ICAR

annual report 2009-10

DOGR

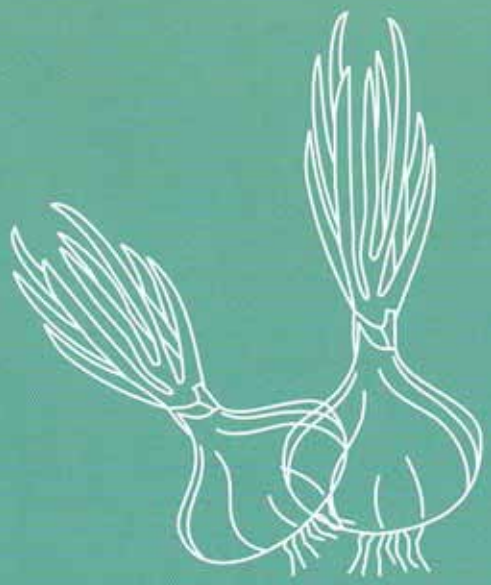
Directorate of Onion and Garlic Research
Rajgurunagar- 410 505, Dist. Pune, Maharashtra

Vision

To become number one in production, productivity, export and add on value to the excess production.

Mission

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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कार्यकारी सारांश

इस वर्ष निदेशालय व्दारा प्याज एवं लहसुन पर अखिल भारतीय नेटवर्क अनुसंधान परियोजना की प्रथम पारस्परिक बैठक का आयोजन प्याज एवं लहसुन अनुसंधान निदेशालय, राजगुरूनगर में किया गया जिनमें 12 मुख्य केन्द्रों और 10 स्वैच्छिक केन्द्रों ने हिस्सा लिया। इस कार्यक्रम के साथ ही कालुस मे प्याज एवं लहसुन बीज फार्म का भी उद्घाटन किया गया। प्याज की चार नई किस्में जैसे भीमा किरण, भीमा शक्ति, भीमा श्वेता और भीमा शुभ्रा, संस्था स्तर पर जारी की गयी। विशेषज्ञों के लिए मॉडक प्रशिक्षण कार्यक्रम और किसानों के लिए तीन दिवसीय प्रशिक्षण कार्यक्रमों के माध्यम से प्याज एवं लहसुन पैदा करने की जानकारी दी गई।

प्याज की किस्म पैदा करने के कार्यक्रम के तहद, आध्र प्रदेश, महाराष्ट्र और छत्तीसगढ़ मे राष्ट्रीय पादप आनुवांशिक संसाधन ब्यूरो, हैदराबाद के सहयोग से प्याज एवं लहसुन के 212 जननद्रव्यों को एकत्रित किया गया। लाल रंग के प्याज पछेती खरीफ मौसम में, 1050, 1048 और 1061 नामक तीन जननद्रव्यों के नतीजे उत्साहजनक रहें जब कि रबी मौसम में 1092,1073,1187,1077 और 645 नामक जननद्रव्यों का विपरण योग्य उपज चेक किस्म की तुलना में 15% ज्यादा पायी गयी। खरीफ मौसम में तीन जननद्रव्य ऐंसे पायी गयी जिनकी विपरण योग्य उपज चेक किस्म की तुलना मे 20% ज्यादा थी। औसत उत्पादन के आधार पर लाल रंग के प्याज की खरीफ मौसम में 10 जननद्रव्यों, पछेती खरिफ मौसम में 32 जननद्रव्यों तथा रबी मौसम मे 33 जननद्रव्यों का उपज सराहनीय पाया गया। प्याज की एक उत्कृष्ट किस्म (इ एल 1044) का उपज सभी मौसम मे अच्छी पायी गयी। भंडारण अध्ययन से ज्ञात हुआ कि 3 इलाइट लाइन्स (इ एल–1044, इ एल–671 और इ एल–670) में तीन माह भंडारण के पश्चात भी केवळ 10% से कम ही वजन मे कमी आई। संकर ओज प्रजनन कार्यक्रम में, माताहारी, नन–3001 और रियो टिन्टों के उपज अच्छे पाये गये लेकिन इनकी भंडारण हानि स्थानीय किस्मों की तुलना मे ज्यादा पायी गयी। थ्रिप्स के प्रति पाँच प्रतिरोधी जननद्रव्यों का पहचान किया गया। सफेद प्याज के प्रजनन कार्यक्रम मे एक लाइन (डब्लू–029) पछेती खरीफ मौसम मे, 6 लाइन्स रबी मौसम में और 2 लाइन्स खरीफ मौसम में उपज एवं संबन्धित घटकों के लिए उत्तम पायी गयी। सफेद प्याज की अधिक संपुर्ण घुलनशील ठोस युक्त किस्म विकास के तहद 11.4 से 13.5% संपुर्ण घुलनशील ठोस वाली लाइन्स मिली। समष्टि सुधार द्वारा 15.0 से 19.9% तक संपुर्ण घुलनशील ठोस वाले सफेद प्याज की लाइन्स का विकास किया गया। निर्यात के लिये पीले रंग के प्याज प्रजनन कार्यक्रम मे, एक पीली जीनपूल का विकास किया गया। सफेद प्याज की संकर किस्मों को तैयार करने के क्रम मे अगेती सुप्रीम हवाइट, बी जी एस – 227 और सेरेन्गेती–1202 अधिक पैदावार देने वाली किस्मों के रूप में पायी गयी जबकि पीली प्याज की किस्मों में गोबी–1201, मर्सिडीज, ओल्गा–1404 और प्राडलर से अच्छी उपज प्राप्त हुई। लेकिन दो माह भंडारण के बाद सफेद विदेशी किस्मों मे 41 से 56% और पीली विदेशी किस्मो मे 45% से ज्यादा प्याज के वजन मे कमी आयी। यह भी देखा गया कि लाल प्याज की तुलना मे सफेद और पीली प्याजों मे ज्यादा नुकसान हुआ और सेरेन्गेती एवं बेसिक एफ–1 किस्मे थ्रिप्स के प्रति प्रतिरोधक पायी गयी।

जी –41 की तुलना में लहसुन के 9 जीनोटाइप अच्छी उपज देने वाले पाये गये। शितोष्ण जलवायु मे विदेशी जननद्रव्यों का मुल्यांकन किया गया जिनमें कुछ अच्छी उपज देने वाली जननद्रव्य पायी गयी। पहली बार ऐसा हुआ कि ताजेपन मे और शुष्क भार के आधार पर एलिसिन और अन्य थियोसल्फीनेट के लिए 97 इकोटाइप का परिक्षण किया गया। ताजे भार के आधार पर जीनोटाइप 200706, आर जी 345, आइ सी 375010 मे एलिसिन और थियोसल्फीनेट की सबसें ज्यादा सांद्रता पायी गयी जबकि शुष्क भार के आधार पर आइ सी –374981, आइ सी – 375010 और आर जी 345 जीनोटाइप में अधिक सांद्रता पायी गयी। थ्रिप्स के प्रति 7 लाइन्स में प्रतिरोधकता पाया गया। लहसुन की पांच उत्परिवर्ती लाइन्स चेक किस्म जी–41 की तुलना मे उत्तम पायी गयी। इस साल लहसुन के 19 उत्कृष्ट लाइन्स में 10 घटकों जैसे नमी की मात्रा, शुष्क भार, संम्पूर्ण घुलनशील ठोस, पायरूविक अम्ल, प्राकृतिक रेशे, फेनोल, प्रोटीन, गंधक, टाइट्रेबल अम्लीयता और राख की मात्रा के लिए जैव रासायनिक विश्लेषण किया गया। प्राप्त परिणामो मे पाया गया कि गोदावरी किस्म मे नमी कम, शुष्क भार अधिक तथा राख की मात्रा भी अधिक थी; जी जी ३ में सम्पूर्ण घुलनशील ठोस अधिक पाया गया, भीमा ओमकार मे प्राकृतिक रेशे और गंधक अधिक थे, ए सी 50 मे पायरूविक अम्ल की मात्रा अधिक पायी गयी; एसी 219 मे कुल शर्करा की मात्रा अधिक थी; एसी 221 में प्रोटीन बहुत अधिक था और एसी 316 मे फेनोल

की सांद्रता अधिक थी। लहसुन की पाँच किस्मों मे उत्तपरिवर्तजनन के लिए इथाइलमीथेन सल्फोनेट (इ एम एस) और गामा किरणन का प्रयोग किया गया और बहुगुणिता के लिए कोल्चीसिन का प्रयोग किया गया। पौधों को बढ़ाने वाले तन्तुओं के शीर्ष से तैयार लहसुन के पौधों को लहसुन के विषाणुओं की प्रतिरोधकता के लिए आर टी पी सी आर तकनीक का प्रयोग करते हुए परिक्षण किया गया। लगभग सभी पौधे विषाणुओं से संक्रमित पाये गये केवल एक पौधे को छोड़कर जो विषाणु मुक्त प्रकार का पाया गया। लहसुन की अनुवांशिक विविधता का आकलन करते समय 24 प्रवर्धनीय आई एस एस आर संकेतक और 3 जीनोमिक क्रास संयोग, 15 इ एस टी – एम एस आर और 8 न्यु जीनोमिक एम एस आर संकेतक चूने गये। जंगली किस्मों के परिक्षण मे एलियम फिस्टुलोसम श्रेणी की चायना–1 और चायना–2 जीनोटाइप को थ्रिप्स के प्रति अत्याधिक प्रतिरोधक पाया गया तथा इनके संक्रमित होने की रेटिंग केवल एक रही। अल्पकालीन उष्ण प्रदेशीय भारतीय प्याज की विविधता के आकलन, जीनोमिक और इएमटी– एस एस आर संकेतक के कार्य भी हुए जो देशी जंगली किस्मों की दूरस्त संबन्ध को लेकर किये गये।

प्याज एव लहसुन में जैविक उत्पादन के अध्ययन मे जैविक की तुलना में अजैविक उपचार को बेहतर पाया गया लेकिन अजैविक उपचार वाले प्लाटों की तुलना मे जैविक प्लाटों से निकाले गये कंदों के वजन मे न्यूनतम नुकसान मिला। उसके अलावा मृदा जीवाणु, फफूंद, एस्टीनोमाइसीटीज की संख्या और डीहाइड्रोजीनेज क्रिया कलाप जैविक मृदा मे बेहतर पाये गये जिनमे मृदा के गुणों पर अच्छा प्रभाव पडा। खर–पतवार से बचाव के अध्ययन मे पाया गया कि अत्याधिक खर–पतवार के कारण प्याज एवं लहसुन की उपज मे कमी आ जाती है और उपज की यह हानि प्याज के मामले मे 2.4 से 61.8% तक तथा लहसुन के मामले मे 3.56 से 85.5% तक पायी गयी।

सिंचाई संबंधी परीक्षणों मे प्रयोगात्मक परिणामों से ज्ञात हुआ कि ड्रिप सिचाई की विभिन्न विधियों और स्तरों से प्याज के बीज वाली फसल में पौध विकास संबन्धित घटकों, उपज और उपज संबन्धित घटकों पर महत्त्वपूर्ण प्रभाव पड़ा और 100 % पी ई दैनिक ड्रिप सिंचाई करने से प्याज के बीज की अधिकतम पैदावार मिली, उसके बाद दुसरे नम्बर पर 100% पी ई तीन दिन के अन्तर पर ड्रिप सिचाई से ज्यादा बीज की पैदावार मिली।

प्याज एवं लहसुन मे थ्रिप्स लगने की दशाओं और उनसे संरक्षण के बारे मे किए गए अध्ययनों से पाया गया कि सन 2008 का वर्ष विगत दस वर्षो की तुलना मे अपवाद रहा क्योंकि किसी भी पौध रोपण तारीख को थ्रिप्स की संख्या 30 प्रति पौधा से ज्यादा नही हुई। मौसमी घटनाओं के आधार पर भी असामान्य स्थिति दिखाई दि क्योंकि विगत 10 वर्ष के दौरान दो अवसरो (अगस्त, फरवरी) की तुलना मे इस वर्ष केवल एक अवसर (अगस्त) ही रहा जब थ्रिप्स की संख्या 20 प्रति पौधा से ज्यादा नहीं हूई। कीटनाशकों के प्रायोगिक परीक्षणों से ज्ञात हुआ कि फीप्रोनिल 60 ग्राम सक्रियतत्व प्रति हेक्टेयर के हिसाब से सबसे अच्छा रोकथाम रहा और यह किटनाशक भी प्रोफेनोफांस और मिथोमाइल जैसे चेक कीटनाशकों जितना ही प्रभावी रहा। अलग–अलग कीटनाशकों के प्रयोग के बाद थ्रिप्स के पुन: आक्रमण की जांच से पाया गया कि फीप्रोनिक और प्रोफेनाफांस इन कीटों के पुन: आक्रमण को कम करने मे बेहद प्रभावी रहे और यह भी कि पुन: आक्रमण की प्रक्रिया मे पत्तो मे दिए गये थ्रिप्स के अंडे और थ्रिप्स के बाहरी स्रोत का अहम भूमिका पाया गया जबकि उनमे मृदा का योगदान बहुत कम पाया गया। थ्रिप्स की संख्या को रोकने मे नीम का तेल कुछ हद तक प्रभावी रहा। दस दिन के अंतराल से 1.5% सांद्रता वाले खनिज तेल का छिड़काव बहुत ही प्रभावी रहा। उनके साथ ही यह भी देखा गया कि खनिज तेल के छिड़काव से प्याज मे थ्रिप्स के अंडे देने और उनके अंडो से लार्वा निकलने की प्रक्रिया मे कमी आई। थ्रिप्स के जैविक नियंत्रण के लिए हुए प्रायोगिक अध्ययनों से ज्ञात हुआ कि ब्लेप्टोस्टेथस पैलेसेन्स नामक परभक्षी लहसुन के थ्रिप्स को अपना आहार बनाता है लेकिन खेत में उनका कार्य बहुत कम प्रभावी रहा। विभिन्न राज्यों से प्याज के नमूने बाजार से एकत्रित किये गये और उनमें कीटनाशकों के अंश का आकलन करने पर पाया गया कि महाराष्ट्र से प्राप्त अधिकतर नमूनों मे प्रोफेनोफांस का अंश था लेकिन इसके अंश अधिकतम अवशेष स्तरों से कम थे। प्याज उगाने वाले कृषकों को तत्काल ही यह जानना आवश्यक है कि वे कीटनाशकों का प्रयोग इष्टतम स्तर तक ही करें और कीटनाशकों के प्रयोग के लिये उचित समय एवं सिफारिशों का पालन करे।

पादप रोग विज्ञान में प्रयोगशाला परीक्षण के दौरान पाया गया कि प्याज की कुछ जंगली किस्मों के पत्तों से प्राप्त रस से आल्टरनेरिया पोरी और स्टेमफिलिपम वेसिकेरियम पर अच्छा नियंत्रण हो सका। यह भी देखा गया की किसी भी तापमान के दौरान पत्तियों के गीलेपन से अल्टरनेरीया पोरी का संक्रमण बढ़ गया और 20 एव 25° सेन्टीग्रेड तापमान पर यह संक्रमण उच्चतम रहा। तापमान और पत्तो के गीले रहने की अवधि के पारस्परिक प्रभाव से रोगों के संक्रमण बहुत ज्यादा हुए। फ्यूजेरिम आधार विगलन से संबन्धित रोग बढ़ने का अध्ययन करने पर ज्ञात हुआ कि रोग बढ़ने मे प्रजातियो पर अलग–अलग प्रभाव पड़ता है जिसमे भीमा सुपर, एन आर सी ओ जी 595, डब्ल्यू –009 और एन आर सी ओ जी 1156 किस्मो मे खुदाई के समय आधार पर विगलन का स्तर कम रहा और रोगो के बढ़ने की दर कम रही।

बीज की गुणवत्ता के रखरखाव संम्बंधी परिक्षण करने के दौरान पाया गया कि 200 और 400 गेज़ के प्लास्टिक पैकेटों में रखे हुए और थायराम एवं वाविस्टिन से उपचारित बीज का जमाव काफी अधिक रहा जबकि फफूंदी नाशक उपचार किये बिना कपड़े की बोरीयों मे रखे बीजों का जमाव कम रहा। एन्टीआंम्सीडेन्ट (सलिसिलिक एसिड @500 पी पी एम) और पोटेशियम फास्फेट डाइबेसिक @2% का प्रयोग करके 15° सेन्टीग्रेट तापमान पर 24 घंटे उपचार की पध्दति अन्य उपचारों की तुलना में अधिक जमाव देने वाली पायी गयी। बिमारी मुक्त बीज उत्पादन के लिए आइप्रोडिआन + कार्बेन्डाजाइम (वाविस्टिन) के गोल छिड़काव (0.2%) और वाविस्टिन एवं कैप्टान से अलग–अलग उपचार करने से बीज का संक्रमण नियंत्रित हुई।

अन्तत: कहा जा सकता है कि प्याज एवं लहसुन पर सभी प्रकार के दृष्टि से यह वर्ष काफी उल्लेखनीय रहा, उन्नत किस्मों का विकास हुआ, प्याज एवं लहसुन पर अखिल भारतीय नेटवर्क की स्थापना हुई और प्याज एवं लहसुन की किस्मों मे सुधार के नये अध्ययन हुए।

Executive Summary

During the year under report, first interactive meeting of All India Network Research Project on Onion & Garlic (AINRPOG), with 12 main centres and 10 voluntary centres, was held at DOGR, Rajgurunagar and a new seed farm of onion and garlic at Kalus was inaugurated. Four onion varieties i.e., Bhima Kiran, Bhima Shakti, Bhima Shweta, Bhima Shubra were released at institute level. Knowledge about onion and garlic production systems was imparted by organising model training course for experts and three days training programmes for the farmers.

Under onion breeding programme, 212 accessions consisting of onion and garlic were collected from Andhra Pradesh, Maharashtra and Chattisgarh in collaboration with NBPGR, Hyderabad. In red onion (late *kharif*) three lines viz. 1050, 1048, and 1061 were found promising whereas in *rabi* season, five genotypes viz. 1092, 1073, 1187, 1077 and 645 recorded more than 15% marketable yield than the check variety. In *kharif* onion, three lines exhibited more than 20% marketable yield than the check variety. Based on the pooled mean performance of red onion germplasm, ten genotypes/ varieties in *kharif*, 32 genotypes/varieties in late *kharif* and thirty three genotypes in *rabi* season were identified. One elite line (EL1044) was found to perform well in all the onion growing seasons. Storage studies revealed that 3 lines (EL-1044, EL-671and EL-670) exhibited less than 10% weight loss after three months of storage. In heterosis breeding programme, hybrid Matahari, Hybrid Nun-3001and Rio Tinto performed better in terms of yield but the storage loss was more as compared to the local varieties. Screening against thrips led to the identification of five resistant lines.

In white onion breeding programme, one line (W-029) in late *kharif*, 6 lines in *rabi* and two lines in *kharif* performed superior in terms of yield and other horticultural traits. Research in breeding of white onion for high TSS had led to the development of onion lines with TSS range of 11.4- 13.5%. Population improvement has led to the development of lines having population mean of TSS ranging from 15.0% - 19.9%. In breeding for export quality yellow onion, a yellow gene pool has been developed. Heterosis breeding in white onion led to identification of Early Supreme White, BGS-227 and Serengeti-1202 as high yielders whereas in yellow onion Gobi-1201, Mercedes, Olga-1404 and Prowler gave higher yield. But total weight loss was found to be higher (41-56%) in white exotic and 45% in yellow exotic onions after two months of storage. It was also noticed that white and yellow onions are relatively more susceptible than red onion lines and Serengeti and Basic F1 were found to be resistant to thrips.

In garlic, nine genotypes were adjudged to be good yielders than G-41 and based on the evaluation of exotic germplasm under temperate conditions some of the high yielding lines were identified. For the first time, 97 ecotypes were evaluated for allicin and other thiosulphinates on fresh and dry weight basis. Genotypes 200706, RG345, IC375010 recorded highest concentration of allicin and other thiosulphinates on fresh weight basis whereas on dry weight basis genotypes IC-374981, IC375010 and RG345 recorded higher levels. Screening against thrips identified 7 resistant lines. Five mutant garlic lines having superior yield than the check variety G-41 were identified. This year, biochemical analysis of 19 elite lines for 10 characters viz., moisture content, dry matter, TSS, pyruvic acid, crude fibre, phenols, protein, sulphur, titrable acidity and ash content was carried out. Based on the results obtained, it was found that Godavari had low moisture, high dry matter content and high ash content; GG3 had high TSS; Bhima Omkar had hgh crude fibre and sulphur content; AC

50 had high pyruvic acid; AC219 had high total sugars; AC 221 recorded highest protein and AC 316 had highest phenol concentration. Mutagenesis in five garlic varieties was carried out by using ethylmethane sulfonate (EMS) and gamma irradiation and for polyploidisation colchicine was used. Meristem tip derived garlic plants were screened for garlic viruses using RT-PCR technique. Almost all the plants were found to be virus infected except one which exhibited virus free nature. In genetic diversity assessment of garlic, 24 amplifiable ISSR markers and 3 genomic, 15 EST-SSR and 8 new genomic SSR markers have been identified. In wild species trial, two *A. fistulosum* lines, China-1 and China-2 were found highly resistant against thrips with very less injury rating of 1.0 only. Diversity assessment of short day tropical Indian onion and cross amplification of genomic and EST- SSR markers in distantly related native wild species was also carried out.

In studies on organic production in onion and garlic, inorganic treatment was found better than organic one but minimum weight loss was noticed in bulbs harvested from organic plots than the inorganic ones. Also soil bacteria, fungal, actinomycetes population and dehydrogenase activity (DHA) was better in organic soils revealing their healthy effect on soil properties. Weed management studies exhibited that yield losses in onion and garlic is due to heavy weed competition which reaches upto the extent of 2.4 - 61.8 % in onion and 3.56 - 85.5 % in garlic.

Under irrigation trials, experimental results revealed that, there was significant effect on growth, yield and yield contributing characters of onion seed crop as influenced by different methods and levels of drip irrigation practices and highest seed yield was recorded in drip irrigation @ 100 % PE daily followed by drip irrigation @ 100% PE at 3 days interval.

In crop protection, studies on population dynamics of thrips in onion and garlic revealed that year 2008 was exceptional as compared to last 10 years since average thrips population never crossed 30/plant in any of the planting date. Also an unusual trend in seasonal incidence was observed where only one peak occurred (August) this year against the usual 2 peaks (August, February) appearing for the last 10 years and thrips population never crossed 20/plant. Trial on insecticide evaluation revealed that fipronil @ 60 g ai / ha is the best treatment, as good as check insecticides viz., profenofos and methomyl. Work on reinfestation of thrips using different insecticides revealed that fipronil and profenofos were every effective in slowing down re-infestation and that in re-infestation process, eggs laid in the leaves and external sources of thrips play a major role and contribution from soil is every less. Neem oil showed some effect on reducing thrips population. Spray of mineral oil @10 days interval with 1.5% concentration, recorded the highest efficacy. Besides this, it was also observed that mineral oil was affecting oviposition and egg hatching of thrips in onion. Studies on biological control of thrips revealed that though predator, *Blaptostethus pallescens,* was found feeding on thrips on garlic, their performance under field conditions was poor. Assessment of pesticide residues on market samples of onion bulbs collected from different states showed that more number of samples from Maharashtra had profenofos residues but it was below maximum residue levels (MRL). There is an immediate need to educate the onion growers so as to optimize the use of insecticides and a need to revise the insecticides schedules/ recommendations.

In plant pathology, leaf extracts of some *Allium* wild species were found to have goodcontrol over *Alternaria porri* and *Stemphylium vesicarium* under laboratory conditions. It was also found that infection by *Alternaria porri* increased with increasing duration of leaf wetness at all temperatures and was highest at 20 and 25°C. Highly significant interaction between temperature and leaf wetness period was observed for disease infestation. Disease progression studies on fusarium basal rot (FBR) revealed that cultivars differed in their disease progression trends and Bhima Super (FF), NRCOG 595, NRCOG 595(FF), N2-4-1, W448BR-4(FF), W-009 and NRCOG 1156(FF) had low FBR severity at harvest and a low rate of disease progression.

In trials on management of seed quality, it was observed that seeds stored in polythene packets of 200 and 400 gauge with thiram and bavistin seed treatment stored better and had significantly higher seed vigour than the seeds stored in cloth bags without fungicide treatment. Use of antioxidant (salicylic acid @500 ppm) and application of K_2HPO_4 @2% and 24 hours treatment at 15°C gave maximum germination than other treatments. Disease free onion seed production was obtained by spray of Iprodione + carbendazime (Bavistin) formulation spray (0.2%) and seed treatment with bavistin and captan individually controlled the seed infection.

To conclude, it was a fruitful year in onion and garlic research in all the spheres with development of elite varieties, formation of All India Network on Onion and Garlic and new strides towards onion and garlic improvement.

Contents

Introduction

The Centre

The Indian Council of Agriculture Research (ICAR) established the National Research Centre for Onion and Garlic in the year 1994 and sanctioned the same during VIII plan with its headquarters at Nasik. Though the centre was initially located in Nasik, it was shifted to Rajgurunagar, 43 km away from Pune on Pune-Nasik highway and started functioning at the new location from June 1998. Till now 6 varieties of onion and one variety of garlic have been released by the Centre. Based upon the performance of the centre, ICAR has upgraded the centre from National Research Centre to the Directorate of Onion and Garlic Research in 2009. Now the centre has been officially renamed as **Directorate of Onion & Garlic Research.**

Location and Weather

The Centre 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 - 42.0 °C and having an annual average rainfall of 669 mm.

