Annual Report 2007-08

National Research Centre for Medicinal and Aromatic Plants
Boriavi, Anand - 387 310, Gujarat, India

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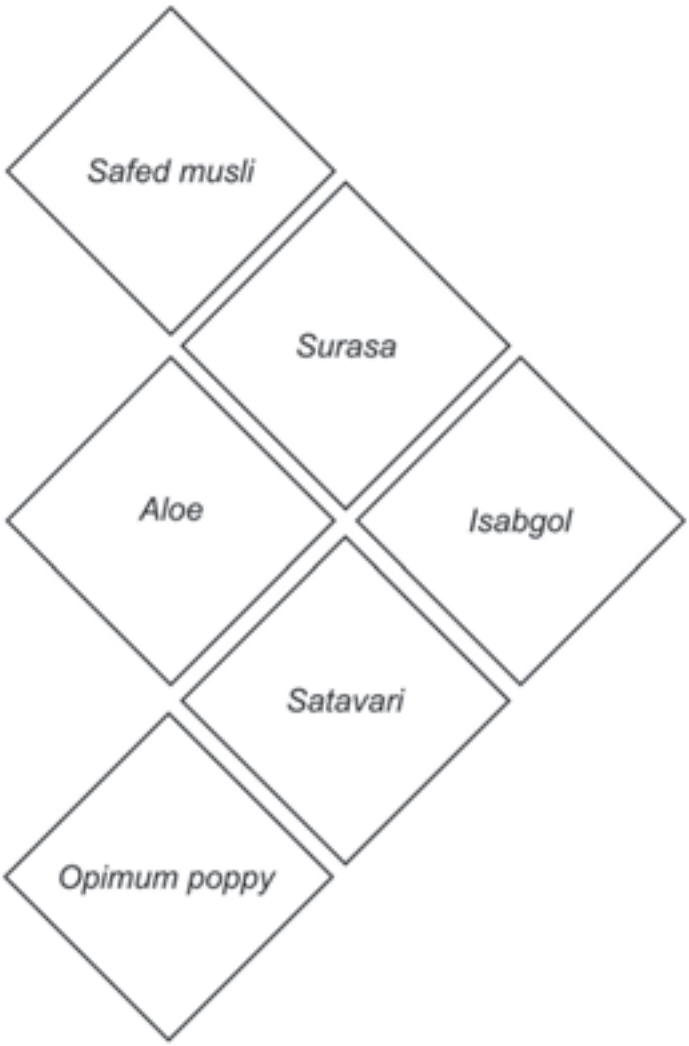

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National Research Centre for Medicinal and Aromatic Plants

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PREFACE

The journey of Medicinal and Aromatic Plant Research in ICAR system started in Plant Introduction Division of IARI, New Delhi. In 1972 All India Coordinated Research Project on Medicinal and Aromatic Plants was created under the ICAR to boost the research and cultivation of this group of plants considering its future importance in the global scenario. After gaining experience of doing research on MAP for two decades, the ICAR took another historic decision to establish a National Research Centre for Medicinal and Aromatic Plants at Anand in 1992 keeping the AICRP on MAP as an outreach programme to give a blend of basic, strategic and applied research for the popularization of the MAP cultivation in view to make the quality raw drug available to the various end users. A phenomenal progress has been made by the NRCMAP in last one decade by establishing a world class research facility for conducting basic research on crop breeding, biotechnology, phyto-chemistry, crop physiology, plant protection and crop production. Other facilities available in the NRC are well laid out experimental field, herbal garden, field gene bank, botanical garden, polyhouses, library, auditorium, etc.

NRCMAP has contributed in drafting Guidelines for Good Agricultural Practices (GAP) of Medicinal Plants which has facilitated in finalizing Guidelines for GAP of medicinal plants by the National Medicinal Plant Board (NMPB) and also initiated GAP validation cum refinement programme of five important medicinal plants with the funding of NMPB.

NRCMAP has made its mark in the research field of Medicinal and Aromatic Plants by its some of outstanding contributions during last one year. To name a few, NRCMAP has registered an elite germplasm of Andrographis paniculata with NBPGR (registration No. INGR 07041); accession IC 310610 of Tinospora cordifolia has been identified having large starch granules size; micropropagation protocol for Chlorophytum arundinaceum has been standardized and ready for transfer of technology; root knot nematode disease of Swertia chiryita caused by Meloidogyne javanica has been reported from Kalimpong, West Bengal for the first time. The NRC has also initiated an unique programme of networking of herbal gardens through generous funding from NMPB. One NAIP project for unravelling molecular processes involved in adventive polyembryony towards genetic engineering for fixation of heterosis is persuaded as partner institute. In addition, it is also working as DUS testing centre of PPV&FR, Authority.

I am hopeful that our scientists, administrator and other functionaries would continue to do their best within the boundaries provided to them which would made the NRCMAP feel proud as ever before.

I take this opportunity to place on record my gratitude to Dr. Mangala Rai, Secretary, DARE & Director General, ICAR and Dr. H. P. Singh, Deputy Director General (Horticulture)

for their keen interest and generous support in the activities of the institute. I am thankful to Dr. K. V. Ramana, Assistant Director General (Hort. II) (Upto November, 2007) and Dr. Umesh Srivastava, Assistant Director General (Hort. II) for their sustaining support in dealing the matters at headquarters. Thanks are also due to all the scientists of NRCMAP and AINRP on MAP and Betelvine for their contributions those have been included in this annual report. Timely support received from my colleagues, Dr. Manivel, Dr. Kunal Mandal, Dr. Manish Das, Dr. Sarvanan Raju and Dr. K. A. Geetha in compilation of this volume and help of Dr. Vipin Choudhary for Hindi translation of the summary are gratefully acknowledged.

Jai Hind!

Anand **Satyabrata Maiti**

December 22, 2008

सारांश

राष्ट्रीय औषधीय एवं सगंधीय पादप अनुसंधान केन्द्र व इसके बाह्य प्रसार कार्यक्रम, अखिल भारतीय पान अनुसंधान नेटवर्क परियोजना तथा अखिल भारतीय औषधीय एवं सगंधीय पादप अनुसंधान परियोजना, औषधीय एवं सगंधीय पौधो तथा पानलता पर शोध कार्य हेतु कार्यरत है । औषधीय एवं सगंधीय पौधो तथा पानलता की विभिन्न प्रजातियों पर वर्ष 2007 - 08 की महत्वपूर्ण शोध उपब्लधियां निम्नलिखित है ।

घी कंवार (*ऐलो वेरा*)

मृदु विगलन (सॉफ्ट रॉट) रोग फैलाने वाले जीवाणु (*पेक्टोबेक्टीरियम क्राईसेन्थीमी*) का पत्ती, स्तंभमूल संधि (कॉलर) तथा जड़ में निवेशन करने पर पत्ती तथा कॉलर मे इस रोग का संक्रमण हुआ जबकि जड़ में इस रोग का संक्रमण नही हुआ ।

अशोक (*सराका असोका*)

त्रिचूर केन्द्र पर बाह्य संरचनात्मक गुणो के लिए जाँचे गए 42 संकलनो में काफी विविधता देखी गई । त्रिचूर तथा त्रिवेन्द्रम से एकत्र किए गए संकलन पुष्ठ थे तथा इनमें तने की लम्बाई, पत्तीयों की संख्या तथा तने की वक्ष परिधि में काफी अधिक वृद्धि देखी गई ।

अशोका के विकसित पेडों (15 से 20 वर्ष पुराने) में किये गए पुष्पन व्यवहार के अध्ययन में यह पाया की त्रिचूर के वातावरण में फरवरी–मार्च में पुष्प उत्पादन तथा फ्लेरेट्स की संख्या अधिक पाई गई जबकि परिपक्व फलीयों की संख्या तथा प्रति फली बीजों की संख्या क्रमशः मार्च–अप्रैल तथा फरवरी से अप्रैल में अधिक थी ।

अश्वगंधा (*विथैनियां सोम्निफेरा*)

रा.औ.स.प.अनु.के. पर किये गये 140 संकलनों के मूल्यांकन में आर.ए.एस.–139 एम.एस.डबल्यू.–205, एम.एस. डबल्यू.–216, एम.एस.डबल्यू.–206, एम.एस.डबल्यू.–316, एम.एस.डबल्यू.–315 तथा एम.एस.डबल्यू.–328 पंक्तियों को हाडा बीटल द्वारा कम पसंद किया गया । आणंद केन्द्र पर संकलन 4बी, कैरट तथा भरुच में जाँच डबल्यू एस–100 की तुलना में अधिक शुष्क जड़ उपज हुई । हिसार केन्द्र पर जननद्रव्य पंक्तियां डबल्यू.एस.–124-1, डबल्यू.एस.–202, एच.डबल्यू.एस.-06-32 तथा एच.डबल्यू.एस.-06-31 में प्रति पौधा जड़ उपज जाँच जे.ए.-20 की तुलना से अधिक थी । मंदसौर केन्द्र पर जननद्रव्य एम.डबल्यू.एस.-226, एम.डबल्यू.एस.-227, आर.ए.एस.-20, आर.ए.एस.-22 तथा आर.ए.एस.-33 शुष्क जड़ उपज के लिए श्रेष्ठतम थे ।

रा.औ.स.प.अनु.के. पर विकास संबंधी अध्ययन मे यह पाया गया की आरम्भ में जड़ की लम्बाई में वृद्धि बुवाई से 30 दिन तक बहुत धीमी थी । तद्पश्चात् बुवाई के 165 दिन तक जड़ की लम्बाई में नियमित वृद्धि दर्ज की गई । तरुण जड़ो में परिपक्व जड़ो की तुलना से विथैनोफरिन–अ, 12 आक्सीविथैनोस्ट्रेमोनोलाइड तथा विथैनोलाइड–अ की मात्रा प्रति इकाई भारनुसार अधिक थी ।

फैजाबाद केन्द्र पर 10 टन प्रति है. की दर से निपडित मृदा (प्रेसमड) के प्रयोग से ताजा व शुष्क जड़ उपज जाँच की तुलना में काफी अधिक थी । उदयपुर केन्द्र पर किए गए परीक्षण में यह पाया की ओपीयम पॉपी की फसल में गोबर खाद के 15 टन प्रति है. के प्रयोग या 50 कि.ग्रा. नत्रजन प्रति है. के बराबर अरण्डी की खली के प्रयोग से ओपीयम पॉपी पश्चात् उसी खेत में बोई गयी आगामी अश्वगंधा की फसल में जड़ तथा बीज उपज में वृद्धि दर्ज हुई ।

इसी केन्द्र पर किये गये एक अन्य अध्ययन में जड़ो में रोग संक्रमण के स्रोत का पता लगाने हेतु विभिन्न स्रोतो जैसे, किसान का तबेला, बाजार तथा गोदाम इत्यादि से नमूने एकत्र किए गए । किसान के तबेले से एकत्र नमूनों में संक्रमण नही था अपितु बाजार (अगस्त तथा सितंबर माह में) तथा गोदामों (जुलाई तथा अगस्त में) से एकत्र नमूने *पेनिसिलियम* कवक से संक्रमित थे ।

काली इसबगोल (*प्लेंटेगो इण्डिका*)

रा.औ.स.प.अनु.के. पर 15 से 30 नवम्बर के मध्य बोई गई *प्लेंटेगो इण्डिका* की फसल में वृद्धि तथा उपज अधिकतम थी । एक अन्य परीक्षण में 50 से.मी. (50 x 15 से.मी.) की परस्पर दूरी वृद्धि तथा उपज की दृष्टि से श्रेष्ठ थी तथा इस दूरी पर 18.3 प्रतिशत कटाई सूचकांक के साथ अधिकतम बीज उपज 1079 कि.ग्रा. प्रति है. प्राप्त हुई ।

चन्द्रशूर (*लेपिडियम सटाइवम*)

फैजाबाद केन्द्र पर किए गए परीक्षण में 20 टन प्रति है. की दर से गोबर खाद के प्रयोग तथा 30 x 10 से.मी. दूरी से अधिकतम बीजोउत्पादन क्रमशः 14.38 तथा 13.22 क्विंटल प्रति है. प्राप्त हुआ । मंदसौर केन्द्र पर किए गए परिक्षण में 30 x 10 से.मी. की दूरी तथा 50:75:25 के अनुपात में एन.पी.के. उर्वरक प्रति है. के प्रयोग से अधिकतम उपज प्राप्त हुई । एक अन्य परीक्षण में बुवाई की तारीख तथा बीज दर का वृद्धि, उपज तथा मृदुरोमिल मिल्डयू के प्रकोप पर प्रभाव संबंधी अध्ययन में 30 अक्टूबर में बोई गई फसल तथा छ कि.ग्रा. प्रति है. बीज दर से अधिकतम उपज प्राप्त हुई । मृदुरोमिल मिल्डयू का प्रकोप जल्दी बोई गई फसल में, देर से बोई गई फसल की तुलना में कम था ।

चिरायता (*स्वार्शिया चिरायता*)

स्वार्शिय प्रजाति के लिए कालिंमपोंग केन्द्र द्वारा दार्जिलिंग जनपद के विभिन्न क्षेत्रों के व्यापक सर्वेक्षण से यह पता चला कि इस क्षेत्र में *स्वार्शिया बाईमेक्यूलेटा, स्वार्शिया चिरायता* की तुलना में बहुत्यात में उपलब्ध है ।

कालिंगपोंग के वातावरण में *स्वार्शिया चिरायता* के बीजो में अंकुरण कम पाया गया (<37%) जबकि 400 पी.पी.एम. जी.ए.-3 के उपचार से बीजों की अंकुरण प्रतिशत में वृद्धि हुई (63.66%) ।

गिलोय (*टिनोस्पोरा कॉर्डीफोलिआ*)

रा.औ.स.प.अनु.के. पर गिलोय के तरुण तथा बहुवर्षीय तनो में मांड कणो के तुलनात्मक अध्ययन से यह ज्ञात हुआ की तरुण तने में पाये जाने वाले मांड कण बहुवर्षीय तनो में पाये जाने वाले मांड कणों से छोटे आकार के थे । तरुण तनों में मांड का संग्रह वल्कुट की दरारो से शुरु हुआ, जबकि पुराने तनों में मांड का संग्रह मुख्यतया वल्कुट, मेडयूलरी रेज तथा मज्जा में था ।

एक अन्य परीक्षण में 43 संकलनों का मूल्यांकन किया गया तथा इन में पौधपुष्ठता, तने की मोटाई, पत्ती का आकार, पत्ती की कोर, पत्ती का आधार, पत्ती का रंग, मांड कण, क्रियात्मक घटक जैसे प्रकाशसंश्लेषण की दर, श्वसन दर, पत्ती द्वारा वाहिता तथा वाष्पोत्सर्जन, इत्यादि में काफी विविधता देखी गई ।

पर्ण चित्ती कवक (*सिरकोस्पोरेला टीनोस्पोरी*) पर बाहरी कारकों के अध्ययन से ज्ञात हुआ की कोनिडया का अंकुरण तथा जनन नली की लम्बाई 25-30° से. के मध्य सर्वाधिक थी । उजाले व अंधेरे का कोनिडीया अंकुरण तथा जनन नली की वृद्धि पर कोई विशेष प्रभाव नहीं था ।

हाइपेरीकम (*हाईपेरीकम पर्फोरेटम*)

नर्सरी तकनीकों के मानकीकरण हेतु किये गये अध्ययन में कांच घर में मृदा तथा वर्मीकम्पोस्ट (1:1) माध्य में बोये गए बीजो में अंकुरण अधिकतम था तथा बीज निर्गमन में लगा समय भी कम था । खुले वातावरण में अंकुरण 19.6% तथा बीज निर्गमन में लगा समय 34 दिन था ।

विभिन्न कार्बनिक संयोजको का विकास तथा उपज पर प्रभाव संबंधी अध्ययन में वर्मीकम्पोस्ट का प्रभाव विकास व उपज पर गोबर खाद से बेहतर था । जैवउर्वरकों के विभिन्न उपचार लगभग समान थे, किन्तु वर्मीकम्पोस्ट तथा *एजोटोबेक्टर* के संयोजनात्मक प्रयोग से विकास तथा उपज अधिकतम थी ।

इसबगोल (*प्लेंटेगो ओवेटा*)

आणंद पर दो वंशरूप चयन-8 तथा चयन-12 उपज की दृष्टि से जाँच जी.आई.-2 की तुलना में श्रेष्ठ पाये गए । हिसार केन्द्र पर वंशरुप पी-43, एम-5 तथा पी-33 द्वारा श्रेष्ठतम जाँच एच.आई.-5 की तुलना में प्रति पौधा बीज उपज अधिक प्राप्त हुई । आणंद पर फास्ट न्यूट्रोन-II के उपचार से नंपुसक नर पौधो की संख्या में वृद्धि हुई ।

तगर (*वेलिरियाना जटामाँसी*)

कालिमपोंग केन्द्र पर काईनेटिन 200 पी.पी.एम. तथा जी.ए.-3 (200 पी.पी.एम.) से उपचारित बीजों में अंकुरण अच्छा था तथा पौध निर्गमन में भी कम समय लगा ।

भरसार केन्द्र पर 27 वें मौसमी सप्ताह में बोई गई फसल में, पौध निर्गमन, पौध का ताजा भार, पौध की लम्बाई, जड़ की लम्बाई तथा पत्तीयों की संख्या सर्वाधिक थी । विभिन्न वृद्धि नियामकों का वृद्धि पर प्रभाव संबंधी अध्ययन में मृदा:रेत:गोबर खाद के उपचार में पौध निर्मगन, पौध का ताजा भार, पौध की लम्बाई तथा पत्तीयों की संख्या सर्वाधिक थी ।

कालमेघ (*एन्ड्रोग्राफिस पेनीकुलेटा*)

रा.औ.स.प.अनु. केन्द्र पर एक सर्वोत्तम जननद्रव्य का एन.बी.पी.जी.आर. नई दिल्ली में पंजीकरण कराया गया । जिसकी पंजीकरण संख्या आई.एन.जी.आर. 07041 है ।

अकोला केन्द्र पर 30 x 15 से.मी. की परस्पर दूरी से सर्वाधिक ताजा व शुष्क पत्ती की उपज, पौधे की उचाईं तथा एन्ड्रोग्रेफोलाईड तत्व प्राप्त हुआ । इसी प्रकार विभिन्न दिवसों पर 50 प्रतिशत पुष्पन पश्चात की गई कटाई पर अधिक ताजा व शुष्क पत्ती उपज (50 प्रतिशत पुष्पन पश्चात् 60 दिवस पर कटाई), बीज उपज (50 प्रतिशत पुष्पन पश्चात् 45 दिवस पर कटाई), एन्ड्रोग्रेफोलाईड तत्व (50 प्रतिशत पुष्पन पश्चात् 15 दिवस पर कटाई) तथा एन्ड्रोग्रेफोलाईड उपज (50 प्रतिशत पुष्पन पश्चात् 30 दिवस पर कटाई) प्राप्त हुई ।

