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ANNUAL REPORT
2011-12

Directorate of Onion and Garlic Research
(Indian Council of Agricultural Research)
Rajgurunagar, Pune – 410 505, Maharashtra, India

DOGR

MISSON

Harness the national resources to increase the production of onion and garlic and identify the strategies for sustainable and eco-friendly practices to enhance profitability and welfare of the farming community.

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

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Contents

Executive Summary

During the year under report the ongoing R&D programmes have contributed significantly in product and technology development and dissemination. Three onion varieties viz. Bhima Shakti, Bhima Shweta and Bhima Shubhra and a garlic variety viz. Bhima Purple were recommended for release at national level. Continuing the breeding programme to develop table red onion varieties, germplasm explorations were undertaken in Karnataka and Tamil Nadu and 112 new red onion germplasm were collected, which includes 42 multiplier onion and 9 rose types. Breeding material was evaluated in different stages. The elite lines EL-1043 (DR), EL-1044, EL-592 and EL-1172 were found superior during late *kharif* and EL-1172 was found superior in *rabi* over check Bhima Kiran. The massing lines DOGR-1203-DR and DOGR-1203-LR were early and took only 92 days to harvest. Among the advanced lines, during *rabi*, lines N-2-4-1-DR (36.72 t/ha), NRCOG-1168 (31.00 t/ha), R-Rb-M-IV (30.33 t/ha) and Red Genepool-2 (30.00 t/ha) were found superior over check Bhima Kiran (27.94 t/ha). Four F_1 hybrids recorded significantly higher heterosis for marketable yield over check Bhima Super during late *kharif* and six hybrids showed more than 24% heterosis for marketable yield during *rabi*. Three F_1 hybrids performed better during *kharif* and showed more than 20% heterosis in marketable yield over the best check Arka Lalima. DOGR-1203, EL-671, Red Elite Composite, EL-595, MS 48A, Red Genepool, EL-531, Bhima Raj, Bhima Kiran, EL-1044 and EL-1064 showed field resistance to thrips.

In white onion breeding programme, under germplasm evaluation, genotype W-078 (40.85 t/ha) was found significantly superior over check Bhima Shweta (36.92 t/ha) for marketable yield during *rabi*. Among the varieties screened, Bhima Shweta and Bhima Shubra were found suitable for organic cultivation. Among the advanced lines, marketable yield was found to be higher in W-407AD (40.26 t/ha) compared to check Bhima Shweta (34.96 t/ha). The high TSS lines have been developed for processing and are being purified. Among the F_1 crosses made, one performed better with 44 t/ha marketable yield and standard heterosis of 28.14% over Phule Safed. Only two lines viz. W-514 and W-441 showed resistance against thrips during *rabi*.

Garlic germplasm was evaluated under field condition and diversity was observed for traits like polar diameter, equatorial diameter, clove polar diameter, clove equatorial diameter, weight of 10 cloves, average bulb weight and net marketable yield. Garlic germplasm was analysed for diversity using molecular markers like RAPD, ISSR and SSR. For the production of inbreds through haploid induction, gynogenesis was achieved using immature flower buds. Four male sterile lines were established in tissue culture and multiplication was evaluated through flower bud and basal plate explants. In an effort to introgress disease resistance from wild species, hybridization of cultivated *Alliums cepa* with *A. tuberosum* has been initiated.

Under the programme for development of plant protection technologies, different insect pathogens in combination with neem oil were evaluated. *Metarrhizium anisopliae* 1X107 +

sunflower oil recorded the highest efficacy of 28.27% followed by *M. anisopliae* + neem oil with 26.46% efficacy. The rearing of *Thrips tabaci* under laboratory conditions were standardised for vector (*Thrips tabaci)* – virus (IYSV) relations studies. Further, about 48 lines of red onion were evaluated for thrips incidence under field conditions, 11 lines showed field resistance with 1-2 scales. The highest thrips population was recorded in 1st December planting (61.55 thrips/plant) followed by 15th November planting (52.75 thrips/plant).

The combination of thiram seed treatment with nursery beds treated with basamid, metam sodium and spray of Fluopyram+ tebuconazole and raised bed plating gave protection to the tune of 65% for fungal pathogens. An alternate cropping experiment on fixed sick plot design for pink root disease on non hosts was initiated at Rajgurunagar during *kharif* 2009. The effect of planting dates on seasonal variation in foliar diseases viz. Stemphylium blight, Purple blotch and Anthracnose were studied by planting onion at 15 days intervals and the highest incidence of disease was observed in 1st September planted crop while the highest yield was recorded in 15th November planted crop under unprotected condition. The Double Antibody Sandwich Enzyme Linked Immunosorbent Assay (DAS-ELISA) based protocol for the detection of SLV and GCLV has been standardized.

Among crop production trials, the nutrient uptake pattern of onion bulb crop revealed that the dry matter accumulation in onion leaves increased at faster rate up to 60 days from the date of planting and declined thereafter. However, the dry matter accumulation in bulbs increased after 60 days till harvest *i.e.* during bulb development and enlargement stage. Further, the nutrient uptake rate reached the peak at 60 days after planting. The results indicated that P, S, Zn and Mn requirement was critical during bulb development and enlargement stages.

In the studies on organic production of onion and garlic it was observed that the Farmyard manure (FYM) package recorded relatively higher yield than other organic manures in both the crops. It was noticed that soil bacteria, fungal and actinomycetes population were higher in soil nourished with organic manures and other organic inputs as compared to inorganic fertilizers applied plot. Among the various organic growth stimulants applied under organic production system, based on the three years results, it was concluded that foliar application of *panchagavya* (5%) at 30, 45 and 60 days after planting improved the marketable bulb yield in onion and garlic. Among the various weedicides evaluated, application of Oxyflurofen 23.5% EC @1.5ml/L before planting and one hand weeding at 55 days after transplanting recorded higher marketable bulb yield of 36.1 t/ha coupled with good weed control efficiency (73.6 %) and B:C ratio (2.54). The onion seed drill developed locally and tested at DOGR revealed that indigenous manually operated seed drills do not help in labour saving and also precision particularly depth of sowing and spacing are not satisfactory. The transplanting method of onion production recorded the highest marketable yield followed by direct seeding by pneumatic seed drill.

To enhance the storage life of onion the sprays of CIPC, ABA and Ca $(NO_3)_2$ were undertaken. The CIPC residues ranged from as low as 0.08 mg/kg fresh weight to the highest concentration of 1.84 mg/kg fresh weight in these samples, which were below permitted MRL. The sprouting was observed only after two months of storage in all the varieties tested. However, the preharvest spraying of CIPC 75 DAP in *kharif* season was found to reduce sprouting under storage. The phyto-toxicity / forced ripening symptoms were also evident. The genotypic variations were significant. The Pyruvic acid contents increased during the storage. However, the total sugars and ascorbic acid decreased during storage.

The postharvest practices to enhance storage life of onion showed that the gamma irradiation restricted sprouting absolutely in storage. The cold storage at 5°C with 60-65% RH was found to reduce physiological weight loss significantly; however, irradiation of onions was found imperative. A survey conducted to examine the working and efficacy of cold storages substantiated that the onions may be stored in ventilated cold storages without irradiation. The working cost of cold storage was found to be Rs 0.40 /kg/month at Rajkot, Gujarat.

The invigoration via hydration of seeds for 24 hours at 15°C significantly enhanced the germination (11%) over control. The vigour index was also high in case of hydration treatment. While studying the longevity of onion seeds, the germination percentage varied from 89% in Bhima Shakti to 54 % in Co-5 after 10 months of storage. The highest loss in seed germination after ten months of storage was recorded in cv. Agrifound Dark Red (24%). The reproductive traits like number of scapes per plant and scape length were found significantly higher in crop raised from vernalized bulbs (5°C for 40 days) in variety Bhima Kiran.

The constraint analysis of onion and garlic production and post harvest management was carried out using a questionnaire for 150 randomly selected farmers from Pune, Ahmednagar; and Nashik districts of Maharashtra. Major constraints according to farmers are crop damage due to erratic rainfall at the time of harvesting of *kharif* onion and nursery preparation of *rabi* onion (71.33% respondents), labour shortage at the time of transplanting (67.33% respondents), spurious seed supply from seed companies (64.66% respondents), lack of farmers' scientific knowhow about field operations (61.33% 150 respondents) and farmers inability to maintain isolation distance during seed production (51.33% respondents). The ITKs were collected from different states which were comprised of ITK in seed treatment, nursery management, crop production, plant protection measures and storage. The impact analysis of technologies developed by DOGR revealed that the adoption of technologies was the highest in Pune (77.10%), followed by Ahmednagar (71.56%) and Nashik (68.21%). DOGR varieties, package of practices, Broad Based Furrow with micro irrigation and modified storage structures were adopted by 80.66%, 68.66%, 58.66% and 46% farmers, respectively. Findings indicated a significant association between the level of adoption among the farmers and level of overall change in socio-economic aspects.

Many other extension and co-curricular activities were also organized during the year. DOGR participated in Agricultural exhibition 'Kisan 2011'on December 14 – 18, 2011 at Moshi, Pune organized by Kisan Forum Pvt Ltd, Pune. DOGR also participated in and 2nd Horticulture-Industry Meet at IIHR, Bangalore during March 6-7, 2012. The technologies developed at DOGR invoked great response from farmers and large number of technical and extension publications were sold out. A farmers training entitled 'Sustainable onion and garlic cultivation' was organized at the Directorate under ATMA scheme. The Agriculture Education Day was celebrated at Directorate on February 18, 2012 wherein, students of different schools actively participated in various competitions. The Sports team of DOGR participated in different events at Zonal ICAR Sports meet held at CAZRI, Jodhpur during 13 – 17, 2012.

The QRT meeting was held during 23-27 February, 2012. QRT committee made exhaustive review of infrastructural facilities created viz. farm development, laboratories and research programmes implemented during the period 2006-2011 and their output. The team observed that DOGR has made significant contribution during the period of review not only in research achievements and technology development in onion and garlic but also in research farms development and equipping the laboratories.

Introduction

The Directorate

Realizing the importance of onion and garlic in the country, Indian Council of Agricultural Research (ICAR) established National Research Centre for Onion and Garlic in VIII Plan at Nasik in 1994. Later, the Centre was shifted to Rajgurunagar on 16th June 1998. Due to expansion of R& D activities of onion and garlic, the centre was rechristened and upgraded to Directorate of Onion and Garlic Research (DOGR) in December 2008. Besides the R&D at main Institute, DOGR also has All India Network Project on Onion & Garlic with 12 participating centres and 16 voluntary centres across the country.

Location and weather

The Directorate is located at 18.32 °N and 73.51 °E at 553.8 m above m.s.l. with a temperature range of 5.5 °C to 42.0 °C and having annual average rainfall of 669 mm. The Head Quarter of Directorate is located at Rajgurunagar, which is about 45 km from Pune, Maharashtra on Pune –Nashik Highway.

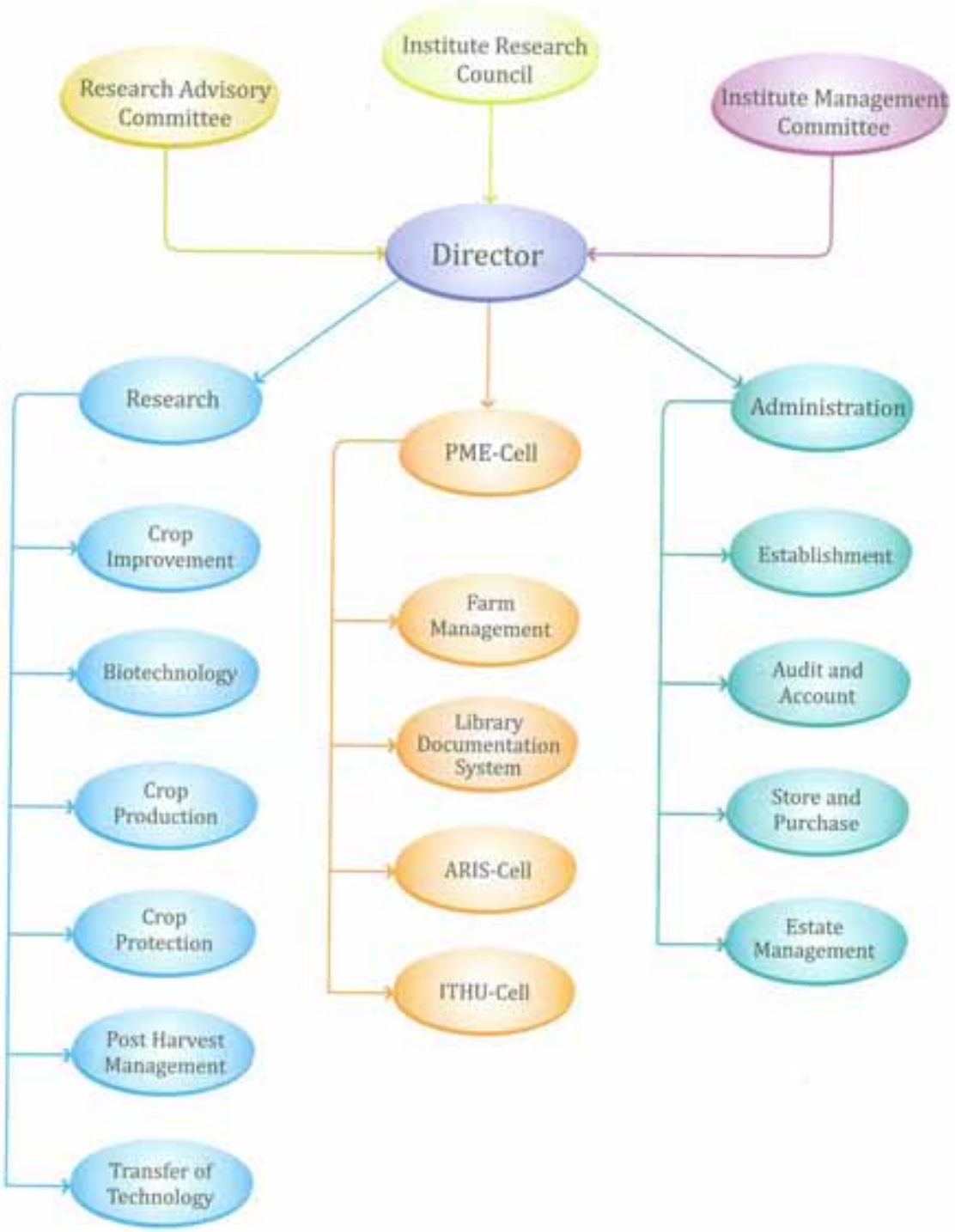
Infrastructure

The centre has 55 acres of research farm with perennial irrigation facilities at Rajgurunagar, 55 acres at Kalus and 10 acres at Manjari. The centre has research laboratories for biotechnology, soil science, plant protection, seed technology and post harvest technology with modern state of the art equipments. The Library at the centre has extensive collection of books, journals, e-sources on *Alliums*. The internet and e-mail connectivity has been strengthened for easy literature access. A website of centre (http://dogr.res.in) has been launched for rapid update and display of information.

Mandate

- To act as a repository of genetic resources and scientific information of onion and garlic
- To undertake basic and applied research for enhancing production and productivity of onion and garlic
- To undertake strategic research for technology development and production of quality seed of onion and garlic
- To promote utilisation and development of value added products through processing and post harvest management practices
- To disseminate technology, provide advisory and consultancy services and promote entrepreneurship
- To develop linkages with national, international and private organisations in network mode for collaborative research programmes

Organogram


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

Research Achievements

Crop Improvement and Biotechnology

Programme 1: Development of red and light red onion varieties/ hybrids suitable for different seasons having resistance to biotic and abiotic stresses

Project 1.1: Collection, evaluation and maintenance of red onion germplasm

Exploration for collection of red onion germplasm

Extensive surveys were carried out for collection of red onion germplasm from parts of Tamil Nadu (Tiruppur, Cuddalore, Namakkal, Erode, Coimbatore, Dindigul and Perambalur) and Karnataka (Chickballapur, Chickmangalur, Chitradurga, Bagalkot, Belgaum, Bijapur, Davanagere, Dharwad, Gadag and Haveri) in collaboration with NBPGR RS Hyderabad, UAS Dharwad and TNAU Coimbatore during August 22-27, 2011 and October 11-19, 2011, respectively. One hundred and twelve new red onion germplasm were collected which includes 42 multiplier onion and 9 rose types. Variability was observed in bulb colour, bulb size, bulb shape and number of bulblets. Ninety-six onion germplasm were obtained from USA through NBPGR in September 2011.

Evaluation of red onion germplasm

Germplasm was evaluated during late *kharif* (47 accessions), *rabi* (32 accessions) and *kharif* (38 accessions) along with checks. During late *kharif*, four accessions were recorded as bolting-free. Accession 926 (44.89 t/ha) yielded higher than check Bhima Shakti (39.66 t/ha). More than 12% TSS was recorded in accessions 619, 645, 739, 974 and 1044. Bulb centerness ranged from 1.20/bulb to 2.07/bulb and average marketable bulb weight ranged from 54.4 (accession 1049) to 102.7 g. (accession 545). Minimum days to harvesting were recorded in accessions 48, 450, 460, 636, 746, 1055 and 1061 (126 to 128 days).

During *rabi*, two accessions were found free from doubles and twenty accessions were free from bolters. Accessions 1370, 1220 and 1395 yielded more than 40.0 t/ha which was higher than check Bhima Kiran (36.67 t/ha). Bulb centerness ranged from 1.40 (accessions 1258 & 1370) to 1.87 (accession 1360).

During *kharif*, four accessions were found free from doubles. Four accessions *viz*; 1390 (25.40 t/ha), 1353 (24.72 t/ha), 1351 (24.26 t/ha) and 1369 (22.04 t/ha) showed more than 40% yield over check Bhima Super (15.71 t/ha). More than 13% TSS was recorded in accessions 1397, 1400 and 1402. Bulb centerness ranged from 1.20 to 1.93.

Bulbs storage performance was evaluated for 35 germplasm accessions from *rabi* season. Four accessions *viz*., 1370, 1395, Bhima Kiran and N-2-4-1 showed less than 20% weight loss and accessions 1252, 1258, 1417 and Agrifound Light Red recorded 20-30% weight loss after three months of storage.

Project 1.2: Development of onion varieties suitable for different seasons for year round availability

Evaluation of red onion elite lines

New elite lines were evaluated during late *kharif* (12 lines), *rabi* (6 lines) and *kharif* (7 lines) along with checks. During late *kharif*, EL-1048 (54.02 t/ha), EL-1047 (46.32 t/ha) and EL-1067 (43.90 t/ha) were found superior over check Bhima Super (33.50 t/ha). Bulb centerness ranged from 1.20 to 1.47 and average marketable bulb weight ranged from 80.0 to 110.7 g. In case of old elite lines, EL-1043 (DR), EL-1044, EL-592 and EL-1172 were found superior over check Bhima Super.

During *rabi*, EL-720 (41.71 t/ha) was found superior over check Bhima Kiran (37.09 t/ha). Bulb centerness ranged from 1.13 to 1.53 and average marketable bulb weight ranged from 60.7 to 67.8 g. In case of old elite lines, EL-1172 was found superior over check Bhima Kiran.

During *kharif*, none of the lines was found superior than check. Maximum average marketable bulb weight was recorded in C4-KM-4 (66.0 g) followed by EL-1043 (63.4 g) and C4-KM-1 (63.0 g).

Evaluation of red onion massing/ breeding lines

Nineteen massing/ breeding lines were evaluated during late *kharif* and 20 massing/ breeding lines during *rabi* along with checks. During late *kharif*, EL-1043-DR (52.22 t/ha), EL-1044 (46.72 t/ha), R-LK-M-IV (42.78 t/ha) and EL-1043-LR (38.52 t/ha) were found superior over check Bhima Super (36.33 t/ha). Centerness ranged from 1.07 to 1.67. Maximum average marketable bulb weight was recorded in EL-1043-LR (118.8 g) followed by EL-1043-DR (111.6 g), LK-07-C2 (LR-3) (99.4 g) and LK-07-C2 (DR-1) (97.9 g). During *rabi*, lines 1043-DR (33.15 t/ha) and 1014 (32.14 t/ha) were found superior over check Bhima Kiran (30.83 t/ha). Minimum days to harvesting were recorded in lines DOGR-1203-DR and DOGR-1203-LR (92 days) followed by LK-07-C2 (DR-1), LK-07-C2 (DR-4), R-Rb-M-I and R-Rb-M-IV (106 days).

Evaluation of red onion advanced lines and varieties

Five advanced lines were evaluated in demonstration trial during late *kharif*, 16 during *rabi* and 9 during *kharif* along with released varieties. During late *kharif*, none of the lines were found superior over the best check Bhima Shakti (37.58 t/ha). NRCOG-1168 (37.25 t/ha) and NRCOG-1133 (33.72 t/ha) were superior for A grade bulbs weight, % bolters and average bulb weight over check.

During *rabi*, lines N-2-4-1-DR (36.72 t/ha), NRCOG-1168 (31.00 t/ha), R-Rb-M-IV (30.33 t/ha) and Red Genepool-2 (30.00 t/ha) were found

Fig.1.1: Early and uniform neck fall in DOGR-1203-DR

superior over check Bhima Kiran (27.94 t/ha). Minimum days to maturity was recorded in DOGR-1203 (92 days, Fig.1.1) followed by RGO-53 (105 days) and Bhima Kiran (111 days). Whereas three lines *viz*:, RGO-53, R-Kh-M-II and R-Kh-M-IV were as promising for yield and quality during *kharif* season.

Screening of onion genotypes for sets production and raising of early *kharif* crop through sets

Eighteen genotypes were screened for sets production during mid January to mid May 2011 in 1.0 sq. m plot with 3 replications. Genotypes varied in quality and quantity of set production. Maximum number of onion sets were recorded in Bhima Super (604/m^2) followed by Agrifound White (588/m^2), RGO-53 (563/m^2), DOGR-1203 (548/m^2), Bhima Shweta (533/m^2) and Bhima Raj (531/m^2). These sets were categorized in four groups on the basis of size of sets and utilized for production of commercial bulbs during *kharif*. Little variation was observed among four sets groups in respect of yield. On the basis of mean of commercial bulbs produced through all the sets groups, the highest marketable yield was recorded in RGO-53 (15.78 t/ha) followed by Phule Samarth (15.12 t/ha), R-KH-M-I (13.15 t/ha), Arka Kalyan (12.47 t/ha), Bhima Shweta (12.45 t/ha) and Bhima Super (11.81 t/ha). These varieties had higher marketable yield crop raised from sets in comparison to transplanted crop.