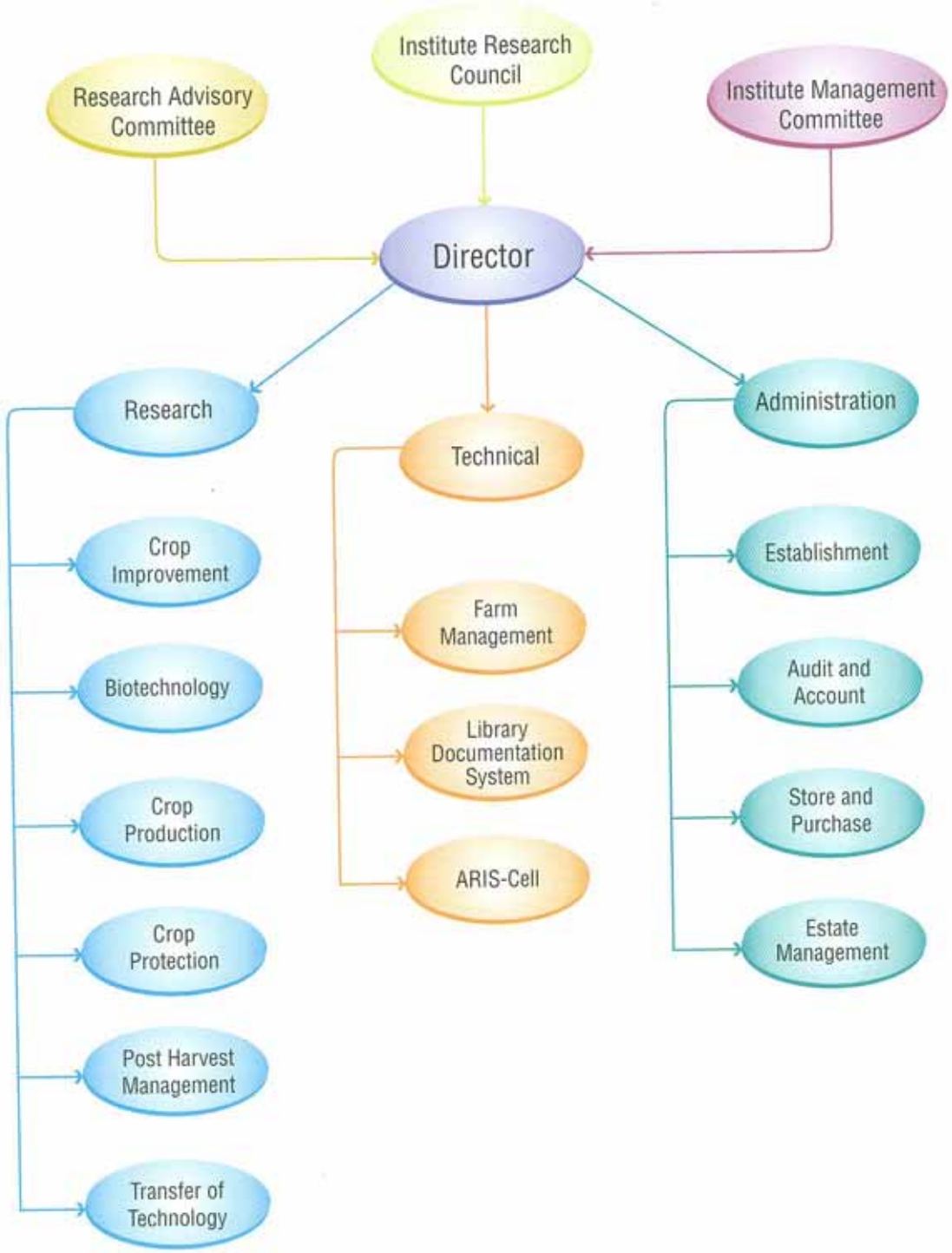
Mandate

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

Infrastructure

The Centre has 55 acres of research farm with perennial irrigation facilities at Rajgurunagar, 25 acres at Kalus and 10 acres at Manjri. The Centre has some major research laboratories for biotechnology, soil science, plant protection and post harvest technology with modern state of art equipments. The existing facilities for Internet and e-mail connectivity have been strengthened. The Institute library has 549 books,112 *gratis* books, 11 national and 5 international journals, CD server, 28 CD-ROMs of relevant literature on *Alliums*, Hort-CD and other relevant facilities.

Organogram


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

Research Achievements

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

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

Exploration and collection of red onion new germplasm

Survey for collection of diverse onion and garlic germplasm from Karimnagar, Nizamabad and Adilabad districts of Andhra Pradesh (North Telangana region); Garchiroli, Chandrapur, Yavatmal and Nanded districts of Maharashtra; Narainpur, Bastar and Dantewada district of Chhattisgarh was conducted during April-May, 2009 in collaboration with NBPGR, Regional Station, Hyderabad. 212 accessions consisting of red onion (109), white onion (57) and garlic (46) were collected. Morphological observation of red onion (109) germplasm were recorded. Polar and equatorial diameter of bulbs ranged from 3.08 to 5.18 cm and 3.20 to 6.64 cm with an average of 3.96 cm and 4.71 cm, respectively. Neck thickness varied from 0.18 to 1.92 cm with the mean of 0.42 cm. TSS ranged from 8.00 to 14.50% with the mean of 10.41%. Centeredness of bulbs ranged from 1 to 4 with the mean of 1.82. Average bulb weight recorded was maximum up to 130.5 g (1228) with a mean of 53.9 g.

Table 1. Morphological traits of red onion germplasm collection

Trait	Total bulbs	Av. bulb wt. (g)	P (cm)	E (cm)	N (cm)	TSS %	Centeredness
Min	6.00	16.20	3.08	3.20	0.18	8.00	1.00
Max	97.00	130.50	5.18	6.64	1.92	14.50	4.00
Mean	22.36	53.88	3.96	4.71	0.42	10.41	1.82

Second survey was also conducted with a focus on large sized, dark red, high yielder onion lines for *kharif* season from Lonand (Satara); Jejuri and Baramati (Pune); Rahuri, Srigonda and Sangamner (Ahmednagar); Yeola, Malegaon, Satana, Devla, Chandwad, Pimpalgaon (Nasik) and Dhule districts of Maharashtra during Nov, 2009 and 94 dark red large sized onion germplasm was collected. Morphological observations were recorded and are presented in Table 2.

Table 2. Morphological traits of red onion germplasm collection

Trait	Total bulbs	ABW (g)	P (cm)	E (cm)	N (cm)	TSS %	Centre
Min	7.00	55.00	3.62	4.85	0.45	7.53	1.20
Max	48.00	150.00	6.13	7.12	1.19	13.15	2.00
Mean	21.69	101.91	4.66	6.19	0.82	10.34	1.52

Evaluation of red onion germplasm during late *kharif* season

Thirty-two red onion germplasm were evaluated during late *kharif* in 3 sq. m plot size along with 2 checks. Percentage A grade bulbs in the germplasm ranged from 0 to 68.5% with 0 to 29.4% double bulbs, 0 to 63.3% bolters and 6.8 to 100% marketable bulbs against the check variety Bhima Super which recorded 41.9% A grade bulbs, 0.9% double bulbs, 16.3% bolters and 81.5% marketable bulbs. Marketable yield and total yield varied from 1.8 to 51.1 t/ha and 23.0 to 53.0 t/ha, respectively in germplasm against check which recorded 43.2 t/ha marketable yield and 52.8 t/ha total yield. Only three lines viz. 1050 (51.1 t/ha), 1048 (47.0 t/ha) and 1061 (45.6 t/ha) were found superior for marketable yield over check Bhima Super (43.2 t/ha) with 18.4%, 8.9% and 5.7% marketable yield superiority over Bhima Super, respectively. Average bulb weight was maximum (93.7 g) in 1049 against Bhima Super (87.2 g). Bulb shape index (E:P ratio) ranged from 0.99 to 1.35 against Bhima Super (1.17).

Evaluation of red onion germplasm during *rabi* season

One hundred forty four red onion germplasm were evaluated during *rabi* season in 2.0 x 2.1 m plot size along with 3 checks. Percentage A grade bulbs in the germplasm ranged from 0 to 71.0% with 0 to 47.9% double bulbs, 0 to 32.3% bolters and 47.9 to 100% marketable bulbs against the check N-2-4-1 which recorded 46.1% A grade bulbs, 0% doubles and bolters and 96.1% marketable bulbs. Marketable yield and total yield varied from 6.3 to 58.7 t/ha and 9.7 to 60.0 t/ha, respectively in germplasm against N-2-4-1 which recorded 37.9 t/ha marketable yield and 39.5 t/ha total yield. Five genotypes viz., 1092 (58.6 t/ha), 1073 (56.6 t/ha), 1187 (45.7 t/ha), 1077 (45.2 t/ha) and 645 (43.8 t/ha) recorded more than 15 % marketable yield than N-2-4-1 (37.9 t/ha). Average bulb weight was maximum (93.6 g) in 1092 against N-2-4-1 (63.3g). Bulb shape index (E:P ratio) ranged from 0.89 to 1.49 as compared to N-2-4-1 (1.33).

Evaluation of red onion new germplasm during *kharif*

Four new red onion germplasm collected as seed in 2009 were evaluated during *kharif* 2009 along with 2 checks in 1 x 2.1 m plot size in three replications. Percentage A grade bulbs, doubles and marketable bulbs ranged from 2.6 to 28.0%, 2.6 to 13.8% and 43.6 to 58.7%, respectively whereas it was 13.0% A grade bulbs, 0% doubles and 73.6% marketable bulbs in check Bhima Super. No bolters were found in germplasm as well as in Bhima Super. Three germplasm lines viz., 1218 (12.9 t/ha), 1303 (16.0 t/ha), 1304 (11.9 t/ha) exhibited more than 20% marketable yield superiority to Bhima Super (9.9 t/ha). All germplasm lines were found early in maturity (79 to 84 days) than Bhima Super (93 days).

Evaluation of red onion germplasm during *kharif*

Fourteen red onion lines were evaluated during *kharif* in 1 sq m plot size along with check variety Bhima Super. Percentage A grade bulbs in germplasm ranged from 0 to 38.1% with 0 to 25.8% doubles, 0 to 0.7 bolters and 22.1 to 88.8% marketable bulbs against the Bhima Super which recorded 10.6% A grade bulbs, 0% doubles and bolters and 65.9% marketable bulbs. Marketable yield and total yield varied from 4.2 to 21.9 t/ha and 13.8 to 30.0 t/ha, respectively in germplasm against Bhima Super which recorded 14.7 t/ha marketable yield and 22.3 t/ha total yield. Accession 1048 (21.9 t/ha) and 998 (18.0 t/ha) were found superior than Bhima super in marketable yield with 48.7% and 22.4% marketable yield superiority over check. Both the genotypes were also found earlier in maturity i.e., 79 to 81 days over Bhima Super (95 days).

Mean performance of red onion germplasm during *kharif* (2000-01 to 2008-09)

Sixty red onion germplasm including two checks (B-780 and N-53) were evaluated for three or more than three years during *kharif* season from 2000-01 to 2008-09 and summarized on the basis of at least three years mean data. Plant height ranged from 35.0 to 57.7 cm. Percent unmarketable bulbs including double bulbs, bolters and rots ranged from 3.6 to 42.5 with percent marketable bulbs from 57.4 to 96.3%. Marketable yield varied from 5.2 to 28.3 t/ha against best check B-780 (29.2 t/ha) and total yield from 6.6 to 30.7 t/ha as compared with best check which had 32.8 t/ha. Earliest maturity was recorded at 98 days after transplanting (696) against B-780 which took 122 for harvesting after transplanting. TSS ranged from 10.2 to 13.7% in germplasm whereas in check it was 11.7%. On the basis of five best genotypes of important traits (Table 3), genotypes 85 and K-519-R were found superior for marketable yield, total yield, % marketable bulbs, average marketable bulb weight and minimum percentage of unmarketable bulbs including doubles, bolters and rots however, B-780 and N-53 were found superior for marketable yield, total yield and average marketable bulb weight. Ten genotypes/ varieties viz., B-780, 85, K-519-R, N-53, 1000, 909, ADR, Arka Kalyan, 1010 and 1019 were found suitable for *kharif* season with more than 20 t/ha marketable yield.

Mean performance of red onion germplasm during late *kharif* (2000-01 to 2008-09)

Eighty-eight red onion germplasm including checks were evaluated for three or more than three years during late *kharif* season from 2000-01 to 2008-09 and summarized on the basis of at least three years mean data. Percentage A grade bulbs ranged from 2.6 to 59.3% with double bulbs 0 to 43.1% and bolter 0 to 29.0%. Marketable bulb percent ranged from 31.8 to 94.2%, marketable yield ranged from 11.4 to 54.2 t/ha and total yield varied from 28.8 to 67.7 t/ha. Bulbs came to harvest from 106 to 135 days after transplanting and TSS ranged from 10.0 to 13.8%. On the basis of five best genotypes for important traits (Table 4), genotypes 1043, 609 and 531 were found superior for marketable yield and total yield. However, 1043 was found superior for marketable yield (54.2 t/ha), total yield (67.7 t/ha), % marketable yield (91.4%) and average marketable bulb weight (88.49 gm). Genotypes 674, 711, 634 and 657 were having good storability (<20% total weight loss after 4 months storage). More than 13% TSS was recorded in 20 genotypes including 674, 651, 655, 614 and 547. Four genotypes 696, 888, 906 and 956 were early in maturity (106 to 109 days). 32 genotypes/ varieties viz.1043, 1044, 609, 1048, 531, 546, 551, 639, 576, 597, 1014, 205, 642, B-780,

1047, 610, Composite, 1067, 634, 571, 131, 613, 956, N-2-4-1, 201, 905, 893, 12, 670, 704, 208 and 465 were found suitable for late *kharif* season with more than 35 t/ha marketable yield having good sized bulbs and other desirable traits.

Mean performance of red onion germplasm during *rabi* season (2000-01 to 2008-09)

Performance of 151 red onion germplasm including three checks (N-2-4-1, ALR and Arka Kalyan) was pooled for three or more than three years during *rabi* season (2000-01 to 2008-09) and summarized on the basis of at least three years mean data. Percentage A grade bulbs ranged from 4.8 to 50.3% with double bulbs 0 to 19.2% and bolter 0 to 17.9%. Marketable bulb percent ranged from 57.1 to 97.3%, marketable yield from 12.1 to 37.8 t/ha and total yield varied from 15.4 to 43.1 t/ha. Bulbs came to harvest from 99 to 128 DAT and TSS ranged from 9.9 to 12.9 %. On the basis of five best genotypes for important traits (Table 5), genotype 595, 645 and 677 were found superior for marketable yield and total yield. However, 595 also indicated early maturity (103 days). Genotypes 670, 1044, 720 and 1015 were having good storability (<15% total weight loss after 4 months storage). More than 12% TSS was recorded in 20 genotypes including 549, 698, 739, ALR and 831. Genotypes namely 536, 650, 592, 595 and 597 were early in maturity (99 to 103 days). 16 genotypes were found free from double bulbs (494, 597, 704, 733, 900 etc.) and 72 genotypes/ varieties were found free from bolters (35, 48, 70, 179, 327 etc.). 33 genotypes/ varieties viz. 595, 597, 645, 677, 650, 545, 632, 536, 624, 670, 1044, 592, 720, 651, 574, 625, 549, 1061, 1156, 1073, 627, 1050, 544, 638, 531, 576, 747, 551, 547, 1064, 769, 571 and N-2-4-1 were found suitable for *rabi* cultivation with more than 30 t/ha marketable yield having good storability and other desirable characters.

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

Evaluation of red onion elite lines during late *kharif* season

Fourteen red onion elite lines were evaluated in 1.0 x 4.5 m plot size in three replications during late *kharif* season along with two checks (Bhima Super and Bhima Red.) Percentage A grade bulbs, % doubles, % bolters and % marketable bulbs were maximum up to 70.5%, 12.6%, 10.9% and 89.9%, respectively in elite lines whereas it was 55.7%, 1.6%, 9.0% and 88.3% in Bhima Super. Marketable yield ranged from 33.1 to 47.9 t/ha and total yield from 42.7 to 59.3 t/ha in elite lines against Bhima Super which recorded 44.8 t/ha and 50.7 t/ha, respectively. One elite line EL-1044 (47.9 t/ha) was found superior in marketable yield over Bhima super (44.8 t/ha).

Performance of late *kharif* red onion elite lines under storage

Harvested bulbs of 14 red elite lines including check were kept in perforated crates and stored for three months in ventilated storage structure to study the post harvest performance of elite lines. Results revealed that 4 lines viz. EL-1044, EL-671, EL-670 and Bhima Red showed less than 10% weight loss after three months of storage whereas nine lines viz. EL-546, EL-Composite, EL-1014, EL-1172, EL-654, EL-650, EL-571, EL-595 and EL-592 recorded 10-20% weight loss after three months of storage. Only one elite lines (EL-651) recorded 20-30% weight loss after three months of storage.

Table 3. Best five genotypes for important traits during *kharif* season.

	Marketable yield (t/ha)		Total yield (t/ha)		Marketable Bulbs (%)		Unmarketable bulbs* (%)		ABW (g)		N (cm)		E:P ratio		DTH (days)	
	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values
1	B-780	29.23	B-780	32.89	MH-20	96.33	MH-20	3.67	B-780	64.60	859	0.25	859	1.05	696	98
2	85	28.37	85	30.70	K-519-R	93.72	K-519-R	6.28	N-53	62.50	1010	0.34	879	1.10	944	99
3	K-519-R	27.43	ADR	29.79	85	92.40	85	7.60	ADR	61.00	1014	0.34	974	1.11	1010	99
4	N-53	24.58	K-519-R	29.27	A K	90.86	A K	9.14	K-519-R	60.60	944	0.37	1000	1.12	MH-20	104
5	1000	23.37	N-53	28.59	121-DR	90.23	121-DR	9.77	85	60.00	909	0.38	B-780	1.13	909	106

AK = Arka Kalyan, ADR = Agrifound Dark Red, GP= Germplasm, * = Unmarketable bulbs including doubles, bolters and rots.

Table 4. Best five genotypes for important traits during late *kharif* season.

	Marketable yield (t/ha)		Total yield (t/ha)		Marketable Bulbs (%)		Double (%)		Bolter (%)		ABW (g)		N (cm)		E:P ratio		DTH (days)		TSS (%)		Storage Loss* (%)	
	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values
1	1043	54.26	551	67.75	1044	94.28	465	0.00	610	0.00	1043	88.49	1016	0.41	614	1.00	696	106	674	13.83	674	15.76
2	1044	51.14	531	60.93	1014	92.75	956	0.41	1047	0.00	546	81.00	1014	0.43	1048	1.00	888	109	651	13.81	711	16.49
3	609	49.03	610	60.10	1048	92.69	905	1.15	1093	0.00	732	80.00	1044	0.46	1094	1.02	906	109	655	13.79	634	18.18
4	1048	48.73	1043	59.32	1043	91.46	1048	2.43	693	0.17	551	78.50	1006	0.47	1073	1.04	956	109	614	13.74	657	19.24
5	531	46.30	609	58.20	1047	90.33	1047	2.46	708	0.31	1048	77.94	909	0.47	911	1.05	901	111	547	13.69	547	20.31

GP= Germplasm, * = Percentage total weight loss after 4 months of storage.

Table 5: Best five genotypes for important traits during *rabi* season.

	Marketable yield (t/ha)		Total yield (t/ha)		Marketable Bulbs (%)		Double (%)		Bolter (%)		ABW (g)		N (cm)		E:P ratio		DTH (days)		TSS (%)		Storage Loss* (%)	
	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values	GP	Values
1	595	37.81	549	43.16	720	97.33	494	0.00	35	0.00	549	80.91	943	0.31	617	1.11	536	99	549	12.93	670	12.96
2	597	37.68	677	42.00	1044	97.01	597	0.00	48	0.00	670	75.50	980	0.32	961	1.13	650	100	698	12.77	1044	13.10
3	645	37.35	645	41.02	1074	96.44	704	0.00	70	0.00	597	75.00	925	0.33	1055	1.13	592	102	739	12.60	720	14.20
4	677	36.77	595	39.59	597	96.17	733	0.00	179	0.00	1044	74.46	970	0.35	747	1.13	595	103	ALR	12.53	1015	14.57
5	650	36.69	545	39.45	592	95.95	900	0.00	327	0.00	1156	72.52	954	0.37	1050	1.13	597	103	831	12.44	592	16.80

* = Percentage weight loss after 4 months of storage.

Evaluation of advanced lines and varieties in demonstration trial during late *kharif*

Ten advanced lines along with nine varieties were evaluated in demonstration trial in bigger plot size of 1 x 6 m in 3 replications during late *kharif*. Percentage A grade bulbs in lines ranged from 47.4 to 68.1% and in varieties 5.9 to 61.3% as compared to check Bhima Super (55.7%). Percentage doubles and % bolters were maximum 12.6% and 19.2% in lines where as 53.0% and 28.9% in varieties, respectively as compared to Bhima Super which recorded 1.6% doubles and 10.4% bolters. Percentage marketable bulbs in lines ranged from 70.2 to 94.4% where as in varieties it ranged from 15.1 to 91.1% as compare to Bhima Super (87.2%). Marketable yield in lines ranged from 33.0 to 51.7 t/ha and in varieties from 5.1 to 43.5 t/ha marketable yield. NRCOG-1156 (51.7 t/ha) was found superior to Bhima Super (43.5 t/ha) in marketable yield. Highest average bulb weight was also recorded by NRCOG-1156 (100.5 g) against the Bhima Super (84.9 g).

Performance of late *kharif* red onion advance lines under storage

Late *kharif* harvested bulbs of 18 red advance lines and varieties were kept in perforated crates and stored for four months in ventilated storage structure to study the post harvest performance of advanced lines. The perusal of results revealed that 2 lines viz. NRCOG-595 and Bhima Red showed less than 20% weight loss after four months of storage whereas 7 lines viz. Bhima Raj, Bhima Super, NRCOG-1156 PP, RGO-53 BR-4, NRCOG-1168 ML, NRCOG-597 and NRCOG-1133OL recorded 20-30% weight loss after four months of storage. Rest of the lines viz. N-2-4-1, N-53, B-780 MPKV, Red

LK Massing II, Red LK Massing IV, Arka Niketan, Red LK Massing III, Red LK Massing I and Phule Samarth recorded 30-40% weight loss after four months of storage.

Evaluation of red onion massing cycles during late *kharif* season

Eight red onion massing cycles were evaluated in 1 x 2.25 m plot size during late *kharif* season along with check variety Bhima Super. Percentage A grade bulbs, % doubles, % bolters and marketable bulbs were maximum up to 60.0%, 33.3%, 19.0% and 80.9, respectively in massing cycles whereas it was 41.9%, 0.9%, 16.3% and 81.5% in check variety Bhima super. Marketable yield ranged from 20.0 to 47.6 t/ha and total yield from 40.0 to 71.4 t/ha in massing cycles against Bhima Super which recorded 43.1 and 52.8 t/ha, respectively. Massing cycle LK-07-C1 (LR-2) recorded highest marketable yield (47.6 t/ha) and total yield (71.4 t/ha) as compared to Bhima Super (43.1 t/ha and 52.8 t/ha), respectively.

Evaluation of red onion elite lines during *rabi* season

Thirteen red onion elite lines along with check N-2-4-1 were evaluated during *rabi* season in plot size of 2 x 3 m in 3 replications. Percentage A grade bulbs in elite lines ranged from 26.6 to 49.4%, doubles from 0.1 to 3.2%, bolters from 0 to 2.0% and marketable bulbs from 89.2 to 98.8% as compared to the N-2-4-1 where it was 36.9%, 0.6%, 0.2% and 93.7%, respectively. Marketable yield and total yield in elite lines ranged from 32.2 to 43.0 t/ha and 36.1 to 44.6 t/ha, respectively against check N-2-4-1 which recorded 34.8 t/ha marketable yield and 37.3 t/ha total yield. Six elite lines viz; EL-546 (41.6 t/ha), EL-595 (40.8 t/ha), EL-651 (40.9 t/ha), EL-654 (40.4 t/ha), EL-670 (42.2 t/ha), EL-1172 (43.0 t/ha) recorded more than 15 % marketable yield superiority over N-2-4-1 (34.8 t/ha).

Performance of *rabi* red elite lines under storage

Rabi harvested bulbs of 14 red lines including check were kept in perforated crates and stored for four months in ventilated storage structure to study the post harvest performance of elite lines. The perusal of results revealed that 7 lines viz. EL-1172, EL-571, EL-1014, EL-546, EL-651, EL-Composite and EL-654 showed 20 to 30% weight loss after four months of storage whereas 5 lines viz. EL-670, EL-597, EL-671, EL-592 and N-2-4-1 recorded 30-40% weight loss after four months of storage. Only two line viz. EL-595 and EL-650 recorded 40-50% weight loss after four months of storage.

Evaluation of advance lines and varieties in demonstration trial during *rabi* season

Ten advanced lines along with 5 varieties were evaluated in bigger plot size of 1 x 6 m in 3 replications in demonstration trial during *rabi* season. Percentage A grade bulbs in lines was maximum 73.5% (NRCOG-1156) and in varieties 54.8% (N-2-4-1). Percentage doubles and bolters were maximum 1.5% and 6.3% in lines, respectively whereas 29.1% doubles and 1.2% bolters in varieties. Percentage marketable bulbs in lines ranged from 88.5 to 99.6% whereas in varieties it ranged from 67.0 to 97.5%. Marketable yield in lines ranged from 37.5 to 55.8 t/ha and in varieties from 18.5 to 45.4 t/ha marketable yield. Three lines viz. NRCOG-1133 (51.1 t/ha), NRCOG-1156 (55.8 t/ha) and NRCOG-1168 (55.5 t/ha) were found superior over N-2-4-1 (45.4 t/ha). These lines also recorded 86 to 91 g average bulb weight as compared to N-2-4-1 which recorded 77.6 g average bulb weight.

Performance of *rabi* red onion advanced lines and varieties under storage

Harvested bulbs of 16 red onion advanced lines and varieties were kept in perforated crates and

stored for five months in ventilated storage structure to study the post harvest performance of advanced lines. The perusal of results revealed that 5 lines viz. N-2-4-1, NRCOG-595, NRCOG-1133 OL, NRCOG-597 and NRCOG-1168 ML showed 30 to 40% weight loss after five months of storage whereas 2 lines viz. NRCOG-1156 and Otur Local recorded 40 to 60% weight loss after five months of storage. Rest of the lines viz. Bhima Raj, L-28, Bhima Red, Red Rb Massing I, Red Rb Massing IV, RGO-53, Red Rb Massing III, Red Rb Massing II and Bhima Super recorded more than 60% weight loss after five months of storage.