एक अन्य परीक्षण में गोबर खाद 7.5 टन प्रति है. के प्रयोग तथा 135 दिन पश्चात कटाई द्वारा सर्वाधिक ताजा तथा शुष्क पत्ती उपज तथा एन्ड्रोग्रेफोलाईड तत्व की मात्रा प्राप्त हुई । जबकि फैजाबाद केन्द्र पर प्रेसमृदा 5 टन प्रति है. तथा पी.एस.बी. 10 कि.ग्रा. प्रति है. के संयुक्त प्रयोग से पौधे में अधिक उंचाई प्राप्त हुई, किन्तु अधिकतम प्रति पौधा प्राथमिक शाखाओं की संख्या प्रेसमृदा 10 टन प्रति है. के प्रयोग से प्राप्त हुई ।

मुलहठी (*ग्लिरसराइजा ग्लैब्रा*)

हिसार केन्द्र पर चार साल पुरानी फसल में यह देखा गया की जून माह में लगाई गई फसल में ताजा तथा शुष्क

भूस्तारीओं की उपज अधिक थी तदपश्चात् जुलाई तथा जनवरी में लगाई गई फसल का क्रम रहा । जून माह में फसल की बुवाई तथा 90 x 30 से.मी. की परस्पर दूरी द्वारा अधिकतम शुष्क भूस्तारी उपज दर्ज हुई ।

मंडुकपर्णी (*सिंटेला एसियाटिका*)

रा.औ.स.प.अनु.के. पर दो प्रकार की मंडुकपर्णीयों का आर.ए.पी.डी. सूचकों द्वारा मानकीकरण किया गया । रेखाचित्र (डेण्डोग्राम) तथा जैकार्ड के समानता गुणंक ने यह दर्शाया की दोनो मंण्डुकपर्णीयों की प्रजातिया 0.55 समानता मान के साथ काफी निकट थी ।

मैट्रिकेरीया (*मैटेरिकेरीया चेमोमीला*)

फैजाबाद केन्द्र पर 15 टन प्रति है. की दर से प्रेसमड के प्रयोग से पौधे की उचाई तथा प्राथमिक शाखाओं की संख्या अधिकतम प्राप्त हुई । जाँच नमूने (शून्य उपचार) में कलिका ने सबसे कम समय में निकलना प्रारम्भ किया । ताजा तथा शुष्क पुष्प की उपज 10 टन प्रति है. प्रेसमड के प्रयोग से अधिकतम प्राप्त हुई ।

अफीम (*पैपैवर सोम्निफेरम*)

फैजाबाद केन्द्र पर छ संकरो का जाँच नमूनो (एन.ओ.पी.-4 तथा आई.सी.-42) के साथ लेटेक्स, भूसी तथा बीज उपज के लिये मूल्यांकन किया गया । लेटेक्स में मॉर्फिन तत्व के लिये भी मूल्यांकन किया गया । किसी भी संकर द्वारा जाँच नमूनों से अधिक उपज प्राप्त नही हुई । मंदसौर केन्द्र पर 235 संकलनों का मूल्यांकन किया गया, एम.ओ.पी.-585, एम.ओ.पी.-700, एम.ओ.पी.-1055, एम.ओ.पी.-1056, एम.ओ.पी.1057, आई.सी.-3, एन.ओ.पी.-4 तथा एन.बी. पी.जी.आर.-2 की अधिक मॉर्फिन तत्व वाले संकलनों के रुप में पहचान की गई । आठ संकलन, जे.ओ.पी.-539, एम.ओ.पी.-1078, एम.ओ.पी.-1079, यू.ओ.पी.-48, एन.बी.पी.जी.आर.-5, एन.बी.आर.आई.-8, एन.बी.आर.आई.-9, तथा एन.डी.-25 मृदुरोमिल मिल्डयू के प्रति प्रतिरोधी थे ।

फैजाबाद केन्द्र पर 10 डिग्री तापमान पर सर्वाधिक मृदुरोमिल मिल्डयू के कोनीडिया का अंकुरण हुआ ।

सफेद मूसली (*क्लोरोफाईटम बोरिविलिएनम*)

विविध स्थानों पर विभिन्न जनन द्रव्यों में, मांसल जड़ उपज, मांसल जड़ की लम्बाई तथा प्रतिपौधा मांसल जड़ की संख्या में काफी विविधता देखी गयी । हिसार केन्द्र पर 23 वंशरूपों में से, वंशरूप एच.सी.बी.-5 तथा एच.सी.बी.-6 द्वारा जाँच की तुलना में अधिकतम सार्थक प्रति पौधा मांसल जड़ उपज प्राप्त हुई । मंदसौर केन्द्र पर प्रति पौधा मांसल जड़ की अधिकतम उपज एम.सी.बी.-412 से प्राप्त हुई । एक अन्य परीक्षण में तीन विकसित वंशरुपों (ए.एम.एस.वी.-II, एम.सी.बी.-412 तथा एम.सी.बी.-414) का स्थानिय जाँच (जे.एस.एम.-405) के साथ प्रारम्भिक मूल्यांकन से यह पता चला की अधिकतम प्रति पौधा मांसल जड़ उपज वंशरूप एम.सी.बी.-414 द्वारा प्राप्त हुई ।

सफेद मूसली की फसल पर छ बीटल देखी गई इन में से सुण्डी बीटल (*माईलोसिरस प्यूबीसेंट*) का फसल में प्रकोप तथा इस बीटल द्वारा फसल में नुकसान सर्वाधिक था । वर्षा ऋतु में इस कीट की जनसंख्या तथा फसल में नुकसान अधिक था ।

रा.औ.से.प.अनु.के. द्वारा तरुण पुष्पक्रम को एक्सप्लांट की तरह प्रयोग कर *क्लोरोफाईटम अरुंडीनेशियम* के सुक्ष्म संवर्धन का एक कारगर मसविदा तैयार किया गया ।

शतावर (*एस्पेरेगस रेसीमोसस*)

फैजाबाद केन्द्र पर 22 जनन द्रव्यो के मूल्यांकन से पता चला की एन.डी.ए.एस.-28 में प्रति पौधा जड़, एन.डी.ए.एस.-24 में जड़ की लम्बाई तथा ताजा व शुष्क जड़ उपज तथा एन.डी.ए.एस.-27 में जड़ का व्यास अधिकतम था ।

सनाय (*केसिया ऑगस्टीफोलिया*)

रा.औ.प.अनु.के. पर सनाय फसल में कुल 12 कीट तथा 2 मकड़ीया देखी गई । इनमें से *कैटोपसिलिया* प्रजाति की लट का प्रकोप फसल में सबसे अधिक था ।

सनाय फसल में *कैटोपसिलिया पाइरेन्थी* का प्रकोप जनवरी व फरवरी को छोडकर पूरे वर्ष था । इस कीट की गतिविधि सितंबर तथा अक्टूबर में अधिक थी तथा नवम्बर–दिसम्बर में न्यूनतम थी । फसल की उम्र का *कैटोपसिलिया पाइरेन्थी* के प्रकोप पर प्रभाव पडा । इस अध्ययन से यह पता चला की 15 तथा 30 जून को बोई गई फसल में *कैटोपसिलिया पाइरेन्थी* (लटो) का प्रकोप सितंबर तथा अक्टूबर में अधिक था । अगस्त तथा सितंबर में बोई गई फसल में *कैटोपसिलिया पाइरेन्थी* का प्रकोप काफी कम था ।

निर्गुंडी (*वीतेक्स ट्राइफोलिआ*)

निर्गुंडी के तने, पत्ती तथा वृंत के एक्सप्लांट से लिए गए कैलस संवर्धन से पौध की पुर्नोउत्पत्ति में सफलता दर्ज हुई । सूक्ष्म संवर्धन से तैयार पौधो में तथा मूल पौधो में आर.ए.पी.डी. सूचको द्वारा किए गये जैनेटिक स्थिरता अध्ययन में प्रयोगशाला में तैयार पौधो तथा मूल पौधो में कोई विविधता नही पाई गई ।

औषधिय पौधो में बीज अंकुरण संबंधी अध्ययन

रा.औ.स.प.अनु.के. पर किये गये अकुरण संबंधी अध्ययन से पता चला कि ईसबगोल तथा चन्द्रसूर में कटाई के दौरान प्रसुप्ति थी । नवम्बर माह में अंकुरण अधिकतम था जो की आठ माह के भण्डारण पश्चात घटने लगा । सनाय में बडे बीजों में, छोटो बीजों की तुलना से अधिक अंकुरण देखा गया ।

सूचना प्रबंध

एरीस सैल द्वारा एक नया प्रोजेक्ट जिसका शीर्षक ''नेटवर्किंग ऑफ हर्बल गार्डन्स फॉर क्वालिटी प्लांटीग मेटिरियल इन इण्डिया'' शुरु किया गया जिसका मुख्य उद्देश्य देश में स्थित औषधीय पौधो के बगीचो की सूचना एकत्र कर आन लाइन प्रस्तुत करना है । एक अन्य प्रोजेक्ट ''संस्थान प्रबंधन सूचना तंत्र'' (Institute Management Information System (IMIS) भी शुरु किया गया जिसका मुख्य उद्देश्य संस्थान में उपलब्ध सभी प्रकार की सूचना को कम्पयूटरीकृत करना तथा इसके द्वारा संस्थान में एक बेहतर प्रबंधन कायम करना है । वर्ष के दौरान संस्थान मे उपलब्ध विभिन्न प्रकार के डेटाबेसो का अद्यतन किया गया ।

पानलता (*पाईपर बीटल*)

संकर मूल्यांकन परीक्षण में जी.एन.-1, संकर का सांघली, कल्याणी तथा सिरुगमानी केन्द्र पर मूल्यांकन किया गया । इन सभी केन्द्रो पर यह संकर, इन केन्द्रों की स्थानिय किस्मों से बेहतर साबित नही हुआ ।

गोबर खाद तथा तैलीय खल के रूप में नत्रजन की संस्तुत खुराक अधिक उपज तथा श्रेष्ठ गुणवत्ता वाली पत्ती के लिए सभी केन्द्रो पर बेहतर साबित हुई । इसलामपुर तथा पूसा केन्द्रों पर वर्मीकम्पोस्ट के प्रयोग द्वारा अधिक फसल

उत्पादन हुआ । इन दोनों केन्द्रों पर एक अन्य परीक्षण में 1.50 लाख प्रति है. की पादप जनसंख्या द्वारा अधिकतम पत्तीयां प्राप्त हुई ।

जोरहट केन्द्र पर फरवरी तथा सितंबर माह में की गई छटाई द्वारा अधिकतम शुद्ध प्रतिफल प्राप्त हुआ जबकि कल्याणी केन्द्र पर अधिक उपज फरवरी तथा जून की छटाई द्वारा प्राप्त हुई ।

विभिन्न केन्द्रों पर जलवायु कारको का *फाईटोप्थेरा, एनथ्रेक्नोस* तथा विभिन्न जीवाणु जनित रोगो के फैलाव में प्रभाव के अध्ययन से ज्ञात हुआ कि विभिन्न जलवायु कारको की इन रोगो के फैलाव में महत्त्वपूर्ण भूमिका थी ।

जोरहट केन्द्र पर किए गए परीक्षण में *ट्राईकोडर्मा हरजीयानम* की जनसंख्या उपचार के 20 दिन पश्चात् अधिक थी तथा उपचार के 80 दिन पश्चात् कम हो गई, जबकि सिरुगमानी केन्द्र पर इस कवक की जनसंख्या मूल परिवेषी भाग में उपचार पश्चात् दिवसों में वृद्धि के साथ 20 से 80 दिवसों तक बढी । बापटला केन्द्र पर *ट्राईकोडर्मा विरडी* की जनसंख्या उपचार के 40 दिन पश्चात् अधिकतम थी तथा यह उपचार के 60 दिन पश्चात् घटना शुरु हो गई ।

बापटला केन्द्र पर प्रति पौधा तीन तंबाकू की लट तथा सिरुगमानी केन्द्र पर प्रति लता पाँच से अधिक स्केल दिखाई देने पर आर्थिक नुकसान से बचाव हेतु प्रभावी नियंत्रण आवश्यक बताया गया । कल्याणी केन्द्र पर काली मक्खी जिसकी पहचान *एल्यूरोकैन्थस* की प्रजाति के रुप में की गई, का प्रकोप पानलता में देखा गया । इसी केन्द्र पर अवशिष्ट विश्लेषण के आधार पर क्लोरपाईरीफोस तथा डाईक्लोरवोस के उपचार पश्चात् फसल की कटाई हेतु प्रतीक्षा क्रमशः 11.5 तथा 3.6 दिवस की आंकी गइ ।

बापटला केन्द्र पर *सिसबेनिया* (पानलता का जीवीत आधार) में पत्तीयों को काटने वाली चार लटों का प्रकोप अगस्त तथा सितंबर माह में अधिक था जबकि तना छेदक का प्रकोप सितंबर-अक्टूबर माह में था ।

सभी केन्द्रो पर इष्टतम पादप जनसंख्या, सिंचाई प्रबंध, अनुसूचित स्प्रे द्वारा फसल संरक्षण, जैवनियंत्रण कारक (ट्राईकोड्रमा प्रजाति) तथा आवश्यकता अनुसार अकार्बनिक उर्वरको द्वारा समन्वित फसल प्रबंध से किसानो की तकनीको की तुलना में अधिक शुद्ध प्रतिफल प्राप्त हुआ ।

अन्य गतिविधियाँ

संस्थान में शोध व विकास की गतिविधियों के मूल्यांकन एवं निरीक्षण हेतु संस्थान अनुसंधान समिति (आई.आर.सी.), अनुसंधान सलाहकार समिति (आर.ए.सी.), संस्थान प्रबंधन समिति (आई.एम.सी.) तथा मासिक बैठकें नियमित रुप से आयोजित की गई । राष्ट्रीय औषधीय एवं सगंधीय पादप अनुसंधान केन्द्र परिवार ने हिन्दी सप्ताह, संस्थान का वार्षिक दिवस, स्वतंत्रता दिवस, गणतंत्र दिवस, सतर्कता दिवस, सद्भावना दिवस इत्यादि तथा अन्य महत्त्वपूर्ण समारोह पूर्ण सोहर्द और उत्साह से मनाये । राष्ट्रीय औषधीय एवं सगंधीय पादप अनुसंधान केन्द्र तथा अखिल भारतीय पान अनुसंधान नेटवर्क परियोजना के वैज्ञानिकों ने कई महत्त्वपूर्ण शोध पत्र प्रकाशित किये । डॉ. एच.पी. सिंह, उप महानिदेशक (बागवानी), भारतीय कृषि अनुसंधान परिषद, नई दिल्ली ने संस्थान का दौरा किया तथा संस्थान में हो रहे शोध कार्यो की प्रसंशा की । संस्थान के निदेशक, डॉ. सत्यब्रत माईति द्वारा औषधिय एवं सगंधीय पादप पर तैयार डीजीटल हर्बेरीयम का शुभारम्भ किया गया ।

SUMMARY

National Research Centre for Medicinal and Aromatic Plants (NRCMAP) and its outreach programmes, All India Networking Research Project (AINRP) on Medicinal and Aromatic Plants and AINRP on Betelvine are engaged in research on these groups of plants. Important research findings of 2007-08 are presented below:

Aloe (*Aloe barbadensis*)

Inoculation of soft rot causing bacterium (*Pectobacterium chrysanthemi*) at leaf and collar produced typical disease symptoms. However, no such symptoms developed in case of root inoculation.

Asoka (*Saraca asoca*)

At Trichur, significant variability was observed in the 42 accessions for different morphological traits. Accessions collected from Trichur and Trivandrum showed vigorous growth in terms of height, leaf numbers and stem girth.

Flowering behaviour studies of 15-20 years old trees revealed that under Trichur conditions, maximum flower production occurred during February-March while, maximum mature pods and number of seeds per pod were seen during March-April and February-April, respectively.

Ashwagandha (*Withania somnifera*)

Among 140 accessions evaluated at NRCMAP, field tolerance towards hada beetles (*Henosepilachna vigintioctopunctata*) was observed in RAS-139, MWS-205, MWS-216, MWS-316, MWS-315 and MWS-328. At Anand, 3 lines *viz.*, Selection 4B, Carrot and Bharuch produced higher root yields than the check WS-100. WS-124-1, WS-202, HWS-06-32 and HWS-06-31 recorded higher fresh root yield plant^{-1} compared to the check JA-20 at Hisar. At Mandsaur, MWS-226, MWS-227, RAS-20, RAS-22 and RAS-33 were superior for root yield.

Growth studies conducted at NRCMAP revealed that root growth rate was slow till 30 days after sowing (DAS) and steady increase in length was observed upto 165 DAS. Young root had more withaferin A, 12-deoxywithanostramonolide and withanolide-A content than mature roots.

Application of 10 t ha^{-1} pressmud significantly increased fresh dry root yield at Faizabad. At Udaipur conditions, addition of 15 t ha^{-1} FYM or castor cake equivalent to 50 Kg N ha^{-1} to preceding opium poppy crop caused significant increase in root yield in succeeding ashwagandha crop.

Study conducted at Faizabad on microbial contamination in stored dry roots collected from different sources showed no fungal contaminants in the samples collected from farmers' yard. However, presence of *Penicillium* spp. was detected in the market samples (during August-September) and stores (during July-August).

Black Isabgol (*Plantago indica*)

At NRCMAP, it was observed that crop sown during 15-30th November recorded maximum growth and yield. In another experiment it was also found that row spacing of 50 cm was good for growth and yield. Maximum seed yield of 1079 kg ha^{-1} with harvest index of 18.3% was recorded at this spacing.

Chandrasur (*Lepidium sativum*)

At Faizabad, maximum seed yields of 14.38 and 13.22 q ha^{-1} was obtained with application of 20 t ha^{-1} FYM and close spacing of 30 x 10 cm, respectively. At Mandsaur, spacing of 30 x 10 cm and fertiliser dose of 50 kg N, 75 kg P and 25 kg K ha^{-1} recorded maximum grain yield. In another study on different sowing dates and seed rates, highest grain yield was recorded when the crop was sown on 30th October with the seed rate of 6 kg ha^{-1}. Incidence of downy mildew was less in early sown crop compared to late sown crop.

Chirayita (*Swertia chirayita*)

Extensive survey conducted by Kalimpong Centre in different regions of Darjeeling district (West Bengal) for *Swertia* spp. showed that population of *S. bimaculata* was quite high compared to *S. chirayita*.

At Kalimpong conditions, seed germination was very low (<37%). Treatment of GA_3 at 400 ppm was found best in increasing germination percent (63.66%).

Giloi (*Tinospora cordifolia*)

Studies on comparison of starch granules of young and perennial stems at NRCMAP revealed that in the younger stems starch granule size was smaller than older stems. Starch accumulation initiated in the furrow areas of cortex in young stems and in older stem starch granules accumulated mainly in cortex, medullary rays and pith.

Germplasm characterisation of 43 accessions at NRCMAP showed wide variability in plant vigour, stem thickness, leaf shape, leaf margin, leaf base, leaf colour, starch granules and physiological parameters like photosynthetic rate, respiration rate, leaf conductance and transpiration rate.

Study of external factors on leaf spot fungus *Cercosporella tinosporae* revealed that maximum conidial germination and highest germ tube lenght were achieved at 25-30° C. However, light and dark conditions had no significant effect on conidial germination and growth of germ tube.

Hypericum (*Hypericum perforatum*)

Studies on standardisation of seed nursery techniques at Solan showed maximum seed germination (34.2%) with minimum seedling emergence time (12.29 days) in soil :

vermicompost media in glass house conditions. Under open conditions, germination was only 19.6% with 34 days seedling emergence time.

