than 80% marketable bulbs were recorded in five lines against Phule Suwarna (72.7%). No doubles were recorded in six lines and 23 entries had no bolters (Table 21).

Table 21 : Performance of yellow onion germplasm

Characters	Range	Values	Entries
AGB (%)	0.0 - 22.6	Above 40%	0
Doubles (%)	0.0 - 37.9	Below 5%	11
Bolters (%)	0.0 - 3.9	0% Share	23
MY (%)	32.6 - 89.4	Above 75%	8
MY (t/ha)	2.2 - 16.3	Sig. sup. over check	9
TY (t/ha)	5.5 - 19.3	Sig. sup. over check	9

Evaluation of germplasm for storage : Storage studies in twenty yellow onion germplasm were conducted during *rabi* season. After 2 months of storage, 14 entries recorded less than 30% losses and only 2 entries after 4 months of storage, while losses in Phule Suwarna were 32.3 and 54.7%, respectively. Five entries had 30 to 40% losses after 4 months of storage and only one entry was recorded in this range after 6 months of storage whereas Phule Suwarna recorded 83.3% losses. Losses in top 5 entries ranged from 28.20 to 35.8% after 4 months of storage. (Table 22).

Table 22 : Range values for percent storage losses in onion germplasm

Percent storage losses	Entries after 4 months
Below 30%	2
30 - 40 %	5
40 - 50%	5
50 - 60%	6
60% & above	8

Genetic improvement of Garlic

Evaluation of white garlic germplasm : During *rabi* 2003-04, a total of 110 lines of white garlic germplasm were evaluated along with the commercially released varieties *viz.,* G-1, G-41, GG-2 and GG-3. Among the commercially released varieties, var. G-41 performed best with a marketable yield of 5.6 t/ha. Among the accessions studied, two accessions 221-5-2 (8.75 t/ha) and 183-4-1 (7.93 t/ha) recorded significantly superior yield over the best check variety (G-41). In addition to this, 20 accessions *viz*., 229, 201, 183, 74-7, 316-11-1, 200, 74-4, 221, 427, 315-1, 162, 410, 219, 321-3-1, 321-4-1, 407, 286, 321-4-2, 327 and 321-12 recorded at par yield with G-41.

Marketable yield ranged from 0.3 12.5 t/ha whereas average weight of bulb ranged from 1.7 - 26.6 g. Germplasm showed wide variation for other characters *i.e.,* plant height (21.8-70.8 cm), number of leaves (4.8-12.4), leaf length (15.8 - 53.3 cm), leaf width (0.3 - 1.9 cm), polar diameter (1.2 - 3.1 cm), equatorial diameter (1.2 - 4.2 cm), neck thickness (0.1 - 0.8 cm), number of cloves (6-36) and weight of 50 cloves (7- 68 g) (Table 23).

Table 23 : Performance of promising lines of garlic germplasm

Acc. No.	PD (cm)	ED (cm)	NT (cm)	NOC	Wt50C (g)	MY (t/ha)
221-5-2	2.9	3.6	0.4	24.8	43.6	8.8
183-4-1	2.6	3.2	0.6	22.5	31.0	7.9
G-1	1.7	2.2	0.3	12.3	17.9	1.8
G-41	2.4	3.3	0.5	19.5	31.9	5.6
GG-2	1.7	2.4	0.3	13.2	20.6	1.7
GG-3	2.1	2.7	0.4	18.0	25.1	3.5

Evaluation of garlic genotypes for storage losses : 104 white garlic genotypes were evaluated in three replications to assess the storage loss (Table 24). The genotypes were classified in groups based on the storage losses observed after 140 days of storage, which is given hereunder :

Table 24 : Genotype classification on the basis of storage losses after 140 days of storage

Wt. Loss (%)	Genotypes	Accession numbers
< 10	5	321-4-1, 223, 386, 398, 321-3-1
10-15	21	387, 469, 74-4, 321-4-2, 449, 477, 316-11-1, 407, 424, 436, 410, 404, 183-4-1, 391, 439, 327, 395, 315-1, 416, 406, 371
15-20	42	363, 433, 415, 383, 430, 392, 286, 221-5-2, 369, 201, 451, 321-12, 443, 427, 414, 400, 221, 435, 428, GG-3, 368, 183, 409, G-41, 473, 219, 229, GG-2, 380, 447, 200, 396, 373, 412, 375, 408, 450, 397, 452, 394, 448, 446
20-25	19	74-7, 384, 422, 434, 441, 432, 366, 365, 162, 465, 403, 399, 367, 390, 263, 378, 370, 405, 429
25-30	9	468, 393, G-1, 377, 475, 462, 426, 388, 376
30-35	6	381, G-50, 470, 425, 466, 471
> 35	2	389, 385

Evaluation of purple coloured garlic germplasm : A total of 108 lines of purple garlic germplasm were evaluated along with the commercially released varieties *viz.*, G-1, G-41, GG-2, GG-3, Godavari and G-41. Among the commercially released varieties, var. G-41 performed best with a marketable yield of 5.97 t/ha. Among the accessions studied, six accessions 401 (4.53 t/ha), 472 (4.43), 174 (4.43), 358 (4.30), 114 (3.95) and 74 (3.93) recorded significantly superior yield over the purple check variety Godavari (2.52) (Table 25).

Marketable yield ranged from 0.3- 7.4 t/ha whereas average weight of bulb ranged from 1.1-16.6 g. Germplasm showed wide variation for other characters *i.e.*, plant height (19.2 - 61.4 cm), number of leaves (3.4 - 12.2), Leaf area (4.9 -145.2 cm), polar diameter (1.0 - 3.6 cm), equatorial diameter (1.2 - 3.7 cm), neck thickness (0.2 - 1.0 cm), number of cloves (5.8 - 50.4) and weight of 50 cloves (7.0 - 50.4 g).

Table 25 : Performance of purple coloured garlic germplasm

Acc. No.	PD (cm)	ED (cm)	NT (cm)	NOC	Wt50C (g)	MY (t/ha)
G-41	2.3	2.8	0.5	19.0	35.7	5.97
Godavari	1.9	2.5	0.4	14.9	21.3	2.52
401	2.3	2.6	0.3	14.8	26.2	4.53
472	2.0	2.4	0.3	16.7	17.8	4.43
174	2.2	2.6	0.4	14.6	17.5	4.43
G-1	1.9	2.1	0.3	11.4	12.4	3.10
GG-2	1.8	2.2	0.2	17.0	15.7	1.07
G-50	2.3	2.8	0.4	15.3	23.9	2.75

Evaluation of bulb to row garlic germplasm : Progenies having bulb weight more than 20-25 g/bulb were again selected from previous bulb to row germplasm and evaluated for identifying superior genotypes. The experiment was laid out along with checks G-41, G-1, G-50 and Godavari. It was observed that four progenies 219-7-1 (10.30), 201-7-2 (9.68), 201-7-1 (9.51) and 200-10-3(9.51) recorded significantly superior yield than the best check variety G-41 (7.43 t/ha). Accessions 229-2-2 (9.21), 200-8-3 (8.79), 316-12-2 (8.59), 316-8-3 (8.56), 316-8-2 (8.08), 263-6-1 (8.07), 321-3 (7.97), 321-2-1 (7.97), 315-8 (7.94), 74-2 (7.73), 221-4-1 (7.61), 321-13 (7.59) and 72-4 (7.49) recorded at par yield with the best check variety G-41 (7.43 t/ha) (Table 26).

Table 26 : Performance of bulb to row garlic germplasm

Acc. No.	PD (cm)	ED (cm)	NT (cm)	NOC	Wt50C (g)	MY (t/ha)
219-7-1	2.9	4.1	0.4	24.9	41.2	10.3
201-7-2	2.5	3.5	0.4	21.5	32.7	9.68
201-7-1	2.6	3.6	0.4	22.8	38.2	9.51
200-10-3	2.9	3.8	0.5	18.4	59.8	9.51
G-1	2.4	3.5	0.5	20.1	37.4	3.39
G-50	2.2	3.0	0.3	15.0	19.1	2.60
G-41	2.5	3.5	0.4	23.6	35.5	7.43
Godavari	2.2	3.4	0.4	25.1	23.6	3.88

Evaluation of elite lines of garlic germplasm : During *rabi* season 2003-04, a total of 11 elite lines along with four check varieties were evaluated for yield performance (Table 27). It was observed that accessions 221 (6.22 t/ha), 200 (6.11) and 183 (6.03) recorded significantly at par marketable yield with the best check variety G-41 (5.78 t/ha).

Table 27 : Performance of elite lines of garlic germplasm

Acc. No.	PD (cm)	ED (cm)	NT (cm)	NOC	Wt50C (g)	TSS (%)	Dry Matter (%)	MY (t/ha)
183	2.36	2.77	0.53	21.07	30.47	41.36	62.95	6.03
200	2.64	3.2	0.59	29	36.93	42.79	61.92	6.11
221	2.34	2.83	0.55	19.6	34.1	41.98	59.75	6.22
G-1	2.27	2.81	0.45	14.73	25.5	37.23	62.43	1.8
G-41	2.39	2.71	0.51	21.33	35.17	43.15	61.52	5.78
G-50	2.41	2.89	0.5	16.27	29.27	33.2	68.18	1.85
Godavari	2.33	2.86	0.51	32.77	19.9	38.03	63.22	3.21

Evaluation of storage losses in elite garlic genotypes : A total of 11 elite lines of garlic were evaluated for percent reduction in weight for 135 days. It was found that Acc. 200 and 316 performed best in terms of storage losses, recorded lowest storage losses and was at par with Godavari. Variety G -50 recorded highest storage losses.

Evaluation of NBPGR garlic accessions : A total of 53 lines were evaluated out of which 36 lines were able to grow under our conditions. Out of these, no line performed significantly superior than the check variety G-41 (0.53 kg/m^2). Only one accession IC 375091 (0.45) was found to be at par with the check variety (Table 28).

Table 28 : Performance of NBPGR accessions of garlic

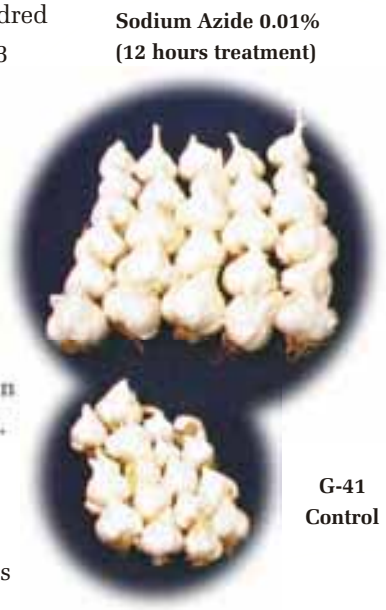
Acc. No.	PD (cm)	ED (cm)	NT (cm)	NOC	Wt50C (g)	MY(kg/m^2)
IC 375091	2.1	2.6	0.3	20.7	24.0	0.45
IC 35388	2.1	2.5	0.4	23.1	17.4	0.35
IC 49357	1.9	2.3	0.3	15.8	19.4	0.33
IC 48665	2.0	2.4	0.3	20.2	12.2	0.32
EC 286083	2.0	2.4	0.3	21.3	15.8	0.31
G-1	2.0	2.5	0.4	15.1	21.2	0.21
G-50	1.7	2.0	0.4	12.9	11.7	0.11
G-41	2.3	2.7	0.3	20.0	24.5	0.53

Garlic varietal trial IET and AVT-I : Six varieties were received in garlic for IET and 3 varieties for AVT-I along with 4 checks. Total yield was recorded along with leaves at the time of harvest and one month after curing. Net weight was recorded without leaves after one month of harvesting. Total initial yield was statistically at par with best check G-50 (11.33 t/ha) in five entries and two checks while after one month of curing it was at par with best check G-282 (6.92 t/ha). Net yield in 3 entries *viz.,* JNDG-213, AC-50 and AC-200, gave significantly higher yield (6.2 to 6.3 t/ha) than best check G-282 (4.9 t/ha). Varieties SKAUG-151, DARL-52, PG-17 and Agrifound Parvati had only vegetative growth and did not form any bulbs even after 180 days of planting. Weight of 50 cloves was highest in G-282 (36.3 g).

