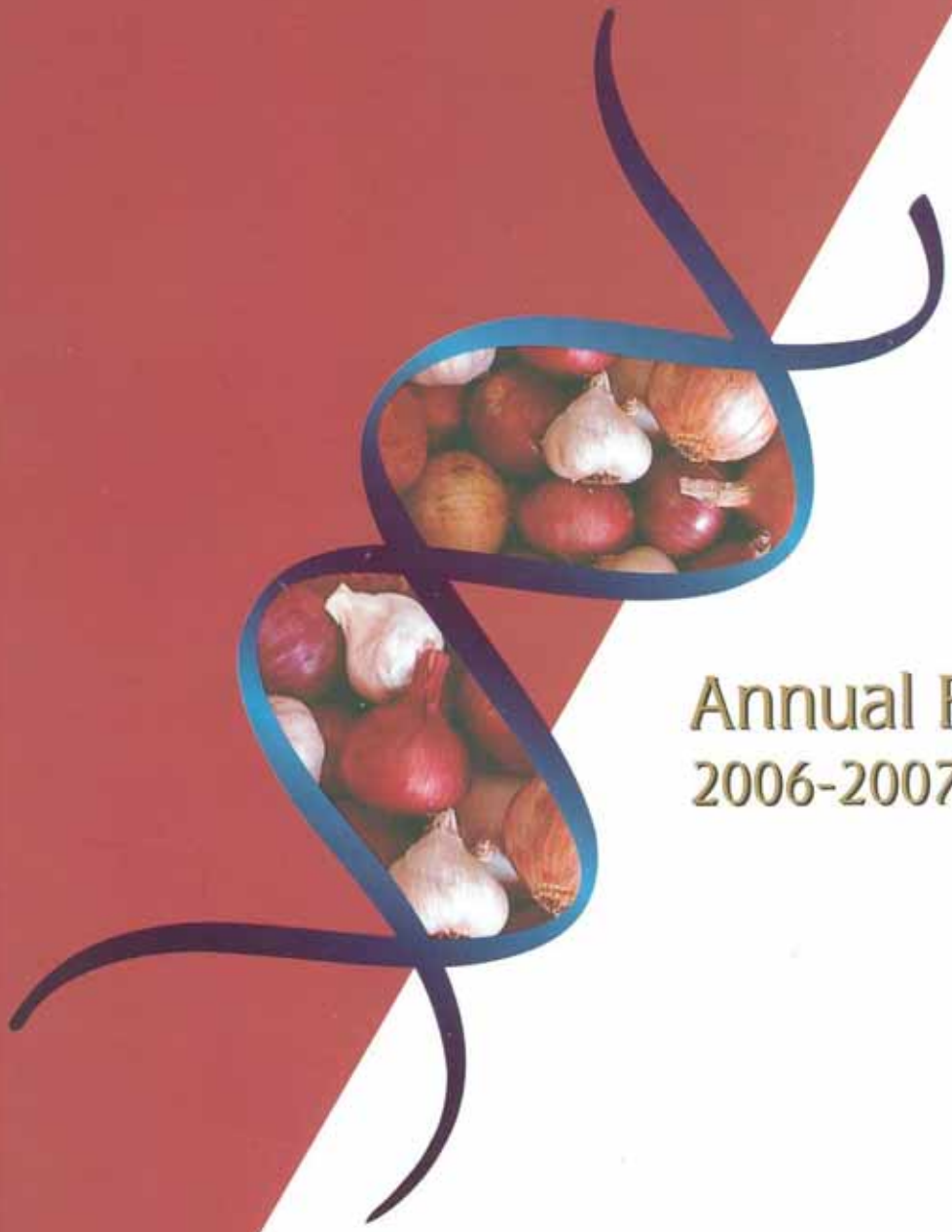
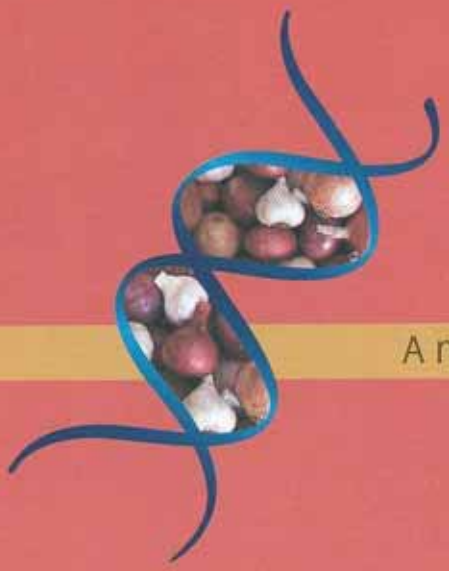


Annual Report
2006-2007

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



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Rajgurunagar - 410 505, Dist. Pune, Maharashtra

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कार्यकारी सारांश

राष्ट्रीय प्याज एवं लहसुन केंद्र को इन दोनो फसलों एवं इनकी जंगली जातियों के कृषि सम्बंधी मुद्दो को सुलझाने का कार्य सौंपा गया है । प्याज एवं लहसुन उत्पादकों द्वारा सामना किए जा रहे प्रमुख समस्याओं को ध्यान में रखते हुए इस केंद्र का अधिदेश बानाया गया है । तदनुरूप, रिपोर्ट वर्ष में, इन फसलों के उन्नयन के मोर्चे पर कई उपलब्धियाँ हासिल की गयीं । कुछ प्रमुख उपलब्धियाँ निम्मवत हैं :

✦ लाल प्याज के औद्यानिक गुणों हेतु किए गए जननद्रव्य मूल्यांकन से कुछ उत्साहजनक पंक्तियाँ मिलीं । पछेती खरीफ मौसम 2005-2006 में एन. आर. सी. ओ. जी. 1164 से 62.6 टन / है. की अधिकतम उपज प्राप्त हुयी । इस पंक्ति ने विपणन योग्य उपज अ, ब, एवं स श्रेणी के कंदभार में भी श्रेष्ठ प्रदर्शन किया । रबी 2005-2006 में एन. आर. सी. ओ. जी. - 638, एन. आर. सी. ओ. जी. -1054, एन. आर. सी. ओ. जी. - 624, एन. आर. सी. ओ. जी. - 576 एवं एन. आर. सी. ओ. जी. -1064 पंक्तियों ने कुल एवं विपणन योग्य उपज दोनों में श्रेष्ठ प्रदर्शन किया ।

✦ पछेती खरीफ 2005-2006 में विशिष्ट पंक्तियों के परीक्षण मे ई.एल. -546, ई.एल. -651, ई.एल. -571,ई.एल. -1014, ई.एल. -597, ई.एल. -592, एवं ई.एल. कम्पोजिट पंक्तियाँ ए श्रेणी के कंदो के प्रतिशत में श्रेष्ठ पायी गयीं । जब कि एन. आर. ओ. जी. - 1164 एवं एन. आर. सी. ओ. जी. - 1014 प्रविष्टियाँ अधिकतम विपणन योग्य उपज में सर्वश्रेष्ठ रहीं । रबी 2005-2006 के परीक्षण में ई एल. -650 पंक्ति कुल उपज एवं विपणन योग्य उपज दोनो में ही सर्वश्रेष्ठ पायी गयी जब कि ई एल. - 1044 दूसरे स्थान पर रही । खरीफ मौसम के मूल्यांकन में बी - 780 अभी भी विपणन योग्य उपज में सर्वश्रेष्ठ पायी गयी जब कि 1014 एवं 1044 क्रमश: दूसरे एवं तीसरे स्थान पर रही ।

✦ रबी 2005-2006 में कन्द से पंक्ति मूल्यांकन में एन. आर. सी. ओ. जी. -1082, 1089 - 1, एल. आर., 1089-3 एल. आर., 1091-5 एवं 1091-1 का प्रदर्शन सर्वोत्तम रहा जिनसे 34.5 -77.0 टन /है. कुल उपज प्राप्त हुई ।

✦ शस्योत्तर अध्ययन में पछेती खरीफ की पंक्तियों एन. आर. सी. ओ. जी. - 531 एवं एन. आर. सी. ओ. जी. - 619 में भंडारण के 120 दिन बाद वजन में 20 प्रतिशत से भी कम कमी पायी गयी । जबकि रबी जननद्रव्यों में भण्डारण के 150 दिन बाद सभी के वजन में 30 % से अधिक घटोत्तरी पायी गयी।

✦ पछेती खरीफ 2005- 2006 में सफेद प्याज की 3 पंक्तियों में चेक किस्म -फुले सफेद की तुलना में सार्थकरूप से अधिक विपणन योग्य उपज प्राप्त हुयी । जननद्रव्यों में कुल घुलनशील पदार्थ का प्रतिशत 8.4 - 15.5 के बीच रहा जबकी चेक किस्म -फुले सफेद (11.2%) की तुलना में आठ जननद्रव्यों में यह 13% के उपर पाया गया ।

✦ रबी 2005 - 2006 में, 156 पंक्तियो का मूल्यांकन किया गया परंतु किसी पंक्ति में चेक किस्म से अधिक उपज नहीं प्राप्त हुई। खरीफ 2006 में , 18 पंक्तियों में चेक किस्म की तुलना में सार्थकरूप से अधिक विपणन योग्य उपज प्राप्त हुई।

✦ तीनों मौसम में सफेद प्याज की विशिष्ट पंक्तियों के परीक्षण में अधिकतम विपणन योग्य उपज पछेती खरीफ (49.7 टन/है.) में तथा रबी में 44.7 टन/है. एवं निम्नतम उपज (20.2 टन/ है.) खरीफ में मिला ।

✦ सफेद प्याज में कुल घुलनशील पदार्थ की मात्रा बढ़ाने हेतु चलाये जा रहे प्रजनन कार्यक्रम द्वारा ऐसी संततियों का विकास किया गया है जिनमें कुल घुलनशील पदार्थ का सामूहिक औसत 10.0 - 20.0 प्रतिशत के बीच है ।

✦ देश के विभिन्न प्याज उत्पादक क्षेत्रों में अग्रिम किस्म परीक्षण - द्वितीय के अन्तर्गत छ: पंक्तियों का परीक्षण किया गया । इसमें केंद्र द्वारा विकसित किस्म बी -780-5-3-1 ने 39.0 टन /है. की सर्वाधिक विपणन योग्य उपज प्रदान किया जबकि चेक किस्म - ए. एफ.एल. आर से 35.9 टन/ है. की उपज प्राप्त हुयी । लहसुन में केंद्र की किस्म ए. सी. - 20 से सर्वाधिक विपणन योग्य उपज (9.6 टन/ है.) प्राप्त हुआ जो चेक किस्म आर. ए. यू. जी. - 5 की उपज (9.4 टन/है.) से सांख्यकीय रूप से समतुल्य रहा ।

✦ प्याज की सी. एम. एस. पंक्तियों (ए. एवं बी.) में प्ररोध गुणन द्वारा सूक्ष्म प्रवर्धन का सफलता पूर्वक विकास किया गया । तीन क्षमतावान सी पंक्तियों में अप्रत्यक्ष आरगेनोजेसिस का कार्य भी पूर्ण किया गया । लहसुन की अग्रिम पंक्ति (ए. एन. -38) में सोमेटिक इम्ब्रियोंजेनेसिस भी सफल रहा । लहसुन की कुछ पंक्तियों मे मेरीस्टेम टिप कल्चर एवं गुणन का प्रोटोकाल भी विकसित किया गया ।

✦ देश में प्रथम बार प्याज की कुछ पंक्तियों में हैप्लाइड विकसित करने हेतु इनविट्रो गायनोजेनेसिस का सफलता पूर्वक मानकीकरण किया गया । इन संततियों का प्लाइडी स्थिती हेतु आंकलन किया जाएगा । इस प्रकार विकसित सामग्री का भविष्य के प्रजनन कार्यक्रमों में उपयोग किया जाएगा ।

✦ लहसुन में कंद से पंक्ति संतति अध्ययन में उत्साहजनक परिणाम प्राप्त हुए इसमें 7 पंक्तियों ने 10 टन/ है. से अधिक उपज प्रदान किया । उत्पर्वर्तन प्रजनन में यह पाया गया कि तीनों उत्पर्वर्तक रसायन (कालिचिसिन, ई. एम. एस., सोडियम एजाइड) चौथी पीढ़ी (एम. 4) में सार्थक रूप से अधिक उपज देने वाली पंक्तियों को अभिप्रेरित करने में सफल रहे ।

✦ उर्वरक एवं सिंचाई अध्ययन के दौरान विभिन्न जैविक खादों (गोबर की खाद, कुक्कट खाद एवं वर्मीकम्पोस्ट) एवं टपक सिंचाई द्वारा नत्रजन का एकाधिक प्रयोग संयुक्त रूप से करने पर प्याज एवं लहसुन दोनो में पत्तियों की संख्या एवं पौधों की बढ़वार अधिक पाया गया ।

✦ प्याज में एन. पी. के. 50:50:80 कि. ग्रा./ है. आधारीय, 100 कि. ग्रा. / है. नत्रजन सात बराबर भागो में टपक सिंचाई के साथ एवं गोबर की खाद (7 टन/है.), कुक्कट खाद (3 टन/है.), वर्मीकंपोस्ट (3टन/है.) एवं जैव उर्वरकों के सम्मिलित प्रयोग से सर्वाधिक (55.2 टन / है.) विपणन योग्य उपज प्राप्त हुआ । लहसुन में नत्रजन: फास्फोरस : पोटाश 50:50:80 कि. ग्रा./है. आधारीय, 50 कि. ग्रा./है. नत्रजन सात बराबर भागों में टपक सिंचाई के साथ एवं कुक्कट खाद 10 टन /है. से सर्वाधिक विपणन योग्य उपज (14.1 टन/है.) प्राप्त हुआ ।

✦ केंद्र पर सिंचाई की विभिन्न प्रणालियों के किए गए मूल्यांकन से टपक सिंचाई द्वारा अन्य प्रणालियों की तुलनामें सार्थकरूप से अधिक उपज प्राप्त हुआ । इस विधि से पानी का सर्वाधिक बचत होने के साथ भण्डारण क्षति भी न्यूनतम पाया गया ।

✦ समेकित पोषण प्रबंधन के अन्तर्गत किए गये परीक्षणों में प्याज की कुल एवं विपणन योग्य उपज पर पिछली फसल का सार्थक असर देखा गया । बाजरा के बजाए सोयाबीन के बाद प्याज की फसल लेने से 2.6 टन /है. अतिरिक्त विपणन योग्य उपज प्राप्त हुआ जबकि लहसुन की उपज में 2 टन/है. का अंतर पाया गया । समेकित पोषण प्रबंध मोड्यूल - 3 (नत्रजन : फास्फोरस:पोटाश: सल्फर, 150:50:50:30), मोड्यूल-4 (गोबर की खाद 10 टन/है, नत्रजन : फास्फोरस : पोटाश, 75:75:25 कि. ग्रा./है.) तथा मोड्यूल - 5 (कुक्कट खाद 10 टन / है. एवं नत्रजन : फास्फोरस:पोटाश, 75:75:25 कि. ग्रा./है.) प्याज एवं लहसुन के भण्डारण के दौरान होने वाली क्षति को कम करने में काफी असरदार पाया गया ।

✦ पोषक तत्वों के अवशोषण पर किये गये अध्ययन में यह पाया गया कि खुदाई के 75 दिन बाद की अवस्था में पौधा अधिकतम पोषक तत्व ग्रहण करता है । सामान्य परिस्थिति में प्याज के बीज की जीवन क्षमता केवल एक वर्ष होती है । अत: इसके जमाव एवं ओज को बढाने हेतु विभिन्न तरीके प्रयुक्त किये गए । दो वर्षो के अध्ययन में नमीअवशोषक के साथ प्याज के बीज को डेसीकेटर में रखने के 21 माह बाद भी 70% से अधिक जमाव पाया गया जो अन्य उपचारों की अपेक्षा आठ गुणा अधिक था । बीज नमी तथा सम्वेष्ठन सामग्री पर किये गए परिक्षणों में पाँच प्रतिशत नमी वाले प्याज के बीजों को अल्युमिनियम लैमिनेटेड थैलियों में 27 माह तक रखने के बाद भी 51.7 % अंकुरण पाया गया ।

✦ थ्रिप्स के नियंत्रण हेतु कीट रोगज़नकों के परीक्षण में कोई भी स्ट्रेन कीटनाशी (कोर्बोसल्फान) की तुलना में थ्रिप्स की संख्या घटाने में समर्थ नही पाया गया । नए कीटनाशियों के मूल्यांकन में मेथोमिल (500 ग्रा. सक्रिय अवयव/है.), सर्वश्रेष्ठ पाया गया । इससे थ्रिप्स की संख्या में 90.4 % (नियंत्रित की तुलना में) की कमी पायी गयी । थ्रिप्स के परभक्षी कीटों यथा - *चीलेमीनस सेक्समाकुलाटा एवं ओरियस टेन्टिलस* को आकर्षित करने वाली फसल के रूप में सूरजमुखी एवं मक्क की पहचान की गयी, जबकि *हिपोडेमिया वेरीगेटा* के लिए सौंफ की फसल उपयुक्त पायी गयी । प्याज की अपेक्षा लहसुन की फसल में छिपने की जगह अधिक होने के कारण कीट परभक्षियों की संख्या अधिक पायी गयीं । एक अध्ययन में इस बात की पुष्टि की गयी कि थ्रिप्स, भण्डारण में भी कंदो को क्षति पहुँचाते है जिससे कंदो की गुणवत्ता प्रभावित होती है ।

✦ प्याज बीजोत्पादन में थ्रिप्स नियन्त्रण हेतु मल्च का प्रभाव विषय पर किये गये अध्ययन से यह ज्ञात हुआ कि मल्च के प्रयोग से यद्यपि शुरूआत में थ्रिप्स की संख्या में कमी होती है, परन्तु कन्दों के सड़ने से पौधों की संख्या कम होने के कारण बीज की उपज कम पायी गयी ।

✦ महाराष्ट्र के प्रमुख प्याज एवं लहसुन उत्पादक क्षेत्रों के सर्वेक्षण का कार्य पूरा किया गया एवं फफूंद के 2350 आइसोलेट तैयार किये गये जिसे शुध्द कल्चर तैयार करने हेतु केन्द्र पर संग्रहित किया गया है । छँटे हुए प्याज के कम्पोस्टिंग पर किये गये एक अध्यन में यह पाया गया कि छँटे हुए प्याज, वर्मी कम्पोस्ट व ट्राईकोडरमा के संयुक्त प्रयोग से शतप्रतिशत सड़ा हुआ कम्पोस्ट तैयार किया जा सकता है ।

✦ प्याज भण्डार गृहों का गंधक द्वारा धूमन करने पर प्याज एवं लहसुन में काली फफूंद एवं लहसुन में मृदु सड़न संक्रमण कम होने से भण्डारण क्षमता में वृद्धि हुयी । भण्डारण अध्ययन में यह भी पाया गया कि कृत्रिम वायु संचार द्वारा भण्डारण अच्छा होता है । विभिन्न संवेष्ठन सामग्रियों में टाट की बोरियों एवं प्लास्टिक क्रेट्स में नुकसान सबसे कम पाया गया ।

✦ प्याज एवं लहसुन के उत्पादन एवं विपणन से सम्बद्ध मुद्दों को सुलझाने के उद्देश्य से " भारतीय एलियम समिति" नामक एक नयी संस्था की स्थापना 2 मई 2006 को की गयी । अभी तक लगभग नब्बे आजीवन एवं वार्षिक सदस्य पंजीकृत हुए हैं।

✦ केन्द्र द्वारा 'कीट एवं रोग : वर्तमान स्थिति एवं भावी रणनिति ' विषय पर दो दिवसीय ब्रेनस्टार्मिंग सत्र का आयोजन किया गया । केंद्र प्रसार गतिविधियों में भी सक्रिय है । इसी क्रम में प्याज एवं लहसुन पर किए गए शोध के विभिन्न आयामों पर कृषकों हेतु तीन सी.डी. तैयार किया गया । राष्ट्रीय बागवानी शोध एवं विकास प्रतिष्ठान, नासिक एवं भारतीय एलियम समिति के सहयोग से इस केंद्र पर दो दिवसीय किसान मेला एवं राष्ट्रीय संगोष्ठी का सफलता पूर्वक आयोजन किया गया । केंद्र द्वारा " प्याज एवं लहसुन की उन्नत उत्पादन तकनीकी" विषय पर तीन दिवसीय तथा " प्याज एवं लहसुन के लिए सूक्ष्म सिंचाई प्रौद्योगिकी " विषय पर एक दिवसीय प्रशिक्षण का आयोजन राष्ट्रीय बागवानी शोध एवं विकास प्रतिष्ठान के साथ मिलकर किया गया । प्याज बीजोत्पादन, अनुवांशिक शुद्धता एवं गुणवत्ता मानकों के मुद्दों पर जागरूकता लाने के उद्देश्य से बीज उत्पादकों एवं वितरकों की एक सहमति बैठक का आयोजन भी केंद्र पर किया गया ।

✦ प्रमुख शोध उपलब्धियों के मद्देनजर अनुसन्धान के विभिन्न क्षेत्रों में कमियों एवं बाधाओं को चिन्हित करके उनका पूर्ण परिमार्जन किया गया । संस्थान शोध परिषद में हुई बहसों एवं शोध सलाहकार समिति की संस्तुतियों के ध्यान में रखते हुए नए परीक्षण तैयार किये गए जिनका क्रियान्वयन इन दोनों फसलों के उन्नयन हेतु किया जा रहा है ।

Executive Summary

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

- Germplasm evaluation for desirable horticultural traits in red onion revealed few promising lines for different seasons. During late *kharif* 05-06, line NRCOG-1164 recorded a highest of 62.6 t/ha. This line also registered superior performance in terms of marketable yield, weight of A, B and C grade bulbs. Whereas, in *rabi* 05-06, lines NRCOG-638, NRCOG-1054, NRCOG-624, NRCOG-576 and NRCOG-1064 recorded superior performance both in terms of total yield and marketable yield.