On the basis of two year data, maximum number of sets were recorded in DOGR-1203 (554.8/sq m) followed by Bhima Super (530.2/sq m), Bhima Raj (475.3/sq m) and RGO-53 (462.1/sq m). Maximum commercial bulb yield was recorded in R-KH-M-I (22.09 t/ha) followed by RGO-53 (20.16 t/ha), Bhima Super (20.13 t/ha) and Bhima Shweta (20.10) through sets whereas bulb yield of these lines through transplanted crop were 19.15, 18.12, 19.49 and 15.07 t/ha, respectively. Through sets technology, crop matures about one month earlier

Fig. 1.2: Commercial bulbs and sets of RGO-53

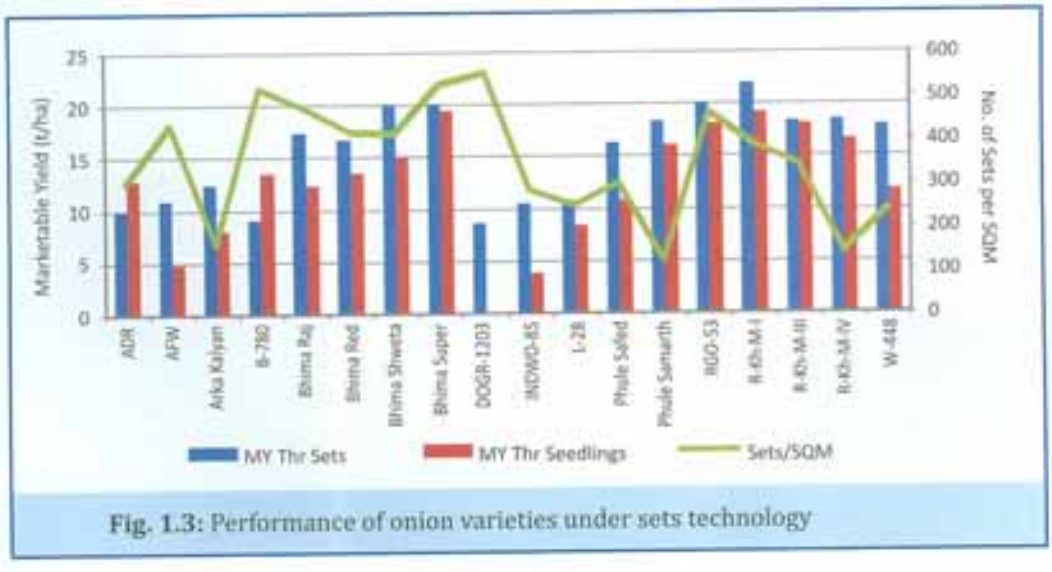


Fig. 1.3: Performance of onion varieties under sets technology

than transplanted crop. Bhima Super and RGO-53 (Fig 1.2, 1.3) performed better in production of sets as well as commercial bulb crop raised from sets.

Assessment of onion varieties and advance lines for bolting

Twelve varieties/ advance lines of onion were screened for bolting tolerance during late *kharif* at four dates of planting (Table1.1). Minimum bolting was recorded in Bhima Kiran (4.35%, Fig1.4) followed by NRCOG-595 (4.50%), NRCOG-1168 (5.55%), NRCOG-1133 (6.58%) and Bhima Shakti (7.80%) and these genotypes produced more than 35.0 t/ha marketable yield.

Table 1.1: Screening of onion varieties/ advance line for bolting tolerance during late *kharif*

S. No.	Entries	% Bolters on different transplanting dates					Marketable yield (t/ha)				
		I*	II*	III*	IV*	Mean	I*	II*	III*	IV*	Mean
1	Bhima Kiran	2.44	6.14	4.28	4.55	**4.35**	15.67	43.44	37.85	48.37	**36.33**
2	Bhima Raj	9.09	12.77	9.79	13.29	**11.24**	24.78	37.33	32.50	40.47	**33.77**
3	Bhima Red	23.96	22.58	11.10	21.22	**19.72**	22.11	30.11	30.27	31.46	**28.49**
4	Bhima Shakti	3.11	4.57	9.57	13.95	**7.80**	21.83	42.33	34.31	38.07	**34.14**
5	Bhima Super	16.54	23.44	12.76	15.53	**17.06**	23.50	32.22	38.58	38.01	**33.08**
6	Bhima Shweta	21.16	27.77	25.13	29.51	**25.89**	16.22	22.11	29.94	25.37	**23.41**
7	N-2-4-1	2.48	6.97	26.71	13.28	**12.36**	17.89	42.67	32.20	31.75	**31.13**
8	NRCOG-1133	3.83	8.41	5.65	8.43	**6.58**	20.00	44.11	51.25	42.39	**39.44**
9	NRCOG-1168	2.00	3.47	6.35	10.37	**5.55**	26.39	47.44	46.21	46.00	**41.51**
10	NRCOG-595	3.07	4.39	3.46	7.08	**4.50**	21.89	44.11	42.57	44.73	**38.32**
11	RGO-53	16.92	23.93	16.30	21.95	**19.78**	22.33	30.22	28.84	33.78	**28.79**
12	W-448	19.45	22.25	20.05	25.85	**21.90**	18.39	35.78	23.93	40.39	**29.62**

*I date =16th Sep 2010; II date =1st Oct 2010; III date =16th Oct 2010; and IV date =1st Nov 2010

Fig. 1.4: Tolerance to Bolting in Bhima Kiran as compared to RGO-53 during late *kharif*

Screening of onion varieties and advance lines for organic farming

Thirty-six varieties/ advance lines of onion were screened during late *kharif* for performance under organic farming at Kalus Farm of DOGR. Percentage of A grade bulbs ranged from 16.32 to 67.54% doubles from 1.39 to 34.29%, bolters from 0.80 to 47.82% and marketable bulbs from 25.49 to 95.63%. Marketable yield and total yield ranged from 7.78 to 47.44 t/ha and 11.26 to 50.11 t/ha, respectively. Six genotypes *viz:*, EL-1047, EL-1048, NRCOG-1168, Bhima Red, EL-1044 and RGO-53 performed better under organic conditions and produced more than 40.0 t/ha marketable yield during late *kharif*. More than 100g average bulb weight was recorded in EL-1044, EL-1172, EL-546, EL-592 and RGO-53. In storage studies, 4 genotypes *viz.*, EL-1043, EL-670, EL-1048 and N-2-4-1 showed less than 40% total weight loss after four months of storage.

Project 1.3: Heterosis breeding in red onion

Evaluation of red onion F_1 hybrids developed through male sterile lines

Twenty-two F_1 hybrids along with their parents and check Bhima Super were evaluated during late *kharif* season. Four F_1 hybrids recorded 21 to 50% heterosis for marketable yield over check (25.56 t/ha).

During *rabi*, 55 F_1 hybrids were evaluated along with its parental lines and check Bhima Kiran. Standard heterosis was recorded up to 44.0% (MS-111A x 592) in marketable yield. Six F_1 hybrids showed more than 24% heterosis in marketable yield over check (30.68 t/ha). On the basis of two year data, four F_1 hybrids with 21 to 34% heterosis for marketable yield over standard check (32.6 t/ha) were identified.

During *kharif*, 53 F_1 hybrids along with their parents and check Arka Lalima were evaluated. Standard heterosis up to 26.8% was recorded in case of the hybrids for marketable yield. Three F_1 hybrids *viz.* MS-1600A x 1133, MS-111A x RGO-53 and MS-1600A x Bhima Raj performed better during *kharif* and showed more than 20% heterosis in marketable yield over best check Arka Lalima (25.40 t/ha). Days to harvesting in some hybrids were also as low as 107 days.

Further, Sixty F_1 hybrids of red onion were developed by crossing 6 MS lines with selected 12 elite lines as pollinators viz. Bhima Raj, Bhima Super, Bhima Red, RGO-53, NRCOG-1133, NRCOG-592, NRCOG-1168, Bhima Kiran, Bhima Shakti, NRCOG-595, DOGR-1203 and N-2-4-1. Evaluation of these hybrids during *rabi* 2011-12 is in progress.

Evaluation of red exotic onion hybrids

Evaluated 8 red onion exotic hybrids during late *kharif*, *rabi* and *kharif* along with checks. During late *kharif*, none of exotic hybrids was superior to check Bhima Super in marketable yield. During *rabi*, hybrid Matahari was free of doubles and bolters and produced more than 90% marketable yield. BSS-441 (40.0 t/ha) was superior over check Bhima Kiran (37.78 t/ha). Whereas during *kharif*, hybrids Indum-44 (24.56 t/ha) and Red Passion (19.16 t/ha) were superior to check Arka Lalima (16.91 t/ha) in marketable yield. Minimum centerness was recorded in Lucifer (1.07) followed by Flare (1.20) and BSS-827 (1.27).

Maintenance of MS lines and development of inbreds

Purification and multiplication of MS 48A and MS 65A was continued with the selected bulbs. Sixteen combinations were used for backcrossing to transfer male sterility in different varietal background. Development of 48 new inbred lines (I_1) from single bulb of selected lines and advancement of 10 inbred lines (I_2) is in progress. Advancement of selected bulbs of F_2 hybrids is also in progress.

Introgression Breeding

Thirty hybrid combinations developed between exotic and Indian lines are being advanced at CITH, Srinagar. Evaluation of 18 new combinations by crossing of selected elite lines with DOGR-1203-DR is in progress.

Project 1.4: Breeding red onion varieties resistant to biotic and abiotic stresses

Evaluation of red onion lines to thrips

During *rabi* season 48 onion accessions/ lines were evaluated for their reaction to thrips under field conditions. Based on the damage due to thrips feeding, injury rating and curling accession were rated on 1-5 scale. Eleven lines *viz.*, DOGR-1203, EL-671, Red Elite Composite, EL-595, MS 48A, Red Genepool, EL-531, Bhima Raj, Bhima Kiran, EL-1044 and EL-1064 showed field resistance. Thirty-one lines were moderately resistant to thrips and 6 lines were susceptible. However, for confirmation these lines will be evaluated for one more season.

Evaluation of red onion lines to diseases

Lines EL-592, Indem-44, NRCOG-1168, Bhima Shakti and Bhima Super were found moderately resistant against purple blotch and *Stemphylium* blight during *rabi* season. During *kharif*, lowest PDI of *Stemphylium* blight was recorded in Bhima Super (10.2%) followed by Bhima Red (10.3%), Agrifound Dark Red (10.5%) and Bhima Raj (11.3%). Less than 16% PDI of Anthracnose was recorded in B-780-5-3-1, Red Genepool-2, R-Kh-M-I and R-Kh-M-II.

Programme: 2. Development of onion (white and yellow) varieties/hybrids for processing, export and resistant to biotic and abiotic stresses

Project 2.1: Collection evaluation and maintenance of white onion germplasm

Evaluation of white onion germplasm

Nine germplasm accessions along with check Bhima Shubra were evaluated for different traits during late *kharif*. W-222 recorded the highest (63.18%) of 'A' grade bulbs (AGB) followed by W-184 (43.88%) and were significantly superior to check (40.38%). Accessions W-340 recorded least percent of doubles (14.01%) followed by W-222 (14.28%) and W-210 (14.29%). Accessions W-222 and W-440 were completely free of bolters compared to 21.5% bolters in variety Bhima Shubra. Check Bhima Shubhra gave the highest yield (28.57 t/ha), which was at par with W-222 and W-210 giving 28.33 and 27.77 t/ha yield respectively. TSS was higher in accessions W-029 (12.97%) and W-507 (12.88%) compared to check (12%).

During *rabi* season, forty one white germplasm entries with two checks were evaluated. Marketable yield ranged from 6.54 t/ha to 40.85 t/ha. Accession W-078 (40.85 t/ha) was significantly superior to check Bhima Shweta (36.92 t/ha) for marketable yield. Total soluble solids ranged from 10.68% to

14.38% and five lines were superior to check (12.29%). W-055 had the highest TSS of 14.38%. Twenty three accessions were earlier in maturity (108-112 DAT) compared to check (118 DAT). Six accessions were completely free of doubles. Twenty five accessions had no bolters.

During *Kharif* season, fifteen lines (including two massing, eight advance, two elite and three germplasm lines) were evaluated. Marketable yield ranged between 00.52 to 8.77 t/ha. Nine lines recorded zero percent doubles. No bolters were observed in all lines. TSS ranged between 11.04 to 13.70%. W-510 had maximum TSS (13.70%). Entry W-526 was found to be earlier in maturity (101 DAT) in comparison to check (113DAT)

Performance of white onion lines under organic cultivation

Seven varieties were evaluated during late *kharif* season for organic cultivation. Bhima Shubra recorded the highest percent 'A' grade bulb (51.64%) and Agrifound White recorded the lowest (3.57%). Minimum double bulbs were in Bhima Shweta (4%) followed by Bhima Shubra (4.8%) and the highest were in Agrifound White (39.51%). Marketable yield was low (3.92 to 30.19 t/ha) in organic as compared to inorganic cultivation (5.71 to 50.16 t/ha). Bhima Shweta and Bhima Shubra (30.19 and 29.17 t/ha, respectively) performed better than other varieties. Total soluble solids ranged between 10.85 to 12.28%. Under inorganic condition, Bhima Shubra recorded the highest marketable yield (50.16 t/ha).

Eight lines produced organically were stored for four months for evaluation of storage behaviour. Total losses in weight ranged from 48.85 to 78.27%. Bhima Shweta recorded the minimum (48.85%) total weight loss followed by Bhima Shubra (56.27%). Pusa White Round recorded the maximum 78.27% loss in weight. Under inorganic cultivation, Agrifound White recorded the minimum (64.06%) total weight loss while W-448 BR-4 recorded the maximum (90.33%). Bhima Shubra recorded 67.50% total weight loss.

Evaluation of white onion *rabi* germplasm for storage

Forty one germplasm lines were evaluated in storage. Two lines, W-256 and W-462 had less than 50% weight loss after 5 months of storage. Five lines showed 50-60% weight loss.

Evaluation of white onion late *kharif* germplasm for storage

Harvested bulbs of nine genotypes produced during late *Kharif* were stored for 120 days in ventilated storage structure. Total weight loss ranged from 39.13 to 63.27%. Accessions W-222, W-340 and W-029 recorded less than 40% weight loss.

Project 2.2: Development of high TSS white onion varieties suitable for different seasons and processing

White Advanced lines

Twenty seven advanced lines were evaluated during *rabi* season. Marketable yield ranged from 16.97 to 40.26 t/ha. Marketable yield was higher in W-407AD (40.26 t/ha) compared to check Bhima Shweta (34.96 t/ha). Five lines had no doubles. Twenty lines were completely free of bolters. TSS ranged from 10.94% in W-411AD to 14.52% (W-306AD) and four lines were better than check Bhima Shweta (12.74%). Highest percent AGB was observed in line W-407 AD (70.21%). W-418AD was found to be earlier maturing (111 DAT) compared to check Bhima Shweta (119 DAT).

White high TSS lines

During *rabi* season, thirty two lines along with two checks were evaluated for yield and TSS. Three entries had no doubles. Nineteen entries including check Bhima Shweta had no bolters. Marketable yield ranged between 6.67 to 27.95 t/ha. Five lines (range 22.18-27.95 t/ha) were at par with check (28.46 t/ha) for marketable yield. TSS value ranged from 13.48 to 20.13%. Thirty one entries were superior over check Bhima Shweta (12.35%) for TSS. None of the white varieties developed in India recorded TSS more than 15% under evaluation. In a high TSS line in 5th generation progenies of WHT-5A-2/self-2 and WHT-5C-3/self-2 had 100% bulbs with mean TSS 20.13 and 17.11%, respectively.

White elite breeding lines

Twenty five elite lines were evaluated during *rabi* season along with two checks. Marketable yield ranged from 3.33 t/ha to 43.19 t/ha. Genotypes W-401/EL-3 and W-077/EL-3 recorded higher marketable yield of 43.19 and 38.85 t/ha over check Bhima Shweta (34.96 t/ha). Line W-077/EL-3 recorded the highest 'A' grade bulbs (59.43%) compared to be check Bhima Shweta (35.50%). Two lines had no double bulbs. Seventeen lines were found to have no bolters.

Fourteen massing lines were also evaluated. 'A' grade bulbs in massing lines ranged from 5 to 71.57% with 0 to 17.86% double bulbs and no bolters in all the lines except in W-127/M4 (4.76%). Marketable yield varied from 25.48 to 43.06 t/ha against 33.49 t/ha in check Bhima Shweta. Two lines viz., W-401/EL-3 and W-077/EL-3 had significantly higher marketable yield (43.19 and 38.85t/ha) than check.

Rabi onion white advance, elite and high TSS lines for storage

Out of 27 advanced lines, four lines (53 to 57.8%) showed less than 60% weight loss after 5 months of storage. Among 24 white elite lines, four lines viz., W-047/EL-3, W-422/EL-3, W-063/EL-3 and W-174/EL-3 showed less than 50% weight loss. Line W-047/EL-3 had the least (28.17%) weight loss after four months of storage. Among 14 massing lines entry W-340/M-2 recorded the least (53.07%) total weight loss. In thirty two high TSS lines, total weight loss ranged between 47.0 to 89.13%.

Project 2.3: Collection, evaluation and maintenance of yellow onion germplasm

During *rabi* season, six germplasm were evaluated along with check Phule Suwarna. Marketable yield ranged between 24.09 to 37.62 t/ha. Entry Y-009 gave the highest marketable yield (37.62 t/ha) followed by Yellow gene pool with (30.45 t/ha) and Y-042 with 28.81 t/ha over check. All lines were free of doubles and bolters. TSS ranged from 10.08% (Y-042) to 13.56%. Among six yellow onion germplasm, Y-009 and check recorded less than 45% of weight loss after four months of storage.

Project 2.4: Development of yellow onion variety suitable for export

Yellow exotic onions

Ten yellow exotic lines with check Arka Pitambar were evaluated for performance during late *kharif*. Marketable yield ranged between 8.59 t/ha to 46.92 t/ha, the highest being in Hy-Collina. Five lines were significantly superior to check (9.07 t/ha) for marketable yield. 'A' grade bulbs ranged between 17.71 to 88.05%. Percent double bulbs varied between 0.00 to 41.39%. Hy-Collina was free of doubles.

Five lines had no bolters. TSS varied from 8.24% to 12.62%, the check had the highest. Hy-BSS-255 was found to be earlier maturing (139 DAT) than check (150 DAT).

Project 2.5: Heterosis breeding in white and yellow onion

White onion F_1 hybrids

White onion MS lines were introduced and ten crosses were made using 10 white elite lines during *rabi* season. Marketable yield in the F_1 hybrids ranged between 35.24 to 45.74 t/ha. Among 10 F_1 hybrids, one performed better with 52.77% AGB, 97.7% marketable bulb, 44 t/ha marketable yield, 45.74 t/ha total yield with no bolters and doubles and 28.14% heterosis over Phule Safed. Heterosis in the range of 7.24% to 28.14 % was observed in four crosses over check.

During *kharif*, seven F_1 hybrids developed using male sterile lines were evaluated. Marketable yield of the F_1 hybrids ranged between 22.06 to 34.82 t/ha. Two F_1 hybrids showed 8.63% and 2.27% heterosis over red check hybrid Arka Lalima, whereas all the hybrids gave heterosis between 15 to 162% over white check varieties.

Evaluation of crosses made using white and yellow exotic lines

Out of twenty four crosses made using white exotic onion and indigenous onion at CITH, Srinagar, four crosses were superior for marketable yield which ranged between 42.59 to 46.67 t/ha compared to 37.64 t/ha in check Bhima Shubra at Rajgurunagar during late *kharif* season. Six crosses were superior for total yield (47.87 to 52 t/ha) compared to check Bhima Shubra (45.73 t/ha). In case of yellow onion twenty crosses were made using exotic onion. Eighteen crosses were promising with marketable yield between 26.83 to 60 t/ha compared to 25.78 t/ha in check Arka Pitambar. Sixteen crosses yielded 42.33 to 61.11 t/ha compared to 32.53 t/ha in check Arka Pitamber for total yield.

Fifteen crosses made using white exotic with indigenous onion lines at CITH were evaluated at DOGR during *rabi*. Marketable yield in these crosses ranged between 9.74 to 36.67 t/ha whereas check Bhima Shweta recorded 36.92 t/ha. Similarly, out of ten crosses made using yellow exotic lines, seven crosses were superior and yielded 25.87 to 44.4 t/ha compared to check Arka Pitambar (20.95 t/ha) for marketable yield.

Project 2.6: Breeding white and yellow onion varieties resistant to biotic and abiotic stresses

Evaluation of white onion germplasm for resistance against thrips during *rabi*

Thirty nine lines of white onion were evaluated for reaction to thrips under field conditions. A 5 point scale was used for scoring. Only two lines viz. W-514 and W-441 showed resistance against thrips with 1-2 rating. Six lines recorded higher yield than the check.

Screening of white onion germplasm for foliar diseases in *kharif*

Out of thirteen white genotypes screened during *kharif* W 517, W 028 and Phule Safed showed maximum severity of *Stemphylium* leaf blight, while W 448 and W 517 showed maximum severity of purple blotch. For anthracnose, Bhima Shubra, Phule Safed, W 517 and Bhima Shweta were found moderately resistant. Higher marketable yield was found in Bhima Shubra followed by Bhima Shweta and W 302.

Screening of white onion germplasm for foliar diseases in *Rabi*

Seventy seven white genotypes were screened for incidence and severity of major foliar diseases in *rabi*. Only *Stemphylium* leaf blight was observed and its intensity was too low for screening. However, yield performances under untreated condition showed that Bhima Sweta, W 427/EL-3, and W 081 were better performers than all other genotypes.

Programme 3: Improvement of garlic through conventional and biotechnological approaches

Project 3.1: Collection, evaluation and maintenance of garlic (*Allium sativum* L.) germplasm

A total of 120 genotypes alongwith two checks were evaluated and data were recorded on important horticultural traits viz., polar diameter, equatorial diameter, clove polar diameter, clove equatorial diameter, weight of 10 cloves, average bulb weight and net marketable yield. Statistical analysis of data was carried out and it was found that all the characters were statistically significant revealing the diverse nature of the germplasm studied. Traits of the accessions performing better than the check variety G-41 are listed below in table 3.1.

Table 3.1: Diversity among best performing accessions of Garlic

Entries	PD cm	ED cm	NOC	ABW g	W10C g	CP cm	CE cm	MY t/ha
ACC015	2.6	3.5	15.5	12.9	9.5	1.9	1.0	6.0
ACC471	2.6	3.6	16.6	12.4	9	1.9	1.0	5.9
ACC593	2.5	3.1	17	10.8	7.5	1.9	0.9	5.7
ACC316BR	2.5	3.4	15.1	12.4	7.5	1.4	0.8	5.5
ACC275	2.5	3.6	16.5	13.1	9.5	1.9	1.0	5.5
ACC012	2.7	3.6	18.1	12.8	8.5	1.9	1.1	5.1
ACC401	2.5	3.4	16.7	12.6	9.5	1.9	0.9	5.0
G-41	2.4	3.4	16.5	12.2	8.5	1.8	0.9	4.7

PD Polar diameter; ED Equatorail diameter; NOC Number of Cloves; ABW Average bulb weight; W10C Weight of 10 cloves; CP Clove polar diameter; CE Clove equatorial diameter; MY Marketable yield

Evaluation of garlic germplasm for resistance against thrips

In garlic 158 accessions were screened under field conditions, but none of the accessions showed field tolerance against thrips. These lines will be evaluated again during the next year to confirm the status of their resistance and (or) susceptibility

Project 3.2: Development of high yielding garlic varieties suitable for different production areas through clonal selection

A total of 48 genotypes along with two checks (G41 and G50) were evaluated. Data were recorded on eight horticultural traits viz., polar diameter, equatorial diameter, clove polar diameter, clove equatorial diameter, number of cloves, weight of 10 cloves, bulb weight and marketable yield.