The results of effect of different organic amendments on crop growth and yield revealed that performance of vermicompost was better than FYM. Among the bio-fertilisers (Azatobacter, PSB and VAM), all the treatments were at par, however, in combination treatments, combination of vermicompost and Azatobacter gave maximum growth and yield.

Isabgol (*Plantago ovata*)

Germplasm evaluation conducted at different centres showed that Sel-8 and Sel-12 were superior for seed yield than the check (GI 2) at Anand, whereas, at Hisar, significantly higher seed yield plant^{-1} was produced by P-43, M-5 and P-33 against the best check HI-5.

At Anand, fast neutron-II treatment increased the frequency of male sterile plants in the population.

Jatamansi (*Velariana jatamansi*)

Treating the seeds with 200 ppm Kinetin and 200 ppm GA_3 at Kalimpong resulted in good germination and reduced seedling emergence period than the control.

Under Bharsar conditions, sowing during 27th meteorological week (2nd-8th July) was best in terms of seedling emergence, seedlings fresh weight, seedling length, root length and number of leaves. Different growth media tested revealed that seedling emergence, fresh weight of seedling, seedling length and number of leaves were highest in medium of soil:sand:FYM :: 3:1:1.

Kalmegh (*Andrographis paniculata*)

An elite germplasm identified at NRCMAP was registered with NBPGR, New Delhi with registration number INGR 07041.

At Akola, spacing of 30 x 15 cm recorded significantly maximum plant height, fresh and dry foliage yields and andrographolide yield. Significantly highest fresh and dry foliage yields were recorded when harvested at 60 or 45 days after 50% flowering. However, maximum andrographolide content was recorded in crop harvested at 15 days after 50% flowering and total andrographolide yield was highest at 30 days after 50% flowering.

Application of 7.5 t ha^{-1} FYM produced significantly highest fresh and dry foliage yields at Akola. However, at Faizabad, maximum plant height was obtained with combined application of 5 t ha^{-1} pressmud + 10 Kg ha^{-1} PSB while, number of primary branches and fresh and dry herbage yields were maximum with the application of 10 t ha^{-1} pressmud.

Liquorice (*Glycyrrhiza glabra*)

At Hisar, in four years old crop, fresh and dry stolon yields were significantly maximum in June sowing followed by July and January sowing. Interaction effect of date of sowing and spacing revealed that planting in June with 90 x 30 cm spacing produced maximum fresh and dry stolon yields.

Mandukaparni (*Centella asiatica*)

At NRCMAP, two different plant types were characterised through 100 RAPD markers. The dendrogram and Jackard's similarity co-efficient showed that the two plant types were closely related with similarity value of 0.55.

Matricaria (*Matricaria chamomilla*)

At Faizabad, maximum plant height and number of primary branches were obtained with application of 15 t ha^{-1} pressmud. However, addition of no nutrients resulted in minimum days to bud initiation. Fresh and dry flower yields were maximum with the application of 10 t ha^{-1} pressmud.

Opium poppy (*Papaver somniferum*)

Six hybrids were evaluated at Faizabad for latex, husk and seed yields along with two checks. Morphine content in latex was also evaluated. However, none of the hybrids could out yield the checks. Among 235 accessions evaluated at Mandsaur, MOP-585, MOP-700, MOP-1055, MOP-1056, MOP-1057, IC-3, NOP-4 and NBPGR-2 were found to contain higher morphine while eight accessions (JOP-539, MOP-1078, MOP-1079, UOP-48, NBPGR-5, NBRI-8, NBRI-9 and ND-25) were found resistant against downy mildew under natural field conditions.

At Faizabad, it was observed that maximum number of downy mildew conidia germinated at 10° C.

Safed musli (*Chlorophytum borivilianum*)

Considerable variations in terms of fleshy root yield, length of fleshy root and number of fleshy root $plant^{-1}$ were observed among different germplasm tested at different locations. At Hisar, out of 23 genotypes, significantly higher fleshy root yield $plant^{-1}$ was recorded in HCB-5 and HCB-6 than check MCB-405. At Mandsaur, maximum fresh fleshy root yield was recorded in MCB-412. Initial evaluation of three advanced genotypes (ASBM-II, MCB-412 and MCB-414) with local check (JSM-405) at this centre revealed maximum fleshy root yield $plant^{-1}$ in MCB-414.

Six beetles were found associated with this crop under NRCMAP conditions. Of these, snout beetle (*Myllocerus pubescent*) was the most destructive and responsible for major damage to the crop. Pest population and damage were high during rainy season (July-August).

At NRCMAP, an efficient protocol for micro-propagation of *Chlorophytum arundinaceum* was developed by using inflorescence as ex-plant.

Satavari (*Asparagus racemosus*)

At Faizabad, evaluation of 22 accessions revealed that NDAS-28 had more roots plant^{-1}, NDAS-24 had maximum root length and fresh and dry root yields while NDAS-27 had maximum root diameter.

Senna (*Cassia angustifolia*)

Twelve insects and two spiders were found associated with Senna at NRCMAP. Amongst these, caterpillar of *Catopsilia* spp. was most destructive. Infestation of *C. pyranthe* was reported throughout the year except January and February. Pest activity was maximum during September-October and reduced during November-December.

Crop age also influenced infestation of *C. pyranthe*. It was found that crop sown on 15th and 30th June suffered maximum losses due to this insect during September-October, whereas in crops sown during July, maximum infestation was recorded in October. The crop sown in later months *i.e.* August and September received minimum infestation as revealed from the evaluation of incidence of pest in the subsequent months.

Surasa (*Vitex trifolia*)

At NRCMAP, plantlet regeneration was achieved in callus culture derived from stem, leaf and petiole explants. In genetic stability study of micro-propagated plants and the source plants though RAPD markers, no variation was detected within the *in vitro* raised plants and source plants.

Seed germination study of medicinal plants

At NRCMAP, germination studies showed that isabgol, black isabgol and chandrasur had seed dormancy at the time of harvesting. Maximum germination was observed during November and it started declining after 8 months of storage. In senna, bold seeds showed better germination than small seeds.

Information management (ARIS)

ARIS Cell at NRCMAP initiated a project entitled "Networking of herbal gardens for quality planting material supply in India" to compile and provide online information on medicinal plant gardens existing in India. Another project entitled "Institute Management Information System (IMIS)" refers broadly to a computer based system that provides management with the tools for organising, evaluating and efficiently running the institution was initiated. During the year, various databases have been updated and maintained.

AINRP on Betelvine

In hybrid evaluation trial, GN-1 hybrid was evaluated at Sangli, Kalyani and Sirugamani. At all these centers, its performance was lower than the released varieties of respective centers.

Recommended dose of N in the form of FYM or oil cake provided better crop performance with superior quality of leaves at all the locations. At Islampur and Pusa, application of vermicompost registered higher production of crop. Plant population of 150 lakhs ha^{-1} produced maximum marketable leaves at Pusa and Isampur. At Jorhat, lowering in the month of February and September gave highest net returns, whereas, at Kalyani, yield was highest in February and June lowering.

Epidemiological studies of *Phytophthora* rot, anthracnose and bacterial diseases at different locations revealed that climatic factors played important role in disease incidence.

Population of *Trichoderma harzianum* was maximum after 20 days after application and minimum after 80 days of application under Jorhat conditions, whereas, at Sirugamani, *Trichoderma* population in the rhizosphere region increased with the increase in the days after application from 20 to 80 days. At Bapatla, *T. viride* population was maximum after 40 days of application and started declining after 60 days of application.

Under Bapatla conditions, three tobacco caterpillars plant^{-1} caused economic losses. At Sirugamani, more than 5 scale insects vine^{-1} caused economically significant losses. At Kalyani, a black fly identified as a species of *Aleurocanthus* was observed affecting betelvine. On the basis of residual analysis, safe waiting period for chlorpyrifos and dichlorvos was 11.5 and 3.6 days, respectively.

At Bapatla, a complex of four leaf-eating caterpillars was predominant on live support (*Sesbania grandiflora*) during August to September, whereas, stem borer activity was more during September and October.

Integrated crop management through optimum plant population, irrigation management, crop protection with the spray schedules, application of bio-control agent and required inorganic fertilizers proved better in terms of net returns than farmers' practice at all the centres of AINRP.

Other activities

The Centre hold meetings of SRC, RAC, IMC and regular monthly meeting to monitor the research and developmental activities. NRC family also observed the Hindi week, Annual day, Independence day, Republic day, Vigilance day, Sadbhavana day and other important occasions with the full co-ordination and spirit. The workers of MAP and Betelvine published several research articles. Dr. H. P. Singh, DDG (Horticulture), ICAR visited the institute and appreciated the work done by NRCMAP. Online digital herbarium of MAP was launched by Dr. Satyabrata Maiti, Director, NRCMAP during the year.

introduction

Higher plants have been serving as medicinal resource for man since its origin. In most parts of the world information on medicinal plants are generally passed on from generation to generation only by means of folklore. Herbal medicine has been practised worldwide and is now recognised by WHO as an essential building block for primary health care. Today, over three quarters of the world's population rely mainly on plants and plant extracts for health care. Currently, modern medicine prescription and OTC drugs and nutritional supplements are being prepared from plants for care and prevention of variety of diseases world wide. The traditional medicine is being used in health care systems in many countries including India and it is an integrated part of individual culture.

To ensure the future availability of quality medicinal and aromatic plants (MAP), it is essential that the plants should be domesticated and their genetic resources must be conserved. Further, MAP should be brought under cultivation to maintain continuous supply of quality materials and thus reduce the pressure on the wild population.

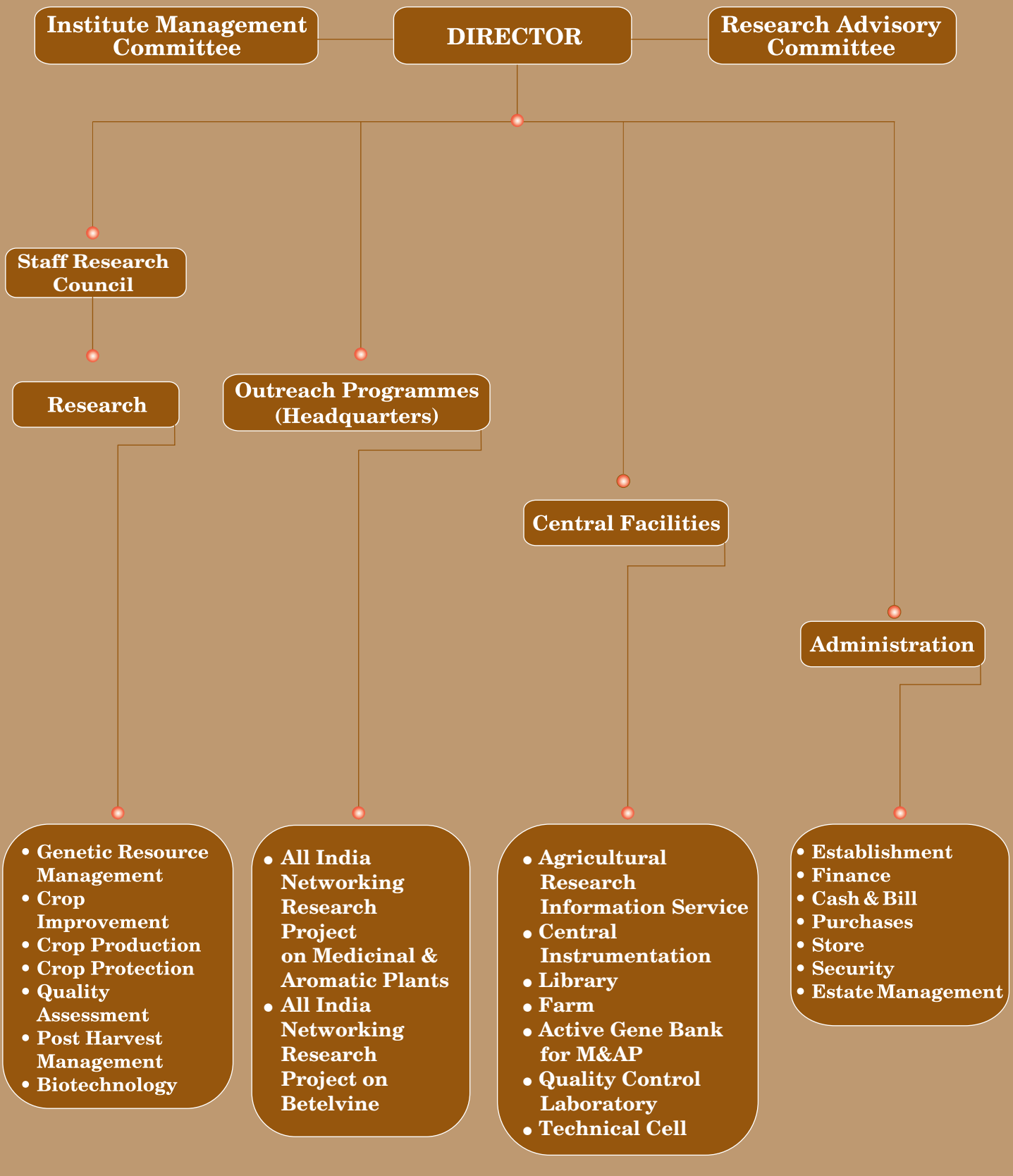
The cultivation method is tailored according to whether the species is an annual herb or perennial in nature; its growth habit *i.e.* herb, shrub, vine or tree; and requirements of growth environment (temperate, semi-temperate or tropical). Soil types to be used, irrigation and fertiliser amounts, its application schedules, sowing and harvesting times are to be standardised. Disease and pest problems in standing crops and harvested material are to be solved to keep the product safe for consumption. Initiation of plant breeding programme is just to ensure that the future crop will be high yielding, high quality and resistant to pests.

Cultivation of medicinal and aromatic plants has now become an economically viable proposition owing to their ever-increasing demand in food, pharmaceutical, perfumery, flavour and cosmetic industries all over the world. To augment the productivity of these crops, good agricultural practices (GAP) including improved plant varieties and post harvest technologies are continued to be made available to growers by many research and development organisations worldwide. National Research Centre for Medicinal and Aromatic Plants (NRCMAP) and its partners at State Agricultural University (SAU) centres under the aegies of All India Networking Research Project on Medicinal and Aromatic Plants (AINRPMAP) are ushering to fulfill this goal. This report presents the salient findings of the research conducted during 2007-08 at NRCMAP and its outreach programme by these organisations.

Mandate

- Develop GAP for important medicinal and aromatic plants through basic, strategic and applied research.
- Germplasm enhancement of various medicinal and aromatic plants.
- Production of parental lines and breeders' stock.
- Act as a National Repository for the genetic resources of some important medicinal

Organisational Structure



and aromatic plants.

- Coordinate research under the All India Networking Research Project on Medicinal & Aromatic Plants and Betelvine.
- Act as an Information Data Bank on medicinal and aromatic plants.
- Transfer of technologies developed by the NRC to the farmers through cooperation with the developmental agencies.

Mandate Crops

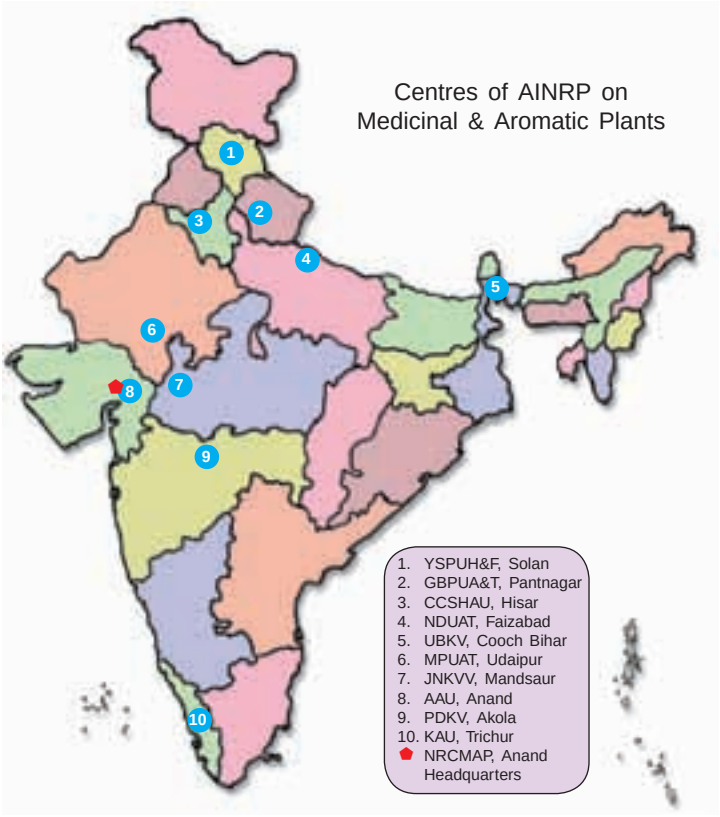
1. Isabgol (*Plantago ovata* Forsk.)
2. Senna (*Cassia angustifolia* Vahl.)
3. Ashwagandha (*Withania somnifera* Dunal.)
4. Giloi (*Tinospora cordifolia* (Willd.) Hook f. & Thoms.)
5. Guggal (*Commiphora wightii* (Arn.) Bhandari)
6. Aloe (*Aloe barbadensis* Mill.)
7. Safed musli (*Chlorophytum borivilianum* Santapau & Fernades)
8. Lemongrass (*Cymbopogon flexuosus* Nees ex. Steud Wats.)
9. Palmarosa (*Cymbopogon martinii* Stapf. Var. *motia*)

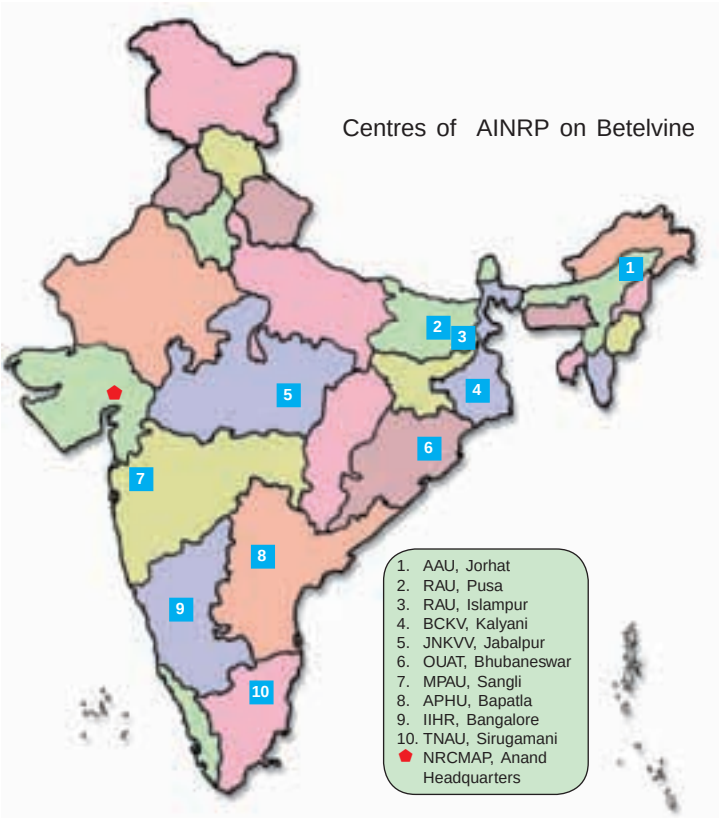
Objectives

- To identify plants which need attention of agricultural scientists and to collect, maintain and evaluate the identified plants.
- To carry out those basic researches on the chosen crops, which are useful to develop their agro-technology.
- To coordinate the activities of the centres of AINRP on Medicinal & Aromatic Plants located in various agro-climatic zones of India.
- To provide planting material and technical know-how generated for further testing and refinement by the centres of the co-ordinated project and NRCMAP.
- To develop partnership between this research centre and private sector, NGOs and farmers' associations/progressive farmers interested in promoting the use of herbal medicines.