- Among the elite lines tested, EL-546, EL-651, EL-571, 1014, El-Composite, EL-597 and EL-592 was found superior in terms of high percent of A grade bulbs during late *kharif* 05-06. Whereas, entries NRCOG-1164 and NRCOG-1014 showed superior performance in terms of higher marketable yield, which includes A, B and C grade bulbs. Results of *rabi* 05-06 showed that EL-650 was superior in terms of both total yield and marketable yield followed by EL-650 and 1044. *Kharif* evaluation showed that B-780 was still the best in terms of marketable yield followed by 1014 and 1044.

- During *rabi* 2005-06 evaluation of bulb to row progeny, NRCOG-1082, 1089-1LR, 1089-3 LR, 1091-5 and 1091-1 recorded superior performance to the tune of 34.5 to 77.0 t/ha of total bulb yield.

- In post harvest studies, two late *kharif* lines viz., NRCOG-531 and NRCOG-619 were identified, which showed less than 20.0% weight loss after 120 days of storage. However, performance of *rabi* germplasm under storage (150 days), revealed that none of the germplasm lines showed less than 30.0% weight loss.

- In white onion germplasm, 3 lines gave significantly higher marketable yield than the check Phule Safed during late *kharif* 05-06. The TSS in the germplasm ranged from 8.4 to 15.5% and 8 germplasm had TSS more than 13.0% over the check Phule Safed (11.2%). During *rabi* 05-06, of the 156 lines evaluated, none of the lines showed superior marketable yield over the check. *Kharif* 06 saw 18 lines showing significantly superior marketable yield over the check.

- Evaluation of elite white onion lines over the three seasons showed that highest marketable yield was obtained in late *Kharif* (49.7 t/ha) followed by *rabi* (44.7 t/ha) and the lowest in *Kharif* (20.2 t/ha).

- In the programme on breeding for high TSS lines in white onion, progenies have been developed, whose mean population TSS ranges from 10.0 to 20.0%.

- Evaluation of six onion lines obtained from the different onion growing regions of the Country, under AVT II showed that B-780-5-3-1 (NRCOG) exhibited significantly superior marketable yield of 390 q/ha over the best check AFLR (359 q/ha). In case of garlic, marketable yield was significantly highest in AC-200 (NRCOG) (9.6 t/ha) which was statistically at par with RAUG-5, which yielded 9.4 t/ha

- Micropropagation through shoot multiplication has been successfully achieved in CMS (A and B) lines of onion. Indirect organogenesis of three potential C lines was also completed. In garlic, somatic embryogenesis was successful in an advanced line Acc. No. 38. Protocol for meristem tip culture and multiplication was also standardized in a few garlic lines.

- *In vitro* gynogenesis for induction of haploids was successfully standardized, in few onion lines for the first time in India. The progeny thus obtained will be assessed for their ploidy status and the developed material will be further used for breeding programme in the near future.

- In garlic breeding, promising result was obtained in bulb to row progeny studies, where more than 10 t/ha yield was recorded in 7 lines. Results of mutation breeding experiments also show that all the three mutagens (viz., Colchicine, EMS, Sodium Azide) induced significantly high yielders in M4 generation.

- The results on fertigation revealed that combined application of different organic manures (farmyard manure, poultry manure and vermicompost) along with split application of N through drip fertigation recorded higher plant growth and number of leaves in both onion and garlic. The highest marketable bulb yield (55.2 t/ha) was noticed in treatment consisting of NPK 50:50:80 kg/ha as basal + 100 kg N in seven splits through drip irrigation + combined application of FYM (7.0 t/ha) + poultry manure (3.0 t/ha) + vermicompost (3.0 t/ha) along

with biofertilizers. In case of garlic, NPK 50:50:80 kg/ha as basal + 50 kg N in seven splits through drip irrigation + poultry manure @ 10.0 t/ha showed higher marketable bulb yield of 14.1 t/ha.

- Amongst the different irrigation systems evaluated at the Centre, drip irrigation method produced significantly higher yields than other methods. Moreover, the storage losses were least in onion produced under drip and surface irrigation. Apart from this, water saving was higher in drip irrigation.

- Under integrated nutrient management trials significant effect was noticed in terms of total and marketable yield of onion bulbs due to preceding crops. Growing onion after soybean produced 2.6 t more marketable bulbs than after bajra, whereas in the case of garlic, the increase was 2.0 t. INM modules, M3 (150 N: 50 P: 50 K + 30 S), M4 (FYM @10 t /ha along with 75:25:25 kg NPK/ha) and M5 (poultry manure @10 t /ha along with 75:25:25 kg NPK/ha) had pronounced effect on reducing storage losses in both onion and garlic over a 5 month period.

- Nutrient uptake study was successfully completed in onion tops and bulbs. The studies showed that the highest nutrient removal was noticed at the 75-day growth stage.

- Seed viability in onion is only for a year under normal conditions. Hence, to improve the viability and vigour, different methods were tried. Two year's results indicated that onion seeds stored in desiccator with moisture absorbent was performing very well with more than 70.0% germination even after 21 months of storage, which was about 8 times higher than the other treatments. As for packing material and seed moisture, seeds having 5.0% moisture packed in laminated aluminium bags remain viable for longer period with 51.7% germination after 27 months of storage.

- In the evaluation of entomopathogens, consisting of different strains of Bb and Vl, against thrips in onion, it was seen that none of the treatments significantly reduced thrips compared to the control (carbosulfan). Results of evaluation of some new insecticides showed that methomyl @ 500 g ai/ha was the best with 90.4% reduction in thrips over control. Sunflower and maize were identified as insectary plants harboring natural predators of thrips like *C. sexmaculata* and *Orius*, whereas, *H. variegata* is most harbored by saunf. The predators where found more on garlic due to availability of more hiding space than onion. A study also confirmed that thrips cause damage to onion bulbs in storage thereby affecting their quality in terms of appearance.

- Effect of different mulches on thrips on seed onion showed that though initially mulches were effective in reducing the number of thrips, the plant stand is affected with bulb rotting at the end of the season, resulting in poor seed yield.

- A survey of the major onion and garlic growing areas of Maharashtra was completed and 2350 fungal isolates were obtained, which are been maintained at the Centre for single spore isolation and development of pure culture. A study on onion cull composting showed that a combination of onion culls, vermicompost and trichoderma resulted in 100% composting.

- Sulfur fumigation of storage structures for enhancing the storability was successful as far as black mould (onion and garlic) and soft rot (garlic) infection were concerned. Storage studies also showed that forced ventilation resulted in better storability. Amongst the various packing materials, lowest losses were recorded in HSC bags and plastic crates.

- To develop a think tank for addressing the intricate issues of onion and garlic production and marketing, a new society named, Indian Society for Alliums was established on 2 May 2006. A total of about ninety members including life and annual members have been registered so far.

- A two day brain storming session on 'Onion pests and diseases: Status and future thrust' was organized by the Centre to discuss about this important area

- The Centre was also active in extension activities as is evidenced by the production of three CDs on different aspects of onion and garlic research for the benefit of the farmers. A highly successful two day National Seminar cum Kisan Mela was conducted at the Centre in association with NHRDF, NRCOG and the newly formed Indian Society for Alliums. The Centre also organized a 3 day training programme on "Improved production technology on onion and garlic' and a one day training on 'Microirrigation technology for production of onion and garlic' in association with NHRDF. With a view to bringing awareness on the aspects of onion seed production and maintaining genetic purity and quality standards, a consensus meeting of seed producers and dealers was organized at NRCOG.

Taking into consideration the major research achievements and after a thorough revision in the various fields of research, the gaps / constraints were identified. Taking into consideration the discussions in the IRC and recommendations of the RAC, new trials have been formulated and are been implemented for the further improvement of these two crops.

Contents

Introduction

The Centre

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

Location and Weather

The Centre is located at 18.32° N and 73.51° E at 553.8 m above m.s.l. with a temperature range of 5.5 °C - 42.0 °C having annual average rainfall of 669 mm.

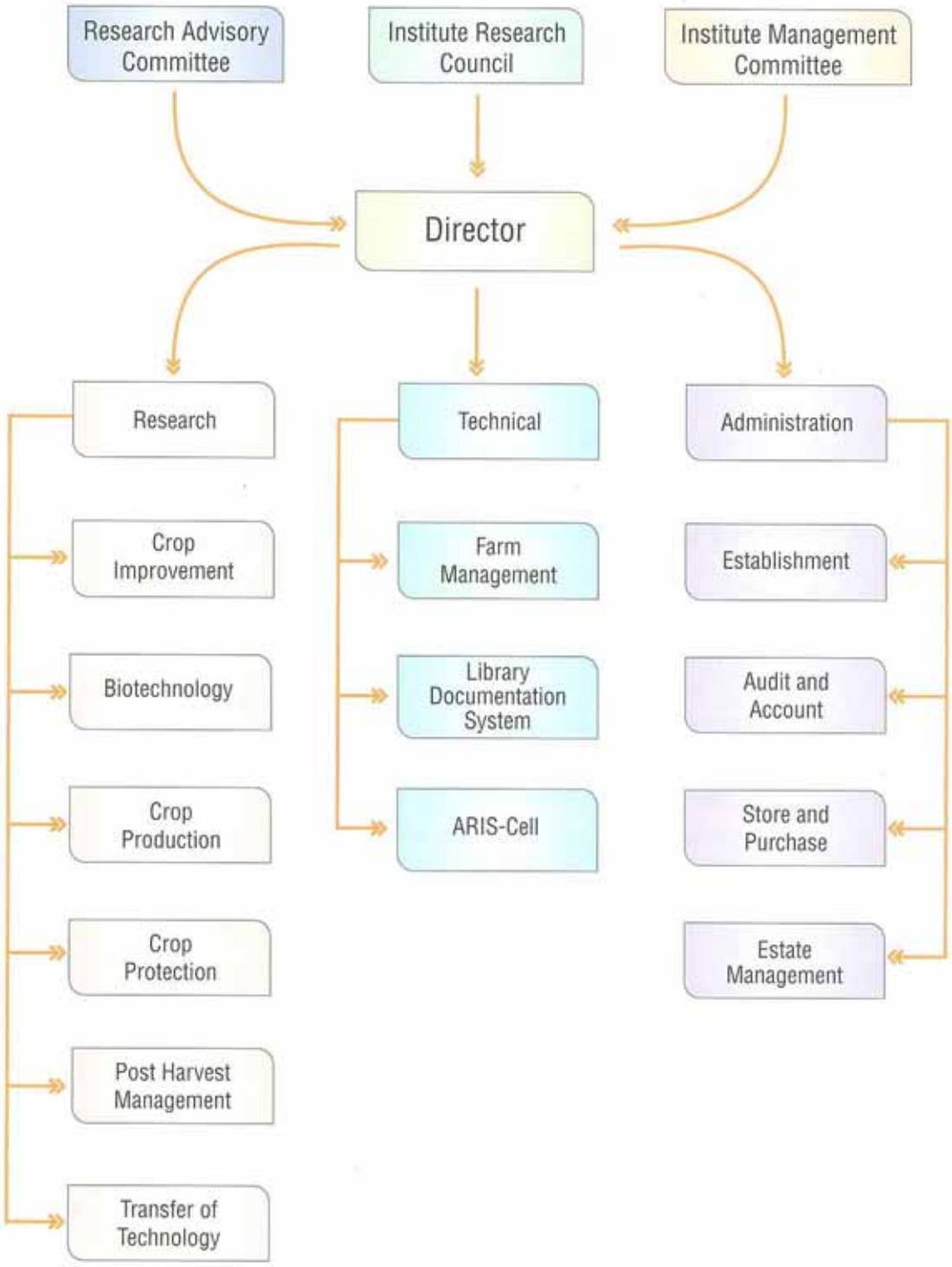
Mandate

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

Infrastructure

The Centre has 55 acres of research farm with perennial irrigation facilities at Rajgurunagar, 25 acres at Kalus and 10 acres at Manjri. Research laboratories of biotechnology, soil science, plant protection and post harvest technology were further strengthened with modern equipments. The existing facilities for Internet and e-mail connectivity have been strengthened. The library is at present having 518 books, 18 national and 5 international journals, a CD server, Hort-CD and other relevant facilities.

Organogram


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

Research Achievements

Crop Improvement

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

Evaluation of red onion germplasm

During late *kharif* 2005-06, 17 genotypes were evaluated under replicated trial. The results indicated that out of 17 genotypes tested, 4 for total yield, 8 for marketable yield, 4 for 5 bulb weight and weight of A grade bulbs, 5 for weight of B grade bulbs, 8 for weight of C grade bulbs, 6 for TSS, 3 each for equatorial diameter and polar diameter, 2 for neck thickness, 1 for pseudostem diameter and 5 genotypes for plant height registered superior performance. Further it is revealed that NRCOG-1164 recorded 62.6 t/ha followed by B-780 (59.4 t/ha), N-53 (58.1 t/ha) and NRCOG-1014 (Fig. 1) (57.4 t/ha). These lines also registered superior performance in terms of marketable yield, weight of A, B and C grade bulbs.

Fig. 1

Whereas, 20 lines were tested during late *kharif* 2005-06 for various attributes in augmented block design. The results indicated that 7 lines out of 20 showed superior performance in terms of total yield and marketable yield, whereas, 12 for 5 bulb weight, 7 for weight of A and B grade bulbs, 6 for equatorial diameter, 7 for polar diameter and 2 for TSS showed superior performance in their respective attributes. The value of skew ness was found to be negative for 5-bulb weight, polar diameter, pseudostem diameter and number of leaves and low for weight of A and B grade bulbs, equatorial diameter and plant height, whereas, high skew ness is recorded for TSS, weight of C grade bulbs, total yield and marketable yield indicating the deviation of modal value from mean. The values of Kurtosis for majority of traits were very low indicating the platicurtic curve with high range of variability in the population. The values for Kurtosis of 5-bulb weight, weight of A and B grade bulbs, equatorial diameter, number of leaves and plant height showed better distribution of individuals, yielding in greater variance.

In *rabi* 2005-06, lines NRCOG-638, NRCOG-1054, NRCOG-624, NRCOG-576 and NRCOG-1064 recorded superior performance both in terms of total yield and marketable

yield. NRCOG-14-2 showed supremacy in 5-bulb weight followed by NRCOG-48, NRCOG-551 and NRCOG-576. Weight of A grade bulbs was maximum in NRCOG-1073 followed by NRCOG-1054, NRCOG-638 and NRCOG-494, whereas, NRCOG-627 possessed maximum weight of B grade bulbs followed by NRCOG-576, Arka Niketan and NRCOG-638. In case of TSS, the variety Rose onion recorded the maximum followed by NRCOG-444, NRCOG-1016 and NRCOG-639.

The results of germplasm grown in augmented block design indicated that 8 genotypes for total yield, 6 each for marketable yield and weight of A grade bulbs, 9 for weight of B grade bulbs, 22 for 5 bulb weight and 9 for number of leaves showed superior performance. The line NRCOG-549 (41.8 t/ha) showed superior performance followed by NRCOG-747 (39.1 t/ha) and NRCOG-720 (37.5 t/ha). However, there were no significant differences among the genotypes for plant height. A good amount of variability existed in equatorial diameter and polar diameter of the bulb.

The value of skewness is negative for weight of C grade bulbs, polar diameter and plant height and very low for equatorial diameter, neck thickness and number of leaves, which indicated a marginal deviation for model value for the mean of the attributes for equatorial diameter, neck thickness and number of leaves. The values of Kurtosis for the traits, total yield, marketable yield, weight of C grade bulbs, polar diameter, equatorial diameter, pseudostem diameter, number of leaves and plant height were negative, whereas, 5-bulb weight and neck thickness was minimum. However, the values of weight of A and B grade bulbs were the maximum. In general, for all the traits, values were low range sketching platicurtic curve which indicated the low values of kurtosis for all traits together with low values of skewness for most of the traits, also showed better distribution of the individuals yield in a greater variance.

Performance of elite lines

During late *kharif* 2005-06, a series of evaluation trials were conducted in replicated and augmented block design to evaluate the elite lines. Results indicated that the lines EL-546, EL-651, EL-571, 1014, El-Composite, EL-597 and EL-592 was found superior in terms of high percent of A grade bulbs. The entries NRCOG-1164 and NRCOG-1014 showed superior performance in terms of higher marketable yield, which includes A, B and C grade bulbs.

In *rabi* 2005-06, out of 18 lines tested, 5 for earliness, 4 each for weight of B grade bulbs, 10-bulb weight, TSS and neck thickness, 3 each for total yield, marketable yield, pseudostem diameter, number of leaves and equatorial diameter and 2 each for weight of A and B grade bulbs, polar diameter and plant height showed superior performance in expression of these attributes. Among the elite lines tested, EL-650 showed superior performance in terms of both total yield and marketable yield (48.1 and 43.9 t/ha) followed by EL-650 (46.4 and 44.8 t/ha) and 1044 (44.0 and 41.6 t/ha) respectively. The check variety Arka Niketan and N-2-4-1 recorded 38.8 ad 38.7 t/ha. A similar trend was also noticed in weight of A grade bulbs. In case of weight of B grade bulbs, EL-650 recorded maximum weight followed by EL-Composite and 1014. 10-bulb weight was the maximum in EL-670 followed by Arka Niketan and 1044.

Several of the superior lines suitable for *kharif* were evaluated during *kharif* 2006 and the results indicated that B-780 (8.1 kg) was found superior in terms of marketable yield followed by 1014 (6.2 kg) and 1044 (7.4 kg). A total of 4 genotypes each for total yield and marketable yield, 2 for 5 bulb weight, 4 for weight of A grade bulbs, 3 for weight of B grade bulbs, 4 for weight of C grade bulbs, 2 each in polar diameter, 3 each in TSS and firmness, 4 for neck thickness, 2 each for number of leaves

and plant height recorded superior performance. Since these superior lines are in the first cycle of selection there is a need for improvement in successive cycles for desirable attributes.

Performance of bulb to row progeny

During *rabi* 2005-06 evaluation, the performance of bulb to row population (NRCOG-1082, 1089-1LR, 1089-3 LR, 1091-5 and 1091-1) recorded superior performance to the tune of 34.5 to 77.0 t/ha of total bulb yield. 3 lines for A grade bulbs, 7 for equatorial diameter, 8 for polar diameter, 7 for neck thickness, 4 for number of leaves and 6 for plant height showed superior performance. Further, it is concluded that evaluation of bulb to row population is required in order to obtain an ideal genotype with high yield potential.

Evaluation of bulb to seed of varieties during *rabi* 2005-06

The seed production of all the varieties was severely effected by Iris Yellow Spot Virus (IYSV) disease transmitted by thrips. For the *kharif* varieties, the results indicated that, 3 lines for scape length, 5 lines for scape diameter, 7 for umbel diameter, 3 each for number of umbels per plot, number of plant per plot and number of umbels per plant showed superior performance in the respective characters. The variety B-780 (62.5 kg) showed supremacy in seed yield followed by Phule Samarth, B-780 (V) and N-53. Scape length was the maximum in B-780 (v) followed by Arka Kalyan and B-780. Umbel diameter was maximum in N-53 followed by Arka Kalyan and B-780 (v) whereas maximum number of umbels per plant was recorded in N-53 followed by Phule safed and ADR.

In case of *rabi* varieties, results revealed that 7 varieties each for scape length, scape diameter, umbel diameter, 8 each for number of umbels per plant and number of plants per plot and 6 varieties for seed yield recorded superior performance in their respective characters. However, the seed yield was severely affected due to sub optimal population and due to severe attack of Iris Yellow Spot Virus disease. The maximum seed yield was recorded in Phule Suwarna (1.0 q/ha) followed by Pusa Madhavi (0.9 q/ha) and Arka Pitamber (0.8 q/ha). The maximum scape length was in Pusa Red followed by N-2-4-1 and Agrifound Rose, whereas, the maximum scape diameter was in Pusa Madhavi followed by Pusa Red, Phule Suwarna and Phule Safed. The maximum umbel diameter was in Pusa Madhavi followed by Pusa Red and Pilipathi Junagadh.

Gene pool development

Systematic selection of desirable individuals with desirable attributes from a population followed by recombination of selected individuals to form new population has been attempted during *kharif* 2006 for developing season specific lines from the gene pool raised at Agricultural College, Pune. Accordingly the base population, cycle0 population have been raised (Fig.2). Seed production of four C1 populations is under progress for *kharif* season. Harvested bulbs of C1 population for late *kharif* season were stored for post harvest performance and the C1 population for *rabi* season is under progress.