Evaluation of red advance lines on farmer's field at Otur during *rabi* season

Five red onion advance lines were evaluated during *rabi* season in plot size of 1 sq m in 4 replications. Percentage A grade bulbs ranged from 33.1 to 50.5%, bolters from 0 to 0.7% and marketable bulbs from 92.5 to 96.5% whereas doubles were not recorded in all the lines. Marketable yield and total yield varied from 34.6 to 38.9 t/ha and 37.0 to 40.7 t/ha, respectively. Average bulbs weight ranged from 66.2 to 75.5g. RGO-53 (38.9 t/ha) was found comparatively high yielder than rest ones.

Evaluation of red onion elite lines during *kharif* season

Five red onion elite lines were evaluated during *kharif* in 1 x 3 m plot size in three replications along with 2 checks. Percentage A grade bulbs in elite lines ranged from 7.3 to 22.6%, doubles from 0 to 0.7%, bolters 0% and marketable bulbs from 41.4 to 62.3% as compared to Bhima Super where it was 13.0% A grade bulbs, 0% doubles and bolters, and 73.6% marketable bulbs. Range for marketable and total yield was 4.7 to 9.6 t/ha and 10.9 to 16.8 t/ha, respectively against check which recorded 9.9 t/ha marketable yield and 13.5 t/ha total yield. None of the line was found superior than check in marketable yield.

Evaluation of advance lines and varieties in demonstration trial during *kharif*

Five red advanced lines along with 6 varieties were evaluated in demonstration trial in 1 x 6 m plot size with 3 replications during *kharif* season. Percentage A grade bulbs in lines ranged from 8.9 to 29.9% and in varieties 12.4 to 38.5% as compared to check Bhima Super (13.0%). Percentage doubles and % bolters were maximum 1.9 and 0% in lines, and 2.3 and 0.3% in varieties as compare to Bhima Super which recorded 0% doubles and bolters both. Marketable yield was maximum 15.6 t/ha in advanced lines (Red *Kharif* Massing IV) with total yield of 23.9 t/ha. In varieties, maximum marketable yield was 10.9 t/ha (Bhima Red) and total yield 19.4 t/ha (B-780). Three lines viz; Red *Kharif* Massing I (11.8 t/ha), Red *Kharif* Massing II (11.4 t/ha) and Red *Kharif* Massing IV (15.6 t/ha) were found superior to Bhima Super (9.9 t/ha) in marketable yield.

Mean performance of red onion elite lines in late *kharif* 2006-07, 2007-08 and 2008-09

Seventeen red elite onion lines were evaluated in 1 x 3 m plot size in 3 replications during late *kharif* along with check variety Bhima Super. Percentage A grade bulbs, % doubles, % bolters and % marketable bulbs were maximum up to 61.0%, 17.1%, 13.9% and 91.0%, respectively in elite lines whereas it was 53.6%, 2.2%, 4.4% and 91.0% in Bhima Super. Marketable yield ranged from 24.3 to 42.2 t/ha and total yield from 29.8 to 48.5 t/ha in elite lines against Bhima Super which recorded 36.7 t/ha and 40.4 t/ha, respectively. Two lines EL-1043 (42.2 t/ha) and EL-1172 (41.5 t/ha) were found superior in terms of marketable yield as compared to Bhima Super (36.7 t/ha). Maximum average bulb weight (84.2 g) was recorded in EL- 1172 against Bhima Super (79.1 g).

Mean performance of red onion advanced lines in late *kharif* during 2006-07, 2007-08 and 2008-09

Six advanced lines along with six varieties were evaluated in bigger plot size of 1 x 6 m with 3 replications in demonstration trial during late *kharif* (2006-07, 2007-08 and 2008-09) (Table 6). Percentage marketable bulbs in lines ranged from 85.6 to 92.9%, doubles from 2.4 to 9.0% and bolters from 1.3 to 6.7% as compare to Bhima Super where it was 93.1%, 0.9% and 5.1%, respectively. Marketable yield and total yield in lines ranged from 37.2 to 45.9 t/ha and 40.0 to 50.3 t/ha, respectively against Bhima Super which recorded 41.1 t/ha marketable yield and 44.3 t/ha total yield. Lines NRCOG-1156 (45.9 t/ha) gave higher marketable yield as compare to Bhima Super (41.1 t/ha). In view of total yield, NRCOG-1156 (50.3 t/ha) and NRCOOG-1168 (47.6 t/ha) were found high yielder as compare to Bhima Super (44.3 t/ha).

Mean performance of red onion elite lines in *rabi* season during 2006-07, 2007-08 and 2008-09

Sixteen red onion elite lines along with check N-2-4-1 were evaluated during *rabi* season in plot size 1 x 3 m in 3 replications. Percentage A grade bulbs in elite lines ranged from 36.4 to 49.1%, doubles from 0.7 to 3.6%, bolters from 0 to 4.9% and marketable bulbs from 88.3 to 95.7% as compared to N-2-4-1 where it was 45.9%, 1.4%, 0.5% and 94.6%, respectively. Marketable yield and total yield in elite lines ranged from 30.4 to 46.4 t/ha and 31.8 to 48.5 t/ha, respectively against N-2-4-1 which recorded 39.2 t/ha marketable yield and 41.4 t/ha total yield. Three elite lines EL-1014 (42.1 t/ha), EL-1172 (46.4 t/ha) and Red *rabi* Massing I (41.7 t/ha) were found superior in marketable yield than N-2-4-1 (39.1 t/ha). EL- 1172 and Red *rabi* Massing-I recorded higher average bulb weight (77 to 78 g) as compare to N-2-4-1 (73 g).

Mean performance of red onion advance lines in *rabi* during 2006-07, 2007-08 and 2008-09

Seven advanced lines along with three varieties were evaluated in demonstration trial in bigger plot size of 1 x 6 m in 3 replications during *rabi* (2006-07, 2007-08 and 2008-09) (Table 7). Percentage A grade bulbs in lines ranged from 44.3 to 65.5%, doubles from 0 to 0.6%, bolters from 0 to 2.7% and marketable bulbs from 93.9 to 98.5% as compare to check N-2-4-1 where it was 49.6%, 0.3%, 0.5% and 97.6%, respectively. Marketable yield and total yield in lines ranged from 36.7 to 47.9 t/ha and 38.2 to 48.8 t/ha, respectively against check N-2-4-1 which recorded 41.1 t/ha marketable yield and 42.1 t/ha total yield. Line NRCOG-1156 was found superior in marketable yield (47.9 t/ha) as well as total yield (48.8 t/ha) over check N-2-4-1 which recorded marketable yield (41.1 t/ha) and total yield (42.1 t/ha). This line also recorded maximum average bulb weight of 80 g against N-2-4-1 (70 g).

Mean performance of red onion advanced lines in *kharif* during 2006, 2007 and 2008

Nine varieties including advance line were evaluated in bigger plot size of 1 x 6 m with 3 replications in demonstration trial during *kharif* (2006, 2007 and 2008) (Table 8). Percentage marketable bulbs ranged from 52.1 to 90.5%, doubles from 0.3 to 16.7% and bolters from 0 to 0.6% as compare to check B-780 where it was 77.3%, 0.8% and 0%, respectively. Marketable yield and total yield ranged from 10.3 to 25.9 t/ha and 17.3 to 29.4 t/ha, respectively against check B-780 which recorded 17.9 t/ha marketable yield and 22.3 t/ha total yield. Three varieties viz. Bhima Super, Bhima Red and Bhima Raj were found comparatively superior over rest of the varieties on marketable yield as well as on total yield.

Table 6. Mean performance of red onion advanced lines and varieties in demonstration trial during late *kharif* 2006-07, 2007-08, 2008-09.

Sr. No.	Entries	AGB (%)	Double (%)	Bolters (%)	Marketable Bulbs (%)	Marketable yield (t/ha)	Total yield (t/ha)	TSS (%)	ABW (g)	DTH	Storage Loss*
1	NRCOG-1133	55.26	2.95	3.45	92.09	38.09	41.51	12.21	77.05	125	28.83
2	NRCOG-1156	61.93	5.69	2.15	91.41	45.94	50.32	12.22	86.14	125	21.12
3	NRCOG-1168	59.10	9.09	3.63	85.61	40.57	47.63	12.43	84.27	125	23.37
4	NRCOG-595	56.30	2.98	3.04	91.88	37.45	40.74	12.58	76.28	125	25.16
5	NRCOG-597	52.14	2.40	1.32	92.91	37.24	40.03	12.40	70.93	125	28.20
6	RGO-53	57.70	2.70	6.75	89.04	37.27	41.88	11.31	77.11	122	33.96
7	Arka Niketan	32.82	9.95	17.92	70.17	28.42	40.91	12.29	68.76	120	35.25
8	B-780	50.17	2.79	10.93	84.85	34.40	41.26	12.13	71.59	122	31.75
9	N-2-4-1	47.35	5.21	5.12	86.92	30.84	35.44	12.67	70.22	125	26.44
10	Phule Samarth	51.07	11.22	8.19	76.14	33.67	45.05	12.14	73.17	122	50.37
11	Bhima Red	57.71	1.96	3.52	93.48	40.54	43.52	11.66	81.19	120	28.25
12	Bhima Super	55.92	0.91	5.11	93.07	41.12	44.32	11.88	76.46	122	30.62
	Mean	53.12	4.82	5.90	87.31	37.15	42.74	12.16	76.10	123	30.28
	Min	52.14	2.40	1.32	85.61	37.24	40.03	11.31	70.93	122	21.12
	Max	61.93	9.09	6.75	92.91	45.94	50.32	12.58	86.14	125	33.96

* = Percentage weight loss after 4 months of storage.

Table 7. Mean performance red onion advanced lines and varieties in demonstration trial during *rabi* 2006-07, 2007-08, 2008-09.

S. No.	Entries	AGB (%)	Double (%)	Bolters (%)	Marketable Bulbs (%)	Marketable yield (t/ha)	Total yield (t/ha)	TSS (%)	ABW (g)	DTH	Storage Loss*
1	NRCOG-595	49.13	0.04	0.68	98.02	38.75	39.50	11.54	65.83	125	25.04
2	NRCOG-597	47.34	0.21	0.06	98.56	40.36	40.92	10.19	68.25	125	30.29
3	NRCOG-1133	51.42	0.05	0.26	97.94	40.32	41.07	11.71	69.78	125	28.16
4	NRCOG-1156	65.53	0.68	0.18	98.06	47.94	48.86	11.64	79.75	134	37.00
5	NRCOG-1168	62.73	0.62	0.35	97.77	43.81	44.70	10.28	77.53	125	37.95
6	RGO-53 46.84	0.33	2.74	93.91	40.54	43.16	10.56	72.19	115	85.08	
7	B-780 5-3-1 LR	44.31	0.25	2.41	95.71	36.73	38.26	11.18	65.76	117	59.50
8	Bhima Red	44.81	0.32	0.31	97.20	37.03	38.11	10.95	64.00	118	79.04
9	Bhima Super	41.22	0.10	0.87	95.97	37.50	39.07	10.74	63.66	115	87.83
10	N-2-4-1	49.63	0.37	0.53	97.69	41.13	42.11	10.40	70.08	125	28.37
	Mean	50.30	0.30	0.84	97.08	40.41	41.58	10.92	69.68	123	49.83
	Min	44.31	0.04	0.06	93.91	36.73	38.26	10.19	65.76	115	25.04
	Max	65.53	0.68	2.74	98.56	47.94	48.86	11.71	79.75	134	85.08

* = Percentage weight loss after 5 months of storage.

Table 8. Mean performance of red onion advanced lines and varieties in demonstration trial during *kharif* 2006, 2007 and 2008.

Sr No.	Entries	AGB (%)	Double (%)	Bolters (%)	Marketable Bulbs (%)	Marketable yield (t/ha)	Total yield (t/ha)	ABW (g)	DTH
1	RGO-53	25.05	1.55	0.00	79.69	20.32	25.51	46.22	109
2	Bhima Red	27.60	0.90	0.00	87.07	25.88	29.46	51.35	109
3	Bhima Raj	28.85	0.34	0.00	90.51	25.22	27.77	51.49	109
4	Bhima Super	28.46	0.90	0.21	89.71	25.95	28.94	52.09	109
5	Phule Samarath	17.56	4.40	0.00	69.82	15.44	23.26	53.33	109
6	A. Kalyan	2.33	0.51	0.00	67.89	11.78	17.31	21.16	102
7	ADR	10.73	16.78	0.00	52.15	10.36	18.19	46.53	109
8	N-53	0.00	2.55	0.65	71.31	16.40	21.71	14.13	102
9	B-780	9.57	0.83	0.03	77.31	17.96	22.32	27.76	102
	Mean	16.68	3.20	0.10	76.16	18.81	23.83	40.45	106
	Min	0.00	0.34	0.00	52.15	10.36	17.31	14.13	102
	Max	28.85	16.78	0.65	90.51	25.95	29.46	53.33	109

Project 1.3 Heterosis breeding in red onion.

Evaluation of red exotic onion hybrids in demonstration trial during late *kharif*

Five red onion exotic hybrids were evaluated during late *kharif* in 1 x 6 m plot size with 3 replications along with five checks. Percentage A grade bulbs, % double bulbs, % bolters and % marketable bulbs were maximum up to 61.1%, 30.2%, 18.8% and 74.3%, respectively in the exotic hybrids where as it was 55.7%, 1.6%, 9.0% and 88.3% in check variety Bhima Super. Marketable yield and total yield varied from 29.1 to 38.1 t/ha and 42.8 to 54.0 t/ha, respectively in exotic hybrids against check which recorded 44.8 t/ha marketable yield and 50.7 t/ha total yield. Average bulb weight was maximum up to 129.8 g (Hy. Matahari) against Bhima Super (84.9 g). Percent plant establishment ranged from 49.0 to 92.1 against check (92.2%). None of exotic hybrid found superior to Bhima Super in marketable yield.

Performance of late *kharif* red onion exotic hybrids under storage

Harvested bulbs of 10 red onion exotic hybrids and varieties were kept in perforated crates and stored for four months in ventilated storage structure to study the post harvest performance of exotic hybrids. The perusal of results revealed that 7 entries viz. N-2-4-1, B-780 MPKV, Bejo Red Group, Hy. BSS-442, Hy. BSS-227, Hy. BSS-441 and Phule Samarth showed 30-40% weight loss after four months of storage whereas Hy. Matahari recorded 40-50% weight loss after four months of storage.

Evaluation of red exotic onion hybrids during late *kharif*

Seven red onion exotic hybrids were evaluated during late *kharif* in 1 x 3 m plot size with 3 replications along with 3 checks. Percentage A grade bulbs, % double bulbs, % bolters and % marketable bulbs were maximum up to 51.8%, 28.2%, 19.5% and 99.4%, respectively in exotic hybrids, where as it was 41.9%, 0.9%, 16.3% and 81.5% in check variety Bhima Super. In exotic hybrids, marketable yield and total yield varied from 28.2 to 54.3 t/ha and 33.2 to 54.6 t/ha, respectively against check which recorded 43.1 t/ha marketable yield and 52.8 t/ha total yield. Average bulb weight was maximum up to 95.9 g (Hy. Nun-3001) against Bhima Super (87.2 g). Hybrid Nun-3001 (50.3 t/ha) and hybrid Rio Tinto (54.3 t/ha) were found superior over Bhima Super (43.1 t/ha) in marketable yield. Percentage of plant establishment ranged from 72.7% to 93.5% in exotic hybrids against Bhima Super 94.3%.

Development of F_1 hybrids in onion through male sterility system during *rabi*

Total 40 F_1 hybrids of onion were developed by crossing between 4 MS lines (MS 48 A, MS 65 A, MS 888A and MS 999A) and selected 10 elite lines as pollinators during 2008-09. Seeds of these 40 F_1 hybrids along with its parents were sown and transplanted during *rabi* 2009-10 and the trial is in progress. Bulbs of 6 exotic hybrids along with 5 red lines (Bhima Super, RGO-53, N-2-4-1, 597 and 595) were sent to CITH, Srinagar for the making crosses between exotic lines and Indian lines during 2008-09. All the crosses are in progress for evaluation during late *kharif* and *rabi* 2009-10 for further selection.

Evaluation of red exotic onion hybrids during *rabi* season

Twelve red onion exotic hybrids were evaluated during *rabi* season in 1 x 4.5 m plot size with 3 replications along with 2 checks. Percentage A grade bulbs, % double bulbs, % bolters and %

marketable bulbs were maximum up to 57.7%, 4.7%, 2.5% and 98.8% in the exotic hybrids, respectively where as it was 48.7%, 0%, 0.4% and 95.6% in check N-2-4-1, respectively. Marketable yield and total yield varied from 27.0 to 47.3 t/ha and 31.2 to 47.7 t/ha, respectively in the exotic hybrids and it was 35.4 t/ha and 37.0 t/ha recorded by check N-2-4-1. TSS ranged from 6.4 to 12.2% and average bulb weight ranged from 55.2 to 75.3 g against check N-2-4-1 recorded 12.5% TSS and 66.0 g average bulb weight. Hybrid Nun-3001 ON (43.3 t/ha) and Hybrid Orient (44.5 t/ha) were found superior than check N-2-4-1 (35.4 t/ha) in terms of marketable yield with 33.5% and 25.8% marketable yield superiority, respectively.

Evaluation of red onion F_1 hybrids during *kharif*

Three F_1 hybrids of red onion were evaluated during *kharif* season 2009 in 1 x 1.05 m plot size with check Bhima Super. Percentage A grade bulbs, % doubles, % bolters and % marketable bulbs were maximum up to 17.8%, 0.6%, 0% and 92.8% in the F_1 hybrids, respectively where as in Bhima Super it was 10.6% A grade bulbs, 0% doubles and bolters, and 65.9% marketable bulbs. Range for marketable and total yield was 14.5 to 21.6 t/ha and 19.5 to 25.3 t/ha, respectively in F_1 hybrids against Bhima Super which recorded 14.7 t/ha marketable yield and 22.3 t/ha total yield. F_1 hybrid, MS 48A x 915 (21.6 t/ha) was found superior in terms of marketable yield against Bhima Super (14.7 t/ha) with 46.7% marketable yield superiority over Bhima Super.

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

Reaction of red onion germplasm to thrips during *rabi*

In *rabi*, 31 germplasm of red onion including N-2-4-1 were evaluated for their reaction to thrips. Thrips population was relatively low compared to previous years. However, considerable symptoms occurred on the accessions that included both foliage damage and curling. Based on the damage occurred due to thrips feeding, injury rating and curling was given on 1 to 5 scale. Out of 31 lines, 4 lines viz. 1181, 1183, 881 and 1162 were found susceptible while 5 lines viz. 201, 531, 754, 876 and 1015 were found resistant to thrips. Remaining accessions fall under moderately resistant category. However confirmation of this reaction is necessary for one more season. With respect to yield, 3 lines recorded higher bulb yield in the order- 1015 (3.9 kg/sqm), 201 (3.8 kg/sqm) and 465 (3.7 kg/sqm) compared to 3.63 kg/sqm in check N-2-4-1.

Reaction of red onion exotic hybrids against thrips during *rabi*

During *rabi*, 8 exotic onion hybrids along with N-2-4-1 were evaluated for their reaction to thrips. The trial was conducted in a single replication with 60 plants/plot. There was a significant variation in the injury caused by thrips among the hybrids. The reaction of hybrids varied with a rating range of 2.0-3.4 on a 1 to 5 scale. No hybrid was found highly resistant. Two hybrids viz. Matahari and Orient had shown resistant reaction to thrips. Three hybrids (Hy. Rio Tinto, Hy. Lucifer and Hy. BSS-227) were found moderately resistant with a rating of 2.6-3.0 and 3 hybrids (Hy. Nun-3001, Hy. Flaro, Hy. Juni- 3800) were susceptible under Indian conditions. Apart from injury inflicted to leaves, curling and twisting of the plants across the hybrids were observed and were recorded on a 5.0 scale. In 4 hybrids, curling was more i.e., above 3.0 rating. Hybrids that performed better than the local commercial variety i.e. N-2-4-1 (3.63 kg/sq. m) include Hy. Matahari and Hy. Orient.

Programme 2 : Development of Onion (White and Yellow) varieties for processing, export and resistant to biotic and abiotic stress

Project 2.1 Collection, evaluation and maintenance of white onion germplasm

Evaluation of white onion germplasm during late *kharif*

During late *kharif* season, 34 germplasm along with 3 white checks were evaluated in row trial of 200 plants per bed. % Marketable yield ranged between 0 to 88.46% in germplasm lines whereas, it was 40.21 (AFW) to 52.83% (Phule Safed) in varieties. Double bulbs were 0 to 78.26% in germplasm against 14.52 to 44.33% in check varieties. Marketable yield and total yield were maximum 36.17 t/ha and 47.22 t/ha, respectively in germplasm lines against best check Phule Safed which recorded 25.89 t/ha marketable yield and PKV White 51.52 t/ha. TSS in germplasm ranged between 11.20 to 14.75% whereas; in check varieties it was 12.05 to 12.79%. % superiority for marketable yield in 5 lines viz. w-340, w-029, w-220, w-172 and w-440 (27.67 to 36.17 t/ha) was 6.86 to 39.69% higher over check Phule Safed (25.89 t/ha). Germplasm w-029 recorded 8.42% higher yield (28.07 t/ha) with early maturity in 112 days after planting as compared with Phule Safed which took 126 days for maturity.

Evaluation of white onion germplasm lines during *rabi* season

33 white onion germplasm were evaluated during *rabi* season in 1 sq m plot size in two replications along with three check varieties. % of doubles, bolters, "A" grade bulbs and marketable bulbs in these lines ranged from 0 to 25.51%, 0 to 9.29%, 10.43 to 48.76% and 70.58 to 96.40%, respectively against the best check variety Udaipur-102, where it was 8.35%, 0%, 26.41% and 88.39%, respectively. No doubles were recorded in 4 lines and no bolters in 17 lines. Days to harvest in the germplasm varied from 108 to 123 days after transplanting whereas; check varieties took 108 to 109 days for harvesting. Marketable yield and total yield was 31.16 and 35.26 t/ha in check variety whereas it ranged from 20.0 to 36.93 and 25.0 to 42.12 t/ha, respectively. 6 lines yielded higher marketable yield and 2 lines higher total yield than the check variety Udaipur 102. Lines W-078, W-186, W-212, W-226, W-043 and W-398 (33.59 – 36.93 t/ha) performed better for marketable yield. 10 lines (W-047, W-397, W-507, W-381, W-171, W-416, W-104, W-414 and W-469) recorded higher TSS (14.16 to 15.60%) above check AFW, which had 13.91% TSS whereas TSS in Udaipur 102 was 12.63%. Marketable yield in these high TSS lines ranged from 20.90 to 30.26 t/ha and 2 lines w-381 and W-469 were at par with checks.

Evaluation of white onion germplasm during *kharif* season 2009.

During *kharif* season 9 germplasm lines were evaluated along with 4 white checks and one red check in 3 replications in plot size of 1.95 sq. m. % double bulbs ranges from 6.94 to 99.14%. Two lines viz. w-514 and w-510 were of multiplier type. Marketable yield was maximum 10.39 t/ha in w-523 followed by w-517 (9.15 t/ha) during *kharif* season over best check Phule Safed (7.18 t/ha). Total yield was higher in 4 lines ranged between 16.92 to 20.34 t/ha. TSS was high in 6 lines (10.66 to 11.92%) over the check Phule Safed which recorded 9.59%. 9 lines were early in maturity and took 81.66 to 88.33 days after transplanting while best check took 95 days for maturity.

Project 2.2 Developments of high TSS white onion varieties suitable for different seasons & processing

Evaluation of white onion elite lines & breeding lines during late *kharif*

Eight elite/ breeding lines along with 3 checks were evaluated during late *kharif* in 1.8 sq. m plot size in three replications. % double bulbs in elite lines/ breeding lines were 0 to 16% while in check Phule Safed it was 14.52%. Bolter percentage ranged between 0 to 19.23% against check Phule Safed recorded 31.64% bolters. Marketable yield was recorded maximum 43.33 t/ha in w-185/M-2-Lk followed by w-441/M-3Lk (39.61 t/ha), w-421/El-2-lk (36.67 t/ha) and w-340/M-3-Lk (32.14 t/ha) against best check Phule Safed yielded 25.89 t/ha. % TSS in elite lines ranged between 11.35 to 13.46% whereas in white varieties it was from 12.05 to 12.79%. Lines w-185/M-2Lk and w-441/M-3Lk besides high marketable yield were 12 days earlier in maturity and took 114 days to harvest after transplanting over check Phule Safed which took 126 days to harvest.

Evaluation of varieties and advance lines in demonstration trial during late *kharif*

Four advance lines of white onion along with 3 white varieties were evaluated in demonstration block in bigger plot size of 1 x 6 m in 3 replications during late *kharif*. % marketable yield in advanced lines ranged from 73.39 to 84.90% whereas in white varieties it was 40.21 to 53.86%. Marketable yield in white lines varied from 34.33 to 36.46 t/ha against Phule Safed (26.42 t/ha). % of bolters in white lines ranged from 8.15 to 15.6%, while in white varieties it was 13.4 to 31.44% and maximum in Phule Safed 31.44%. % double bulbs were lowest in w-448-Br-3 (2.7%) against Phule Safed (13.77%). In the demonstration trial among the white lines, w-009 gave highest marketable yield of 36.46 t/ha with 84.35% marketable bulbs. TSS in these lines ranged from 12.25 to 13.30% in white lines while it was 12.84% in Phule Safed.

Evaluation of white onion elite/ breeding lines during *rabi*

White elite/ breeding lines were selected from the germplasm and being purified. 49 lines were evaluated in 2 replication during *rabi* season on flat bed in 4 sq. m. area per line / replication along with 3 white checks. % bolters in these lines varied from 0 to 20.95% whereas in checks it was 5.2 to 10.8%. 23 lines recorded no bolters. % doubles ranged from 0 to 20.22% in lines and in varieties it was 5.29 to 16.49%. Similarly no doubles were observes in 11 lines. % marketable bulbs were maximum 99.11% in these lines and 88.39% in check Udaipur-102. Minimum % marketable bulbs were 74.43% in these lines and 76.65% in AFW. 22 lines recorded high marketable yield and 9 lines viz. w-119/m-3-Rb, W-401/EL-2-Rb, w-161/m-3-Rb, w-098/m-3-Rb, w-435/m-1-Rb, W-433/EL-2-Rb, w-303/m-3-Rb, W-361/EL-2-Rb and w-444/m-3-Rb were significantly superior as compared with check Phule Safed (30.26 t/ha). TSS ranged from 10.16 to 15.96% in these lines and in check it was 12.18 to 13.91%. 5 lines recorded significantly high TSS ranging from 14.38 to 15.56%.