Performance of garlic varieties under storage : Six garlic varieties received along with 4 checks were evaluated for storage studies. The experiment was done in two sets. In one set the varieties were kept along with the foliage and in another set the varieties were kept without foliage after one month of curing. The losses were recorded after 4, 5 and 6 months of storage. Losses in variety G-1, G-50 and KGS-2 were high in both the sets of experiment. Losses were comparatively less in the garlic kept along with the foliage than stored without foliage. There was about 5% of mean difference in the losses between the varieties stored with and without foliage after 6 months of storage. All the varieties except G-1, G-50 and KGS-2 had less storage losses after 6 month of storage and were at par, which ranged between 17.7 to 21.6% when kept with foliage. Similarly, in the second set losses were compared over the initial weight along with foliage and over initial weight after cutting the foliage. Storage losses after six months of

storage over initial weight when stored without foliage ranged from 22.4 to 52.4%. Losses in the variety G-1, G-50 and KGS-2 were very high *i.e.,* 44.6 to 55.8% whereas it was between 22.4 to 28.7% in rest of the varieties. Losses in the varieties kept without foliage when compared over initial weight without foliage after six months of storage varied from 10.3 to 41.7%. Again the losses in the same 3 varieties *i.e.,* G-1, G-50 and KGS-2 were very high (29.8 to 43.9%), while the losses in rest of the varieties were at par (10.3 to 12.6%).

Creation of variability in garlic through mutations : Five hundred and forty eight bulbs were selected and progenies were evaluated in M3 generation. Maximum bulb weight of 36.6 g was obtained in the M3 progeny of the bulbs treated with colchicine. Among different concentration of colchicine treatments used, overall 65 progenies had significantly higher mean than the progeny mean of G-41 (Table 29). Mortality in case of sodium azide treatment was high in higher concentrations in M1 generation. 40 progenies in M3 generation yielded significantly higher than the check G-41 in the treatments with different concentrations of Sodium Azide. Maximum individual bulb weight (38.5 g) was obtained from the lower concentrations of sodium azide treatment. Maximum range of the progeny mean in case of sodium azide treatment was 11.7 to 23.8 g against the best check G-41, which ranged from 5.9 - 17.5 g (Table 30). All the progenies in M3 generation in one of the sodium azide concentration and 93% progenies from colchicine for 12 hours treatment gave higher mean weight than G-41. Overall 58.8% and 57.1% progenies had significantly higher mean weight over G-41 in 12 hours treatment of sodium azide and colchicine, respectively.



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 (Table 31). Effect of EMS on the progeny mean in M3 generation at lower concentrations was very less. Maximum of 26.3 and 20 percent progenies from the EMS treatment at 6 and 12 hours, respectively, gave significantly higher yield than the best check G-41.

Table 29 : Effect of colchicine on garlic in M3 generation

Colchicine	Percent survival	Average bulb weight (g)	Percentage of progeny significantly superior over G-41
6 hours dip	84.9	7.3 - 21.5	58.8
12 hours dip	69.8	7.9 - 22.4	57.1
G-41 (Control)	82.3	4.7 - 17.9	23.1

Table 30 : Effect of sodium azide on garlic in M3 generation

Sodium azide	Percent survival	Average bulb weight (g)	Percentage of progeny significantly superior over G-41
6 hours dip	70.3	8.92 - 20.8	25.0
12 hours dip	84.4	11.7 - 23.8	58.8
G-41 (Control)	80.7	5.9 17.5	12.5

Table 31 : Effect of EMS on garlic in M3 generation

EMS	Percent survival	Average bulb weight (g)	Percentage of progeny significantly superior over G-41
6 hours dip	66.1	6.1 - 15.1	26.3
12 hours dip	84.7	3.3 - 19.0	20.0
G-41 (Control)	74.8	7.9 - 14.5	8.3

Onion and Garlic - Biotechnology

Standardization of micropropagation protocol for garlic varieties : A simple micropropagation protocol was standardized in garlic using basal plate explants from mature cloves. Two MS based shoot multiplication media namely, MS1 and MS2 were tried with 10 genotypes, which included eight released varieties covering most of the garlic growing states of India, along with two advanced lines of NRCOG, Rajgurunagar. Of the two media tried, MS2 was found to be significantly superior for shoot induction and variety G-41 for its response to shoot multiplication. G-41 resulted in the induction of 16 - 20 shoots after a period of three months in culture. After the fourth month, *in vitro* bulbils were also produced in the same multiplication medium, which are good propagules. Although genetic variability was found to exist among the genotypes tested, acceptable values of shoot multiplication was obtained in MS2 with almost 100% bulb formation *in vitro*.

G-41 showing 16 – 20 shoots in MS2 after 90 days of culture

120 day old culture showing *in vitro* bulbil in MS2 medium

Protocol Standardisation for callus culture and regeneration in onion and garlic : Mature garlic cloves of cultivar G-41 were used in this study. The cloves were cultured on MS medium for root initiation. After 10-12 days, the aseptically grown roots were used for further experiment. Apical root tips of 1 cm length were cut from the axenic seedlings and transferred to the callus induction medium. This medium consisted of MS (Murashige and Skoog, 1962) basal salts and vitamins with 3 % sucrose (w/v), 0.3 % phytagel with different concentrations of auxins and cytokinins. Explants were sub cultured after every 4 weeks and the frequency of callus induction (percentage of root segments with callus formation) was recorded after 8 weeks. After 8 weeks, all the callus forming explants were transferred to the regeneration medium and shoot regeneration (percentage of callus with at least one shoot) was determined after 1 month.

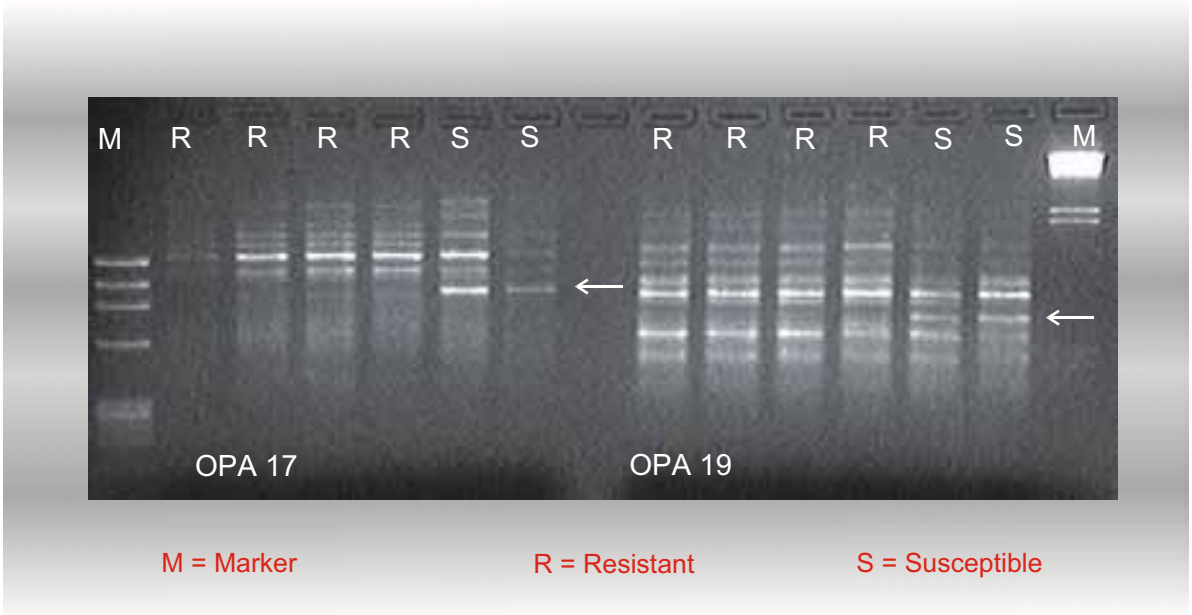
It was found that 2,4-D at lower concentrations and picloram at higher concentration was suitable for efficient callus formation from the root tips. Callus was obtained from the apical portions only from 2,4-D treatment whereas picloram led to callus formation throughout the root segment except the non-apical portion. Callus obtained from induction medium containing both auxins and cytokinins responded well to regeneration. The average shoot regeneration frequency ranged from 16.7 - 50.0 %. The best combination for callus culture and regeneration was found to be CRT 2 induction medium followed by GR 3 as the regeneration medium. In regeneration medium, profuse root formation and appearance of dark green callus was also observed. This protocol may pave way for the development of a suitable and cultivar independent regeneration system in garlic, which in turn will aid in the creation of variability through somaclonal variations and genetic transformation studies in Indian garlic.

In onion, MS medium supplemented with various combinations of growth regulators were tried and success has been achieved in callus culture and regeneration from mature zygotic embryos of cv. B-780. Now work has been initiated to evaluate the callus culture and regeneration of different genotypes on the promising media.

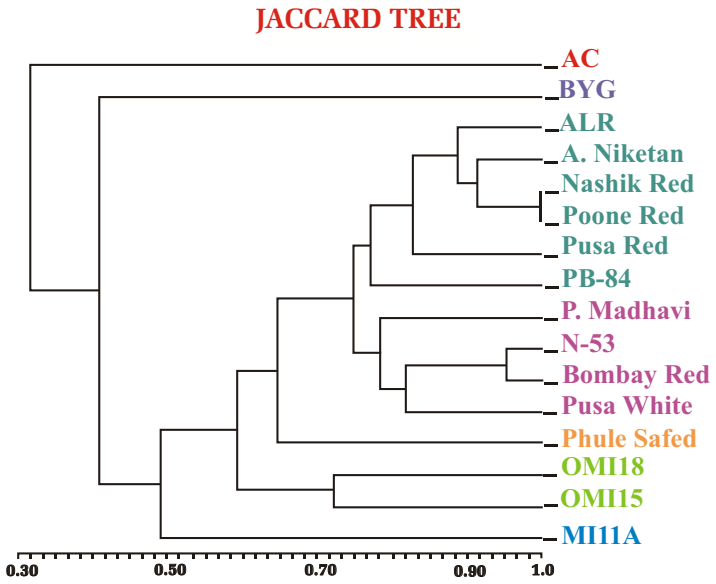
Salinity tolerance studies in onion through in vitro shoot tip culture : A project has been formulated for *in vitro* screening of onion genotypes and subsequently identifying salinity tolerant lines for further studies. MS medium supplemented with different concentrations of sodium chloride is being used to screen the onion varieties and genotypes for determining the lethal dose. Initially shoot tip culture was used but due to ease of using seeds as explant material, based on the references from other crops, mature embryo *i.e.*, seed is being used for initial screening of the genotypes.

DNA profiling of commercial varieties in onion and garlic

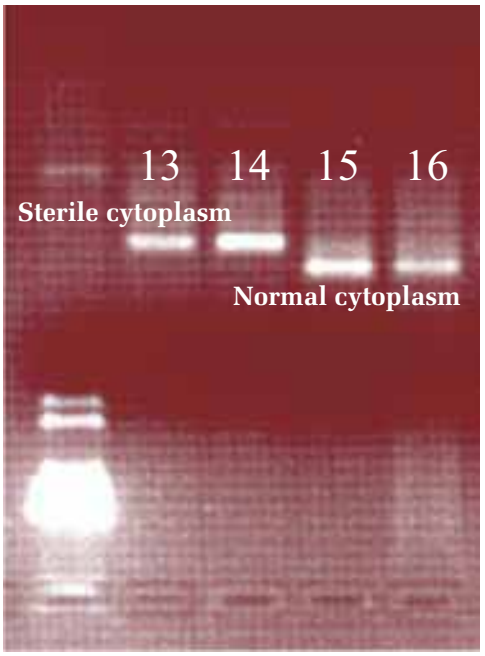
Identification of markers linked to eriophyid mite resistance in garlic : Some lines were identified for eriophyid mite resistance and these lines along with susceptible lines are being characterised on the basis of molecular markers to identify markers (if any) showing distinction between the resistance and susceptible lines. A total of 100 RAPD markers were tried to identify polymorphism. In the initial screening, 40 primers showed polymorphism. After further screening, 27 primers were found to distinguish between resistant versus susceptible lines. Further evaluation of these primers led to identification of 7 primers, which are showing distinction between the resistant and susceptible accessions. Further work will be to use these primers on moderately resistant and susceptible accessions to assess their potential and repeatability.