It was found that polar diameter, equatorial diameter, weight of 10 cloves, number of cloves and clove equatorial diameter were non-significant. Whereas traits viz., average bulb weight, clove polar diameter and marketable yield were found to be significant. It was found that mother variety G41 (3.40 t/ha) recorded the highest yield. As all the progenies were obtained from G-41, ISSR markers were used to evaluate progenies in order to identify the variants. DNA profile indicated that none of the progeny was different from original material (G41).

Project 3.4: Production of virus free garlic through *in vitro* meristem tip culture

Development of virus free garlic was tried using meristem tip culture and shoot tip culture in combination with thermotherapy. It has been possible to develop virus free garlic, free from potyviruses, using *in vitro* techniques. It was observed that more than 90 percent virus free plantlets were obtained from meristem tip culture (0.1 mm – 0.3 mm). A total of 870 mersitems and 302 shoot tips were inoculated and 571 mericlones and 272 plants from shoot tip were obtained. *In vitro* grown virus free plants were grown under the greenhouse conditions. Different combinations of peat:perlite:vermiculite and soil (normal, sterilised and autoclaved) were tried. The root system was very well developed in the multicell trays. But, when the plants were transferred to bigger pots for bulb development, the rate of mortality increased. It was not possible to recover the plants with full grown bulbs. About 90% of the plants died during acclimatization.

Project 3.5: Molecular analysis of genetic diversity in garlic

Garlic is a vegetatively propagated crop, but it displays variation in terms of morphological traits like bulb and clove colour, architecture and bolting ability. Morphological traits are highly influenced by the environmental conditions thus leads to difficulty in scoring and analysis. On the other hand, molecular markers are stable and reproducible.

Genetic diversity of Indian garlic accessions were assessed using RAPD and ISSR primers. A total of 160 RAPD primers (OPA1-20, OPB1-20, OPC1-20, OPD1-20, OPE1-20, OPG1-20, OPJ1-20 and OPM1-20) were used for screening of suitable primers giving amplification. PCR protocols were standardized as required. Eight genotypes were used for primary screening of primers. A total of 40 primers showed amplification, out of which 20 primers gave good amplification and hence were used for further amplification on all the genotypes. Out of a total of 100 ISSR primers (UBC, Canada), twenty seven primers gave amplification out of which 14 primers were further selected for their amplification ability. Analysis of ISSR data revealed that genetic similarity ranged from 1.0 to 0.79 with a mean value of 0.89 among the Indian garlic.

A total of ninety six genotypes of garlic representing around 21 countries were used in this study. A total of sixty genomic and EST based onion microsatellites; eight newly reported garlic microsatellites and 31 microsatellites mined from the garlic EST database (GarlicESTdb) was used for microsatellite amplification. Out of sixty genomic and EST based onion microsatellites, four (6%) were cross amplifiable in garlic germlasm. Out of the eight newly reported microsatellites, four (50%) and from newly mined thirty one microsatellites, seven (23%) were able to amplify in garlic germplasm. A considerable genetic diversity was observed in the germplasm studied. It was also observed that the clustering was independent of the geographical location of the material.

Programme 4: Biotechnological approaches for improvement of onion (*Allium cepa*. L)

Project 4.1: Induction of haploids in onion (*Allium cepa* L.)

Haploid induction in onion was tried through gynogenesis, which is a routinely used method for inbred production in onion. Unopened flower buds which were about to open in three days were cultured on induction media (B5+2mg/L BAP+2mg/L 2,4-D, 7.5% sucrose). The flower buds expanded in culture media and gynogenic ovule germinated in 75 days to 120 days from the matured ovule (Fig 4.1). Different varieties were tried during the *rabi*. Gynogenic potential of different varieties is tabulated below (Table 4.1). The regenerants were subcultured on the MS basal media (with 3% sucrose) for proper plantlet growth. Root tip squash from few gynogenic regenerants were evaluated through cytology and three plants were confirmed for haploidy in variety Bhima Super.

Table 4.1: Gynogenic potential of different varieties/lines

Variety	Plants Obtained	Percent Gynogenesis
N 2-4-1	4	3.0
RLKM1	5	3.1
BS	17	0.9
BSU	15	3.5
BK	7	2.8
ADR	4	2.0

Fig. 4.1 : Germination of gynogeneic embryo from cultured ovary

Project 4.2: Micropropagation studies in Onion

Micropropagation was aimed to multiply the male sterile lines which could support the hybrid seed production programme. To establish the sterile cultures, different explants like seed, ratoon and flower buds were used. Culture establishment was difficult to achieve in ratoon samples due to high percentage of

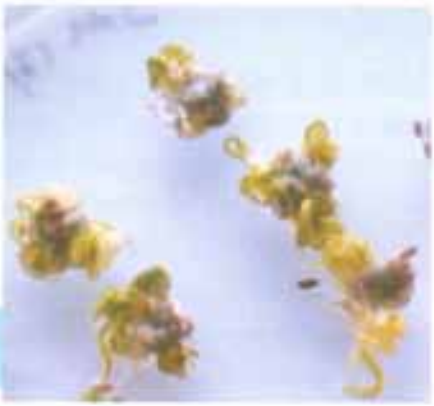


Fig. 4.2: Direct regeneration of shoot from base of floral bud

contamination. Sterile cultures were established on MS basal media for MS222 and MS100 lines through seeds. The lines MS111 and MS 1600 were difficult to generate through seeds due seed borne contamination. Direct regeneration from flower bud cultures was evaluated. The flower buds were cultured on induction medium (B5+2mg/L BAP+2mg/L 2,4-D, 7.5% sucrose) for 6 days followed by differentiation medium (MS+2mg/L TDZ). Shoots differentiate from base of the flower bud after 30 days. Around 5-6 shoots develop from the each explants (Fig.4.2).

Project 4.3: DNA profiling of onion lines using molecular markers

In order to develop a marker which can be converted for automation for easy identification of varieties retroposon based insertion polymorphism (RBIP) was chosen. Ty1 Copia like element is distributed in large number of copies in the onion genome. A conserved sequence from RNaseH gene of Copia1 retrotransposon was retrieved from NCBI database. Primers were designed and the sequence was amplified, cloned and sequenced (Fig.4.3). Seuqnece was also cloned from *A. fistulosum* and *A. ampeloprasum* and confirmed. The sequence was confirmed as copia1 using Blastn programme at NCBI database (Fig. 4.4). Primers were designed based on the sequence for genome walking. Walker library was created by ligating adapter to the RSA1 digested DNA. Walker PCR was carried out using gene specific and adapter primer (Fig. 4.5). Approximately a 430bp fragment was amplified and was cloned and sequenced. The sequence was confirmed for overlap using blastn (Fig.4.6). From the new sequences primers were designed for further walking or SSAP analysis.

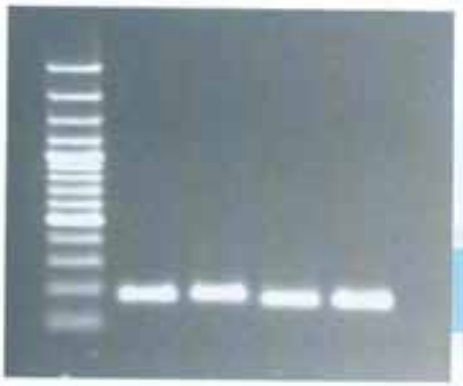


Fig. 4.3: Amplification of RnaseH of Ty1 copia from onion

```
>emb|AJ223065.1|  Allium cepa DNA for Ty1-copia retrotransposon
Length=235

 Score =  217 bits (117),  Expect = 2e-53
 Identities = 143/156 (92%), Gaps = 0/156 (0%)
 Strand=Plus/Plus

Query  1    GGAACAACCTGAGGGATTCAAAGTTCTAGGCAAAGAAAATTTAGTGTGCCGCCTCACGAA  60
            ||||||||||||||||||||||||||| |||||||||| | ||||||||| |||||| ||
Sbjct  24   GGAACAACCTGAGGGATTCAAAGTTCCAGGCAAAGAAGGTCTAGTGTGCCACCTCACAAA  83

Query  61   GAGTCTATACGGGCTTAAGCAAGCACCAAGGCAATGGTCCAAGAAGTTCAACGCATTCAT  120
            |||||||| || ||||||||||||||||||||||||| |||||||||| | ||||||||
Sbjct  84   AAGTCTATATGGACTTAAGCAAGCACCAAGGCAATGGTACAAGAAGTTCGATGCATTCAT  143

Query  121  GGAAGAACATGATTTCAAAAAGACGGAAAGCGATCA  156
            || ||||||||||||||||||||||||||||||||
Sbjct  144  GGCAGAACATGATTTCAAAAAGACGGAAAGCGATCA  179
```

Fig. 4.4: Similarity search (Blastn) confirms RnaseH of Ty1 copia from onion

Fig. 4.5: Amplification of 3' flanking sequence of known copia1 region

```
>emb|AJ223065.1|  Allium cepa DNA for Ty1-copia retrotransposon
Length=235

 Score =  141 bits (76),  Expect = 4e-30
 Identities = 76/76 (100%), Gaps = 0/76 (0%)
 Strand=Plus/Plus

Query  2    AAAAAGACGGAAAGCGATCATTGTGTCTTCATAAAGAGGTATGTAAGTGGTGACTTTCTC  61
            ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Sbjct  160  AAAAAGACGGAAAGCGATCATTGTGTCTTCATAAAGAGGTATGTAAGTGGTGACTTTCTC  219

Query  62   ATACTTCTGCTCTATG  77
            ||||||||||||||||
Sbjct  220  ATACTTCTGCTCTATG  235
```

Fig. 4.6: Blastn analysis for confirmation of overlap for amplified flanking sequence

Programme 5: Collection, characterisation and screening of wild species for *Allium* improvement

Project 5.1: Screening of wild species for biotic and abiotic stresses and introgression of desirable genes in *Allium cepa* L.

A. tuberosum is a tetraploid with resistance to major diseases. A crossing experiment was initiated for evaluation of crossability of *A. tuberosum* with *A. cepa*. *A. cepa* was pollinated with *A. tuberosum*. Embryo abortion was observed in all crosses. Embryo rescue was also initiated to obtain interspecific hybrids. Since *A. tubersoum* is a tetraploid, we are trying to develop haploid plants through *in vitro* gynogenesis for use in crossing programme with *A. cepa*.

Crop Production

Programme 6: Integrated nutrient management for onion and garlic

Project 6.1 Nutrient uptake studies in onion bulb crops

In a field experiment to assess the nutrient uptake pattern of onion bulb crop during *rabi*, the plant samples were collected randomly at 15 days interval from 30 days after planning (DAP) till harvest. The samples were analysed for total nutrient contents in bulbs and leaves. There was no significant difference observed between the treatments for dry matter yield and nutrient uptake. The dry matter accumulation in onion leaves increased at faster rate up to 60 days from the date of planting and declined after 60 days. However, the dry matter accumulation in bulbs increased after 60 days till harvest *i.e.* during bulb development and enlargement stage. Further, the nutrient uptake rate reached to peak at 60 DAP and declined thereafter. More than 75 percent of N, K and Cu were absorbed up to 60 days and the remaining 25 percent after 60 DAP. Whereas, more than 70 percent of P, S, Zn and 60 percent of Mn were removed from the soil after 45 days from the date of planting. The results indicated that P, S, Zn and Mn requirement was critical during bulb development and enlargement stages.

Programme 7: Enhancement of production of onion and garlic through agronomic innovations

Project 7.1 Studies on organic production of onion and garlic

Effect of soil application of various organic manures on growth, yield, quality and storage life of onion and garlic

The results from the present experiment revealed that inorganic treatment consisting of 100 percent recommended dose of NPK fertilizers along with chemical plant protection measures recorded the highest marketable bulb yield in both the crops. In case of organic farming practices among the various organic manures (Farmyard Manure (FYM), Poultry manure, Vermi-compost, Neem cake and their combinations) applied, Farmyard manure (FYM) package recorded relatively higher yield than other organic manures evaluated in both the crops. However, almost 20-30% lesser marketable yield was recorded in organic farming system in comparison with inorganic production system. From the quality aspects, it was observed that organically nourished bulbs recorded better quality in terms of biochemical constituents than inorganic package. However, there was no significant difference observed between various kinds of applied organic manures.

With regards to post harvest storage life of onion and garlic, it was noticed that physiological loss in weight (PLW) and rotting losses were highly influenced by different organic manures and other organic inputs application. Overall, the maximum total storage losses of bulbs were noticed in inorganic farming in both crops after 150 days of storage. However, no significant difference was observed between treatments. Among the various organic and inorganic cultivation practices, soil

available N, P, K and S content (kg/ha) were on higher side in inorganic fertilizers applied plot than organic manure applied plots in both the crops. The influence of organic sources of nutrients on the soil biological properties was studied through the assessment of soil microbial population. It was noticed that soil bacteria, fungal and actinomycetes population were higher in soil nourished with organic manures and other organic inputs as compared to inorganic fertilizers applied plot.

Effect of various organic growth stimulants on growth, yield, quality and storage life of onion and garlic under organic production system

Among the various organic growth stimulants (Panchgavya, Dasparni, Amruthparni, Vermiwash, Seeweed extract, EM Solution, Humic acid, Bio Potash, microbial extract) applied under organic production system, based on the three years results, it was concluded that foliar application of *panchagavya* (5%) at 30, 45 and 60 days after planting improved the marketable bulb yield in onion (20.2 t/ha) and garlic (5.01 t/ha). However, percent of bolters, doubles, biochemical constituents and post harvest storage life of onion and garlic bulbs were not significantly influenced by foliar application of various organic stimulants.

Project 7.2: Weed management in onion and garlic

Chemical weed management in *rabi* onion

Weed infestation is the one of the limiting factor in quality bulb production in onion. Onion exhibits greater susceptibility to weed competition than most of other vegetable crops. It is mainly due to slow initial growth and inherent characteristics of onion bulbs such as short stature, non branching habit, sparse foliage, shallow root systems coupled with frequent irrigation and fertilizers application. Hence an experiment was conducted at DOGR to study suitable weedicides for effective control of weeds in *rabi* onion production in comparison with manual weeding. The results revealed that among the various weedicides evaluated, application of Oxyflurofen 23.5% EC @1.5ml/L before planting (Fig.7.1) and one hand weeding at 55 days after transplanting recorded higher marketable bulb yield of 36.1 t/ha coupled with good weed control efficiency (73.6 %) and B:C ratio (2.54).

Oxyflurofen 23.5% EC @1.5ml/L before planting and one hand weeding at 55 days after transplanting

T8:- Control (without spray)

Fig.7.1: Chemical weed management in *rabi* onion

Project 7.3: Studies on foliar feeding of nutrients and growth regulators on growth and yield of onion and garlic

Effect of foliar application of salicylic acid on growth, yield, quality and storage life of *rabi* onion.

Salicylic acid (SA) is a common plant produced phenolic compound which acts as signal molecule during biotic and abiotic stresses and also has growth promoting effect. To study the plant growth promoting effect of salicylic acid on onion growth, yield and quality, an experiment was conducted at DOGR during *rabi* season. Salicylic acid was sprayed at nursery, main field and its combination. The results revealed that irrespective of treatments, foliar application of salicylic acid improved the yield and yield contributing characters of *rabi* onion. Among the treatments, foliar application of salicylic acid @250mg/L at 20, 40, 60 and 80 days after transplanting recorded higher yield in Bhima Kiran (37 t/ha) compared to control (28.6 t/ha). However, there were no significant difference observed in biochemical constituents and post harvest storage life of onion.

Direct seeding in onion

The onion seed drill developed locally and tested at DOGR reveals that indigenous manually operated seed drills do not help in labour saving and also precision particularly depth of sowing and proper spacing are not satisfactory as per our requirement. To overcome these problems, CIAE - Bhopal has imported the pneumatic seed drill machine from Italy. This versatile and multipurpose machine can be fitted with as many seeding units as needed to meet the specific requirements of the farmers and equipped with everything necessary to handle all the different types of vegetable seed. With this background, direct sowing experiment was conducted at DOGR, Rajgurunagar during the *rabi* season in the variety 'Bhima Kiran' to study the effect of different direct sowing methods in onion production using pneumatic seed drill, local seed drill in comparison with manual sowing (broadcasting) and transplanting method. Among the various direct sowing methods, bigger bulbs, more percent of 'A' grade bulbs contribution and less number of double bulbs were noticed in direct sown method using pneumatic seed drill. However, in transplanting method of onion production the highest marketable yield (Fig.7.2) was recorded followed by pneumatic seed drill and these registered relatively higher marketable bulb yield than other methods of sowing. The less bulb yield in pneumatic seed drilled plots may be due to lower population and crop stand at initial stage. However, low seed rate, easy sowing, saving in time and early maturity of onion were observed in sowing with pneumatic seed drill machine. The lowest marketable yield was observed in Poona seed drill followed by manual sowing (broadcasting) method. The experiment will be continued for two more years.

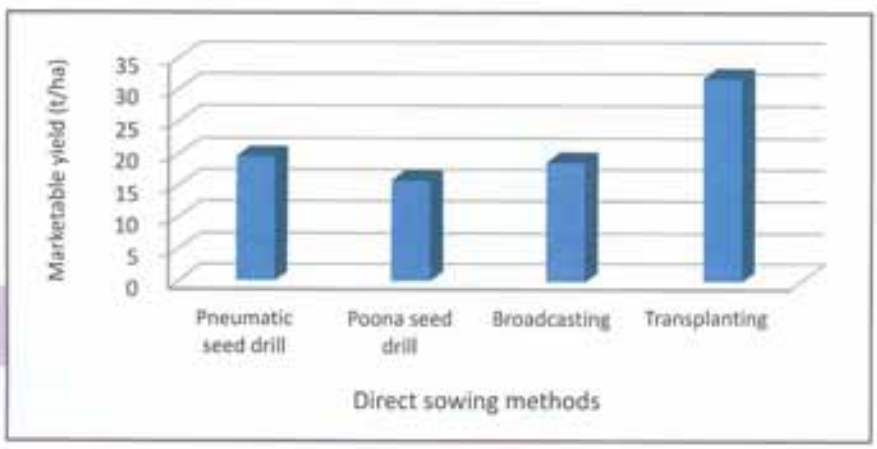


Fig.7.2: Direct seeding in onion

Crop Protection

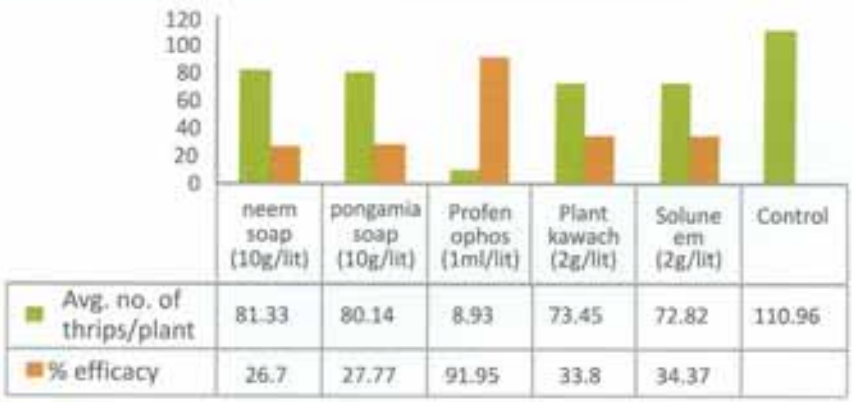
Programme 9: Integrated pest management in onion and garlic

Project 9.1: Bio-intensive pest management in onion and garlic

Evaluation of some botanicals and insect pathogens against thrips in onion

The main objective the project is to reduce the pesticide load and to augment the beneficial insects. This can be achieved through non-chemical methodology of pest management. The trial was initiated during *rabi* to test the efficacy of entomopathogens and botanicals against onion thrips.

Different botanicals like neem soap, pongamia soap, plant kavach, soluneem were evaluated for their efficacy against thrips on onion. Percent efficacy of plant kavach (1ml/l) and soluneem (2gm/l) are 33.80 and 34.37 % (Fig.9.1). Whereas, Neem soap and pongamia soap gave 26.70 and 27.77% reduction over control (Fig.9.1).

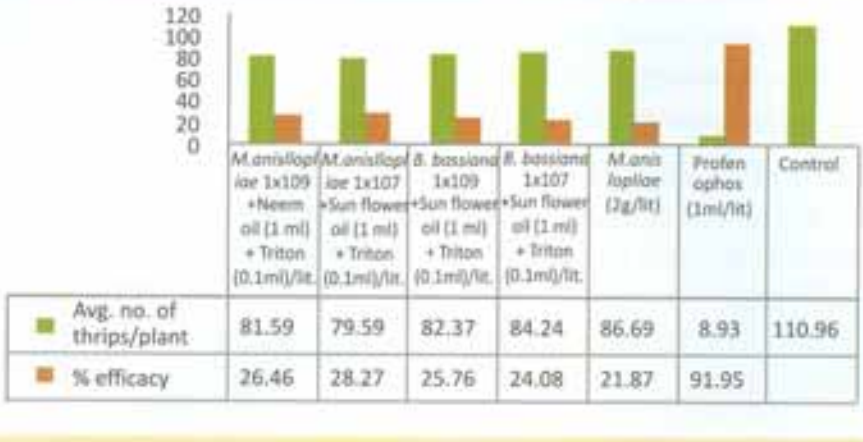


	neem soap (10g/lit)	pongamia soap (10g/lit)	Profen ophos (1ml/lit)	Plant kawach (2g/lit)	Solune em (2g/lit)	Control
Avg. no. of thrips/plant	81.33	80.14	8.93	73.45	72.82	110.96
% efficacy	26.7	27.77	91.95	33.8	34.37	

Fig. 9.1: Efficacy of botanicals against onion thrips

Insect pathogens isolates from IIHR were tested against onion thrips under field conditions. Different insect pathogens like *Metarrhizium anisopliae,Beaveria bassiana,* in combination with neem oil were evaluated in comparision with the commercial isolates (Fig.9.2). *M. anisopliae* 1X107 + sunflower oil recorded highest efficacy (28.27%) followed by *M. anisopliae* + neem oil with 26.46% efficacy. Commercial isolates of *M. Anisopliae* recorded only 21 % efficacy where as chemical insecticide profenofos recorded 91.95% reduction over control.

Both the botanicals and insect pathogens performed poor against onion thrips as compared to chemical insecticides.



	M.anisopliae 1x109 +Neem oil (1 ml) + Triton (0.1ml)/lit.	M.anisopliae 1x107 +Sun flower oil (1 ml) + Triton (0.1ml)/lit.	B. bassiana 1x109 +Sun flower oil (1 ml) + Triton (0.1ml)/lit.	B. bassiana 1x107 +Sun flower oil (1 ml) + Triton (0.1ml)/lit.	M.anisopliae (2g/lit)	Profenophos (1ml/lit)	Control
Avg. no. of thrips/plant	81.59	79.59	82.37	84.24	86.69	8.93	110.96
% efficacy	26.46	28.27	25.76	24.08	21.87	91.95	

Fig. 9.2: Efficacy of entomopathogens on onion thrips

Project 9.2: Vector-virus relations in onion and garlic

To study the vector (*Thrips tabaci)* – virus (IYSV) relations in onion mass rearing of *T. tabaci* under laboratory conditions were standardised. The biology of *T. tabaci* under laboratory conditions were studied. The study reveals that life cycle of *T. tabaci* completes in 35 days under laboratory conditions.