Evaluation of white onion high TSS lines during *rabi*

High T.S.S. lines were developed from single bulb to row progenies in each generation. T.S.S of all the progenies was recorded and bulbs having T.S.S. more than 15 % were selected and rest of the bulbs were rejected. Two groups were made based on T.S.S. 15-17.9 and 18 and above, and bulbs

were planted in groups in isolation for further multiplication. At present 61 lines were multiplied and 51 lines were evaluated in 4th generation. 43 high T.S.S lines were significantly superior to check and 37 lines recorded population mean T.S.S more than 15% to maximum 19.94%. T.S.S range in these lines was 10.83 to 19.94 %. % marketable bulbs ranged between 18.18 to 100 % where as in checks it was 76.55 to 88.39%. Marketable & total yield was maximum 39.62 t/ha and 48 t/ha in these lines whereas, it was maximum 31.16 and 37.33 t/ha in checks, respectively. 16 lines recorded T.S.S more than 17 % and total yield in bulbs having TSS more than 17% ranged between 14.45 to 40 t/ha and marketable yield between 7.08 to 24.17 t/ha. 4 lines viz., WHT –12 B Rb/M, WHT-5A Rb /M, WHT-1 B Rb/M & WHT-13Rb/cross recorded high marketable yield ranged from 24.17, 23.15, 20.42, 20 t/ha with total yield of 30.45, 24.26, 23.34 and 40 t/ha and TSS 17.42, 18.36, 18.59 and 18.59, respectively. New composite of high T.S.S lines of selected bulbs will be made to increase the yield level while maintaining high TSS above 17 % in the population.

Evaluation of white onion high TSS lines during *rabi*

Out of 61 high TSS lines, TSS were recorded from 42 progenies of massing/selfing and mutated lines in 4th generation. 34 lines recorded more than 15% population mean TSS ranged from 15.44 to 19.94% against the check varieties which recorded from 9 to 11.28%. More than 80% bulbs in 20 population recorded TSS above 15%. Lines WHT-5B-Rb/m, WHT-1C-Rb/m, WHT-3D-Rb/M, WHT-5B-Rb/m and WHT-2C-Rb/m recorded more than 95% bulbs with TSS above 15%. Lines WHT-2B-Rb/m, WHT-2C-Rb/m and WHT-1B-Rb/m had more than 70% bulbs with TSS above 18%. More than 18% population mean TSS was noted in 9 lines viz. WHT-2B-Rb/m, WHT-2C-Rb/m, WHT-5B-Rb/m, WHT-1B-Rb/m, WHT-5A-Rb/m, WHT-6A-Rb/M, WHT-3D-Rb/M, WHT-1C-Rb/m and WHT-5B-Rb/m.

Evaluation of varieties and advance lines in demonstration trial during *rabi* season

White onion advance lines (4) along with 4 white onion varieties were evaluated in bigger plot size of 1 x 6 m in three replications in demonstration trial during *rabi* season on raised beds with drip irrigation. % A grade bulbs in white lines was maximum 50.38%, whereas in check varieties it was 38.28%. Similarly % marketable bulbs were maximum up to 96.26% and 86.03%, respectively. Marketable yield and total yield ranged between 37.94 to 42.22 t/ha and 39.42 to 45.66 t/ha in white lines and it was 26.61 to 31.14 t/ha in white varieties, respectively. All the four white advance lines yielded significantly higher yield than the best white check Phule Safed. W-448-Br-4 yielded maximum marketable yield of 42.22 t/ha with 45.66 t/ha total yield.

Evaluation of white onion elite /breeding lines during *kharif* season

Seventeen white onion elite / breeding lines were evaluated during *kharif* season along with 3 white and 1 red check in 3 replication on raised bed. Plot size was 1.95 sq.m. per entry in each replication. 8 lines recorded no doubles and % marketable bulb ranged between 5.28 to 16.11 t/ha in these lines against white check varieties which recorded 4.02 to 7.18 t/ha marketable yield. In red *kharif* variety Bhima Super marketable yield was 15.89 t/ha. Maximum total yield was 23.24 t/ha in these lines whereas it was 11.36 t/ha in check variety Phule Safed. Overall %TSS ranged from 8.16 to 10.36. 2 lines viz. w-355/El-kh-St (10.06 t/ha MY) and w-459/El-5kh (11.28 t/ha MY) were earliest to harvest in 83 days after transplanting. 9 lines viz. W-419/EL-6-Kh, W-428/EL-6-Kh, W-

302/EL-6-Kh, W-453/Kh-m-4, W-448 BR-5, W-459/EL-5 Kh, W-411/EL-6-Kh, W-355/EL-5 Kh- ST, and W-420/EL-2-Kh (9.2 to 16.1 t/h) gave high marketable yield than the check Phule Safed 7.18 t/ha.

Evaluation of *rabi* demonstration varieties and advance lines in storage

Varieties and advance lines of onion produced in demonstration trial during *rabi* season were evaluated for storage life. 10 kg bulbs from each (12) entries were kept in storage during May 08 and observations were recorded at different intervals. Final observation was recorded after 4 months of storage. Total weight loss in white line was lowest 64.6% in w-448 (NRC) after four month of storage. White advance line can be stored maximum up to two months where storage loss ranged from 17.67 in w-009 to 32.67% in White Elite Composite. Total weight loss in N-2-4-1 was lowest 16.0% among the varieties whereas it was above 80% in all medium to dark red varieties during *rabi* season.

Project 2.3 Collection, evaluation and maintenance of yellow onion germplasm

Evaluation of yellow onion germplasm lines during *rabi* season

5 germplasm lines were evaluated during *rabi* along with check variety Phule Suwarna and Arka Pitambar in 3 replications in 1 sq. m plot size. % marketable yield in the germplasm varied from 88.25 to 99.05% while it was 82.72 & 83.09% in the check varieties Phule Suwarna and Arka Pitambar, respectively. % A grade bulbs, % doubles and % bolters ranged from 15.25 to 47.1%, 0 to 5.8% and 0 to 4.55%, respectively in the germplasm lines, whereas it was 27.47%, 8.26% and 5.08% in the check variety Arka Pitambar and 34.21%, 0% and 13.12% in Phule Suwarna, respectively. 3 germplasm viz. Y-003, Y-005 and Y-027 gave higher marketable yield (32.0 to 37.11 t/ha) as compared to check Arka Pitambar (29.45 t/ha). Total yield in germplasm ranged from 31.82 to 39.89 t/ha.

Project 2.4 Development of yellow onion varieties suitable for export

Evaluation of yellow onion breeding lines during late *kharif* season

Six breeding lines including yellow gene pool were evaluated during late *kharif* in row trial on raised bed of 1.5 sq. m./breeding line. Per cent double bulbs, bolters and marketable bulbs ranged between 12.5 to 58.65%, 4.34 to 18.75% and 32.69 to 67.06%, respectively in these lines over best check Phule Suwarna with 7.04% double bulbs, 42.25% bolters and 50% marketable bulbs. Marketable yield was maximum 31.48 t/ha and total yield 50.67 t/ha in these lines, whereas in check it was 18.21 and 36.41 t/ha, respectively. 5 lines showed 33.36 to 72.88% increase over check for marketable yield. Line y-004/m-3 (31.48 t/ha), Yellow Gene pool (29.06 t/ha) and Demo Yellow Srg. (27.33 t/ha) were high yielder with TSS 10.6 to 13.4%. Two lines viz. Yellow Gene pool and Demo Yellow Srg. were earlier in maturity took 114 days after transplanting.

Evaluation of yellow onion germplasm and breeding lines during *rabi* season

6 breeding lines including yellow gene pool and selected progeny of Phule Suwarna in 4th generation were evaluated during rabi along with check variety Phule Suwarna in 3 replication in 1.05 sq. m plot size. % marketable yield in these lines varied from 84.72 to 99.39% while it was

82.72% in the check. Average bulb weight, % A grade bulbs, % doubles and % bolters ranged from 41.98 to 63.14 g, 0 to 35.7, 0 to 13.36 and 0 to 2.1%, respectively in the breeding lines, whereas it was 61.09 g, 34.21%, 0% and 13.12%, respectively in the check variety. 3 lines (Y-009/m-3-Rb., Phule Suwarna (NRC-4) and Yellow Gene pool) recorded high marketable yield (30.13 to 37.69 t/ha) than the check Phule Suwarna (27.09 t/ha).

Project 2.5 Heterosis breeding in white and yellow onion

Evaluation of exotic onions during late *kharif*

White (7) and yellow (13) exotic hybrids along with 3 checks were evaluated during late *kharif* in 2 replications on raised bed with drip irrigation in 3 sq. m. plot size per replications. % marketable bulb was 62.6 to 98.69% in white hybrids and 35.83 to 99.68% in yellow hybrids, whereas in white check Phule Safed it was 52.83 and in Phule Suwarna it was 59.15%. Double bulbs and bolters ranged from 0 to 27.45% and 0 to 36.25%, and 0 to 18.4% and 0 to 8.42%, respectively in white and yellow exotic hybrids. Marketable yield was maximum 50.79 t/ha in white exotic Early Supreme White and 55.87 t/ha in yellow exotic Serengeti (1202) followed by Mercedes over white check Phule Safed and yellow Phule Suwarna with 25.89 and 22.17 t/ha. Overall bolters were very few in most of the exotic and TSS ranged between 7.22 to 13.98%. For maturity/harvesting it took 104 to 132 days after transplanting. Most of the hybrids are still not showing uniformity in size, shape etc. More than 45 t/ha marketable yield was recorded in Carta Blanka 2000, Early Supreme and Onion White F1 BGS-227 in white onion and Serengeti (1202) Mercedes, Olga (1404) and Prowler in yellow onion.

Evaluation of exotic onion hybrids during *rabi* season

White (7) and yellow (14) hybrids were evaluated during *rabi* season in two replications on raised bed of 1.95 sq. m. per hybrid per replication along with yellow check Phule Suwarna and Arka Pitambar and white check Phule Safed. All the hybrids were not uniform. % doubles and bolters were very less in exotic hybrids with maximum of 3.13% and 4.9% doubles and 2.97 and 0% bolters in white and yellow hybrids, respectively. There was no bulb formation in China Local and Gailiang Jingiu No-2. 4 entries were superior over check in white onion and 8 in yellow exotic onion. BGS-245 (42.45 t/ha), Kristal (40.76 t/ha) and Early Supreme White (36.49 t/ha) gave high marketable yield in white onion whereas hybrid Mercedes (53.19 t/ha) gave highest yield of 53.19 t/ha followed by Gobi-1201 (52.67 t/ha) and Serengeti-1201 (50.86 t/ha) in yellow onion. Marketable yield in exotic white and yellow onion ranged between 26.58 to 42.45 and 0 to 53.19 t/ha, respectively against white check Phule Safed (29.61 t/ha) and yellow check Arka Pitambar (29.45 t/ha). White exotic onion took 111 to 119 days to harvest and yellow onion 101 to 119 days after transplanting.

Evaluation of late *kharif* exotic hybrids/varieties in storage

Storage losses were studied in 10 yellow and 2 white exotic onions along with 2 checks from the crop harvested during late *kharif*. 5 kg bulbs per replication were kept in crates in 3 replications. Observations were recorded upto 2 months of storage. Total weight losses after 2 months in white exotic hybrids ranged between 24 (BSS 262) to 42% (Nun – 1500 On) and 24 (Prowler) to 30% (Gobi

1201) in yellow onion whereas, check N-2-4-1 recorded only 5% total loss by weight. Losses after one month of storage were between 17 to 23% in both white and yellow exotic onions.

Evaluation of *rabi* exotic hybrids/varieties in storage

Twelve yellow and 7 white exotic hybrids along with checks (N-2-4-1 and AFW) obtained from *rabi* harvest were kept for storage studies in the month of May. 5 kg bulbs were kept in crate in 3 replications up to 3 months. Per cent total weight loss after 3 month of storage in white hybrids ranged from 69 to 77.5% and in yellow onion from 67.5 to 100%. Total weight loss after 2 months was 41 to 55.5% in white exotic and it was above 45% in yellow exotic onions. Losses in check N-2-4-1 and AFW was 11.92% and 45.5% after 3 month of storage and 9.5% and 34% after 2 months, respectively. Total loss after one month of storage in white exotic was comparatively less (5-17%), as compared with yellow exotic where losses were 9 (Colina) – 44.5% (Prowler). Storage losses in Carta Blanca (white) and Colina (Yellow) were 5% and 9%, respectively after one month of storage.

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

Reaction of white and yellow onion germplasm lines to onion thrips

In *rabi* season, 20 lines of white onion and 2 lines of yellow onion were screened for resistance to thrips. Among the 20 lines of white onions, 7 lines including check variety, Phule safed were found moderately resistant with an injury rating of 2.4- 3.0. Eleven lines were found susceptible to thrips that had rating of 3.2 – 4.0. White onion line W-457 was found highly susceptible with a rating of 4.4 on a 0-5 scale. Bothe the yellow lines were found susceptible. Variety Phule safed recorded an injury rating of 2.6 and bulb yield of 2.9 kg/sqm. Other white lines that recorded bulb yield equal to or above Phule safed were W-469 (2.95kg/sqm), W-473 (3.0 kg/sqm), W-353 (3.2kg/sqm), W-303/m3-rb (3.4 kg/sqm) and W – 503 (3.45 kg/sqm). One yellow onion line, Y-003 recorded higher bulb yield of 3.6 kg/sqm though it has higher injury rating of 3.0.

It was also noticed that white and yellow onions are relatively more susceptible than red onion lines.

	Reaction	Accessions
0-1	Highly resistant	NIL
1-2	Resistant	NIL
2-3	Moderately resistant	w-353, w-015, w-w-137, Phule safed, 303/m-3 rb, w-498, w-396/m-3, Y-003
3-4	Susceptible	Y-009, w-269, w-487, w-501, w-507, w-469, w-473, w-485, w-435, w-453, w-503, w-506, w-302
4-5	Highly susceptible	w-457

Reaction of exotic onion hybrids against onion thrips

During *rabi* 2008, white and yellow exotic onion hybrids were evaluated for their reaction to thrips. The trial was conducted in a single replication with 60 plants/plot. There was a significant variation in the injury caused by thrips among the hybrids. The reaction of hybrids was varied with a rating range of 1.4- 4.8 on a 1.5 scale. No hybrid was found highly resistant. Hy Serengeti and Basic F1 had showed resistant reaction to thrips. 7 lines were found moderately resistant with a rating of 2.1-3.0 and 7 lines were susceptible. Two hybrids, BGS and China local were found highly susceptible under Indian conditions.

Apart from injury inflicated to leaves, curling and twisting of the plants across the hybrids were observed and were recorded on a 5.0 scale. In 10 hybrids, curling was more (above 3.0) rating. Hybrids that performed better than the local commercial variety, N-2-4-1 (3.63 kg/sqm) include- Hy Prowler, Serengeti and Basic F1.

	Reaction	Accessions
0-1	Highly resistant	NIL
1-2	resistant	Hy Serengeti, Hy Basic F1,
2-3	Moderately resistant	Hy Prowler, Hy BSS- 255, Hy BSS- 262, Hy Carta Blanca, Hy Gobi, Hy Kristal, Hy BSS-227, N-2-4-1
3-4	Susceptible	Hy Nun-3001, Hy Colina, Hy Tuarge-4201, Hy Juni- 3800, Hy Colina Singian, Hy Nun -1500, Hy Colina (1600)
4-5	Highly susceptible	Hy BGS, China local

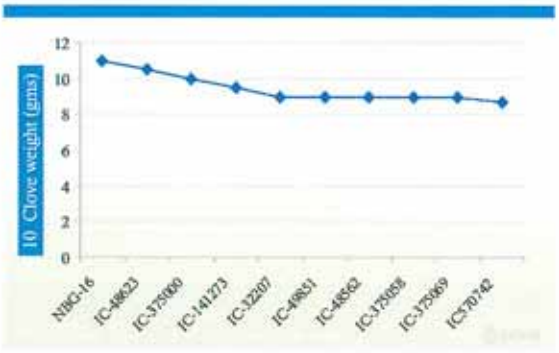
Programme 3.0 : Improvement of garlic through conventional and biotechnological approaches

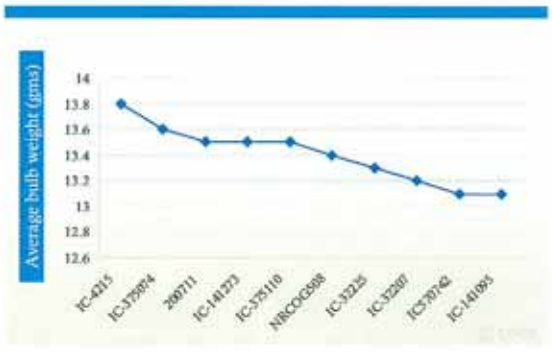
Project 3.1 Collection, Evaluation and Maintenance of Garlic (*Allium sativum* L.) Germplasm

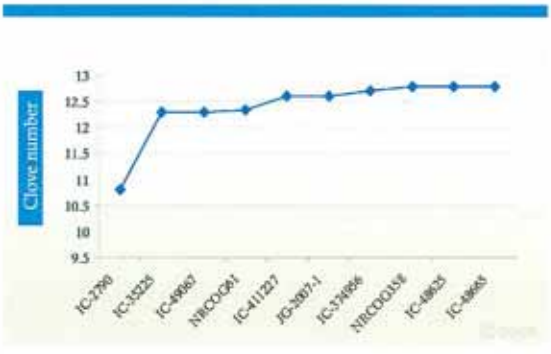
A total of 155 lines including germplasm and some advanced lines were evaluated in three replications in a randomized block design. Data was observed on randomly selected five plants and data obtained was analysed using IndoStat programme. Accessions IC570712-7-1, IC570709-7-2, IC570744, 389, 471, 200711, IC 570742-12-3, IC570683-7 and 409 were found to be good yielders whereas weight of 10 cloves was highest in NBG16, IC48623, IC375000, IC141273, IC49851. Bulb weight was highest in IC4215 and less number of cloves were found in IC2790. A comprehensive table indicating the lowest and highest value including range, mean and CV is presented here.

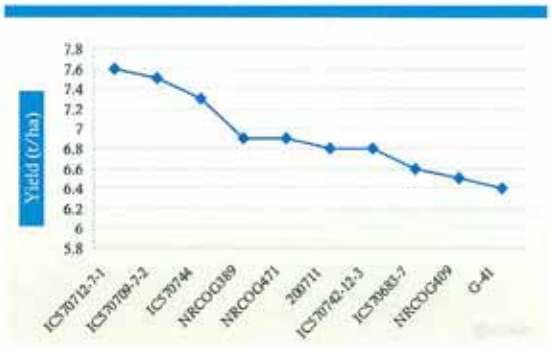
Range of morphological observations in garlic germplasm evaluated under Rajgurunagar conditions

Genotype	Lowest	Highest	Mean	C.V.
Plant Height (cm)	29.1	58.5	46.0	7.3
Number of Leaves	7.2	14.4	11.1	6.5
Leaf length (cm)	19.4	47.5	35.1	9.0
Leaf width (cm)	0.8	2.0	1.6	8.9
Collar thickness (mm)	4.2	13.4	9.3	11.0
Polar Dia. (cm)	1.5	3.3	2.2	9.0
Eq. Dia. (cm)	1.8	4.0	2.8	8.2
Neck Thickness (cm)	0.1	0.6	0.3	18.4
Bulb Weight (g)	6.8	15.4	10.9	13.8
Clove number	10.0	19.6	14.3	9.7
10 Clove Weight (g)	4.0	14.0	6.6	19.8
Clove Polar Dia. (cm)	0.4	2.2	1.3	9.6
Clove Eq. Dia. (cm)	0.2	1.1	0.6	13.9
Yield (t/ha)	0.6	11.2	3.4	29.2









Evaluation of exotic garlic germplasm (NBPGR, Shimla)

A total of 210 garlic germplasm imported from USA and Germany and 9 local checks were evaluated at NBPGR, Shimla under the supervision of Dr. JC Rana. The experiment was laid out in augmented block design along with nine checks. Data on qualitative and quantitative traits e.g., yield and yield related traits was observed and subjected to statistical analysis. Below is the performance of ten best lines on the basis of morphological traits.

Sr. No.	NBPGR No.	Country	PH (cm)	NOL (cm)	LL (cm)	LW (cm)	CT (cm)	NOC	CP (cm)	CE (cm)	BW (gm)	Yield (t/ha)
1	EC634809	Czech Republic	73	9	57.2	3.3	1.54	9	3.17	3.46	112.1	66.08
2	EC634805		45.2	6.5	41.5	3.05	1.34	11	2.66	2.45	102.8	65.10
3	EC634651	Former Serbia and Montenegro	56.5	7.5	45.4	2.6	1.52	8	3.04	2.11	82.2	50.74
4	EC634818	Germany	59.3	7.5	42.9	2.9	1.71	5	3.53	3.5	82.7	50.29
5	EC634745	Albania	58.4	6.5	50.5	3.05	1.5	11	2.91	1.73	80.2	47.04
6	EC634782	Bulgaria	62	8.5	50.5	3.1	1.62	9	3.05	2.88	75.2	46.06
7	EC634724	US	60.2	8	53.2	3.35	1.77	16	2.44	2.04	70.9	45.68
8	EC634751	Turkey	67.55	8.5	57.6	2.9	1.66	12	2.86	2.75	73.4	44.87
9	EC634810	Czech Republic	62.1	8	51.5	3.05	1.62	9	3.11	2.91	71.4	43.59
10	EC634730	Former Soviet Union	53.4	7.5	48.6	2.15	1.47	7	3.65	2.09	73.1	43.06

Estimation of allicin and other thiosulphinates in garlic germplasm

This work was carried under the active collaboration with Dr K. Banerjee, NRC for Grapes, Pune. A total of 97 germplasm lines were evaluated for allicin and other thiosulphinates. Estimation of the chemicals was done on the fresh weight and dry weight basis. A comprehensive list (Table 4) is given about the germplasm lines which exhibited highest and lowest concentration on fresh weight and dry weight basis.

List of genotypes recording highest and lowest for allicin and other thiosulphinates

Fresh weight basis	Genotypes	Conc. (mg/g)
Allicin	200706	5.414
	RG321	1.618
Allylmethyl Thiosulphinate	RG345	3.192
	IC-372982	0.814
Allyl trans 1 propenyl Thiosulphinate	IC-375010	0.443
	IC-374974	0.170
Dry weight basis		
Allicin	IC-374981	16.140
	RG321	4.400
Allylmethyl Thiosulphinate	RG345	10.620
	DUS5	2.781
Allyl trans 1 propenyl Thiosulphinate	IC375010	1.584
	WG432	0.533

Screening of garlic germplasm against thrips during *rabi* season

87 lines of garlic germplasm that included indigenous collections and check lines were evaluated for their reaction to thrips during *rabi* 2008. Considerable variations were recorded with respect to reaction of thrips damage. Using a 1-5 rating scale, thrips damage was recorded on 90 days old plants. Among the lines screened, none were found highly resistant while 7 lines- IC-200711, 200706, 212355, Godavari, 48623 and Singapore were found resistant that recorded the lowest damage rating ranging from 1.3-2.0. Another 56 lines were found moderately resistant and 23 lines were under susceptible category. One line, 2007-1 was found highly susceptible with rating of 4.2.

21 lines of garlic that included 17 mutation lines along with 4 check lines were screened for thrips resistance during *rabi* season. Using a 1-5 scale damage rating was given after 90 days of planting. During the period of study thrips infestation was very low in the block where mutation lines were planted for screening. However variations were noticed within the lines. Among the lines, CDS -12-M4 was found highly resistant. 17 lines including check lines, 183 and GG3 were found resistant and 3 lines including EL-200 and 316 were found moderately susceptible. As there was less infestation during this season, their reaction needs to be confirmed for one more season.

Germplasm Maintenance, Collection and Distribution

About 850 lines of garlic germplasm were maintained by planting them under the field conditions. Forty six lines were collected from Andhra Pradesh and Maharashtra during this year. Garlic germplasm was distributed to Kolkata University (7 lines), Ram Narain Ruia College (5 lines) and Allahabad Agricultural Institute (15 lines) for research purpose

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

Thirty five lines including commercial varieties, elite germplasm and mutated material from G41 (M1-M21) were evaluated for yield and other horticultural traits. The trial was laid out in a randomized block design in four replications. Out of 35 lines, five lines performed significantly better than the check variety G-41. Accessions M4, M19, M3, M1 and M17 were adjudged significantly superior than G-41 in terms of yield (t/ha). Based on the morphological and yield performance, data of best five lines has been presented.

Genotypes	PH cm	NOL	LL cm	LW	CT	P	E	N	CP	CE	ABW gm	NOC	W10C	TY t/ha
M4	47.2	10.4	36.3	1.7	9.7	2.3	2.8	0.3	2.0	0.7	10.9	16.0	5.8	4.1
M19	47.4	11.2	34.4	1.6	9.3	2.2	2.7	0.3	1.9	0.7	10.0	14.0	6.5	3.9
M3	47.0	10.9	35.2	1.7	9.3	2.2	2.8	0.2	1.9	0.7	10.6	16.1	5.3	3.7
M1	50.8	11.9	39.3	1.7	10.2	2.3	2.7	0.2	1.9	0.7	11.2	14.9	6.0	3.6
M17	48.1	10.6	33.5	1.6	9.8	2.3	2.9	0.3	1.9	0.7	10.3	16.8	6.3	3.6
G41	47.4	11.6	36.9	1.8	9.5	2.2	2.8	0.3	1.9	0.7	10.1	15.0	5.8	2.9
CV (%)	5.75	5.88	8.15	8.86	8.67	7.74	7.25	21.75	4.97	8.97	11.87	9.76	20.76	19.3
CD (P=0.05)	3.87	0.92	4.15	0.21	1.17	0.24	0.28	0.08	0.13	0.09	1.71	2.04	1.65	0.75

Biochemical analysis in garlic elite lines

A study was carried out to study the biochemical constituents in 19 garlic lines including commercially released varieties and elite breeding lines. Biochemical analysis for moisture content, dry matter, total sugars, pyruvic acid, crude fibre, phenol, protein, sulphur, titrable acidity and ash content was calculated. It was observed that moisture content (%) ranged from 57.2-63.8, dry matter (%) from 36.2-42.8, TSS (°B) from 31.2-37.2, Total sugar (%) from 50.0-86.5, pyruvic acid (uM/gm) from 60.0-81.8, Crude fibre (%) from 0.9-1.4, Phenol (%) from 0.4-0.7, Protein (%) from 1.7-3.8, Sulphur (%) from 0.5-1.2, Titrable acidity (%) from 0.4-0.7) and Ash content (%) from 1.8-2.6.