DNA fingerprinting through microsatellites in Indian and exotic onion varieties for diversity studies : Twenty four microsatellite primers were used for DNA fingerprinting of 14 Indian varieties and 2 exotic varieties at University of Wisconsin, USA to know the closeness among the varieties. Out of 24 primer pairs, bands were clear in 21 primers. From the 21-microsatellite primers polymorphisms were recorded maximum up to 64 loci. Out of these 68.4 percent bands were recorded maximum in variety Nashik Red. The bands were least (41.7%) in variety M111. Exotic varieties Alisa Craig and Brigham Yellow Globe were quite different than the Indian varieties and fall in separate group. Nashik Red and Poona Red showed 100 per cent similarities with these primers. Similarly N-53 and Bombay Red were also quite close. Variety ALR, A. Niketan, Nashik Red, Poona Red, Pusa Red and PB48 fall under one group, but Pusa Red and PB48 were not much closer than rest of the four varieties in the group. In another group Pusa Madhavi, N-53, Bombay Red and Pusa White were close, but Pusa Madhavi and Pusa White had some differences than N-53 and Bombay Red. Phule Safed was quite different among the Indian varieties and fell in a separate group. Cytoplasmic sterile lines fall in separate group and OM118 and OM15 were closer as compared with the variety M111. These studies will be helpful in selecting the diverse parents (inbreds) for the development of suitable hybrids of onion in India and DNA fingerprinting of the varieties, promising germplasm and parents, which can be utilised in future research.



Identification of cytoplasmic male sterile line in onion : The hybrid onion seed is produced commercially using cytoplasmic genetic male sterility (CMS) in USA since long back. Because onion is a biennial crop, it takes four to eight years to determine if maintainer line (N msms) can be extracted from a population of segregating family and "S" cytoplasm is the most common source of CMS used to produce hybrid onion. But conventional method of identifying maintainer line is labour intensive and time consuming. Chloroplast markers have been identified and are most useful in establishing the cytoplasm of individual plants with "S" cytoplasm. This technique helps to avoid two years required to score the fertility of test crosses to a sterile line. The polymerase chain reaction based technique for identification of male sterile cytoplasm by isolating pooled DNA from seedlings from open pollinated populations was used and simultaneously new primer sequence was also designed for identification of CMS lines and the technique was standardized. This technique was studied in fourteen Indian and two exotic onion varieties at University of Wisconsin at USA. Out of the sixteen varieties evaluated for male sterile cytoplasm, three genotypes viz. M111, OM118 & OM15 had male sterile cytoplasm and can be used as one of the parent for the development of hybrids after selecting the superior combinations.



Difference in bands between sterile and normal cytoplasm

13= OM15 ;
14=OM18 ;
15=Phule Safed;
16=Pusa White

Crop Production

Integrated nutrient management and uptake studies in onion and garlic

Evaluation of INM modules in onion and garlic crops, during rabi 2003-2004 : Five INM modules were developed based on the best treatment effect from the previous three-year experimentation *i.e.*, 2000-01 to 2002-03. The experiments were conducted for different input sources of plant nutrients and their levels on the yield, quality and storability of onion and garlic bulbs. These modules were evaluated in both onion and garlic crop during *rabi* 2003-04.

Bulb Yield : Bulb yield of onion and garlic were significantly influenced by the different INM modules in the study conducted. Among the five modules, M2, M3 and M5 were at par with each other and significant over M1 (NPK as per RDF) on the total yield of onion. While, in garlic crop, the bulb yield due to module M1 and M2 were at par with each other. Module M3, M4 and M5 were found to be significant over M2. The effect of M5 (FYM & PM @ 10t/ha + 30K +30S + Bio-fertilizer) was significant over modules M1, M2 and M3 and at par with M4.

The overall effect of different modules on bulb yield was clearly visible in garlic crop whereas in onion, no significant effect was evident. This might be due to the reason of prevailing disease conditions during growth of onion crop in *rabi* 2003-04. Here the potential yield was affected adversely and not reflected on modules.

Effect of INM modules on nutrient content of onion and garlic bulbs

Nitrogen content (%) : The different INM modules significantly influenced the concentration of nitrogen in harvested bulbs of onion. The highest nitrogen content (1.72%) was noticed in the module M4 (1/2 RDF + 30K +30S + PM @10t/ha) and it was at par with Modules M1 and M2. In garlic, the highest nitrogen content was recorded in M4 (1.81%) and was significant over M1, M3 and M5 but it was at par with M2.

Phosphorus content (%) : The phosphorus content in onion bulbs was found to be non-significant due to different modules. This could be due to the poor growth of crop during whole *rabi* season. While in garlic crop, the different modules significantly affected the concentration of phosphorus. The difference between the P content in module M1, M2, M3 and M4 was not noticed. However, module M5 recorded highest P (0.44%) that was significant over M1 and M2. But M5 was at par with M3 and M4.

Potassium content (%) : The effect of different INM modules on potassium content of onion was found significant. The highest K content (2.06 %) was noticed in module M5 and it was followed by M4 (1.57%). However, the effect of modules on K content of garlic bulbs was non-significant.

Effect of INM modules on soil fertility after harvest of onion and garlic crops : Integrated nutrient management practices profoundly influence soil fertility parameters. In the present study the effect of different modules was recorded on the following parameters.

Organic Carbon (g kg^{-1} soil) : Organic carbon forms the backbone for nutrient management and soil fertility status. Different INM modules had significant influence on the OC of soils after the harvest of both the crops. After onion, the highest organic carbon of 8.85 g/g soil was noticed due to module M5. Similarly, in garlic highest of 7.5 g/kg soil was recorded in M5. The organic carbon content due to modules M1, M2 and M3 was non-significant, whereas the effect between M3 and M4 was at par to each other.

Total Nitrogen (mg kg^{-1} soil) : The mineralization of organic nitrogen to inorganic nitrogen depends on the total nitrogen content of soil, which in turn regulates the availability of nitrogen to crop plants. Addition of organic manures significantly improved the total nitrogen status of soil after the harvest of both the crops. In onion, M5 led to highest build up of total nitrogen (1021 mg/kg soil) and was significant over all other modules. The effect of module M3 and M4 was significant over M1 and M2 but it showed at par results with each other. In garlic, M5 proved significantly best in maintenance of total nitrogen. The effect of different modules followed the order: M5> M4> M3> M2=M1.

Available Phosphorus (kg ha^{-1}) : Modules with organic manure application proved significant in improving the soil available phosphorus. In the soil, after the harvest of onion, the available phosphorus was significantly highest in M4 (39.3 kg/ha) followed by M5 (36.16 kg/ha). The lowest available P was in Module M1 (9.58 kg/ha)< M2 (11.86 kg/ha) < M3 (14.9 kg/ha). While in garlic, the highest and significant amount of available P was recorded in M5 (39.1 kg/ha) followed by M4 (14.0 kg/ha). However, lowest was recorded in M1 (10.9 kg/ha) < M2 (11.0 kg/ha) < M3 (14.0 kg/ha).

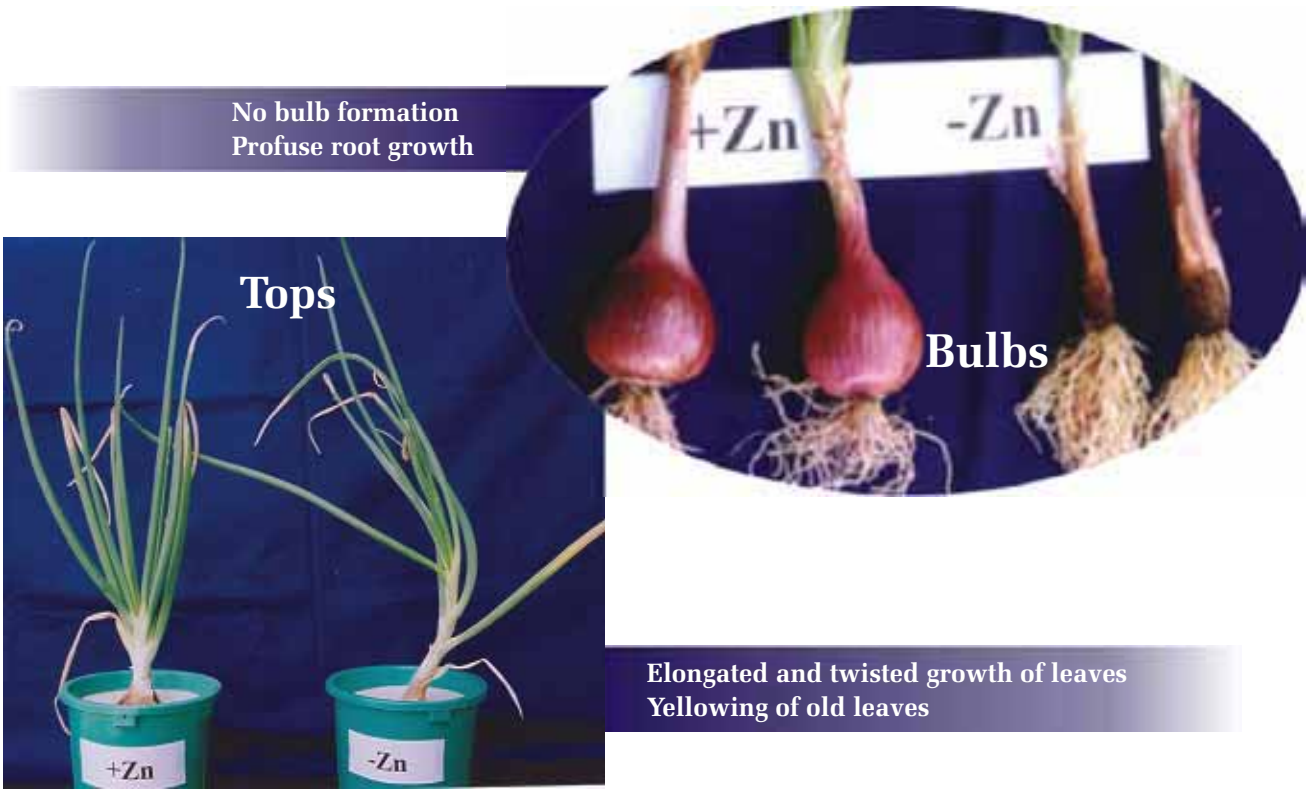
Available Potassium (kg ha^{-1}) : The soil analysis after the harvest of onion crop showed high available potassium in all the modules and this might be due to initial status of soil, which was high. However, in module M5 the available potash recorded highest (402 kg/ha) followed by M4 (377 kg/ha). Similarly, after the garlic crop, soil analysis showed highest available potash in module M5 (518 kg/ha) followed by M4 (489 kg/ha).

Effect of INM modules on storability of onion and garlic bulbs

Onion : After the harvest of the bulbs, onion was field cured for 4-5 days in field, then shade curing was done for 10-12 days. For storage studies 10 kg bulbs were kept in perforated plastic crates. Periodically it was observed for rotting and sprouting. Storage losses were worked on weight basis. Results indicated that the Module-1, Module-2 and Module-4 recorded higher rotting losses. This might be due to more nitrogen contents in the bulbs. Module-5 receiving only organic manures, bio-fertilizer, sulphur and additional potash recorded minimum total losses of 22.2%.

Garlic : In the storage studies of garlic, the kind of losses recorded was only the physiological weight loss. Minimum losses of 28.0 percent were noticed due to module 5 (M5)

Identification of nutrient hunger signs in onion during rabi 2003-04 : A sand culture study was conducted in polyhouse for identification of hunger signs in onion. Hoagland's nutrient solution was used for irrigation with different treatments *viz.*, -N, -P, -K, -S, -Ca, -Mg, -Fe, -Cu, -Mn and Zn. Observations were recorded for the symptoms in onion tops and bulbs.



Effect of selective crops (cereals and pulses) on nitrogen management in onion during *Kharif* 2004

A field experiment was initiated (i) to study the effect of various crops grown in *kharif* season on the enzyme activity for nutrient nitrogen and (ii) to study the status of nitrogen in soils after their harvest. The results pertaining to enzyme activity *viz.*, asparaginase, amidase and urease assayed in rhizosphere and non-rhizosphere soil at 60 days growth period of crops and also the N status in soils after the harvest of these crops is discussed.