The mass rearing of onion thrips was carried out with French bean pods. The average temperature and humidity 25.54±1°C and 54.06 ± 1% were required under laboratory conditions.

About 10 sets of transmission exercises were carried out with 24 and 48 hrs Acquisition Access Period (AAP). I instar larvae were used to acquire the virus from infected onion leaf and transferred to healthy onion plant. The infected plants were shifted to green house for multiplication of virus. The adult thrips were collected in alcohol. The plant and thrips will be screened for virus.

Population dynamics of thrips in onion

Thrips incidence in *rabi* for different planting dates was recorded. The highest incidence was recorded in 1-December planting (61.55 thrips/plant) followed by 15-November planting (52.75thrips/plant). The lowest thrips population was recorded in the dates of 15-July, 1-August and 15-August (1.85, 1.75 & 1.89 thrips/plant respectively). There were considerable variations in the

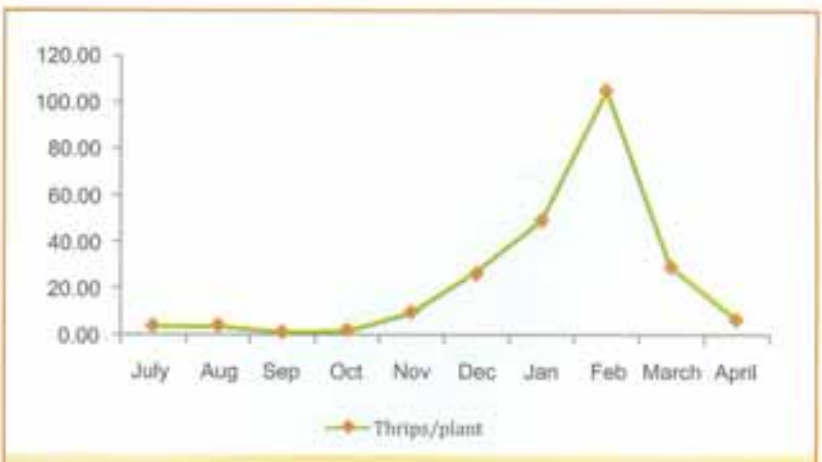


Fig. 9.3: Monthwise incidence of thrips in onion

marketable yields. Planting on 1-December recorded the highest yield (51.11 t/ha) despite of recording the highest number of thrips population. Similarly planting dates 15-August and 1 September recorded lowest thrips population but yields were also low (1.33 and 1.81 t/ha). These yield losses were mainly due to severe anthracnose disease.

Seasonal incidence of thrips has been changing for past two years as compared to last ten years trend. Generally 2 peaks appear one in August and the other in February. But in the past two years lowest thrips population was noticed in August only. It is interesting to note that thrips population never crossed more than 5/plant in the month of August. In the month of February the highest population of thrips (Fig. 9.3) was recorded this year. Average nymph populations were reaching 98.62 thrips/plant. Average adult population was 6.63/plant. Thrips population started declining in the month of March.

Programme 10: Integrated disease management in onion and garlic

Project 10.1: Geospatial pathogenic and molecular characterisation of fungal diseases in onion and garlic- detection, management and risk analysis

A total of 22 isolates of *Alternaria porri* and 25 isolates of *Stemphylium vesicarium* were isolated from onion diseased samples obtained from Srinagar. Several isolates of *S. vesicarium, A. porri, Colletotrichum gloeosporioides, Fusarium oxysporium f sp cepae* and *Pyraenochaeta terrestris* causing foliar and soil borne diseases collected, isolated are maintained (Table 10.1)

Table. 10.1: Pathogenic isolates collected from different parts of India

Region	Pathogen and number of isolates					
	Alternaria	Stemphylium	Colletotrichum	Fusarium	P. terrestris	Emblesia
Maharashtra	720(100ss)	880(150 SS) 62(32 ss)(L)	83(32 ss) 18(10ss) (Chilli) 6(6 ss) (wild species)	83	42	
Tamil Nadu	290(68 ss)	300(86 ss)	82(46 ss)			
Karnataka	658(120 ss)	688(125 ss)	110(68 ss)			
Gujarat	143(87 ss)	868(59 ss)				07
Madhya Pradesh	29(22 ss)	187(79 ss)				
Srinagar	22(20 ss)	32(25 ss)				
China	10(8 ss)					

Resistance to Foliar Diseases

Fifteen lines of onion comprising released varieties, advanced lines, local and wild *Allium* species were raised under net house conditions and artificially inoculated at 30 DAT with highly virulent strains of *A. porri* and *S. vesicarium*. Vigorously growing isolates of *A. porri* and *S.vesicarium* were placed on to sporulating medium. Each tray planted with test plants was inoculated with a single isolate by spraying seedlings to runoff with a conidial suspension of 10' conidia/ml and then maintained at near 100% relative humidity at 25°C for 48h. Ten days after inoculation plants were assessed for disease severity using a 5 point rating scale (1 = less than 15% ; 2 = 16 - 35% ; 3 = 36 - 55%; 4 = 56 - 75% ; 5 = greater than 75% foliage affected). *A. tuberosum* was free from infection whereas *A. altaicum* and *A. fistulosum* showed below 10% infection (Fig 10.2). Among local lines Fursungi and Talaja local showed less than 55 % infection, whereas all other released and advanced lines showed above 50%.

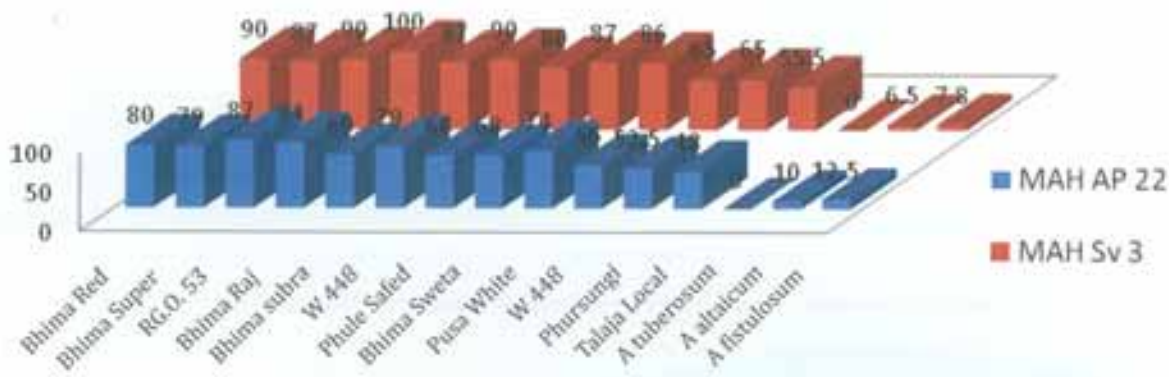


Fig. 10.1: Reaction of onion genotypes to *A.porri* and *S. vesicarium* (artificial inoculation)

Project 10.2: Management of soil borne diseases of onion

Screening for resistance to anthracnose (*Colletotrichum gloeosporioides* Penz.)

A total of 12 lines of onion (released varieties and local lines) were raised under net house in portrays and later transplanted to individual pots containing sterile mix of soil and compost.

Plants at 5-6 leaf stage (30 DAT) were used for screening. Virulent isolates collected from Maharashtra were used in the screening experiments. Only characteristic necrotic spots were scored, unless plants were already destroyed by the disease. The disease was scored 14 days after inoculation.

At 60 days after transplanting, anthracnose developed in all of the test cultivars. Disease developed rapidly in all the cultivars with disease incidence ranging from 10% to 48%. The disease continued to develop as the plants matured. At 75 days after transplanting, the highest disease incidence was observed in all the test lines. However disease progress was slow in Phule safed, W448, Pusa White followed by Fursungi and Talaja local.

Table 10.2: Disease reaction in different genotypes in response to Anthracnose

Genotypes	15 DAY	30 DAY	45 DAY	60 DAY	75 DAY
Bhima Red	35	55	80	90	100
Bhima Super	42	59	79	87	100
R G.O. 53	38	62	87	90	100
Bhima Raj	48	64	84	100	100
Bhima subra	43	56	69	87	100
W 448	20	40	79	90	100
Phule Safed	10	38	68	80	100
Bhima Sweta	34	56	68	87	100
Pusa White	22	49	74	86	100
W 448	32	40	56	65	92
Phursungi	24	32	60	65	90
Talaja Local	22	38	48	62	90

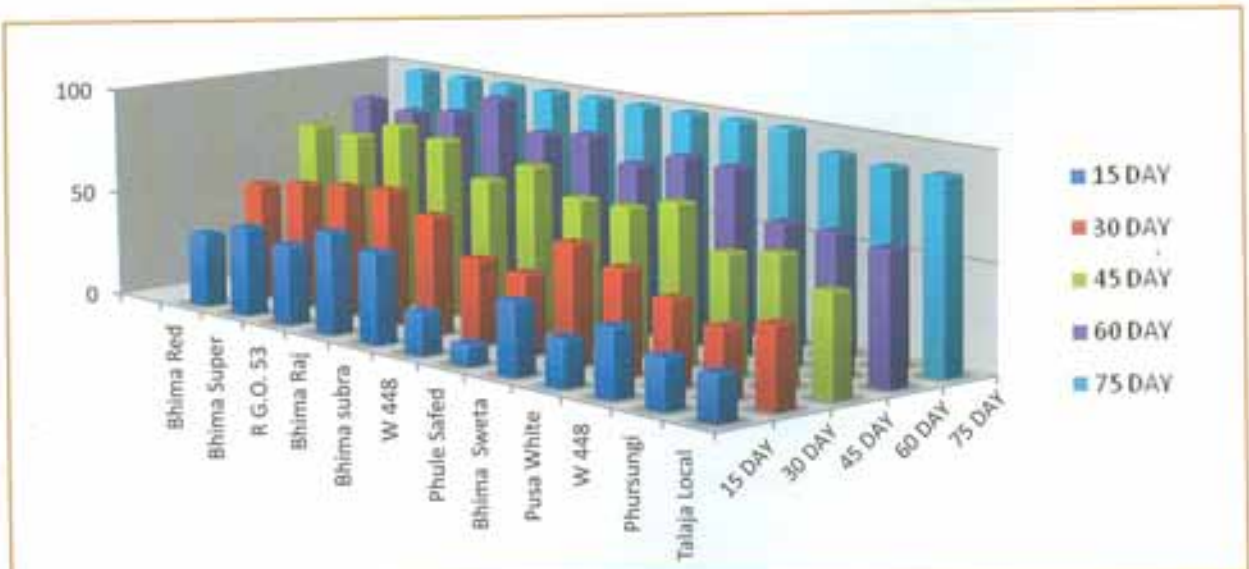


Fig.10.2: Reaction of Onion genotypes to *C. gloeosporioides* (artificial inoculation)

Management of *Colletotrichum gloeosporioides*

A combination of soil, seed and foliar spray schedule was followed for control of anthracnose during *kharif*. The treatments were soil (Metam sodium 14 ml/sq m, Basamid 50g/ sq m and Suzae 14 ml/sq m), seed treatment (Thiram 5 g/kg, Benomy l.5 g/kg and Captan 5g/kg), spray schedule included five

contact fungicides (Benomyl 50%, Mancozeb 75%, Fluopyram+Tebuconazole, Natio 75 WP, Anthracol 70WP) in two agronomic practices viz. flat and raised bed planting systems. Observations were made on intensity of disease by selecting 10 plants in each replications and labeling them at 15 days interval till 75 days after transplanting.

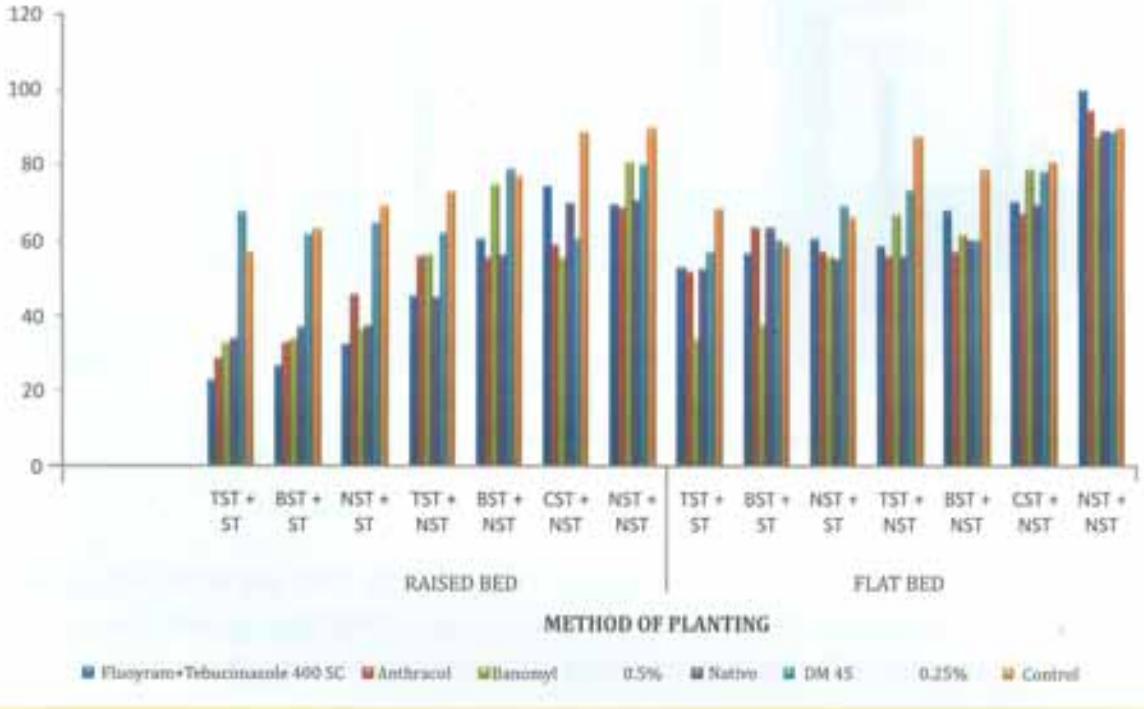


Fig. 10.3: Control of Antracnose through integrated approach

TST: Thiram Seed Treatment; NST: No Seed Treatment; BST: Benomyl Seed Treatment; CST: Captan Seed Treatment; ST: Soil Ttreatment; NST: No Soil Treatment

Combination of thiram seed treatment with nursery beds treated with basamid, metam sodium and spray of Fluopyram+ tebuconazole and raised bed planting gave protection to the tune of 65%. Whereas, under flat bed system none of the treatments proved effective except benomyl seed treatment with soil treatment and spray of 0.5% benomyl at 15 day intervals. The flat bed system succumbed to the disease earlier than raised bed system. The control recorded the highest infection (>90%).

During Late *kharif*, in an experiment on evaluation of new molecules observations were recorded on anthracnose severity and other foliar diseases like purple blotch and *Stemphylium* blight. The treatments included seeds treated with thiram (5g/kg) and soil treatment with suzone (Na_2CS_4) with a control having no seed treatment and soil treatment in the nursery. Foliar sprays were undertaken at 15 days interval till 60 days after transplanting with new molecules Natio, Altracol and Fluropyram. Disease and yield data were recorded as per the standard scale and for total and marketable yield, respectively.

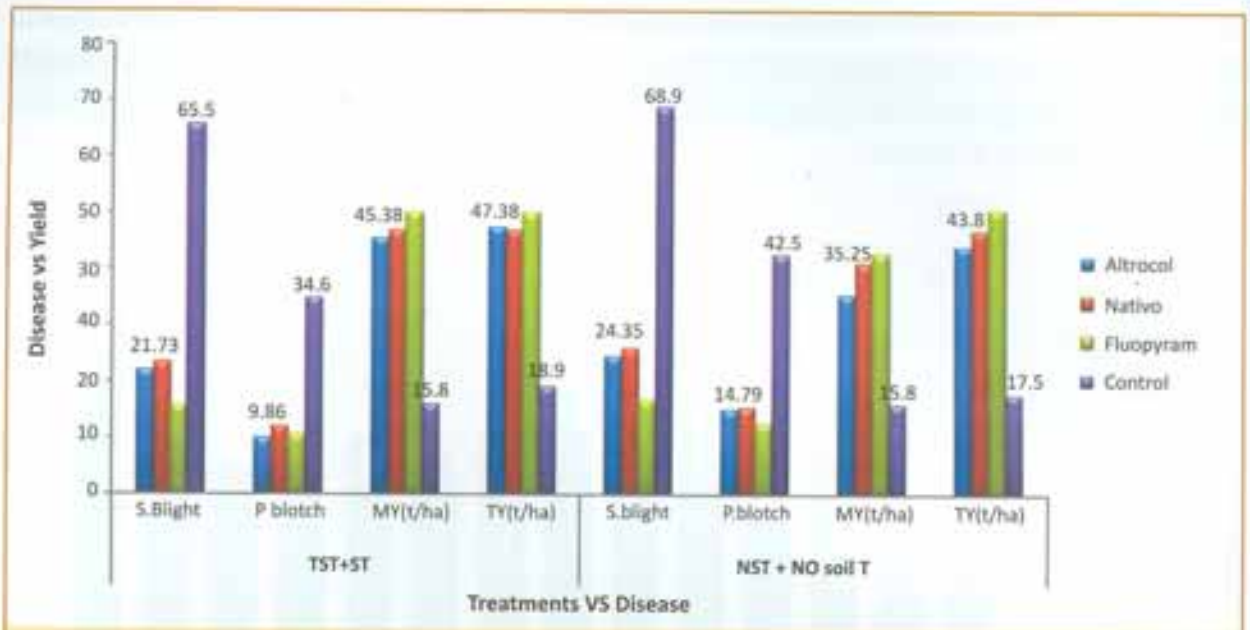


Fig. 10.4: Management of Foliar diseases (new molecules)

TST: Thiram Seed Treatment; NST: No Seed Treatment; MY: Marketable Yield; TY: Total Yield

All the three chemicals were at par in controlling the disease by 75% and 65% respectively for *Stemphylium* blight and purple blotch. These treatments, when complimented with seed treatment with thiram and nursery soil treatment resulted in appreciable increase (by three fold) in total and marketable yield compared.

Screening for disease resistance -*Fusarium* Basal Rot (FBR)

Seventeen onion cultivars were evaluated using a seedling screening procedure conducted in net house. Twenty seeds of each cultivar were planted in each of five trays containing acid washed silica

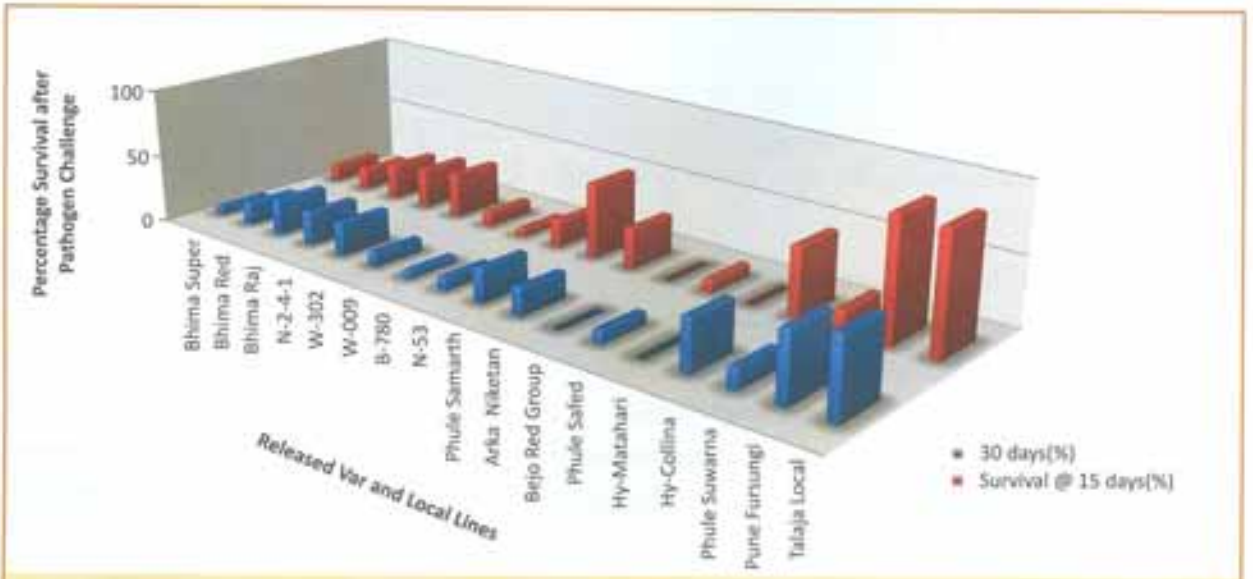


Fig. 10.5: Screening for resistance to FBR (artificial inoculation)

sand. The inoculum was created with 0.5 mm^2 plugs of Isolate grown on potato dextrose agar. Isolate was continually subcultured throughout all of the trials. In order to obtain a spore concentration of 4.0×10^4 $sporesg^{-1}$ sand in each of the inoculated trays, 5.2×10^8 spores were delivered to each inoculated tray using a consistent volume of 1 L. Distilled water (dH_2O) was applied to the uninoculated tray at a volume of 1 L. The seeds were then planted 1.5 cm into the sand. After two weeks, when seedlings had emerged, counts of dead and live seedlings were taken at two and four weeks post-planting. The percentage of survival was calculated as percentage over un-inoculated control.

Table 10.3: Screening for disease resistance -FBR

Sr.No.	Varieties	Percent Survival	
		15 Days after inoculation	30 Days after inoculation
1	Bhima Super	6.67	13.33
2	Bhima Red	16.67	16.67
3	Bhima Raj	26.67	26.67
4	N-2-4-1	25.00	30.00
5	W-302	25.00	33.33
6	W-009	11.11	11.11
7	B-780	6.25	6.25
8	N-53	10.00	20.00
9	Phule Samarth	25.00	55.00
10	Arka Niketan	20.00	30.00
11	Bejo Red Group	0.00	0.00
12	Phule Safed	10.00	10.00
13	Hy- Matahari	0.00	0.00
14	Hy- Collina	37.50	50.00
15	Phule Suwa rna	14.90	15.50
16	Pune Fursungi	48.60	86.9
17	Talaja Local	55.40	85.8

Control of soil borne diseases in garlic using onion waste compost

Seven treatments viz., onion compost @20 and 15 t/ha, Vermicompost @ 5t/ha, Trichoderma @ 5kg/ha, FYM @ 20 and 10t/ha and untreated were designed. Disease assessment was done by uprooting each plant and inspecting for any typical pink discoloration, characteristic of Pink Root Rot (PRR) infection. A plant with at least one root showing pink discoloration was considered as infected. The number of infected roots and the total number of roots of each plant sampled were noted and the percentage root infection calculated to indicate field infection levels. Thirty plants were randomly

uprooted with care per treatment at three distinct stages viz., bulb initiation, bulb development and bulb maturation (8, 10 and 12 weeks after transplantation). Records were also kept of bulb diameters and weights. There was no significant difference in yields except for onion compost at 20 and 10t/ha which had 50 % higher yield compared to control.