Mutation Breeding in garlic

In order to improve yield and other traits in garlic, mutagen treatment of garlic genotypes was done. Mutagens used were Ethylmethane sulfonate (EMS), Colchicine and gamma irradiation and it was done in 5 lines viz., AC38, AC50, AC316, CDT14 and Phule Baswant.

Project 3.3 Studies on somaclonal variations in Garlic (*Allium sativum* L.)

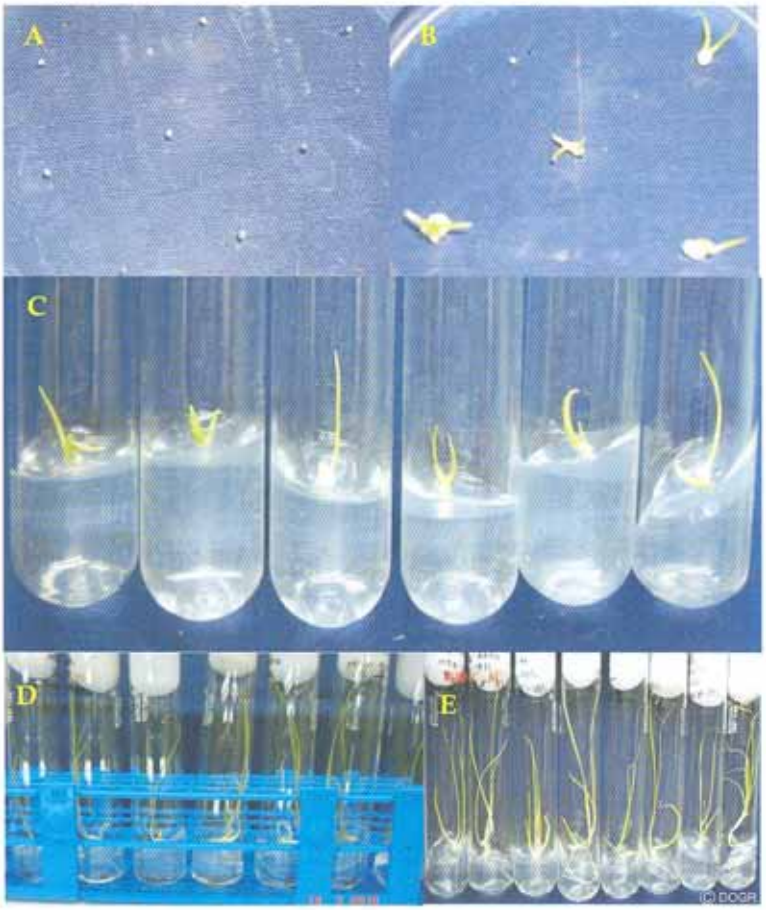
The main aim of this experiment is to generate the somaclonal variation and develop the variants for increased yield and other horticultural traits. Our aim in this experiment was to develop somatic embryos in different varieties through direct or indirect embryogenesis using root tip as explants. Different combinations of auxins and cytokinins were tried to induce somatic embryos in root tips using Gamborg's B5 medium as the basal medium. Elongation, pale yellow, green coloured and other type of callus with friable, watery or other structures were obtained; Somatic embryos thus obtained were shifted to regeneration medium. Most of the embryos led to the development of roots. Only 2-3 medium were able to regenerate somatic embryos but the rate of regeneration was very less. Two varieties G41 and Agrifound Parvati were used in these studies.

Variety	Control	EMS (mg/l)				Colchicine(mg/l)				Irradiation (Kr)			
AC-38	0	0.1	0.3	0.5	0.7	0.05	0.1	0.15	0.2	0.25	0.3	0.6	1.2	1.8	2.4	3.0
AC-316	0	0.1	0.3	0.5	0.7	0.05	0.1	0.15	0.2	0.25	0.3	0.6	1.2	1.8	2.4	3.0
Phule Baswant	0	0.1	0.3	0.5	0.7	0.05	0.1	0.15	0.2	0.25	0.3	0.6	1.2	1.8	2.4	3.0
CDT-14/M-4	0	0.1	0.3	0.5	0.7	0.05	0.1	0.15	0.2	0.25	0.3	0.6	1.2	1.8	2.4	3.0
AC-50	0	0.1	0.3	0.5	0.7	0.05	0.1	0.15	0.2	0.25	0.3	0.6	1.2	1.8	2.4	3.0

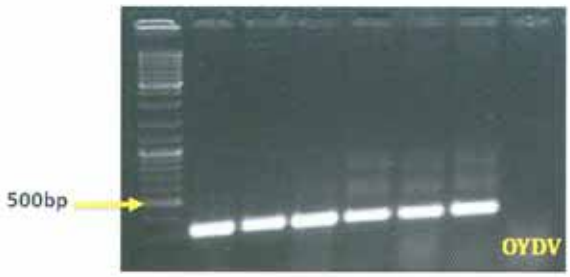
Commercial cultivars viz., Phule Baswant and germplasm viz., AC50, AC200, AC38 and CDT14 (Mutated G41) were given mutation treatment using EMS, Colchicine and Gamma rays and inoculated under *in vitro* conditions. Gamma irradiated material survived whereas other treated material got contaminated and was discarded. Gamma irradiated material was observed for shoot length, number of roots and root length to get an idea about LD 50 dose and the observations were recorded after 4-5 weeks times. Gamma irradiation dose of >1.2 Kr was found to be detrimental to growth and development of garlic

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

Different combinations were tried with different genotypes viz., Agrifound Parvati, Phule Baswant and G41. All the combinations were able to regenerate plantlets from the meristem tip from different genotypes but MT5 (NAA 0.1 mg/l + Kinetin 0.5 mg/l) in Agrifound Parvati and MT8 (NAA 0.1 mg/l + BA 1.0 mg/l) in G41 gave better response. Overall MT7 (NAA 0.1 mg/l + Kinetin 1.0 mg/l) was found to be good medium keeping in view the development of plants and roots in the plantlets. Plants regenerated through meristem tip culture were screened for garlic viruses using RT-PCR technique. Almost all the plants were found to be virus infected except one which exhibited virus free nature. A number of plantlets were obtained from meristem tip culture but when they were transferred to the greenhouse conditions, survival was very less. Future research on acclimatization of meristem tip derived plants will be taken.



Schematic representation of garlic meristem tip culture in garlic cv. G41



Detection of OYDV (Onion Yellow Dwarf Virus) in garlic mericlones through RT-PCR technique

Detection of GCLV (Garlic Common Latent Virus) in garlic mericlones through RT-PCR technique

Project 3.6 Molecular analysis of genetic diversity in garlic

ISSR (Inter simple sequence Repeat) primers were used for diversity assessment in garlic. First the standardization of PCR constituents and protocol was done. A total of 100 ISSR primers (UBC 1-100) were used to assess the amplification in the germplasm. In the initial stage, two garlic DNA samples were used to see amplification. Out of 100 primers used, 24 primers were found to show amplification. Now these primers are being tested on 8 garlic DNA to further affirm their suitability and reproducibility.

In case of microsatellites, 60 SSR markers containing 30 genomic and 30 EST-SSR markers were used. Some of the markers were found to show amplification in garlic. Also a new set of primers (8 genomic SSRs) reported in 2009 were synthesized and used to amplify in our material. Overall, 3 genomic (old), 15 EST-SSR and 8 new genomic SSR markers have been identified for further analysis in the garlic germplasm. Now these primers will be used to assess the polymorphism in the DNA isolated from garlic germplasm.

Cross amplification of primer AMS 04 (Onion genomic microsatellite) in garlic germplasm

Programme 5.0: 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.

Reaction of some *Allium fistulosum* and exotic onion lines to thrips during *rabi* season

During *rabi* season, 16 lines of exotic onion that include 3 lines of *A. fistulosum* and 13 *A. cepa* were evaluated for their reaction to thrips, *Thrips tabaci*. Considerable leaf damage was noticed in all the accessions despite low thrips populations compared to a normal year. Two *A. fistulosum* lines, China-1 and China-2 were found highly resistant with very less injury rating of 1.0 only followed by AKO-17. Former two lines stood erect without any curling and twisting of the leaves. All other exotic lines had shown susceptible and highly susceptible reaction to thrips. Besides damage on leaves, considerable curling ranging from 1.8-4.0 was recorded in all the exotic *A. cepa* lines. Highest leaf damage of 5.0 was recorded in EC 681347 and EC 631346. No bulb development was noticed in any of the lines.

Acc. No.	Species	LIR	LCR
AF China1	*A. fistulosum*	0.6	0.4
AF China2	*A. fistulosum*	0.6	0.6
AKO-17	*A. fistulosum*	1.8	1.0
AKO-18	*A. cepa* exotic	3.0	3.0
AKO-22	*A. cepa* exotic	4.6	1.8
AKO-26	*A. cepa* exotic	4.8	3.6
AKO-27	*A. cepa* exotic	4.0	2.8
AKO-30	*A. cepa* exotic	4.6	4.0
AKO-35	*A. cepa* exotic	4.6	3.4
AKO-43	*A. cepa* exotic	4.2	2.8
AKO-47	*A. cepa* exotic	4.0	2.8
AKO-52	*A. cepa* exotic	3.8	2.8
AKO-61	*A. cepa* exotic	4.4	1.8
EC 631346	*A. cepa* exotic	5.0	3.8
EC 631348	*A. cepa* exotic	4.6	4.0
EC 681347	*A. cepa* exotic	5.0	3.8

Microsatellite marker based genotyping and cross amplification in related *Allium* spp.

Diversity assessment of short day tropical Indian onion and cross amplification of genomic and EST- SSR markers in distantly related native wild species was carried out. Out of 30 genomic SSRs, only 3 (10%) were able to amplify as compared to EST-SSR where 16 (53.3%) primers were able to reveal amplicons. Based on the dendrogram, five clusters were obtained and indigenous short day onion formed separate cluster from the exotic short day and long day onions. *A. roylei* accessions exhibited a dissimilarity index of 35.5% between themselves whereas Pran and A x proliferum grouped together at a genetic distance of 0.4. All the *A. fistulosum* accessions formed a tight cluster and distantly related wild viz., *A. carolinianum*, *A. chinense* and *A. hookeri* formed neutral nodes. Present results are important to aid in analyzing the diversity present in short day onion and its utilization in breeding programs. Further, this is the first time that three accessions of *A. roylei* L. were used and rare alleles amplified in wild species will aid in detecting population structure and molecular marker aided selection for interspecific hybrid development.

Neighbour joining tree of cultivated onion and related wild species based on Jaccard dissimilarity coefficient derived from SSR data

Besides this, some *Allium fistulosum*, *Allium tuberosum* and *A. chinense* lines are being multiplied for onward submission to pathologist and entomologist for screening. One *Allium tuberosum* line (*Ningtham Sidabi*) was received from Central Agricultural University, Manipur for multiplication and further screening work.

Crop Production

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

Project 7.4 Studies in organic production in onion and garlic

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

Results from the present experiment revealed that inorganic treatment consisting of 100 per cent recommended dose of NPK fertilizer with chemical plant protection recorded the highest marketable bulb of 34.1 t/ha in onion and 6.24 t/ha in garlic. Among the various organic manures applied, poultry manure package recorded relatively higher yield (25.8 t/ha in onion and 4.67 t/ha in garlic) than other organic manures evaluated. However, almost 25 - 40% lesser marketable yield was recorded in organic farming system in comparison with inorganic production system in both the crops. From the quality aspects, it was observed that organically nourished plots recorded better quality than inorganic package. However, there was no significant difference between treatments.

With regards to post harvest storage life of onion and garlic, physiological loss in weight (PLW), sprouting and rotting has been found to be highly influenced by different organic manures. It was seen that minimum weight loss was noticed in bulbs harvested from plots which received organic manures in comparison with inorganic farming. The weight loss increased with the extended period of storage. The maximum storage losses of bulbs were noticed in inorganic farming in both crops after 150 days of storage. However, there was no significant difference between treatments.

In general organic farming systems will improve the chemical properties of soil in long run. The added organic manures in the present study (First year experiment) not only acted as source of nutrients but also influenced their availability and uptake. Among the various treatments, soil available N, P, K and S content (kg/ha) were on higher side in inorganic fertilizers applied plots 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. Application of different organic sources of nutrients significantly energized the soil microbial load during year of experimentation. Soil bacteria, fungal and actinomycetes population was higher in soil nourished with organic manures than inorganic fertilizers applied plots. Soil enzyme activity can be used as an indicator of soil quality for assessing the sustainability of agricultural ecosystems. Dehydrogenase activity (DHA) represents overall soil micro floral proliferation and it represents

the index of soil fertility or soil health. Preliminary study on soil DHA and APA (Alkaline Phosphatase Activity) of present experiment revealed that higher level of activities were found in organically nourished plots than inorganic fertilisers applied.

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

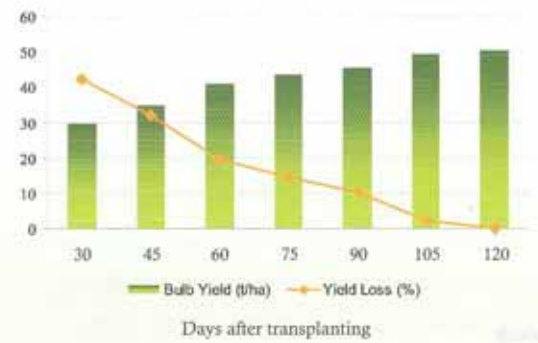
Experiment was laid out in a randomised block design (RBD) with ten different organic growth stimulants in both the crops during *rabi* season under organic package. Foliar application of various organic growth stimulants were applied as per recommended dose (5%) at 30, 45 and 60 days after planting. Among the various organic growth stimulants sprayed, foliar application of *panchagavya* (5%) at 30, 45 and 60 days after planting in onion and garlic bulbs improved the marketable bulb yield (21.7 t/ha in onion and 6.13 t/ha in garlic). However, there was no significant difference between treatments. The per cent of bolters, doubles, biochemical constituents and storage life of onion and garlic bulbs were not significantly influenced by foliar application of organic stimulants.

Project 7.5 Weed management studies in onion and garlic

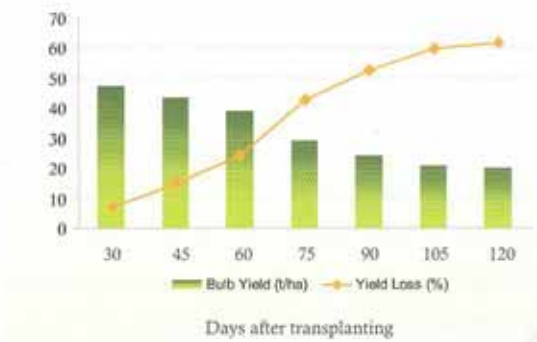
Crop weed competition studies in onion and garlic

Based on the two year results, it was observed that the yield losses in onion and garlic due to heavy weed competition were to the extent of 2.35 - 61.8 % in onion and 3.56 - 85.5 % in garlic respectively. The yield loss will depend upon the types of weed flora, their intensity and duration of crop - weed competition. Delayed weeding operations results into lanky growth, yellowing of leaves, poor development of bulb and impairs the keeping quality of bulbs. Moreover, the bulb size and per cent of marketable bulb yield (A and B grade bulbs) were reduced in weedy check up to 120 days. Weed competition during the whole crop cycle reduced bulb yield upto 61.8 % in onion and 85.5 % in garlic. Among the bulb forming vegetables, garlic is more sensitive to weed menace than onion. It indicates that proper and timely weeding is very essential to get good quality bulbs. Based on the two year results, it was concluded that the critical period of crop-weed competition in both crops occurred from 45 to 90 days after planting.

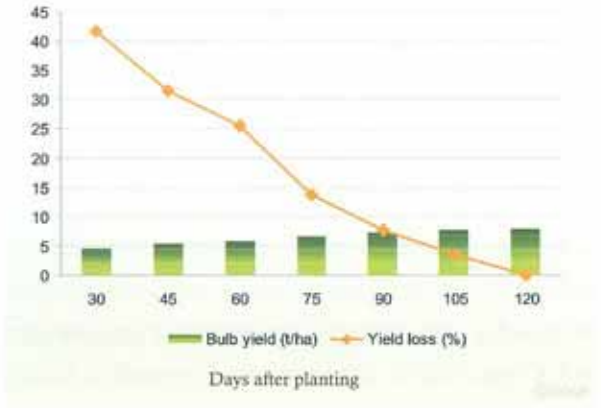
Weed competition in onion (Weed free)



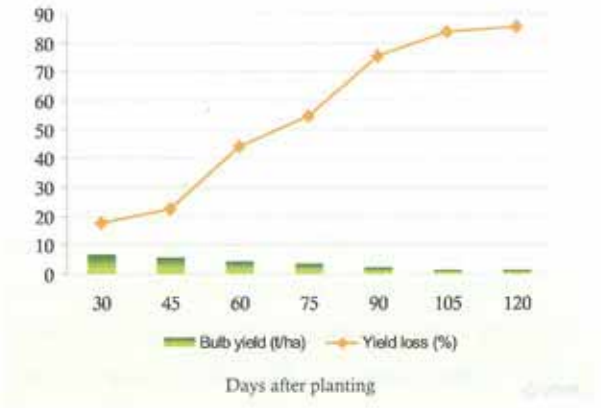
Weed competition in onion (Weedy check)



Weed competition in garlic (Weed free)



Weed competition in garlic (Weedy check)



Project 7.6 Studies on foliar feeding of nutrients and growth regulators on growth and yield of onion and garlic

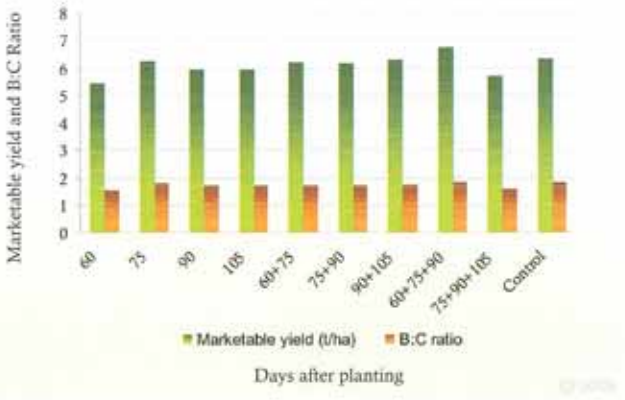
Foliar application of water soluble fertilizers on growth and yield of rabi onion (AINRPOG)

The experiment was conducted during *rabi* season in onion var N-2-4-1 with various grades of water soluble fertilizers. It was observed that foliar application of water soluble fertilizers improved the yield and yield contributing characters of *rabi* onion. Highest marketable bulb yield (54.0 t/ha) was noticed in foliar application of water soluble fertilizers (NPK 20:20:20) at 30, 45 and 60 days after transplanting but it was at par with 19:09:19 and 17:10:27.However no significant difference was observed in between treatments.

Effect of foliar application Chlormequat Chloride (CCC) on growth and yield of garlic var. G41

Growth retardant, Chlormequat Chloride @6ml/L was applied as foliar spray at different intervals of garlic planting (60, 75, 90, 105 days after planting) either alone or in combinations. Based on the results, it was observed that there was no significant difference on growth, yield and yield contributing characters and storage life of garlic influenced by foliar application of CCC. Higher cost benefit ratio was observed in control without spray (1:1.85)

Foilar application of CCC in Garlic



which was closely followed by foliar application of chlormequat chloride at 60, 75 and 90 days after planting (1:1.84).

Programme 8 : Onion seed production technology

Project 8.2 Micro irrigation and fertigation studies in onion seed crop

Optimization of drip irrigation schedule in onion seed crop (AINRPOG)

Drip irrigation is a method which optimizes the use of irrigation water by providing it uniformly and directly to the roots of the plants, through a closed network of plastic pipes, nutrients can also be applied with irrigation water. It is an effective tool for conserving water resources and ensures higher water use efficiency. Drip irrigation had a remarkable successful track record in India. Studies have revealed that significant water saving ranging between 40 - 70 % by drip irrigation compared with surface irrigation, with yield increase as high as 40 - 80 % in some crops. Keeping in view, an experiment was initiated in onion seed crop during *rabi* season under AINRPOG.

Experimental results revealed that, there was significant effect on growth, yield and yield contributing characters of onion seed crop as influenced by different methods and levels of drip irrigation practices. Among the different methods, levels and intervals of drip irrigation in comparison with surface irrigation, highest seed yield was recorded in drip irrigation at 100 % PE daily (1004.4kg/ha) followed by drip irrigation at 100% PE at 3 days (847.4 kg/ha).However, these treatments were at par with each other. As far as water saving is concerned, there was 21- 53 % saving of water in drip irrigation over surface irrigation.

Crop Protection

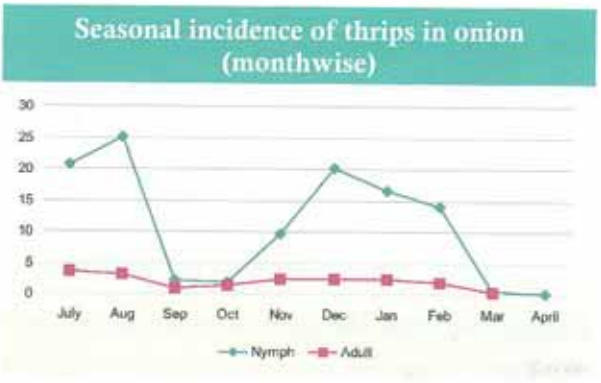
Programme 9 : Integrated pest management in onion and garlic

Project 9.1 Population dynamics of thrips in onion and garlic

Field trial was conducted to study the impact of planting dates on onion thrips. The year 2008 was found exceptional compared to last 10 years. Average thrips population never crossed 30/plant in any of the planting date. *Kharif* plantings spread over 1 June - 1 July recorded higher thrips population, highest being in 1 June (29.95/plant) followed by 15 June (24.9/plant). Thrips attack came down from 15 July and remained low till 1st Sep before it marginally increased from 15 Sep. In later plantings, thrips remained low with an average population range of 5.36-19.81 the highest being in 15 October and the lowest in 15 Jan. planting. In protected conditions, thrips were kept below 2/plant.

There were considerable variations in marketable yield in different planting dates. Marketable yield obtained from unprotected plots was considerably low in *kharif* plantings and ranged from 4.4 t/ha to 12.58 t/ha. However, bulb yields were 6 times higher in protected plots of the respective planting dates. In late *kharif* plantings, 1st Sep recorded the highest yield under protected conditions as well as in unprotected with a yield loss of 12%. In the last 10 years, highest yield was obtained in 15 Sep planting but this year it was an exception with a 32% yield loss. Unlike in previous years, yield loss of only 5% was recorded in 15 Nov planting which was 10 times less than the normal trend. These variations in bulb yield were mainly due to incessant rains that extended beyond normal monsoon in this region.

When seasonal incidence of thrips was examined, again a unusual trend was noticed this year with only one peak that occurred in last 10 years. Generally 2 peaks appear one in August and the other in Feb. But in the current year, highest thrips population was noticed in August only. It is interesting to note that thrips population never crossed 20/plant. In Feb where another larger peak occurs, thrips population was restricted to 17 and 14 /plant only in Jan and Feb respectively. Adult population was found below 5/plant. Thrips population reached to zero in March.



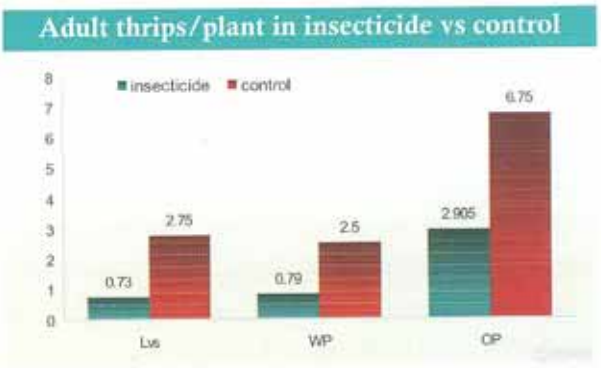
Project 9.4 Management of thrips through chemical control methods

9.4.1. Evaluation of some insecticides against thrips in onion

Insecticides viz., Fipronil, proclaim and methomyl were evaluated against onion thrips during *rabi* season. In all the dates of observations fipronil @ 6- g ai / ha significantly reduced the thrips at both 10 day and 15 day interval and was as good as check insecticides. Other insecticides viz., Profenofos and methomyl were significantly effective at 10 day interval than at 15 day interval.

When thrips population was averaged over all the sprays, fipronil at both the interval was found at par with profenofos., where thrips population was less than 2 thrips/plant. Methomyl @ 10 day interval harboured half the population than that of 15 day interval (12.03 /plant) spray. Efficacy of proclaim was 50-60% when sprayed at 10 day interval which further slipped down to 25% @15 day interval. Fipronil 60 g ai /ha has shown highest efficacy of 94.48% and 93.07% at 10 day and 15 day intervals respectively. However, profenofos recorded the highest efficacy of 96.45% while 60-70% control was achieved with methonyl. Leaf damage was also lowest in fipronil and profenofos sprayed plots followed by methomyl.

Significantly higher yield was recorded in fipronil 60 g ai/ha at 15 day interval and profenofos followed by fipronil treatment at 10 day interval. Proclaim recorded the lowest yield at both the doses. The study suggested that fipronil 60 g ai/ha was as effective as profenofos. As there was no difference w.r.t. spray interval fipronil @ 60 g ai/ha @ 15 day interval may be used against thrips.



Re-infestation of thrips in different insecticides treatments was also studied. It was very clear that re-infestation in open plants was more compared to enclosed plants. Contribution from soil was very less in re-infestation process. In open plants, the re-infestation of adults was 2.5 times more suggesting more external migration from other plants. Even in insecticides sprayed plants, thrips adults were 3 times more suggesting considerable external migration. Nymphal population was also 4-6 times higher in open plants compared to enclosed plants in insecticides sprayed plants.