The activity of amidase and urease was greater than asparaginase and this was far more in rhizosphere soils than non-rhizosphere. After the harvest of the crops, the soil was analyzed for available and total nitrogen. It was seen that the available and total nitrogen in the rhizosphere soil of cereals is lower than its corresponding non-rhizosphere soil. A greater amount of nitrogen was recorded in the pulse crop rhizosphere.

Production technology for *kharif* onion

Effect of shading on nursery production in summer : Different shading materials *i.e.*, Agro shade net 50%, 75% Hessian cloth, nylon net and mulching were tried for nursery production of onion cv Baswant -780 during summer under two methods of irrigation *i.e.*, surface and drip. Among the irrigation methods, drip irrigation was found better than surface irrigation with respect to seedling height, percent final stand, number of roots, root length etc. As far as water saving is concerned, there was 40 % saving of water in drip irrigation treatment than surface irrigation.

Among the various shading treatments, the final stand (percent transplantable seedlings) was significantly higher in all-shading treatments over control and mulching. Seedling height was highest under 75% agro shade net followed by 50% agro shade net. Seedling girth was lesser under all shading treatments and mulch than control but it was not statistically significant. Similarly, number of leaves per seedling, number of roots and length of roots were higher under no shading treatment.

Effect of date and method of planting on growth and yield in onion : Onion cv. Baswant 780 was planted on four dates *i.e.*, 1 June, 15 June, 1 July and 15 July in four method of planting, *i.e.*, flat bed, raised bed, ridge & furrow (R&F) and broad based furrow (BBF) during *kharif* season. Among four dates of planting, the highest marketable yield was obtained in 15 June planting which was significantly higher than 1st June and 15 July planting but similar to 1 June planting. The percentage of 'A' grade and percent rotted bulbs bulbs was also higher in 1 July planting.

Among the four methods of planting, highest yield was recorded in broad based furrow with drip irrigation. This treatment was significantly higher than other methods in all four dates of planting. There was no significant difference in yield in onion planted in flat bed, raised bed and ridge & furrow method. The percent of A grade bulbs was higher in ridge & furrow and BBF methods than remaining two methods but the percentage of B grade bulbs was highest in BBF method. The percentage of rotted bulbs was highest in flat beds followed by ridges & furrows, raised bed and BBF, respectively (Table 32).

Table 32 : Effect of date and method of planting on marketable yield of *kharif* onion cv. B-780

Date of Planting	MY (t/ha)			
	Method of planting			
	Flatbed	Raised bed	R&F	BBF
01.06.04	5.96	7.57	5.81	16.21
15.06.04	11.44	12.53	14.01	38.95
01.07.04	12.82	15.23	15.43	30.47
15.07.04	13.84	13.36	13.48	29.78

Effect of date, method of planting and variety on growth and yield of onion : Two onion varieties *i.e.*, Baswant- 780 and N-53 were planted on two dates 1 July and 15th July under four methods of planting during *kharif* season. Results indicated that there was no significant difference in the plant height, number of leaves and percent plant stand among various treatment combinations. But the total yield and marketable yield was highest in 1 July planting. The total yield of N-53 was higher than B-780 but the marketable yield of N-53 was less due to higher percentage of rotted bulbs. The percentage of A grade bulbs were also higher in 1 July planting. As far as the method of planting is concerned, the highest yield was obtained in BBF followed by ridge & furrow method. The percentage of A grade bulbs was higher in these two methods while the percentage of rotted bulbs were highest in flat beds .

Effect of direct sowing on growth and yield of onion : Onion seed was sown in broad based furrows directly in field in July 2004 using different methods such as manual sowing, pune drill and precision planter. These direct sown treatments were compared with the transplanted onion. The direct sown onion took lesser duration than the combined duration of nursery and transplanted crop. There was no difference in plant height and number of leaves per plant. The final stand was significantly higher in transplanted crop and seed sown by precision planter than other methods. The highest yield was recorded in transplanted crop but it was at par with precision planter sown crop. However, the percentage of A grade bulbs were higher in precision planter treatment (Table33).

Table 33 : Effect of direct sowing on yield of *kharif* onion cv. B-780

Treatments	MY (t/ha)
Transplanted	24.8
Manual sowing	18.8
Pune seed drill (With out filler)	17.8
Pune seed drill (With filler)	17.2
Precision planter	22.2

Weed management studies in direct sown onion : Various weedicides were applied to direct sown onion crop just after sowing in the month of July 2004 to study their effect on seed germination, weed population and yield. It was found that pendimethalin (Stomp), oxydiargyl (Raft) and oxyfluorfen (Goal) effectively control both dicot and monocot weeds up to one month but application of goal and raft adversely affected the germination and seedling growth and resulted in very low yield. Lower concentration of pendimethalin reduced the weed population without affecting the yield of onion and it was at par with hand weeding treatment but higher concentrations of pendimethalin reduced yield of onion.

Weed management in onion nursery : Various concentrations of weedicides e.g. pendimethalin (Stomp), oxydiargyl (Raft) and oxyfluorfen (Goal) were sprayed in late *kharif* / *rangda* nursery just after sowing. The spray of raft and goal in onion nursery effectively controlled weeds at both the concentrations tested but application of these weedicides reduced the seed germination, seedling growth and percent final stand. Lower concentrations of pendimethalin were not effective in controlling weeds but they did not affect the onion seed germination and seedling growth. Application of pendimethalin @ 3 ml per litre was found best in controlling weeds without affecting the germination, seedling growth and final stand while higher concentrations reduced seed germination and seedling growth.

Effect of lihocin on growth and yield of onion : In order to control the plant growth and increase bulb yield, foliar application of lihocin was applied to onion crop cv B-780 at various dates after transplanting *i.e.,* 45, 60, 75 and 90 days individually or in combinations during *kharif* season. It was found that the application of lihocin at 60 days and 75 days individually or combined after transplanting significantly increased the bulb yield and percentage of A and B grade bulbs.

Effect of trimming of seedlings before transplanting on yield : An experiment was conducted to see the effect of trimming the seedlings and without trimming at the time of transplanting on yield in variety B-780. Eight treatments were followed including the control (*i.e.*, trimming of seedlings on the same day as generally followed) and without trimming of the seedlings. In second year trial also, significant differences were observed in the yield. The marketable and total yield were significantly high and at par in the treatments where the seedlings were transplanted without trimming or the seedlings trimmed on one to three days before transplanting. The marketable yield in these treatments ranged from 35.72 to 38.43 t/ha against the control (30.79 t/ha). Similarly total yield was also high over the check. Similar trend was observed in the initial trial (Table 34).

Table 34 : Effect of trimming and without trimming of seedling at the time of transplanting on yield

Treatments	MY(t/ha) 03-04	TY (t/ha) 03-04
Transplanting without trimming	36.92	38.52
Trimming on same day before transplanting	30.79	32.02
Trimming 1 day before transplanting	38.43	39.88
Trimming 2 days before transplanting	38.27	39.34
Trimming 3 days before transplanting	35.72	37.13

Effect of days to uprooting the seedlings before transplanting on yield : Seedlings of variety B-780 were uprooted from seven days before planting up to the same day of planting at regular intervals to see the effect on yield and other characters. It was observed that the yield was significantly higher and at par in the treatments when the seedlings were uprooted 1 to 3 days before transplanting against the control (*i.e.*, the seedling uprooted on the same day of transplanting (Table 35). In previous year trial, no significant difference on the yield in the treatments was observed. Yield was reduced when the transplanted seedlings were uprooted 4 days before or onwards. Thus it can be concluded that onion seedlings can be uprooted up to 3 days before planting which will not affect the yield.

Table 35 : Effect of days to uprooting the seedlings before planting on yield

Treatments	MY (t/ha)	TY (t/ha)
Uprooting on same day of planting	32.50	33.66
Uprooting 1 day before planting	37.30	39.29
Uprooting 2 days before planting	35.47	38.77
Uprooting 3 days before planting	35.68	38.22
Uprooting 7 days before planting	20.42	21.65

Organic Production of Onion and Garlic

Effect of preceding crops and manures on growth and yield of rabi onion : Onion cv. N-2-4-1 was planted under two preceding crops *i.e.*, Pearl millet, Soyabean and four manure/fertilizer treatments under drip irrigation. It was found that the highest yield was obtained in cowpea + recommended fertilizer and pesticide treatment combination. Among the organic treatments, highest yield was obtained in poultry manure treatment. Overall, the yield in organic treatment combinations was 25 to 40 % lower than the recommended fertilizer and pesticide treatment. Percentage of A and B grade bulbs was also higher in recommended fertilizer treatment. A distinct reduction in bulb size was noticed under organic treatment combinations. There was no significant difference in the yield of onion under different preceding crops.

Yield of preceding crops in organic cultivation trial in onion : Four preceding crops *i.e.*, Green gram, French bean, Pearl millet and Soyabean were sown in *kharif* seaon in organic cultivation trial in onion. Green gram cv. ML-818, french bean cv Varun, pearl millet cv. Ankur-2226 and soybean cv. MACS-450 were used for the experiment. Highest yield of all these crops except french bean was recorded in recommended fertilizer treatment. The lower yield of french bean was due to water logging. This was followed by application of poultry manure (10 t/ha). Over all, the yield level of all crops were higher than the previous year.

Effect of preceding crop and manures on growth and yield of late kharif onion : Onion cv. Baswant 780 was planted under two preceding crops *i.e.*, Green gram and French bean during late *kharif* season. Highest yield was obtained in green gram under recommended fertilizer and pesticides treatment. Among the organic treatment combinations, highest yield was obtained in poultry manure treatment and the combination of FYM and poultry manure. Overall, yield in organic treatment combinations was 35 to 45 % lower than the recommended fertilizer and pesticide treatment. Percentage of A and B grade bulbs were also higher in recommended fertilizer treatment. A clear cut reduction in size of bulbs was noticed. Even 5 to 10% plants failed to produce bulbs under organic treatment combinations which was probably due to higher thrips infestation. No significant differences were found in the yield of onion under the preceding crops.

Yield of preceding crops in organic cultivation trial in garlic : Preceding crops *i.e.*, Green gram, French bean, Pearl millet, Soyabean were sown in *kharif* season in the organic cultivation trial. Green gram cv. ML-818, french bean cv Varun, pearl millet cv. Ankur-2226 and soyabean cv. MACS-450 were used for the experiment. Highest yield of all the crops was recorded in recommended fertilizer treatment which was followed by application of poultry manure (10 t/ha). Over all, higher yield was obtained in all four crops than previous year.

Fertigation studies in onion and garlic (AICVIP) : In recent years, greater importance has been given to increase the efficiency of irrigation water and nutrients. In order to maximize the water and fertilizer use efficiency, drip fertigation experiment was started in onion and garlic. In drip system, water and nutrients are supplied at the root zone of the crop with the help of emitters and a network of pipes, which ensures supply of water and other nutrients at the right time in the required quantity at the root zone. The studies were conducted in onion and garlic during the year 2002 - 2005 to find out optimum nutrient requirement of onion and garlic through drip fertigation. The results of pooled data for three years revealed that water-soluble fertilizers through drip irrigation improved the yield and yield contributing characters of both the crops. The highest mean marketable bulb yield was noticed in T1 (onion 30.1 and garlic 8.77 t/ha) which was on par with T2,T3 and T6 (Table 36 & 37).

Among the treatments, the percentage of A grade bulbs were more in 100% of recommended dose of fertilizers applied as water soluble fertilizers through drip system than conventional fertilizer application method. The percentage of bolters and doubles were on the higher side in T8 compared to other treatments. The reduction in fertilizer dose significantly reduced the marketable bulb yield of onion and garlic. Unfortunately, results indicated that an increase in fertilizer dose from 60 - 100 percent, the value of additional yield obtained was less than the additional cost of fertilizer incurred. While calculating the cost:benefit ratio, the treatment comprising of NPK 50:50:80 kg /ha as basal +100 kg N in seven splits through drip irrigation gave higher income per unit area compared to water soluble fertilisers. Hence it can be concluded that this treatment can be adjudged as the best treatment in terms of yield and cost:benefit ratio. As far as water saving is concerned there was 20-30% saving of water in drip fertigation over surface irrigation method.