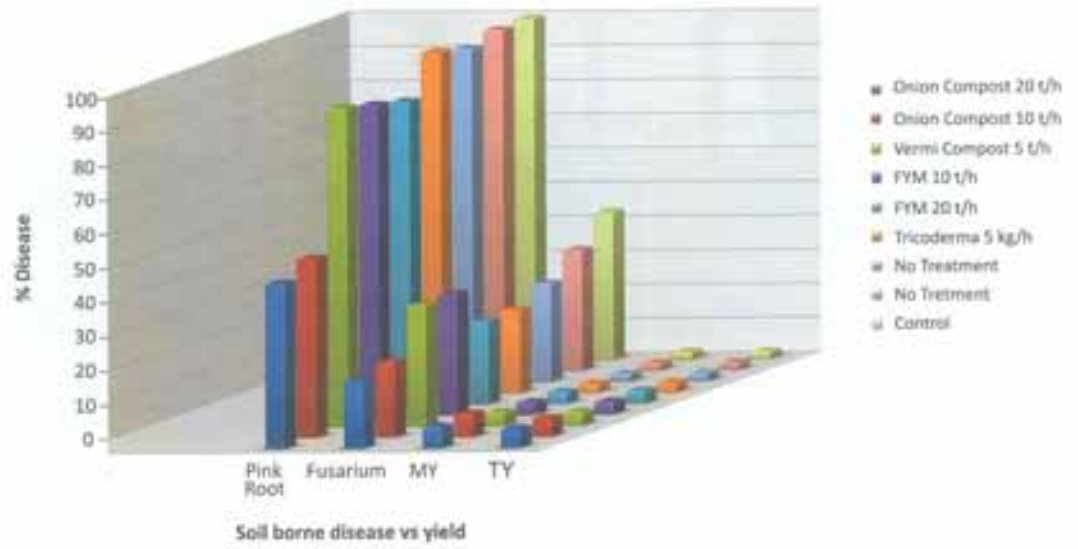


Fig. 10.6: Soil borne diseases vs yield

Alternate Cropping Experiment with non hosts

An alternate cropping experiment on fixed sick plot design for pink root disease on non hosts was initiated at Rajgurunagar during *kharif* 2009. The components of *kharif* cropping sequence were treatment T-1 Soybean, T-2 Groundnut, T-3 Mungbean, T-4 Bajra, and T-5 Cabbage, T-6 Sorghum, T-7 Radish, T-8 Onion, T-9 Onion, T-10 Onion, T-11 Onion. The plants were assessed for pink root infestation from 10 days old seedling stage to flowering stage. The infection was assessed using 1-10

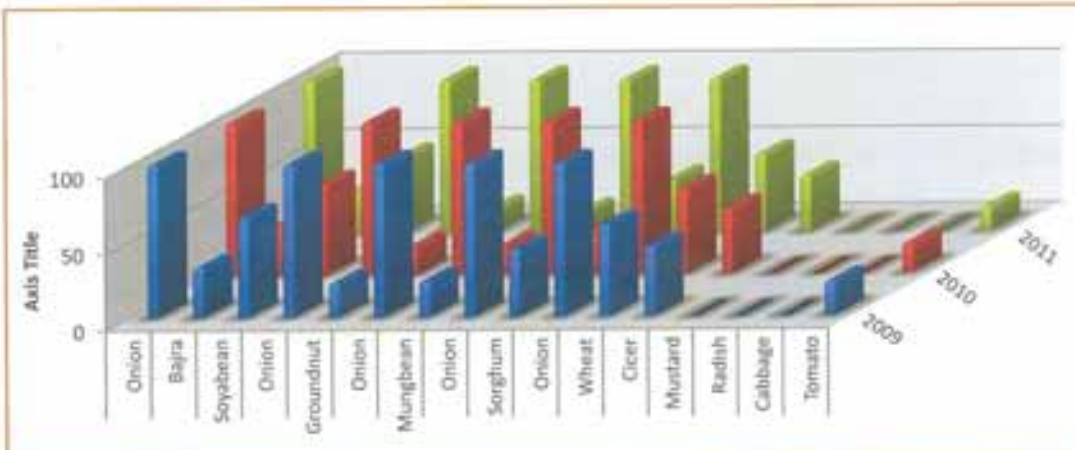


Fig 10.7: Effect of alternate cropping with non hosts on pink root potential (3 years)

scale. The control showed 86-93% infection. Soybean (56.6%) and sorghum (97%) showed higher percent of infection compared to Bajra (33.3%). Radish and cabbage did not show any infection. The roots were again assayed on water agar incorporated with wheat straw for expression of pink coloration. None of the samples from radish and cabbage yielded any positive reaction at any stage of crop growth. Three years data reveals that there is significant decrease in soil potential when non hosts are grown. Among the non hosts wheat and soyabean increase the inoculums load compared to others. The cruciferous hosts did not show any infection.

Project 10.3: Management of foliar diseases in onion and garlic

Spray schedule involving first spray of Mancozeb (0.25%) + Methomyl (0.8g/L) at 30 DAT, Tricyclazole (0.1%) + Carbosulphan (2ml/L) at 45 DAT and Hexaconazole (0.1%) + Profenophos (1ml/L) at 60 DAT was found effective for the management of *Stemphylium* blight and Purple blotch.

Effect of planting dates on seasonal variation in foliar diseases *viz.*, *Stemphylium* blight, Purple blotch and Anthracnose were studied by planting onion in 15 different dates starting from 15th June 2010 to 15th January 2011 at 15 days intervals. The highest incidence of disease was observed in 1st September planted crop while highest yield was recorded in 15th November planted crop under unprotected condition.

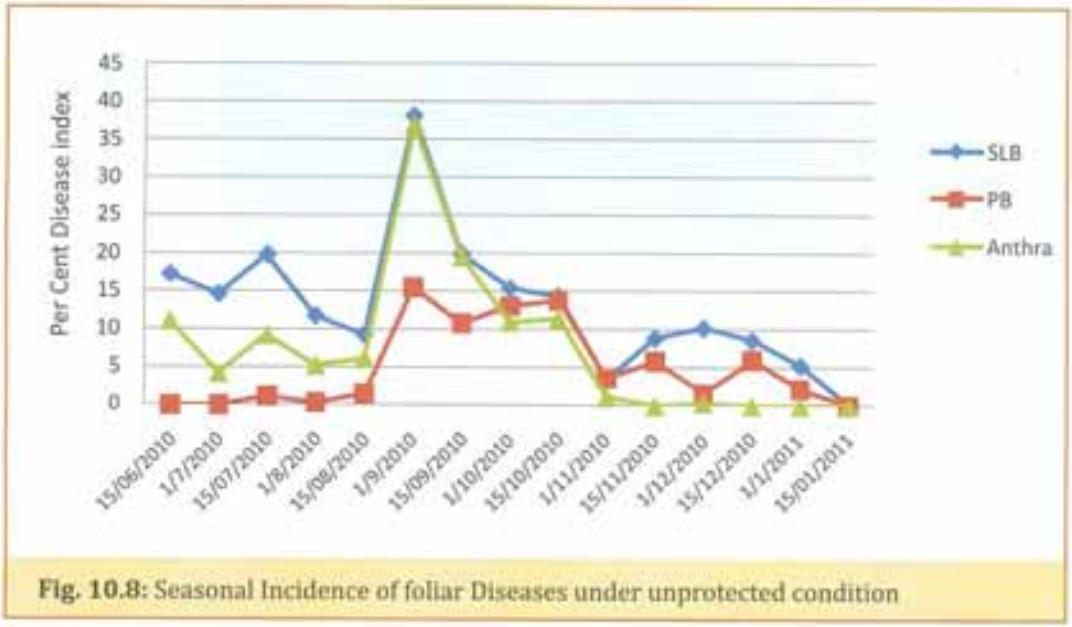


Fig. 10.8: Seasonal Incidence of foliar Diseases under unprotected condition

Project 10.4: Diagnostics of *Allium* viruses

Development of ELISA based protocol for detection of onion and garlic viruses

Double Antibody Sandwich Enzyme Linked Immunosorbent Assay (DAS-ELISA) based protocol for the detection of SLV and GCLV by using polyclonal IgG has been standardized and further validated by testing field samples of onion and garlic varieties and germplasm accessions.

Determination of Onion Yellow Dwarf Virus (OYDV) titre in onion and garlic

To determine titre of OYDV in wild alliums, crossing point value of amplified products was determined through qRT-PCR. Plots of fluorescence versus time was used to identify Crossing Point (CP) value of amplified products using Light Cycler 480 software 1.1. ROX was used as a reference dye. The data obtained were presented as fold change in amplicon level with reference to calibrator (*A.roylei*). Samples were analysed by using CRD with IRRISTAT software. As was evident from relative quantification, the lowest concentration of OYDV was observed in *A. roylei* followed by *A. tuberosum* (India). Further, to know precisely the effect of skin color on virus concentration, two varieties each of white, creamy white and purple color were tested through qRT-PCR. Our result suggests that there is no correlation between garlic skin color and OYDV concentration and incidence.

Table 10.5: Incidence of OYDV on wild *Allium* spp.

Sr. No.	Wild species	Source	qRT-PCR Crossing Point (CP) value
1	*A. tuberosum*	India	20.94
2	*A. ampeloprasum* (Leek)	India	19.38
3	*A. tuberosum* cv. Bawang Kucai	CGN15749	20.05
4	*A. alticum*	CGN 16417	18.53
5	*A. ampeloprasum* cv. Balady	CGN18724	19.97
6	*A. Longicuspuspis*	ALL146	18.81
7	*A. cepa* var. *aggregatum (Multiplier Onion)*	India	-
8	*A. ampeloprasum* (Winterreuzen 2 -Group 1)	CGN16402	18.65
9	*A. ampeloprasum* L. Zwitserse Reuzen Group I	CGN163 98	19.81
10	*A. chinense*	NGB14574	18.66
11	*A. roylei*	CGN20520	23.23
12	*A. senescens*	CGN 15758	-
13	*A. fistulosum*	ALL750	-

Table 10.6: OYDV incidence on leading garlic cultivars

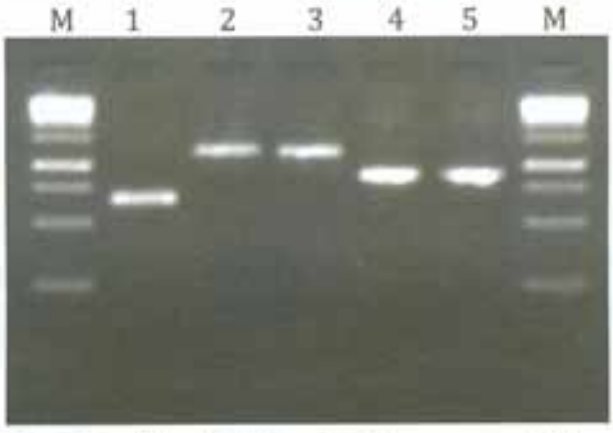
Sr. No.	Garlic Cultivar	Skin colour	qRT-PCR CP value
1.	Bhima Omkar	White	18.65
2.	Agrifound white (G -41)	White	19.42
3.	Phule Baswant	Purple	18.68
4.	Godavari	Purple	18.99
5.	Yamuna Safed -3 (G-282)	Creamy white	19.94
6.	Yamuna Safed -5 (G-189)	Creamy white	19.23

Screening of onion cultivars against Iris Yellow Spot Virus (IYSV)

To locate the sources of resistance in onion against IYSV, twenty-four commercial cultivars of onion were tested for the presence of IYSV through DAS-ELISA. Based on two years of screening, all the cultivars were susceptible for IYSV. The lowest concentration of IYSV was observed in cultivar Bhima Super and B-780 and the highest concentration of virus was recorded on N-2-4-1 followed by Bhima Kiran.

Genome Characterization of IYSV.

The M-RNA segment of IYSV genome encodes for potential viral movement protein (NSm) and the common precursor to the glycoproteins in ambisense arrangement. Total 4.8 Kb M-RNA segments were amplified by 5 pairs of primers (Fig.10.9).



Lane M- 1 Kb Ladder, 1-5: Amplified fragments of M segment

Fig. 10.9 : Amplified products of IYSV M genome segment

Postharvest Technology

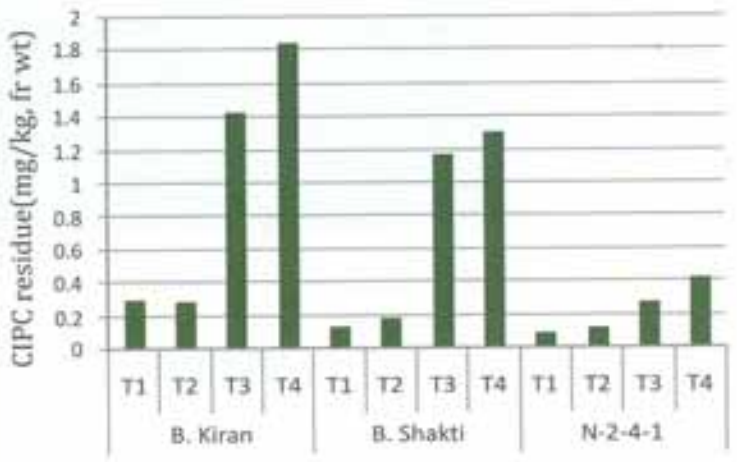
Programme 11: Reduction of postharvest losses in onion and garlic

Project 11.1: Studies on effect of preharvest practices on storage life of onion and garlic

Three varieties viz. Bhima Kiran, Bhima Shakti and N-2-4-1 were grown in *rabi*. The sprays of CIPC, ABA and $Ca(NO_3)_2$ were undertaken after 90 and 105 DAP (i.e. 30 and 15 days prior to harvest, respectively). The observations were recorded for physical and biochemical parameters.

It was observed that the indigenous ABA content of the bulbs did not alter due to external application. Further, the application of ABA and $Ca(NO_3)_2$ was not observed to enhance storability of onion. The application of CIPC was found effective.

The CIPC residues ranged from as low as 0.08 mg/kg fresh weight to the highest concentration of 1.84 mg/kg fresh weight in these samples (Fig.11.1). The differences in residues due to date of treatment and genotype were observed. All the residues observed in these samples were within the recommended MRL of 30 mg/kg by Environmental Protection Agency and 10 mg/kg as recommended by EU for potatoes.



T1: CIPC 0.05 % (90 DAP), T2: 0.5 % (90 DAP), T3: CIPC 0.05 % (105 DAP), T4: CIPC 0.5 % (105 DAP)

Fig. 11.1: CIPC residue level in different treatments of preharvest application in different varieties of onion

The physiological loss of weight (PLW) was recorded after every two months up to six months. The highest weight loss was observed in Bhima Shakti followed by N-2-4-1 and the lowest was recorded in Bhima Kiran (Fig. 11.2). PLW in cv. Bhima Kiran decreased uniformly for each two months. However, the PLW in Bhima Shakti and N-2-4-1 reduced up to four months and again increased in last two months.

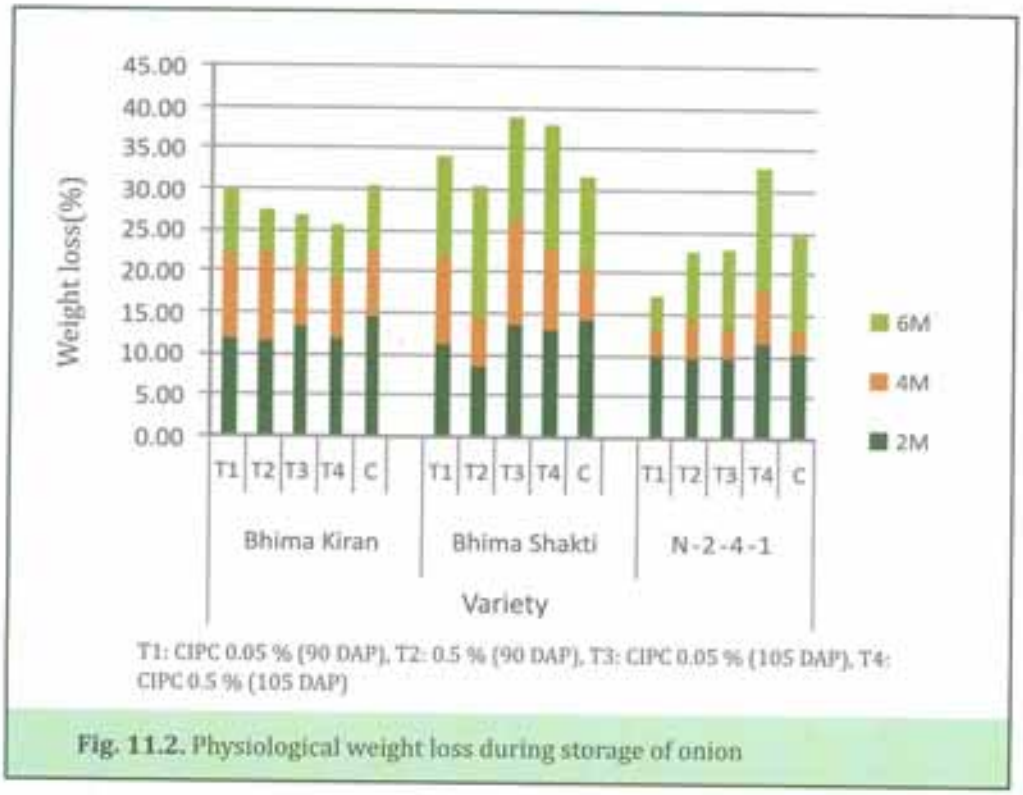


Fig. 11.2. Physiological weight loss during storage of onion

The sprouting was observed only after two months of storage in all the varieties in this trial. Variation due to genotype was significant. The sprouting percentage increased in all varieties with time and the highest sprouting after six months was observed in Bhima Kiran followed by N-2-4-1 and the lowest in Bhima Shakti (Fig.11.3).

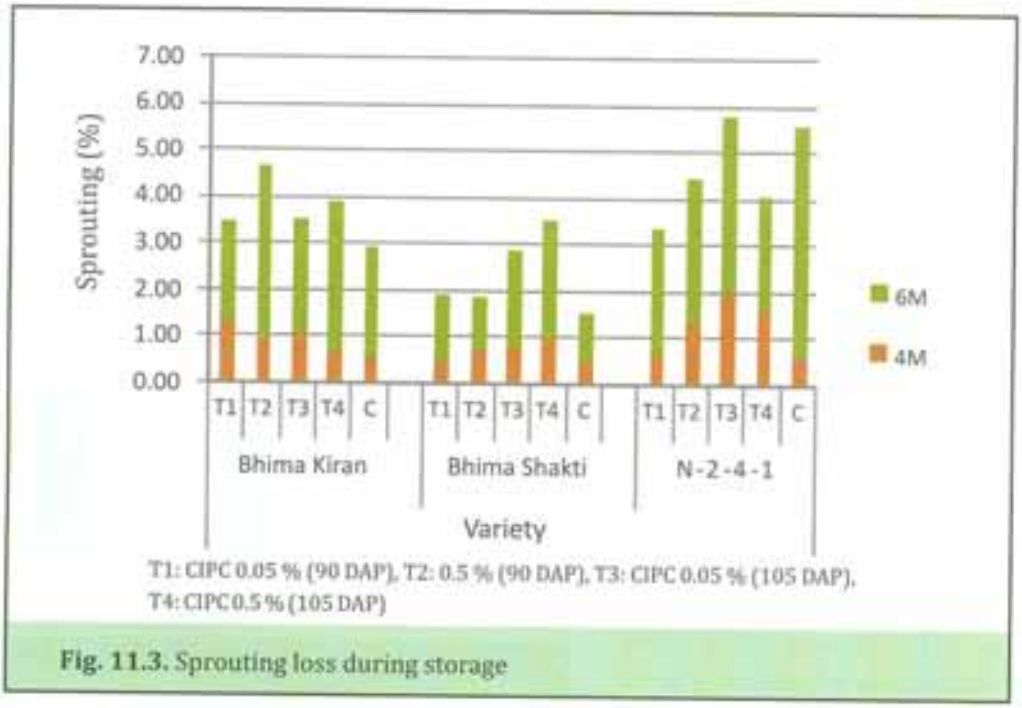


Fig. 11.3. Sprouting loss during storage

The microbial decaying increased after two months and again reduced after four months in all the varieties. The variation due to genotype was significant. In general, the decaying was lowest in N-2-4-1 followed by Bhima Kiran and the highest in Bhima Shakti (11.4).

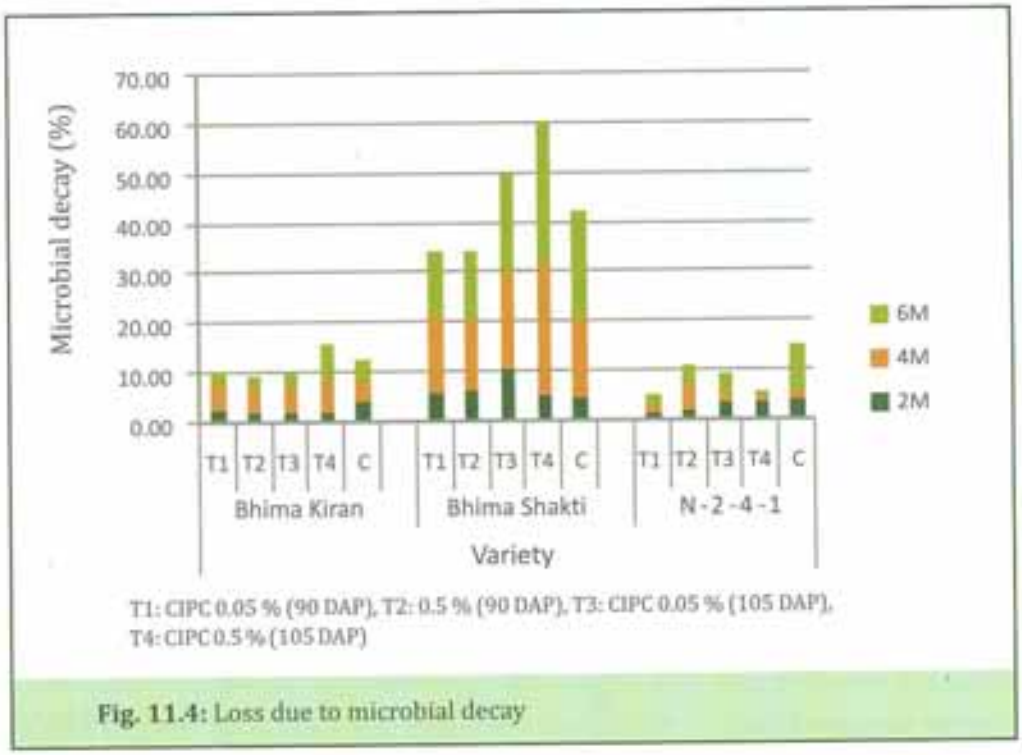


Fig. 11.4: Loss due to microbial decay

The Pyruvic acid contents increased during storage. However, the total sugars and ascorbic acid decreased during storage. There was significant difference among genotypes. The chemical treatments did not show any significant difference over control.