Outreach Programmes

The head quarters of two All India Networking Projects such as All India Networking Research Project on Medicinal and Aromatic Plants (AINRPMAP) and All India Networking Research Project on Betelvine (AINRPB) are housed in the NRCMAP. The Director is also


Centres of AINRP on
Medicinal & Aromatic Plants
1
2
3
4
5
6
7
8
9
10
1. YSPUH&F, Solan
2. GBPUA&T, Pantnagar
3. CCSHAU, Hisar
4. NDUAT, Faizabad
5. UBKV, Cooch Bihar
6. MPUAT, Udaipur
7. JNKVV, Mandsaur
8. AAU, Anand
9. PDKV, Akola
10. KAU, Trichur
NRCMAP, Anand
Headquarters


Centres of AINRP on Betelvine
1
2
3
4
5
6
7
8
9
10
1. AAU, Jorhat
2. RAU, Pusa
3. RAU, Islampur
4. BCKV, Kalyani
5. JNKVV, Jabalpur
6. OUAT, Bhubaneswar
7. MPAU, Sangli
8. APHU, Bapatla
9. IIHR, Bangalore
10. TNAU, Sirugamani
NRCMAP, Anand
Headquarters

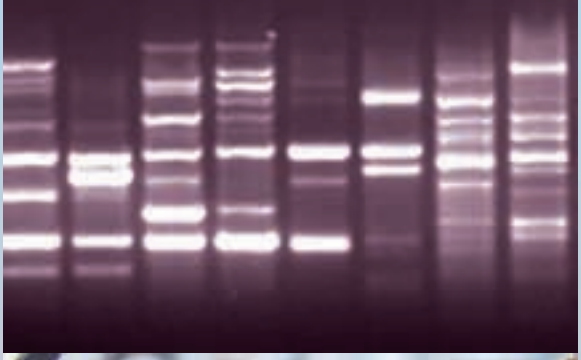
responsible for coordination and monitoring of research work in these two projects as Project Co-ordinator in addition to his duties. There are ten centers in SAUs under AINRPMAP and nine centers in SAUs and one centre at IIHR, Bangalore are participating under AINRPB.

The different centres under the AINRPs are as follows:

AINRPMAP	AINRPB
Y.S. Parmar University of Horticulture & Forestry (YSPUH&F), Solan	Assam Agricultural University (AAU), Jorhat
G.B. Pant University of Agriculture & Technology (GBPUA&T), Pantnagar	Rajendra Agricultural University (RAU), Pusa
C.C.S. Haryana Agricultural University (CCSHAU), Hisar	Rajendra Agricultural University (RAU), Islampur
N.D. University of Agriculture & Technology (NDUAT), Faizabad	Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Kalyani
Uttar Banga Krishi Vishwavidyalaya (UBKV), Cooch Bihar	Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur
Maharana Pratap University of Agriculture & Technology (MPUAT), Udaipur	Orissa University of Agriculture & Technology (OUAT), Bhubaneswar
Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Mandsaur	MP Agriculture University (MPAU), Sangli
Anand Agricultural University (AAU), Anand	Andhra Pradesh Horticultural University (APHU), Bapatla
P.D. Krishi Vishwavidyalaya (PDKV), Akola	Tamil Nadu Agricultural University (TNAU), Sirugamani
Kerala Agricultural University (KAU), Trichur	Indian Institute of Horticultural Research (IIHR), Bangalore

BUDGET PROFILE

Head	Expenditure (Rs. in lakhs)
Non Plan Expenditure	106.25
Plan Expenditure	
• NRCMAP	153.49
• AINRP on Medicinal & Aromatic plants	180.00
• AINRP on Betelvine	90.00
Ad-hoc schemes	
• Project on Digital herbarium	1.70
Externally funded projects	
• Good Agricultural Practices for MAPs	6.12
• DUS testing	4.26
• NAIP	5.57
• Central Sector Scheme	1.92
• Revolving fund scheme	0.84



research achievements

RESEARCH ACHIEVEMENTS

ALOE *(Aloe barbadensis)*

Aloe - a member of the family Liliaceae is indigenous to African countries and later naturalised in India. The plant is perennial herb with fleshy leaves and condensed stem. Leaves contain gel (polysaccharides) and leaf exudates contain aloins which are commercially useful. Gel has a cooling and moisturizing action and hence used in cosmetic industries. Aloins and aloe emodine of leaf exudate are used as pain killer and purgative.

Infection process in soft rot

Hydroponically grown healthy plants were separately inoculated at leaf, collar and root with soft rot bacterium *Pectobacterium chrysanthemi*. Leaf was punctured and inoculated with bacterial suspension and the exposed surface was covered with plastic adhesive tape. For inoculation in the collar region, the plants were punctured in this region and placed in the growing medium (Hoagland solution) so that the medium touches wounded areas. In third group, root tips were clipped and returned to the growth medium. In the latter two cases medium was supplemented with bacterial culture suspension. For each group, appropriate controls, plants wounded similarly receiving no bacterial cells, were maintained. All the control and test plants were incubated at room temperature and observed for 7 days. Plants inoculated at the collar zone and leaf, developed typical disease symptoms showing soft rot of the tissues. Whole leaf area and the collar region were destroyed due to infection by these two-inoculation techniques. Interestingly, roots of these plants did not show any visible rotting symptoms. All the control plants and plants inoculated at root did not develop any soft rot symptoms and remain healthy till the end of the experiment.

ASOKA *(Saraca asoca)*

It is a medium sized, evergreen tree, which belongs to family Fabaceae-Caesalpinoideae. It is distributed through out India particularly in humid areas. The plant is considered as sacred tree of Hindus and Buddhists. Asoka bark is widely used in Indian medicines for the treatment of uterine disorders. The activity of the drug is due to the presence of steroidal component and calcium salt. Bark also contains tannins. It is propagated by seeds and is also cultivated as an ornamental plant. Increased demand

of the raw drug in recent years has caused overexploitation of the species in wild habitats. It is one of the flagship species targeted for wide scale cultivation in south India.

Evaluation of germplasm

At Trichur, 42 accessions were evaluated for different morphological traits and significant variability was observed among these accessions. It was observed that the accessions collected from Trichur and Trivandrum showed vigorous growth represented by its increased height, number of leaves and higher girth of the stem. It was also shown that higher number of leaves had a positive association with mean girth of stem. Accessions collected from Trichur district recorded more height, number of leaves and stem girth compared to those of Trivandrum. Accession numbers 32 and 37 (both from Trichur) started flowering after two years of planting.

Flowering behaviour of mature trees

Flowering behaviour of mature asoka trees of 15 to 20 years old was studied at Trichur. Maximum flowers were produced during the months of February-March and no flowers were produced during September and October. Trees were producing flowers at least in some of the branches throughout the year except two months. Maximum number of florets was seen during March followed by February. Maximum mature pods were recorded during April followed by March. Seed setting took two months after flowering. Number of seeds per pod was also higher during February to April.

ASHWAGANDHA *(Withania somnifera)*

Ashwagandha is a member of Solanaceae family and is distributed throughout India. It is cultivated in north-western and central India. The species is an annual to perennial branched under-shrub to herb of about 30 cm to 120 cm height. Root is the major medicinally important part in addition to leaves and seeds. Alkaloids (withanoloids and withanins) present in the roots are believed to be effective in treatments of stress induced disorders, fatigue, dropsy, male impotency, neurosis, etc. It is commonly used as a general tonic. It is traditionally cultivated in Madhya Pradesh near Mandsaur and Neemach.

Evaluation of germplasm

Sixty seven germplasm lines from Mandsaur and 64 from Udaipur were obtained and added to the germplasm collection of NRCMAP which made the total collection to 140. Attempt was made to purify all these germplasm through selfing. Considerable genotypic

variability was observed for photosynthesis, respiration and transpiration among the germplasm accessions. Single plant selections were made from the germplasm lines based on plant height (dwarf, medium and tall), flowering (early/late, less/profuse), branching types (less/profuse), berry colour (red, yellow and orange) and root characters (mono root-without branching/ branched root, less/more fibrous root, short/long root, thick/thin root, etc.). Natural infestation of hada beetle (*Henosepilachna vigintioctopunctata*) was recorded at NRCMAP and field tolerance was observed in RAS-139, MWS-205, MWS-216, MWS-206, MWS-316, MWS-315 and MWS-328.

Three cultivated and two wild genotypes were evaluated at Akola for eighteen different characters and considerable differences were observed for plant height, number of main branches, leaf length and leaf breadth. The growth habit was erect in cultivated type except in Poshita whereas wild type was bushy in nature. Leaf margins were wavy in cultivated type and straight in wild type. Berry colour varied from yellow to red, the prominent yellow colour berries were noticed in JA-20 and JA-134 and Local-Hushangabad, whereas Poshita and Wild type had red berries. On the basis of plant maturity period, plants were classified into three groups *i.e.* early (150-165 days), medium (166-180 days) and late maturing (above 181 days), however, the growth habit of the wild plant was perennial.

At Anand, three selections *viz*. Selection 4B, Carrot and Bharuch recorded 21.24, 30.89 and 21.62% increase in dry root yield, respectively over the check, WS-100.

Thirty four germplasm lines were evaluated at Hisar. Highest fresh root weight plant^{-1} was recorded in WS-124-1 (71.00 g), followed by WS-202 (44.50 g) as compared to check, JA-20 (18.30 g). In another trial at Hisar, 31 wild germplasm lines were evaluated and significant variation among them was observed. The highest fresh root weight plant^{-1} was recorded in Acc.-22 (91.00 g) followed by Acc.-2 (51.00 g). At Hisar, 43 selected plants were grown in progeny row and evaluated for various morphological and root yield parameters. The highest fresh root weight plant^{-1} was recorded in genotype, HWS-06-32 (32.50 g) followed by HWS-06-31 (28.50 g) against check, JA-20 (13.75 g).

Out of 119 germplasm lines tested at Mandsaur for higher dry root yield and qualitative characters, the genotypes MWS-100, MWS-101, MWS-108, MWS-124, MWS-130, MWS-218, MWS-221, MWS-222, MWS-226, MWS-227, RAS-20, RAS-22, and RAS-33 were superior for dry root yield and MWS- 100, MWS-108, MWS-114, MWS-201, MWS-203, MWS-204, MWS-214, MWS-90, MWS-121, RAS-36 and RAS-42 for seed yield.

Four entries (one each from Anand and Udaipur and two from Mandsaur) along with local check, JA-134 were tested at Mandsaur. Significant differences for days to 50% flowering, root branches, dry root yield and seed yield were observed. MWS-100 and MWS-101 were found superior for dry root and seed yield.

Growth studies

At NRCMAP, growth study was conducted in two varieties, JA 20 and JA 134. Data were

recorded at 15 days interval starting from 30 days after sowing (DAS). Growth pattern and chemical constituents were studied. Initially the increase in root length was very slow upto 30 DAS and then it steadily increased upto 165 DAS. However, root girth and the dry weight significantly increased only after 105 DAS. The young roots had more withaferin A, 12-deoxywithanostramonolide and withanolide-A content per unit mass and during maturity, the concentrations of active ingredients decreased. However, the total active ingredients' yield increased due to the increase in dry weight of root.

Effect of different organics on growth and root yield

At Faizabad, an experiment was conducted to find out the appropriate organic sources for increasing root yield. Results revealed that the plant height and number of branches per plant did not vary significantly. The fresh and dry root yields varied significantly due to different organic amendments either alone and in combinations. Maximum fresh root production was recorded in pressmud at 10 t ha^{-1} (18.97 q ha^{-1}) followed by FYM at 10 t ha^{-1} (17.67 q ha^{-1}) and pressmud at 5 t ha^{-1} (17.36 q ha^{-1}). The minimum fresh root yield was obtained in control (12.13 q ha^{-1}). Dry root yield was maximum in pressmud at 10 t ha^{-1}(6.63 q ha^{-1}) followed by FYM at 10 t ha^{-1} (6.18 q ha^{-1}) and pressmud at 5 t ha^{-1} (5.90 q ha^{-1}).

Effect of varieties and seed rate on yield attributes and root yield

At Hisar, two released varieties JA-20 and JA-134 were sown with four seed rates 6, 8, 10 and 12 kg ha^{-1}. The results revealed that final plant population, root length and root diameter were statistically at par in these two varieties, whereas dry root weight $plant^{-1}$ and fresh and dry root yields were significantly superior in JA-134 compared to JA-20. The fresh and dry root yields were 15.8 and 23.6% higher in JA-134 than JA-20. Final plant population was significantly more with increased seed rates. The root length significantly increased in 8, 10 and 12 kg ha^{-1} seed rates compared to seed rate of 6.0 kg ha^{-1}, whereas the trend was reverse in case of root diameter and dry root weight $plant^{-1}$. Dry root yield was statistically at par between 10 and 12 kg ha^{-1} seed rates and the 12.0 kg ha^{-1} seed rate produced 51.8 and 17.5% higher dry root yield compared to 6 and 8 kg ha^{-1}, respectively.

Effect of plant growth regulators on root yield

At Mandsaur, highest root yield of 5.0 q ha^{-1} was recorded when triiodo benzoic acid (TIBA) at 50 ppm was applied, whereas the lowest yield of 3.0 q ha^{-1} was recorded in control. Further it was observed that there was no significant difference among different concentration of TIBA such as 50, 100 and 150 ppm. But these were recorded superior as compared to other treatments such as Cycocil at 250, 500 and 750 ppm and MH at 100 and 150 ppm.

Integrated nutrient management in ashwagandha-opium poppy crop rotation

In order to find out integrated nutrient management recommendation for ashwagandha-opium poppy crop rotation, an experiment was conducted at Udaipur. Successive increase in FYM levels from 5 to 15 t ha^{-1} to opium poppy significantly increased seed yield, root length and root diameter of succeeding ashwagandha crop. Application of castor cake equivalent to 50 kg N ha^{-1} to opium poppy had significantly increased root diameter, root yield and seed yield of succeeding ashwagandha compared to castor cake equivalent to 25 kg N ha^{-1}. Application of 30 kg N ha^{-1} directly to the ashwagandha crop through urea had significantly increased root yield of ashwagandha compared to no nitrogen.

Post harvest studies on fungal load on root

A study was conducted at Mandsaur to detect possible sources of microbial contamination in roots. Samples were collected from different locations comprising of farmers yard, market and storage at monthly intervals starting from June till December. The samples were tested for fungal load. It was observed that no fungal contaminants were observed in the samples collected from the farmers' yard. However, market samples showed presence of *Penicillium* spp. during August ($74x10^4$ spore g^{-1}) and September ($85x10^4$ spore g^{-1}). Considerable fungal load was also detected in storage samples collected during July and August and *Penicillium* concentrations were $70x6^4$ and $82x6^5$ spore g^{-1}, respectively during this period.

BLACK ISABGOL *(Plantago indica)*

The plant is an annual highly branched herb belongs to family Plantaginaceae. The species is popularly known as Indian Plantain. Seed coat of black isabgol is the source of the psyllium husk and it is inferior to those of *P. ovata,* since it has much lower mucilage content. Dried, ripe seed is used as laxative for the treatment of chronic constipation. Seed coat is also useful in rheumatism and inflammation. The species is grown as winter crop in Gujarat.

Influence of different dates of sowing on growth and yield

At NRCMAP, five dates of sowing (30th October, 15th November, 30th November, 15th December and 30th December) were tried. Growth parameters were significantly influenced due to different dates of sowing. Plant height, number of branches, shoot growth (fresh and dry weights) and number of nodes and internodes were maximum at all stages of crop growth in 30th October sowing followed by 15th November and 30th November sowing. Sowing on 15th November produced more bushy growth with higher number of branches (12.6, 19.9, 21.5 and 21.7 branches at 45, 60, 75 and 90 DAS, respectively). Maximum number of spikes $plant^{-1}$ was obtained in 15th November sowing (148) followed by 30th

November (145) and 30th October (135). Maximum seed yield recorded was 1156 kg ha-1 with a harvest index (HI) of 14.6% in 15th November sowing followed by 30th November (1058 kg ha-1 yield and 12.5% HI). Late sowing *i.e.* 30th December produced very low yield (578 kg ha-1) and HI (6.2%).

Influence of different spacings on growth and yield

An experiment was conducted at NRCMAP to see the effects of 6 different row spacings (50, 60, 65, 70, 75 and 80 cm). The results revealed that growth parameters were significantly influenced due to different row spacings. Maximum plant growth in terms of plant height, number of branches, shoot growth (fresh and dry weights) and leaf growth was observed in 50 cm spacing followed by 60 cm and 65 cm. Maximum plant height (106.8 cm) was recorded in 50 cm spacing at 90 days after sowing (DAS) and minimum was in 80 cm spacing (97.3 cm).

Shoot dry matter obtained was 28 to 37% more in 50 cm as compared to minimum obtained in 80 cm spacing from 50 to 90 DAS. There was 40% increase in number of leaves plant-1 in 50 cm spacing compared to 80 cm at 90 DAS. Leaf area increased by 30% in 50 cm spacing compared with 80 cm. Maximum leaf area index (LAI) was observed in 50 cm spacing (1.38) followed by 60 cm (1.31) and 65 cm (1.23) spacings at 90 DAS. Photosynthetic activity was maximum in 50 cm spacing and it was 40% more compared to that of 80 cm at 50 DAS.

Maximum number of effective spikes plant-1 was obtained in 50 cm spacing (92.3) followed by 60 cm spacing (90.3) and 65 cm spacing (77.8) and minimum being in 80 cm spacing (62.9). Number of seeds per spike varied from 31.2 (80 cm spacing) to 53.1 (50 cm spacing). Maximum seed yield was 1079 kg ha-1 with a HI of 18.3% in 50 cm spacing followed by 60 cm (1053 kg ha-1 yield and 17.8% HI) and 65 cm (876 kg ha-1 yield and 14.5% HI) and 80 cm (634 kg ha-1 yield and 9.8% HI). Test weight (1000 seeds) of seed varied from 1.18 g to 1.52 g in 80 and 50 cm spacings, respectively.

CHANDRASUR *(Lepidium sativum)*

The crop is an annual herb of family Cruciferae. It is an erect annual herb grown in rabi season. It is traditionally cultivated in the drier tracts of Gujarat, Rajasthan and Madhya Pradesh. The species is believed to originate in Ethiopia and Eritrea from where it spread to other parts of the world including India. Mucilage present in the seed coat is used to treat irritation of the mucous membrane of intestine in diarrhoea and dysentery. The leaves are used as salad, which contains high quantity of Iron. The seed mucilage popularly known as cress seed mucilage is also used as substitute of tragacanth and gum-Arabic.