Table 36 : Pooled analysis of fertigation studies in onion (AICVIP)

Treatments	Marketable Bulb Yield (t/ha)			
	02-03	03-04	04-05	Mean
T1	32.22	32.41	25.7	30.1
T2	32.07	31.40	23.4	29.0
T3	33.43	31.75	22.9	29.4
T6	31.89	33.85	22.9	29.6
T8 (control)	27.57	24.01	21.3	24.3

Table 37 : Pooled analysis of fertigation studies in garlic (AICVIP)

Treatments	Marketable Bulb Yield (t/ha)			
	02-03	03-04	04-05	Mean
T1	9.57	8.86	7.87	8.77
T2	7.69	9.28	7.33	8.10
T3	7.31	8.58	7.27	7.72
T4	8.54	8.39	6.80	7.91
T8 (control)	9.02	8.45	6.70	8.06

Studies on onion and garlic based cropping systems : Among the various cropping sequences evaluated in onion during *kharif* season, yield of potato, marigold, groundnut and bajra were lower than the previous year while aster and bajra recorded higher yield than the last year. In onion also, the marketable bulb yield was lower in *kharif* season. Decline in yield of potato, marigold, groundnut and onion may be due to high rainfall coupled with more entry of pest and diseases.

Pooled data for five-years (except *rabi* & summer, 2005) indicated that the higher marketable bulb yield of onion was noticed in legume based cropping sequences like groundnut followed by onion, and soyabean onion cropping sequences. The highest average marketable bulb yield of onion (36.1 t/ha) was recorded in preceding crop of groundnut followed by succeeding crop of onion in S10 sequence in late *kharif* season. In *rabi* season, the highest marketable mean bulb yield of 29.3 t/ha. was noticed in soybean-onion sequence. The increased yield could be attributed to preceding crop of soybean and groundnut and their residual effect was beneficial for succeeding crop of onion. It is a well known fact that the cultivation of legumes increases the available N content in the soil. The increased available N showed that biological N fixation was effected by the root nodules of soybean by microbial decomposition and mineralization. This would have helped for the slow and sustained release of N and enhanced availability of nutrients in the soil promoted the vegetative and reproductive phase of onion. The results of soil chemical properties revealed that tremendous improvement was noticed in organic carbon, organic matter, soil available N, P and K content of the soil in legume based cropping systems like Soyabean (*kharif*) followed by Onion (*rabi*) and Groundnut (*kharif*/summer) followed by Onion (*rabi*/late *kharif*) than other sequences evaluated. More over, the higher cost:benefit ratio was also obtained from soybean onion cropping sequence.

Garlic : In case of garlic also, this experiment was initiated during the year 2003-04 to identify and establish garlic based economically viable cropping sequence. In *rabi*, the yield level of garlic was lower in all the sequences due to higher infection of diseases during Dec- Feb. In summer season, three crops *viz.,* groundnut, cucumber and bajra were sown. The yield of all the three crops were good. With respect to *kharif* season, crops like bajra, groundnut, green gram, pea, soybean and potato were planted and the crops were harvested from respective sequences after attaining proper maturity. The yield of groundnut and pea were very low than average yield which may be due to the higher incidence of pests and diseases. Further studies on the uptake of plant and soil nutrients and its correlation with yield and yield contributing characters are to be evaluated.

Post Harvest Management

Assessment of storage losses in onion

Effect of different grades of onion on storage losses : Different grades of onion *viz.*, A, B, C, doubles and bolters produced in *rabi* 03-04 were stored from May to November 2004 to study various types of storage losses. It was found that the physiological weight loss (PLW) was higher in C grade bulbs and bolters while sprouting was less in bolters. Total losses in bolters were highest followed by doubles and C grades bulbs. Minimum losses were recorded in A and B grade bulbs after 7 months of storage.

Effect of different curing methods on storage life of onion : Onion bulbs of cv. N-2-4-1 were cured by various methods such as polyethylene tunnels (fully closed, half open, one side open etc), pit curing, field curing and no curing just after harvesting during *rabi* 03-04. These bulbs were stored under ambient conditions and periodic observations on storage losses were recorded. It was found that the minimum losses were recorded in field curing treatment while higher losses were recorded in curing in fully closed polytunnel. Bulb colour development was found better in pit curing treatment.

Effect of pre harvest treatments : Various chemicals such as glycine, gallic acid, pyrogallol, borax, FeSO4, salicylic acid etc. were sprayed fifteen days before harvesting to control rotting, sprouting and other storage losses. Bulbs were stored under ambient conditions from May to November 2004 and periodic storage losses were recorded. It was observed that the application of Borax (500 ppm and 1000 ppm) and ferrous sulphate (500 ppm and 1000 ppm) were effective in reduction of bulb rotting. Bulbs of these treatments remained firm and colour retention was better than other treatments.

Among various concentrations of carbendazim, benomyl and carbaryl sprayed on onion crop, 15 days before harvesting, application of carbendazim @ 2g and 4g/l reduced rotting in storage whereas there was no effect on PLW, sprout and black mould. Application of paclobutrazol, as pre harvest treatments 15 and 25 days before harvesting, did not reduce the sprouting and other storage losses in any combination tried.

Use of *Trichoderma* as drenching in onion crop, 15 days before harvesting, was found to be effective in reduction of rotting and black mould when applied @ 5g and 10 g per litre.

Effect of post harvest treatments

Effect of sulphur fumigation : Onion bulbs of cv. N-2-4-1 were given sulphur fumigation for different durations to reduce the disease infection. These onions were kept in ambient conditions from May to November 2004 and storage losses were recorded at periodic intervals. It was observed that sulphur fumigation in onion for more than one hour was found effective in reduction of rotting during storage. But sulphur fumigation did not show any positive effect on weight loss and black mould infection.

Effect of curing duration and irradiation on storage losses : Bulbs of onion cv N-2-4-1 were given gamma irradiation treatment after 30 and 45 days of shade curing in the month of June 2004. Irradiated bulbs along with untreated control were kept under ambient conditions and periodic observations of various type of storage loss were recorded up to December. Results revealed that the duration of curing did not have any effect on weight loss, rotting, sprouting and black mould whereas gamma irradiation effectively controlled sprouting of onion bulbs. Effectiveness of gamma irradiation treatment on controlling sprouting was similar for both durations of shade curing.

Effect of irradiation on storage losses of different onion varieties : Different onion varieties were gamma irradiated in the month of June 2004 and stored under ambient conditions for 7 months and periodic storage observations were recorded. Results revealed that the dark red colour varieties showed less effect of irradiation and there was considerable amount of sprouting despite of irradiation whereas in light red coloured varieties sprouting was effectively checked. Sprouting was suppressed in white onion cultivars. However, rotting increased by the irradiation treatment in all varieties and it was higher in dark red and white coloured varieties. No significant effect of irradiation on PLW and black mould infection was evident. Overall response of irradiation was different in different onion varieties.

Effect of storage environment

Performance of various types of onion storage structures for storage of late kharif onion : Three-onion storage structures *i.e.*, Bottom ventilated storage structure with asbestos roof and chain links on sides, Mud plastered top and bottom ventilated storage structure with asbestos roof and Modified bottom ventilated double row storage structure with asbestos roof were evaluated for their performance in late *kharif* onion during Feb to June 2004. Among these storage structures, mud plastered top and bottom ventilated storage structure with asbestos roof was found more efficient in reducing physiological loss of weight (PLW) and rotting as compared to modified bottom ventilated storage structure. Pooled analysis for three years (2002-04) also revealed that the mud plastered top and bottom ventilated storage structure with asbestos roof was best in reducing physiological loss of weight (PLW) and rotting as compared to modified bottom ventilated storage structure and modified bottom ventilated double row storage structure with chain linked side walls.

Calculation of cost:benefit ratio of these onion storage structures for storing late *kharif* onion revealed that net profit (Rs/t) was highest in mud plastered top and bottom ventilated storage structure (Rs. 653/t) for 2004. Net profit on the basis of pooled analysis of three years also revealed that mud plastered top and bottom ventilated storage structure was most profitable (Rs 449/t) for storage of late *kharif* onions. Storage of late *kharif* onion at a net profit of Rs.449/t may not be a commercially viable option but it may be used for specific purposes.

Performance of various types of onion storage structures for storage of rabi onion : Seven different type of onion storage structures *i.e.,* Traditional non ventilated double row onion structure, Bottom ventilated double row storage structure with chain links on sides, Mud plastered top and bottom ventilated storage structure with asbestos roof, Modified bottom ventilated double row storage structure with asbestos roof, Low cost bottom ventilated storage structure, Traditional single row storage structure with Mangalore tiled roof and Modified single row structures with Mangalore tiled roof were evaluated for storage of *rabi* onion cv N-2-4-1 during May to September 2004. Among the double row type of onion storage structures, mud plastered top and bottom ventilated storage structure with asbestos roof was found more efficient in reducing physiological loss of weight (PLW) and rotting as compared to modified bottom ventilated storage structure. Losses in traditional type of storage structures were highest. Among single row type storage structures, low cost thatched roof structure was found better over bottom ventilated mangalore tiled storage structure and traditional mangalore tiled storage structure. Overall, low cost thatched roof structure was found best. Calculation of cost:benefit ratio of onion storage in various type of storage structures revealed that the net profit was highest in low cost thatched storage structure (Rs 3136/t) than all other storage structures and was closely followed by mud plastered top and bottom ventilated storage structure with asbestos roof (Rs 2939/t).

Mud plastered top and bottom ventilated onion storage structure

Effect of packing material on storage losses in rabi onion : Bulbs of onion cv. N-2-4-1 were packed in different packing materials *i.e.*, Staking, Hessian cloth bags, lino-bags (Netlon) and plastic crates and stored in four different onion storage structures from May to September 2004. Results revealed that the weight loss was highest in crates while it was less in stakes and bags. But this trend was reverse for rotting and highest rotting was recorded in hessian cloth bags followed by lino bags and stakes. There was no definite pattern for sprouting and black mould infection but the occurrence of sprouting and black mould was less during 2004 than 2003. Overall, the onion storage in stakes in mud plastered top and bottom ventilated storage structure with asbestos roof was the best combination in minimizing losses and obtaining highest net profit.

Assessment of storage losses in garlic : Well cured bulbs of garlic were topped in the month of April and graded in three categories *i.e.*, A (>35mm diameter), B (25-35 mm) and C (<25mm) grade and were kept in crates under ambient conditions from April to November 2004 to assess the storage losses. It was observed that the weight loss in garlic was less than onion and lower losses were recorded in bigger bulbs than medium and smaller size bulbs. Infection of soft rot was also more in smaller sized bulbs whereas more internal sprouting was recorded in A grade bulbs.

Effect of sulphur fumigation on storage losses in garlic : Garlic bulbs of cv. G-41 were given sulphur fumigation for different durations to reduce the disease infection. It was found that the fumigation of sulphur significantly reduced the black mould infection in garlic bulbs and also reduced the rotting.

Performance of garlic cv. G-41 stored in various types of onion storage structures : Garlic cv. G-41 was stored in different onion storage structures *i.e.*, Traditional non ventilated double row onion structure, Bottom ventilated double row storage structure with asbestos roof and chain links on sides, Mud plastered top and bottom ventilated double row storages structure with asbestos roof, Modified bottom ventilated double row storage structure with asbestos roof in two methods i) In circular stakes (heaps) of 1x1m size along with intact leaves and ii) in Hessian cloth bags (without leaves) during April to October 2004. There was no effect of different storage environments (storage structure and method of storage) on the physiological weight loss but disease infection (%) was lower in heaps (stakes) of untopped garlic as compared to the topped garlic stored in hessian cloth bags. Similarly, visual quality with less discolouration was also better in garlic stored in stakes.

Crop Protection

Pest management in onion and garlic : Onion thrips, *Thrips tabaci* Lindeman is the most important pest on onion and garlic. Yield loss is more significant if unchecked in *rabi*. This pest is mainly controlled by application of insecticides. During the year 2004-05, different field trials were conducted to evaluate individual control tactics as well as integrating compatible options to control thrips. The results are presented hereunder :

Cultural Control

Barrier cropping for the management of onion thrips : Thrips are weak fliers and are carried by wind very easily from one field to the other. Use of barriers may block dispersion of thrips by wind from old plantings to new ones. Hence, blocking their movement through live barriers may reduce the thrips population.

Maize plants as barrier for blocking migrating adult thrips was evaluated for three years from 2001-2004 in onion during *rabi*. Live barrier crops used for surrounding onion were 2 rows of maize (2M); an outer row of maize and an inner row of wheat (MW); 2 rows of wheat (2W).