The preharvest application trials of CIPC were carried out in *kharif* season with three varieties viz. Bhima Super, Bhima Raj and Bhima Red. The application of CIPC, 75 DAP was found to reduce sprouting under storage in all the varieties. The phyto-toxicity symptoms were evident in all the treatments.

Project 11.2: Studies on effect of postharvest practices on storage life of onion and garlic

Four varieties viz. Bhima Kiran, Bhima Shakti, Bhima Super and N-2-4-1 were used for trial under the said project. The varieties were gamma irradiated at BARC, Mumbai with 60 Gy with Cobalt-60 source. The CIPC hot fogging was done @ 100 ml/ton. The treated bulbs were stored at ambient temperature and in cold storage at 5°C with 60-65% RH.

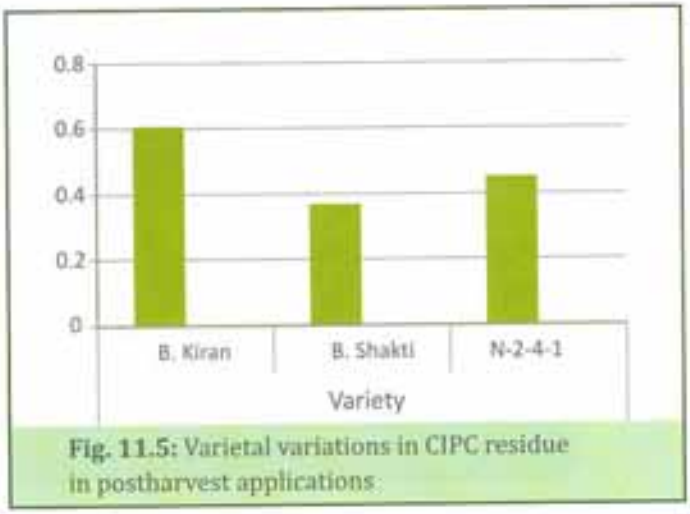


Fig. 11.5: Varietal variations in CIPC residue in postharvest applications

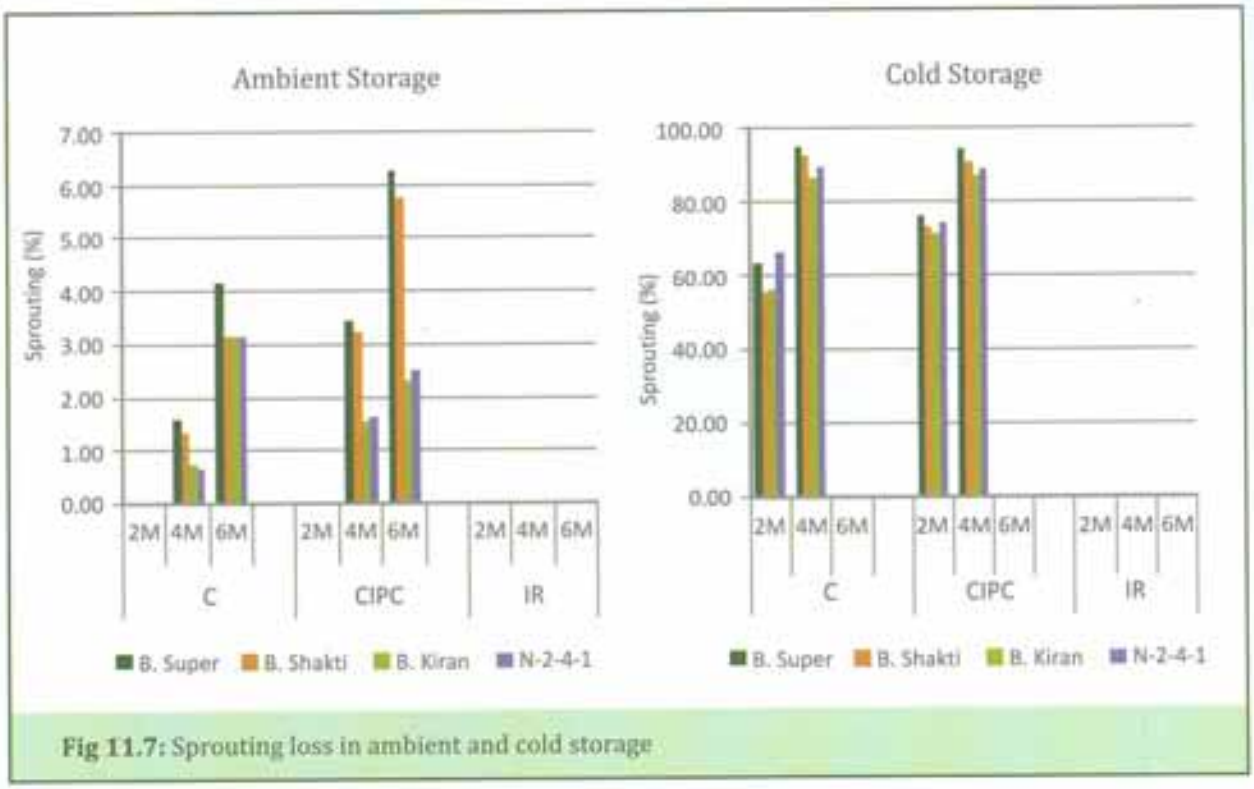


Fig 11.7: Sprouting loss in ambient and cold storage

Microbial decay

The microbial decaying increased gradually over the period of experiment. Under ambient storage the decaying was more in irradiated commodity than control (Fig.11.8).

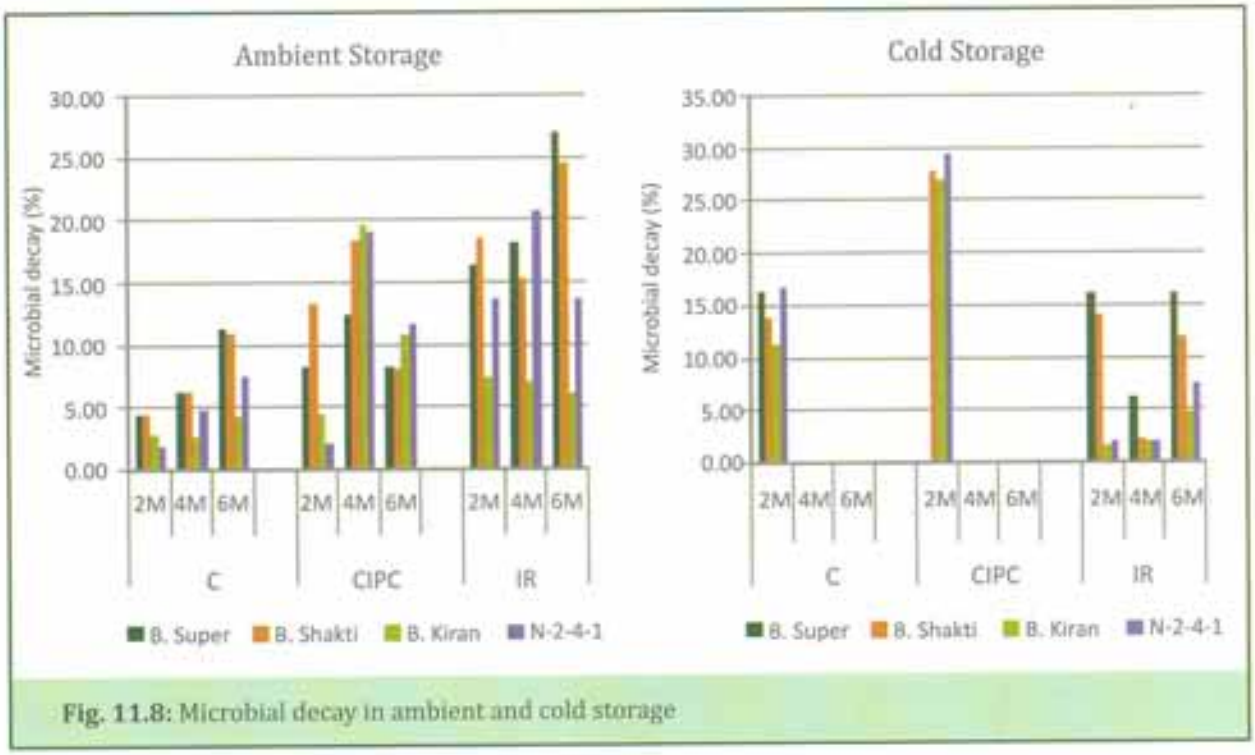


Fig. 11.8: Microbial decay in ambient and cold storage

Survey of cold storages

A survey was conducted to examine the working and efficacy of Controlled Atmosphere (CA) storage for onion at Rajkot, Gujarat on August 5, 2011. The said CA storage structure has been erected by M/S Jaimin Engineering Pvt ltd. Rajkot, Gujarat. The owner, revealed that 3200 tons capacity storage structure maintains about 2-3% oxygen and 6000 - 8000 ppm carbon dioxide, apart from 65 -75% RH and temperature 0 - 1°C. The working cost of cold storage was Rs 0.40 /kg/month.

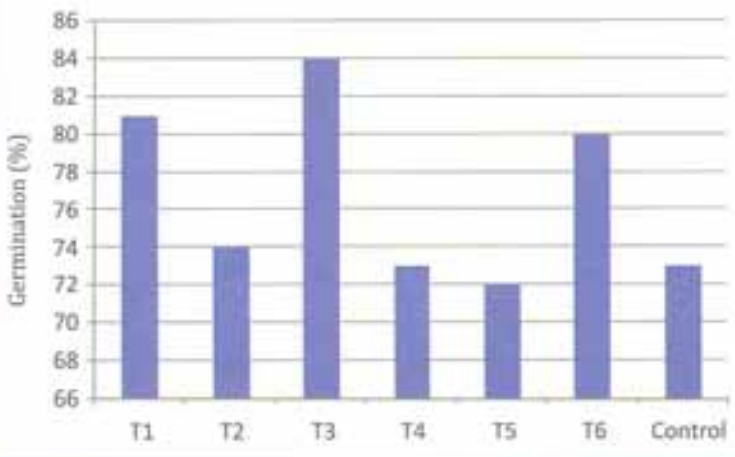
The working and efficacy of onion cold storages and the issue of feasibility of storage of onions in cold storages was discussed with the owners at Jalandhar, Punjab on September 19, 2011 and 'Janta Cold Storage' and 'Kartarpur Cold Storage' were visited. It was observed that the onion varieties were spoiled in cold storage due to sprouting mainly. The black mould infection and rotting was also observed at Janta Cold Storage. The damage was significantly higher in dark red varieties as compared to light red varieties.

Seed Technology

Programme 12: Seed quality management in onion and garlic

Project 12.1: Improvement of seed quality by invigoration

Seeds of onion variety N-2-4-1 stored for 24 months were primed with different concentrations of K_2HPO_4 and Hydration for different durations. Hydration for 24 hours at 15°C significantly enhanced the germination (11%) over control. The vigour index was also high in case of Hydration treatment (Fig 12.1 and 12.2).



T1-2% K_2HPO_4 for 24 hours , T2-3% K_2HPO_4 for 24 hours, T3- Hydration for 24 hours , T4-2% K_2HPO_4 for 48 hours, T5-3% K_2HPO_4 for 48 hours, T6- Hydration for 48 hours.

Figure 12.1: Effect of different priming treatments on germination of 24 months stored seeds

T1-2% K_2HPO_4 for 24 hours , T2-3% K_2HPO_4 for 24 hours, T3- Hydration for 24 hours , T4-2% K_2HPO_4 for 48 hours, T5-3% K_2HPO_4 for 48 hours, T6- Hydration for 48 hours.

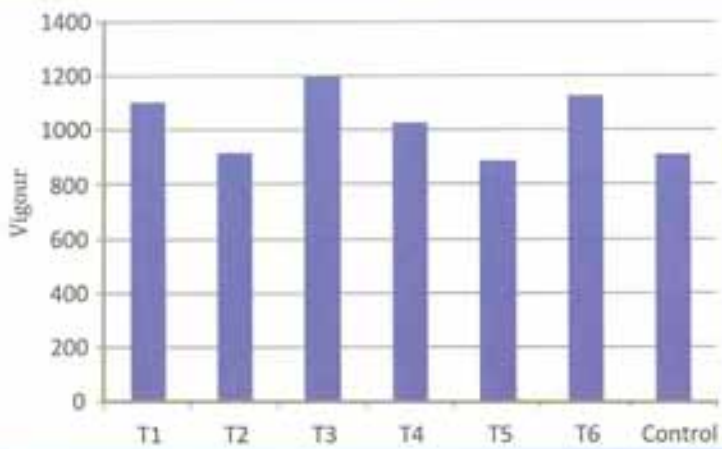


Figure 12.2: Effect of different priming treatments on seedling vigour of 24 months stored seeds

Project 12.2: Genetic purity testing of onion through biochemical approaches

Among different combinations of stacking and resolving gel for total seed proteins in onion through PolyAcryl Gel-Electrophoresis, 4% stacking gel and 10% resolving gel was found to be the best combination. Onion seed protein purification through PAGE perfect kit produced excellent resolution of protein bands in the range of 11 kDa to 72 kDa without lipid and salt interference.

Project 12.3: Screening of onion varieties for seed longevity

Twenty four onion varieties were screened for seed longevity under ambient condition. The germination percentage varied from 89 % in Bhima Shakti to 54 % in Co-5 after 10 months of storage. The highest loss in seed germination after ten months of storage was recorded in cv. Agrifound dark red (24 %).

Project 12.4: Vernalization studies in onion seed production

Seed bulbs of onion cv. Bhima Super and Bhima Kiran were vernalized *in vitro* to study its effect on seed yield and quality. Reproductive traits like number of scapes per plant and scape length were significantly higher in vernalization at 5°C for 40 days in variety Bhima Kiran. Higher number of scapes per plant in cv. Bhima Super was found in vernalization at 10°C for 30 days.

Extension

Programme 13: Socio-economic studies of onion and garlic growers

Project 13.1: Constraint analysis of onion and garlic production and postharvest management

The data were collected using questionnaire from randomly selected 150 farmers of randomly selected 15 villages viz. Otur, Rohokadi, Santwadi, Hiware and Yenere from Pune; Manori, Sangvi-Bhusar, Ravande, Bahirwadi and Shahapur from Ahmednagar; and Shirsmani, Talwade, Behed, Sulewadi and Dahiwal from Nashik district.

Major constraints identified by the farmers in onion cultivation were crop damage due to erratic rainfall at the time of harvesting of *kharif* onion and nursery preparation of *rabi* onion (71.33% farmers), labour shortage at the time of transplanting (67.33%), spurious seed supply from seed companies (64.66%), lack of farmers' scientific knowhow about field operations (61.33%) and farmers inability to maintain isolation distance during seed production (51.33%).

Table 13.1: Constraints in onion production and postharvest management in Pune district

S.No.	Constraints	Frequency (N=50)	Percentage	Rank
1	Inability to maintain isolation distance during seed production	29	58	V2
2	Spurious seed supply from seed companies	35	70	III
3	Weed problem	26	52	VI
4	Labour shortage at the time of transplanting	37	74	II
5	Fertilizer shortage	16	32	X6
6	Unavailability of insecticides, pesticides and herbicides in time	9	18	XIII
7	Unable to control pest and diseases	17	34	IX
8	Lack of scientific knowhow about field operations	33	66	IV
9	**Crop damage due to erratic rainfall**	**38**	**76**	**I**
10	Non scientific way of grading and packaging	7	14	XIV
11	Non scientific storage structure	19	38	VIII
12	More cost involved in transportation	10	20	XII
13	Market price fluctuation	22	44	VII
14	Less marketable share due to bolters, twin bulbs, etc	19	38	VIII
15	Competition in the market	12	24	XI

Table 13.2: Constraints in onion production and postharvest management in Ahmednagar district

S.No.	Constraints	Frequency (N=50)	Percentage	Rank
1	Inability to maintain isolation distance during seed production	23	46	V
2	Spurious seed supply from seed companies	33	66	III
3	Weed problem	20	40	VI
4	Labour shortage at the time of transplanting	34	68	II
5	Fertilizer shortage	11	22	X
6	Unavailability of insecticides, pesticides and herbicides in time	7	14	XIII
7	Unable to control pest and diseases	11	22	X
8	Lack of scientific knowhow about field operations	31	621	V
9	**Crop damage due to erratic rainfall**	**35**	**70**	**I**
10	Non scientific way of grading and packaging	5	10	XIV
11	Non scientific storage structure	14	28	VIII
12	More cost involved in transportation	8	16	XII
13	Market price fluctuation	19	38	VII
14	Less marketable share due to bolters, twin bulbs, etc	13	26	IX
15	Competition in the market	9	18	XI

Table 13.3: Constraints in onion production and postharvest management in Nashik district

S.No.	Constraints	Frequency (N=50)	Percentage	Rank
1	Inability to maintain isolation distance during seed production	25	50	V
2	Spurious seed supply from seed companies	29	58	III
3	Weed problem	23	46	VI
4	Labour shortage at the time of transplanting	30	60	II
5	Fertilizer shortage	15	30	X
6	Unavailability of insecticides, pesticides and herbicides in time	09	18	XIII
7	Unable to control pest and diseases	16	32	IX
8	Lack of scientific knowhow about field operations	28	56	IV
9	**Crop damage due to erratic rainfall**	**34**	**68**	**I**
10	Non scientific way of grading and packaging	08	16	XIV
11	Non scientific storage structure	18	36	VIII
12	More cost involved in transportation	11	22	XII
13	Market price fluctuation	20	40	VII
14	Less marketable share due to bolters, twin bulbs, etc	16	32	IX
15	Competition in the market	12	24	XI

Table 13.4: Overall constraints in onion and garlic production and postharvest management (N=150)

S.No.	Constraints	Frequency (N=50)	Percentage	Rank
1	Inability to maintain isolation distance during seed production	77	51.33	V
2	Spurious seed supply from seed companies	97	64.66	III
3	Weed problem	69	46.00	VI
4	Labour shortage at the time of transplanting	101	67.33	II
5	Fertilizer shortage	42	28.00	XI
6	Unavailability of insecticides, pesticides and herbicides in time	25	16.66	XIV
7	Unable to control pest and diseases	44	29.33	X
8	Lack of scientific knowhow about field operations	92	61.33	IV
9	**Crop damage due to erratic rainfall**	**107**	**71.33**	**I**
10	Non scientific way of grading and packaging	20	13.33	XV
11	Non scientific storage structure	51	34.00	VIII
12	More cost involved in transportation	29	19.33	XIII
13	Market price fluctuation	61	40.66	VII
14	Less marketable share due to bolters, twin bulbs, etc	48	32.00	IX
15	Competition in the market	33	22.00	XII

Project 13.2: Collection, documentation and validation of indigenous technical knowledge (ITK)s from onion and garlic farmers

ITKs were collected from different states viz. Maharashtra, Tamil Nadu, Karnataka, Gujarat, Orissa, Rajasthan, Madhya Pradesh, Bihar, Uttar Pradesh, Himachal Pradesh, Jammu & Kashmir, Haryana and Andhra Pradesh. Collected ITKs were scrutinized and important ITKs were selected after discussion with the experts.

Some of the important ITKs found in onion production were:

1. **ITK in seed treatment-** Onion seed dressed with cow dung and sheep dung enhance the seed germination and result in better crop stand in nursery as well as in main field.
2. **ITK in nursery management-** Use of well decomposed organic manures and green manures for preparation of nursery beds leads to improved soil fertility.
3. **ITK in crop production-** Wood ash (source of potash) application at the time of field preparation and application of concentrated organic manures like neem cake and other plant

cakes are used as soil amendments. A mixture of goat dung (25 kg), powder of berry of neem tree (10 kg), Phosphate Solubilizing Bacteria (PSB; 1 kg), ginger (100 gm) and jaggery (200 gm) is used as micronutrient.

4. **ITK in plant protection measures-** Mixed spray of cow urine + asafoetida + milk for pest control, herbal extract of *acacia* leaves, custard apple leaves and neem seed kernel extract is used for controlling pest and diseases. *Vites nugundo* leaf extract is used for thrips control.

5. **ITK in storage-** Cleaned onion seed packed in gunny bags or stored in earthen pot for maintaining seed moisture enhance storage life.

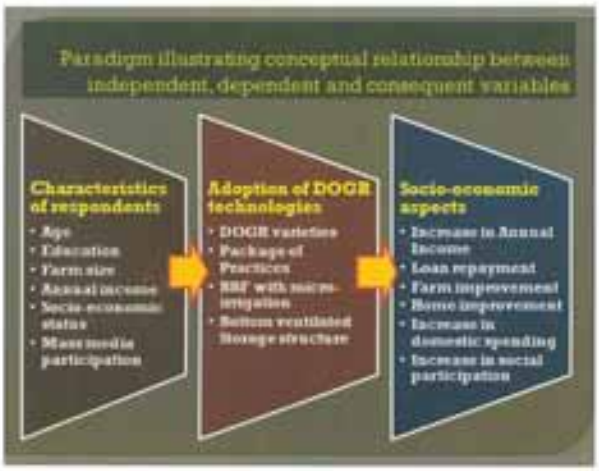
Some of the important ITKs found in garlic production were:

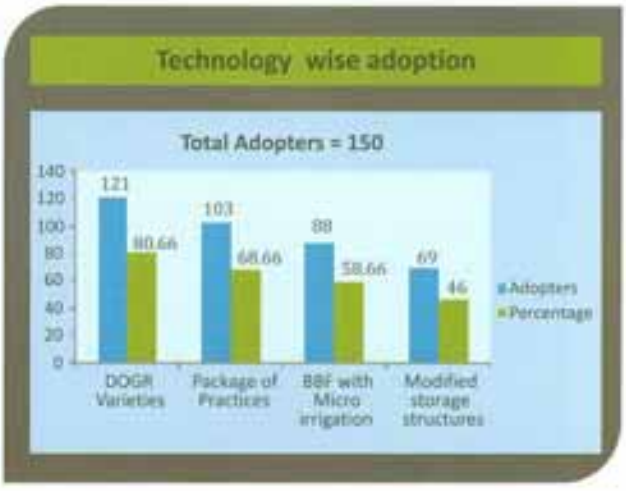
Dipping of garlic cloves in buttermilk before sowing results in fast sprouting process, and Indigenous practice of hanging garlic bulbs in storage is followed in Vidarbha region of Maharashtra and Madhya Pradesh.