Effect of nutrient and spacing on plant growth

Significant higher plant height (121.63 cm) was obtained with 20 t ha^{-1} FYM while minimum was in control (107.49 cm) at Faizabad. Number of branches also varied significantly due to FYM application and spacing. Highest number of branches (25.10) was recorded with FYM at 20 t ha^{-1} and least being observed in control (19.85). A spacing of 30 x 15 cm was found to be significantly superior over other treatments in terms of number of branches. Wider spacing (30 x 20 cm) showed production of 20.75 branches $plant^{-1}$. Fertiliser levels significantly influenced days to bud initiation which was maximum (95.33) with FYM at 20 t ha^{-1} as compared to other treatments.

Earliest bud initiation was observed in control (89.33 days). However, spacing and interaction had nonsignificant effect on bud initiation. Highest test weight (162.33 mg) was recorded with FYM at 20 t ha^{-1} and minimum being in control (160.67 mg). The wider spacing level (30 x 20 cm) performed better in terms of test weight (163.67 mg) while minimum was observed in closer spacing level of 30 x 10 cm (160.0 mg). Maximum seed yield (14.38 q ha^{-1}) was obtained with the application of higher level of FYM at 20 t ha^{-1}. The minimum yield was recorded in control (10.32 q ha^{-1}). Significantly higher seed yield (13.22 q ha^{-1}) was obtained under closer spacing (30 x 10 cm).

At Mandsaur, spacing of 30 x 10 cm recorded maximum grain yield of 20.6 q ha^{-1}, whereas the lowest yield of 11.5 q ha^{-1} was obtained with spacing of 45 x 20 cm. A fertiliser dose of NPK at 50:75:25 ha^{-1} produced the highest grain yield of 19.2 q ha^{-1} whereas, lowest grain yield of 8 q ha^{-1} was recorded with control.

Effect of sowing dates and seed rates on the growth, yield and downy mildew

A study was conducted at Mandsaur to find out effect of different sowing dates on growth, yield and downy mildew severity. Crop was sown on five different dates starting from 10th October to 20th November at 10 days intervals. Results revealed that the highest grain yield of 19.6 q ha^{-1} was recorded when sown on 30th October, whereas the lowest (14.0 q ha^{-1}) was recorded in 10th October sowing. The highest grain yield of 19.4 q ha^{-1} was recorded with seed rate of 6 kg ha^{-1}, whereas, the lowest (13.8 q ha^{-1}) was recorded with seed rate of 10 kg ha^{-1}.

Downy mildew (caused by *Hyaloperonospora parasitica*) incidence was recorded at 15 days intervals between 30th November and 30th January. It was observed that early sown crops (10th and 20th October sowing) suffered less from the disease with low incidence. In these treatments, downy mildew incidence varied from 0.6 to 3.0%. However, disease incidence increased steadily with the delay in sowing. Crop sown at the last, suffered the most with highest disease incidence (15.3%). However, as the crop approached maturity, disease incidence decreased.

CHIRAYITA *(Swertia chirayita)*

The plant belongs to family Gentianaceae. It is an erect annual herb which is distributed in temperate Himalayas from Kashmir to Bhutan. The plant is propagated by seeds. It grows well in moist, temperate forests of Himachal Pradesh. Dried herbage portion is used as raw drug. The drug is extremely bitter in taste. The bitter tonic made from the raw drug improves bile secretion and is used for the treatment of bronchial asthma, liver disorders, and anaemia. The active ingredient of the raw drug includes ophelic acid, glucosides, etc. The crop requires cold temperate climate for its growth. Nursery raised seedlings are used for propagation; however, its cultivation practices are not yet fully stanadrdised.

Survey and Collection of different *Swertia* spp.

Kalimpong centre conducted extensive survey for collection of different *Swertia* spp. from different regions of Darjeeling district: Sukhiapokhri (6,400 ft), Sonada (6,800 ft), Lava (7,200 ft), Ghoom (7,400 ft), Rimbick (6,800 ft), Algara (5,600 ft) and Takdah (5,500 ft) along with part of Sikkim. It was observed that availability of *S. bimaculata* was quite high compared to S. chirayita. Seeds were collected from the farmers' field of Sukhiapokhri for germplasm conservation.

Floral biology

Floral biology study of *Swertia chirayita* at Kalimpong indicated that flowers were regular and bisexual with four sepals alternating with petals. It had four petals, aestivation contorted, valvet, connet at the base, imbricate persistent, corolla in tubular shape. Stigma bilobed, style simple with glandular hypogynous disk. Number of anthers was 4, anther two celled basifixed. Inflorescence is - cymose and floral formula is represented by ♀ $K_4C_4A_4G_{2.}$ Where, K = Calyx, C = Corolla, A = Androceium, G = Gynoecium.

Studies on seed germination

Seed germination was very low (<37.0%) under Kalimpong conditions. GA_3 at 400 ppm was found to be the best for increasing germination (63.66%) and reducing mean germination time (22 days) followed by 500 ppm of IAA (55.00% germination and 28 days mean germination time).

Amongst all media, maximum germination (61%) was observed with compositions of soil: sand: FYM at 1:1:2 followed by 1:2:1 (57.7%) which were at par and significantly superior to rest of the media compositions.

At Solan, seeds were sown in the basal media (Soil: Sand: FYM :: 1:1:1) containing different biofertilisers. Seed germination was maximum (78.3%) when seeds were treated with GA_3 (100 ppm) for 12 hrs and sown in media containing Azotobacter, phosphate solublizing bacteria (PSB) and vesicular arbuscular mycorrhiza (VAM). Minimum germination (50.0%) was recorded in control which was statistically at par with seed sown in media containing Azotobacter and PSB each at 2 g kg^{-1} soil. Seedling dry biomass was also maximum (1.9 g $seedling^{-1}$) when seeds were treated with GA_3 (100 ppm) for 12 hrs and sown in media containing Azotobactor and VAM.

Infestation of root knot nematode

Crop at Kalimpong showed infestation with root knot nematode for the first time, which was identified as *Meloidogyne javanica*. The number of root gall produced per plant varied from 45 to 120 and number of eggs per mass were about 135-246. The severe infestation of these nematodes was seen quite distinctly with gall formation in root zone. This is new host record of *M. javonica*.

Studies on seed viability

At Solan, seed viability was studied by seed germination method. At the time of harvest, 83.3% seeds were found viable. The viability of seed was found to decrease with the increase in storage duration. Seeds became completely inviable after 15 months of storage at room temperature and 17 months of storage at 4°C. The results indicated that immediately after harvesting, seeds should be stored under refrigerated condition (4°C) and should be utilised for raising nursery in the same year during March-April for getting better germination.

GILOI *(Tinospora cordifolia)*

Giloi is a member of family Menispermaceae. It is a deciduous perennial climber and is distributed throughout tropical India. It is propagated by stem cuttings as well as by seeds. The stem and leaves are medicinally used as raw drug. Tinospora stem is a common constituent of a number of ayurvedic vital tonics for the treatment of general debility, dyspepsia, fevers and urinary diseases. Starch present in the stem along with alkaloids are the active principle of the species.

Studies on starch granules

Size of starch granules was compared in the young (upto 5 moths old) and perennial stems (above one year old) of the species at NRCMAP. It was found that in the younger

stem, starch granule size was smaller compared to the older stem. Longitudinal length varied from 3.40 to 8.10 μm in young stem while it ranged from 9.23 to 8.77μm in older stem. Vertical length ranged from 2.47 to 8.77 μm in young stem and in older stem it ranged from 5.64 to 14.50 μm. Perimeter of starch granules was from 11.47 to 29.83 μm in young stems and in older stems it was from 25.80 to 64.20 μm. Starch accumulation initiated in the younger stems in the furrow areas of the cortex and in older stem starch granules were accumulated mainly in the cortex, medullary rays and pith.

Screening of germplasm indicated that starch granule was eccentric type in the species. Starch granule size varied greatly within germplasm. Starch granular length varied from 15.31 (GAU 3) to 29.05 μm (IC 310610), vertical length varied from 9.57 (GAU 3) to 23.62 μm (IC 310610) and perimeter varied from 43.39 (GAU 3) to 88.03 μm (IC 310610). Starch shape also varied among different accessions.

Morphological and physiological characterisation

Forty three accessions were characterised based on plant vigour, stem thickness, leaf shape, leaf margin, leaf base, leaf colour, flowering and starch grains at NRCMAP. Nine accessions were slow growing, 5 were vigorous and 29 had medium growth. Leaf shape was defined as cordate and cordate elongate. Cordate leaves had leaf length:breadth ratio below 1 and that in cordate elongate leaves were above 1. Seven accessions were of cordate, twenty nine accessions were cordate elongate, six accessions were near to cordate and one accession had both cordate and cordate elongate leaves. Nineteen accessions had leaves of wavy margin and 24 had leaves of straight margin. Dark green leaves were common, however with different shades. Four accessions had parrot green colour leaves. Screening of the germplasm through physiological parameters showed that photosynthetic rate (μmolCO_2 m^{-2} s^{-1}) ranged from 25.65 (IC 283954) to 9.03 (IC 283953). Respiration rate (μmolCO_2 m^{-2} s^{-1}) ranged from 3.56 (GUJ 3) to 1.71 (IC 31008). Leaf conductance (mmol H_2O m^{-2} s^{-1}) ranged from 0.0213 to 0.065. Transpiration rate (mmolH_2O m^{-2} s^{-1}) ranged from 7.21 to 3.63. Ploidy comparison by flow cytometry revealed that there were no differences in the ploidy level among the studied germplasm.

Effect of external factors on conidia germination of *Cercosporella tinosporae*

Influence of different external factors like temperature and light on conidial germination of *C. tinosporae*- casual agent of leaf spot was studied at NRCMAP. Initiation of conidia germination started after 6 h of incubation. However, temperature did not have any role in determining incubation time for germination initiation. Highest germination (77.80%) was achieved at 25°C. However, it was at par with incubation at 30°C (75.92%). Significantly lowest germination was found when conidia were incubated at 15°C, which was statistically at par with 35°C. Highest germ tube length (85 μm) was produced at an incubation temperature of 30°C which was at par with 25°C (76.5 μm). Significantly the lowest germ tube length (53 μm) was produced at 35°C. However, incubation temperature of 15°C and

20°C, which produced germ tube of 65 μm and 66.5 μm, respectively, were statistically at par with each other and also with 35°C. There was no significant difference between light and dark conditions on conidial germination as well as growth of germ tube.

Induction of *Cercosporella tinosporae* sporulation on culture media

Small fungal colonies multiplied in potato dextrose broth (PDB) in a shaker (60 rpm) at 25°C for few days were used as inoculum for this study. On a solidified medium 2 ml stock culture from PDB was poured and evenly distributed. Three different media *viz*. potato dextrose agar (PDA), V-8 juice agar (V-8) and corn meal agar (CMA) were tested. The plates were then incubated at 25°C for a period of 7 days. Among three solid media tested for induction of conidia formation, PDA was found to be the best. Appearance of the colonies on PDA was dull. However, on V-8 the fungus produced fluffy white growth. Microscopic observation revealed that fungal colonies growing on V-8 mostly composed of vegetative mycelium. However, PDA supported asexual reproductive structures. Number of conidia produced varied significantly between the culture media used. Highest number of conidia (106×10^4 plate^{-1}) was produced on PDA and CMA produced 82.2×10^4 conidia plate^{-1}. However, significantly the lowest (33.4×10^4 plate^{-1}) conidia production was observed on V-8.

Since PDA supported maximum conidia per unit area, further study was conducted on this medium only. Incubation temperature of 15 to 35°C resulted significant difference on growth and conidia production. At 15°C growth of fungus was very low. As a result fungal colonies were sparsely distributed at this temperature. Increased temperature had gradual growth inducing effect till 30°C. However, visual observation could not distinguish between 25 and 30°C in terms of growth pattern. At 35°C fungal growth was severely affected, as a result appearance of fungal colony was seldom detected. Maximum conidia (64.5×10^4 plate^{-1}) were produced at 25°C and increase or decrease of incubation temperature resulted in lower conidia production per unit area. Incubation temperature of 30°C showed 78.29% efficiency in conidia production compared to 25°C. However, drastic reduction in conidia production was observed at 20°C and 15°C (59.69 and 32.56% that of 25°C). Incubation at 35°C did not support any conidia production.

HYPERICUM *(Hypericum perforatum)*

The species is an aromatic rhizomatic perennial herb of family Hypericaceae. It is distributed in the Western Himalyas at altitudes of 3000-10500'. It has a balsamic odour and bitter, astringent taste. The commercially important St. John's Wort Oil is prepared by using the fresh flowers of the species along with olive oil. The important chemical constituents of the herb are essential oil, tannins, resins and hypericin. The plant possesses expectorant,

diuretic properties and is used to treat pulmonary and urinary troubles, diarrhoeae and in stress related problems.

Reproductive biology

At Solan the reproductive biology of hypericum was studied. Cymose type of inflorescence was observed with flowers arranged in monochasial, helicoid pattern. The flowers were bracteate, pedicellate, actinomorphic, hypogynous, hermaphrodite, complete and bright yellow in colour. Flowering started in May and continued up to August. Calyx had five sepals, gamosepalous, connate at base, normally lanceolate with almost equal size, green with translucent dots. Odd sepal is posterior to mother axis. Average sepal length was 0.41 cm. Corolla had five petals, polypetalous, petals obliquely cut on one side, with imbricate arrangement. Odd sepal is posterior to mother axis. The yellow coloured petals have black glands in abundance (16-28 petal^{-1}) mostly on the cut side. Petal length averaged 1.25 cm. Petals persist up to capsule development stage. Stamens were numerous, arranged in three groups, with their filaments connate at base (in each group). The average filament length was 0.93 cm bearing bilobed and dorsifixed anthers. Each anther was characterised by the presence of one dark coloured gland. Gynoecium was tricarpellery, syncarpous with trilocular ovary containing numerous anatropous ovules with axile placentation. Ovary superior with three prominently radiating styles. Style length averaged 0.73 cm and the stigma tip remains surrounded by anthers. Fruit was capsule with an average length of 6.60 mm and breadth of 3.28 mm at mature stage. The unripe capsule was green in colour, turning rusty brown on maturity. Dehiscence started at the tip and continued downward, along the fusion marks of the capsule. Seeds were small, round to ovoid in shape and dark brown to black in colour. Test weight (1000 seeds) was 125 mg.

Large and small sized pollen grains were observed in the same anther. The pollen size ranged from 17.97 μm (small) to 22.18 μm (large). Pollen stainability was found to be 66.4% and all the unstained pollen was small in size. Amongst the two types of pollen, 100% of large sized and 30% of small sized pollen were stainable. Most of the pollen mother cells showed 16 bivalents at metaphase I or 16-16 segregation at anaphase I. One to three quadrivalents apart from bivalents were also observed in many cells. In some pollen mother cells, secondary associations between bivalents could also be seen. No other meiotic abnormality could be observed.

Standardisation of nursery raising techniques

An investigation was carried out at Solan to standardise nursery raising techniques for which the seeds were sown in glass house and open conditions during November in different growing media. Results revealed that maximum seed germination (54.2 %), minimum seedling emergence time (12.39 days), maximum root length (18.36 cm) and highest number of leaves (84.08 plant^{-1}) were recorded in soil : vermicompost (1:1) followed by soil : cocopeat : FYM (1:1:1) which resulted in 52.9% seed germination, 16.55 days seedling emergence

time, 17.42 cm maximum root length and 80.78 leaves plant^{-1}, under glass house conditions. Performance was better in glass house conditions as compared to open conditions. Under open conditions germination was only 19.6 % with 34 days seedling emergence time.

Effect of spacing on growth and yield

The crop was grown at six spacings at Solan. Maximum plant height (50.15 cm) was observed with closer spacing of 45 x 30 cm followed by 60 x 30 cm (48.57 cm). Plant spread was found maximum in 60 x 30 cm (99.52 cm^2) followed by 60 x 45 cm (98.71 cm^2). Aerial biomass was found maximum in spacing of 60 x 60 cm (63.91 g plant^{-1}) followed by 60 x 45 cm (63.85 g plant^{-1}) which were statistically at par with each other, but herb yield was maximum in 30 x 30 cm spacing (6.62 t ha^{-1}).

Growth and yield in different organic ammedments

Different organic ammendments comprising of manures and bio-fertilisers were tried at Solan. Results revealed that performance of vermicompost on growth and yield was better than FYM. Among biofertilisers (Azotobacter, PSB, and VAM), no significant difference was found in terms of growth and yield. But in interaction with organic manures and biofertilisers, the combination of vermicompost with Azotobacter gave maximum plant height (55.87 cm), number of branches (42.27), root length (46.35 cm) and fresh herb yield plant^{-1} (62.56 g). This was followed by combination of vermicompost with VAM and PSB.

ISABGOL *(Plantago ovata)*

The species belongs to the family Plantaginaceae. It is an annual herb grown during the rabi season. Seed coat is known as isabgol husk under trade. Upon absorption of water the husk swells and helps in peristalsis. Hence, it is used against constipation and gastrointestinal irritations. In addition, it is used in food industries for the preparation of icecreams, candy, etc. India is the leader in Isabgol production and largest exporter of husk. Country earns on an average Rs. 200 crores annually from its export. It is a cultivated species of North Gujarat, adjoining Rajasthan and Madhya Pradesh over an area of about 1,00,000 ha. A number of high yielding varieties are available for cultivation.

Evaluation of germplasm

At Hisar, 83 lines were assessed for five characters namely, plant height, branches plant^{-1}, spikes plant^{-1}, spike length and seed yield plant^{-1}. The highest seed yield plant^{-1} was recorded in genotype. P-43 (25.53 g) followed by DM-5 (24.29 g), P-33 (24.06 g) as against the best check, HI-5 (14.49 g).

Seventeen advanced lines (6 from Udaipur, 8 from Hisar) including three checks (HI-5, GI-2 and JI-4) were evaluated at Hisar in a separate experiment. Highest seed yield was recorded in HI-158 (17.289 q ha^{-1}) followed by HI-2007 (16.667 q ha^{-1}), HI-7-2 and HI-10-4 (15.124 q ha^{-1}), HI-06-2 (13.580 q ha^{-1}), HI-10-6 (12.346 q ha^{-1}) and MPI-1 (11.934 q ha^{-1}). All these seven genotypes produced significantly higher yield against the best check, HI-5 (11.729 q ha^{-1}).

At Anand, fast neutron-II treatment increased male sterile plants to about 4.5% than in natural population. The selections from mutation breeding were evaluated along with check (GI 2). Sel. 8 and Sel. 12 gave significantly higher seed yield (23% and 23.9%) over check. Number of spikes in Sel. 12 was also significantly higher than the check. Differences between Sel. 8, Sel. 12 and GI 2 were nonsignificant for all other parameters. However, none of the entries showed distinct phenotypic marker for identification.

JATAMANSI *(Valeriana jatamansi)*

The species belongs to family Valerianaceae and is a perennial herb of about 45 cm height and rootstock including rhizome is thick, nodular and aromatic. The species is distributed in the Himalayan region. Roots of the species are useful in diseases related to eye, blood, liver and spleen. Leaves are used for the treatment of headache. Roots are also used in aromatic industry. Raw drug is collected mainly from the wild since cultivation is not yet popularised. Since it is a temperate plant, it requires cold weather for proper growth.