Based on the blocking efficiency of barrier crops and infestation of thrips, treatment 2W was removed in the year 2003-04 *rabi* season. In total, blocking efficiency of thrips was highest in 2 rows of maize (88.1%) followed by 85.7% in MW. Nymph density was the lowest in 2M with 11.1 / plant as compared to control (40.2 / plant). Thrips multiplication was faster in control plots compared to plots with barrier crops. Similar trend was also noticed in previous years. Although the adult population / plant was non significant, higher number may have definitely contributed to increased nymph population and further multiplication in control plots. This method reduces the pesticide load on onion by restricting the sprays to one or two compared to 4-5 in regular schedule of insecticide sprays.

To minimize or eliminate the shading effect of barrier crops on bulb yield, the block size was increased to 250 sq m. in 2003-04 and the maize variety with shorter stature was used as barrier. These two modifications minimized the shading effect and resulted in obtaining higher yields with barrier crop of maize compared to control. Highest total yield of 31.8 t/ha was recorded in MW followed by 30.7 t/ha in 2M. Control plot with no barrier recorded the lowest 24.2t/ha and 26.2t/ha of marketable and total yield, respectively.

Onion crop stage susceptibility to thrips and biochemical alterations due to thrips feeding : In *rabi* 2003, the crop was planted at 15 day interval from 15 October to 15 January. Thrips count was taken on 2 dates - 28.1.04 and 4.2.04 so that all the stages of the crop were present in the field. Based on the data, it was clear that thrips infestation was in 60-75 day old crop. Significantly positive correlation was obtained between thrips and age of the plant up to 75 days and a negative correlation thereafter.

Plant analysis was done at different growth stages that were grown under sprayed and unsprayed plots for phenols, reducing sugars, proteins and free amino acids so that the alterations in plant profile due to thrips feeding is known. Low amount of phenols, high content of proteins, reducing sugars and amino acids was found to be responsible for the higher infestation of thrips during bulbing stage.

Management of thrips based on critical growth stages of onion : Thrips attack onion at all the stages of the crop growth. It is important to identify the critical stages in onion with respect to thrips so that suitable control measures could be taken during that period, thereby minimizing the pesticide load as well as frequency of application.

Based on the pooled data over 3 years *i.e.,* 2001-2003 it was found that the benefit: cost ratios were highest when insecticides were sprayed at 60,75 days (5.47) and 45, 60 and 75 days (5.03). Percent A grade bulbs were higher in the latter . This study suggests that thrips management is crucial during bulbing stage of onion.

Biological Control

Evaluation of insect pathogens against onion thrips : Many insect pathogens have been reported to be effective against different sucking pests in field and laboratory. In this direction, insect pathogen formulations namely, *Verticilium lecani, Beauveria bassiana, Paecilomyces* and spinosad at different doses along with insecticide carbosulfan were evaluated in the field during *rabi* season for the control of thrips.

All the treatments were found significantly superior over control. This trend followed at 4, 7 and 10 days after spray (DAS). Spinosad @0.25 ml/l dose recorded the lowest thrips population (25.9/plant) but only after insecticide carbosulfan spray. Overall efficacy of all other insect pathogens tested at both the doses did not differ significantly amongst them and were inferior to insecticide (carbosulfan) sprays. Lowest injury was noticed in carbosulfan sprayed plots with a mean leaf injury rating of 2.1. Both marketable (21.2t/ha) and total (25.9t/ha) yields were higher in the carbosulfan sprayed plots.

Apart from the commercial formulations, another trial was conducted in *rangda* season in collaboration with Project Directorate on Biological Control, Bangalore. 13 strains belonging to different species namely, *B. bassiana, V. lecani* and *Metarrhizium anisopliae* were evaluated for their efficacy against onion thrips.

In all the sprays, barring two occasions, insect pathogens were found to be effective in controlling the thrips as compared to the control. But they could not bring down the thrips population to below ETL at any instance. Thrips infestation level was unusually high during the period of study compared to normal year. No insect pathogen strain showed consistent performance in bringing down thrips population. After 10 days of first spray, all the strains were at par except *Beauveria bassiana* 9 (Bb-9). During second and third spray, thrips infestation was severe and reached as high as 470 / plant in control. But in all the treatments, thrips count was significantly less than the control. No insect pathogen performed consistently in all the sprays. In fifth spray, thrips population decreased which may be due to the weakening of the plants in control and the treatments except in insecticide sprayed plots. With regards to yield, both marketable and total yield was higher in cypermethrin and carbosulfan sprayed plots. Yields of all insect pathogens were found insignificant.

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

Chemical Control

Combined effects of neem and insecticides against onion thrips : Present pest management in onion is chemo-intensive. To bring down the pesticide usage in onion, a trial was conducted in *rabi* season to evaluate the efficacy of neem, insecticides *viz.*, profenofos, acephate, cypermethrin applied alone as well as combined application of neem with the above insecticides.

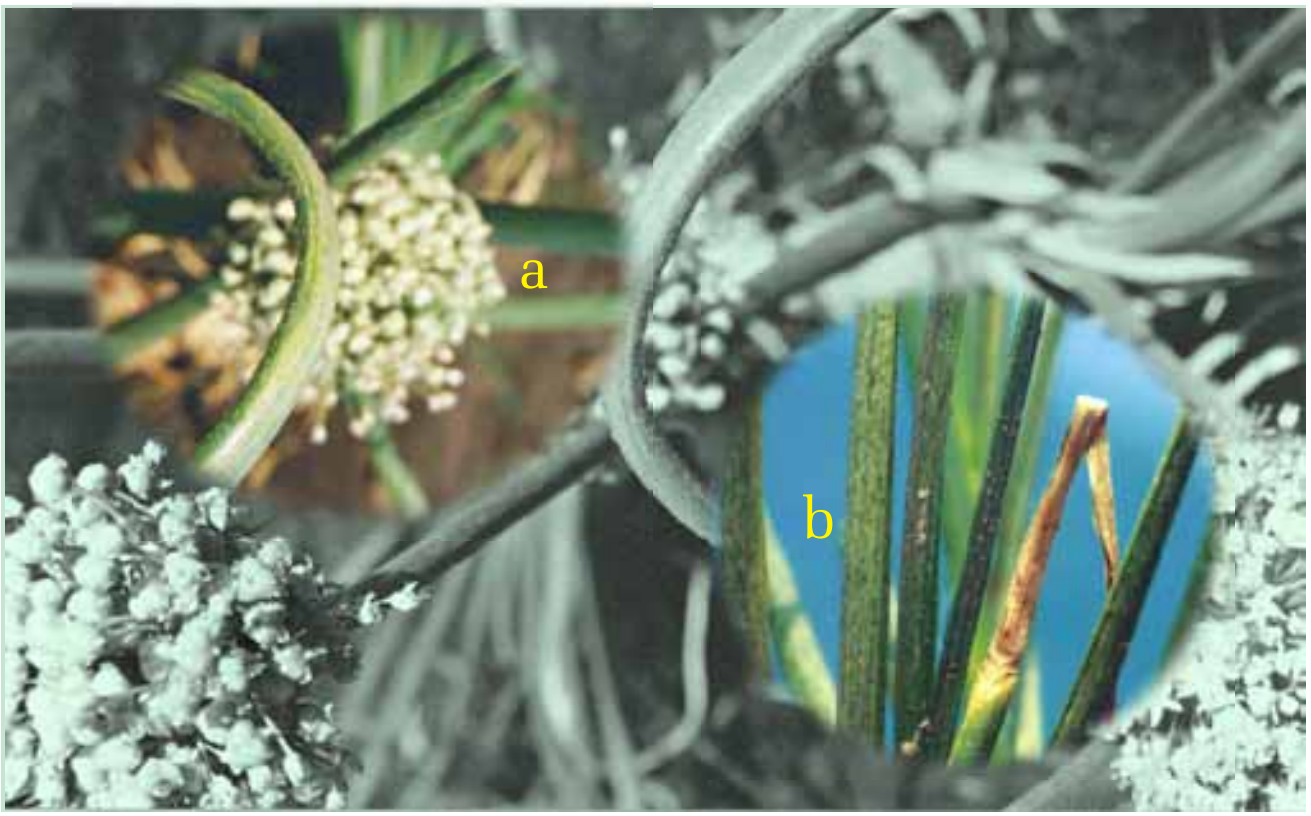
Combined application of insecticides with neem were found effective in controlling thrips. Based on the overall efficacy, lowest number of thrips were found in Neem 3ml/l + profenofos @ 0.025% sprayed plots (2.38/plant) and was at par with the profenofos (0.05%) sprayed alone (3.27/plot). Combined effect of neem with other insecticides was also found as effective as the insecticides that were applied alone. Higher marketable yields were recorded in plots treated with neem + profenofos, acephate, and profenofos alone with 22.9, 21.9 and 21.6 t/ha respectively. Lower plant injury was noticed in all the insecticide treatments. An injury rating of 2.5 was recorded in neem alone treated plots and control recorded the highest injury of 3.4.

Evaluation of some new insecticides against onion thrips : Use of insecticide remains as the most effective method to control thrips. Therefore, it is essential to evaluate the new insecticides available in the market. This is also useful to overcome the problem of development of insecticide resistance by minimizing the use of same old insecticides repeatedly.

During *rabi* 2003, four new insecticides, namely, Diafenthiuran (Pegasus 50WP), Thiamethoxam (Actara 25WG), Acetamaprid (Pride 20SP) and Lambda cyhalothrin (Karate) were evaluated against thrips. Among the different insecticides tried, Karate at 80 g ai/ha was found very effective (10.17 thrips/plant) followed by karate at 40g ai/ha and monocrotophos. Highest marketable yield of 26.4 and 24.3t/ha was recorded in monocrotophos and karate @ 80g ai/ha treatments.

Pest Monitoring

Red spider mite on onion and garlic : The red spider mite that occurred on onion and garlic was identified as *Tetranychus cinnabarinus (= urticae)* (Acari: Tetranychidae). In the year 2001-02, during *rabi* season, the incidence was first noticed on 120- day old garlic crop in the month of February 2002. Later it was observed on onion seed crop grown under cages. In garlic, silk webbings were seen on the upper surface of the leaves. Both nymphs and adults were seen in colonies under webbing. Due to feeding, small white specs formed on the leaves. Both old and new leaves were infested. In onion, both foliage and flower stalks were infested. Fine silk webbing was spun around the umbel. Mites were also found on the plants grown in poly houses.



a. Red spider mite on onion inflorescence b. Red spider mite on onion leaves

In garlic, during *rabi* season 2001-02, a mean of 11.13 eggs / cm^2 were recorded. Nymph population was more than the adults. On an average, 19.53 mites (both nymphs and adults) were observed per 1 cm^2 .

In both the years (2001-02 & 2003-04), mite infestation was observed only after 100 days of planting. Incidence of mites on onion bulb crop was also noticed but at a later stage when garlic reached full maturity. Mite infestation on garlic (28.25/cm^2) was higher than that of onion (13.55/cm^2). In garlic, mite population was significantly higher in insecticide sprayed plots as compared to unsprayed plots (4.9 mites / cm^2). This may be because of the continuous insecticide usage and elimination of natural enemies of mites in the agro ecosystem.

Host Plant Resistance

Reaction of onion germplasm to thrips : In *kharif* season, 20 lines of white and red onion were screened for thrips resistance. B- 780 for red and Phule safed for white lines were used as commercial checks. Due to continuous rains during the study period thrips population remained less and sufficient leaf damage was not seen for scoring on the leaf damage. Therefore, injury in terms of leaf curling was recorded. Based on the LCR (1= Erect leaves; 2= 90° curling; 3= 180° curling; 4 = all leaves showing 180° curling and/or leaves showing distortion and moderate twisting; 5= plant with complete curling and twisting), in white onion the curling was in the range of 1.4 to 3.1. Lowest rating was recorded in W-397-M followed by W-073 with 1.5 rating whereas the check variety recorded a rating of 2.0. Highest rating of 3.1 was noticed on W-139-E. In case of red onion, lowest rating was recorded in 1032 (1.8) and 1005 (1.9) and the highest was 2.5 in NRCOG hybrid-1(2.5). The final crop stand in both red and white onions was poor and hence yield data was not recorded.