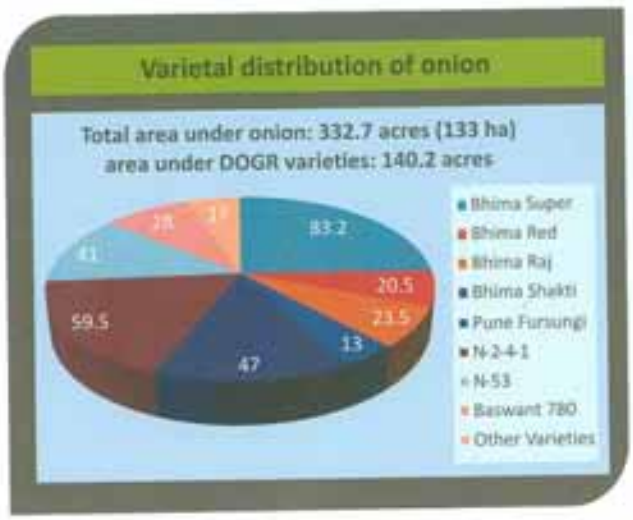
Project 13.3: Impact analysis of technologies developed by DOGR

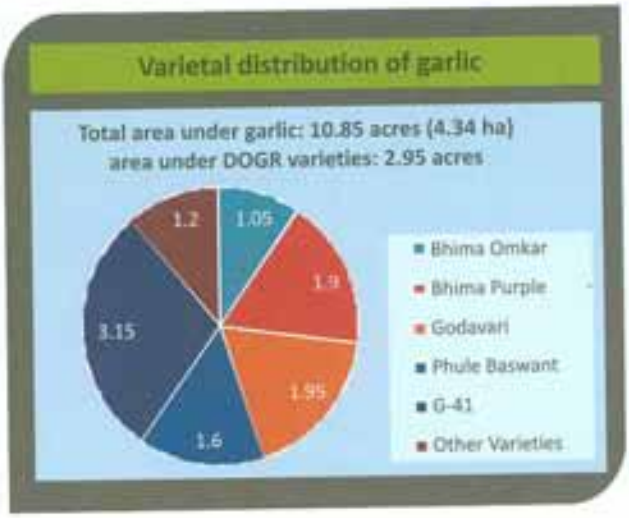
The data were collected using questionnaire from randomly selected 150 farmers of 15 villages namely Otur, Rohokadi, Santwadi, Hiware and Yenere from Pune; Manori, Sangvi-Bhusar, Ravande, Bahirwadi and Shahapur from Ahmednagar; and Shirsmani, Talwade, Behed, Sulewadi and Dahiwal from Nashik district.

It was found that the adoption of DOGR developed technologies was the highest in Pune (77.10%), followed by Ahmednagar (71.56%) and Nashik (68.21%). DOGR varieties, package of practices, Broad Based Furrow (BBF) with micro irrigation and modified storage structures were adopted by 80.66%, 68.66%, 58.66% and 46% farmers, respectively. In onion cultivation, 140.2 acres area was covered by DOGR varieties i.e. 42.14% of the total 332.7 acres onion cultivated area surveyed in the study. While in garlic, 2.95 acres area was under DOGR varieties i.e. 27.19% of the total 10.85 acres garlic cultivated area surveyed in the study.









Findings indicated a significant association between the level of adoption among the farmers and level of overall change in socio-economic aspects. Among the farmers who adopted medium to high degree of adoption, majority of them reported a positive change in socio-economic aspects. There was significant impact of DOGR technologies (varieties, package of practices, BBF with drip irrigation and modified storage structures) on socio-economic aspects (increase in annual income, loan repayment, farm improvement, home improvement, increase in domestic spending and increase in social participation) of onion and garlic farmers.

Table 13.5: Categorization of respondents

Variable	Standard Deviation	Mean
Age	11.34	38.64
Education	1.22	2.15
Farm size	1.63	2.61
Annual income	2.52	5.26
Socio-economic status	8.12	21.32
Economic motivation	8.71	23.40
Extension contact	6.32	7.12
Social participation	5.60	6.78
Mass media participation	7.84	9.45

Table 13.6: Relationship between characteristics of respondents and adoption of DOGR technologies

Characteristics of respondents	'r' values
Age	-0.3221*
Education	0.3458*
Farm size	0.3713*
Annual income	0.4212*
Socio-economic status	0.7328*
Economic motivation	0.4274*
Extension contact	0.3322*
Social participation	0.6143*
Mass media participation	0.6732*

*Significant at 1% level of probability

Table 13.7: Association between adoption level and socio-economic aspects

Socio-economic aspects	X2 values	Degree of freedom
Increase in Annual Income	12.24*	4
Loan Repayment	23.56*	6
Farm Improvement	18.12*	6
Home Improvement	13.00**	6
Increase in domestic spending	14.67*	4
Increase in social participation	22.12*	6

DOGR Varieties Recommeded for Release

Bhima Shakti

Bhima Shakti (1156) (IC No. 572769) was identified at National level for release during 2nd AINRPOG group meeting at Ooty (TNAU, Coimbatore) during 2011 for four zones viz. Zone III (Delhi, UP, Haryana, Bihar and Punjab), Zone IV (Rajasthan and Gujarat), Zone V (MP, Chhattisgarh and Orissa) and zone VI (Maharashtra, Karnataka and Andhra Pradesh) for late *kharif* as well as *rabi* season. Bulbs attains immediate attractive red colour after harvest. Shape is round. Very less number of bolters 2.15% & 0.36% and doubles 5.69% & 1.38% during late *kharif* and *rabi* season, respectively. TSS 11.8%. Small to medium neck thickness, uniform neck fall during *rabi* and more than 70% neck fall during late *kharif*. Bulbs have very good storage life upto 5-6 months. Bulbs mature in 130 days after transplanting during late *kharif* and *rabi* season. It is tolerant to thrips. Marketable yield during late *kharif* is 45.9 t/ha and during *rabi* 42.7 t/ha in Maharashtra compared to national average of 29.18t/ha during *rabi* season.

Bhima Shweta

Bhima Shweta (White El. Comp. Selection/ NRCWO-2) (IC No. 572761) was identified at National Level for release during IInd AINRPOG group meeting at Ooty (TNAU, Coimbatore) during 2011 for three zones viz., Zone III (Delhi, UP, Haryana, Bihar and Punjab), Zone V (MP, Chhattisgarh and Orissa) and Zone VI (Maharashtra, Karnataka and Andhra Pradesh) for *rabi* season. Bulbs are attractive white in colour, round in shape, very less number of bolters and doubles less than 3% in *rabi* season, thin neck, TSS 11.5%, matures in 110-115 day after transplanting during *rabi*, medium in keeping quality upto 3 months. Average marketable yield is 35.9 t/ha compared to national average of 28.2 t/ha. It is tolerant to thrips.

Bhima Shubhra

Bhima Shubra (w-009) (IC No. 572763) was released at institute level during 2010 for *kharif* and late *kharif* season for Maharashtra region. Bulbs are attractive white in colour, oval to round in shape bulb, have less number of bolters up to 6% during late *kharif* and no bolters during *kharif* and doubles less than 3% in late *kharif* and *kharif* season, thin neck, TSS 10.4% in *kharif* and 11.7% in late *kharif*, matures in 112 days after transplanting during *kharif* and 125 days in late *kharif*. Bulbs can be stored for 2-3 months during late *kharif*. It has capacity to tolerate environmental fluctuation, hence can be cultivated in all the three seasons. Average marketable yield during *kharif* is 24.16 t/ha and during late *kharif* 38.9 t/ha. It can fill the gap for processing from October to February.

Bhima Purple

Bhima Purple (IC 570742), has been recommended in IInd AINRPOG group meeting (2011-12) organised by TNAU, Coimbatore at Ooty. It can be successfully grown in the tropical growing areas of India and has been recommended for cultivation in Zone III (Delhi, UP, Haryana, Bihar and Punjab) and Zone VI (Maharashtra, Karnataka and AP). This line has been identified for high yield and better quality. It has been developed through clonal selection of the local material obtained from Angul, Orissa. The bulbs of this variety are medium in size, compact and purple in colour, 16-20 cloves/bulb, TSS 33.6% and allicin @ 2.9 mg/g (fresh weight basis) and 9.6 mg/g (dry weight basis). Leaves are narrow with medium green colour and the average yield in multi-location trials was 68.9 q/ha.

On Going Programmes and Projects at DOGR

Programme 1	Development of red and light red onion varieties/ hybrids suitable for different seasons having resistance to biotic and abiotic stresses
Scientist	Dr. A.J. Gupta PI
Project 1.1	Collection, evaluation and maintenance of red onion germplasm
Project 1.2	Development of onion varieties suitable for different seasons for year round availability
Project 1.3	Heterosis breeding in red onion
Project 1.4	Breeding red onion varieties resistant to biotic and abiotic stresses

Programme 2	Development of onion (white and yellow) varieties/ hybrids for processing and export having resistance to biotic and abiotic stresses
Scientist	Dr. V Mahajan, PI
Project 2.1	Collection, evaluation and maintenance of white onion germplasm
Project 2.2	Development of high TSS white onion varieties suitable for different seasons and processing
Project 2.3	Collection, evaluation and maintenance of yellow onion germplasm
Project 2.4	Development of yellow onion varieties suitable for export
Project 2.5	Heterosis breeding in white and yellow onion
Project 2.6	Breeding white and yellow onion varieties resistant to biotic and abiotic stresses

Programme 3	Improvement of garlic through conventional and biotechnological approaches
Scientist	Dr. A Khar, PI
Project 3.1	Collection, evaluation and maintenance of garlic germplasm
Project 3.2	Development of high yielding garlic varieties suitable for different production areas through clonal selection

Project 3.3	Studies on somaclonal variations in garlic
Project 3.4	Production of virus free garlic through in vitro meristem tip culture
Project 3.5	Molecular analysis of genetic diversity in garlic

Programme 4	**Biotechnological approaches for improvement of onion (*Alliums cepa* L.)**
Scientist	**Dr. S. Anandhan, PI**
Project 4.1	Induction of haploids in onion
Project 4.2	Micropropagation studies in onion
Project 4.3	DNA profiling of onion lines using molecular markers

Programme 5	**Collection, characterization and screening of wild species for *Allium* improvement**
Scientist	**Dr. A Khar, PI**
Project 5.1	Screening of wild species for biotic stresses and introgression of desirable genes in *Allium cepa*

Programme 6	**Integrated nutrient management for onion and garlic**
Scientist	**Dr. A. Thangasamy, PI**
Project 6.1	Nutrient uptake studies in onion and garlic

Programme 7	**Enhancement of production of onion and garlic through agronomic innovations**
Scientist	**Dr. V Sankar, PI**
Project 7.1	Studies on organic production of onion and garlic
Project 7.2	Weed management studies in onion and garlic
Project 7.3	Studies on foliar feeding of nutrients and growth regulators on growth and yield of onion and garlic

Programme 9	**Integrated pest management in onion and garlic**
Scientist	**Mrs. BR Jayantimala, PI**
Project 9.1	Bio-intensive pest management in onion and garlic
Project 9.2	Vector-virus relation in onion and garlic

Programme 10 Integrated disease management in onion and garlic	
Scientist	**Dr. CR Ramesh, PI**
Project 10.1	Geospatial pathogenic and molecular characterization of fungal diseases in onion and garlic detection, management and risk analysis
Project 10.2	Management of soil borne diseases of onion and garlic
Scientist	**Dr. SJ Gawande, PI**
Project 10.3	Management of foliar diseases of onion and garlic
Project 10.4	Diagnostic of Allium viruses

Programme 11 Reduction of post- harvest losses in onion and garlic	
Scientist	**Dr. AA Murkute, PI**
Project 11.1	Studies on effect of pre- harvest practices on storage life of onion and garlic
Project 11.2	Studies on effect of postharvest practices on storage life of onion and garlic

Programme 12 Seed quality management in onion and garlic	
Scientist	**Mr. YR Vishwanath, PI**
Project 12.1	Improvement of seed quality by invigoration
Project 12.2	Genetic purity testing through biochemical approaches
Project 12.3	Screening for onion varities for seed longivities
Project 12.4	Vernalisation studies in Onion seed production

Programme 13 Socio-economic studies of onion and garlic growers	
Scientist	**Dr. SS Gadge, PI**
Project 13.1	Constraint analysis of onion and garlic production and postharvest technology management
Project 13.2	Collection, documentation and validation of Indigenous Technical Knowledge (ITK)s among onion and garlic farmers
Project 13.3	Impact analysis of different technologies generated and developed by DOGR for onion and garlic growers

Externally funded projects

Scientist	**Dr. V Mahajan** (Nodal Officer)
Project 1	All India Network Project on Onion & Garlic
Scientist	**Dr. A.J. Gupta** (Nodal Officer)
Project 2	DUS Testing through ICAR-SAU's System
Scientist	**Mrs. BR Jayantimala**
Project 3	Outreach Research Project on Sucking Pest

List of Publication

Research articles/ reviews

1. Joshi, N., A. Ravindran and V. Mahajan (2011). Investigations on chemical mutagen sensitivity in onion (*Allium cepa* L.). International J. Botany, 7 (3): 243-248.

2. Khar, A., K. Banerjee, M. Jadhav and K.E. Lawande (2011). Evaluation of Indian garlic ecotypes for allicin and other allyl-thiosulphinates. Food Chemistry, 128: 988-996.

3. Tripathi P.C., V. Sankar, V. Mahajan and K.E Lawande (2011). Response of gamma irradiation on post harvest losses in some onion varieties. Indian J. Horticulture, 68 (4): 556-560.

Conference proceedings/ souvenir/ abstracts

1. Mahajan, V. (2011). Genetic diversity and crop improvement in onion and garlic. In: 'Exploiting Spices Production Potential of the Deccan Region, SYMSAC-VI, Indian Society for Spices, December8-10, 2011, Dharwad: 19-40 pp.

2. Pankti, G., B.B. Patel, V. Rane, J. George, A. Khar, V. Mahajan, B. Narula, S. Shankhdarwar and J. Pius (2011). Comparative karyomorphological studies in eleven accessions of *Allium cepa* Linn. National Seminar on Sustainable Crop Productivity through Physiological Intervention. November 24-26, 2011, Ruia College, Mumbai.

3. Gadge, S.S. and Lawande K.E. (2011). Crop damage due to climatic change: A major constraint in onion farming. 6th National Extension Education Congress. December 17-19, 2011, Society of Extension Education, Agra.

4. Lawande K.E. and A.A. Murkute (2011). Initiatives in onion and garlic cool chain management. National seminar on 'Post-Harvest Packaging, Cold chain logistics and instrumentation techniques for quality and safety of perishables'. December 19-20, 2011, CIPHET, Ludhiana.

Technical bulletin

1. Sankar V. and K.E. Lawande (2011). A film on Micro irrigation in Onion and Garlic - Drops of Life - DVD.

Popular articles

1. Mahajan, V. and K.E. Lawande (2011). *Khharif kandhyache utpadan*. Baliraja, June: 90-95.
2. Mahajan, V. and K.E. Lawande (2011). *Sudharit paddhatine kara kanda lagwad*. Agro-One, July 18 2,011.
3. Mahajan, V. and K.E. Lawande (2011). *Sudharit paddhatine kara kanda lagwad*. Sakal Pragati, July 30, 2011.
4. Mahajan, V. and K.E. Lawande (2011). *Kanda beejoupadan* Part-I. Annadata, September: 43-47.
5. Mahajan, V. and K.E. Lawande (2011). *Kanda beejoupadan* Part-II." Annadata, October: 36-39.
6. Mahajan, V. (2011). *Rangada kandhyache utpadan shashtra*. Shetimitra, October: 66-72.
7. Mahajan, V. and K.E. Lawande (2011). *Niyojan rabbi kandhyache*. Agro-One, October 7, 2011.
8. Mahajan, V. (2011). *Lasun lagwadisathi niyojan*. Annadata, December: 43-47.
9. Mahajan, V. and K.E. Lawande (2011). *Ase karaa kandyache vyavasthapan*. Agro-One, October 8, 2011.
10. Mahajan, V. and K.E. Lawande (2011). *Rabi kanda lagwad va peek niyojan*. RCF Sheti Patrika, December: 5-6.
11. Mahajan, V. (2012). *Kanda Sathvanukisathi kadhnipoorvi va kadhaninanterche tantragyan* Part-I. Annanadata, February: 43-47.
12. Mahajan, V. (2012). *Kanda Niryat: Kanda Sathvanukisathi kadhnipoorvi va kadhaninanterche tantragyan* Part-II" Annanadata, March: 22-23.
13. Lawande, K.E. and Gadge S.S. (2011). *Rangda kanda: Keed va rog niyantran*. Annadata. October: 47.
14. Lawande, K.E. and Gadge S.S. (2011). *Rangda kandyachya lagwadiche tantradnyan*. Annadata. August: 8-12.

Transfer of Technology

Lectures delivered

Topic	Event & Organizer	Date and Venue
Dr. K.E. Lawande		
Technological Interventions for Sustainable Onion and Garlic Production at High Altitude Cold Deserts of India	International Conference on Emerging Trends on Food and Health Security in Cold Deserts at Leh-Ladakh organized by Defence Institute of High Altitude Research DRDO, Leh-Ladakh	23/09/2011, DIHAR, DRDO Leh-Ladakh
Dr. V. Mahajan		
Onion cultivation, storage and seed production.	DOGR	27/05/2011, DOGR, Pune
Onion cultivation, management and storage.	Society for Agro-tourism and Maharashtra Agriculture Department	8/10/2011, Sagunabaug, Ratnagiri
Onion and garlic production	DOGR under ATMA scheme	5/3/2012, DOGR, Pune
Processing and value addition of onion and garlic	DOGR under ATMA scheme	6/3/2012, DOGR, Pune
Dr. Anil Khar		
DOGR technologies for commercialization	2nd Horticulture-Industry Meet, IIHR, Bangalore	6/3/2012, IIHR, Bangalore
Dr. A.J. Gupta		
Nutraceutical importance of onion and garlic	DOGR under ATMA scheme	5/3/2012, DOGR, Pune
Varietal Improvement in Onion	DOGR under ATMA scheme	6/3/2012, DOGR, Pune

Dr. S.S. Gadge		
Role of Self Help Groups in improving socio-economic status of onion and garlic farmers	DOGR under ATMA scheme	5/3/2012, DOGR, Pune
Insect, pest and disease control in onion and garlic	Sub Divisional Agriculture Officer, Bhubaneshwar (Orissa) under NHM scheme	5/1/20122, DOGR, Pune
Advance production technology of onion and garlic farming	Sub Divisional Agriculture Officer, Nandurbar (MS) under NHM scheme	16/12/2011, DOGR, Pune
Management of *rabi* onion crop	Sub Divisional Agriculture Officer, Lasalgaon (MS) under NHM scheme	19/9/2011, DOGR, Pune
New technology for increasing productivity of onion crop	District Horticulture Officer, Nawada (Bihar)	13/9/2011, DOGR, Pune
Government policies for onion and garlic growers	Sub Divisional Agriculture Officer, Aurangabad (MS)	25/4/2011, DOGR, Pune
Dr. S. Anandhan		
Role of Biotechnology in Onion and Garlic	DOGR under ATMA scheme	7/3/2012, DOGR, Pune
Dr. A.A. Murkute		
Initiatives in onion and garlic cool chain management.	National seminar on Post-Harvest Packaging, Cold chain logistics and instrumentation techniques for quality and safety of perishables'. CIPHET, Ludhiana.	19/12/20122, CIPHET, Ludhiana.
Postharvest management of onion and garlic	DODR under ATMA scheme	6/3/ 2012, DOGR, Pune
Onion seed production	DODR under ATMA scheme	5/3/ 2012, DOGR, Pune

Participation in exhibition

Title	Organizer	Venue & Date
Dr. Anil Khar		
2nd Horticulture-Industry Meet	IIHR, Bangalore	IIHR, Bangalore March 6-7, 2012
Dr. S.S. Gadge and staff members		
Exhibition on the occasion of "Science Day celebration"	Giant Metrewave Radio Telescope, Tata Institute of Fundamental Research, Narayangaon	GMRT Site, Khodad, Tal. Junnar, Dist. Pune, February 28 -29, 2011
Agricultural Exhibition "KISAN 2011"	Kisan Forum Pvt Ltd, Pune	Moshi, Pune December 14-18, 2011
Agricultural Exhibition " Enabling farmers for secondary agriculture"	Ministry of Agriculture, New Delhi	Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, December 3-5, 2011

Human Resource Development

Participation of scientists/ staff in conferences/ short term courses/ meetings/ workshops / trainings etc. during 2011-12

Title and Venue	Period
Dr. Jai Gopal	
Pre-QRT Interaction meeting of QRT team of DOGR along with DDG (H) at ICAR Hqrs., New Delhi	February 2, 2012
Directors - Vice Chancellors Interface and Directors' Conference of ICAR Institutes at NASC, New Delhi	February 17-18, 2012
Meeting for finalizing combined XII Plan EFC of IIVR, DMR and DOGR at DMR, Solan	March 9, 2012
Nanotechnology Platform and Outreach Programmes meeting organized by Horticulture Division at ICAR Hqrs., New Delhi	March 12-13, 2012
Meeting of Core Group on State S&T oriented demonstration projects at INSA, New Delhi	March 14, 2012
Meeting with Director of Horticulture, Govt. of Maharashtra, at Pune	March 17, 2012
Dr. K.E. Lawande	
Divisional Meeting of the Directors of Horticulture Division, ICAR under the chairmanship of DDG (H) at NASC Complex, New Delhi	April 11, 2011
Directors' Conference of ICAR at NBPGR Auditorium, NBPGR, Pusa, New Delhi	July 15-16, 2011
Meeting with Hon'ble Agriculture Minister, Government of India regarding CA storage on onion at Ministry of Agriculture, Govt. of India, New Delhi	July 18, 2011
167th Executive Council Meeting of Marathwada Agricultural University, Parbhani at Aurangabad	July 23, 2011
Interactive Meeting of Secretary, DARE and Director General, ICAR with PCs of AICRPs/AINRPs under Horticulture Division at Committee Room No.1, Krishi Bhawan, New Delhi	July 25, 2011
Meeting of working subgroup of Horticulture Crops in Agricultural Research & Education for XII Five Year Plan (2012-2017) under the chairmanship of DDG (H) at Conference Room, NAAS Block, NASC Complex, New Delhi	July 26, 2011

Title and Venue	Period
Preliminary Meeting of 6th National Conference on Krishi Vigyan Kendra - 2011 under the chairmanship of Secretary, DARE & Director General, ICAR at Board Room of NASC Complex, New Delhi	August 9, 2011
Visited NAARM, ICRISAT and NBPGR RS, Hyderabad for studying crop modulation and simulation modules for conducting research on abiotic stresses with physiology scientist, ICRISAT for studying crop modeling and disease forecasting system.	August 25-30, 2011
XII Plan EFC Meeting under the chairmanship of DDG (H), ICAR and to present XII Plan of DOGR & AINRPOG at ICAR, New Delhi	September 6-7, 2011
Meeting of Vice-Chancellors' of Agricultural Universities at NASC Complex, ICAR, New Delhi	September 26-27, 2011
Meeting with Mission Director (NHM), ICAR, Krishi Bhawan, New Delhi regarding onion storage and supply chain management at New Delhi	October 4-5, 2011
RAC Meeting of IIHR, Bangalore at IIHR, Bangalore	October 10, 2011
Dr. C.R. Ramesh	
135th Managing Committee Meeting of NHRDF at Mumbai	November 7, 2011
Technology Meet at KVK, Baramati.	November 16, 2011
ICARDA Meeting of the International Workshop on cactus crop to improve the rural livelihoods and the to adapt to climate change in the arid and semi arid regions of India at NBPGR, New Delhi	November 25, 2011
Conference on Agro-biotechnology at IARI Auditorium, New Delhi	December 19-20, 2011
Dr. V. Mahajan	
Interaction meeting of Project Coordinators / Project Directors chaired by DG, ICAR at CIAE, Bhopal.	June 16, 2011
Discussion on identified platform areas for XII plan by horticulture division scientists. Organized by DDG (Hort.) at N. Delhi.	September 6-7, 2011
Interaction meet with Scientists trained abroad in frontier areas of Agricultural Sciences organized by NAIP, under chairmanship of DG, ICAR at New Delhi.	November 28-30, 2011
Preliminary QRT Meeting with DDG and QRT members at New Delhi	February 2, 2012
Meeting with Director Horticulture at Pune regarding onion seed production	March 16, 2012
Dr. Anil Khar	
Two and a half months International training on Marker Assisted Selection (MAS) at The Plant and Food Research Limited, Christchurch, New Zealand under the NAIP Programme.	June to August 2011

Title and Venue	Period
Interaction meet with Scientists trained abroad in frontier areas of Agricultural Sciences organized by NAIP, under chairmanship of DG, ICAR at New Delhi.	November 28-30, 2011
Second Workshop-cum- Installation training program for the Nodal Officers of Project "Strengthening Statistical Computing for NARS" organized at CIFE, Mumbai	January 6, 2012
Dr. A.J. Gupta	
Refresher Course on Agricultural Research Management for Newly Recruited Senior / Principal Scientists at NAARM, Hyderabad	January 19 to February 8, 2012
Annual Day Celebration and DUS Review Meeting at ICAR, New Delhi	November 11-12, 2011
Dr. S. S. Gadge	
6th National Extension Education Congress organized by Society of Extension Education on the theme 'Emerging Models of Technology Application for Agri-Rural Development' at ICAR Research Complex, Goa	December 17-19, 2011
Dr. A.A. Murkute	
Technical deliberations with Hon'ble Agriculture Minister, Govt of India on feasibility of Controlled Atmosphere (C.A.) Storage for onion storage, along with Director DOGR at Ministry of Agriculture, Krishi Bhavan, New Delhi	July 18, 2011
Refresher Course on Agricultural Research Management for Newly Recruited Senior / Principal Scientists at NAARM, Hyderabad	January 19 to February 8, 2012
National Seminar on 'Post-Harvest Packaging, Cold Chain Logistics and Instrumentation Techniques for Quality and Safety of Perishables'. CIPHET, Ludhiana	December 19-20, 2011
Dr. S. Anandhan	
Refresher Course on Agricultural Research Management for Newly Recruited Senior / Principal Scientists at NAARM, Hyderabad	January 19 to February 8, 2012
Dr. A. Thangasamy	
Attended National Workshop of Soil Test Crop Response for fertilizer recommendation held at IISS, Bhopal	July 28-29, 2011
Mr. Vishwanath	
National Stakeholders' Consultation Meeting on Seed Platform at ANGRAU, Hyderabad	December 17, 2011

Institutional Activities

All India network research project on onion & garlic, 29-30, April 2011, Ooty (TNAU, Coimbatore)

The second group meeting of All India Network Research Project on Onion and Garlic was organized by TNAU, Coimbatore at Ooty during 29-30, April 2011. Dr N. Kumar, Dean HC & RI, TNAU, Coimbatore delivered the welcome address. In keynote address Dr. K.E. Lawande, Director DOGR outlined the importance of onion and garlic vis-à-vis problems associated with these sensitive commodities along with importance of networking centres. He expressed sincere gratitude towards university authorities for organization of AINRP.