Studies on seed germination

Seed germination studies with different growth regulators were conducted at Kalimpong and it was found that 200 ppm Kinetin and 200 ppm GA_3 treated seeds showed good germination than control. These treatments also reduced time taken in seedling emergence.

Effect of time of sowing on seedling performance

At Bharsar, observations were recorded on seedling growth parameters sown on different dates. It was found that the percent seedling emergence was highest (83 %) in 27th Meteroligical Week sowing (MWS) *i.e.* 2nd July to 8th July, which was significantly higher as compared to other dates of sowing (26th, 27th, 28th and 29th MWS) except 25th MWS. Similar trend was found in seedling fresh weight (3.25 g), which was also found to be significantly higher in 27th MWS as compared to other dates of sowing. Seedling length (6.08 cm), root length (6.13 cm) and number of leaves per plant (6.12) were also found to be significantly higher in 27th MWS.

Effect of growing media

At Bharsar, observations were recorded on different growth parameters to assess the performance of different growing media. Significantly higher seedling emergence (89%) was recorded in soil : sand : FYM (2:1:1) as compared to other treatments. Fresh weight of seedling (5.65 g) was significantly higher in treatment, soil : sand : FYM (3:1:1) which was at par with treatment, soil : sand : decomposed forest litter (3:1:1). The seedling length (6.93 cm) and number of leaves (7.87) were also significantly higher in treatment, soil : sand : FYM (3:1:1).

KALMEGH *(Andrographis paniculata)*

Kalmegh is a branched annual herb of family Acanthaceae and is of about 30-100 cm tall. The species is distributed in India, Sri Lanka, Bangladesh and Malaysia. In India it is found in the plains of Himachal Pradesh to Assam and Mizoram and also in Peninsular India. The whole herb is medicinally useful. Andrographolide is the active principle having the therapeutic action. The herb is used for treating diabetics, bronchitis, pile, jaundice and fever. It is considered as a blood purifier and used for the treatment of skin diseases.It is cultivated as kharif season crop in Gujarat, Uttar Pradesh, West Bengal, Madhya Pradesh, Orissa, Andhra Pradesh and Tamil Nadu.

Germplasm registration

Based on evaluation at NRCMAP, an elite germplasm, NRCAP 2 having compact plant type with high andrographolide content has been identified and registered with NBPGR, New Delhi with registration number INGR 07041.

Effect of spacing and harvesting time on foliage and seed yields

At Akola, spacing of 30 x 15 cm recorded significantly maximum plant height (52.06 cm) followed by 30 x 30 cm (51.85 cm) and 30 x 45 cm (47.15 cm) spacings. However, number of branches was maximum at a spacing of 30 x 45 cm (25.6 plant^{-1}). Spacing of 30 x 15 cm also produced significantly higher fresh (63.02 q ha^{-1}) and dry foliage yields (18.90 q ha^{-1}). However, spacing had non-significant effect on seed yield and andrographolide content. Total yield of andrographolide (42.68 kg ha^{-1}) was significantly higher with plant spacing of 30 x 15 cm.

Harvesting time had no significant effect on plant height. Significantly highest branches (23.66 plant $^{-1}$) and fresh and dry foliage yields (51.42 and 15.42 q ha^{-1}) were recorded with harvest at 60 days after 50% flowering. However, it was at par with harvest at 45

days after 50% flowering. The seed yield was significantly highest with harvest at 45 days after 50% flowering (1.86 q ha^{-1}), however, it was at par with harvest at 30 days after 50% flowering (1.74 q ha^{-1}). Significantly higher andrographolide content (2.36 %) was recorded with harvesting at 15 days after 50% flowering, and it was at par with harvest at 30 days after 50% flowering (2.33 %). However, total andrographolide yield was significantly higher with harvest at 30 days after 50% flowering (34.76 kg ha^{-1}) followed by harvest at 45 days after 50% flowering (32.67 kg ha^{-1}) and harvest at 15 days after 50% flowering (32.02 kg ha^{-1}). Interaction effect of spacing and harvesting time was found to be nonsignificant.

Effect of different levels of FYM and harvesting time on yield

At Akola, an experiment was conducted to assess the effect of application of FYM (at 0, 2.5, 5.0 and 7.5 t ha^{-1}) and different times of harvesting (105, 120 and 130 days after planting) on foliage yield and quality. Application of FYM significantly influenced the foliage yield, andrographolide content and its yield. Significantly highest fresh (41.29 q ha^{-1}) and dry (14.27 q ha^{-1}) foliage yields were obtained with the application of FYM at 7.5 t ha^{-1}. Similarly, highest total yield of andrographolide (34.90 kg ha^{-1}) was recorded with FYM at 7.5 t ha^{-1}, however, it was at par with FYM at 5.0 and 2.5 t ha^{-1}. FYM application had non-significant effect on andrographolide content.

Fresh (39.87 q ha^{-1}) and dry (15.15 q ha^{-1}) foliage yields and total andrographolide yield (35.15 kg ha^{-1}) were significantly higher with the harvesting at 135 days after planting (DAP) followed by harvests at 120 and 105 DAP. The interaction effect between FYM levels and harvesting time was found to be nonsignificant.

Effect of different organics on herbage yield

At Faizabad, an experiment was conducted with an aim to find out the appropriate organic sources in increasing herbage yield. Maximum plant height (61.0 cm) was recorded with the combined application of pressmud at 5 t ha^{-1} and PSB 10 kg ha^{-1}, while minimum was noted in control (49.3 cm). Application of vermicompost at 5.0 t ha^{-1} was also found beneficial in increasing plant height (60.0 cm). Data indicated that maximum number of primary branches (12.0) was obtained with the application of pressmud at 10 t ha^{-1}, which was found significantly superior over other treatments. The least number of branches was noted in control (6.0). Fresh herbage yield was significantly higher (144.03 q ha^{-1}) with the application of pressmud at 10 t ha^{-1}. Application of 10 t ha^{-1} FYM was also proved beneficial for increasing herbage yield (135.89 q ha^{-1}), which was found significantly higher as compared to other treatment including control. Some treatments like FYM at 5 t ha^{-1}, vermicompost at 5 t ha^{-1} and FYM at 5 t ha^{-1} + PSB at 10 kg ha^{-1} were found at par. However, the maximum dry herbage yield (44.55 q ha^{-1}) was recorded with the application of pressmud at 10 t ha^{-1}. Minimum dry herbage yield was recorded in control (31.50 q ha^{-1}).

LIQUORICE *(Glycyrrhiza glabra)*

The plant belongs to family Fabaceae-Papilionoideae. It is a perennial herb or sub-shrub distributed in sub-tropical and temperate zones. Under-ground stem (stolon) are used as the raw drug, which contains glycyrrhizin as the principle active ingredient. The plant can be propagated by seeds as well as by stolons. The liquorice stolons and roots are used both in medicines as well as for flavours. It is used to treat cough and gastric and duodenal ulcers, dermatitis, etc. The raw drug availability of the species within the country is not sufficient and it is mainly imported from Afghanistan by the industries.

Effect of planting dates and spacing on yield and quality

At Hisar, four years old crop showed that both fresh and dry stolon yields (339.35 and 108.41 q ha^{-1}, respectively) were significantly superior in June planting followed by July (276.69 and 89.21 q ha^{-1}) and January (239.81 and 76.62 q ha^{-1}) plantings. Lowest yield was obtained in August planting (149.74 and 47.84 q ha^{-1}). Plant spacing of 90×30 cm was statistically at par with 75×45 cm in terms of dry stolon yield compared to 75×30 cm and 90×45 cm spacings. The interaction effect between date of sowing and plant spacing for both fresh and dry stolon yields revealed that planting on June with 90×30 cm produced maximum yield.

MANDUKPARNI *(Centella asiatica)*

Mandookaparni is a member of family Apiaceae and is a prostrate slightly aromatic, perennial herb commonly found as a weed in crop fields. The species is widely distributed in India. It is propagated both by stolons as well as by seeds. It is used for the treatment of leprosy, skin diseases and to improve memory. It is also used against cholera, ulcers, bronchitis, leucorrhoea and kidney troubles. Asiaticoside, indocentelloside and thankuniside are the major glycosides responsible for the medicinal properties. Humus rich soil and partial shade are suitable for cultivation.

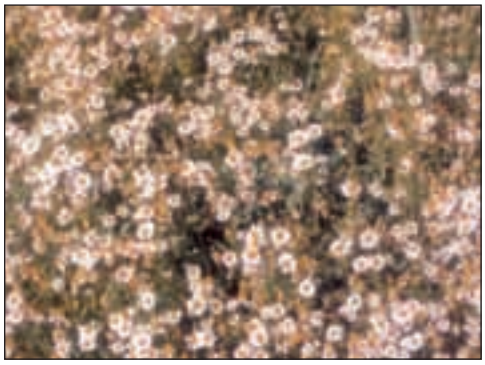
Genetic relationship studies through RAPD markers

Genetic relationship between two plant types through RAPD markers were assessed at

NRCMAP. Total genomic DNA was extracted following CTAB method (4% CTAB, 1.4 M NaCl, 20mM EDTA (pH 8.0), 100mM Tris- HCl (pH 8.0) and 0.2%(v/v) ß-mercaptoethanol).

One hundred primers from OPA, OPD, OPJ, OPN and OPP series were tested to find out the genetic relationships between two types. From OPA series of primers, all twenty numbers of primers (OPA 01-20) produced good amplification. Among the OPD series 11 primers produced clarity in banding patterns. Of all the primers of OPJ series only OPJ 02 did not show amplification. Maximum amplification and clarity in banding patterns were observed in all the primers of OPN series. Except OPP18 and OPP 20, eighteen primers showed clear bands. The data were scored for each primer plant type combination for RAPD analysis. The dendrogram and Jaccard's similarity coefficient showed that the two plant types were closely related with a similarity value of 0.55.

MATRICARIA *(Matricaria chamomilla)*



It is a highly branched aromatic herb belongs to family Asteraceae and variously known as wild, sweet, false, Persian, Hungarian or German chamomile and used as a substitute of true or Roman Chamomile (*Anthemis nobilis*). The species is distributed in Europe and at present it is cultivated in limited areas of Punjab and Gangetic Plains. The essential oil extracted from the flower heads is medicinally as well as aromatically important. It is used to treat indigestion, dyspepsia and fever and also important in perfumary.

Effect of different organics on growth and flower yield

At Faizabad, a study was carried out with an aim to find out the best organics effecting flower yield. Results revealed that the plant height varied significantly amongst various treatments. However, maximum plant height (46.1 cm) was obtained with application of 15 t ha^{-1} pressmud followed by 5 t ha^{-1} pressmud (42.4 cm). Minimum plant height (31.5 cm) was recorded in control. Application of 15 t ha^{-1} pressmud showed the highest number of branches $plant^{-1}$ (18.7) which was found significantly superior over other treatments. Control took minimum days to bud initiation (49.3) followed by FYM 5 t ha^{-1} (49.9 days) and maximum days to bud initiation was in 15 t ha^{-1} pressmud.

Fresh flower yield was significantly higher (38.6 q ha^{-1}) with the application of 10 t ha^{-1} pressmud. Application of 15 t ha^{-1} FYM produced 37.86 q ha^{-1} flower yield. Minimum flower yield (21.91 q ha^{-1}) was obtained in control. Similar trend was observed for dry flower yield. The maximum dry flower yield (8.65 q ha^{-1}) was recorded with 10 t ha^{-1} pressmud followed by 15 t ha^{-1} FYM (8.61 q ha^{-1}) and minimum in control (4.98 q ha^{-1}).

OPIUM POPPY *(Papaver somniferum)*

It is an erect herbaceous plant belongs to family Papaveraceae. The species is medicinally very important due to the presence of a group of alkaloids present in the plant parts. Latex obtained from the capsules is used for the extraction of the alkaloids. Seeds are also important for culinary as well as neutraceutical purposes. In India the crop is cultivated under the control of Narcotics Department through licensing system in selected areas of Rajasthan Madhya Pradesh and Uttar Pradesh.

Evaluation of germplasm and selected hybrids

Two hundred and thirty five lines were evaluated for different qualitative and quantitative characters at Mandsaur and higher range of variability was recorded among the characters. High (>16%) morphine content lines identified were: MOP-585, MOP-700, MOP-1055, MOP-1056, MOP-1057, IC-3, NOP-4, and NBPGR-2.

At Faizabad, 6 hybrids such as, NDH-1 and NDH-2 (from Faizabad), MOH-1 and MOH-2 (from Mandsaur), ROH-36 and ROH-42 (from Udaipur) along with two checks (NOP-4 and IC-42) were evaluated. Significant differences for latex yield ranging from 10.18 to 47.38 kg ha^{-1} were observed. Highest latex, husk and seed yields were recorded in NDH-1 followed by NOP-4 and NDH-2. These hybrids were also tested at Mandsaur along with local check (JOP-540) and national check (IC-42). Analysis of variances for latex, seed and husk yield showed the significant differences among the entries tested. Latex yield ranged from 46.29 kg ha^{-1} (NDH-2) to 66.14 kg ha^{-1} (ROH-36). Only two hybrids (ROH-36 and MOH-1) recorded higher yield than the check. The seed yield ranged from 727 kg ha^{-1} (ROH-42) to 1148 kg ha^{-1} (MOH-2). Only one hybrid (MOH-2) recorded significantly superior seed yield than the check. Higher morphine content was recorded by hybrid MOH-1 (14.2%), however, the higher morphine yield was recorded by NDH-1 (7.49 kg ha^{-1}).

In an another trial six hybrids developed at Faizabad Centre NDH-1 (NOP-1 x ND-20), NDH-2 (U.O.-285 x ND-20), NDH -3 (NOP-1 x ND-46), NDH-4 (U.O.-285 x ND-46), NDH-5 (NOP-4 x ND-46) and NDH-6 (NOP-4 x ND-20) were also evaluated for latex, husk and seed yields against two checks (NOP-4 and IC-42). Three hybrids NDH-1, NDH-2 and NDH-3 had significantly higher yield than the checks.

Determination of best temperature for downy mildew conidia germination

Optimum temperature for *in vitro* downy mildew conidia germination was determined at Faizabad. Conidia were collected early in the morning (before sunrise) by washing heavily infected leaves in sterile distilled water. After 6 h of incubation at four different temperatures

(5, 10, 15 and 20°C) it was observed that at 5°C no conidia germinated. However, at 10°C, maximum number of conidia (32%) germinated and with increasing temperature to 15°C, the germination percentage reduced to 7%. Further increase in incubation temperature to 20°C resulted with no germination.

Screening for resistance against downy mildew

A total of 235 genotypes were screened for resistance against downy mildew at Mandsaur. Screening was done under the field epiphytotic conditions. Disease index was recorded in 0-5 scales. Eight genotypes (JOP-539, MOP-1078, MOP-1079, UOP-48, NBPGR-5, NBRI-8, NBRI-9, ND-25) were found to be resistant.

SAFED MUSLI *(Chlorophytum borivilianum)*

Safed musli belongs to family Liliaceae. There are a number of Chlorophytum species, which are known as 'safed musli' under the trade of which *C. borivilianum* is the commercially utilised species. The plant is a perennial herb with condensed stem disc and a whirl of sessile leaves. Fasciculated roots contain saponins which are medicinally important. It is used as a general tonic and is a well-known aphrodisiac. The species is naturally distributed in the forest areas of Maharashtra, MP, Rajasthan and Gujarat. Raw drug is collected both from wild as well as from cultivation. Unorganised collection of the species from the natural habitat brought the species to threatened status. The plant is propagated by the stem disc with the attached fleshy roots as well as by seeds.

Evaluation of germplasm

At Hisar, 23 genotypes were evaluated and significant variation was observed for various characters. Significantly highest fleshy root yield plant^{-1} was recorded in HCB-5 (94.0 g), followed by HCB-6 (92.9 g) against the check MCB-405 (87.3 g).

Twenty-four lines were evaluated at Mandsaur. Maximum fresh fleshy root yield was recorded in MCB-412 (2888 kg ha^{-1}) followed by MCB-409 (2444 kg ha^{-1}) and MCB-424 (2333 kg ha^{-1}).

Initial evaluation of three advanced genotypes, ASMV-II, MCB-412 and MCB-414 along with local check JSM-405 was done at Mandsaur. Significant differences in fleshy root yield, length of fleshy root and number of fleshy roots plant^{-1} were observed among the genotypes. Maximum fleshy root yield of 1150 kg ha^{-1} was recorded in MCB-414 followed by ASMV-II (1132 kg ha^{-1}) and MCB-412 (1130 kg ha^{-1}).

Micropropagation of *Chlorophytum arundinaceum*

An efficient protocol for micropropagation of *C. arundinaceum* was developed at NRCMAP. Young inflorescence (~8.0 cm in length after cutting the peduncle) with intact floral buds was cut into three parts; the apex (0.0 -2.5 cm), middle (2.5-5.0 cm) and basal (5.0-8.0 cm) segments for use as explants. Direct shoot bud regeneration was achieved on half-strength Murashige and Skoog's (MS) medium supplemented with 3.0 mg l^{-1} BA, 150 mg l^{-1} Ads, 0.1 mg l^{-1} NAA and 3% sucrose under a 16-h photoperiod. The shoot buds developed within 2-3 weeks of culture. High frequency of shoot bud regeneration was achieved when cultured on similar medium in subsequent subcultures. The apex portion of the inflorescence produced more shoot buds as compared to the middle ones. More than 75% of the terminal segment explants produced shoot buds within 4-week of culture. Response of basal portion was negative for shoot bud initiation. Microshoots rooted on half-strength basal MS medium supplemented with 0.01-0.25 mg l^{-1} IBA/IAA and 2% sucrose. Best rooting was observed in 0.1 mg l^{-1} IBA after 9-10 days of culture. Micropropagated plantlets were hardened in the green house and successfully established in the soil where 90% of the plants survived.

Incidence of snout beetle

At least five to six beetles were found to be associated with the crop. Among these, three belonging to Curculionidae were economically important and the rest were ground beetle, mainly predacious. Of the three economically important beetles, the black coloured beetle having round abdomen which was identified as *Myllocerus pubescent* was the most destructive and was responsible for major damage. One month after planting when size of leaf whorl increased, infestation of snout beetle was detected. The beetle resided inside the lower portion of the whorl and fed on the margin of leaves in randomised fashion. In severe cases when feeding from both the margin reached to mid rib, the leaf bent down at this point and appeared as if it was cut down. Subsequently, the cut end turned yellow and later died.

During second fortnight of July, percent damage was 22.89 with 19 adults $plant^{-1}$. Percent damage remained static at this level (21.49%) during August, while number of adults $plant^{-1}$ decreased to 5. The infestation was very low during September. No fresh damage due to beetle could be observed and also number of adults in the screened plants was very less. The beetle being ploy phagous, did not specifically dwell in the safed musli plants. Hence, no correlation between percent plant damage and number of adults per plant could be observed.

SATAVARI *(Asparagus racemosus)*

It is a member of Liliacaeae family. Satavari is a perennial spiny climber and is distributed throughout tropical and subtropical India. Cladodes are in tufts of 2-6 and leaves are reduced to spines. Fasciculated roots are medicinally important. It contains saponins and is used for the treatment of dysentery, tumours, rheumatism and kidney and liver disorders. Powdered roots are common ingredient of a number of vital tonics.