Fig. 2

Post harvest performance

Performance of late *kharif* germplasm grown under replicated trial, after storage (120 days), showed that only two lines ie. NRCOG-531 and NRCOG-619 showed less than 20.0 % weight loss after 120 days of storage. 6 lines viz., NRCOG-544, NRCOG-551, NRCOG-576, NRCOG-610, NRCOG-625 and NRCOG-642 recorded 20.0 30.0 % weight loss after 120 days of storage. The check varieties Agrifound Dark Red and N-53 recorded more that 55.0 % weight loss, whereas, B-780 showed 46.0 % weight loss after 120 days of storage. Whereas, results of germplasm raised under augmented block design revealed that, NRCOG-131 (10.8 %) recorded minimum loss after 120 days followed by NRCOG-1073 (15.2 %), NRCOG-205 (16.1 %) and NRCOG-208 (16.9 %). On the contrary, in the check variety B-780, the yield losses ranged from 18.0 to 38.3 %.

Performance of *rabi* germplasm grown under replicated trial, after storage (150 days), revealed that none of the germplasm lines showed less than 30.0 % weight loss. However, 6 lines viz., NRCOG-465, NRCOG-460, NRCOG-568, NROCG-609, NRCOG-660 and Agrifound Light Red recorded 30.0 - 40.0 % weight loss. The popular variety N-2-4-1 registered nearly 50.0 % weight loss. The promising germplasm such as NRCOG-1000, NRCOG-1016, NRCOG-1019, NRCOG-1056, Rose Onion, Arka Niketan and NRCOG 1163 recorded more than 50.0 % weight loss after 150 days of storage. Whereas, in case of *rabi* germplasm grown under augmented block design, the check variety N-2-4-1 showed weight loss ranging from 50.0 - 72.0 % after 150 days of storage. Among the genotypes tested, NRCOG-926 (50.0 %) recorded minimum percent weight loss, followed by NRCOG-975 (55.0 %), NRCOG-1159 (56.0 %) and NRCOG-923 (57.0 %). The value of skewness was found to be very low for 60, 90, 120 and 150 days after storage, which indicated the marginal deviation of modal value for mean. The values of kurtosis for initial weight and percent weight loss after 150 days was in the low range, indicating the platycurtic curve indicating high variability in the samples taken for study.

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

Evaluation of white onion germplasm

Forty-six white onion germplasm were planted in augmented block design along with 4 white checks during late *kharif* 05-06. Days to harvest varied from 118 to 128 days after planting. 15 germplasm had significantly higher A grade bulbs, above 55.0 % than the check Phule Safed (36.2 %). 8 germplasm had no double bulbs whereas, 11 germplasm recorded less than 5.0 % doubles. Percentage bolters varied from 0.0 to 58.5 %. 25 germplasm had no bolters against check Phule Safed (5.6 %) and PKV White (19.2 %). Marketable bulbs were more than 85.0 % in 16 lines. TSS in the germplasm ranged from 8.4 to 15.5 % and 8 germplasm had TSS more than 13.0 % than the check Phule Safed (11.2 %). Marketable yield and total yield ranged from 8.2 to 46.3 and 18.9 to 51.2 t/ha, respectively. 3 germplasm lines gave significantly higher marketable yield (42.8 to 46.3 t/ha) than the check Phule Safed (36.8 t/ha).

During *rabi* 05-06, 156 white onion germplasm lines were evaluated along with 6 white check varieties. Days to maturity ranged from 92 to 112 days after planting in the germplasm as against check Phule Safed, which took 106 days. 52 germplasm matured between 92 to 100 days after

planting. 31 germplasm recorded significantly high percent A grade bulbs (ranged between 43.8 to 72.2 %) as compared with check Phule Safed (30.0 %) and GWO-1 (31.8 %). No double bulbs were recorded in 38 lines and maximum were 52.4 % in the germplasm. No bolters were recorded in 101 germplasm while it showed a maximum of up to 18.5 %. Doubles and bolters in check varieties varied from 3.2 to 14.8 % and 0.0 to 8.9 %, respectively. 77 germplasm had more than 90.0 % marketable bulbs. Total soluble solids (TSS) in germplasm were 9.4 to 14.1 % and 13 lines recorded significantly higher TSS than Phule Safed (11.3 %). Three germplasm lines had TSS above13.5 % but marketable yield was between 9.5 to 18.3 t/ha as compared with check Phule Safed (22.6 t/ha). There is scope for increasing marketable yield in two germplasm lines as total yield was 24.3 and 21.1 t/ha as compared with Phule Safed (27.4 t/ha). 8 germplasm lines attained maturity in less than 104 days after planting, marketable yield above 35.0 t/ha, double bulbs less than 2.0 % with no bolters and more than 75.0 % marketable bulbs. Out of these, two lines attained maturity in 97 and 100 days with no doubles and bolters and 100.0 % marketable bulbs. Maximum marketable yield was 50.0 t/ha and 70 lines gave significantly higher yield (28.0 to 50.0 t/ha) over check Phule Safed (22.6 t/ha).

110 white onion germplasm were evaluated during *kharif* 06 with white checks. All the germplasm were harvested at 97 days after planting. More than 25.0 % A grade bulbs were recorded in 21 lines whereas, it was only 12.3 % in Phule Safed. Marketable bulbs were more than 75.0 % in 18 lines as against Phule Safed (63.7 %). Double bulbs ranged between 0.0 to 31.5 % in the germplasm lines and 60 lines recorded no doubles. TSS was between 9.2 to 11.2 % in these lines. Marketable yield varied from 0.3 to 30.2 t/ha in the germplasm. 18 lines recorded significantly high yield of 30.2 t/ha compared to the check Phule Safed (12.2 t/ha). Total yield was maximum at 34.4 t/ha, whereas, Phule Safed yielded 19.2 t/ha.

Evaluation of white onion elite lines

Six elite lines were evaluated during late *kharif* 05-06 along with 4 white check varieties. One line was early in maturity (115 days after planting) with 49.7 t/ha marketable yield than the check Phule Safed, which took 123 days to harvest with 43.3 t/ha marketable yield. Days to maturity in these lines ranged from 115 to 128 days after planting. TSS ranged from 13.3 % to 10.4 %, whereas, it was 12.1 % in Phule Safed, 11.4 % in AFW and 11.3 % in PKV White. Percentage A grade was more than Phule Safed (55.4 %) in one of the lines (63.4 %) and minimum was 33.9 % in PKV White. Percentage doubles were minimum in check Phule Safed (6.9 %) and maximum in PKV White (25.8 %). Bolters in these lines ranged from 1.8 to 18.5 % against check Phule Safed (16.0 %), PKV White (23.6 %) and AFW (28.8 %). 4 lines had less than 8.0 % bolters. One elite line gave significantly higher marketable yield (49.7 t/ha) (Fig. 3) than Phule Safed (43.3 t/ha) and one line had total yield of 70.0 t/ha with a marketable yield of 41.6 t/ha, hence, there is scope for improvement in this line.

Fig. 3

Elite lines were selected from the germplasm on the basis of two year performance. 18 lines were evaluated with 7 white check varieties during *rabi* 05-06. Maturity ranged between 101 to 112 days

after planting, in these lines. A grade bulbs were significantly more than check Phule Safed (49.3 %) in 6 elite lines, which ranged between 59.6 % to 70.5 %. Double bulbs were less than 5.0 % in 5 lines as against Phule Safed (11.2 %) and no bolters were recorded in 8 lines. TSS varied from 10.4 to 12.0 % in these lines. Marketable yield was significantly higher in 4 lines, which ranged from 41.7 to 44.7 t/ha (Fig. 4) over check Phule Safed (37.7 t/ha). Total yield was maximum at 55.3 t/ha and 3 lines had significantly higher total yield than Phule Safed (44.7 t/ha).

Fig. 4

14 elite lines were evaluated during *kharif* 06 with white check Phule Safed and 2 red *kharif* checks. All the lines were harvested between 97 to 101 days after planting. More than 25.0 % A grade bulbs were recorded in 4 lines. Maximum A grade bulbs was up to 46.9 % as compared to the check Phule Safed (15.1 %). Doubles were less than 2.0 % in 7 entries. Percentage marketable yield was higher in these lines and more than 70.0 % marketable bulbs were recorded in 6 entries, whereas it was 65.0 % in Phule Safed. TSS ranged between 10.0 to 11.5 %. 4 Entries recorded significantly higher yield (17.5 to 20.2 t/ha) than check Phule Safed (14.3 t/ha).

Evaluation of exotic onions

Six yellow, three white and seven red exotic hybrids were evaluated during late *kharif* 05-06 along with one yellow, four white and four red checks. Days to harvest in these hybrids and check varieties ranged from 111 to 128 days after planting. Percentage A grade bulb in yellow hybrids ranged between 64.0 to 92.0 % as compared with check Phule Suwarna (57.0 %); 5.0 to 78.0 % in white hybrids as against white check, which had 35.0 to 51.0 % and 18.0 to 79.0 % in red hybrids as against red checks with 38.0 to 64.0 % of A grade bulbs. Linda Vista (92.0 %), Couger (85.0 %), Lexus (84.0 %) and Mercedes (80.0 %) recorded maximum A grade bulbs, less than 3.0 % doubles and no bolters. Marketable yield was maximum in Couger (Y) (63.6 t/ha) followed by Early Supreme White (60.8 t/ha), Lexus (Y) (60.7 t/ha), Mercedes (Y) (58.5 t/ha) and Linda Vista (Y) (55.7 t/ha) as against check B-780 (R) (50.0 t/ha), ALR (R) (30.6 t/ha), Phule Suwarna (Y) (38.0 t/ha) and JNDWO-85 (W) (37.0 t/ha). Average bulb weight in these hybrids was between 110 to 153 g per bulb.

Seven yellow exotic, one white and five red hybrids were evaluated along with one yellow, one white and four red checks during *rabi* 05-06. A grade bulbs were more than 65.0 % in Reforma, Couger, Linda Vista, Early Supreme White, Mercedes and Matahari. Days to maturity in these hybrids ranged between 96 to 108 days after planting. Marketable bulbs were more than 95.0 % in Linda Vista, Couger, Early Supreme White, Reforma, Mercedes and Lexus as against checks ALR (73.3 %), Arka Niketan (87.0 %), N-2-4-1 (92.0 %), Phule Safed (88.9 %) and Phule Suwarna (90.4 %). Marketable yield in yellow hybrids ranged between 29.0 t/ha in Liberty to a maximum of 73.8 t/ha in Reforma, which was followed by Lexus (63.8 t/ha) and Linda Vista (56.8 t/ha) over Phule Suwarna (24.7 t/ha). None of the red hybrids were significantly superior over red checks, but 5 yellow hybrids yielded significantly high yields over all the checks.

Breeding of high TSS white onion

Ratoon bulbs of selected high TSS white onion were retained after seed production and progenies were raised. TSS was recorded in these progenies and 48 massing groups were made after selecting high TSS bulbs and planted for seed production. The seeds were obtained and the progenies were raised during *rabi* 05-06 along with three checks. Out of 48 groups, seed could be produced in 37 groups only. TSS in these progenies was recorded along with bulb weight. Mean population TSS in these groups ranged between 10.0 to 20.1 %. 23 progenies had TSS more than 15.0 % and 8 progenies had more than 17.0 % TSS. 26 progenies had more than 50.0 % bulbs with TSS above 15.0 %. Average bulb weight in 11 groups ranged from 52.0 to 80.0 g with more than 15.0 % mean TSS as compared with the check recorded 60.0 to 61.0 g average bulb weight with mean TSS between 10.9 to 11.8 % only. This indicates that further purification is required and there is great scope for the development of high TSS varieties with bigger size bulbs.

White onion varieties Phule Safed and AFW were subjected to mutation treatments with colchicine, EMS, Sodium azide and gamma irradiation in various concentrations. Individual bulb to row progenies were raised on the basis of TSS in second generation but due to Iris Yellow Spot Virus, very less seed could be produced. High TSS bulbs were selected from bulb to row progenies and of the 16 progenies where seed could be produced, only 11 progenies could be evaluated. Mean TSS in these progenies was between 11.4 to 16.7 % as compared with checks (10.9 to 11.8 % TSS). HT-Mut-GR-3 (15-18) recorded maximum TSS (16.7 %) as compared with Phule Safed, which had 10.9 % TSS. More than 60.0 % bulbs had TSS above 15.0 % in these lines, which will be purified further.

Evaluation of yellow onion germplasm

17 yellow onion germplasm were evaluated during *rabi* with one yellow check Phule Suwarna. 12 lines gave significantly more A grade bulbs, which ranged between 31.1 to 57.3 % as compared with Phule Suwarna (18.3 %). No bolters were observed in 9 lines whereas in Phule Suwarna it was 6.7 %. TSS in these lines varied from 10.1 to 12.5 %. Marketable and total yield ranged between 41.9 t/ha and 42.7 t/ha, respectively. 8 lines recorded significantly higher marketable yield and 5 lines had higher total yields, which ranged between 31.6 to 41.9 t/ha and 34.9 to 42.6 t/ha, respectively than the check Phule Suwarna (26.8 and 29.1 t/ha, respectively).

Screening of onion germplasm for disease resistance

At present, no variety is known to have resistance for major diseases of onion. Screening of onion germplasm is necessary to identify any source of resistance. During late *kharif* season, 53 lines of onion including 4 checks were screened under natural condition for disease resistance. After 90 days of transplanting, plants were screened on 0-5 rating scale for foliar diseases. At the time of harvesting, plant stand was also counted.

Among the 53 lines of onion, Percent Disease Index (PDI) varied between 22-90. Commercial variety PKV White and line BSS-142 New recorded the lowest PDI of 22. The highest disease was recorded in lines W-047, W-425 and Hybrid Lucifer New with a PDI of 90. Percent plant mortality ranged from 0.0 to 43.3. No mortality was noticed in Hybrid Lucifer New and W-302 Kh EL4, while highest mortality was recorded in W-217. In this study, none of the material was found even moderately resistant. Total yield ranged from 9.9 - 59.3 t/ha. Lowest yield was recorded in W-494. ADR-NRC-3 line may be a tolerant as it gave highest yield of 59.3 t/ha in spite of 42.0 % disease index.

Post Harvest Studies 2005-06

Evaluation of white onion germplasm

79 white onion germplasm harvested in late *kharif* were studied for storage life and observations were recorded after two months of storage at monthly intervals. Less than 30.0 % losses were noticed in 75 entries after 3 months and in 55 entries after 4 months of storage. Minimum losses were 8.3 % to a maximum of 55.1 % after 4 months of storage, whereas, in checks it was 26.5 to 31.5 % total weight loss in white varieties and in red varieties also it ranged between 15.8 to 33.9 %.

228 white onion *rabi* germplasm and 11 breeding lines were stored up to 6 months and storage losses were recorded after 3 months of storage at 1.5 month interval up to October. Less than 30.0 % total weight loss were observed in 16 lines after 4.5 months, while losses in Phule Safed was 92.2 %. Minimum loss was 18.3 % followed by 22.0 % and 22.6 %, while maximum losses ranged up to 91.7 %. After 6 months of storage only one entry had loss up to 35.0 % and 4 entries had losses between 40.0 to 50.0 %. In white checks, losses were 56.4 % in Udaipur 102 and rest of the 7 entries had losses more than 90.0 %. Loss in Phule Safed was 96.0 % after 6 months of storage. In red varieties also, the losses ranged between 43.5 to 83.5 % during *rabi* 05-06.

Evaluation of white onion elite lines

6 late *kharif* elite lines were studied for storage losses. 5 lines had less than 30.0 % total weight loss after 4 months of storage. Losses in three lines ranged from 18.1 to 30.5 %, whereas in white varieties it was 26.5 to 31.5 % and in red varieties it was 11.8 to 34.9 % after 4 months of storage. This indicates that there is scope to develop white onion varieties having better storage life, which can be utilized for processing.

15 white elite lines were stored during *rabi* 05-06. Losses were less than 40.0 % in one entry (36.8 %) after 4.5 months of storage and it ranged between 36.8 to 92.2 % in these lines whereas, loss in Phule Safed was 89.7 % and in other white checks it was more than 50.0 %. Less than 50.0 % losses were noticed in 4 elite lines only. After 6 months of storage, losses were less than 65.0 % in two entries, whereas it was 94.8 % in Phule Safed and 94.7 % in Pusa White Round. In red varieties N-2-4-1 and ALR, the losses were 57.6 and 41.8 %, respectively.

Evaluation of yellow onion *rabi* germplasm lines

34 yellow onion germplasm were stored during *rabi* along with 3 red and 1 yellow check. Observations were recorded up to 4.5 months of storage. Losses less than 30.0 % were recorded in 12 lines. Least losses were observed in y-024/M (14.4 %) followed by y-078 (14.5 %) and y-032 (15.6 %). Loss in yellow check Phule Suwarna was 53.5 % and in red check it was 79.9 % in Arka Niketan, 24.4 % in N-2-4-1 and 21.7 % in ALR.

Evaluation of exotic hybrids / varieties

Yellow, white and red exotic onion / hybrids were studied for storage losses in late *kharif*. Three yellow hybrids viz. Lexus (18.4 %), Mercedes (22.9 %) and Couger (24.8 %) recorded less than 30.0 % loss after 3 months of storage whereas, there was one white and 7 red hybrids, which had less than 30.0 %

loss. In varieties, the loss after three months of storage ranged from 20.6 to 27.3 %. Thus Mercedes, Lexus and Couger had good yield potential along with better storage life during late *kharif*.

Varietal Evaluation Trial of Onion AVT-I & II under AICRP project at NRCOG during *rabi* 05-06

Out of seven entries and two checks, seeds of six entries were received for AVT-I. Seeds of Syn-3 were not received. AFLR was used as the national as well as local check. None of the entries performed superior over best check AFLR.

Four entries, along with two checks were evaluated in AVT-II during *rabi*. Percentage A grade bulbs were maximum (67.6 %) in B-780-5-2-2 which was followed by B-780-5-3-1. In best check variety (AFLR), percentage A grade bulbs was 51.8 %. Percentage doubles were lowest in B-780-5-2-2 (0.3 %), which was followed by B-780-5-3-1 (1.2 %) against the best check variety AFLR (26.4 %). Percentage marketable yields were 99.1 % and 98.0 % in B-780-5-2-2 and B-780-5-3-1, respectively, which were quite high over both the checks i.e. AFLR (73.4 %) and Arka Niketan (86.1 %). TSS was non significant, which ranged between 10.2 to 10.8 %. Entry RHR-O-S1 was earliest in maturity (98 days), which was followed by B-780-5-2-2 (100 days), which was statistically at par and significantly earlier than the best check AFLR, which matured in 109 days. Marketable yield was significantly superior in B-780-5-3-1, which yielded 390 q/ha over the best check AFLR (359 q/ha). The yields were statistically at par but higher than the best check AFLR (359 q/ha), in B-780-5-2-2 (365 q/ha), which is 9 days earlier in maturity than the check AFLR.

Onion improvement through biotechnological approaches

Micropropagation of CMS lines

For micropropagation of CMS lines, 18 different MS based media fortified with different combinations of BA / 2iP (0.5 - 2.0 mg/l) and TDZ (0.5 1.0 mg/l) alone and in combination with NAA / IAA (0.5 mg/l) were tried (OMS 4 - 21). Axenic shoot tip was used as explant for all the experiments and the sucrose concentration was maintained at 3.0 %. Two MS lines obtained from IIHR, Bangalore viz., MS 65 A & B (Fig. 5) and MS 48 A & B were used. Genotypic variation was noticed in these lines with respect to shoot multiplication. MS 65 A gave the best results amongst the four lines and maximum number of shoots (20 25) was formed in combinations of TDZ + NAA.

Fig. 5
Shoot multiplication in MS 65B

Indirect organogenesis

Three varieties viz., N-53, N-2-4-1 and AFW were subjected to indirect organogenesis in MS based media containing various combinations of 2,4-D (0.5 2.0 mg/l) + BA / TDZ / 2iP (0.25-0.5 mg/l). All the varieties were amenable to organogenesis and induced shoots. Highest number of regenerants was obtained in N-53 (35 - 40 shoots)

Fig. 6
Callus regeneration in Agrifound white

in medium containing a combination of BA + 2,4-D. This was followed by Agrifound white (Fig. 6) inducing 17 - 20 shoots and N-2-4-1 gave 3 - 7 shoots.

Somatic embryogenesis

An experiment was initiated to induce somatic embryogenesis in onion, which will help at a later stage in transformation studies. Fifteen different hormonal regimes were tried consisting of 2,4-D (0.5 2.0 mg/l) in combination with cytokinins BA / TDZ / 2iP (0.25 - 0.05 mg/l). Apart from these, another experiment with 2,4-D (1.0 3.0 mg/l) was tried alone with two gelling agents viz., agar agar and phytagel. Three varieties, N-2-4-1, N-53 and AFW were used. In all the treatments, only indirect regeneration was effected. Few combinations showed highly friable callus, which will be transferred to different media supporting somatic embryogenesis.

Induction of haploids through *in vitro* gynogenesis

During *rabi* 05-06, experiments was conducted using three genotypes (viz., N-53, N-2-4-1 and Arka Niketan) and three different media (viz., MS, B5 and N6) for the induction of haploids in onion. Two different strengths (full and half) of these media were tried along with different concentrations of sucrose (3.0 15.0 %). About 2000 buds of each variety were inoculated. However, none of the combinations showed any direct induction of plants from the ovary.