On-Going Projects

Project Code	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, V Sankar and A Aziz Qureshi
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
Sponsored Projects		
NATP	Development of hybrids in vegetables	KE Lawande
Central Sector Scheme	Implementation of PVP and FR legislation and DUS testing for onion and garlic	VSR Krishna Prasad
NATP	Reduction in Post harvest losses in onion	PC Tripathi
Central Sector Scheme	Breeder Seed Production of onion	V Mahajan
AP Cess Fund	Evaluation of selenium status in Indian type onion and garlic- Studies on the nutritional behaviour of selenium and sulphur	A Aziz Qureshi

List of Publications

Research papers

Khar A, RD Bhutani and N Yadav. 2005. *In vitro* studies on multiple shoot induction in onion. *Ind. J. Hort.* 62 (1) : 94-95.

Khar A, A Asha Devi, V Mahajan and KE Lawande. 2004. Performance studies of some promising garlic accessions under Rajgurunagar conditions. *J. Maharashtra Agr. Univ.* 29 (2) : 214-216.

Srinivas PS and KE Lawande. 2004. Impact of planting dates on *Thrips tabaci* Lindeman infestation and yield loss in onion (*Allium cepa* L.). *Journal Pest Management in Horticultural Ecosystems.* 10(1):11-18.

Srinivas PS and KE Lawande. 2004. Red spider mite- A new pest on onion and garlic. *Insect Environment.* 10(2): 79-80.

Papers/Abstracts presented in conferences

Aziz Qureshi A and KE Lawande. 2004. Influence of sulphur on yield and storability of onion (*Allium cepa* L.). In *Proceedings* of *69th Annual Convention of Indian Society of Soil Sciences*, Acharya NG Ranga Agricultural University, Hyderabad, 163.

Aziz Qureshi A, V Sankar and KE Lawande. 2004. Combined effect of organic manures and fertilizers in yield and storability of onion. In *Proceedings of ICAR National Symposium on Input Use Efficiency in Agriculture- Issues and Strategies*, KAU, Kerala, 25-27 November, 12.

KrishnaPrasad VSR, KE Lawande and V Mahajan. 2004. Response to environmental variations of onion lines grown for year round cultivation. In *Proceedings of First Indian Horticultural Congress on Improving Productivity, Quality, Post Harvest Management and Trade in Horticultural Crops*, New Delhi, 6-9 November, 93.

Lawande KE and PC Tripathi. 2004. Status and need for mechanization of production and post production operations in onion and garlic. In *Proceedings of National Working Group Meeting on Mechanization of Horticulture and Hill Agriculture for Production and Post Production Operations and Value Addition,* CIAE, Bhopal, 16-17 April, 125-127.

Lawande KE. 2004. Present status, constraints and prospects in export of onion and garlic from India. Lead paper in *Proceedings of First Indian Horticultural Congress on Improving Productivity, Quality, Post Harvest Management and Trade in Horticultural Crops*, New Delhi, 6-9 November.

Lawande KE. 2004. Preservation of onions and garlic by radiation processing. BARC, Mumbai, 15-17 November.

Mahajan V, KE Lawande, A. Khar and VSR Krishna Prasad. 2005. Screening of white onion germplasm for year round production. In *Proceedings of International Conference on Sustainable Crop Production in Stress environment: Management & Genetic Option*, JNKVV, Jabalpur, 9 -12 February.

Sankar V, A Aziz Qureshi, PC Tripathi and KE Lawande. 2004. Efficient water management in onion through micro irrigation. In *Proceedings of ICAR National Symposium of Input Use Efficiency in Agriculture -Issues and Strategies,* KAU, Kerala, 25-27 November, 12.

Sankar V, A. Aziz Qureshi, PC Tripathi and KE Lawande. 2004. Effect of organic biostimulants on growth and yield of onion var. Baswant - 780. In *Proceedings of First Indian Horticultural Congress on Improving Productivity, Quality, Post Harvest Management and Trade in Horticultural Crops*, New Delhi, 6-9 November, 246.

Srinivas PS and KE Lawande. 2004. Bulbing stage: Crucial for management of onion thrips. In *Proceedings of ICAR National Symposium of Input Use Efficiency in Agriculture-Issues and Strategies*, KAU, Kerala, 25-27 November, 122.

Tripathi PC, KE Lawande and HM Jadhav. 2004. Motorized grader- an economic option for onion grading. In *Proceedings of International Seminar on Emerging Technologies in Agricultural and Food Engineering*, IIT, Kharagpur, 14-17 December, 116.

Research bulletins

Lawande KE. 2004. *Pyaj Ki Kheti.* Research bulletin No. 4. Published by National Research Centre for Onion and Garlic.

Lawande KE. 2004. *Lahsun Utpadan.* Research bulletin No. 5. Published by National Research Centre for Onion and Garlic.

Lawande KE. 2004. Onion Graders. Research bulletin No. 6. Published by National Research Centre for Onion and Garlic.

Lawande KE. 2004. *Pyaj Ka Bijotpadan.* Research bulletin No. 8. Published by National Research Centre for Onion and Garlic.

Lawande KE. 2004. *Kanda Va Lasun Sathavan*. Research bulletin No. 9. Published by National Research Centre for Onion and Garlic.

Tripathi PC and KE Lawande. 2004. *Kanda Pratvari Yantra*. Research bulletin No. 7. Published by National Research Centre for Onion and Garlic.

Tripathi PC and KE Lawande. 2004. *Pyaj evam lahsun bhandaran*. Research bulletin No. 10. Published by National Research Centre for Onion and Garlic.

Tripathi PC and KE Lawande. 2004. Top and bottom ventilated onion storage structure. Research bulletin No. 11. Published by National Research Centre for Onion and Garlic.

Tripathi PC and KE Lawande. 2004. Low cost bottom ventilated onion storage structure. Research bulletin No. 12. Published by National Research Centre for Onion and Garlic.

Transfer of Technology

Lectures/talks delivered

Topic	Organizer	Venue	Date
KE Lawande			
Production and problems of onion and garlic	MSAMB, Pune	APMC, Indapur	July 1, 2004
Onion and Garlic Export	Indore	Fresh-O-Veg Krishak Club, Indore	August 21, 2004
Kanda Utpadan Paramparik Padhat Va Thimbak Sinchan, Tulanatmak Abhyas	Krishi Melawa, Otur	Chaitanya Farmers Club and Jain Irrigation System Pvt. Ltd.	October 26, 2004
Onion cultivation, storage, processing and marketing	Bijapur	IAT Bangalore Bijapur Chapter, Bijapur	October 28, 2004
Onion production, prospects and management	Shirur	Safal Growers Association, Shirur	November 25, 2004
Recent developments in onion and garlic research	Pune	Reserve Bank of India, Pune	February 16, 2005
Biotechnological applications in crops	Kalwan	College of Arts, Commerce & Science, kalwan	March 17, 2005
V Mahajan			
Cultivation of *kharif* and *rabi* onion	KVK, Nandurbar	Nandurbar	June 5, 2004
Improved varieties of onion and onion seed production	NHRDF and *Shivenari Krishi Gram Vikas Prathisthan* Junner/Ambegaon.	Junner	June 14, 2004

Topic	Organizer	Venue	Date
Technology for onion production, storage, processing and export	Horticulture Training Centre, Talegaon Dhabade.	Talegaon	June 18, 2004
Kharif onion production	IFFCO, Pune and *Ambegaon Taluka Shetmala Prakariya Sah Sanstha Maryadit,* Manchar	Manchar	June 22, 2004
Onion cultivation	Panchayat Samiti, Shirur	Shirur	July 1, 2004
Kanda peek utpadan, rog- keed margdarshan va shanka samadhan	IFFCO, KVK-Malegaon *Pandare Panchcroshi Shetakari Mandal,* Pandare	Pandare, Baramati	July 16, 2004
Kanda lagwad, utpadan waad, akatmik keed rog vyavasthapan, kadhani poorve va kadhani nantarche tantragyan	*Krishi utpann Bazar Samiti Shirur* and Maharashtra State Marketing Board, Pune.	Jambut, Shirur	July 28, 2004
Onion production, processing and storage	District Co.operative Bank and Agriculture Produce Market Committee	Bhavnagar, Gujarat	Aug. 13, 2004
Onion production technology and storage	Godrej Aadhar	Ranjani Karmala, Tal. Ambegaon	Aug. 30, 2004
Garlic production techniques	NRCOG	Rajgurunagar	Sep. 8, 2004
Hybrid seed production in onion and practical	NRCOG under NATP project	NRCOG	Dec. 29, 2004
Onion seed production for export	APMC, Solapur	Solapur	Jan. 29, 2005
Kanda peek parisanwad	Zuari Industries Ltd., Goa and Maharashtra Bank, Manchar.	Pimpalgaon, Khadki	Mar. 23, 2005
Kanda pikache utpadan va sathavanuk	Pune Zila Parishad, Panchayat Samiti Khed, Agri. Dept. & Agri. Produce Marketing Committee, Khed.	Koregaon, Budruk	Mar. 28, 2005

Visual Aid

The centre has produced a video CD of 15 minutes on "Post harvest handling of onion and garlic" for dissemination of knowledge to the farmers.

Human Resources Development

Participation of scientists / other staff in conferences/ courses/ meetings/ seminars/ symposia/ workshops/ trainings etc. during 2004-05

Name	Title	Date
Dr. PC Tripathi	National seminar on Mechanization of Hill Horticulture at CIAE, Bhopal	16 - 17 April 2004.
Dr. PS Srinivas	Training on Biological control of crop to develop bio-intensive pest management practices in different cropping system at PDBC, Bangalore	19 April - 18 May 2004
Dr. V Mahajan Dr. PC Tripathi	Workshop on All India Coordinated Research Project (Vegetable crops) Group meeting at ANGRAU, Hyderabad	27 - 30 May 2004
Dr. PC Tripathi	Review Workshop of NATP (PHT) at NIRJAFT, Kolkata	26 June 2004
Dr. KE Lawande	Directors' Conference of ICAR Institutes at ICAR Hqrs, New Delhi	14 - 16 July 2004
Dr. KE Lawande	Seminar on Potential and Perspective of Sugarbeet Research and Development in Maharashtra State at VSI, Pune	24 - 26 July 2004
Dr. KE Lawande	National level seminar on Prospects of Potato, Onion and Garlic in Malwa belt for processing and export purpose at Fresh-O-Veg Krishak Club, Indore	21 August 2004
Dr. PS Srinivas	Short term training on Network & ERNET Connectivity at NAARM, Hyderabad	23-27 August 2004
Dr. A Khar	Training on Plant genetic engineering and molecular breeding at NRCPB, New Delhi	22 Sep. - 13 Oct. 2004

Name	Title	Date
Dr. KE Lawande	Workshop on Utilization of Plant genetic resources at NBPGR, New Delhi	5- 7 October 2004
Dr. KE Lawande	Onion seminar at IAT, Bijapur, Karnataka	28 October 2004
Dr. KE Lawande	15th Annual Conference of Indian Nuclear Society (INSAC-2004) at BARC, Mumbai	15-17 November 2004
Dr. KE Lawande	Onion seminar at Safal Growers Association, Shirur, Pune	25 November 2004
Dr. A Aziz Qureshi Dr. PS Srinivas Dr. V Sankar	ICAR National Symposium on Input Use Efficiency in Agriculture - Issues and Strategies at KAU, Kerala	25-27 November 2004
Dr. PC Tripathi	International seminar on Emerging technologies in agricultural and food engineering at IIT, Kharagpur	14 -17 December 2004
Dr. VSR Krishna Prasad	Training on Statistical techniques useful for DUS testing at NBPGR, New Delhi	10-15 January 2005
Dr. V Sankar	Training on Environmental protection through organic production at Gandhigram Rural Institute, Dindigul	18 Jan. - 8 February 2005
Dr. V Mahajan	International Conference on Sustainable crop production in stress environment: Management & Genetic Option at JNKVV, Jabalpur	9-12 February 2005
Scientists, NRCOG	DUS Testing of Onion and Garlic - Principles and Procedures at NRCOG, Rajgurunagar	21-24 February 2005
Dr. Anil Khar	Training on Implementation of the Global Plan of Action in India for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture - North and Eastern Region (Region 1) NBPGR, New Delhi	15-16 March 2005
Sh. N Gopal	Workshop on Accounting Reforms at NIFM, Faridabad	20-21 September 2004
Sh. N Gopal	Workshop on Personnel Management Information System at IASRI, New Delhi	1-2 September 2004
Mr. HSC Shaikh	Workshop on Personnel Management Information System at IASRI, New Delhi	1-2 September 2004
Mr. HSC Shaikh	Training on Network & ERNET Connectivity at NAARM, Hyderabad	23-27 August 2004
Mr. VV Patil	Traing on Effective Technical Assistance in Management of Agricultural Research at NAARM, Hyderabad	3-9 February 2005
Mr. PR Sonawane	Training on Agromet. Observers at IMD, Office of DDGM (Agrimet), Pune	7- 5 February 2005