Low efficacy of proclaim resulted in to higher re-infestation of adults thrips. Re-infestation was lowest in fipronil treated plants. Fipronil and profenofos were every effective for a long period compared to methomyl and proclaim. This study suggested that in the re-infestation process, eggs laid in the leaves and external sources of thrips play a major role and contribution from soil is every less.

Evaluation of some botanicals and insect pathogens against thrips in onion

During *rabi* 2008, different botanicals like neem crude oil, *dashparni*, pongamia crude oil, insect pathogen, *B. bassiana* and Spinosad were evaluated against thrips. In all five sprays, all treatments

were found significantly superior over control. Among the treatments, profenofos recorded the lowest number of thrips in all sprays. Among the other treatments, thrips population was significantly lower in crude neem oil sprayed plots followed by spinosad. When thrips population was averaged over 5 sprays, profenofos significantly reduced thrips population to less than 1 thrips / plant followed by crude neem oil (6.22 / plant). *B. bassiana*, *dashparni* and crude pongamia oil could cause 44.91 - 52.72% reduction over control. Bulb yield was highest with profenofos followed by Spinosad. Control plots recorded 32.98 t/ha. Similar trend was observed in total yield also.

Evaluation of mineral oil against onion thrips

Agro spray® mineral oil was evaluated at three concentrations and at 2 intervals during *rabi* 2008 against onion thrips. Among the mineral oil treatments lower thrips population was noticed in sprays of 1.5% concentration @10days interval. Thrips population in this treatment was 11.93 - 51.87 between 40 - 90 day period. There was no significant difference w.r.t. interval of sprays. When thrips population averaged over 40-90 days, significantly low population (32.77/plant) of thrips were noticed in mineral oil @ 1.5% concentration at 10 day interval. Check treatment profenofos recorded the lowest number of thrips of 1.16/plant compared to 44.27/plant in control plots. The insecticidal efficacy of mineral oil ranged between 20 - 26 % only compared to 97% with profenofos. This poor performance also resulted in to higher foliage damage by thrips. Leaf damage was almost same in all the mineral oil treatments with a rating ranging from 2.76-3.10 corresponding to 40-60% damage. Within the mineral oil, sprays at 10 day interval with 1.5% concentration recorded the highest efficacy. Marketable and total bulbs yield was highest in profenofos sprayed plots. All mineral oil treatments did not differ significantly with control.

Effect of mineral oil on egg hatching and oviposition of thrips in onion

Mineral oils are known to form thin layer over the eggs laid down. As a result eggs do not hatch due to suffocation. To check this property and oviposition deterrence of mineral oil to thrips, a trial was conducted under poly house. The study clearly indicated that mineral oil had affected the emergence of thrips from eggs. T- test suggested that mineral oil recorded 2.44 thrips/plant compared to control which recorded 6.43 thrips/plant.

To know the oviposition deterrence, mineral oil was sprayed on the plants. On mineral oil sprayed plants 2.81 thrips/plant were emerged against 8.33 thrips/plant in case of control. The study suggested that mineral oil was effecting both oviposition and egg hatching of thrips in onion.

Combined effect of mineral oil and insecticides against onion thrips

Most of the times, insecticides are frequently used for better control of thrips in onion. The recommended insecticides, profenofos and carbosulfan at half the recommended dose were mixed with mineral oil 1% and evaluated for their combined effect against thrips. Similarly mineral oil and insecticides were applied alternatively to onion crop against thrips. In all the days of observation, mineral oil + profenofos significantly reduced the thrips populations and even better than sole spray of profenofos. Similarly mineral oil + carbosulfan decreased thrips population significantly. In alternate sprays with profenofos or carbosulfan thrips population increased whenever mineral oil was sprayed but, never crossed 20 thrips /plant. Based on the overall performance, mineral oil +

profenofos combination was found significantly effective among all the treatments (0.99 / plant) followed by profenofos. Alternate sprays of mineral oil with carbosulfan and profenofos did not differ significantly. Combined efficacy of mineral oil with profenofos and carbosulfan are at par with the sole application of profenofos and carbosulfan. In all those treatments thrips were reduced by 91-98%. However alternate sprays recorded 82-84% reduction over control. This reduction was due to increase in thrips population with spray rotations of mineral oil. Foliage damage caused by thrips was almost same with sole sprays of mineral oil and combination of mineral oil + insecticides with a damage rating of 1.1-1.27. Bulb yield of all the treatments were at par except control where 36.82 t /ha marketable yield was recorded. The marketable yield in other treatments ranged between 42.67 - 50.41 t/ha.

Evaluation of anthocorid predator, *Blaptostethus pallescens* against onion thrips

The trial was again laid out in open field with 5 treatments replicated 4 times. Predators were released 6 and 8 times at weekly interval. Release of the predators was commenced only from 2 Jan 2009 onwards as there was delay in incidence of thrips population during *rabi* season. In all the releases, thrips nymphs ranged from 0.95 to 2.6 compared to 6.2/plant in control plots. Similarly adult thrips were 1.55-2.1 per plant in plots where *Blaptostethus* were released compared to control. The damaged caused by thrips was very less in all the treatments with a damage rating of 1.05-1.15 that correspond to around 20% leaf damage. There was no significant difference in number of thrips and damage caused by them under different releases and the doses. There was no difference in the bulb yield in all treatments and were at par with control plots.

It was also noticed that the *Blaptostethus* migrated to maize plants that were present nearer to bio control plots. This suggests that *Blaptostethus* does not prefer garlic plants for egg laying. Hence they migrated to maize plants. This may be the reason that no multiplication of *Blaptostethus* was noticed even after 8 releases at weekly interval. However the released *Blaptostethus* fed on thrips present on the leaves. It was also noticed that no single predator was recorded on control plots which are in the same block. This shows that they are not searching the thrips effectively. The study showed that although *Blaptostethus* was found feeding on onion thrips in confined conditions, they did not prefer garlic plants and performed poorly under open field conditions.

Assessment of pesticide residues onion bulbs in different states

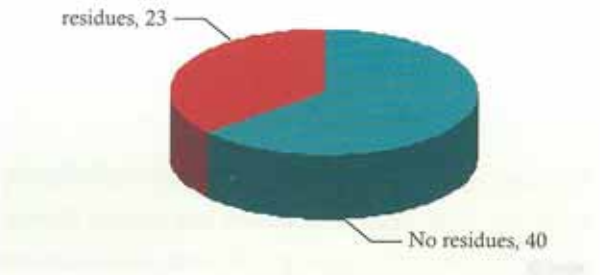
Onion is an important vegetable crop grown world wide. In India it is used as salad and even green tops are consumed as vegetable. It gives the emphasis on the pesticide residue free bulbs for consumption. Therefore an attempt was made to assess the pesticide residue levels in onion bulbs. For this onion bulbs were collected from different states. Samples were collected from markets. After sample preparation pesticide residues were analysed at NRC Grapes.Onion samples were tested for all the commonly used insecticides and fungicides on onion. 37% samples showed residues of only one insecticide, Profenofos. Onion samples from UP and Rajasthan were free of residues. One sample from AP (Kurnool), Gujarat (Bhavnagar) and 2 samples from Tamil Nadu had shown residues of Profenofos. In Maharashtra, where residues were found, 19 were from

Nasik, Ahmednagar and Satara districts. Samples from Pune were free from pesticide residues. Even the two samples from Tamil Nadu which were found contaminated with profenofos were from Maharashtra that was exported to Tamil Nadu. The multiplier onion samples from Tamil Nadu were not contaminated with residues.

Number of onion samples found with Profenofos residues in different states

This study clearly showed that onion samples from Maharashtra had more residues of Profenofos than any other states. Nasik and Ahmednagar are among the major onion producing districts in Maharashtra. There is an immediate need to educate the growers of those regions so as to optimise the usage of Profenofos on onion. In another study conducted at DOGR, Rajgurunagar suggested that Profenofos sprayed @ 1ml/l on 85 day old crop left no residues in bulbs after harvest during *rabi* season. This indicates that farmers may be practicing application of higher doses of the insecticide and may be extending sprays till harvesting bulbs.

Residues in 37% of onion samples

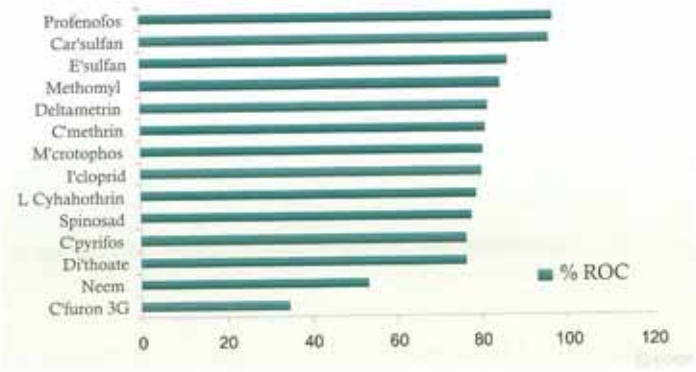


Among the fungicides tested, Carbendazim residues were found in 5 samples out of 63 samples. All these samples were from Maharashtra (Nasik and Ahmednagar) and Tamil Nadu where bulbs were sent from Maharashtra for sale. However in no sample the residue level crossed the MRL of 0.2 mg/kg as suggested by FAO. Some farmers practice spraying carbendazim on stored onions for control of blackmold. This may be resulting in to the residues in the bulbs. Therefore, awareness of farmers about the harmful effects of these pesticides needs to be increased. This discriminate usage of Profenofos and Carbendazim should be minimized as onions are being exported to many countries from our country beside domestic consumption.

Detection of pesticide residues in green tops and bulbs of onion

A field trial was conducted in *rabi*, 2008 with 15 commonly used insecticides at recommended doses against thrips. The insecticides sprayed were- Organo-phosphates (Dimethoate, Chlorpyriphos, Monocrotophos, Profenofos), carbamates (Carbofuran, Carbosulfan, Methomyl), Pyrethroids (L-cyhalothrin, Cypermethrin, Deltamethrin) endosulfan, Neem oil, Spinosad and imidacloprid. Thrips observations were taken at regular interval and the reduction over control was calculated to know the efficacy of these common insecticides.

Efficacy of different insecticides against onion thrips during *rabi* 2008



It was found that Profenofos and Carbosulfan were found very effective against onion thrips with an efficacy of above 96% followed by endosulfan and methomyl. Very commonly used dimethoate recorded 75.59% reduction over control whereas Monocrotophos reduced thrips population by 80.29%. Neem oil performed poorly among the tested chemicals with a reduction of only 53.23% thrips compared to control.

To study the amount of residue of these insecticides and their dissipation on green tops insecticides were sprayed on 45 day old crop. Sampling of green tops was done up to 14 days after spray. Among the insecticides dissipation was very fast in Methomyl followed by Spinosad and Monocrotophos after a day, and was lowest in Cypermethrin and Carbosulfan. All insecticides dissipated above to 98% by 14th day except Carbosulfan and L-cyhalothrin. On first day after application a drop of concentrations in all insecticides was observed this corresponded to 12.52 - 70.58% dissipation, lowest and highest being in Cypermethrin and Methomyl respectively. Similarly Spinosad was dissipated by 94%, while the lowest 65% was dissipated in carbosulfan by 7th day. All the insecticides except Carbosulfan and L- cyhalothrin dissipated above 90% by 11th day.

All the insecticides have showed the non-linear regression pattern with high r^2 values. In all the cases, dissipation was faster at the beginning but slowed down with the passage of time.

Half - life (t 1/2) of all the insecticides were estimated and ranged from 2 - 4.5 days. Carbosulfan had the highest t1/2 followed by L-cyhalothrin. In the international markets, maximum residue limit (MRL) regulations are stringent in most countries. Thus, the dose specific recommendations regarding Pre-Harvest Interval (PHI) should be the lowest so as to provide safety to the end users. Among the insecticides, waiting period was highest for Monocrotophos followed by L-Cyhalothrin. Only Methomyl and Spinosad (2 days) had the lowest PHI. The study clearly suggests that if onion is to be sent to market as green tops the safest insecticide is Spinosad. Green tops are commonly consumed as vegetable in many parts of India. With the present study results, there is a need to revise the insecticides schedules/ recommendations in vogue in case the green tops are to be consumed. No insecticide residues were detected in any of the samples after harvesting.

Programme 10 : Integrated disease management in onion and garlic

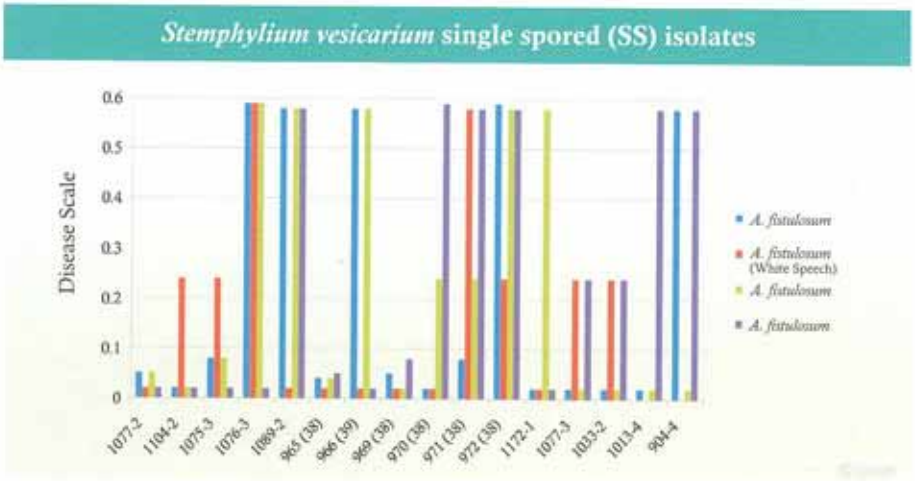
Project 10.1 Geospatial pathogenic and molecula characterisation of fungal diseases in onion and garlic- detection, management and risk analysis

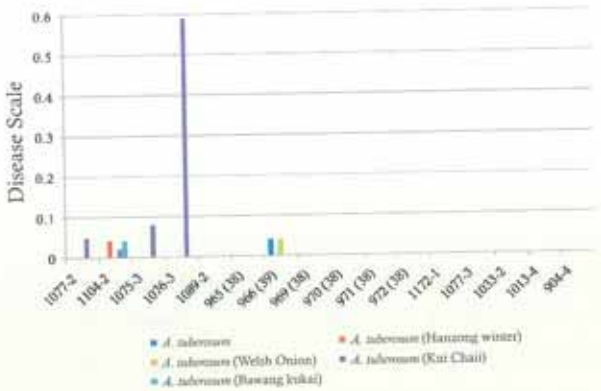
One hundred and fifty isolates of *Alternaria porri* were single spored and maintained on V-8 juice medium. Two hundred and forty two isolates of *Stemphylium vesicarium* from Maharashtra and

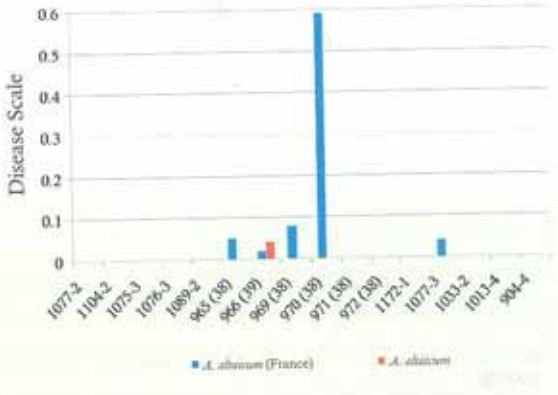
Gujarat have been single spored and maintained on Acidified weak PDA (potato dextrose agar). Inclusion of 2% tamarind juice in the medium facilitated easy harvest of spores. Six different growth media with additives were evaluated for their effect on the growth and sporulation of non sporulating types. V-8 Juice and green peas medium was found effective in *Alternaria porri* where as apricot medium was found suitable for *Stemphylium* for higher rate of sporulation. Leaf extracts of some of the wild species of *Allium* which were found to have field resistance to *Alternaria porri* and *Stemphylium vesicarium* were assayed for sporulation. Aqueous leaf extracts of wild species viz.,, *A. fistulosum*, *A. tuberosum* and *A. altaicum* were prepared using pestle and mortar with neutral silica gel to facilitate crushing and the extracts were passed through cheese cloth and later through millipore filter to remove bacterial contamination. Extracts were incorporated in to 2% water agar media just before cooling and the petri plates were inoculated with plugs of actively growing cultures of *Stemphylium* and *Alternaria* and incubated at 25°C. Growth of culture was observed after a week and it was observed that both the pathogens could grow on all the leaf extracts except *A. tuberosum* which displayed inhibitory effect.

Screening wild accessions of *Alliums* against *Alternaria* and *Stemphylium*

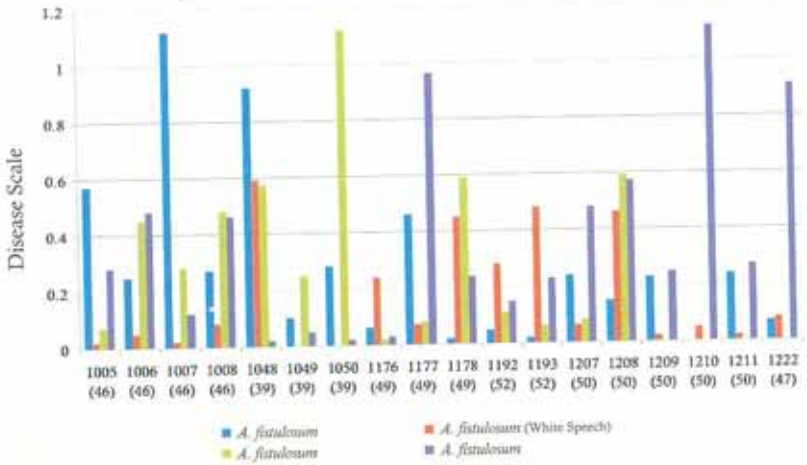
Single spored isolates of *Stemphylium* which were grouped earlier as per the molecular characterization were used for artificial screening. Group 1, 2, diverse group and single spored isolates of *Alternaria* from Maharashtra, Gujarat and Madhya Pradesh were used. The spores were harvested from the suspension culture and the spore concentration was adjusted with a haemocytometer to approximately 400 conidia ml-1 and sprayed on *Allium fistulosum* (4 landraces), *A. tuberosum* (5 landraces) and *A. altaicum* (2 landraces) and covered with a polythene bag for 48 hrs. Data was recorded based on the 1-5 scale. *Allium fistulosum* showed susceptibility to all *Stemphylium* isolates except for two isolates viz., 1013-4 and 904-4, which did not cause symptoms on White speech. Only five isolates viz., 1076-3, 1077-2, 1104-2, 1075-3 and 966(39) could cause symptoms either on all the five landraces or at least on one land race. 1104-2 could cause infection on Hanzong winter, Kui Chaii' and Bawang kukai. Five isolates could cause infection on *A. altaicum* (965-38, 966-39, 969-38, 970-38 and 1077-3). Isolate 966-39 could cause infection on both the landraces whereas others could cause on only one land race and not on the one from France. Among the *Alternaria porri* isolates tested, isolate 1005,1050,1193,1207 and 1209 could cause symptoms on both the land races of *A. altaicum* whereas 1210, 1211 and 1222 could not infect land race "France".

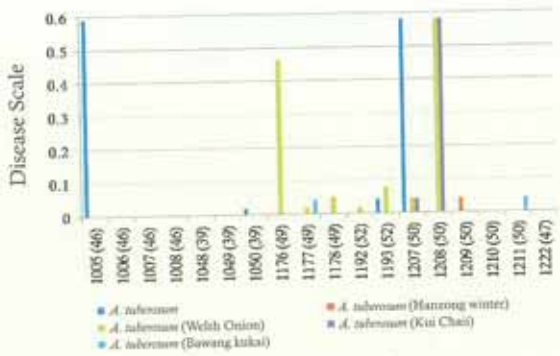


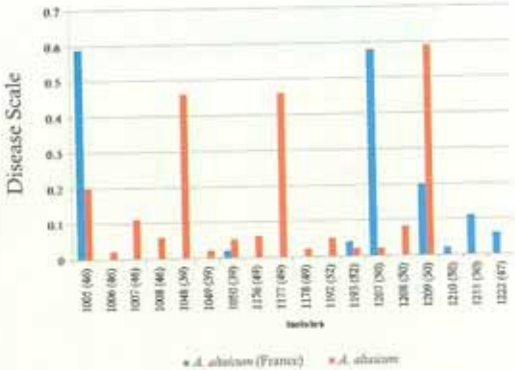




Alternaria porri isolates (SS) Maharashtra & MP



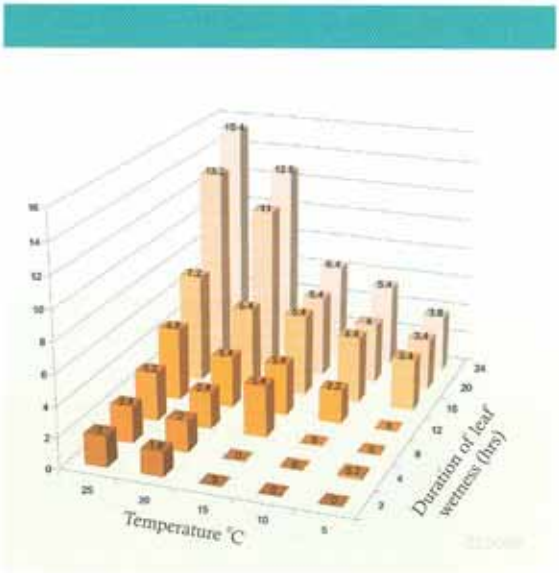




Duration of leaf wetness and temperature on infection by *Alternaria porri*

All inoculation tests were carried out under laboratory conditions. Conidial suspensions ($5x10^4$ conidia ml^{-1}) of one isolate was prepared from 7 day old cultures. 100µl aliquot of conidial suspension was sprayed with an atomizer on leaves at susceptible stage (30 days after seedling transplanting). Inoculated leaves were kept in polythene bags completely sealed for high humidity and were incubated at 5, 10, 15, 20, 25 and 30°C. Bags were opened at regular intervals to match the duration of hours of leaves inside the polythene bag indicating duration of wetness (2-24 hrs). A split plot experimental design with four replications was used with temperature as the main plot and incubation time as the subplot.

Symptom development was observed three days after spray as white specks and the same was graded following 1-5 scale. Maximum infection occurred at 20-25°C with 20-24 hrs of leaf wetness This shows that continuous leaf wetness with 20-25°C is ideal for disease development. At 5°C, infection of onion leaves by *A. porri* occurred after 16 hrs of leaf wetness whereas at 10 ± 25°C, infection occurred only after 8 hrs of leaf wetness. Infection increased with increasing duration of leaf wetness at all temperatures and was highest at 20 and 25°C. There was a highly significant interaction between temperature and leaf wetness period.



Fungal isolation and identification (*Fusarium proliferatum*)

Diseased samples of garlic which were rotting, displayed water-soaked tan lesions often with white mycelium near the bulb axis. Similar symptoms were noted in the specimens brought by farmer from Indore. In each case, surface-disinfested tissue plated on agar produced a *fusarium* with catenate micro conidia borne on polyphialides. Garlic samples were also collected from field and storage. Basal disc from each sample was surface sterilized and placed on water agar (WA) amended with streptomycin sulphate and incubated at ambient room conditions for 7 days. Fusarium isolates obtained were subcultured on potato dextrose agar (PDA). Based on morphological characters, fusarium isolates were identified according to Nelson et al. (1983).

Pathogenicity test

Five isolates were randomly selected from the population of *F. proliferatum* isolated from garlic in the field and storage. Conidial suspensions used for the inoculums were obtained from two week-old cultures. A mycelia plug of the sub-cultured monoculture of eleven isolates was transferred to potato-dextrose broth and incubated at 26°C on a rotary shaker @ 120 rpm. After seven days, mycelia with spores and broth were homogenized for 2 min at low speed in a Warring Blender. The mixture was filtered through four layers of cheese cloth to remove hyphen and spore concentration was adjusted with a haemocytometer to approximately 10^7 conidia ml^{-1}. Sterilised garlic cloves were

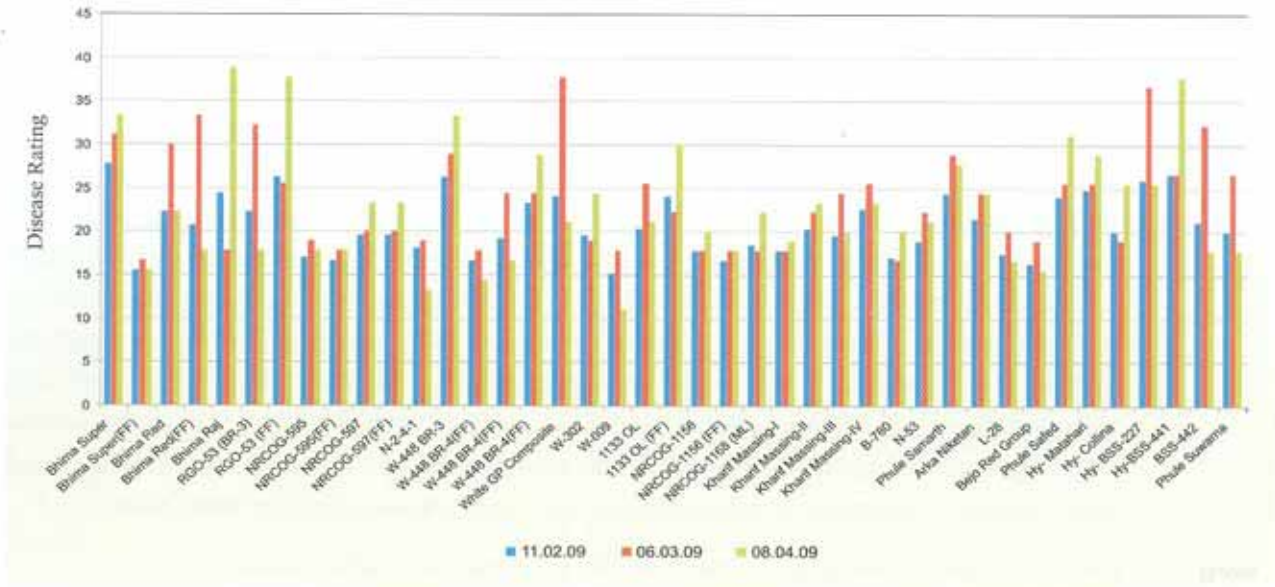
soaked in the conidial suspension of each isolate of *F. proliferatum* for 24 hrs and then planted in crates with soil artificially inoculated with the single isolate of *F. proliferatum*. Symptoms on garlic plants were observed three weeks after inoculation. The roots and bulb/clove rot disease symptoms were graded into five classes: 1 = no symptoms; 2 = <10% rotted roots; 3 = 10-50% rotted roots; 4 = >50% rotted roots and slight symptoms on bulbs/cloves; 5 = completely rotted roots and severe symptoms on bulbs/cloves. *F. proliferatum* has been reported on onion from USA we have yet to see whether this infects onion in India also.