Previous experiments for *in vitro* gynogenesis resulted in the induction of a few plants from flower buds directly in var. N-53 and N-2-4-1 in combinations consisting of BA alone (N-53) and BA in combination with IAA (N-2-4-1). These plants were multiplied *in vitro* and following *in vitro* bulblet induction, were transferred to the environmentally controlled green house for bulb formation. Bulbs were harvested upon maturity (Fig. 7) and after proper curing were stored at room temperature and planted in the green house during *rabi* 06-07. Before planting, roots were isolated and fixed in Carnoy's solution for cytological analysis, which is underway. Two of the plants produced flowers. Meiotic studies will be initiated to ascertain the ploidy level apart from mitotic studies.

Fig. 7
Bulbil formed from gynogenic plant
Inset - Plant arising directly from the ovary

Induction of haploids through parthenogenesi

For induction of haploids, a field experiment was formulated, where foreign pollen (viz., maize and parthenium) and dead pollen of the same female onion parent were dusted on onion varieties N-2-4-1 and N-53, having two replications each. Few seeds were obtained in all the combinations tried. These were sown during *rabi* 06-07 and the population is in the field. The whole population will be evaluated for its ploidy level.

DNA profiling of onion varieties as well as advanced lines

DNA was isolated from 18 onion varieties and four advanced lines using CTAB method, quantified using λ DNA and used for RAPD profiling along with two garlic varieties (as out groups). 56 Operon

primers were initially screened, of which 40 were found to give polymorphism and hence used for further profiling studies. Among the selected primers, twenty-four has been completed. Scorable bands were obtained with 12 primers. Further work is in progress. Preliminary results showed that variation is less in onion and hence after completing RAPD profiling, other techniques viz., ISSRs will be attempted.

Garlic improvement through conventional and biotechnological approaches

Evaluation of white and red garlic germplasm during *rabi* 05-06

118 white garlic germplasm were evaluated along with 6 checks. Average bulb weight was 24.2 g in line NRCGW-114 followed by 23.5 g in NRCGW-5 as against G-41, which had 20.2 g /bulb. Weight of 50 cloves was more than 50.0 g in 5 entries, whereas, it was 47.5 g in G-323 and 45.0 g in G-41. Total yield after one month of curing and without foliage ranged from 0.3 to 9.9 t/ha. 3 lines recorded higher yield (9.4 to 9.9 t/ha) than the check G-41 (7.6 t/ha).

110 red garlic germplasm was evaluated along with one red check during *rabi* 05-06 in RBD with 2 replications. Average bulb weight was maximum at 20.7 g followed by 19.8 g and 18.9 g as compared to Godavari (16.1 g). Weight of 50 cloves was more than 50 g in 6 lines (51.3 to 61.5 g), as against red check Godavari (41.7 g). Total yield after curing and without foliage ranged from 2.1 to 10.7 t/ha. 3 entries recorded significantly higher yield of 10.8, 10.5 and 10.4 t/ha, respectively over check Godavari (7.5 t/ha).

Evaluation of garlic germplasm received from NBPGR and Dehradun during *rabi* 05-06

40 IC collections submitted by NBPGR were evaluated in 2 replications in RBD. The crop was harvested after 103 days of planting. Average bulb weight was maximum in G-41 (17.9 g) whereas, in the other lines, it ranged between 3.7 to 12.5 g. Total yields was also less than the checks G-41 (5.7 t/ha) and G-1 (4.4 t/ha) in these lines. Similarly 144 lines were also received from NBPGR and Dehradun, but the quantity of bulbs were less and hence planted in augmented block design during *rabi* 05-06. Average bulb weight was 19.5 g in DRG-78 followed by NBG-77 (19.2 g) and NBG-28 (17.8 g) as compared with the check G-41 (15.8 g). More than 50.0 g weight of 50 cloves was observed in 7 lines. Total yield after curing was maximum at 6.4 t/ha, which was followed by 6.4 t/ha as against G-41 (5.9 t/ha). None of the entries were significantly superior over G-41, may be due to specific climatic requirement.

Evaluation of garlic bulb to row progenies during *rabi* 05-06

114 garlic bulb to row progenies were selected and planted in augmented block design for evaluation. Days to maturity ranged between 115 to 125 days after planting. 24 lines came to maturity in less than 120 days after planting. Average bulb weight varied from 6.4 to 27.0 g. More than 20.0 g bulbs were recorded in 25 entries over check G-41 (15.2 g). Weight of 50 cloves was more than 50.0 g in 37 lines as compared to G-41 (40.4 g). Yield after one month of curing and without leaves was maximum in line SSG-23 (15.5 t/ha), which was followed by SSG-7 (11.5 t/ha) and BR-37 (11.3 t/ha). More than 10 t/ha yield was recorded in 7 lines and 3 lines gave significantly higher yield than check G-41 (5.6 t/ha)

Evaluation of garlic elite lines during *rabi* 05-06

11 garlic elite lines with 4 checks were evaluated during *rabi* 05-06 in 3 replications in RBD. Average bulb weight was maximum in AC-200 (23.7 g) followed by AC-183 with 22.9 g over check G-41, which had 20.6 g. Number of cloves per bulb were less in AC-200 (18.1 / bulb) while in other lines it was more than G-41 (20.3 / bulb). Weight of 50 cloves was maximum in AC-38 (57.6 g). TSS in these lines ranged from 38.8 to 43.2 %. Total yield was recorded after curing for one month without leaves. 4 lines had significantly higher total yields of 8.0 to 8.7 t/ha over check G-41 (7.9 t/ha).

Evaluation of garlic mutated progenies derived from colchicine, EMS and SA treatments during *rabi* 05-06 in M-4 generation

95 garlic bulb to row progenies from colchicine treatments in variety G-41 were evaluated. Days to maturity varied from 126 day to 132 days after planting as compared to G-41 (130.8 days) and AC-200 (129.5 days after planting). 14 progenies had significantly higher bulb weight of 12.0 to 13.9 g than G-41, which had 9.3 g and 46 progenies had 10.9 to 13.9 g average bulb weight above AC-200 (8.2 g). Total yield without foliage after curing ranged between 8.1 t/ha to 3.8 t/ha in these progenies. Significantly higher yields were recorded in 13 progenies (7.3 to 8.1 t/ha) over G-41 (5.5 t/ha). Out of 85 bulb to row progenies obtained from sodium azide treatments, significantly higher bulb weight (more than 12.3 g) than check G-41 was recorded in 3 progenies. Total yield after curing and without foliage was maximum at 8.0 t/ha, whereas in G-41 it was 6.0 t/ha. 3 progenies gave significantly higher yield than check, whereas, 50 progenies had significantly higher yields than AC-200. 27 garlic bulb to row progenies obtained from EMS treatments were evaluated and maximum bulb weight was 12.5 g, recorded in the progenies as compared with checks G-41 (9.4 g) and AC-200 (8.7 g). Total yield was significantly higher in 2 progenies (6.7 to 7.2 t/ha) as compared with checks G-41 (5.4 t/ha) and AC-200 (4.4 t/ha).

Varietal Evaluation Trial Garlic AVT-II under AICRP Project at NRCOG

In garlic, 5 entries along with two checks were evaluated during *rabi* 05-06 season. Marketable yield was significantly highest in AC-200 (9. 6 t/ha) which was statistically at par with RAUG-5 which yielded 9.4 t/ha as compared with the best check G-282 (7.2 t/ha). Average weight of bulb and weight of 50 cloves were also high in AC-200 and RAUG-5. Percentage A grade of bulbs were high in RAUG-5 (70.1 %) which was followed by AC-200 (62.0 %). There was not much difference in number of cloves per bulb, which ranged from 21.9 to 24.7 cloves / bulb.

Garlic biotechnology

Somatic embryogenesis

2,4-D raised calluses of five garlic varieties, G-41, G-282, G-323, AC50 and AC 200 were transferred to pre-maturation medium consisting of IAA and TDZ for embryogenic development, both in solid as well as liquid medium. The liquid medium was kept in an orbital shaker to study the effect of rotational speed on the development of embryoids. Two rotation speeds of 100 and 120 rpm were tried. However, calli incubated in neither the solid medium nor the liquid medium formed any embryoids. Rhizogenesis occurred in many cases. A few replications showed regeneration of 5-6 shoots followed by *in vitro* bulblet induction.

Another experiment was planned with Godavari and Acc. No. 38 with different concentrations of 2,4-D (1.0 3.0 mg/l) in two solidifying agents (agar and phytagel). Preliminary results showed embryogenesis and plantlet formation along with callus regeneration in Acc. No. 38 (Fig. 8) in one combination of 2,4-D along with phytagel, after transfer to agar medium. In similar conditions, Godavari showed only regeneration.

Fig. 8
Bi-polar structure formed from callus of garlic Acc. 38

Meristem tip culture

Garlic, being vegetatively propagated, is a storehouse of different viruses. Meristem tip culture is a method whereby virus free cultures can be raised. Three different varieties, G-41, G-282 and G-323 were used for the experiment. Meristem tip were isolated from cloves germinated *in vitro* (after 1 month) and were inoculated into culture initiation / multiplication media consisting of various combinations of TDZ (0.1 1.0 mg/l) and NAA (0.05 - 0.15 mg/l) alone and combinations of the same. Another multiplication media having combination of 2iP (0.1 1.0 mg/l) + NAA (0.05 - 0.15 mg/l) was also studied. All the varieties studied initiated multiple shoots (Fig. 9) from meristem tip. The shoots formed were subjected to *in vitro* bulblet induction and these are stored for further ELISA studies.

Fig.9
Multiple shoots include from meristem tip. Inset-Meristem tip explant

Network project on Wild species in *Alliums*

Collection and maintenance of wild species

One *Allium* species, *A. angulosum,* from Slovakia was obtained via NBPGR, New Delhi. Few seeds were planted in the environmentally controlled green house and the other half was sent to NBPGR RS, Shimla for further multiplication

Planting of interspecific hybrids in *rabi* for evaluation

Out of 20 onion lines, including varieties and elite lines crossed with *Allium fistulosum* (TA 106), 15 hybrid seed could be obtained. These were planted in *rabi* 06-07 for further evaluation.

Onion and garlic production technology

Studies on combined effect of organic manures and water-soluble fertilizers on growth, yield and quality of onion and garlic

The importance of organic manure has been well recognized in the cultivation of vegetable crops long back. Organic manures play a vital role in maintaining the soil fertility and also improve the yield and quality of the vegetable produce. Combined application of organic manures and fertilizers can help in improving the nutrient uptake and mitigate the losses of plant nutrients when applied to the soil.

In recent years, greater importance has been given to increase the efficiency of irrigation water and nutrients. In drip system, water and nutrients are supplied at the root zone of the crop with the help of emitters and a network of pipes, which ensures supply of water and other nutrients at the right time in the right / required quantity at the root zone. Keeping in view this fact and to maximize the fertilizer use efficiency, drip fertigation experiment was started to find out optimum nutrient requirement of onion and garlic through drip fertigation combined with different organic manures and biofertilizers.

The results revealed that combined application of different organic manures (farmyard manure, poultry manure and vermicompost) along with split application of N through drip fertigation recorded higher plant growth and number of leaves in onion and garlic. However, there was no significant difference in main plot, subplot and their interactions.

The highest marketable bulb yield (55.2 t/ha) was noticed in M1 S4 treatment (NPK 50:50:80 kg/ha as basal + 100 kg N in seven splits through drip irrigation + combined application of FYM (7.0 t/ha) + poultry manure (3.0 t/ha) + vermicompost (3.0 t/ha) along with biofertilizers). In case of garlic, M1 S2 (NPK 50:50:80 kg/ha as basal + 50 kg N in seven splits through drip irrigation + poultry manure @ 10.0 t/ha) noticed higher marketable bulb yield of 14.1 t/ha. Significant difference was noticed only in subplot treatments (between different organic manures). However, there was no significant difference in main plot and main plot x sub plot interactions. Likewise, there was no significant effects on yield contributing characters like percentage of A, B and C grade bulbs, equatorial and polar diameter of bulbs in both crops.

The increased bulb yield in onion and garlic was mostly due to the favorable effect of combined application of various organic manures along with split application of N at the right time in the required quantity during the entire growth period. The highest B: C ratio of 2.51 in onion and 2.66

in garlic were noticed in M1 S6 (foliar application of polyfeed + micronutrients + multi K at 30, 45 and 60 days after planting).

With regards to storage life, there was significant effect in total losses in four month stored onion bulbs, under well-ventilated ambient storage conditions. The maximum storage losses (50.2 %) were noticed in M1 S5 (NPK 50:50:80 kg/ha as basal + 100 kg N in seven splits through drip irrigation + without organic manures) and minimum (44.7 %) was observed in M2 S4 (80.0 % of recommended dose of fertilizers in the form of water soluble fertilizer through drip irrigation + combined application of FYM + poultry manure + vermicompost). In case of garlic, the minimum physiological loss of weight (17.3 %) was noticed in M2 S2 (80.0 % of recommended dose of fertilizers in the form of water soluble fertilizer through drip irrigation + poultry manure @10 t/ha).

Studies on garlic based cropping sequences

Studies on sequential cropping of well-delineated agro ecological zone would help for optimization of nutrient inputs thereby minimizing the external inputs. In recent years, soil fertility - fertilizer use research is focused on cropping sequences. Due to escalated chemical fertilizer production cost, impaired quality of produce, degraded soil and polluted surroundings necessitated the practice of cropping systems for vegetable production in recent years. So far, there is no prominent cropping system for garlic. Garlic is a short duration spicy vegetable crop commercially grown in India. The productivity of garlic could be increased through improved agronomic practice especially through different cropping pattern. Garlic based cropping system is to grow two or more crops in a sequential way in a year from the same piece of land. However, the available information on similar aspects in garlic is very meager. Hence, an experiment was conducted in garlic at NRCOG, Rajgurunagar to study the garlic based cropping systems to get higher yield and net profit per unit area per unit time.

The present investigation was carried out during *kharif*, *rabi* and summer seasons to find out the most economically viable, environmentally suitable and socially acceptable garlic based cropping systems under Western Maharashtra conditions. The selected cropping systems were soybean-garlic, groundnut-garlic, potato-garlic, pea-garlic, mung bean-garlic, bajra-garlic, cucumber-garlic along with traditional cropping systems like bajra (summer)-garlic and groundnut (summer)-garlic.

The yield of garlic crop harvested during the *rabi* 05-06 was good compared to last year. Among the sequences evaluated, higher marketable bulb yield (11.2 t/ha) was noticed in soybean-garlic sequences (Table 1). No significant difference was noticed between treatments. Based on the results, it was found that the highest B: C ratio (3.42) was noticed in groundnut (summer)-garlic *(rabi)* followed by soybean in *kharif* season and garlic in *rabi* season (3.09).

Apart from yield and B: C ratio, there was slight improvement in physical and chemical properties of soil in the legume based cropping sequences, particularly available N content of the soil. It is a well-known fact that cultivation of legumes increases the available N content in soil. The increased available N showed that biological N fixation by the root nodules of soybean / groundnut by microbial decomposition and mineralization was taking place. This would have helped the slow and sustained release of N and enhanced availability of nutrients in the soil, which promoted the vegetative and reproductive phase of garlic. The results of soil chemical properties revealed that there was an improvement in organic carbon, organic matter, soil available N, P and K content of the soil in legume based cropping systems like soybean followed by garlic and groundnut (summer) followed by garlic *(rabi)*, than other sequences evaluated.

Table 1: Bulb yield of garlic over last three years

Cropping Sequences	Crops	03-04 (t/ha)	04-05 (t/ha)	05-06 (t/ha)	Mean (t/ha)
S1	Bajra (K) – Garlic (R)	5.6	5.4	10.9	7.3
S2	Potato (K) - Garlic (R)	6.1	4.5	8.3	6.5
S3	Mungbean(K) - Garlic (R)	6.6	4.8	10.1	7.2
S4	Soybean (K) - Garlic (R)	6.4	3.8	11.2	7.1
S5	Groundnut (K) - Garlic (R)	6.3	3.4	9.1	6.3
S6	Cucumber (S) - Garlic (R)	6.3	4.7	8.5	6.5
S7	Bajra (S) - Garlic (R)	5.5	4.7	7.7	6.0
S8	Groundnut (S) - Garlic (R)	5.5	4.9	10.6	7.0
S9	Pea (K) - Garlic (R)	5.5	7.8	8.9	7.4

K – *kharif* R – *rabi* S – summer

Mulching studies in onion and garlic bulb crops

Mulching is one of the important practices in weed control method followed in most of the commercial vegetable crops. It is very efficient, socially acceptable and eco friendly in nature. Information on this aspect with respect to onion and garlic bulb production is very meager. Mulches can either be organic or inorganic. It reduces the weed population in crop field, conserves the soil moisture, protects the soil from erosion, maintain the soil temperature and also increases the crop yield. Keeping in view these facts, a new experiment was conducted in onion bulb crop to study the effect of different mulching materials on growth, yield and weed control. In this experiment, the organic mulches included paddy straw, soybean husk, bajra husk and saw dust and in organic mulches, transparent polythene, black polythene and bicolor polythene sheets were used. The variety used for this experiment was N-2-4-1 in onion and G-41 in garlic and recommended cultural practices were followed uniformly for all treatments. The field was irrigated by drip method.

Among the mulches applied, it was observed that organic mulch - paddy straw (43.3 t/ha) was found to be superior in terms of higher marketable bulb yield than other synthetic mulches tried and control. The highest weed control efficiency was noticed in black colour polythene mulch (90.4 %). This may be due to penetration of more sunlight and the increase in soil temperature of black polythene mulch applied plots. In case of garlic, it was observed that saw dust (12.3 t/ha) was found to be superior in terms of higher marketable bulb yield and the highest weed control efficiency (87.0 %) was noticed in black colour mulch treatment.

Comparison of irrigation systems in onion

Different irrigation systems viz., drip, big sprinkler, mini sprinkler and surface were used to test their efficacy in onion during *rabi* 05-06. The results revealed that the drip irrigation method produced

significantly higher yield than other methods. The yield in other treatments viz., surface, big sprinkler and mini sprinkler was statistically similar. The percentage of bigger bulbs (>60mm diameter) and medium sized bulbs were higher in drip irrigation, while percentage of small bulbs (35 to 50 mm diameter bulbs) was higher in mini sprinkler irrigation and surface irrigation. There was no statistical difference in doubles and bolters in the different irrigation systems studied. The percentage of rotted bulbs was higher in sprinkler irrigation systems. As far as the diameter and neck thickness of bulbs and total soluble solids are concerned, there was no difference among the various systems except polar diameter, which was highest in drip irrigation system (Fig 10).

The amount of water applied during the crop period was highest in surface irrigation (84.0 ha cm^{-1}) while lowest water was required in drip irrigation system (57.9 ha cm^{-1}). There was around 30.0 % water saving in drip irrigation system as compared to surface system (Fig 11).

Storage losses

The onion produced under different treatments was kept for storage studies. It was found that the highest losses were recorded in big sprinkler after 3 months and 6 months of storage. The rotting and sprouting losses were highest sprinkler. The lowest losses were found in onion produced in drip irrigation and surface irrigation (Fig. 12).

Fig. 10

Comparison of irrigation methods in onion

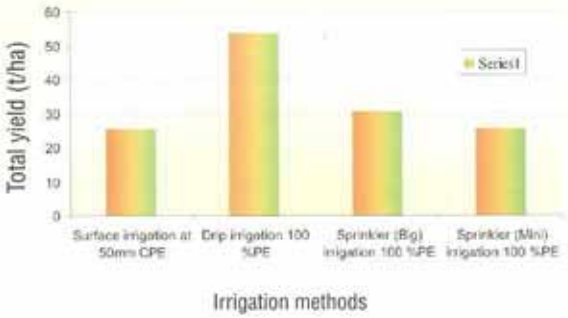


Fig.11

Percent water saving in different irrigation systems

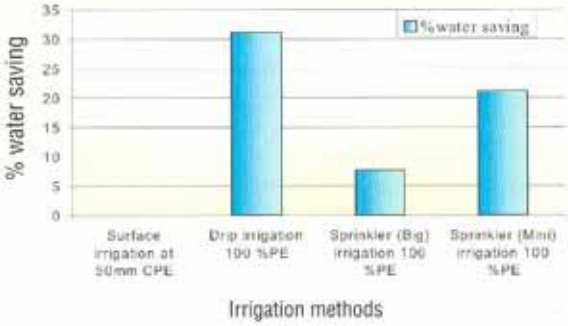
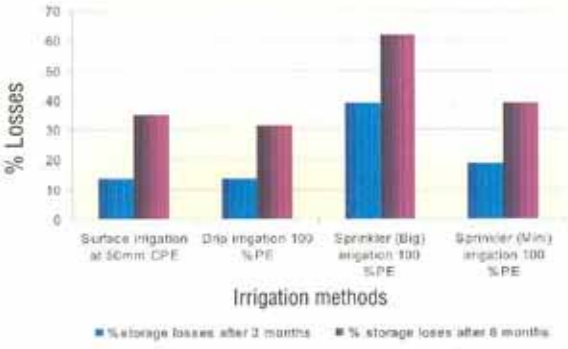


Fig 12:

Effect of irrigation methods on storage losses in onion



Effect of direct sowing on growth and yield of onion

Onion seed was sown in lines at 15 cm distance in the field during June using different methods such as manual sowing and Pune drill. These were compared with the onion transplanted on BBF and flat beds. The direct sown onion took lesser duration than the combined duration of nursery and transplanted crop. The final stand was higher in transplanted crop and seed sown manually than other methods. The highest yield was recorded in onion crop transplanted on broad based furrow with drip irrigation than all other treatments. The percentage of A grade bulbs and equatorial diameter of bulbs was higher in this treatment. The seed germination and seedling growth in direct sown crop were heavily damaged by heavy rain, which subsequently affected the crop yield.