Evaluation of germplasm

At Faizabad, 22 accessions were evaluated for various characters related to fleshy root. Considerable variation was observed in number of roots plant^{-1}, root length, root diameter and fresh and dry weights of root. Some of the promising lines based on the studied characters were NDAS-28 (316 roots plant^{-1}), NDAS-24 (root length 48.0 cm), NDAS- 27 (root diameter 1.39 cm) and NDAS-24 (fresh and dry root yields 7.89 and 1.79 kg plant^{-1}).

Floral biology

Floral biology was studied at Faizabad and it was found that the inflorescence was raceme, indeterminate, alternately arranged on main stem and bears secondary branches with white florets. Anthesis started from 5.00 AM and continued up to 11.00 AM. Bud to flower opening took 11 to 14 days. Stigma was receptive for 30-32 hours. Pollen viability was 95-98%. Flower to berry setting took 11-13 days and between berry setting to seed maturity required 90-100 days. Natural seed setting was 65-73% and seed setting under selfing was 63-70 %.

SENNA *(Cassia angustifolia)*

Senna belongs to family Fabaceae-Caesalpinoideae. It is a native to Yemen and parts of Pakistan. Dried young leaves, flowers and 3-5 days old pods are used as source of raw drug. It contains sennosides which is responsible for the purgative action. In European countries, it is used as herbal tea. In world market, there are two sources of senna raw drug, one is Tinnevely Senna, which has gone from India and the other is Alexandrian senna that has gone from Arabian Countries. The former species is *Cassia angustifolia* and the latter is *Cassia acutifolia*. In India the species is cultivated both as irrigated and rain-fed crop in Tamil Nadu, Rajasthan and Gujarat. Seeds are used for propagation.

Incidence of insect pest

Altogether 12 insects belonging to order Lepidoptera (07), Coleoptera (02), Homoptera (01), Isoptera (01) and Mentodia (01) apart from Araneae (02) were found to be associated with this crop at NRCMAP. Amongst them, caterpillar of *Catopsilia* spp. was major pest.

To understand the seasonal distribution of *Catopsilia pyranthe* population observations were taken at monthly intervals starting from May to March. The adults were common during May to August and again during March. All other life stages *viz.,* egg, larva and pupa were present during these months. The adults and number of eggs in the month of June were more, however in July-August due to rains the number of adults decreased and correspondingly the number of eggs and larvae were also less during this period. The adult population again became abundant in post rainy season (during September and October) when humidity was more. Correspondingly, eggs and larvae populations were also high during these months. Hence, infestation was maximum during these months. The population started dwindling with the decrease in temperature from November and was totally absent during January and February. In March with the increase in temperature, activity of adults was seen and stray incidence of egg laying was also observed but no immature stages could be recorded.

Effect of different sowing dates on *Catopsilia* population

At NRCMAP a study was conducted to know the effect of date of sowing on incidence of *C. pyranthe* The crop was sown at fortnightly intervals starting from 15th June to 28th September and population index was determined at monthly intervals.

Infestation of *C. pyranthe* was more during September and October. In August 48.20% infestation was recorded on the crop sown on 15th June and it was only 2.22% in the crop sown on 30th June with corresponding population of different life stages of *C. pyranthe*. Infestation was further increased in September when 97.6, 50.0 and 19.74% infestation was observed in crop sown on 15th June, 30th June and 15th July, respectively and it reached to maximum in October when 87.6-100 percent infestation was observed in the crop sown on 15th June and 30th June and 38-50% in the crop sown on 15th July, 30th July, 14th August and 29th August. The population of different life stages of *C. pyranthe* was also correspondingly increased during these months with maximum in October. Thereafter infestation started dwindling and only 0-2.3% infestation was found in crop sown in June and July, however, the infestation was slightly more and correspondingly the different life stages was also more in crop sown in August and September. With the decline in temperature, infestation of *C. pyranthe* also declined and during December, only 3.2 per cent infestation was reported in the crop sown on 28th September. In January and February the adult of *C. pyranthe* was totally absent and accordingly no egg and larvae were reported from the crop. However, with the increase in temperature in March the activity of *C. pyranthe* was again observed and stray incidence of egg laying was also observed.

SURASA *(Vitex trifolia)*

It is a stout aromatic shrub or small tree of family Verbenaceae. The species is distributed throughout India. The shrub resembles *Vitex nigundo* (Nagod) and possesses common medicinal properties. The leaves are medicinally important and are used against the treatment of rheumatic pains, sprains, etc. The leaves also have insecticidal and antibacterial properties. The plant can be propagated by vegetative cuttings as well as by seeds. Generally the species is grown as a hedge plant.

Assessment of genetic fidelity of the micropropagated plants

At NRCMAP, plantlet regeneration was achieved in callus cultures derived from stem, leaf and petiole explants on MS medium supplemented with 0.1-2.5 mg l^{-1} BAP, 0.1-3.0 mg l^{-1} NAA and 3% sucrose. Addition of 50-100 mg l^{-1} Ads and 0.25-0.5 mg l^{-1} GA_3 to the culture medium increased the growth of shoot buds. The highest rate of shoot bud regeneration responses were obtained in stem explants using 3.0 mg l^{-1} BA in combination with 0.1 mg l^{-1} NAA, 100 mg l^{-1} Ads and 0.5 mg l^{-1} GA_3. Rooting of the differentiated shoots was achieved in media containing 0.25 mg l^{-1} IBA with 2% sucrose. However, there was still possibility of generating somaclonal variations due to several factors. Therefore, a study was made to assess the genetic stability of micropropagated plants and the source plants through RAPD markers. Forty different decamers (OPA, OPN and OPP series) were used to amplify DNA from *in vitro* and *in vivo* donor plants to assess the genetic integrity. Out of them, six primers (OPA 09, OPA 10, OPN02, OPN04, OPN06, and OPN19) were selected on the basis of their clarity in the electrophoresis banding patterns. All RAPD profiles from in vitro raised plants were monomorphic and similar to that of field grown donor plants. No variation was detected within the *in vitro* raised plants and also with the source plant.

SEED GERMINATION EXPERIMENT

Germination in different genotypes of *Plantago* species, Chandrasur and Senna

At NRCMAP, one year old seeds of isabgol (cvs. GI 2 and Niharika), black isabgol, chandrasur (cv. GA 1) and senna (cv. ALFT 1) were subjected to germination testing.

Isabgol *(Plantago ovata)* varieties GI 2 and Niharika had initial dormancy with more than 80%, *P. indica* with less than 60% and chandrasur with 60-70% dormancy in the month of April. Subsequently, germination speed increased and dormancy reduced thus reducing mean germination time (MGT) in all the genotypes. Germination became maximum (100%)

in November. However, it started decreasing after 8 months of storage without affecting the MGT. Germination was more than 70% after 10 months of storage. Germination at 21°C was significantly better than 25°C in all the months and genotypes.

In senna, bold seeds showed better germination than small seeds. Germination, emergence index and germination speed were higher at 25°C as compared to 21°C. Germination of big seeds was 70.1% at 25°C as compared to only 14.8% at 21°C, whereas, it was 56.6 % in small seeds at 25°C and 11.3% at 21°C. There was no significant difference so far as colour (green and white) of seed was concerned.

GERMPLASM HOLDING OF MEDICINAL AND AROMATIC PLANTS

Herbal garden and Arboretum

At NRCMAP herbal garden a total of 250 medicinal and aromatic plant species in addition to 110 tree species in the arboretum are being maintained. Farmers, students, NGOs, and scientists visited and got benefited from the gardens. Also sample seeds, rooted cuttings, slips, etc. were supplied to the interested parties for their use.

Germplasm maintained at NRCMAP

S. No.	Species	Total
1.	*Aloe* spp.	55
2.	*Andrographis paniculata*	59
3.	*Asparagus* spp.	47
4.	*Cassia angustifolia*	5
5.	*Chlorophytum borivilianum*	54
6.	*Commiphora* spp	67
7.	*Cymbopogon flexuousus*	13
8.	*Datura spp.*	2
9.	*Evolvulus alsinoides*	3
10.	*Phyllanthus* spp	13
11.	*Tinospora cordifolia*	38
12.	*Tribulus terrestris*	7
13.	*Urgenia* spp	6
14.	*Withania somnifera*	140
15.	*Plantago* spp.	6
16.	*Plantago ovata*	87
Total		**602**

Germplasm maintained at different AINRP on MAP centers

Sl No.	Crop/Species	Centre	No. of Accessions
1	*Aloe* spp.	Anand Trichur Udaipur Faizabad Hisar	20 14 5 2 25
2	*Andrographis paniculata*	Anand Hisar Trichur	5 13 6
3	*Asparagus* spp.	Hisar Anand Faizabad	24 6 28
4	*Bacopa monnieri*	Trichur	29
5	*Cassia angustifolia*	Anand	3
6	*Catharanthus* spp.	Anand	6
7	*Chlorophytum borivilianum*	Anand Hisar Mandsaur Udaipur	18 12 24 32
8	*Chlorophytum tuberosum*	Anand	1
9	*Commiphora stocksiana*	Anand	1
10	*Commiphora wightii*	Anand Udaipur	32 16
11	*Cymbopogon flexuosus*	Hisar Trichur Faizabad	40 20 16
12	*Cymbopogon martinii*	Hisar Faizabad	64 01
13	*Cymbopogon winterianus*	Hisar	6
14	*Gentiana kurroo*	Solan	9
15	*Glycyrrhiza glabra*	Hisar Anand	3 2
16	*Gymnema sylvestre*	Hisar	9
17	*Hyoscyamus* spp.	Solan	14
18	*Heracleum* spp.	Solan	10
19	*Hypericum perforatum*	Solan	5
20	*Intigofera tinctoria*	Trichur	25
21	*Kaempferia galanga*	Trichur	12

Sl No.	Crop/Species	Centre	No. of Accessions
22	*Lepidium sativum*	Anand Mandsaur	10 10
23	*Matricaria chamomilla*	Solan	4
24	*Mentha* spp.	Hisar Solan Faizabad	7 9 01
25	*Mucuna* spp.	Hisar Solan	4 7
26	*Nelumbo nucifera*	Trichur Hisar	24 4
27	*Ocimum* spp.	Hisar	18
28	*Papaver somniferum*	Faizabad Mandsaur Udaipur	40 235 90
29	*Pelargonium graveolense*	Udaipur	6
30	*Piper longum*	Trichur	67
31	*Plantago ovata*	Anand Mandsaur Hisar Udaipur	39 80 83 68
32	*Plantago* spp.	Anand	5
33	*Plumbago rosea*	Trichur	25
34	*Podophyllum hexandrum*	Solan	12
35	*Picrorhiza kurroa*	Solan	25
36	*Pogostemon cablin*	Udaipur Trichur	3 6
37	*Psoralea corylifolia*	Faizabad	02
38	*Tinospora cordifolia*	Trichur Anand Hisar	12 12 30
39	*Saraca asoca*	Trichur	42
40	*Silybum marianum*	Anand	10
41	*Valeriana jatamansi*	Solan	30
42	*Vetiveria zizanioides*	Trichur Faizabad Hisar	37 12 25
43	*Withania somnifera*	Mandsaur Udaipur Hisar Anand	118 52 50 6

INFORMATION MANAGEMENT (ARIS)

Networking of Herbal Gardens for quality planting material supply in India

There are a number of herbal gardens existing in India. However, there is no system for getting information of these nationwide spread herbal gardens. Hence, a project entitled "Networking of Herbal Gardens for quality planting material supply in India" funded by National Medicinal Plants Board, New Delhi was initiated. It was planned to compile and provide online data base information on medicinal plants gardens existing in India. Hence this networking of herbal garden shall maintain a conservatory of not only the most common and important species of medicinal and aromatic plants which are being used in day-to-day primary health care but also take care of those species which are under various degrees of threats in India. This will provide de-centralised access to information of the herbal gardens of India for the common people.

The designing and development of the web based information system was undertaken with the following main activities:

- Identify the locations of herbal gardens in India
- Construct a herbal garden network and link up all the herbal gardens to this net
- Database development on number of species, availability of planting material, quantity of the available planting material, cost of planting material, etc., from different herbal gardens of India under this umbrella
- Development of web based software package
- Provide online information about the herbal gardens and facilitate the exchange of medicinal species among the member herbal gardens within the country

Institute Management Information System

ARIS cell initiated a project entitled Institute Management Information System (IMIS) refers broadly to a computer-based system that provides management with the tools for organizing, evaluating and efficiently running the institution. MIS helps in decision making on database resources such as Research Information, Project management, Human resources information, Physical resources information, and any computerised processes that enable the department to run efficiently. This project deals with the collection, compilation, digitalisation and development of software package on the institute MIS information and a variety of reports retrieval will be generated for planning, monitoring and evaluation.

Databases

During the year, attempts are continued for updating the databases like Medicinal and Aromatic Plants References Information System, Traders Information system on Medicinal

and Aromatic plants, Website of NRCMAP, Digital Photo Library of Medicinal & Aromatic Plants, and Digital Herbarium of Medicinal & Aromatic Plants in India.

ALL INDIA NETWORKING RESEARCH PROJECT ON BETELVINE

All India Networking Research Project on Betelvine is in operation in ten centres. Nine of these centres are in operation in various state agricultural universities and one under ICAR institute (IIHR, Bangalore). The Isalmpur centre under Rajendra Agricultural University, Bihar is working exclusively on development of production technology of Maghai pan. The centre at IIHR Central Horticultural Experimental Station, Hirehallay is working on breeding through hybridisation. A multidisciplinary team of scientists of plant breeding, agronomy, horticulture, plant pathology and entomology are working on various aspects of crop improvement, crop production, crop protection, post harvest physiology, etc. Emphasis was given for development of Integrated Crop Management (IPM) module by incorporating efficient nutrient and water management strategies as well as IPM for major insect pests and diseases.

Germplasm collection, maintenance and evaluation

Germplasm maintained, evaluated and catalogued during the year at different centres are as follows:

Centres	Total collections	Catalogued
APHU, Bapatla	51	51
AAU, Jorhat	14	14
BCKV, Kalyani	39	39
IIHR, Hirehallay	104	-
JNKVV, Jabalpur	20	20
MPAV, Sangli	28	28
OUAT, Bhubaneswar	40	40
RAU, Pusa	20	20
RAU, Islampur	16	16
TNAU, Sirugamani	45	45

Major emphasis was given to leaf characteristics, vine growth, resistance to pest and diseases, keeping quality and organoleptic properties while evaluating the betelvine germplasm.

Hybrid evaluation trial

Growth of GN_1 hybrid was very slow compared to check variety, Krishna Pan at Sangli. GN_1 hybrid produced 55 leaves compared to 190 by Krishna pan. Leaf weight of GN_1 hybrid was also less (190 g for 100 leaves) compared to the latter (240 g for 100 leaves). However, keeping quality was 19 days in GN_1 hybrid which was two days more than the local check. At Kalyani, the GN_1 hybrid was successfully raised and maintained in Bareja for evaluation. At Sirugamani, among the entries, GN_1 hybrid was found promising and yielded 47.47 lakh leaves ha^{-1} yr^{-1} which was lower than the released varieties SGM1 (55.73 lakh leaves ha^{-1} yr^{-1}) and SGM BV-2 (53.36 lakh leaves ha^{-1} yr^{-1}). SGM-1 registered more number of laterals (24.3 $vines^{-1}$) followed by Kalipatti (16 $vine^{-1}$).

Hybridisation programme

Flowering was observed in fifty accessions out of which 29 were female and 21 male clones at Hirehally. Flowering was observed for the first time in 11 female accessions and 9 male accessions. Among the new accessions flowered, Kalipatti has shown very shy flowering and bore very few flowers and laterals. The accessions Kakair, Bangla Mandsore, Meetha pan, Maghai and Kali patti did not produce either laterals or flowers even two years after planting.

It was found that maximum number of female and male accessions came to flowering during February to March. Thereafter, reduced flowering and pollen production were observed in male clones. Reduction of flowering in female clones was observed during November to January.

A total of 141 different cross combinations were carried out using 1713 catkins involving 25 female and 21 male clones. Higher number of catkins were crossed in female parent SGM 1 (288) and 18 male parents were used for hybridisation followed by Halisahar Sanchi and Ramtek Bangla where 209 and 166 female catkins were hybridised with 10 and 8 male parents respectively. Out of the 25 female parents used, six were crossed with single male parent and all other parents were crossed with 2 or more male parents. Among the male parents, Vasani Kapoori (187), Tellaku Chintalapudi (185), Swarna Kapoori (175) and Kapoori Cuddapah (173) were widely used for pollination of female catkins.

Seed germination and raising of hybrid seedlings

A total of 480 fruits were harvested from 83 crosses. Maximum number of fruits were harvested from the female parents SGM 1 (139) followed by Simrali Babna (local) (85) and Bangla (MP) (52). The seed germination varied from 2.2 to 67.2% among the crosses. Seed germination was higher in Bangla Nagaramx Kuljedu Cuddapah cross (67.2%) followed by Bangla Ganmala x Shirpurkata (65%). The seeds of Halisahar Sanchi x Swarna Kapoori, Hirehalli local x Swarna Kapoori and Simrali Sanchi xSwarna Kapoori recorded very poor germination percent i.e 2.1, 2.2 and 2.59%, respectively. Poor establishment of seedlings

was also observed in the crosses involving Halisahar Sanchi, Simurali Sanchi and Hirehalli Local as female parents. In total 2197 hybrid seedlings were raised from 72 different crosses. Maximum number of hybrid seedlings was raised in the cross, SGM1 x Vasani Kapoori (169) followed by SGM1 x Tellaku Ponnuru (140). Wide variability was observed for many morphological traits like plant vigor, leaf size, leaf shape, leaf color, petiole length, inter-nodal length and stem pigmentation. Severe reduction in growth and vigor, leaf size and growth abnormalities were also observed among the hybrid population.

The vines grew to a length of 97-175 cm in a period of three months and produced roots at each node. The rooted vines were cut into single nodes, separated and planted in polybags under polyhouse conditions for establishment. The rooted vines yielded 11-21 single node rooted cuttings. Establishment of the rooted cuttings ranged from 70.83-95.24%. This method can be successfully utilised for rapid propagation of betelvine hybrids.

Twenty hybrid seedlings were selected from the hybrid population based on their vigour, leaf size, and leaf colour. Variation in terms of leaf colour was observed and it ranged from light green to dark green. Among the hybrids, variation was recorded for vine length (73-175 cm), leaf length (4.1-10.8 cm), leaf width (3.7-9.7 cm), petiole length (3.1-13.5 cm) and internode length (2.6-9.5 cm).

Nutrient uptake studies

Nutrient uptake studies carried out at different centres showed that the application of nitrogen in the form of FYM or oilcake equal to recommended dose of N provided better crop performance with superior leaf quality.