Project 10.2 Management of soil borne diseases

Disease Progress Study: Fusarium Basal Rot (FBR)

Disease progression for mature bulbs of *rabi* and *rangda* onion was evaluated to determine if the pathogen was present in the basal plate but not causing symptoms. After the initial rating was taken, bulbs were stored at ambient conditions in paper bags for four weeks at laboratory conditions. Bulbs that were rated as 9, on a scale of 1-10, were not stored. At two and four weeks interval, basal plates were re-cut and rated for FBR severity. Observations were taken after two weeks and the bulbs were again returned to storage for reevaluation after four weeks. A mean incidence for each cultivar was calculated from the average FBR incidence per plot.

After four weeks in storage, FBR severity increased in all the cultivars. However, cultivars differed in their disease progression trends over their four week storage period. Bhima Super (FF), NRCOG 595, NRCOG 595 (FF), N2-4-1, W448BR-4 (FF), W-009 and NRCOG 1156 (FF) had low FBR severity at harvest and a low rate of disease progression. Bhima Raj, GO 53 (FF) and HY BSS441 had high FBR severity at harvest and high rate of disease progression over four weeks .Whereas in Bhima Red, Bhima Red (FF), RGO 53 (BR-3), White GP Composite, Hy BSS 227, Hy 442 and Phule Suvarna exhibited low FBR severity rating at harvest and high rate of disease progression over two weeks.

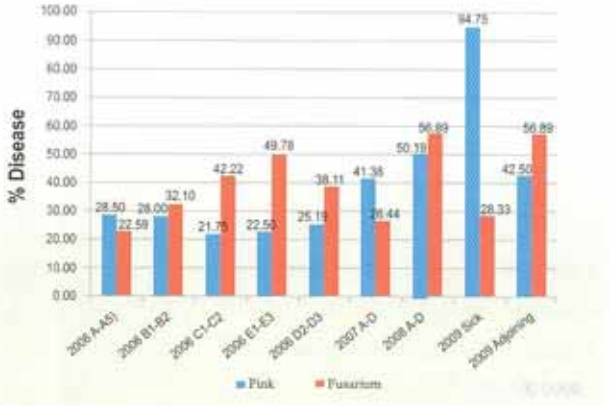


Fusarium and Pink root potential of DOGR Rajgurunagar Farm

From 2006-2010, diseases samples of Fusarium and pink root affected bulbs were drawn from minimum of 10 sites from selected block and the disease was assessed using the 1-10 scale and the disease potential of the soils were calculated. Onion growing blocks selected were 1 (A1-A5), 2 (B1-B2), Tank block, (C1-C2), Met block, (E1-E3) and Sick plot (D2-D3).

In all the plots, sampling was done 9 to 12 weeks after transplanting. In each surveyed field, fifteen plants were randomly uprooted with care by means of a dibble so as to minimise damage to the root system. They were labelled and taken to the laboratory for analysis. The root system of each plant was carefully washed in slow running water and inspected for any typical pink discoloration, characteristic of 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 was calculated to indicate field infection levels. Increase in disease incidence has been noticed over the years for all the plots except 2 plots where the incidence increased during 2007 and the further increase over 2008 and 09 were not significant. Pink root disease also has increased at a very slow pace compared to Fusarium. Incidence in 2006 varied between 22-28% and increased to 41 and 50% during 2007 and 08 and remained at 41% whereas in the sick plot percentage infection remainedt 94%.

Pink Root and Fusarium Potential of soils



Infectivity of Fusarium and Pink root pathogens on host and non host genotypes

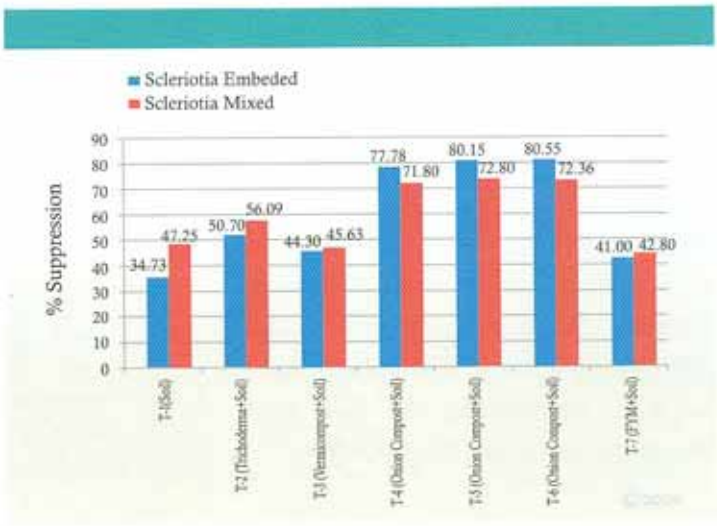
Non hosts of *Pyrenochaeta terrestris* viz., soybean, chickpea, wheat, sorghum, bajra, tomato, chilli, brinjal, radish, cabbage, aster and marigold were selected for cross inoculation and comparison with onion. Seeds of these crops were raised in sterile soil and mixed with inoculums of the pathogen multiplied on sorghum grains. Surface sterilized seeds of these non hosts were also germinated in petriplates and the roots were kept in contact with the culture in petriplates for 48 hrs and later transplanted to sterile soil and kept in net house for expression of disease symptoms. The seedlings thus raised were periodically pulled out from the crates for scoring root infection and the disease rating was done following 1-10 scale as in onion. Percent infection varied from 0-80% in nonhosts being in Wheat (85.71), followed by soybean (80), mungbean(46.51), mustard(5.45), chickpea (14.6), sorghum (65), bajra (65.85), tomato(34.21), chilli (40), brinjal (31.57), radish (0), cabbage (5.0), aster(9.09), marigold(22.22) and onion (100). Though all the non hosts showed root infection, there was no aerial symptoms as seen in onion as tip burn symptoms. *Phoma terrestris* (*Pyraenochaeta*) is reported as a widespread saprophyte and a weak parasite of many hosts.

Effect of sequence cropping on incidence of soil borne diseases of onion

A sequence cropping experiment on fixed sick plot design for pink root disease on non hosts was initiated at Rajgurunagar during *kharif* 2009. Components of *kharif* cropping sequence were 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 and T-11 Onion. Plants were pulled out at 10 day old seedling stage to flowering stage for assessing pink root infestation and the infection was assessed using 1-10 scale at 30, 60 and 90 days after transplanting. Control showed 86-93% infection whereas soybean (56.6) and sorghum (53.3) 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 colouration. None of the samples from radish and cabbage yielded any positive reaction at any stage of crop growth.

Suppression of soil borne diseases of onion through composting

Crates filled with 12 kg of sterilized soil and clay loam were infested with three sclerotia g-1 of soil. Sclerotia for inoculation were produced on autoclaved sorghum /wheat seeds and incubated at 19°C for 20 days. Formed sclerotia were harvested and used to infest the soil. Experiment was laid out in randomized block design having three replications and seven treatments viz., T-1 (soil), T-2 (*Trichoderma* + soil), T-3 (Vermicompost + soil), T-4 (onion compost + soil @ 10 t/ha), T-5 (onion compost + soil @15 t/ha), T-6 (onion compost



+ soil @ 20t/ha), T-7 (FYM + soil). Each replication consisted of one crate sown with known number of surface sterilized onion seeds. Disease incidence was recorded every three days and severity was determined at the end of the experiment using an arbitrary index from zero to five, where 0=0% of seedlings affected and 5= 86 to 100% seedlings affected by the fungus.

In the second experiment, same treatments were followed but each treatment was mixed with freshly harvested sclerotia @ 3 sclerotia /gm of soil and observations were recorded on seedling emergence and disease incidence. It was observed that disease incidence was less in onion compost treated soils. Soil without any treatment revealed 34% survival and the treatment with *trichoderma* showed 50% survival compared to Vermicompost(45.4) and the onion compost suppressed the sclerotial infection of seedlings.

Effect of composting on *Colletotrichum* inoculums

During *kharif* 2009, several plots were affected with *Colletotrichum gloeosporioides* ranging from 40-90%. Infested plant debris with sporodochia having high inoculums concentration were selected and composted and following treatments were undertaken in three replications under semi anaerobic conditions in crates. Treatments were Onion culls (20 kg), Onion culls (20 kg)+ *Colletotrichum* infested debris +Vermicompost (5 kg) + *Trichoderma* (50 g). Crates were kept covered for 120 days and the compost was harvested. The compost thus obtained out of three treatments was incorporated to soil @ 20t/ha in a plot which was severely infested with *Colletotrichum* along with control where only debris was added. 45 day old onion seedlings were transplanted and high soil moisture was maintained in the plots and also the plants were covered with polythene covers for three days to maintain high humidity. The growth of seedlings was monitored for disease incidence and it was observed that though there was no typical symptoms of *Colletotrichum* expressed in any of the treatment including control, the control plot plant growth was very much retarded compared to treatments.

Programme 12 : Seed quality management in onion and garlic

Project 12.1 Seed packaging and storage studies

Effect of packing material and fungicide treatment on seed germination

Seeds of onion variety N-2-4-1 were stored in polythene packets of 200 gauge, 400 gauge and cloth bag with thiram and bavistin seed treatment. There was significant loss of germination during different periods of 9, 12 and 15 month of storage. The seeds stored in polythene packets of 200 and 400 gauge with thiram and bavistin seed treatment stored significantly better than the seeds stored in cloth bags without fungicide treatment. Germination of seeds in 400 gauge polypacket with thiram treatment was maintained up to 84% which is 13% more than control.

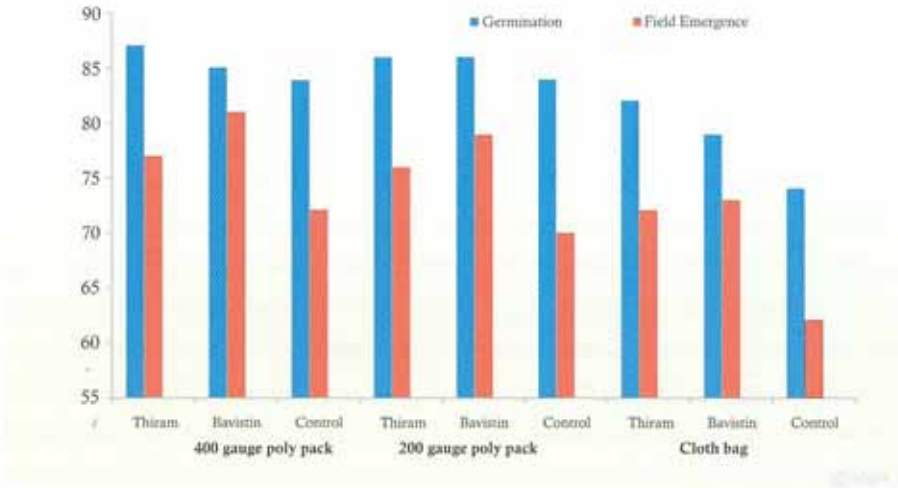
Effect of packing material and fungicide treatment on seed vigour

Seed vigour was significantly higher in poly packets of 200 and 400 gauges with thiram and bavistin seed treatment than the control cloth bag packing. The field emergence of 15 month old seed was also significantly higher in seeds stored in poly packs of 200 and 400 guage with thiram and bavistin treatment.

Effect of antioxidant treatment on onion seed

The seeds of N 2-4-1 were treated with different antioxidant chemical (ascorbic acid, Salicylic acid and α-Tocoferol) of different concentration and exposed to accelerated ageing condition of 40°C and 95% RH. After 12 days of accelerated ageing the germination was reduced 95% to as low as 32%. Maximum germination (60%) was found in case of Salicylic acid treatment (500 ppm).

Germination and field emergence of 15 months old seeds stored in different types of packaging materials with different seed treatments



Project 12.2 Improvement of seed quality by invigoration

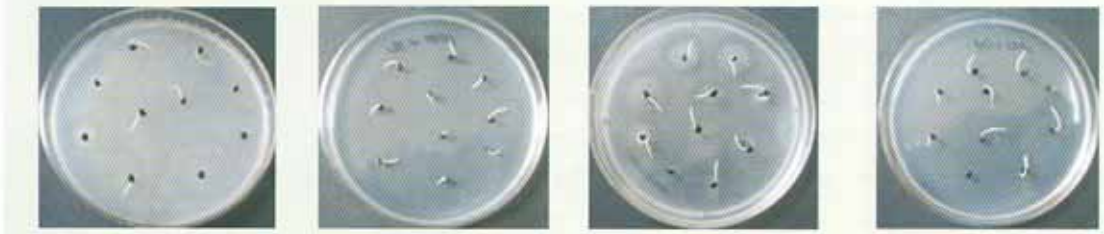
Priming with different concentration of K_2HPO_4 and hydration were tried to improve the vigour and germination of stored onion seeds. The K_2HPO_4, 2% solution and 24h treatment at 15°C gave better result than others. This treatment improved germination about 12%. Hydration treatment was also comparable which improved germination by 10% over control.

The priming treatment before storage was not beneficial. The germination was lower in case of stored primed seeds than the control seeds after one year of storage. The germination percentage of stored and seeds which were primed with K_2HPO_4 (3% for 48 h at 15°C) was lowest (54%) followed by K_2HPO_4 (2% for 48 h at 15°C) which is 61% as compared to control (78%).

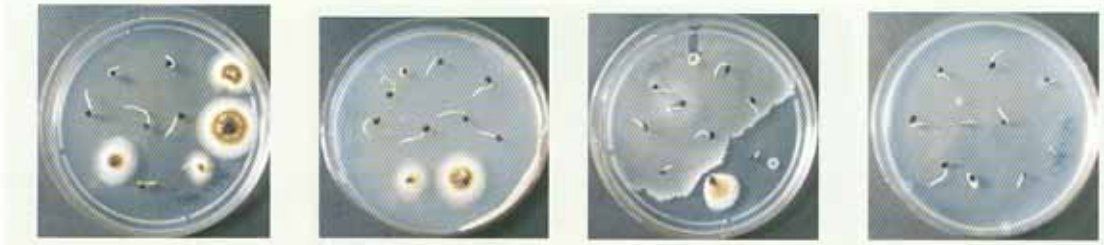
Project 12.3 Disease free seed production

Of various combination of pre-harvest prophylactic spray of fungicides the degree of seed infection in case of control, thiram and captan spray were 60, 50 and 40% respectively. The iprodione + carbendazime (Bavistin) formulation spray (0.2%) produced seed completely free from saprophytic seed infection. Seed treatment with bavistin and captan individually controlled the seed infection. Highest germination (94%) and field emergence (84%) was found in iprodione + carbendazime (Bavistin) formulation spray (0.2%) and lowest germination (88%) and field emergence (71%) was found in control.

Thiram | Thiram + Thiram | Thiram + Bavistin | Thiram + Captan



Iprodione | Iprodione+Thiram | Iprodione+Bavistin | Iprodione+**Captan**



Captan | Captan+Thiram | Captan+Bavistin | Captan+Captan

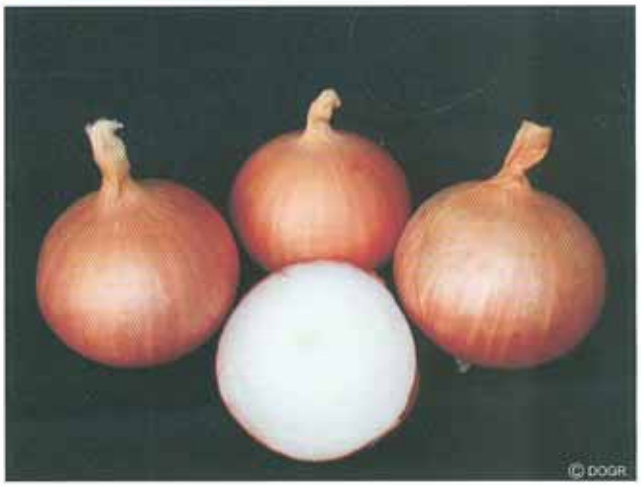
Control | Control+Bavistin | Control+captan

Degree of seed infection in different treatments

Variety release from DOGR

Bhima Kiran (RO-597) (IC No. 572766) was identified at DOGR and also at National level for release during Ist AINRPOG group meeting at CITH, Srinagar during 2010 for two zones viz. Zone III (Delhi, UP, Haryana, Bihar and Punjab) and VI (Maharashtra, Karnataka and AP) for *rabi* season. Bulb attains immediate light red colour after harvest. Bulbs are oval to round in shape, have very less number of bolters and doubles in *rabi* (less than 5%), thin neck, TSS 12%, good keeping quality suitable for storage upto 5-6 months. Matures in 130 days after transplanting. The average marketable yield potential is upto 41.5 t/ha during *rabi* season with national average yield of 30.3 t/ha.

Bhima Kiran



Bhima Shakti

Bhima Shakti (1156) (IC No. 572769) has been released at Institute level for Maharashtra region during 2010 and is suitable for late *kharif* as well as *rabi* season. Bhima Shakti performed better at IIHR, Kalyani, Jabalpur, Akola, Raipur, Rahuri, Parbhani, Hisar, Kalyanpur, Rajgurunagar, Nashik, Junagadh and Mukhteshwar. Bulbs attain immediate attractive red colour after harvest. Shape is round with very less number of bolters 2.15% & 0.36% and doubles 5.69% & 1.38% during late *kharif* and *rabi* season, respectively. It has TSS of 11.8% with small to medium neck thickness, uniform neck fall during *rabi* and has more than 70% neck fall during late *kharif*. Bulbs have good storage life and 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 with national average yield of 29.18 t/ha during *rabi* season.

Bhima Shweta

Bhima Shweta (White El. Comp. Selection/ NRCWO-2) (IC No. 572761) developed after random pollination among the selected elite lines followed by mass selection and released at institute level during 2010 particularly for *rabi* season. The variety has been recommended for Maharashtra and is also suitable for Madhya Pradesh, Delhi, Punjab, Uttaranchal, Haryana and Gujarath during *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 about 120 day after transplanting during *rabi*, medium in keeping quality upto 3 months during *rabi* season. Average marketable yield during *rabi* season is 35.9 t/ha with national average yield of 28.2 t/ha. It is tolerant to thrips.

Bhima Shubra

Bhima Shubra (w-009) (IC No. 572763) 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 110 day 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 and can fill the gap for processing from October to February.

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. AJ 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 white and yellow onion 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

Project 3.3	Studies on somaclonal variations in garlic
Project 3.4	Production of virus free garlic through *in vitro* meristem tip culture
Project 3.6	Molecular analysis of genetic diversity in garlic

Programme 4	**Onion improvement through biotechnological approaches**
Scientist	**Dr. A Asha Devi, 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 and abiotic stresses and introgression of desirable genes in *Allium cepa*

Programme 6	**Integrated nutrient management for onion and garlic**
Scientist	**Dr. A Thangasamy, PI**
Project 6.4	Studies on nutrient deficiency symptoms in garlic
Project 6.5	Assessment of nutrient requirement for garlic
Project 6.6	Nutrient uptake studies in garlic

Programme 7	**Enhancement of production of onion and garlic through agronomic innovations**
Scientist	**Dr. V Sankar, PI**
Project 7.3	Micro-irrigation and fertigation studies in onion and garlic
Project 7.4	Studies on organic production of onion and garlic
Project 7.5	Weed management studies in onion and garlic
Project 7.6	Studies on foliar feeding of nutrients and growth regulators in onion and garlic

Programme 8	**Onion seed production technology**
Scientist	**Dr. V Sankar, PI**
Project 8.2	Micro-irrigation and fertigation studies in onion seed crop

Programme 9	**Integrated pest management in onion and garlic**
Scientist	**Dr. PS Srinivas, PI**
Project 9.1	Population dynamics of thrips in onion and garlic Outreach programme on sucking pests- onion thrips
Project 1	Effect of plant nutrients on thrips infestation in onion
Project 2	Off season survival of onion thrips in onion ecosystem
Project 3	Monitoring of development of insecticide resistance in thrips infesting onion
Project 4	Evaluation of IPM modules against onion thrips
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
Programme 10	**Integrated disease management in onion and garlic**
Scientist	**Dr. SJ Gawande**
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	**Sr. Scientist (Hort.), PI**
Project 11.1	Studies on effect of pre- harvest practices on storage life of onion and garlic
Project 11.2	Effect of different storage environments / structures on storage life of onion and garlic
Programme 12	**Seed quality management in onion and garlic**
Scientist	**Dr. MK Kuchlan, PI**
Project 12.1	Seed packing and storage studies
Project 12.2	Improvement of seed quality by invigoration
Project 12.3	Disease free seed production
Project 12.4	Studies on seed pelleting in onion

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 post harvest technology management
Project 13.2	Collection, documentation and validation of Indigenous Technical Knowledge (ITK) 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
Project 1	DUS Testing under Central Sector Scheme for Implementation of Plant Variety Protection and Farmers Rights through ICAR-SAU's System
Project 2	All India Network Research Project on Onion & Garlic

List of Publications

Research Papers/Reviews

Lawande KE, A. Khar, V Mahajan, PS Srinivas, V Sankar and RP Singh. 2009. Onion and garlic research in India. *J. Horticultural Sciences.* 4: 91-119.

Sankar V and KE Lawande. 2010. Effect of mother clove size on growth, yield, quality and storage life of garlic. *J. Maharashtra Agric. Univ.* 35(1) : 82-85.

Sankar V, D Veeraragavathatham and M Kannan. 2009. Effect of organic farming practices on post harvest storage life and organoleptic quality of yellow onion (*Allium cepa* L.) *Ind. J. Agric. Sci*. 79: 36-42.

Sankar V, D Veeraragavathatham and M Kannan. 2009. Post harvest storage life of onion (*Allium cepa* L.) influenced by organic farming practices. *Asian J. Hort.* 4: 16-20.

Sankar V, D Veeraragavathatham and M Kannan. 2009. Studies on organic farming in onion (*Allium cepa* L.) for the production of export quality bulbs. *Asian J. Hort.* 4: 65-69.

Tripathi PC , V Sankar and KE Lawande. 2010. Influence of micro irrigation methods on growth, yield and storage of rabi onion. *Ind. J. Hort.* 67: 61-65.

Tripathi PC and KE Lawande. 2009. A New Gadget for Onion Grading. In AG Journal, Vol.90.

Papers / Abstracts / Posters presented in conferences

Parakh DB, V Celia Chalam, D Sharma, RK Khetarpal and A Khar. 2009. Detection of Garlic common latent virus and Garlic virus C in garlic germplasm imported from USA. National Symposium on Recent Global Developments in the management of Plant Genetic Resources. Dec. 17-18. p 323-324.

Mahajan V. 2009. "Development of onion & garlic for processing" at National Seminar on "Vegetable production and post harvest management" held at NHRDF Chitegaon, Nashik from 14-15 Oct., 2009.

Popular articles

Gadge SS. 2010. Group Dynamics in Onion and Garlic Growers. In Training Manual on Production Technology in Onion and Garlic. DOGR, Pune. p 112-116.

Mahajan V and KE Lawande. 2009. *Kanda beejoutpadanachi niga.* Lok Mangal Sheti Prateek, July, 35 - 44.

Mahajan V and KE Lawande. 2009. *Rangada Kandyache utpadan shashtra.* Baliraja, September, 52 - 59.

Mahajan V and KE Lawande. 2009. *Rabi kanda utpadan.* Shetakari, November, 13 - 15.

Mahajan V and KE Lawande. 2010. *Ashi karaa Kanda lagwad.* Agro-one, Jan. 3.

Mahajan V and KE Lawande. 2010. *Changlya utpadanasathi kandhyache yogya vyasthapan.* Agro-one, Jan. 5.

Mahajan V and KE Lawande. 2010. *Kandhya vareel fulkide, karpa rogache niyantran.* Agro-one, Jan. 21.

Mahajan V. 2010. *Lahsoon utpadan Tantragyan.* Shetakari, Feb., 46-49.

Lawande KE. 2009. *Dushkali Pattyat Kanda Lagwad Fayadeshir.* Saptahik Ashti Chitra Darshan Visheshank, August.

Lawande KE . 2009. *Kandyasathi Thibak Sinchan Yashogatha*, Agrowon, June.

Lawande KE . 2009. *Taleband - Kanda Utpadanacha*, Agrowon, July.

Training Manual

Lawande KE and SS Gadge. 2010. Production Technology in Onion and Garlic. Training Manual. Compiled and Edited. DOGR, Pune. p120.

Book chapter

Lawande KE. 2010. Impact of Climate Change on Onion and Garlic Production. In Challenges of Climate Change - Indian Horticulture, HP Singh, JP Singh and SS Lal (Eds). Westville Publishing House, New Delhi. p 100-103.