Organic cultivation trial in onion

Effect of preceding crops and fertilizers on the growth and yield of late *kharif* (05-06) onion

Onion cv. Baswant 780 was planted under two preceding crops i.e. mung bean and french bean and four fertilizer / manure combinations in October 05. The results revealed that there was no difference in plant height and number of leaves among crop sequences and manure / fertilizer treatments. As far as yield was concerned, the total yield and marketable yield was significantly higher in recommended practices, which was 39.0 t/ha and 36.0 t/ha, respectively. Almost 35.0 to 40.0 % lesser yield was recorded in organic treatments. Among the organic treatments, highest yield was recorded in poultry manure and farmyard manure combination followed by poultry manure, which were 26.9 and 26.7 t/ha, respectively. Overall, the yield of onion was almost 10.0 t higher in all treatments over the previous year, which was mainly due to use of the effective bio pesticides for the control of thrips. The percentage of A grade (>60 mm size) bulbs were higher in recommended practices while the percentage of B grade and C grade bulbs were higher in organic treatments. The equatorial diameter of bulbs was higher in recommended practice treatment while polar diameter and neck thickness was similar in all treatments (Fig. 13).

Fig 13
Effect of fertilizers/ manures on yield of onion

Effect of preceding crops and fertilizers on storage losses of late *kharif* onion

The onion produced in various cropping sequences and manure treatments was stored from February to June 06 to study the various types of storage losses. It was revealed that total storage losses were statistically similar in all treatment combinations and preceding crops. The weight loss (PLW), rotting, sprouting and black mould infection was similar in all treatments.

Effect of preceding crops and fertilizers on growth and yield of *rabi* onion

Onion cv. N-2-4-1 was planted under two preceding crops i.e. bajra and soybean and four fertilizer / manure combinations in December 05. The results revealed that there was no difference in plant height and number of leaves among the different crop sequences and manure / fertilizer treatments. As far as yield was concerned, the total yield and marketable yield was significantly higher in recommended practices, which was 23.6 t/ha and 23.1 t/ha respectively. Almost 25.0 to 40.0 % lesser yield was recorded in organic treatments. Among the organic treatments highest yield was recorded in poultry manure followed by poultry manure and farmyard manure combination, which was 19.3 and 18.1 t/ha respectively. Overall, the yield of *rabi* onion was almost half of late *kharif* onion in all treatments. The percentage of A grade (>60 mm size) bulbs were higher in recommended practices while the percentage of B grade and C grade bulbs were higher in organic treatments. The equatorial diameter of bulbs was higher in recommended practice treatment while polar diameter and neck thickness was similar in all treatments (Fig. 13).

Effect of preceding crops and fertilizers on storage losses of *rabi* onion

The onion produced in various cropping sequences and manure treatments was stored from May to October 06 to study various types of storage losses. It was found that there was no significant difference in total storage losses among the various treatment combinations after 3 and 5 months of storage. The weight loss (PLW), sprouting and black mould infection was similar in all the treatments, but rotting was significantly higher in all organic manures treatments than recommended dose of fertilizer treatment after 5 months of storage.

Yield of preceding crops in *kharif* 2006

The preceding crops i.e. green gram, french bean, pearl millet, soybean were sown in *kharif* season 06 in the organic cultivation trial in garlic. The green gram cv. ML-818, french bean cv. Varun, pearl millet (bajra) cv. Ankur-2226 and soybean cv. MACS-450 were used for the experiment. The green gram, french bean and pearl millet crops were completely damaged by heavy rains. In case of soybean, higher yield (19.9 q/ha) was recorded in recommended fertilizer treatment. This was followed by application of poultry manure (19.9 q/ha). Overall, the yield levels of all the crops were almost similar to previous year.

Effect of preceding crops and manures on nutrient status of soil

The phosphorus and potassium content in soil samples of different treatments was analyzed and it was found that the phosphorus content was higher in recommended dose of fertilizer treatment, which was 11.4 kg/ha. There was no significant difference among the various preceding crops. As far as potassium content is concerned, it was statistically similar in all treatment combinations. There was no difference in the phosphorus and potassium content of soil samples collected after harvesting of preceding crops.

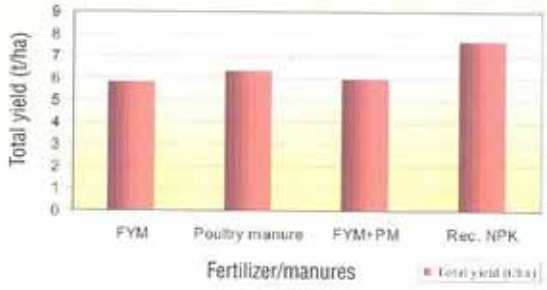
Organic cultivation trial in garlic

Effect of preceding crop and fertilizers on growth and yield of garlic (*rabi* 2005-06)

Garlic cv. G-41 was planted under four preceding crops i.e. mung bean, french bean, bajra and

soybean and four fertilizer / manure combinations in October 05. The results reveal that the cropping sequences and the fertilizer / manure treatment did not show any statistical difference for height and number of leaves per plant. The bulb yield was significantly higher (7.7 t/ha) in recommended practices than organic treatment combinations. All the organic treatments were statistically similar for yield, but slightly higher yield (6.3 t/ha) was recorded in poultry manure treatment. As for as the effect of preceding crops is concerned, higher yield (7.3 t/ha) was found in case of garlic planted after soybean. The percentage of A grade bulbs was higher in recommended practice than FYM treatment, while it was at par with remaining treatments (Fig. 14).

Fig 14:
Effect of fertilizers/manures on yield of garlic



Effect of preceding crop and fertilizers on chemical composition of garlic

The garlic produced in various preceding crops and manure treatments was analysed for various chemical parameters such as TSS, dry weight, pyruvic acid and total sugar. But there was no significant difference in these parameters with respect to preceding crops or manure treatments.

Effect of preceding crop and fertilizers on storage losses of garlic

The garlic produced in various preceding crops and manure treatments was kept for storage studies for 6 months with intact leaves under ambient conditions. It was found that there was no significant difference among various treatments with respect to storage losses from first months to the sixth.

Yield of preceding crops during *kharif* 2006

The preceding crops i.e. green gram, french bean, pearl millet, soybean were sown in *kharif* season in various organic manures and recommended practices treatments. The green gram cv. ML-818, french bean cv. Varun, pearl millet (bajra) cv. Ankur 2226 and soybean cv. MACs-450 were used for the experiment. The green gram, french bean and pearl millet crops were completely damaged by heavy rains. In case of soybean, higher yield (21.6 q/ha) was recorded in recommended dose of fertilizer treatment. This was followed by application of farmyard manure treatment (19.4 q/ha).

Effect of preceding crops and manures on nutrient status of soil

The phosphorus and potassium content in soil samples of different treatments of organic cultivation trial in garlic was analyzed and it was found that the phosphorus content was higher in recommended dose of fertilizer treatment, which was 1.0 kg/ha. The higher level of phosphorus was found where bajra was preceding crop. As far as potassium content was concerned, it was statistically similar in all treatment combinations. There was no difference in the phosphorus and potassium content of soil samples collected after harvesting of preceding crops.

Integrated nutrient management and uptake studies in onion and garlic

Onion

Effect of INM modules and preceding crops on total and marketable yield of onion

The effect of preceding crops was significant on both marketable yield and total yield of onion bulbs (Fig. 15). Growing onion after soybean produced 2.6 t more marketable bulbs than after bajra. Similarly, a difference of 2.9 t was noticed in total bulb yield due to soybean over bajra as preceding crop. Among the modules, the highest marketable yield of 35.9 t/ha was recorded due to application of 150 N: 50 P: 50 K + 30 S + 30 K. Application of FYM or poultry manure @ 10 t/ha along with 75 N: 25 P: 25 K (i.e. modules M4 or M5)(Fig. 16) produced at par bulb yields in comparison with M2 (150 N: 50 P: 50 K).

Fig.15

Performance of INM modules in 2 preceding crops

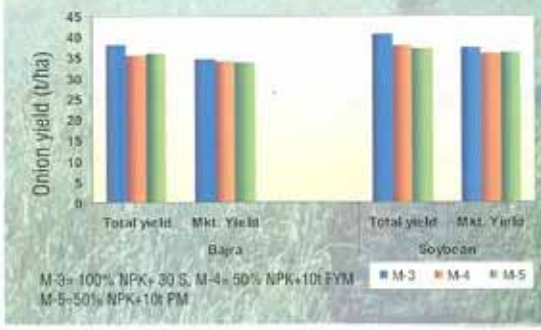


Fig.16

Influence of INM modules and preceding crops on storage losses of bulbs and their nutrient contents

Preceding crops did not significantly influence in reducing the loss of stored bulbs. However, INM modules M3, M4 and M5 had pronounced effect in bringing down the losses of stored onion (for a period of 5 months). Significant minimum losses were recorded in M1, absolute control.

The concentrations of N, P, K and S in bulbs play a major role in their shelf life. The concentration of nitrogen in onion bulbs was same in the INM modules M3, M4 and M5. The concentration of P was highest in M6 module, which had received only organic manures and bio-fertilizers. The potassium content and sulphur was high in M3, M4 and M5 modules.

Influence of INM modules and preceding crops on soil fertility parameters

The organic carbon content in soil after the harvest of onion crop was shown to improve in the modules which had received organic manures. The highest of 4.7 g/kg soil was noticed in M6 module, wherein only manures and bio-fertilizers was the source of nutrients. Oxidizable organic carbon was improved in the whole block where soybean was preceding crop prior to onion

The soil fertility after the harvest of onion was improved with respect to available N, P, K and S which was more profound in INM Modules receiving organic manures. The effect was more pronounced in the block where soybean was the preceding crop prior to onion.

The status of micronutrients namely, iron and copper was improved due to organic manure addition in the INM modules M4, M5 and M6. However, the concentration of manganese and copper was not improved. Soybean as preceding crop improved the availability of DTPA extractable iron and copper.

Soil health after the harvest of onion

Soil enzyme activity

The phosphatase activity was highest in the INM module M6, which had received organic manures and bio-fertilizers (N and P), when compared to M4 and M5 modules, which had received manures along with reduced fertilizer doses. However, the phosphatase activity was substantially high in soybean block.

Dehydrogenase activity represents overall soil micro-floral proliferation and it represents the index of soil fertility or soil health. The results showed that dehydrogenase activity was more in soybean block than in bajra. Highest activity was noticed in M5 module (receiving poultry manure @10 t /ha along with 75:25:25 kg NPK/ha).

Garlic

Effect of INM modules and preceding crops on total yield of garlic and storage losses

The effect of preceding crops was significant on total yield of garlic bulbs. Growing garlic after soybean had produced 2.0 t more garlic bulbs than after bajra. Among the modules, the highest yield of 13.2 t/ha was recorded due to application of 150 N: 50 P: 50 K + 45 S + 30 K. Application of FYM or poultry manure @ 10 t/ha along with 75 N: 25 P: 25 K (i.e. modules M4 or M5) produced at par bulb yields in comparison with M2 (150 N: 50 P: 50 K).

Effect of preceding crops was significant in reducing losses of stored garlic. However, INM modules M3, M4 and M5 had pronounced effect in bringing down the losses of stored garlic over a period of 5 months. The significant minimum losses were recorded in M6, which had received only manures and bio-fertilizers. Interaction effect due to soybean as preceding crop and INM module M6 had shown significantly minimum losses (20.0 %).

Influence of INM modules and preceding crops on major and micro nutrient content of garlic bulbs

Major nutrient content

The concentrations of N, P, K and S in bulbs play a major role in their shelf life. The concentration of nitrogen in garlic bulbs was high in M5 module which had received PM @ 10t + 50 % RDF. The concentration of P was highest in M6 module, which had received only organic manures and bio-fertilizers. The potassium and sulphur contents were high in M3, M4 and M5 modules.

Micronutrient content

In garlic, except copper, all other micronutrient concentrations in bulbs were significantly improved when grown after soybean as preceding crop compared to bajra. All the INM modules receiving organic manures produced bulbs with high amounts of micronutrients. However, module M3 though it received balanced (NPKS) nutrients, the respective micronutrient contents in the bulb was low when compared to INM modules, which had received organic manures.

Soil fertility evaluation

Organic carbon, major and micronutrients (N, P, K, S, Zn, Cu)

The organic carbon content in soil after the harvest of garlic crop was shown to improve in all the modules, which had received organic manures. The highest of 4.5 g/kg soil was noticed in M6 module, wherein only manures and bio-fertilizers were the source of nutrient input. Oxidizable organic carbon was improved in the block where soybean was the preceding crop prior to onion.

The soil fertility after the harvest of garlic was improved with respect to available N, P, K and sulphur was more profound in INM Modules receiving organic manures. The effect was more pronounced in the block when soybean was grown before garlic.

Micronutrient status viz., iron, manganese, zinc and copper were improved due to addition of organic manure in the INM modules M4, M5 and M6. Similarly, soybean as preceding crop improved all the four DTPA extractable micronutrients.

Soil health

Assay of soil enzymes after the harvest of garlic crop

After garlic crop, the highest urease activity was reflected in soybean block. The entire INM modules that had received urea as nitrogen showed pronounced urease activity.

The alkaline phosphatase activity was highest in the INM module M6, which had received organic manures and bio-fertilizers (N and P), when compared to M4 and M5 modules. Substantially high phosphatase activity was recorded in soybean block.

Dehydrogenase activity represents overall soil microbial proliferation and it defines soil health. The overall dehydrogenase activity was more in soybean block than in bajra. Highest activity was noticed in M6 module [receiving poultry manure and FYM each @10 t /ha + bio-fertilizers (Azospirillum and phosphate solubilizing bacteria) @ 4 kg/ha].

Nutrient uptake study in onion

To know the nutrient uptake pattern at different growth stages in onion, a field experiment was conducted during *rabi* 05-06. Different nitrogen levels were tried keeping phosphorus and potassium levels constant. Four treatments have been considered for the results and discussion, which are relevant to the above study in onion.

Dry matter production of onion tops and bulbs

The highest dry matter yield of onion tops was recorded at 75 DAT.

Fig. 17: Dry matter yield of onion tops

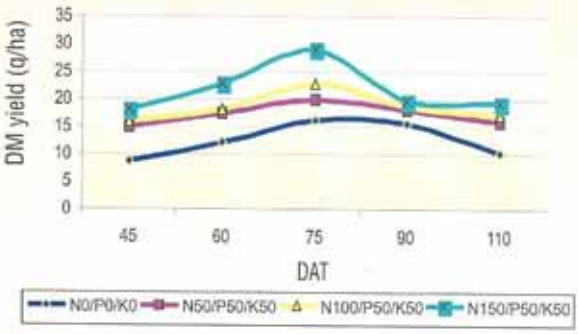
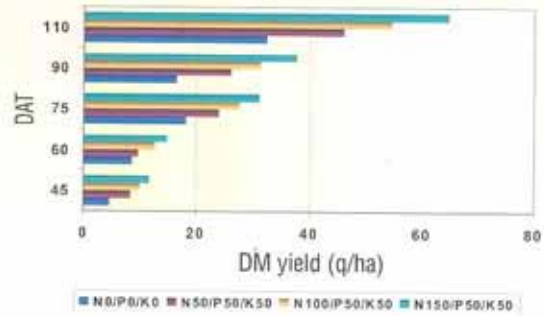


Fig. 18: Dry matter yield of onion bulbs



Dry matter yield of onion bulbs

The highest dry matter yield of onion bulbs was noticed at 110 DAT

Nitrogen content and its uptake at different growth stages in onion

Nitrogen in onion tops

Percent N content in tops increased with growth period up to 60 days

In control, it increased up to 75 days

Fig. 19: Nitrogen content in onion tops

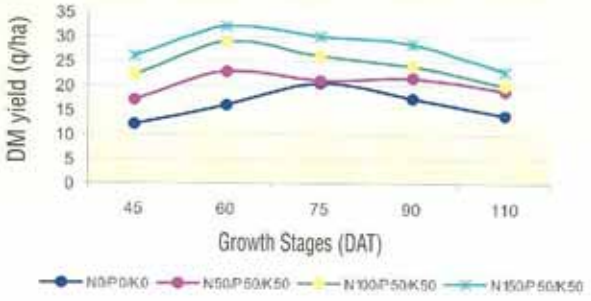
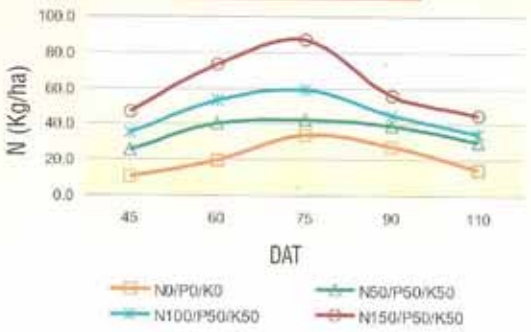


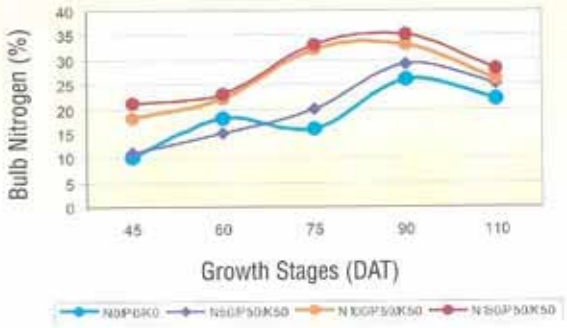
Fig. 20: N uptake in tops



The highest nutrient removal was noticed at 75-day growth stage

Nitrogen in onion bulbs

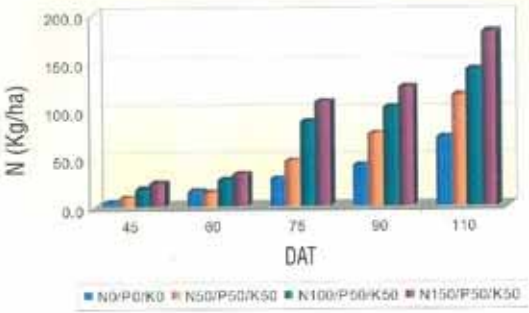
Fig. 21: Nitrogen content in Onion bulbs



The N level gradually increased till 60 days and was highest at 90 days

Fig. 22: N uptake in bulbs

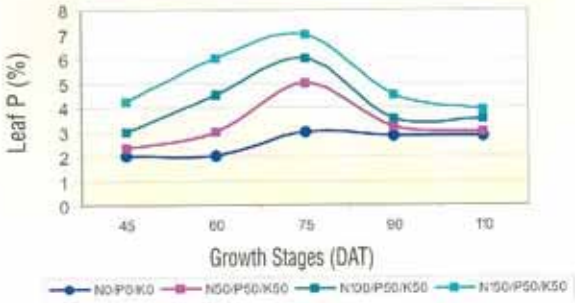
The N uptake in bulbs was increased after 60 days and achieved the highest at 110 days



Phosphorus content and its uptake at different growth stages in onion

Phosphorus in onion tops

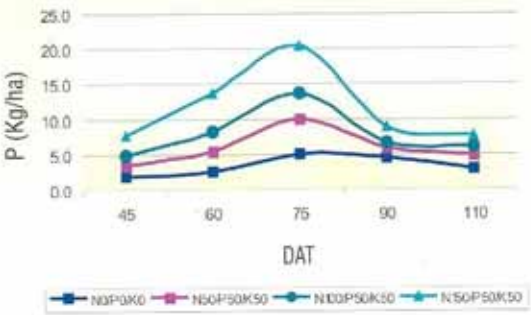
Fig. 23: Phosphorus content in onion tops



P uptake in tops remained highest at 75-day growth stage

Fig. 24: P uptake in tops

P uptake in tops remained highest at 75-day growth stage



Phosphorus in onion bulbs

P level is high at 60 day growth, then dropped, might be due to dilution as BDM increased

Fig. 25: Phosphorus content in onion bulbs

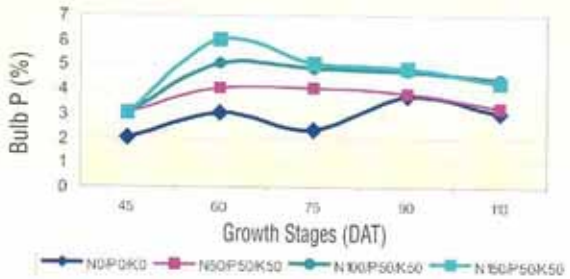
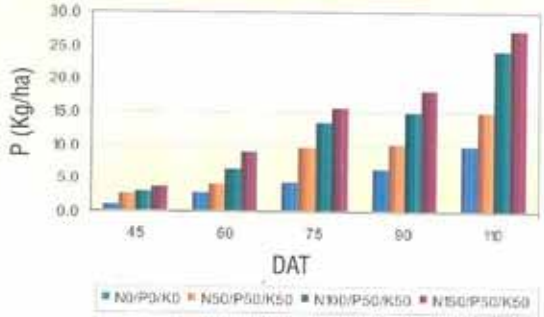


Fig. 26: P uptake in bulbs

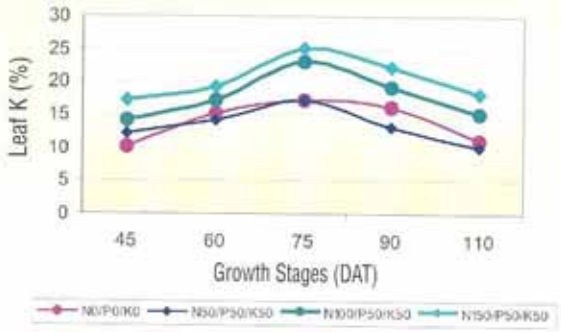


P uptake was highest at 110-day stage

Potassium content and its uptake at different growth stages in onion

Potassium in onion tops

Fig. 27: Potassium content in onion tops

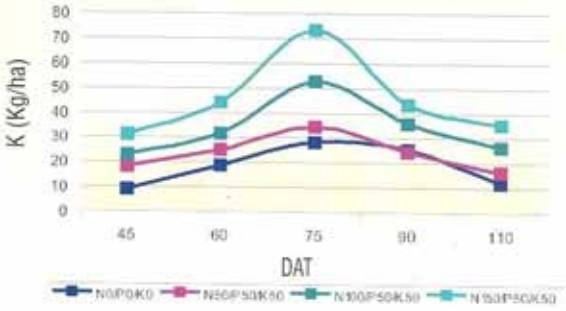


K level in tops reached high at 75-day growth stage

In control, K was higher than N 50 / P 50 / K 50 treatment

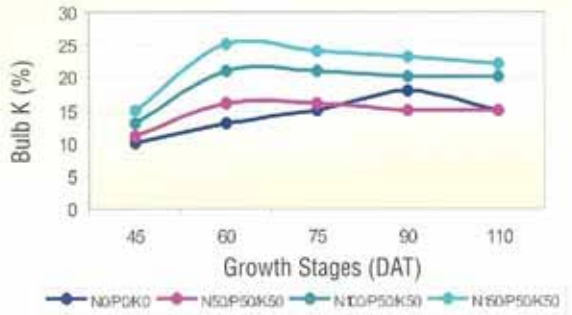
K uptake in tops was high at 75-day growth stage

Fig. 28: K uptake in tops



Potassium in onion bulbs

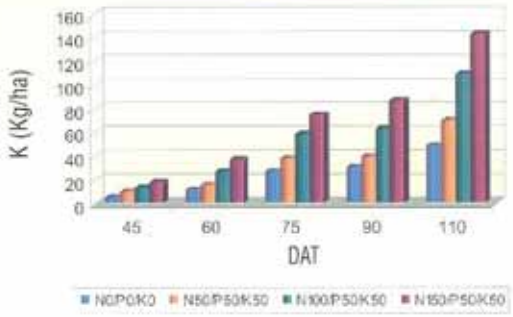
Fig. 29: Potassium content in Onion bulbs



K in bulbs was highest between 60 - 75 day growth, then gradual decline in control.