Deputations / Visits abroad

Scientist	Purpose of visit	Place of visit	Period
Dr. V Mahajan	Received training in Onion breeding particularly identification and use of CMS system in development of onion hybrid	USDA-ARS Dept. of Hort., University of Wisconsin, USA	27 Oct. - 31 Dec. 2004

Training programmes organised by the centre

Title of the programme	Duration	Sponsoring Agency (if any)
Onion and Garlic Production Technology	8 - 10 October 2004	Dept. of Agriculture, Tamil Nadu
Post harvest handling of onion	12 October 2004	NATP (PHT)
Post harvest handling of onion	3 November 2004	NATP (PHT)
Onion seed production	29 December 2004	NATP (PHT)
Hybrid seed production	29 - 30 December 2004	NATP (Veg - Onion)
DUS testing of onion and garlic- Principles and Procedures	21 - 24 February 2005	DUS Programme

Institutional Activities

Inauguration of the building

The administrative-cum- laboratory building of our centre was inaugurated by Hon'ble Shri Sharadchandraji Pawar, Union Agriculture Minister and Director General, ICAR along with DDG (H) on 9th Nov 2004. Dr. Mangla Rai, Secretary, DARE & DG, ICAR presided over the function while Dr. Gautam Kalloo, DG (Hort. & CS) and other dignitaries presided over the function. In his speech, the hon'ble minister emphasized the need for increasing the productivity of onion and garlic in our country. Dr. Mangla Rai, Director general, ICAR in his address ensured for continuous support to the centre for its betterment. About 1500 farmers and guests attended the function.

NRCOG Foundation Day

The foundation day of NRCOG was organized on 16 June 2004. Dr. S. S. Dhumal, Director, Horticulture Training Centre, Talegaon Dabhade, Pune was the chief guest of the function. Farmers were briefed about the experiments in the field and storage structures. A *Kisan Ghoshti* was conducted to clear the problems relating to onion and garlic, cultivation, production and post harvest challenges. Nearly 70 farmers, non-officials and local authorities attended the programme. On this occasion, NRC for Onion and Garlic felicitated the former colleagues.

हिन्दी सप्ताह

दिनांक ०८.०९.२००४ से १४.०९.२००४ तक हिन्दी सप्ताह मनाया गया । इस अवसर पर टिप्पणी प्रतियोगिता, सुलेखन प्रतियोगिता, कविता पाठ, निबन्ध प्रतियोगिता, वाद-विवाद प्रतियोगिता एवं टंकण प्रतियोगिताएं आयोजित की गई।

हिन्दी दिवस के समापन कार्यक्रम में मुख्य अतिथी डॉ. रमाशंकरजी व्यास, वरिष्ठ हिन्दी अधिकारी, राष्ट्रीय रासायनिक प्रयोगशाला एवं सचिव, नगर राजभाषा कार्यान्वयन समिति, पुणे का निदेशक महोदय, राष्ट्रीय प्याज एवं लहसुन अनुसंधान केन्द्र, राजगुरूनगर ने स्वागत किया एवं निदेशक महोदय का स्वागत श्री एन. गोपाल, सहायक प्रशासन अधिकारी एवं सचिव, राजभाषा कार्यान्वयन समिति, राष्ट्रीय प्याज एवं लहसुन अनुसंधान केन्द्र, राजगुरूनगर ने किया।

स्वागत कार्याक्रम के पश्चात् निदेशक महोदय ने हिन्दी के प्रति जागरूगता एवं उपयोगिता पर भाषण दिये। अन्त में मुख्य अतिथि महोदय के भाषण के पश्चात् विजेता प्रतियोगियों को मुख्य अतिथि महोदय के हाथों से पुरस्कार प्रदान किये गये।

Participation in Sports Meet

This year a team of NRCOG was sent to participate in the Inter-Zonal Sports Tournament held at CAZRI, Jodhpur *w.e.f.,* 7-11 Feb. 2005.

Institutional meetings

- SRC meeting was held on 10 -11 June 2004 under the chairmanship of Dr. K. E. Lawande, Director. The concerned scientists presented their results of experiments. New trials with technical programme were proposed and finalized after thorough discussion.
- Seventh SRC meeting was held on 14-15 September 2004 under the chairmanship of Dr. K.E. Lawande to review the research work done during the year 2003-04. All the scientists presented their research findings and future research programmes were finalized after thorough discussion.
- Seventh RAC meeting was held on 21 Sep., 2004 under chairmanship of Dr. Vishnu Swarup, Director, Indo - American Hybrid Seeds. The proceedings of the RAC meeting were examined in the council and same have been approved by the Director General, ICAR.
- Ninth IMC meeting was held on 25 October 2004. Mr C. B. Holkar and Mr Suryakant Palande attended the meeting. The committee discussed the agenda at length and approved accordingly.
- The newly constituted Research Commitee of NRCOG headed by Dr. V.S. Seshadri, Member, RAC was held on 28 Feb. 2005 to finalise the revision of 'Vision 2020' of this centre. Other members Dr S Shinde, Dr. N Ahmed, Sh. CB Holkar and Sh. S Palande attended the meeting.

Personnel

Awards

Dr. V Sankar, Scientist (Hort.) was awarded Ph.D degree from Tamil Nadu Agricultural University on 18.11.2004. His thesis was on "Studies on organic practices and post harvest technology in onion for the production of export quality bulbs."

Promotions

Dr. Anil Khar, Scientist (Horticulture) was promoted from Scientist to Scientist Senior Scale *w.e.f.,* 31.10.2002.

Dr. PS Srinivas, Scientist (Entomology) was promoted from Scientist to Scientist Senior Scale *w.e.f.,* 30.11.2002.

Dr. Asha Devi A, Scientist (Genetics) was promoted from Scientist to Scientist Senior Scale *w.e.f.,* 19.12.2003.

Transfer

Sh. SV Kasabe, AF &AO, was transferred from this centre to CIFE, Mumbai on 8.04.2004

Staff position

S.No.	Category	Sanctioned Post	Filled	Vacant
1	RMP	01	01	00
2	Scientific	10	08	02
3	Technical	08	08	00
4	Administrative	09	08	01
5	Supporting	07	07	00
	Total	35	32	03

List of Staff

Name	Designation
Dr. KE Lawande	Director
Dr. VSR Krishna Prasad	Principal Scientist (Horticulture)
Dr. PC Tripathi	Senior Scientist (Horticulture)
Dr. V Mahajan	Senior Scientist (Horticulture)
Dr. AA Qureshi	Scientist Sr. Scale (Soil Science)
Dr. A Asha Devi	Scientist Sr. Scale (Genetics)
Dr. Anil Khar	Scientist Sr. Scale (Horticulture)
Dr. PS Srinivas	Scientist Sr. Scale (Entomology)
Dr. V Sankar	Scientist (Horticulture)
Mr. N Gopal	Assistant Administrative Officer
Mrs. SS Joshi	Assistant
Mr. VV Patil	Technical Officer (T-5)
Mr. DB Mundharikar	PA to Director
Mr. NL Gore	Technical Assistant T-4 (Field/Farm)
Mr. AP Trivedi	Technical Assistant T-4 (Field/Farm)
Mr. HSC Shaikh	Computer Programmer T-4
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
Mr. DM Panchal	Technical Assistant T-2 (Lab. Tech.)
Mr. RB Baria	Technical Assistant T-2 (Field/Farm)
Mr. BA Dahale	Tractor Driver T-2
Mr. SP Yeole	Jeep Driver T-2
Mr. SK Said	S.S.Gr.III (Beldar)
Mr. PR Sonawane	S.S.Gr.II (Lab Attendant)
Mr. PE Tadge	S.S.Gr.II (Lab Attendant)
Mr. MS Kale	S.S.Gr.II (Messenger)
Mr. RS Kulkarni	S.S.Gr.I (Lab Attendant)
Mr. SD Waghmare	S.S.Gr.I (Watchman)
Mr. NH Shaikh	S.S.Gr.I (Messenger)

Distinguished Guests

Name	Designation	Date
Dr. MH Mehta	Chairman, Gujarat Life Sciences & Ex-Vice Chancellor, GAU, Anand	14 April 2004
Dr. SS Dhumal	Director, Horticulture Training Centre, Talegaon Dabhade, Pune	16 June 2004
Dr. G Kalloo	DDG (Hort. & Crop Sciences), ICAR, New Delhi	25 July 2004 9 November 2004
Dr. SL Mehta	National Director, NATP, New Delhi	31 July 2004
Dr. SN Puri	Vice Chancellor, MPKV, Rahuri	29 October 2004
Hon'ble Shri Sharad Pawar	Union Agriculture Minister, Govt. of India	9 November 2004
Dr. Mangla Rai	DG, ICAR and Secretary, DARE	9 November 2004
Sh. DM Patil	MLA, Khed	9 November 2004
Dr. SN Puri	VC, MPKV, Rahuri	9 November 2004

Total number of farmers visited : 3791

Finances

Financial Statement for the year 2003-2004		
Head of Accounts	**Rupees in Lakhs**	
	Budget Allocation	**Expenditure**
Non-Plan	79.50	64.71
Plan	180.00	164.98
KVK	Nil	Nil
NATP	17.67	14.75
AP Cess Fund Scheme	15.99	0.11
Pension & Retirement Benefits	Nil	Nil
' P' Loans & Advances	8.00	1.90
' R' Deposit Schemes	35.25	11.20
Revolving Fund Scheme	7.00	3.32
Total	343.41	260.98
Revenue receipt	5.94	-

Abbreviations

A. Niketan	Arka Niketan
A. Kalyan	Arka Kalyan
ADR	Agrifound Dark Red
AFW	Agrifound white
AGB	A grade bulbs
AICVIP	All India Co-ordinated Vegetable Improvement Project
AVT	Advanced Varietal Trial
ALR	Agrifound Light Red
BBF	Broad Based Furrow
BGB	B grade bulbs
CGB	C grade bulbs
cm	centimetre
DAP	Days after planting
DAT	Days after transplanting
ED	Equatorial diameter
IET	Initial Evaluation Trial
ETL	Economic Threshold Level
g	Gram
LCR	Leaf Curl Rating
m	Metre
MY	Marketable yield
MB	Marketable bulb
NPK	Nitrogen: Phosphorus: Potassium
NOC	Number of cloves
NOL	Number of leaves
NT	Neck thickness
P. Safed	Phule Safed
PD	Polar diameter
PH	Plant height
PLW	Physiological loss in weight
RDF	Recommended dose of fertilizer
SI	Shape index
t/ha	Tonnes per hectare
TSS	Total soluble solids
TY	Total yield
Wt50C	Weight of 50 cloves
5BW	Weight of five bulbs

Annexure-1

Meteorological data for the year 2004-05 at NRC for Onion and Garlic, Rajgurunagar						
Month	Temperature (in ^{0}C)		RH (in %)		Total Rain Fall (in mm)	Average sunshine per day (in hrs)
	max.	min.	max.	min.		
January	29.2	10.3	84	32	0.00	9.00
February	32.1	11.0	77	23	0.00	9.47
March	32.7	14.1	70	16	0.00	9.20
April	38.9	18.3	75	29	0.00	9.42
May	35.9	22.4	79	38	0.00	6.52
June	31.9	23.4	74	61	191.0	4.11
July	28.6	21.5	83	68	031.5	3.02
August	27.2	20.6	89	81	310.0	2.03
September	29.9	14.4	87	64	092.0	6.09
October	30.8	16.5	78	48	0.00	2.28
November	31.1	18.0	75	39	012.0	7.17
December	29.0	10.3	82	31	0.00	9.00

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