Dr. P. Subbian, Registrar, TNAU, Coimbatore delivered presidential address. Chief Guest of the function Dr H.P. Singh, DDG (Hort), ICAR, New Delhi suggested for formulating groups to discuss the line of future research keeping in view the impact of climatic change and future requirements of the market. Dr. L. Pugalendhi, Organizing Secretary & Professor and Head (Vegetable Crops), TNAU proposed vote of thanks. The meet proceeded with different technical sessions. Plenary session was chaired the Dr. P. Murugesa Bhupati, Vice-Chancellor, TNAU. The group identified three varieties of the onion and three varieties of the garlic for release at national level. Eight recommendations on production technology were also finalized for release.

Meeting of Quinquennial Review Team

The Quinquennial Review Team (QRT) - 2006-2011 constituted by ICAR was comprised of the following members

1.	Dr. Brahma Singh,	Chairman
2.	Dr. R. K. Jain,	Member
3	Dr. D. Veeraragavathatham,	Member
4.	Dr. P. S. Sirohi,	Member
5.	Dr. Harihar Ram,	Member
6.	Dr. Vijay Mahajan,	Member Secy.

The meeting of QRT was organized at Directorate of Onion and Garlic Research, Rajgurunagar during 23/2/2012 to 27/02/2012. The committee made exhaustive review of infrastructural facilities created viz. farm development, laboratories and research programmes

implemented during the period 2006-2011 and its output. The meeting was initiated by a formal welcome of the Chairman and members by Dr Jai Gopal, Director DOGR followed by brief presentation by the Director about the salient achievements of the Directorate. The scientists presented the progress of individual projects and outcome in terms of technologies developed and disseminated, papers published, and infrastructure developed during the review period. The QRT observed that Directorate of Onion and Garlic Research has made significant contribution during the period of review not only in research achievements and technology development in onion and garlic but also in research farms development and equipping the laboratories. The Chairman noted that the Directorate has also established strong linkages with several national and international institutions and organizations. The committee commended about properly maintained seed production plots of onion and garlic. It also gave compliments for the Directorate's endeavors for the seed production of released varieties and attempts to commercialize the same through public and private partnership approach. The active involvement of Directorate in training programmes for farmers, stake holders, exhibition, etc. with regard to future perspective and the Perspective Plan 2030 were also appreciated by the committee. Further, the QRT reviewed Directorate's research programme on both onion and garlic and visited seed production farms at Kalus and Manjri and fields of onion growers who are being guided by DOGR. Keeping in view, the constraints in terms of manpower, availability of power, budget, infrastructure etc. the committee made certain valuable recommendations. One of the members of QRT Dr. R.K. Jain visited on 27.3.2012 and critically reviewed the work going in Plant Protection.

Research Advisory Committee Meeting

The fourteenth RAC meeting of DOGR was held on November 21-22, 2011. Dr. B.S. Dhankhar, Former Assistant Director General (ADG) chaired the meeting. Other RAC members were Prof. M. Udayakumar, UAS, Bangalore, Prof. A.N. Maurya, Emeritus Scientist, BHU, Varanasi, Dr. Hari Har Ram, Vice President (R&D) Krishidhan Seeds Pvt. Ltd., Dr. S.J. Singh, Former Head, IARI Regional Station, Pune. Dr. Umesh

Srivastava, ADG (Vegetable Crops) ICAR, New Delhi, Dr. R.P. Gupta, Director, NHRDF, Nashik, Mr. Dilip Mohite Patil, MLA, Khed. Mr. Vikram T. Awachat was present as Non-Official Member, and Dr. S. R. Bhat Principal Scientist, NRCPB, New Delhi and Dr. Anil Kush, CEO, VMSRI, Bangalore attended the meeting as Invited Experts. All the scientists of DOGR were also present in the meeting. Dr. C.R. Ramesh, Director (Actg) gave brief overview of research activities of DOGR. The achievements of the different programmes were presented by respective scientists, which were followed by discussion at length. The interaction between RAC members and group of scientists evolved the recommendations for streamlining the research programmes. It was thought that the research activity on issues like impact of climate change on onion and garlic production, flower induction in garlic and identification of photo-insensitive garlic should be initiated during course. A unique feature of RAC meeting was that the RAC members and invited experts delivered lectures on the topic of interest in present context. Prof M. Udayakumar elaborated on "Approaches to improve stress adaptation of crops", while Dr S.R. Bhat delivered lecture on "Biotechnological interventions in onion and garlic improvement". Similarly, Dr Hari Har Ram delivered talk on "Onion Breeding and Seed Production in India-Perception and Facts". A visit to farmers' field was also organized for RAC members.

Stakeholders' Meeting

A stakeholders meeting was convened on 30th Jan. 2012 to prioritize research programmes for finalization of XIIth plan. It was attended by representatives from KVKs, private companies, SAUs, state department officials and farmers. Dr CR Ramesh, Principal Scientist, DOGR, stressed upon the importance of stakeholders meet for finalization of XIIth plan. Dr Jai Gopal, Director, DOGR briefed about the ongoing research activities of DOGR. Dr UB Pandey, Principal Scientist, JISL, Jalgaon gave overall account of researchable issues in onion and garlic from industries point of view. Mr DM Sable, Project manager, MSAMB, Pune talked on problems and prospects in onion and garlic marketing. Mr J. Jadhav, Joint Director (Horticulture) talked on Prospects and Problem of Onion and Garlic cultivation in Maharashtra State. Dr Ulmek, Assoc. Dean, MPKV, Pune, stressed upon the need of conserving indigenous germplasm and landraces. Onion farmers, Mr SD Padekar and Mr Uddhav Khedkar gave overall accounts of researchable issues in Onion and Garlic from farmers' point of view. After detailed discussions and deliberations, following salient recommendations emerged.

- Heterosis breeding in onion is important to enhance the productivity and efforts in this direction need to be strengthened.
- Frontline demonstrations of technologies developed and varieties released from DOGR, to popularize their adoption, needs to be addressed on priority basis.
- Development of biotic and abiotic tolerant varieties to counter the challenges of climate change must be the priorty area of research.
- Development of low pungency, yellow onion varieties is important to improve export to European countries.
- There is dearth of quality seed material of recommended varieties. In this direction, collaboration with Mahabeej, private companies, KVKs and a seed village concept should be adopted to increase the production of quality seed.
- For processing industry, onion varieties with low reducing sugar and big bulb (>50 mm dia), high TSS (>20B) and in garlic white coloured, thin skin and big cloved (>20 mm dia.) varieties should be developed.
- Promising landraces being used by the farmers should also be evaluated along with recommended varieties.
- Microirrigation and fertigation both need importance. Nutrient uptake studies need to be taken up at all the centres under AINRPOG programme.
- Techniques for seed production technology and effect of climate change on seed production needs to be addressed. Research on effect of honey bees on seed yield and quality is also a major issue
- Research on farm mechanization techniques viz., garlic planter, direct seeder, onion transplanter needs to be emphasized keeping in view the manpower shortage and increasing costs in future
- In weed management only two chemicals e.g., Pendimethalin and oxyfluorfen are used. Work on novel chemicals having broad spectrum action may be taken up.
- Market intelligence for export purpose of onion is lacking since existing markets (Bangladesh, Middle East countries) are saturated and if we have to expand business, initial steps to give freight subsidy to European countries is important
- Well ventilated wagons are important for onion transport and research work in this direction should also be taken up.
- Thrips is major problem and have chemical control measure only. Emphasis on biological control should be given.
- Extension of onion and garlic cultivation needs major impetus for successful adoption. In this direction, effective collaborations with KVKs, agricultural departments and private companies like BASF, Syngenta, DuPont etc needs to be developed.
- Other suggestions like Minimum support price, insurance to the farmers, increased subsidy for storage, eliminate middlemen intervention were also made but these are policy issues and need to be take up at the appropriate forum for their redressal.

हिन्दी सप्ताह

प्याज एवं लहसून अनुसंधान निदेशालय, राजगुरूनगर में दिनांक 12/09/2011 से 17/09/2011 तक हिन्दी सप्ताह मनाया गया। इस दौरान (1) प्रश्न मंजुषा (2) शुध्द लेखन (3) वाद-विवाद: स्वेच्छा मरण उचित या अनुचित? (वैज्ञानिक एवं तकनीकि कार्मिको के लिए) (4) वाद-विवाद: मृत्यु दण्ड उचित या अनुचित (प्रशासनिक एवं सहायक श्रेणी कार्मिको के लिए) (5) कविता पाठ (6) निबन्ध: द्वितीय हरीत क्रांति (वैज्ञानिक एवं तकनीकि कार्मिको के लिए) (7) निबन्ध: प्रसार माध्यम लोक तंत्र का चौथा स्तम्भ। (प्रशासनिक एवं सहायक श्रेणी कार्मिको के लिए) (8) वैज्ञानिक शोध निबन्ध कि हिन्दी में अभिव्यक्ति का आयोजन किया गया था। समापन कार्यक्रम दिनाँक 17/19/2011 को मुख्य अतिथि डॉ. ओमकारनाथ शुक्ल, हिन्दी अधिकारी, भारतीय उष्णदेशीय मौसम विज्ञान संस्थान, डॉ. होमी भाभा रोड, पाषाण, पुणे-411008 एवं निदेशक, प्याज एवं लहसून अनुसंधान निदेशालय, राजगुरूनगर की अध्यक्षता मे समपन्न किया गया। निदेशक महोदय ने मुख्य अतिथि महोदय का मेमेन्टो, शाल, श्रीफल एवं पुष्प गुच्छ भेट दे कर स्वागत भाषण में अपने उदगार प्रगट किये उसके पश्चात् मुख्य अतिथि महोदय ने अपने अध्यक्षीय भाषण में हिन्दी भाषा को बोलचाल में अधिक से अधिक उपयोग में लाने पर बल दिया। अन्त में विजेता प्रतियोगियों को पुरस्कार प्रदान किये गये । डॉ. एस. एस. घाडगे ने सुत्रसंचालन किया और डॉ. विजय महाजन, प्रधान वैज्ञानिक ने आभार प्रगट किया।

DOGR celebrates agriculture education day

India is a land of Agriculture and majority of our population gets its livelihood from this pious profession. Thus, it is our duty to enlighten the young pupil of our country to persuade them towards agricultural business in general, and agricultural education in particular. In consonance, the Directorate of Onion and Garlic Research (DOGR), Rajgurunagar organized Agricultural Education Day on February 18, 2012 at DOGR, Rajgurunagar. Different competitions were organized on the day for the school students of class VIII to X to encourage them towards the envisaged goal. Students of Kendriya Vidyalay, CME School, Pune, Mahatma Gandhi Vidyalay, Rajgurunagar and Pius Memorial High School, Rajgrunagar participated in the essay writing competition on the topic "Agriculture as a profession" and quiz.

In the welcome address Dr C.R. Ramesh elaborated the concept of the celebration of the Agriculture Education day urged students to

opt agriculture business as career. Chief Guest of the function Dr. P.K. Korde, Principal, Hutatma Rajguru Mahavidyalay, Rajgurunagar discussed about the Agriculture Education policy in the country and emphasized on the strengthening the same. The winners of different competitions were awarded with memento and certificates by the Chief Guest. Coordinator of the event Dr. A.A. Murkute proposed the vote of thanks.

Directorate organizes farmers' training programme

A farmers training was organized at The Directorate of Onion and Garlic Research, ICAR, Rajgurunagar under ATMA scheme. Fifteen onion and garlic growers from Bhusawal taluka of Jalgaon district participated in the training programme organized during Mach 5 to 7, 2012. The different relevant topics were covered by the scientists under this programme entitled 'Sustainable onion and garlic cultivation'. The scientists delivered lectures on cultivation practices, fertilizer management, micro-irrigation, pest control, harvesting, storage and postharvest management including processing. The various agro-practices were demonstrated to farmers with the experiments laid on the Rajgurunagar, Manjri and Kalus farms of the Directorate. The famers were also exposed to different agro-innovative technologies. A visit to all the laboratories of Directorate was also organized during this period. Dr Jaigopal, Director DOGR had extensive deliberations with the farmers in the valedictory function to know there specific constraints related to sustainable production techniques. To get appropriate market price amid frequent price fluctuations, Dr Jaigopal emphasized on development of professional attitude of farmers for storage and processing business, in the valedictory address. The coordinator of the training programme Dr S.S. Gadge proposed vote of thanks.

DOGR participated in KISAN 2011

DOGR participated in Agricultural exhibition 'Kisan 2011'on December 14-18, 2011 at Moshi, Pune organized by Kisan Forum Pvt Ltd, Pune. The technologies developed at DOGR were displayed at DOGR stall. DOGR stall invoked great response from farmers and large numbers of publication were sold out.

Participation of sports team in ICAR zonal tournament

The sports team of DOGR participated in ICAR Zonal Sports Meets - West Zone held at CAZRI, Jodhpur during February 13- 17, 2012. The team participated in Carom, Table Tennis, Badminton and Volley Ball events.

Visitors

Dr S. Ayyappan, Secretary DARE, Ministry of Agriculture, Govt of India and Director General ICAR

Dr. Vasudevappa, Sr. Executive Director, National Fisheries Development Board, Hyderabad

Dr. Bharat Dhokane Patil, Chairman, Hindistan Agro Co-op. Ltd., Mumbai

Personnel

Recruitment

Dr. Jai Gopal, Director, w.e.f. 09/01/2012

Sh. C. M. Wakodkar, AAO, w.e.f. 03/10/2011

Relieving

Dr. K. E. Lawande, Ex-Director on 01/11/2011 (AN)

Promotions

1. Sh. Shaikh H.S.C. promoted to T-6 (Technical Officer) w.e.f. 08/05/2011
2. Sh. R. Baria, promoted to T-4 (Field/Farm Technical Assistant) w.e.f. 27/04/2011
3. Sh. S.P. Yeole, promoted to T-4 (Driver) w.e.f. 12/08/2011
4. Sh. P.S. Takle, promoted to T-3 (Field Farm Technician) w.e.f. 14/05/2011
5. Sh. D.M. Panchal, promoted to T-3 (Lab Technician) w.e.f. 23/04/2011
6. Sh. A.B. Dahale, promoted to T-3 (Tractor driver) w.e.f. 29/06/2011

Retirement: Nil

Staff Position

Category	Sanctioned Posts	Filled up Posts	Vacant
RMP	01	01	-
Scientific	15	12	03
Technical	10	10	-
Administrative	12	09	03
Skilled Supporting Staff	11	11	-
Total	49	43	06

List of Staff

Sl. No.	Name	Designation
Scientific Staff		
1.	Dr. Jai Gopal	Director
2.	Dr. C. R. Ramesh	Principal Scientist (Plant Pathology)
3.	Dr. V. Mahajan	Principal Scientist (Horticulture)
4.	Dr. Anil Khar	Sr. Sciensit (Horticulture)
5.	Dr. V. Sankar	Sr. Scientist (Horticulture)
6.	Dr. A. J. Gupta	Sr. Scientist (Horticulture)
7.	Dr. S. S. Gadge	Sr. Scientist (Agri. Extenstion)
8.	Dr. S. J. Gawande	Sr. Sciensit (Plant Pathology)
9.	Dr. A. A. Murkute	Sr. Scientist (Horticulture)
10.	Dr. S. Anandhan	Sr. Scientist (Biotechnology)
11.	Dr. A. Thangasamy	Scientist (Soil Science)
12.	Mr. Vishwanath	Scientist (Seed Technology)
13.	Mrs.Jayanthimala B.R.	Scientist (Entomology)
Technical Staff		
1.	Sh. H.S.C. Shaikh	T-6 (Tech. Officer Computer)
2.	Sh. V. V. Patil	T-5 (Tech. Officer)
3.	Sh. N. L. Gore	T-5 (Tech. Officer) Field/ Form
4.	Sh. R. B. Baria	T-4 (Field/Farm)
5.	Sh. S. P. Yeole	T-4 (Driver)
6.	Sh. A. R. Wakhare	T-3 (Field/Farm)
7.	Sh. P. S. Takale	T-3 (Field/Farm)
8.	Sh. D. M. Panchal	T-3 (Lab Technician)
9.	Sh. B. A. Dahale	T-3 (Tractor Driver)
10.	Sh. H. S. Gawali	T-1 ((Field/Farm Technician)

Sl. No.	Name	Designation
Administrative Staff		
1.	Sh. C. M. Wakodkar	Assistant Administrative Officer
2.	Miss Vijya N. Chaudhari	Assistant Finance & Accouts Officer
3.	Sh. D. B. Mundharikar	Private Secretary
4.	Sh. S. P. Kandwal	Assistant
5.	Sh. P. S. Tanwar	Assistant
6.	Smt.M. S. Salave	Assistant
7.	Smt. N. R. Gaikwad	Upper Division Clerk
8.	Sh. R. K. Dedage	Upper Division Clerk
9.	Sh. Nilesh S. Warkar	Lower Division Clerk
Skilled Supporting Staff		
1.	Sh. S. K. Said	SSS
2.	Sh. P. K. Khanna	SSS
3.	Sh. P. R. Sonawane	SSS
4.	Sh. P. E. Tadge	SSS
5.	Sh. M. S. Kale	SSS
6.	Sh. R. S. Kulkarni	SSS
7.	Sh. S. D. Waghmare	SSS
8.	Sh. N. H. Shaikh	SSS
9.	Sh. S. B. Tapkir	SSS
10.	Sh. A. D. Fulsundar	SSS
11.	Sh. S. S. Gopale	SSS

Financial Statement

Head of Accounts	Rupees in Lakhs	
	Budget Allocation	Expenditure
Non-Plan	249.37	248.34
Plan	178.42	178.42
AINRP Project	49.08	49.08
Pension & Retirement	6.00	00
P-Loans & Advances	13.97	13.97
R-Deposit Scheme	7.42	7.04
Total	504.26	496.85
	Target	**Achieve**
Revenue Receipts	**13.00**	**19.07**

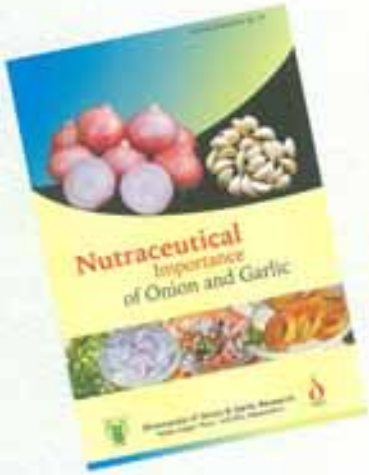
Meteorological data for year 2011-12

Month	Temperature °C		Relative humidity (%)		Rainfall	Evaporation	Sunshine
	Max.	Min.	Max.	Min.	(mm)	(mm)	(Hrs)
April	36.8	16.3	66	34	0.00	7.32	8.57
May	35.3	19.6	70	42	0.00	7.89	9.14
June	29.3	20.4	85	75	47.2	3.81	4.51
July	27.9	19.2	87	78	208.8	2.72	1.12
August	27.8	19.3	90	79	137.1	2.39	2.07
September	29.1	18.3	87	70	160.2	3.33	5.06
October	31.3	16.4	83	55	246.4	4.71	7.40
November	30.1	14.6	80	55	0.00	6.00	8.31
December	30.8	14.4	79	55	0.00	6.00	8.30
January	28.9	10.4	80	40	0.00	4.00	9.35
February	32.1	9.7	69	39	0.00	5.40	9.08
March	35.4	11.1	57	29	0.00	7.20	8.48

Abbreviations

ABW	Average Bulb weight
P	Polar Diameter
E	Equatorial Diameter
N	Neck thickness
TSS	Total Soluble Solids
DTH	Days to harvest
DAT	Days after transplanting
GP	Germplasm
AGB	A Grade Bulbs
NOL	Number of leaves
PH	Plant Height
LL	Leaf length
LW	Leaf width
CT	Collar thickness
CP	Clove polar diameter
CE	Clove equatorial diameter
W10C	Weight of 10 cloves
NOC	Number of cloves
TY	Total yield

Recent Publications



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