K levels increased up to 90 days

Fig. 30 : K uptake in bulbs



The highest uptake of K in bulbs was at 110 days of growth

Micronutrients content and its uptake at different growth stages in onion

Iron uptake (gram/ha)

Tops	45	60	75	90	110
N0/P0/K0	116.7	261.1	319.8	291.1	60.5
N50/P50/K50	280.4	423.2	419.3	376.4	116.0
N100/P50/K50	358.3	721.9	619.7	465.3	134.8
N150/P50/K50	612.4	1020.8	909.8	558.7	171.2

Bulb	45	60	75	90	110
N0/P0/K0	43.7	195.7	444.5	366.6	391.3
N50/P50/K50	125.1	242.1	595.9	646.5	617.1
N100/P50/K50	180.8	439.5	798.6	848.8	897.8
N150/P50/K50	310.4	547.1	1030.5	1202.6	1287.8

Uptake of iron is high in tops at initial growth stages.

Manganese uptake (gram/ha)

Tops	45	60	75	90	110
N0/P0/K0	31.0	66.3	68.8	31.3	5.9
N50/P50/K50	69.1	104.9	96.9	44.2	14.3
N100/P50/K50	98.9	125.7	134.6	49.0	20.0
N150/P50/K50	119.1	174.2	191.7	59.4	26.4

Bulb	45	60	75	90	110
N0/P0/K0	11.2	46.6	67.5	37.4	54.1
N50/P50/K50	27.6	59.0	110.3	73.7	113.3
N100/P50/K50	41.4	82.2	147.0	106.5	141.6
N150/P50/K50	53.9	105.1	195.9	134.9	240.5

The quantity of Mn removed by onion crop was less than Fe, however, followed similar uptake pattern.

Zinc uptake (gram/ha)

Tops	45	60	75	90	110
N0/P0/K0	44.5	71.9	75.2	61.9	38.4
N50/P50/K50	126.1	174.6	163.0	136.6	79.1
N100/P50/K50	141.7	195.2	199.4	151.0	97.4
N150/P50/K50	188.1	255.7	287.5	178.8	116.7

Bulb	45	60	75	90	110
N0/P0/K0	17.7	44.0	79.4	74.1	96.0
N50/P50/K50	50.0	70.1	177.7	206.2	248.8
N100/P50/K50	66.2	105.7	217.8	259.1	391.3
N150/P50/K50	88.8	134.9	273.0	352.6	560.6

The requirement of Zn seems to be quite higher than Mn.

Copper uptake (gram/ha)

Tops	45	60	75	90	110
N0/P0/K0	7.9	13.3	15.4	13.7	4.5
N50/P50/K50	17.1	23.2	22.5	18.9	8.4
N100/P50/K50	22.6	28.5	31.4	20.6	12.8
N150/P50/K50	27.4	36.7	42.8	26.3	18.3

Bulb	45	60	75	90	110
N0/P0/K0	2.9	6.8	15.9	17.4	28.5
N50/P50/K50	5.7	10.0	20.9	28.0	43.5
N100/P50/K50	9.4	13.8	26.0	40.5	54.0
N150/P50/K50	12.1	19.5	36.2	69.5	81.1

Among all the micronutrients, the uptake of copper was lowest.

Uptake pattern was similar to other micronutrients.

Calculation of Nutrient ratio in onion tops and bulbs at different growth stage

45 DAT	Onion Tops			Onion Bulb			Bulb : Top		
Treat	N	P	K	N	P	K	N	P	K
N100	4.4	0.6	2.8	1.8	0.3	1.3	1:2.4	1:2	1:2
N150	4.6	0.84	3.4	2.1	0.3	1.5	1:2.2	1:2.8	1:2

Nutrient concentration in tops at 45-day growth is high than bulb.
Concentration has increased with N application.

Nutrient ratio in bulb to top is high at this stage.

60 DAT	Onion Tops			Onion Bulb			Bulb : Top		
Treat	N	P	K	N	P	K	N	P	K
N100	4.8	1.0	4.0	2.2	0.45	1.7	1:2.2	1:2.5	1:2.3
N150	5.2	1.2	4.6	2.3	0.60	1.9	1:2.3	1:2	1:2.4

The concentration of nutrients has gradually increased in the bulb.

The nutrient ratio in bulb: top has slightly dropped for P and increased for K.

75 DAT	Onion Tops			Onion Bulb			Bulb : Top		
Treat	N	P	K	N	P	K	N	P	K
N100	4.6	1.2	4.6	2.4	0.48	2.1	1:1.9	1:2.5	1:2.2
N150	5.0	1.4	5.0	2.5	0.50	2.4	1:2	1:2.8	1:2

The concentration of P and K has further increased in tops
Level of N, P and K also increased in bulbs at this stage
The bulb: top ratio has shown slight decline

90 DAT	Onion Tops			Onion Bulb			Bulb : Top		
Treat	N	P	K	N	P	K	N	P	K
N100	4.4	0.7	3.8	2.2	0.47	2.0	1:2	1:1.5	1:1.9
N150	4.8	0.9	4.4	2.3	0.48	2.3	1:2.1	1:1.8	1:1.9

At this stage the drop in level of N is slow than P and K in tops compared to bulbs
The nutrient ratio in bulb: tops has been on decline

110 DAT	Onion Tops			Onion Bulb			Bulb : Top		
Treat	N	P	K	N	P	K	N	P	K
N100	4.0	0.70	3.0	1.9	0.44	2.0	1:1.2	1:1.5	1:1.5
N150	4.2	0.78	3.6	1.9	0.42	2.2	1:1.9	1:1.8	1:1.6

The level of N in tops has dropped substantially at this stage
However, the concentration of P and K has almost remained constant in bulbs
The nutrient ratios in bulb: tops were lowest at this stage

Onion seed production and storage technology

Increasing the seed viability and vigour in onion seeds

The experiment on seed viability and vigour in onion seed was conducted with onion cv. Baswant 780. The results of 2005 trial revealed that seed germination was more than 70.0 % even after 21 months of storage in seed stored in desiccator with moisture absorbent. This was 8 times higher than the other treatments and control. The seed vigour index in desiccator stored onion seed was also higher than other treatments. The trial was repeated in the year 2006. The results revealed that the seed germination and seed vigour index in seed stored in desiccator were higher than other

treatments in the first 15 months. The germination was good in the seeds kept in dessicator while there was no germination in other treatments after 18 months of storage. On the basis of two years trial it can be concluded that storage of onion seeds in dessicator helps in maintaining the viability and vigour of seeds for more than one and half years.

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

The onion seed cv. Baswant 780 was primed with several chemicals such as Para amino benzoic acid, potassium nitrate, di-potassium hydrogen phosphate and poly ethyl glycol in different concentrations. These seeds were dried and packed in 400 gauge polyethylene bags and stored at ambient temperature. The results revealed that there was no difference in percent germination and seed vigour index among treatments in the initial months while there was some effect of di-potassium hydrogen phosphate on percent germination after 18 months.

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

The onion seeds of cvs. Agrifound Dark Red and Agrifound Light Red of different moisture levels i.e. 5.0, 6.0, 7.0 and 8.0 % were packed in various packing materials i.e. cloth bags, polyethylene bags, laminated aluminium bags and laminated aluminium bags with vacuum packing. These bags were stored at ambient condition in August 04. The percent germination and viability of seed was recorded after 12, 15, 18, 21, 24 and 27 months. The results indicated that in onion cv. Agrifound Dark Red, seed germination percent and seed vigour was higher in seed having 5.0 % moisture than seed having 8.0 % moisture. As far as packing material is concerned, the lowest seed germination and viability was recorded in cotton cloth bags. The highest seed germination was found in laminated aluminium bags with vacuum packing > the seed packed in cloth bags lost their complete viability and vigour within 18 months of storage > among the various treatments combinations seed having 5.0 % moisture and packed in aluminum laminated bags remain viable for longer period and the percentage germination was 51.7 % after 27 months of storage. Similar results were recorded with onion cv. Agrifound Light Red. The trial was repeated in 2005 with onion cv. N-2-4-1. The initial results are showing trends similar to 2004 trial.

Integrated pest management in onion and garlic

Evaluation of entomopathogens against thrips in onion

Field trials were conducted in late *kharif* and *rabi* seasons in the year 2005 to evaluate different entomopathogen strains against thrips. In *rangda* (late *kharif*) season, 5 rounds of sprays were given in each season. All the treatments significantly reduced the thrips population compared to control. In all the sprays, the performance of any of the insect pathogen was not consistent. Their efficacy ranged from 4.0 to 42.4 % reduction over control (Fig. 31).

Among all, carbosulfan sprays brought down thrips population above 90.0 % compared to control. The *B. bassiana* isolates performed better than *V. lecanii* isolates in bringing down thrips population. The leaf curling was also lowest in carbosulfan sprayed plots. Among the entomopathogens, Bb-1 recorded the lowest damage of 2.0. Although thrips population was significantly low compared to control, desirable thrips mortality was not achieved with any of the insect pathogen treatments. Based on pooled data, highest reduction of thrips population (26.5 %) was recorded with Bb-6. Carbosulfan sprayed plots recorded the highest marketable and total yield compared to all other treatments. Yield of all insect pathogens sprayed plots were at par with control plot (27.5 t/ha).

Fig. 31:
Performance of entomopathogens during late *kharif*

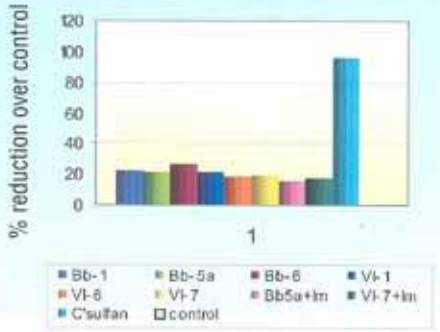
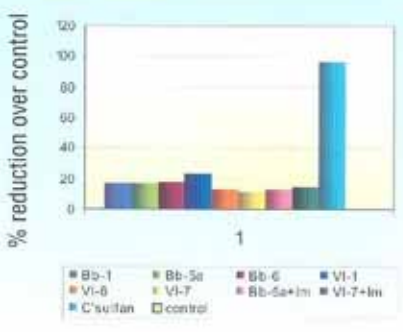


Fig. 32:
Performance of entomopathogens during *rabi*



The same trial was conducted in *rabi* season also. During the season, 6 rounds of sprays were given. As in *rangda*, no entomopathogenic fungi performed consistently. The efficacy ranged from 5.2 - 26.5 % only, whereas the check insecticide carbosulfan brought down thrips above 90.0 % in all sprays. None of the entomopathogenic fungi achieved desirable control of thrips. Among the fungal isolates VI-1 recorded the highest efficacy of 22.6 % over control (Fig. 32). The leaf damage / curling was lowest in carbosulfan plots, whereas, the curling ranged from 3.3 to 3.9 in all other treatments. Among the entomopathogens, *B.bassiana* performed better than *V. lecanii* in both *rangda* and *rabi* seasons. All the treatments yielded at par with the control. The carbosulfan sprayed plots recorded the highest yield of 46.5 t/ha.

Effect of mulching on thrips on seed onion during *rabi*

All the three mulches viz., silver, straw and aluminium painted black mulch, significantly repelled the adult thrips up to 35 - 40 days after planting. Among the three mulches, aluminium painted black mulch effectively repelled the adults followed by silver mulch. Plants without mulch recorded 9 and 4 times more thrips than aluminium painted and silver mulch, respectively. Similarly, the nymph population up to 31.1.06 was significantly lower in black /aluminium mulch followed by silver mulch. In straw mulch plots, the thrips (nymph) population was 4 times less than no mulch plots.

All sprays significantly reduced both adults and nymphs. Thrips population was significantly lower in all the mulches compared to no mulch plots. In all 4 rounds of sprays, thrips were significantly less in sprayed plots compared to unsprayed plots. As the sprays proceeded, the efficacy of mulches to bring down thrips decreased considerably. The decrease in efficacy is due to shading / covering of mulch with plant foliage and thus minimizing the reflectance. However, the efficacy in reducing adults was up to 5 - 6 times in mulch plots whereas in case of reducing nymphs the efficacy was 2 - 3 times only.

The mulches did not affect the number of predator *Orius*. However, straw mulched plot harboured more bugs than other mulches.

During the period of study, the plant stand was very poor i.e. less than 40.0 %. Irrespective of mulches, bulb rotting was also more at the end of the crop season resulting in poor seed yield. However, the seed yield was significantly higher in mulching plots compared to no mulch plots. Similarly, the sprayed plots recorded higher seed yields than unsprayed plots.

Evaluation of some new insecticides against thrips in onion

Performance of 5 newer insecticides viz., Methomyl, Alphamethrin, Deltamethrin, Clothianidin and Cypermethrin as check was evaluated in *rabi* season. During the crop period, 4 rounds of sprays were given. Except in I spray the efficacy of methomyl @ 500 g ai/ha was the highest among the treatments with 90.4 % reduction of thrips over control. All the other treatments were found inferior to check insecticide cypermethrin. Efficacy of methomyl @ 400 g ai/ha was found at par with cypermethrin.

During the season, thrips population was higher on onion crop. Based on pooled data, thrips populations (26.0 / plant) was significantly lowest in methomyl @ 500 g ai/ha treated plots followed by cypermethrin with 48.2 thrips / plant. In control plot, thrips population was 197.2 / plant.

Thrips population in all the treatments was significantly less than the control. Overall, the efficacy of methomyl @ 500 g ai/ha was found significantly higher than (78.0 %) all other treatments and control. Highest marketable yield as well as total yield was recorded in plots sprayed with methomyl @ 500 g ai/ha followed by cypermethrin and methomyl @ 400 g ai/ha, which were at par. Significantly lower yield was recorded in control plots (24.2 t/ha).

Insectary plants: To attract predators in onion and garlic ecosystem

All the flowering plants planted attracted the natural enemies viz. coccinellids and *Orius*. The important species of coccinellids recorded were *Coccinella septumpunctata*, *Cheilomenes sexmaculata* and *Hippodamia variegata*. Coccinellids incidence started in the 3rd week of January. The crops, maize and sunflower harboured coccinellids for longer period as well as in larger numbers too. *C. sexmaculata* was more attracted to maize, whereas, saunf supported *H. variegata*. These species were also recorded on garlic and onion with a mean number of 13.8 / 60 plants and 1.68 / 60 plants, respectively. Garlic provided more shelter places to coccinellids and they were least attracted to onion.

The plants like sunflower and maize attracted more of *Orius*. Incidence of *Orius* first occurred on sunflower. Later *Orius* migrated to garlic. *Orius* was found in large numbers from the last week of February to the 2nd week of March, with the highest number being recorded on the first week of March. On average, 39.1 / 60 plants were recorded on garlic (Fig. 33). But their number was very less on onion (1.5 / 60 plants). They were least attracted to onion. *Orius* migrated to maize in April. The study suggests that sunflower attracts more of *Orius*. Later, maize acts as a shelter and food resource for *Orius*, once the garlic was harvested.

Fig. 33:
Incidence of orius on onion and garlic

Thrips damage on stored onions

Thrips not only cause damage to onion plants in field, but also in stores. Although the damage is not quantitatively insignificant, it affects the quality of the bulbs, like appearance (Fig. 34). This kind of damage should be kept minimum when onions are exported. Therefore, the presence of thrips and their damage was studied on stored onions. Two sets of samples were examined for damage. One set, onions from plots where insecticides was sprayed and the second, where no insecticides (but entomopathogens) were sprayed. The observations were recorded for 3 months.

Barring two instances, damage was noticed 100 % in all the sampled bulbs. In all the dates of observations the damage on upper half of the bulbs was higher than the lower half. On average, in insecticides, the damage was more (53.3 %) as compared to non-insecticide sprayed plots.

Fig. 34

The damage caused to bulbs due to thrips feeding was significant in insecticide and non-insecticide sets. The damage was not progressive with the storage period suggesting that the damage was done in the initial stages but not later. Number of thrips found on bulbs was higher in insecticide sprayed set compared to non-insecticide set. In the latter set, thrips were more in the initial stage but not later. On average, number of thrips per bulbs was 0.77 in insecticide set as compared to 0.52 in non- insecticide sprayed set.

The depth of penetration of thrips in onion was more in insecticide sprayed set than non -insecticide set. However, their penetration into the bulb was random and no pattern was observed during storage period. Thrips penetrated into onion bulbs more in insecticide sprayed sets. On average thrips penetrated to 1.1 scales whereas in non -insecticide set, it was 0.8. This may be due to the fact that thrips in insecticides sprayed plots penetrated more inside to avoid contact from insecticides.

There was no difference in neck thickness between the sets. No relation was derived between neck thickness and thrips population / damage on bulbs.

Geospatial pathogenic and molecular characterization of fungal diseases in onion and garlic- detection, management and risk analysis

Survey of major onion and garlic growing areas in Maharashtra (Sangamner, Nashik, Chitegaon, Sinnar, Lonand, Phaltan, Baramati, Chandwad, Lasalgaon, Jalgaon) and Madhya Pradesh (Indore, Ratlam, Maundsur, Ujjain, Khandwa, Berhampur) was carried out and disease samples were collected from 48 GPS sites (Fig. 35). The samples were processed and 2350 isolates were obtained, out of which, 795 stemphylium, 246 anthracnose and 344 of purple blotch pathogen have been obtained. 36 fusarium isolates from Rajgurunagar and Phaltan, *Sclerotium cepae* isolate from Chitegaon are being maintained. *Sclerotium cepae* has been isolated on PDA and sclerotium bodies production was maintained on wheat straw medium Liquid media was inoculated with discs of Stemphylium culture to see toxin production and media has been standardized for toxin production. Visual observation of the culture

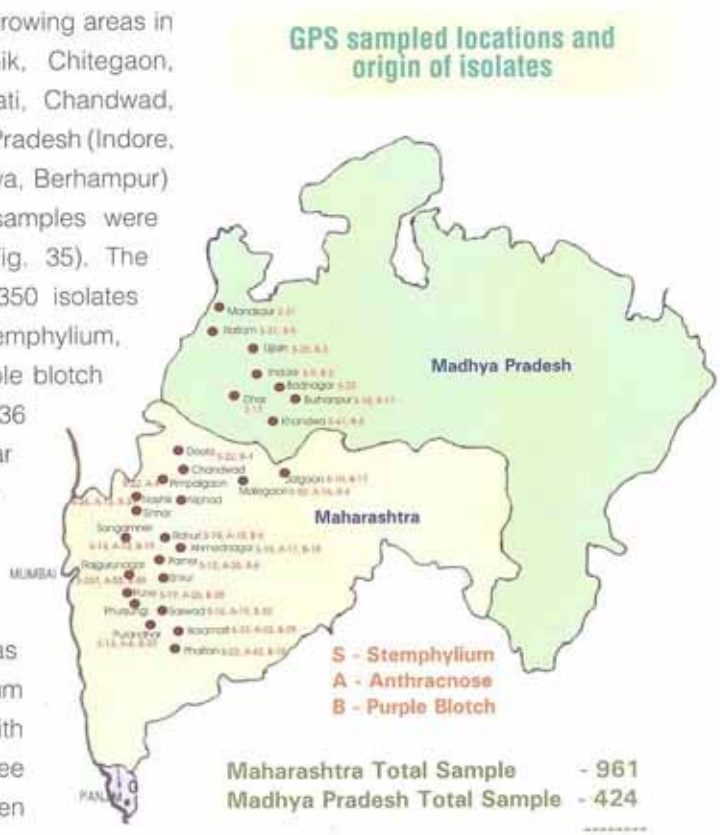


Fig. 35

filtrate indicated color difference for toxin for different isolates. Although 85 isolates were obtained, only one fungal species was obtained out of sterilisation of thrips whereas all other isolates were obtained without sterilisation. The isolates were identified at Agharkar Research Institute, Pune. Thrips sterilised and unsterilised both produced fusarium colonies, which needs identification.