Transfer of Technology

Lectures delivered

Topic	Organiser(s)	Venue & Date
Dr. KE Lawande		
Varietal improvement for processing qualities in onion	National workshop on Onion with special reference to processing	Nashik Aug. 24, 2009
Solar Powered Constant Move Pivot Irrigation -A Tool for Second Green Revolution	Innovations in Irrigation Conference	San Antonio, Texas Dec. 2-4, 2009
Onion and Garlic - An Indian Perspective with Special Reference to Rajasthan	National workshop on 'Spices and Aromatic Plants in 21st Century India' at SKN College of Agriculture (RAU)	Jobner, Rajasthan Dec. 20-21, 2009
Dr. V Mahajan		
Onion & Seed production	Maharashtra State Agril. Dept., Ahmednagar	Nandur Khandharmal, Ahmednagar Jun. 11, 2009
Onion production	Gramunnati Agri. Business Management College (MPKV), Narayangaon & Agro Rasayan & Shri Ram Genetic India. Ltd.	Dumberwadi, Junner Jul. 14, 2009
Improved technology for production of Onion & Garlic	Maharashtra Dept. of Agril., Rajgurunagar, Pune.	Chandoli Hort. Nursery Sep. 4, 2009
Onion production technology for commercial cultivation & its marketing	Human Service Foundation, MACCIA & Gavkari Krishi Manch, Nasik	Nashik Nov. 28, 2009
Onion production, seed production, protection and storage	Deepak Fertilizers and Petro Chemicals Ltd., Nasik	Sawargaon, Sangamner Dec. 23, 2009

Topic	Organiser(s)	Venue & Date
Onion production, seed production, protection and storage	Deepak Fertilizers and Petro Chemicals Ltd., Nashik	Bel Pimpalgaon, Nevasa Dec. 23, 2009
Genetic improvement in onion	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 15, 2010
Processing & value addition of onion & garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 17, 2010
Advances in production technology of onion & garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 17. 2010
Onion bulb production	Dept. of Agri., Maharashtra Govt., under ATMA scheme	DOGR, Rajgurunagar Mar. 4, 2010
Processing & value addition of onion & garlic	Dept. of Agri., Maharashtra Govt., under ATMA scheme	DOGR, Rajgurunagar Mar. 5, 2010
Dr. A Khar		
Genetic Improvement of Garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar 15th Feb., 2010
Role of Biotechnology in Onion & Garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar 17th Feb., 2010
Garlic Production	Dept. of Agri., Maharashtra Govt., under ATMA scheme	DOGR, Rajgurunagar 4th March, 2010
Dr. PS Srinivas		
Insect pest problems in onion and garlic and their management	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar 17 February 2010
Integrated pest management in onion and garlic	Dept. of Agri., Maharashtra Govt., under ATMA scheme	DOGR, Rajgurunagar 5 March, 2010

Topic	Organiser(s)	Venue & Date
Dr. V Sankar		
Nursery management in onion	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 15-22,2010
Micro irrigation in onion and garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 15-22,2010
Post harvest management in onion and garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 15-22,2010
Nursery and weed management and micro irrigation in onion and garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 15-22,2010
Post harvest management in onion and garlic	Dept. of Agri., Maharashtra Govt., under ATMA scheme	DOGR, Rajgurunagar Mar. 4-6,2010
Dr AJ Gupta		
Nutritional importance of onion and garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 15-22, 2010
Dr. SS Gadge		
Insect pest management in onion	Zuari Industries Ltd, Goa	Hiware, Tal. Shirur, Pune Sep. 24, 2009
Group dynamics in onion and garlic growers	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 15-22, 2010
Government policies for onion and garlic growers	Dept. of Agri., Maharashtra Govt., under ATMA scheme	DOGR, Rajgurunagar Mar. 4-6, 2010
Dr. A Thangasamy		
Integrated nutrient management for onion and garlic	Directorate of Extension, Dept. of Agriculture and Co-operation, MOA, Government of India.	DOGR, Rajgurunagar Feb. 15-22, 2010
Integrated nutrient management for onion and garlic	Dept. of Agri., Maharashtra Govt., under ATMA scheme	DOGR, Rajgurunagar Mar. 4-6, 2010

Participation in Exhibition

Name	Organiser(s)	Venue & Date
Mahajan V	Agriculture Exhibition organized by Lt. Amit Singh Memorial Foundation under "*Swadesh Prem Jagrati Sangosthi*-09".	Samastipur, Bihar May 28-31, 2009
Gadge SS and staff members	KISAN-2009 organized by KISAN Forum Pvt Ltd and supported by Department of Agriculture, Maharashtra	Moshi, Pune Dec. 14-18, 2009

Human Resource Development

Participation of scientists / staff in conferences / courses / meetings / seminars / symposia / workshops / trainings etc. during 2007-08

Title and Venue	Name	Period
National conference on 'Production of quality seeds and planting material - Health management in Horticultural crops' at New Delhi by Society for promotion of Horticulture, IIHR Confederation of Horticultural Association of India, NHB, Gurgaon and ICAR Hqrs, New Delhi	Dr KE Lawande	Mar. 11-14, 2010
Directors meeting and Inauguration programme of VC, SAUs at New Delhi organized by ICAR Hqrs	Dr KE Lawande	Feb. 15-18, 2010
Directors meeting with DG, ICAR and Divisional meeting of Horticulture Division with DDG (H), ICAR at New Delhi organized by ICAR Hqrs and Hort. Division, New Delhi	Dr KE Lawande	Feb. 2-3, 2010
Two-days State level seminar on 'New advances in biochemistry and molecular biology' at Loni organized by College of Agricultural Biotechnology, Loni	Dr KE Lawande	Jan. 29-30, 2010
XVIII AICRP (VC) group meeting at Bangalore and felicitation programme organized by IIVR, Varanasi and IIHR, Bangalore	Dr KE Lawande	Jan. 16-19, 2010
International conference on 'Nurturing Arid zones for people and the environment: Issues and Agenda for the 21st Century' at Jodhpur organized by CAZRI & AZRAI, Jodhpur	Dr KE Lawande	Nov. 24-28, 2009
National seminar on 'Horticultural Biotechnology' at Bangalore organized by IIHR, Bangalore in collaboration with IISR, Calicut	Dr KE Lawande	Oct. 30, 2009

Title and Venue	Name	Period
Seminar on 'Potato Production Technology and Marketing' at DOGR, Rajgurunagar, Pune organized by Farms Pune, Source Foundation Pune, MPKV, Rahuri and Department of Agriculture, Govt. of Maharashtra	Dr KE Lawande	Sep. 11, 2009
2nd Agriculture Leadership Summit and Awards-2009 as Special Invitee at New Delhi organized by Agriculture Today, The National Agriculture Magazine, New Delhi	Dr KE Lawande	Sep. 4-5, 2009
National seminar on 'Present status and future prospects of acid lime in India' at Rahuri organized by MPKV & Maharashtra Acid Lime Growers Association, Pune	Dr KE Lawande	Aug. 11, 2009
ICAR's Foundation Day	Dr KE Lawande	July 16, 2009
Director's meet, and National meet on 'Conservation agriculture' at NASC organized by ICAR Hqrs and DDG (NRM), ICAR, New Delhi	Dr KE Lawande	July 17, 2009
Interactive meeting of Principal Investigators of All India Network Research Project on Onion and Garlic under the Chairmanship of Dr. H.P. Singh, DDG (H) at Rajgurunagar, Pune	Dr KE Lawande	Apr. 26-27, 2009
One-day Brainstorming on 'Management of Horticultural Crop Genetic Resources' at NBPGR under the Chairmanship of Dr. H.P. Singh, DDG (H), ICAR organized by NBPGR, New Delhi	Dr KE Lawande	Apr. 21, 2009
Winter school on "Marker Assisted breeding in Vegetable crops" at Indian Institute of Vegetable Research, Varanasi	Dr. V Mahajan Dr. AJ Gupta	Dec. 1-21, 2009
National Seminar on "Vegetable production and post harvest management" held at NHRDF Chitegaon, Nashik	Dr. V Mahajan	Oct. 14-15, 2009
Application of Genomics Technologies in Plant Breeding conducted at ICRISAT, Hyderabad	Dr. A. Khar	Nov. 16-27, 2009
National Seminar on Horticultural Biotechnology held at IIHR, Hessaraghatta	Dr. A. Khar	Oct. 28-29, 2009

Title and Venue	Name	Period
Hands-on experience for "Virus detection in garlic using ELISA and RT-PCR methods" at Advanced Centre of Plant Virology, IARI, Pusa, New Delhi	Dr. A Khar	Sep. 2009.
Workshop on ICAR Zonal Technology Management & Business Planning Development, held at CICR, Nagpur	Dr. PS Srinivas	Jan 19, 2010
Special interactive workshop on Administrative and Financial matters for ICAR institutes held at NAARM, Hyderabad	Dr. PS Srinivas	Sep.10-11, 2009
Interactive group meeting Status and future strategies for managing various pests of horticultural crops held at CISH, Lucknow	Dr. PS Srinivas	July 10-11, 2009
Trainers Training Programme on Enhancing Water Productivity in Agriculture under XI th plan Scheme on Scaling up water productivity for livelihood in agriculture through Training and demonstration: Training of Trainers and farmers organized by IARI -WTC	Dr. V Sankar	July 1-14, 2009
Interactive Group meeting on "All India Network Project on Onion and Garlic" held at DOGR Pune	All Scientists	April 26-27, 2009

Details of Recognitions and Training/ Refresher courses/ Summer / Winter Institutes/ Seminars/ Conferences/ Symposia/ Workshops organised by the Institute

Recognitions

Dr. K.E. Lawande felicitated for lifetime contribution in vegetable science

Dr. K.E. Lawande, Director, Directorate of Onion and Garlic Research was felicitated by Dr. H.P. Singh, Deputy Director General (Horticulture), on the occasion of All India Coordinated Research Project on Vegetable workshop held at Indian Institute of Horticultural Research, Bengaluru on 16-19th January 2010 for his lifetime contribution in the field of vegetable science. Dr. Lawande started his career as Assistant Professor and rose to Professor of Horticulture in MPKV, Rahuri. During this tenure from 1973 to 1997, he has released 13 varieties of different vegetables crops at state as well as national level. The varieties developed and released by him are still in cultivation and are being multiplied by Mahabeej and other seed companies. In 1997 he joined as the First Director of National Research Centre for Onion and Garlic. He has established the Centre at Rajgurunagar,

Pune in a record time by creation of infrastructural facilities for research. Under his dynamic leadership, the Centre has released 7 varieties of onion for different seasons and one variety of garlic. These varieties are gaining popularity very fast among Maharashtra and Karnataka farmers. The Centre has developed good technologies in the fields of micro-irrigation, fertigation, IPM and storage which are being adapted by onion and garlic farmers. Recently, the Centre has been upgraded as Directorate with 12 coordinating and 15 voluntary centres spread all over the country.

Training Programmes Organized

Officers Training

Eight days Model Training Course on "Production Technology in Onion and Garlic" sponsored by Directorate of Extension, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi was organized by Directorate of Onion and Garlic Research, Rajgurunagar, Pune from 15-22 February 2010. In this training course, nineteen officials from Agriculture and Horticulture, from Andhra Pradesh (01), Maharashtra (08), Orissa (02), Punjab (01), Tamil Nadu (04), Tripura (02) and Uttar Pradesh (01) participated. During the training, participants were given information on Status of onion and garlic in India and abroad, Genetic improvement in onion and garlic, Nutritional importance of onion and garlic, Nursery management, Micro Irrigation, Integrated Nutrient Management, Integrated diseases and pest management, Processing and value addition of onion and garlic, Role of biotechnology in onion and garlic, Onion seed production, Post harvest management, Marketing and export of onion and garlic, Group dynamics of onion and garlic growers, and Seed technology of onion, etc. Trainees were exposed to DOGR experts and farmers, who shared their success stories. In field visits, they were taken to onion markets, farmers' fields and storage structures.

The entire training programme was completely residential in nature and participants were exposed through theoretical and practical orientations. The training manual, relevant books and CDs were provided to the participants. The participants were highly satisfied with time schedule and conduct of training, lodging arrangement, food arrangement, transport facilities, training manual, technical

expertise of resource persons, communication skill of resource persons, content of the course, field exposure, and interaction with resource persons. The trainees were evaluated before and after training for gain of knowledge. It was a good experience and it was noted that the knowledge level increased from 47.66% to 85.20%.

Farmers Training

Three days farmers training programme on "Scientific Cultivation of Onion and Garlic" from 4-6 March 2010 was sponsored by Taluka Agricultural Officer, Erandol, Dist. Jalgaon under ATMA scheme in which 20 farmers from Maharashtra participated. Farmers were enlightened with the various aspects of scientific cultivation of onion and garlic through lectures followed by field and market visits.

Institutional Activities

Scientific and Management Meetings

First interactive meeting of All India Network Research Project on Onion & Garlic (AINRPOG)

First interactive group meeting of the All India Network Research Project on Onion & Garlic (AINRPOG) was held on 26-27 April, 2009 at DOGR, Rajgurunagar. Dr. H.P. Singh, Deputy Director General (Horticulture) was the chief guest. On this occasion Dr. Singh inaugurated the new seed farm of onion and garlic at Kalus. Principal investigators from 12 main centres as well as scientists from 10 voluntary centres attended the meeting. At the outset the Director welcomed the DDG and all the participants of Network project. He outlined the importance of onion and garlic and the problems associated with the breeding and development of new varieties in both the crops.

While delivering Presidential address, Dr. HP Singh, DDG (Horticulture) emphasised on the germplasm management and the steps needed for characterisation of germplasm; development of trait specific breeding lines and informatics for database management; He also emphasised that the developed production technologies should be tested at different centres for validation. During second session, under the chairman ship of Dr. K.E. Lawande technical programme for the season 2009-10 was discussed thoroughly and finalized.

Seed Production facilities inaugurated

Being cross pollinated crop, onion needs isolation distance for maintaining purity of varieties under seed production which is not possible in one location. 22 ha area was acquired from Government of Maharashtra at Kalus, 25 km away from Rajgurunagar. The area has been shaped by levelling undulated land and field facilities like roads, farm stores, irrigation system, water storage tank, micro irrigation etc have been developed. Dr. H. P. Singh, DDG (Horticulture) visited the farm and inaugurated the newly developed facilities. He expressed great satisfaction regarding developments and achievements in terms of seed production.

Institute Management Committee (IMC)

IMC meeting

XIV IMC meeting was held on 08.12.2009 under the Chairmanship of Dr. K.E. Lawande, Director, DOGR. Members Dr. B.R. Ulmek, Associate Dean, College of Agriculture, Pune, Dr. R.L. Sapra, PS, IARI, New Delhi, Dr. S.J. Singh, Ex-Head, IARI- RS, Pune, Dr. S.S. Mehetre, DoR, MPKV, Rahuri, Mr. V.T. Awachat, Otur, Dr. C.R. Ramesh, PS, DOGR, Mr. N. Gopal, Member Secretary and Ms. V.N. Chaudhari, AFAO as invitee attended the meeting. After the welcome address, Dr. Lawande presented a detailed report along with research accomplishments. The committee expressed satisfaction about the functioning of the centre.

Institute Research Council (IRC)

Institute Research Council (IRC) meeting was held on 25-27 March 2010 at Rajgurunagar, under the chairmanship of Dr. K.E. Lawande, Director. All the scientists presented the results of the projects and after thorough discussion the technical programme was finalised for the coming season.

हिन्दी सप्ताह

प्याज एवं लहसुन अनुसंधान निदेशालय, राजगुरूनगर में दिनाँक 14/09/2009 से 19/09/2009 तक हिन्दी सप्ताह मनाया गया। इस दौरान 1. निबन्ध प्रतियोगिता : वृध्दा अवस्था में समस्यायें एवं उनका समाधान 2. वाद-विवाद : समलैंगिकता कितना नैसर्गिक 3. कविता पाठ 4. प्रश्न मंजुषा 5. भाषान्तर 6. सुलेखन प्रतियोगिताओं एवं हिन्दी कार्यशाला का आयोजन किया गया। समापन कार्यक्रम दिनाँक 19/09/2009 को मुख्य अतिथि श्रीमती रेखा सिंह, हिन्दी अधिकारी, अनुसंधान तथा विकास स्थापन (इंजिनीयरिंग) कलस, पुणे (महाराष्ट्र) एवं निदेशक, प्याज एवं लहसुन अनुसंधान निदेशालय, राजगुरूनगर की अध्यक्षता मे सम्पन्न हुआ। निदेशक महोदय ने मुख्य अतिथि महोदया को पुष्प गुच्छ, श्रीफल एवं शाल भेट दे कर स्वागत किया। निदेशक महोदय ने स्वागत भाषण में अपने उदगार प्रकट किये तथा उसके पश्चात मुख्य अतिथि महोदया ने अपने अध्यक्षीय भाषण में हिन्दी से संबंधित उदाहरणो के साथ अपने भाव प्रकट किये । अन्त में विजेता प्रतियोगियों को पुरस्कार प्रदान किये गये।

Institute Management Council (IMC)

Name	Designation	Status	Address
Dr. KE Lawande	Director	Chairman	DOGR, Rajgurunagar
Dr. Umesh Srivastava	ADG (H-II)	Member	ICAR, New Delhi
Dr. RL Sapra	Pr. Scientist	Member	IARI, New Delhi
Dr. BR Ulmek	Associate Dean	Member	College of Agriculture, MPKV, Pune
Dr. SJ Singh	Ex-Head, IARI RS, Pune	Member	Flat No.23, 5th Floor, Prachi Pune
Dr. KV Deshmukh	Joint Director	Member	Department of Agriculture, Pune
Dr. SS Mehetre	Director of Research	Member	MPKV, Rahuri
Director of Horticulture	Director of Research	Member	Dept. of Agril., Govt. of Karnataka, Bangalore
Dr. CR Ramesh	Pr. Sci.	Member	DOGR, Rajgurunagar
Mr. Dilip Mohite Patil	MLA	Member	Khed-Alandi, Rajgurunagar
Mr. Vikram T Awachat	Progressive Farmer	Member	President, Chaitanya Farmers Club, Otur (MS)
Sh. RK Singh	F & AO	Member	CIRCOT, Mumbai
Mr. N Gopal	AAO	Member Secretary	DOGR, Rajgurunagar

Institute Research Council (IRC)

Name	Designation	Status	Address
Dr. KE Lawande	Director	Chairman	DOGR, Rajgurunagar
Dr. CR Ramesh	Pr. Sci.	Member Secretary	DOGR, Rajgurunagar
All Scientists		Members	DOGR, Rajgurunagar

Research Advisory Committee (RAC)

Name	Designation	Status	Address
Dr. Brahm Singh	Ex. OSD, President of India	Chairman	Pocket 'E', 713, Mayur Vihar, Phase- II, New Delhi
Dr. KE Lawande	Director	Member	DOGR, Rajgurunagar
Dr U Srivastava	ADG (Hort. II)	Member	ICAR, New Delhi
Dr. Kalyan Singh	Professor and Head	Member	Department of Agronomy, Institute of Agricultural Sciences, BHU, Varanasi (Uttar Pradesh)
Dr. PL Tandon	Ex-Pr. Sci., PDBC	Member	B2/001, White House, 6th Main, 15th Cross, RT Nagar, Bangalore
Dr. RD Rawal	Pr. Sci. (Plant Pathology)	Member	Deptt. of Plant Pathology, IIHR, Bangalore
Dr. CR Ramesh	Pr. Sci. (Plant Pathology)	Member Secretary	DOGR, Rajgurunagar

Personnel

Recruitments

Dr. V. Mahajan	Principal Scientist	01/05/2009
Dr. S. S. Gadge	Sr. Scientist (Agri. Extension)	10/07/2009
Dr. S. J. Gawande	Sr. Scientist (Plant Pathology)	01/01/2010
Miss Vijaya N. Chaudhari	Assistant Finance & Account Officer	07/09/2009

Modified Assured Career Progression Scheme

Name	Designation	Date of MACPS
Smt. S. S. Joshi	Ex-Assistant	01/09/2009
Sh. D. B. Mundharikar	Stenographer/Personal Assistant	29/10/2008
Sh. S. P. Kanwal	UDC	01/09/2008
Sh. P. S. Tanwar	UDC	02/12/2008
Smt. M. S. Salve	UDC	28/11/2008
Smt. N. R. Gaikwad	LDC/Hindi Typist	06/11/2008
Sh. R. K. Dedage	LDC	25/11/2008

Retirement

Name	Designation	Date of retirement
Smt. S. S. Joshi	Assistant	30/06/2009

Staff Position

Category	Sanctioned Posts	Filled up post	Vacant
RMP	01	01	-
Scientist	16	11	05
Technical	10	10	-
Administrative	09	08	01
Supporting Staff	11	11	-
Total	47	41	6

List of Staff

Name	Designation
Scientific staff	
Dr. KE Lawande	Director
Dr. CR Ramesh	Principal Scientist (Plant Pathology)
Dr. V Mahajan	Senior Scientist (Horticulture)
Dr. (Mrs) A Asha Devi	Senior Scientist (Genetics)
Dr. Anil Khar	Senior Scientist (Horticulture)
Dr. PS Srinivas	Senior Scientist (Entomology)
Dr. V Sankar	Senior Scientist (Horticulture)
Dr. AJ Gupta	Senior Scientist (Horticulture)
Dr. SS Gadge	Senior Scientist (Agricultural Extension)
Dr. SJ Gawande	Senior Scientist (Plant Pathology)
Dr. A Thangasamy	Scientist (Soil Science)
Dr. MK Kuchlan	Scientist (Seed Technology)
Technical staff	
Sh. VV Patil	T-5, Technical Officer T-5
Sh. NL Gore	T-5, Technical Officer (Field/Farm)
Sh. HSC Shaikh	T-5, Technical Officer (Computer)
Sh. RB Baria	T-3, (Field/Farm Technical Assistant)
Sh. AR Wakhare	T-3 (Field/Farm Technical Assistant)
Sh. DM Panchal	T-I-3 (Lab Technician)
Sh. PS Takale	T-I-3 (Field/Farm Technician)
Sh. BA Dahale	T-I-3 (Tractor Driver)
Sh. SP Yeole	T-3 (Driver)
Sh. HS Gawali	T-1 (Field/Farm Technician)

Name	Designation
Administrative staff	
Sh. N Gopal	Assistant Administrative Officer
Miss Vijaya N. Chaudhari	AF&AO
Sh. DB Mundharikar	PA
Sh. SP Kandwal	Assistant
Sh. PS Tanwar	Sr. Clerk/UDC
Smt. MS Salve	Sr. Clerk/UDC
Smt. NR Gaikwad	Sr. Clerk/UDC
Sh. RK Dedge	Jr. Clerk/LDC
Supporting staff	
Sh. SK Said	SSS
Sh. PK Khanna	SSS
Sh. PR Sonawane	SSS
Sh. PE Tadge	SSS
Sh. MS Kale	SSS
Sh. RS Kulkarni	SSS
Sh. SD Waghmare	SSS
Sh. NH Shaikh	SSS
Sh. AD Fulsundar	SSS
Sh. SB Tapkir	SSS
Sh. SS Gopale	SSS

Distinguished Guests

Mr. Chaman Kumar, Addl Secretary & FA, DARE/ICAR	03.05.2009
Dr. K.L. Chadha, DDG (Retd), ICAR	10.08.2009
Dr. Ajai Kumar, Director (IC) & CVO, DARE, ICAR	07.10.2009
Dr. C.D. Mayee, Chairman, ASRB	24.03.2010
Total number of farmers visited	**3540**

Dr. K.L. Chadha,
DDG (Retd), ICAR

Dr. C.D. Mayee
addressing DOGR Scientists.

Finances

Financial Statement for the year 2009-2010

Head of Accounts	Rupees in Lakhs	
	Budget Allocation	Expenditure
Non-Plan	221.05	220.92
Plan	175.87	175.87
AINRP Project	289.13	289.13
Pension & Retirement	24.26	24.25
P-Loans & Advances	0.60	0.60
R-Deposit Scheme	9.30	7.44
Total	720.21 Target	718.21 Achieved
Revenue Receipts	19.66	20.38

Abbreviations

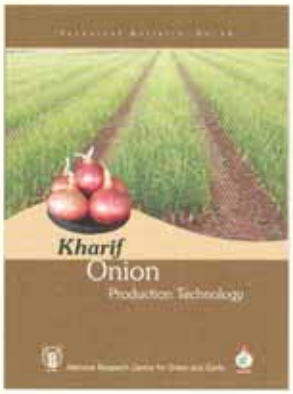
ABW	Average Bulb weight
P	Polar Diameter
E	Equatorial Diameter
N	Neck thickness
TSS	Total Soluble Solids
DTH	Days to harvest
DAT	Days after transplanting
GP	Germplasm
AGB	A Grade Bulbs
NOL	Number of leaves
PH	Plant Height
LL	Leaf length
LW	Leaf width
CT	Collar thickness
CP	Clove polar diameter
CE	Clove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

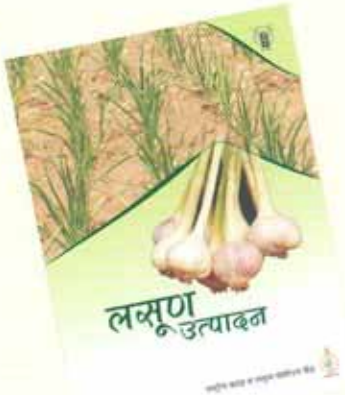
Annexure - 1

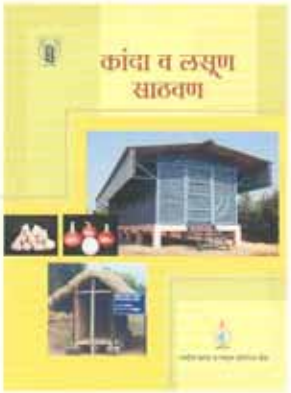
Meteorological data for the year 2009-10

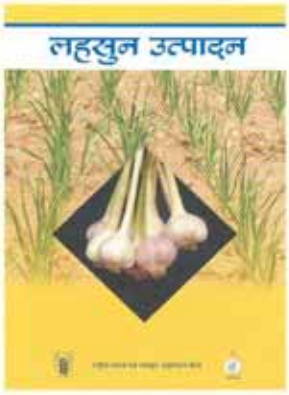
Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.	Max.	Min.		
April	39.2	19.9	58	33	0	9.1
May	37.0	20.6	67	37	80.0	8.9
June	35.0	23.0	75	46	0	8.2
July	28.4	20.6	88	80	263.8	1.8
August	31.2	20.4	90	70	115.0	1.9
September	31.7	19.6	86	62	150.0	3.2
October	33.0	16.7	78	49	66.6	4.4
November	30.3	15.5	80	56	127.8	2.8
December	29.4	12.0	84	48	0	3.4
January	28.7	10.7	79	46	0	3.6
February	32.0	12.3	77	40	0	4.2
March	36.3	14.1	65	30	10.6	5.3
Mean	32.7	17.1	77	50	813.8	4.7

Recent Publications









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