Suppression of soil borne diseases of onion through composting

Onion culls augmented with combination of BAM and antagonists with vermicompost, mushroom spent and FYM were incubated for 27 and 40 days under semi anaerobic conditions. Combination of onion culls, trichoderma and vermicompost resulted in 100% composting. Onion culls were treated with different combination of organic manure and antagonists in different combinations, Onion culls, vermicompost with *Trichoderma* in the ratio of 4:2:0.25 were found very effective in composting the culls in semi anaerobic conditions for 27 days. Whereas the quality of compost out of FYM was not good and was foul smelling with maggots. In another treatment again vermicompost and *Trichoderma* combination proved superior to mushroom spent and *Trichoderma* where in composting was only to the tune of 80% under semi anaerobic conditions. Inclusion of *P. florescens* did not show any significant change over the rest of treatments.

C Post Harvest Technology

Post harvest studies in onion and garlic

Onion

Assessment of losses in yellow onion

The yellow onion cv. Mercedes was stored from February to May 06 to assess the various types of storage losses. The results revealed that storage losses in smaller bulbs (<50 mm) were higher than the bigger bulbs (>50 mm). The total losses after 3 months were 76.6 % in smaller bulbs while it was 55.3 % in bigger bulbs during similar period of storage. The rotting and sprouting losses were also higher in smaller bulbs.

Effect of post harvest treatments

Effect of sulfur fumigation

Onion bulbs cv. N-2-4-1 was given sulfur fumigation (50 g/m^3)for different durations to reduce the disease infection during storage. It was found that fumigation of sulfur significantly reduced the infection of black mould in onion, but did not show any effect on rotting, sprouting and weight losses.

Effect of storage environment

Late *kharif*

Effect of size of heaps (stakes) on storage losses in late *kharif* onion cv. B-780

The bulbs of late *kharif* onion cv. Baswant 780 was stored in heaps (stakes) of different sizes from February to June 06 for studying the storage losses. It was found that lower rotting was recorded in smaller heaps than bigger heaps. The total storage losses were also less in smaller heaps.

Rabi

Effect of size of heaps (stakes) on storage losses in onion cv. N-2-4-1

The bulbs of *rabi* onion cv. N-2-4-1 were stored in heaps (stakes) of different sizes from May to October 06 and observations on storage was recorded. The results revealed that the total

storage losses were less in smaller heaps. There was no effect of heap size on PLW and sprouting but rotting and black mould infection was higher in bigger heaps.

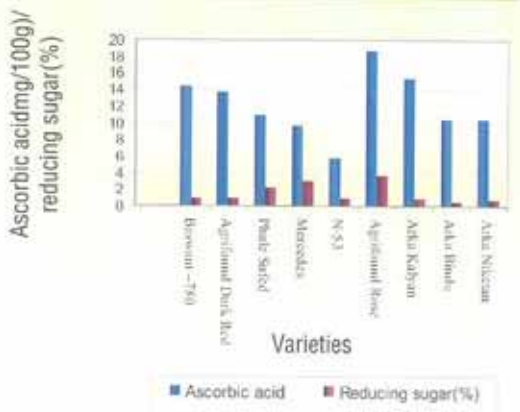
Effect of forced ventilation on storage losses in onion

The modified bottom cum top ventilated double row storage structure was partitioned into three compartments i.e. naturally ventilated, forced ventilated with exhaust fan, forced ventilated with wind operated fan along with four packing materials i.e. staking, HSC bags, netlon bags and plastic crates. The performance of three compartments of bottom cum top ventilated mud plastered storage structure was evaluated for onion cv. N-2-4-1 during May to October 06. The results revealed that lower losses were recorded in controlled ventilated compartments than natural ventilated compartment. The PLW, rotting, sprouting and black mould was less in forced ventilated compartment. Among the various packing materials, the lowest losses was recorded in HSC bags and plastic crates. Overall lowest losses (31.1 %) were found in HSC bags and plastic crates kept in control forced ventilated compartments after 5 month of storage.

Biochemical analysis of onion varieties

The analysis of various biochemical properties of some onion varieties and lines revealed that the highest total soluble solids (19.7 %) were found in onion cv. Agrifound Rose while the lowest TSS (9.7 %) was found in Mercedes. Similarly, dry matter content was also highest (20.3 %) in cv. Agrifound Rose while lowest was observed in onion cv. Mercedes. Pyruvic acid percentage was highest in Agrifound Rose followed by Arka Bindu. There was no significant difference among red and white varieties with regards to pyruvic acid content. The higher protein content and higher ascorbic acid was found in Agrifound Rose while higher titrable acidity was found in Udaipur 102. Total ash content was also highest in Agrifound Rose. The higher total sugar and reducing sugars were found in cv. Mercedes and Phule Safed. The highest antrocyanin content was found in onion cv. N-53 (12.6 mg/100g) followed by Arka Kalyan, Agrifound Rose and Baswant 780 (Fig. 36).

Fig. 36: Ascorbic acid and reducing sugar content in onion varieties



Garlic

Assessment of storage losses

The assessment of storage losses in garlic revealed that lower losses were recorded in small sized bulbs in the initial 3 months of storage, but after three months, the losses were higher in bigger bulbs than medium and small sized bulbs.

Effect of pre harvest treatments on storage losses in garlic

Various pre-harvest treatments were given to garlic crop 15 days prior to harvesting and treated garlic were kept for storage studies for 6 months. It was found that there no difference in various losses after 3 and 6 months of storage.

Effect of sulphur fumigation on storage losses

Garlic bulbs of cv. G-41 was subjected to sulfur fumigation (50 g/m^3) for different durations during April 06 and these fumigated bulbs were kept for storage studies for 6 months. It was found that sulphur fumigation of garlic bulbs significantly reduced the soft rot and black mould infection up to 3 months of storage. But after 6 months of storage, these treatments reduced black mould, but there was no effect on soft rot.

Effect of size of heaps on storage losses in garlic

The bulbs of garlic cv. G-41 were stored in heaps (stakes) with leaves of different sizes from April to October 06 and observation on storage was recorded. The results revealed there was no effect of heap size on storage losses in garlic.

Biochemical analysis of garlic varieties and germplasm

Nine garlic varieties viz. G-1, G-41, G-50, G-282, G-323, GG-2, GG-3, Godavari, DARL-5 and twenty five garlic germplasm lines were analyzed for various chemical characters during 2006-07. Among the garlic varieties, highest bulb weight was recorded in garlic cv. G-50 (22.6 g) followed by G-41 (18.7 g) and GG-2 (17.5 g). These were significantly higher than all other varieties. The minimum weight of bulb was recorded in variety G-1 (10.1 g). Similarly highest equatorial bulb diameter was recorded in garlic cv. G-50 (39.9 mm) followed by GG-2 (39.1 mm) and G-41 (37.1 mm). G-41 (27.5 mm) observed highest polar bulb diameter, followed by GG-2 (27.2 mm) and G-50 (26.3 mm). The highest clove width and clove length, 8.19 mm, and 20.4 mm, respectively was recorded in G-41 followed by G-50 (7.8 mm and 19.6 mm, respectively). Garlic G-50 (0.83 g) recorded higher clove weight followed by G-41 (0.8 g). GG-3 (0.4 g) recorded minimum clove weight. Garlic GG-2 (40.6) showed more number of cloves per bulb followed by GG-3 (28.0). Higher dry weight was found in GG-2 (37.5 g) and G-50 (36.2 g), while higher total soluble solids were recorded in cv. G-323 (33.0 %), DARL-50 (32.5 %) and G-41 (32.4 %). Higher percentage of ash was observed in garlic cv. GG-2 (1.7) followed by G-41 (1.6) and Godavari (1.6). The highest titrable acidity was found in garlic cv. G-282 (1.2 %) followed by DARL-50 (1.2 %), while highest ascorbic acid was recorded in cv. DARL 50 (23.5) followed by cv. Godavari (22.7). As far as the colour pigments are concerned, highest anthrocyanin pigment was found in the peel of cv. Godavari (23.5), while highest anthrocyanin pigments content in clove was found in cv. DARL-50 (0.56). Among the garlic lines, higher bulb weight was found in line 316 (21.4 g) and 162 (13.8 g), while number of cloves per bulb was highest in line nos. 286 (44.6), 326 (33.9) and 15 (28.9). The clove length was highest in line nos. 70 (22.1 mm), 177 (19.3 mm) and 316 (18.7 mm), while clove width was highest in line no. 316 (8.5 mm) and 227 (98.2 mm). The clove weight was highest in line no.316 (1.4 g) followed by 0.9 g in line no.177. Highest dry weight (37.4 %) was found in line no.109 followed by 279 (36.8 %). The highest total soluble solids were found in line no. 320 and 301.The highest titrable acidity was recorded in line no.109 and 326 (1.2 %). The highest ascorbic acid was found in line no 260 (33.8 mg) followed by 29.9 mg in line no.162.

On Going Projects

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

Project No.	Project Title	Scientists Involved
1.3.11	Isolation, characterization and evaluation of antagonists against onion and garlic pathogens	RP Singh and A Aziz Qureshi
1.3.12	Geospatial pathogenic and molecular characterization of fungal diseases in onion and garlic detection, management and risk analysis.	CR Ramesh, A Khar and A Asha Devi
1.3.13	Biological and molecular characterization and control of *Iris yellow spot virus* in onion: A rapidly emerging tospovirus in India	CR Ramesh, PS Srinivas, A Khar and A Asha Devi
1.3.14	Suppression of soil borne diseases of onion through composting	CR Ramesh, PC Tripathi and A Aziz Qureshi

Externally funded projects

Title	Scientists Involved
Central Sector Scheme	
Implementation of PVP and FR legislation and DUS testing in onion and garlic	VSR Krishna Prasad
Breeder seed production of onion	V Mahajan
Intercropping of onion and garlic in sugarcane with modern irrigation systems	KE Lawande and PC Tripathi
Comparison of chemical sprout suppressant and irradiation on storage life of onion under different storage conditions	KE Lawande and PC Tripathi
AP Cess Fund	
Evaluation of selenium status in Indian type onion and garlic - Studies on the nutritional behaviour of selenium and sulphur	AA Qureshi
Mega Seed Project, ICAR	
Seed production in agricultural crops and fisheries	KE Lawande and PC Tripathi

List of Publications

Research papers

Asha Devi A, A Khar and KE Lawande. 2007. Genotypic response of short day Indian garlic (*Allium sativum L.*) accessions to shoot multiplication. *J. Spices Arom. Crops* 16 (1): (In Press)

Aziz Qureshi A and KE Lawande. 2006. Response of onion (*Allium cepa*) to sulphur application for yield, quality and its storability in S-deficient soils. *Indian J. Agric. Sci.* 76(9): 535-7.

Jernej J, A Telgmann, C Jung, A Khar, S Melgar, F Cheung, CD Town and MJ Havey. 2006. Comparative sequence and genetic analyses of asparagus BACs reveal no microsynteny with onion or rice. *Theor. Appl. Genet.* 114: 31-39.

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

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

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

Krishna Prasad VSR, KE Lawande, V Mahajan and A Khar. 2006. Assessing and prediction of environmental response of short day onion genotypes grown in three seasons of Western India. *Indian J. Hort.* 63(3): 270-275.

Srinivas PS and Lawande KE. 2006. Maize (*Zea mays*) barrier as a cultural method for management of thrips in onion (*Allium cepa*). *Indian J. Agric. Sci.* 76(3): 167-71.

Tripathi PC and KE Lawande. 2006. Effect of cold storage and gamma-irradiation on storage losses in garlic. *J. Spices Arom. Crops* (In Press).

Review articles

Khar A, Asha Devi A and Lawande KE. 2005. Current status of biotechnological approaches in onion (*Allium cepa* L.) - a review. *The Botanica* 55: 716.

Papers / Abstracts / Posters presented in conferences

Khar A, J Jakse and MJ Havey. 2006. Genetic mapping of loci affecting bulb and seed colors in onion. Research paper presented at the "National Allium Research Conference", at Texas A&M University, Texas on December 8, 2006.

Khar A, J Jakse and MJ Havey. 2007. Mapping of bulb and seed color loci in onion. Poster presented in "Plant and Animal Genome XV Conference", at San Diego, California from January 13-17, 2007.

Krishna Prasad VSR, V Mahajan and KE Lawande. 2006. Potentials of plant genetic resources in onion (*Allium cepa* L.) improvement for year round cultivation. In: *Proceedings of "SYMSAC-III: Crop & Product Diversification"* held at Karnataka from 8-10 November, organized by Indian Society of Spices.

Krishna Prasad VSR, V Mahajan and KE Lawande. 2007. Exploitation of heterosis in development of F1 hybrids in onion under short day conditions. In: *Proceedings of "VIII Agricultural Science Congress"*, held at TNAU from 15-17 February organized by NAAS, New Delhi and TNAU, Coimbatore.

KE Lawande and PC Tripathi. 2006. Marketing of irradiated onion and garlic. In: *National Symposium on Radiation Processing of Foods, Food Products and Feeds at FFA*, Hyderabad from September 8-9. Pp. 82-90.

Mahajan V, KE Lawande, A Khar and VSR Krishna Prasad. 2006. Screening of white onion germplasm for year round production. In: *Proceedings of "International Conference on Sustainable Crop Production in Stress Environment: Management and Genetic Option"*, at JNKVV, Jabalpur from 9-12 February 2005. Pp. 217-222.

Mahajan V, VSR Krishna Prasad and KE Lawande. 2006. Development of white onion variety for *kharif* season. In: *Proceedings of "SYMSAC-III: Crop and Product Diversification"* held at Karnataka from 8-10 November, organized by Indian Society of Spices.

Sankar V, D Veeraragavathatham and M Kannan. 2005. Effect of panchakavya (cow urine based organic growth stimulant) on growth and yield of onion (*Allium cepa* var. *cepa*) *Allium Newsletter* 15: 32-37.

Sankar V, D Veeraragavathatham, M Kannan, K Subbiah and V Prakasam. 2005. Studies on influence of different types of application of organic manures and organic growth stimulants on growth and yield of organically produced white onion. *Allium Newsletter* 15: 23-31.

Srinivas PS, A Khar, A Aziz Qureshi and KE Lawande. 2007. Wild alliums as sources of resistance to *Thrips tabaci*. In: *Souvenir and Abstracts of III National Symposium on Plant Protection in Horticulture: Emerging Trends and Challenges*, held during 7-9 March 2007 at Indian Institute of Horticultural Research, Bangaluru, India. Pp. 30.

Popular articles

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Mahajan V and KE Lawande. 2006. "Lasun utpadanachi shashtroukt paddhati". *Shetakari*, October: 35-38.

Tripathi PC and KE Lawande. 2006. Pyaj ke bhandaran ke liye naveentam bhandargrih, suvidha. *Phal Phool*, May-June: 3-5,10.

Tripathi PC, V Sankar and KE Lawande. 2006. Micro-Irrigation in onion and garlic. *Phal Phool*. September October: 11-13.

Tripathi PC, V Sankar and KE Lawande. 2006. Pyaj aur lahsun me sukshma sinchae pranaliyo ka mahatva, *Taknik*, September-October: 11-14.

Tripathi PC, V Sankar and Lawande KE. 2007. Medicinal and therapeutic value of garlic. *Spice India* (In press).

Tripathi PC and Lawande KE. 2007. Lahsun ki unnat kheti. *Phal Phool* (In press).

Research bulletins

Aziz Qureshi A and KE Lawande. 2006. *Diagnosis and management of nutrient deficiency in onion*. Technical Bulletin No.16. Published by National Research Centre for Onion and Garlic.

Lawande KE and VSR Krishna Prasad. 2006. National Test Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability of Onion (*Allium cepa* L.) and Garlic (*Allium sativum* L.). Published by National Research Centre for Onion and Garlic.

Contributions made in compilation/documentation

Dr. KE Lawande, Director contributed in a review on 'Impact of Excess Rains on Yield, Market Availability and Prices of Onion' published by CRIDA, Hyderabad in collaboration with NRM Division, ICAR, CRIDA, NRCO&G and NHRDF, 2006.

Book chapter

Lawande KE and V Mahajan. Pyaj Ki Kheti. In: *Subjiyo ki kheti.* (Eds. Mathura Rai *et al.*), Indian Institute of Vegetable Research, Varanasi. (In Press)

Mahajan V and KE Lawande. Lahasun Ki Kheti. In: *Subjiyo ki kheti.* (*Eds.* Mathura Rai *et al.*), Indian Institute of Vegetable Research, Varanasi. (In Press)

Srinivas PS, KJ Srivastava and KE Lawande. 2006. Status and prospects of integrated pest management strategies in selected crops: Onion and Garlic. In: Integrated Pest Management Principles and Applications. Vol.2: Applications. (Eds. Singh A, Sharma OP and Garg DK). Pp. 393-424.

Project (Student) report

Mahajan V, A Asha Devi and KE Lawande 2006 guided Mr. Bongale NS in the project entitled 'Micropropagation of garlic through meristem tip culture', submitted for the partial fulfillment of BSc (Applied Biotechnology) to Vidya Pratisthan School of Biotechnology, Baramati.

Srinivas PS and KE Lawande 2006 guided Ms. Sadashive G in the project entitled 'Isolation and identification of fungal flora on onion thrips', submitted for the partial fulfillment of BSc (Applied Biotechnology) to Vidya Pratisthan School of Biotechnology, Baramati.

Tripathi PC and KE Lawande 2006 guided Mr. Ahire AR in the project entitled 'Studies in morphological and chemical characters of garlic collections', submitted for the partial fulfillment of BSc (Applied Biotechnology) to Vidya Pratisthan School of Biotechnology, Baramati.

Transfer of Technology

Lectures Delivered

Topic	Organizer(s)	Venue	Date
Dr. V Mahajan			
"Niryat kshyam Kanda lagwad, utpadan vaad, Ekatamak keed rog vyavasthapan, kadhni purva va kadhani nantarche tantragyan va sathavan".	APMC, Junnar, MSAMB, Pune	Otur, Junnar	15.9.06
"Onion cultivation"	Bank of Maharashtra, Pune	Bhigwan	16.9.06
"Niryat kshyam Kanda lagwad, utpadan vaad, Ekatamak keed rog vyavasthapan, kadhni purva va kadhani nantarche tantragyan va sathavan"	APMC, Shirur, MSAMB, Pune	Talegaon Dhamdere, Shirur	20.9.06
"Niryat kshyam Kanda lagwad, utpadan vaad, Ekatamak keed rog vyavasthapan, kadhni purva va kadhani nantarche tantragyan va sathavan"	APMC, Shirur, MSAMB, Pune	Daund	28.9.06
"Onion and garlic production, protection and post harvest technology"	Regional Agricultural Extension Management Training Institute, Aurangabad.	NRCOG, Rajgurunagar	17.10.06
"Kanda va lasun utpadan, sathavan, niryat va keed va rog niyantran"	Department of Agriculture, Maharashtra	At village Kapurvadi, Distt. Ahmednagar	20.10.06
"Kanda utpadan tantragyan"	MPKV, RAWE Students	At village Retwadi, Tal. Khed	9.11.06
"Onion seed production"	NRCOG, Rajgurunagar and NABARD, Pune	NRCOG, Rajgurunagar	14.11.06

Topic	Organizer(s)	Venue	Date
"Onion & Garlic an - Overview"	NRCOG, Rajgurunagar and NHRDF, Nashik	NRCOG, Rajgurunagar	16.11.06
"Kanda Lasun lagwad va Kadhani pashchat tantragyan"	District Agricultural Officer, Ahmednagar	Ahmednagar	18.11.06
"Seed production of Onion"	Jindal Crop Science Pvt. Ltd., Jalna and KVK, Kharpudi	KVK, Kharpudi, Jalna	20.11.06
"Onion varietal improvement and suitable varieties for cultivation for export and processing"	NHRDF, Nashik	Alephata	10.12.06
"Kanda peek parisanvad"	Zuhari Chemicals Ltd.	Madunge, Ambegaon	22.12.06
"Onion cultivation"	Godrej Agrovet Ltd.	Mengadewadi, Gawadewadi	6.1.07
"Onion cultivation"	Godrej Agrovet Ltd.	Maswandi, Tal. Sangamner	21.1.07
"Onion cultivation"	Godrej Agrovet Ltd.	Ranjani, Sakari	27.1.07
"Onion and garlic production technology, post harvest management, seed production and plant protection"	Department of Agriculture, Rajgurunagar	Horticulture Nursery, Rajgurunagar	14.2.07
"Onion an introduction"	NRCOG, Rajgurunagar	NRCOG, Rajgurunagar	15.2.07
"Onion and garlic production technology, post harvest management, seed production and plant protection"	Department of Agriculture, Rajgurunagar	Horticulture Nursery, Rajgurunagar	21.2.07
"Onion seed production"	NRCOG, Rajgurunagar and NHRDF, Nashik	NRCOG, in National Seminar on Onion and Garlic Production and Post Harvest Management	28.2.07
"Onion and garlic production technology, post harvest management, seed production and plant protection"	Department of Agriculture, Rajgurunagar	Horticulture Nursery, Rajgurunagar	1.3.07

Participation in Exhibitions

Topic	Organizer(s)	Venue	Date
Mahajan V, VV Patil, S Mani, P Raut, P Jagtap, V Patil, A Muley, PR Sonawane, PE Tadge, S Tapkir, MS Kale, RS Kulkarni	Kisan Forum Pvt. Ltd, Pune, supported by Ministry of Agriculture, Government of India	Kisan-2006, Moshi, Pune	13 to17 Dec. 2006
All Scientists and staff of NRCOG, Rajgurunagar	NRCOG, Rajgurnagar and NHRDF, Nashik	National Seminar on Onion & Garlic Production and Post Harvest Management at NRCOG, Rajgurnagar	27-28 February 2007

Audio - visual aids

For greater dissemination of promising technologies developed by the Centre, three CD-ROMs were prepared, for the benefit of the farmers-

Lawande KE and Tripathi PC. 2006. *Kharif* Onion Production.

Lawande KE, VSR Krishna Prasad and Tripathi PC. 2006. NRCOG - Marching Ahead.

Srinivas PS and KE Lawande. 2006. Integrated Pest Management in Onion and Garlic.

National Seminar and Kisan Mela

NRCOG organized a 2-day National Seminar and Kisan Mela sponsored by NHRDF, Nasik and Indian Society of Alliums on 27-28 February 2007 at Rajgurunagar. Dr. RB Deshmukh, VC, MPKV, Rahuri was the chief guest on the occasion while Dr. HP Singh, DDG (Hort) presided over the function. Other distinguished guests who attended the seminar includes Dr. VD Patil, Director of Horticulture, Pune, Sh. BV Gopal Reddy, MD, Maharashtra State Horticulture and Medicinal Plants Board, Sh. CB Holkar, Vice chairman, NAFED and Dr. RP Gupta, Director, NHRDF. On this

Release of CDs

Active participation of women during the Kisan mela

Title and Venue	Name	Period
International Training Course on 'Agricultural Water Management for Enhancing Water Productivity' at ANGRAU, organized by ALTERRA ILRI Wageningen University, The Netherlands and Acharaya N.G. Ranga Agricultural University, Hyderabad.	Dr. PC Tripathi and Dr. V Sankar	22.01.2007 to 11.02.2007
National Seminar on 'Onion and Garlic Production and Post Harvest Management' at NRCOG organized by NRCOG, Rajgurunagar and NHRDF, Nashik	All Scientists and Staff, NRCOG	27.02.2007 to 28.02.2007
Review workshop of mega seed project on 'Seed Production on Agricultural Crops and Fisheries' at NASC, New Delhi	Dr. PC Tripathi	01.03.2007 to 02.03.2007

Deputations / Visits abroad

Name and designation	Purpose of visit	Place of visit	Period
Dr. Anil Khar, Scientist SS (Horticulture)	Received BOYSCAST Fellowship from Department of Science and Technology, Government of India	USDA-ARS Department of Horticulture, University of Wisconsin, Madison, USA	One year w.e.f. 30.3.06 to 29.3.07

Training programmes organized

Conducted a three day training programme from 13 -15 November 2006 on 'Improved Production Technology on Onion and Garlic', where 20 farmers from Maharashtra state were trained on different aspects of production technologies in onion and garlic. This was conducted in collaboration with NABARD, Pune.

In collaboration with NHRDF, Nasik, a one-day training programme on 'Micro Irrigation Technology for Production of Onion and Garlic' was organized on 16 November 2006 at the Centre, where 25 farmers from Maharashtra participated in the training programme.

Organized a brain storming session from 16-17 January 2006 on 'Onion Pests and Diseases: Status and Future Thrust' in which 32 Scientists from different parts of the Country participated.

Organized a two day National level seminar / Kisan Mela from 27 - 28 February 2007 on 'Production, Processing and Marketing of Onion and Garlic'. About 2500 farmers attended the same from the states of Maharashtra, Gujarat, Madhya Pradesh, Rajasthan along with scientific delegates from ICAR Institutes / SAUs / NABARD / Seed Companies. An exhibition of various agricultural produces and farm implements was also there during the Mela.

Institutional Activities

Scientific and Management Meetings
Quinquennial Review Team (QRT)

Chairman

Dr. KV Peter, Professor of Horticulture, Kerala Agriculture University, Vellanikara, Thrissur, Kerala

Members

Dr. B Singh, OSD (Horticulture), President's Garden, Rashtrapathi Bhavan, New Delhi

Dr. AK Misra, Ex-Additional Commissioner (Horticulture), New Delhi

Dr. NS Rao, Principal Scientist, Project Directorate of Biological Control, Hebbal, Bangalore, Karnataka

Dr. Lalita Anand, Ex-Head, Division of Biotechnology, Indian Institute of Horticultural Research Bangalore, Karnataka

Member Secretary

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

The QRT team headed by Dr. KV Peter visited NRCOG along with other members, Dr. B Singh, Dr. AK Misra, Dr. Lalita Anand, Dr. NS Rao and Dr. VSR Krishna Prasad, Member Secretary. The team conducted two meetings on 29-30 December 2006 and 12-16 March 2007 and discussed with the Scientists about the targets and achievements and assessed the progress made in their research programmes. The team also had discussion with the staff and visited the experimental farms, seed production plot and farmers' fields to witness the technology dissemination carried out by the Centre. The team also visited NHRDF, Nasik, Lasalgaon, BARC irradiation center facility and agricultural marketing yards and had discussion with the officials. The team complemented the Director and Scientists for achieving good results in all fronts. The team also submitted its report to the ICAR.

Institute Research Council (IRC)

Chairman

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

Members

All Scientists of the Centre

Member-Secretary

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

The tenth IRC meeting was held on 17-18 March 2007 under the chairmanship of Dr. KE Lawande, Director. All the Scientists presented the results of their projects and the progress made in the previous year along with the technical programmes for the next year. After thorough discussion the programmes were finalized.

Research Advisory Committee (RAC)

Chairman

Dr. MR Thakur, Ex-Vice Chancellor, Dr. YSPU of H & F, Sanyukta, PO Raja ka Bagh, Nurpur, Kangra (H.P.)

Members

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

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

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

Dr. RB Jain, Managing Director, Jain Irrigation System Limited, Jain Plastic Park, Jalgaon, Maharashtra

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

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

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

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

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

Member Secretary

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

The tenth RAC meeting was held on 21-22 March 2007 at the Centre, under the chairmanship of Dr. MR Thakur. Among the members, Dr. VS Seshadri, Dr. KE Lawande, Dr. SN Pandey, Dr. SJ Singh, Dr. N Ahmad, Dr. SH Shinde, Shri. S Palande, Shri CB Holkar, Dr. V Mahajan (I/C Member Secretary) and all the Scientists of the Centre attended the meeting. The members visited the experimental plots at the Centre. Dr. KE Lawande, Director presented the progress of research work and the results along with action taken report of IX RAC. The Chairman and members expressed their satisfaction over the research programmes, farm management and infrastructure facilities developed at the Centre. The committee critically reviewed the progress and the appropriate suggestions were made for further improvement.

Onion Seed Producers Meet

Success of onion production largely depends upon genetically pure seed of a given variety. Onion being cross-pollinated, posses many problems in maintenance of purity during seed production. Many farmers and seed growers are unaware of seed production principles or ignore those or are unable to follow those principles due to circumstances prevailing at their level. As a result, the varieties/land races outcross and create new variables, which many not suit to the farmers, traders and finally consumers.

With a view to bringing awareness on these aspects of onion seed production and maintaining genetic purity and quality standards, a consensus meeting of seed producers and dealers was organized on 04 April 2006 at NRCOG. Representatives and owners of seed production agencies attended the meeting. Dr. KE Lawande, Director presented a brief account of status of onion seed in the country and highlighted problems encountered by the dealers. He also suggested that there should be exclusive association of seed growers which will provide a common platform for regular discussion and interaction with research organizations, farmers' representatives, authorities from seed certification and development department and seed producers for better quality seed production, storage and distribution. A concept of 'Seed Village' was discussed at length for overcoming the main problem in maintaining isolation and genetic purity of different varieties. At this event an association of onion seed growers was also formed.

Indian Society for Alliums (ISA) established

Onion and garlic crops now became more vibrant from domestic supply as well as from export point of view. Focussed attention has been bestowed by ICAR by starting NRC for Onion and Garlic. Lots of national consultations have gone in for improvement of productivity and quality. With a view to having more cohesiveness among the researchers, traders, industrialists, processors and farmers, it was proposed to have a separate society for strengthening and development of 'Alliums'. The intricate issues of these commodities can be discussed in an elaborate manner under the umbrella of a society in the form of symposia, seminar, workshops, brainstorming session, consultative meetings etc. A meeting was held under the Chairmanship of Dr. KE Lawande with researchers, seed growers, agribusiness specialists and representatives from seed companies. After thorough discussion, a society called "Indian Society of Alliums" was born on 2 May 2006. The new society was formulated with the following objectives.

1. To promote knowledge and research in onion, garlic and other edible *Alliums*.
2. To encourage closer relationship among the research workers, farmers, processors and traders.
3. To encourage the development of onion cultivation and seed production based on scientific and technical knowledge.
4. To organize conference, symposium and meeting from time to time for exchange of ideas and discussion on edible *Alliums*.

हिन्दी पखवाड़ा

इस केन्द्र में दिनाँक 14.09.2006 से 28.09.2006 तक हिन्दी पखवाड़ा मनाया गया । इस दौरान हिन्दी में पत्र लेखन, वैज्ञानिक संभाषण, हिन्दी प्रश्न मंजुषा, हिन्दी पठन, हिन्दी शब्द ज्ञान सुलेखन, कविता पाठ, निबन्ध, वाद-विवाद एवं टंकण आदि प्रतियोगिताओं का आयोजन किया गया । हिन्दी पखवाड़ा का समापन समारोह दिनाँक 28.09.2006 को मुख्य

अतिथि डॉ. (श्रीमती) संतोष कालिया, प्राध्यापक, सर परशुराम भाऊ महाविद्यालय, पुणे के सानिध्य में सम्पन्न हुआ । इस अवसर पर प्रथम, द्वितीय एवं तृतीय स्थान प्राप्त प्रतियोगियों को पुरस्कार प्रदान किये गये ।

Brain Storming on Pests and Diseases

A brain storming session on 'Onion pests and diseases: Status and future thrust' sponsored by NHRDF, Nasik, was conducted at the center on 16-17 January 2007. Dr. KE Lawande, Director delivered the inaugural address and status report with Dr. G Kalloo, Former DDG (Horticulture) in the chair and Dr. BL Jalali, Ex-Director of Research, HAU, presiding over the occasion. Around 32 Scientists from all over India attended and actively participated in the session. In an open-ended discussion, all the participants expressed their views and thoroughly discussed the various aspects of the major pests and diseases like thrips, purple blotch, stemphylium blight etc. During the two days of deliberation, an action plan along with technical programme was formulated.

New DDG (Horticulture) visits NRCOG

Dr. HP Singh, DDG (Horticulture) made his maiden visit to the Centre on 18 February 2007. Dr. KE Lawande, Director and Scientists congratulated and welcomed Dr. Singh. Director presented the status of onion and garlic research and achievements of the Centre. Dr. Singh visited the experimental farm and discussed the programmes with the Scientists in brief. He expressed satisfaction about the growth and achievements of the Centre.

Women's Cell

Chairperson

Dr. A Asha Devi , Scientist Senior Scale (Genetics)

Members

Smt. SS Joshi, Assistant

Smt. MS Salve, Senior Clerk

Smt. NR Gaikwad, Senior Clerk

The Women Cell met on the event of Womens' Day, on 08.03.2007 and discussed the various issues related to women at the Centre. In the meeting, points were discussed which helped in ensuring a congenial working atmosphere to the women employees.

Personnel

Awards

Dr. KE Lawande was felicitated by Mahabeej, Akola 2006 for best contribution in the field of vegetable research.

Recruitments

Name	Designation	Date of joining
Dr. RP Singh	Senior Scientist (Plant Pathology)	14.09.06
Sh. SB Tapkir	SS Gr. I	01.12.06
Smt. RD Tilekar	Jr. Clerk (on 11 month basis)	11.12.06
Sh. HS Gawali	T1 (Field / Farm Technician)	12.12.06
Sh. AD Fulsundar	SS Gr. I	13.12.06
Sh. AR Wakhare	T3 (Field / Farm Assistant)	16.12.06

Promotions

i) Smt. SS Joshi, Assistant to AAO (on Ad-hoc basis) w.e.f. 01.08.06

ii) Sh. SP Kandwal, Sr. Clerk to Assistant (on Ad-hoc basis) w.e.f. 01.08.06

iii) Smt. NR Gaikwad, Hindi Typist to Sr. Clerk (on Ad-hoc basis) w.e.f. 01.08.06

Deputation

i. Sh. N Gopal, AAO was deputed as SAO Grade II at VRDE (DRDO), Ahmednagar w.e.f. 30.06.06 (AN)

Transfers

i. Sh. AP Trivedi, Technical Assistant T-4 was transferred from NRCOG, Rajgurunagar, Pune to NRCMAP, Boriavi, Anand, Gujarat w.e.f. 30.06.06 (AN)

Retirements

i. Sh. AA Hole, SSGr.IV (Sr.Mali) was relived from his post w.e.f. 31.08.06 (AN)

Demise

i. Sh. HS Shaikh, SSGr.IV (Beldar) passed away on 14/02/2007.

Staff position

Sl. No	Category	Sanctioned Posts	Filled up posts	Vacant Posts
1.	RMP	01	01	Nil
2.	Scientific	11	10	01
3.	Technical	10	10	Nil
4.	Administrative	09	08	01
5.	Supporting	11	11	Nil
	Total	**42**	**40**	**02**

List of Staff

Name	Designation
Scientific staff	
Dr. KE Lawande	Director
Dr. CR Ramesh	Principal Scientist (Plant Pathology)
Dr. VSR Krishna Prasad	Principal Scientist (Horticulture)
Dr. PC Tripathi	Senior Scientist (Horticulture)
Dr. V Mahajan	Senior Scientist (Horticulture)
Dr. RP Singh	Senior Scientist (Plant Pathology)
Dr. AA Qureshi	Senior Scientist (Soil Science)
Dr. PS Srinivas	Scientist Senior Scale (Entomology)
Dr. Anil Khar	Scientist Senior Scale (Horticulture)
Dr. A Asha Devi	Scientist Senior Scale (Genetics)
Dr. V Sankar	Scientist Senior Scale (Horticulture)

Name	Designation
Technical staff	
Sh. VV Patil	Technical Officer T-5
Sh. NL Gore	Technical Officer T-5
Sh. AP Trivedi	Technical Assistant T-4 (till 30.06.06)
Sh. HSC Shaikh	Computer Programmer T-4
Sh. AR Wakhare	Technical Assistant T-3 (Farm)
Sh. PS Takale	Technical Assistant T-2
Sh. DM Panchal	Technical Assistant T-2 (Lab)
Sh. RB Baria	Technical Assistant T-2 (Field)
Sh. BA Dahale	Technical Assistant T-2 (Tractor Driver)
Sh. SP Yeole	Technical Assistant T-2 (Jeep Driver)
Sh. HS Gawali	Technical Assistant T-1 (Farm)
Administrative staff	
Sh. N Gopal	Assistant Administrative Officer (till 30.06.06)
Smt. SS Joshi	Assistant Administrative Officer
Sh. SP Kandwal	Assistant
Sh. DB Mundharikar	PA to Director
Sh. PS Tanwar	Senior Clerk
Smt. MS Salve	Senior Clerk
Smt. NR Gaikwad	Senior Clerk
Sh. RK Dedge	Junior Clerk
Smt. RD Tilekar	Junior Clerk
Supporting staff	
Sh. AA Hole	SS Gr. IV (Sr. Mali) (till 31.08.06)
Sh. HS Shaikh	SS Gr. IV (Beldar) (till 14.02.07)
Sh. SK Said	SS Gr. III (Beldar)
Sh. PK Khanna	SS Gr. III (Messenger)
Sh. PR Sonawane	SS Gr. II (Lab Attendant)
Sh. PE Tadge	SS Gr. II (Lab Attendant)
Sh. MS Kale	SS Gr. II (Messenger)
Sh. RS Kulkarni	SS Gr. I (Lab Attendant)
Sh. SD Waghmare	SS Gr. I (Watchman)
Sh. NH Shaikh	SS Gr. I (Messenger)
Sh. AD Fulsundar	SS Gr. I
Sh. SB Tapkir	SS Gr. I

Distinguished Guests

1	Dr. Krishna Lavhekar, Commissioner Agriculture, Pune	20.07.2006
2	Dr. A.S. Patil, Director (ARE), VSI, Pune	03.08.2006
3	Mr. Bhagwan Datar, News Editor, Loksatta, Pune	16.12.2006
4	Dr. K.V. Peter, Ex-VC, KAU, Kerala	29.12.2006
5	Dr. Shyam Singh, Director, NRC Citrus, Nagpur	30.12.2006
6	Dr. J.H. Kulkarni, VC, UAS, Dharwad	31.12.2006
7	Dr. Harihar Ram, Chief R&D, KVSIPL, Pune	01.02.2007
8	Dr. H.P. Singh, DDG (H), ICAR, New Delhi	18.02.2007
9	Mr. S.K. Pattanayak, Director, NHM, New Delhi	24.02.2007
10	Dr. H.P. Singh, DDG (H), ICAR, New Delhi	27.02.2007
11	Dr. R.B. Deshmukh, Vice-Chancellor, MPKV, Rahuri	27.02.2007
12	Mr. B.V. Gopal Reddy, MD, MSHMPB, Pune	28.02.2007
	Total number of farmers visited	**6416**

Dr. RB Deshmukh, VC, MPKV, Rahuri on a field visit to NRCOG

Finances

Financial Statement for the year 2006-2007

Head of Accounts	Rupees in Lakhs	
	Budget Allocation	Expenditure
Non-Plan	98.00	96.69
Plan	200.00	198.66
KVK	Nil	Nil
NATP	Nil	Nil
AP-CESS Fund Scheme	4.25	14.16
Pension and Retirement	7.10	7.09
P-Loan and Advances	6.00	6.00
R-Deposit Scheme	78.74	81.84
Revolving Fund Scheme	7.75	1.48
Total	**401.84**	**405.92**
Revenue Receipt	**12.63**	

Abbreviations

ADR	Agrifound Dark Red
AFLR	Agrifound Light Red
AFW	Agrifound White
AICRP	All India Co-ordinated Research Programme
ALR	Agrifound Light Red
AVT	Advanced Varietal Trial
B-780	Baswant – 780
BARC	Baba Atomic Research Centre
CMS	Cytoplasmic Male Sterile
DAT	Days after Transplanting
FYM	Farm Yard Manure
ICAR	Indian Council of Agricultural Research
INM	Integrated Nutrient Management
ISSR	Inter Simple Sequence Repeat
NABARD	National Bank for Agriculture and Rural Development
NBPGR	National Bureau of Plant Genetic Resources
NHRDF	National Horticultural Research and Development Foundation
NPK	Nitrogen Potassium and Phosphorous
PLW	Physiological Loss of Weight
PM	Poultry Manure
RAPD	Random Amplified Polymorphic DNA
rpm	Rotations per minute
SAU	State Agricultural University
TSS	Total Soluble Solids

Annexure-I

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

Month	Temperature (°C)		RH (%)		Average sunshine per day (hrs.)	Total rain fall (mm)
	Max.	Min.	Max.	Min.		
April	37.2	18.0	50	21	10.50	0.0
May	37.2	19.6	55	35	9.00	34.2
June	28.0	20.0	77	57	6.00	278.2
July	26.0	21.4	83	76	1.30	331.3
August	27.0	22.0	88	80	2.00	379.2
September	29.5	21.0	84	62	5.30	169.8
October	31.0	20.0	75	46	7.00	25.8
November	33.0	17.0	76	44	8.50	258.0
December	29.0	13.0	76	39	10.20	8.0
January	.0.0	12.1	81	34	8.60	0.0
February	27.0	11.2	75	30	8.39	0.0
March	35.0	16.0	57	24	10.06	0.0

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