At Bapatla, the results also showed that the treatment consisting of 200 kg N through neem cake + urea at 1:1, 100 kg P_2O_5 and 100 kg K_2O ha^{-1} recorded significantly low incidence of *Phytophthora* foot rot disease

Effect of plant population

At Pusa, a plant population of 2 lakh plants ha^{-1} registered highest yield (27.36 lakh leaves ha^{-1}), but the leaf size was comparatively reduced as compared to lower plant population densities, thereby fetching lower price. The treatment having plant population of 1.5 lakh ha^{-1} fetched higher price for the leaves and hence suitable for higher marketable leaves. At Islampur the plant population of 1.50 lakh ha^{-1} produced maximum number of branches (7.53), higher vine elongation (8.41 cm $month^{-1}$), higher marketable leaves (24.10 lakh ha^{-1}) with minimum foot rot disease score compared other population densities.

Crop regulation through staggered lowering

Experiments were carried out with an objective of improving productivity by harvesting the leaves in the lean period through staggered lowering of betelvine at Jorhat and Kalyani. At Jorhat significant differences between different lowering period were observed for leaf

yield, disease incidence and in terms of net return. Lowering in the month of February and September gave highest net return of Rs. 2.52 lakh ha^{-1} yr^{-1}.

At Kalyani, vine elongation per month was found to be highest when lowering was done in July and November. Fresh weight of 100 leaves was found highest in September and January lowering. Yield was highest (39.94 lakh $ha^{-1}yr^{-1}$) in February and June lowering. The lowest yield (27.66 lakh $ha^{-1}yr^{-1}$) was found in August and December lowering which was statistically at par with September and January (28.02 lakh $ha^{-1}yr^{-1}$) lowering. Lowest (3.8%) leaf spot disease was recorded in July and November lowering. Maximum (11.8%) leaf spot disease was recorded in September and January lowering. Minimum (5.8%) leaf rot disease was recorded in February and June lowering. Maximum (13.8%) leaf rot disease was recorded in September and January lowering.

Efficacy of bio-fertilisers and organic manures on yield and quality

Bio-fertilisers manures were tested for their efficacy for yield and quality improvements in betelvine cultivation at Islampur and Pusa. At Islampur, among the six treatments tried, vermicompost at 10 t ha^{-1} gave encouraging results compared to other treatments. The average vine growth $month^{-1}$, number of branches $plant^{-1}$, and marketable leaves were 22.15 cm, 12.15 and 25.15 lakh ha^{-1}, respecively in the above treatment.

At Pusa, application of vermicompost registered the highest production of crop in terms of total number of leaves (24.21 lakh ha^{-1}), fresh weight of hundred leaves (290.5 g), and leaf area (95.4 cm^2). All other treatments were at par in respect of leaf yield and other growth attributes.

Plant Protection

Epidemiological studies of different diseases

Epidemiological studies were carried out at different centres for fungal and bacterial diseases to understand the disease dynamics and to predict the influence of weather parameters on disease development and yield loss.

i) *Phytophthora* stem and leaf rots

The results indicated that minimum temperature has significant negative correlation with disease development. The step down analysis revealed that for 1 mm increase in rainfall will increase the disease incidence to an extent of 0.32% at Bapatla. Results revealed that all weather parameters collectively influenced the disease incidence to an extent of 64.76%.

Maximum and minimum temperatures, morning relative humidity (RH) and rainy days had significant positive correlation and evening RH and rainfall had negative correlation on the incidence and spread of the disease. However, the number of rainy days had positive correlation at Jorhat.

Correlation studies of different weather parameters with the disease incidence revealed that coefficients for minimum temperature, maximum RH and rainfall had positive significant effect on PDI while that of maximum temperature and minimum RH had negative effect in two betelvine varieties at Kalyani.

At Jabalpur, correlation studies clearly indicated that the disease development was positively correlated with relative humidity, rainfall, number of rainy days and number of cloudy days. The regression analysis of percent leaf rot incidence with weather parameters showed that the amount of rainfall contributed to the extend of 35.69% followed by bright sunshine hour (BSH) (25.97%), morning RH 8.89% and afternoon RH 5.31% for the disease development at OUAT.

At Sirugamani, the weather factors *viz.*, minimum temperature, RH and rainfall had positive effect on the disease incidence, while other factors like maximum temperature and number of rainy days had negative correlation with the disease incidence.

ii) Anthracnose

The maximum temperature, morning RH and rainfall had significant negative correlation and minimum temperature, evening RH and number of rainy days had positive correlation with incidence and spread of the disease at Jorhat.

At Bhubaneswar, regression analysis of PDI with that at weather parameters showed that maximum contribution was from that of rainfall (27.73) followed by morning RH (21.72) and BSH (18.55). However the overall contribution of weather parameters in the development of anthracnose was only 31.1%.

iii) Bacterial diseases

In Jorhat, correlation studies revealed that maximum and minimum temperatures, morning relative humidity and rainy days had significant positive correlation and evening relative humidity and rainfall had negative correlation with the disease incidence and development.

At Sirugamani, the correlation studies revealed that minimum temperature, relative humidity (evening) and rain fall were found to have positive effect on the disease while the other factors *viz.*, maximum temperature, relative humidity (morning) and number of rainy days had negative effect on the disease incidence.

Rhizosphere competence and survival period of *Trichoderma*

At Jorhat, initial population of the *Trichoderma harzianum* was very low. The population density increased significantly after twenty days of application. The highest density was recorded after 20 days when application was done in July. After 40 days of application of *T. harzianum,* the population density was declining in all the treatments and it was least after 80 days of application.

At Bapatla, significant increase in *T. viride* population was observed after application. Mean colony forming units g^{-1} of rhizosphere soil 20 days and 40 days after application were 4.0 x 10^5 and 7.2 x10^5, respectively. However, after 60 days, there was decrease in mean colony forming units g^{-1} of soil.

The population of *T. harzianum* in the rhizosphere region was increased with increase in days after application from 20 to 80 days under Sirugamani conditions. The maximum population of 84.00 x 10^3 cfu g^{-1} was recorded at 80 days after application.

Demonstration of disease management technology developed by the centre in the farmer's field

All the farmer's field of Bangla pan at Ambagan (Baroj type), the incidence of basal rot (*Sclerotium rolfsii,* 10.8%), leaf spot complex (*Colletotrichum* and *Xanthomonas*, 12.0%) and leaf rot (*Phytophthora* sp., 6.7%) were recorded. All the diseases showed significant reduction under recommended techniques over the farmers' practices. Yield, fresh weight and net return were also significantly higher in this technique. A net return of Rs. 4.37 lakh was earned with recommended technique in comparison to Rs.2.94 lakh in the farmers' practice. At Borhola, cultivation with areca nut support, higher mean incidence of leaf spot complex (*Colletotrichum* and *Xanthomonas*, 17.66%), basal rot (10.50%) and leaf rot (*Phytophthora*, 8.30%) were observed. Significant reduction of all the diseases was recorded when recommended technologies were followed. Yield, fresh weight and net return also produced significantly higher result with this technique. A net return of Rs. 6.24 lakh was earned in recommended technique in comparison to Rs.5.07 lakh in the farmers' practice. Demonstration trial under Khuti type cultivation at Lengeri, revealed the higher occurrence of leaf spot complex (*Colletotrichum* and *Xanthomonas*, 11.6%), leaf rot (*Phytophthora*, 8.50%) and basal rot (8.6%) were recorded in the farmers' practice. The reduction of all the diseases was highly significant in recommended techniques over the farmers' practice. An average of Rs. 3.25 lakh of net return was earned in improved technique compared with farmers' practices of Rs. 2.36 lakh.

The results showed that all the parameters tested were statistically superior in disease management technologies developed by Kalyani centre over the farmers' management practices.

Field demonstration trials were conducted in five locations at different farmer's field, *viz.* Gandhigram, Pateria, Sehra, Umariapan and Deonagar of Jabalpur district. The results showed overall death percentage of vine, percent disease intensity of foot rot, bacterial leaf spot and stem infection and basal rot was minimum in the plots supplied with the new IDM package as compared to farmers' practice (control). There was 18% increase in yield over control. Disease intensities reduced by 64 and 43% in foot rot and basal rot while in bacterial stem and leaf infections there was 38 and 41% reduction in disease index. Overall, the treated plot was significantly superior over untreated plots in all the selected locations.

One trial each was conducted at Mahadhanapuram (Trichy dist.) and Kulithalai (Karur dist.) with variety Vellaikodi. The results indicated that the disease incidence was minimum by using the management package than adopted by farmers' practice. The foot rot incidence was 4.03% and 2.57% at Mahadhanapuram and Kulithalai respectively, when the improved technologies were adopted. Whereas, the disease incidence was 24.95% and 11.28% at Mahadhanapuram and Kulithalai, respectively under the farmers' practice of disease management.

Fixing ETL for important insect pests

At Bapatla three larvae of tobacco caterpillar per plant can cause significant yield loss at which control measures need to be initiated to avoid economic loss.

At Sirugamani, more than two years old crop could tolerate (without affecting yield) infestation of scale insect when it was upto 5 scales vine^{-1}. More than five scales veine^{-1} needs control measure.

Residue analysis on dissipation and persistence of chlorpyrifos and dichlorvos in leaves

At Kalyani, field grown vines sprayed with chlorpyrifos and dichlorovos were tested for pesticide residue at regular intervals till it reached below detection level. Recovery percentage of chlorpyrifos and dichlorvos was found to be 95.5 and 97.7%, respectively. Dissipation of chlorpyrifos and dichlorvos was calculated from this data. Chlorpyrifos level reduced to negligible at 15 days after application. Considering limit of quantification (LOQ) to 0.1 ppm, safe waiting period for this chemical was calculated to be 11.5 days. However, dissipation rate was higher in dichlorovos and the residue became undetectable at 5th day after spraying. Hence, considering a LOQ value of 0.03 ppm, the safe waiting period for this pesticide was calculated to be 3.6 days.

Monitoring for biodiversity of pests and natural enemies and their identification in Betelvine ecosystem

Fixed plot survey was conducted in betelvine garden at Bapatla centre. Observations on seasonal occurrence of pests and natural enemies were recorded and submitted for identification. Leaf eating caterpillar complex on *Sesbania* (act as support for the vine) such as *Eurema hecabae*, *Hyposidra successaria*, *Mauruca testulalis* and *Spodoptera litura* were predominant during August to September. Stem borer *i.e Azygophleps scalaris* activity was more during September and October. Red spider mites were dominant during November and December. Spiders were dominant natural enemies in Betelvine ecosystem.

At Kalyani, two aleyrodid flies namely, whitefly *Singhiella pallida* (=*Dialeurodes pallida*) and Blackfly (*Aleurocanthus rugosa*) occured sympatrically. Recently an un-identified blackfly was observed affecting betelvine at Kalyani. The black fly was identetified as a species of *Aleurocanthus*. A good number of parasitoids of *A. rugosa* were observed in the betelvine boroja. An internal parasitoid was observed in high frequency.

Integrated Crop Management

To optimize the resources for maximizing the yield and quality leaf production, integrated crop management through optimum plant population, irrigation management, crop protection with spray schedules, application of bio-control agent (*Trichoderma* spp) and required inorganic fertilisers were tried at different levels at various centres.

At Jorhat, leaf yield was significantly higher in treatment comprising of 2 lakh ha^{-1} plant population + 100% replenishment of CPE + 4 application of *Trichoderma* + 200 kg N ha^{-1} in splits + 100 kg ha^{-1} P_2O_5 + 100 kg ha^{-1} K_2O + Sanitation. Final soil status indicated the fixation of phosphorus as well potash in the soil leading to soil build up of both the nutrients. The farmers' practices resulted in lower return compared to integrated approach.

At Bapatla, it was observed that the treatment having best plant population + recommended fertiliser with application of neem cake + Urea (1 : 1) giving 200 kg N, 100 kg P_2O_5 and 100 kg K_2O ha^{-1}, irrigation 100% replenishment of CPE and application of BM (4 drenches and 8 sprays) recorded significantly superior performance with respect to growth parameter like branches $plant^{-1}$ (27.95), leaf yield (38.06 lakh ha^{-1}) and low disease incidence (18.22%) when compared to other treatments.

At Kalyani, the results revealed that vine elongation $month^{-1}$ (43.05 cm), fresh mass of 100 leaves (477.14 g) and highest leaf yield (38.01 lakh ha^{-1}) were obtained when treatments comprising of 200 kg N in organic form and in splits+100 kg P_2O_5 + 100 kg K_2O + irrigation at 100 % replenishment of CPE + BM application (4 Drenching and + 8 Spraying) + recommended insecticides if required. Chemical analysis of residual soil revealed that percentage of total N (0.054%), available P (194.38 kg ha^{-1}), available K (261.00 kg ha^{-1}) and percentage of organic carbon (0.35 %) were found be highest in the above mentioned treatment. Chemical analysis of plants revealed that percentages of total N-P-K also were found to be highest in the above mentioned treatment. N-P-K uptake was highest in the above mentioned treatment also.

At Jabalpur, vine elongation $month^{-1}$ (16.78 cm), length of internode (7.70 cm), number of leaves (37.52 lakh ha^{-1}), weight of 100 leaves (639.42 g) and keeping quality (16.32 days) were significantly higher in treatment comprising of 75 lakh plant population + 200 kg ha^{-1} N in four split doses in organic form +100 kg ha^{-1} P_2O_5 +100 kg ha^{-1} K_2O + irrigation at 100% replenishment of CPE + 4 applications of *Trichoderma viride* + sanitation + recommended insecticide over other treatments. The maximum disease incidence (18.00%) was observed with farmers' practice. It was also found that maximum C: B ratio (1:1.21) was observed with above mentioned best treatment.

At Sangli, best plant population + 200 kg nitrogen in splits as organic form + 100kg P_2O_5+ 100kg K_2O + irrigation at 100% replenishment of CPE + BM application (4D + 8S) + recommended insecticides recorded significantly more leaf yield (48.03 lakh ha^{-1}). The

fresh weight of 100 leaves and keeping quality were found significantly more in farmers' practice. The incidence of foot rot in the farmers' practice was 25.69%. The maximum cost:benefit ratio of 1:1.59 was received in the farmers' practice.

At Pusa, the results showed that sanitation of bareja along with 3 drenches of BM (BM) (1%) plus use of organic insectides, plant population of 1.5 lakh ha^{-1} with application of 200:100:100 kg (N:P:K) ha^{-1} in organic form (4 splits) was found most effective producing the highest yield (24.20 lakh leaves ha^{-1}). It was also at par with treatment having 4-applicatioin of Trichoderma viride (inoculated in mustard oil cake) plus use of organic insecticides maintaining similar plant population with same level of nutrient supply.

general information

COMMITTEE MEETINGS

Research Advisory Committee

Research Advisory Committee meeting was held on 24th April 2007 at NRCMAP under the chairmanship of Prof. K.V. Peter, Kerala Agricultural University, Thrissur. Dr. O.P. Srivastava, Ex-Director, Institute of Agricultural Sciences, BHU, Varanasi and Dr. S. Maiti, Director, NRCMAP attended as members of the committee while Dr. (Mrs.) S. Samantaray, Sr. Scientist acted as Member Secretary. At the outset, Dr. S. Samantaray, welcomed the Chairman and members of RAC. Dr. S. Maiti, Director, NRCMAP presented work done report of the last one year. Chairman and other members appreciated the progress made by the centre and congratulated the Director and Scientists of NRCMAP. After detailed deliberations, RAC suggested some important recommendations for further progress of the centre. The meeting ended with the vote of thanks by Dr. P. Manivel, Principal Scientist (Plant Breeding).

Institute Management Committee

Institute Management Committee (IMC) meeting was held on 25th April 2007 under the chairmanship of Dr. Satyabrata Maiti, Director, NRCMAP. The meeting was attended by Dr. B. G. Bagle, Head, CHES, Godhra, Dr. A. R. Pathak, Director of Research and Dean, Anand Agricultural University, Anand, Dr. S. Samantaray, Sr. Scientist (Biotechnology), Dr. M. Das, Sr. Scientist (Plant Physiology), Dr. K. Mandal, Sr. Scientist (Plant Pathology), Mr. V. S. Parmar, AAO and Mr. T. A. Vishawanath, AFAO as members. Dr. Maiti presented the recommendations of the QRT, AINRP on betelvine for information to the committee. The committee reviewed the various research and development activities of the

institute and suggested a number of measures to speed up the development of the institute.

Second IMC meeting was held on 4th August, 2007 under the chairmanship of Dr. Satyabrata Maiti, Director, NRCMAP. The meeting was attended by Dr. K. V. Ramana, ADG (Hort-II), ICAR, New Delhi; Thakur Randhir Singh, President, Aromatic & Medicinal Plants Growers Association of India, Jammu; Dr. S. Chaphalkar, Director, Vidya Pratishtha's School of Biotechnology, Vidyangari, Baramati; Mr. D. V. Barot, Dy. Director of Horticulture; Dr. B. G. Bagle, Head, CHES, Godhra; Dr. S. Samantaray, Sr. Scientist (Biotechnology); Dr. M. Das, Sr. Scientist (Plant Physiology) Dr. K. Mandal, Sr. Scientist (Plant Pathology), Mr. V. S. Parmar, AAO and Mr. T. A. Vishawanath, AFAO as members. Dr. Bali Ram Tyagi, Chairman, QRT, NRCMAP & AINRPMAP also attended the meeting as special invitee and presented the recommendations of the QRT for information to the committee.

Research Review and Staff Research Council

The 15th Staff Research Council Meeting (SRC) was held under the Chairmanship of Dr. Satyabrata Maiti, Director, NRCMAP during 5-6th June, 2007. First of all he welcomed three new scientists *viz*. Dr. P. Manivel, Principal Scientist (Plant breeding), Dr. V.P. Chaudhary, Senior Scientist (Entomology) and Mrs. G.R. Smitha, Scientist (Horticulture). He further wished that our institute could become a role model for other institutes of ICAR. The recognition of the institute is to be known by its quality of work and not through propaganda and hence our motto should be 'let the people recognise us through our good work'. Member Secretary, Dr. P. Manivel presented the action taken report and appraised the developments made. All the scientists presented their progress report pertaining to the ongoing research projects. Thorough discussion was held after each presentation. Two new project proposals were also presented. Several modifications were suggested and finally incorporated in the proposals. Scientists also presented their targets for next six months. Altogether twelve projects covering different aspects of medicinal and aromatic plants such as germplasm characterisation, plant breeding, crop production, crop physiology, quality management and information technology were presented.

OTHER ACTIVITIES

Online Digital Herbarium of Medicinal and Aromatic Plants launched

ARIS cell at NRCMAP developed a web based interactive software application entitled "Digital Herbarium of Medicinal & Aromatic Plants in India". Dr. Satyabrata Maiti, Director, NRCMAP launched the online facility (linked in NRCMAP's site http://www.nrc-map.org) at the XV Staff Research Council Meeting on 5th June, 2007. Digital Herbarium is an authenticated collection of high resolution images of medicinal and aromatic plant specimens with their associated data which will help for their easier identification. The

database presents alphabetical list of each plant along with its thumbnail view. Users can view the brief or detailed description about the accession and its enlarged view by clicking appropriate links. The site also provides information regarding the usage of the plant. The software package is having two main options (modules) to access the facility such as 'Client' and 'Administrator'. The client module allows the visitor to access the available information from the Digital Herbarium database. Anybody can visit the site with a formal registration procedure and will get the access to the site. User can also contribute to the refinement of the herbarium information to the master database. The suggestions give by the user will be directed to the administrator for its consideration and inclusion in the main database. The administrator module manages the database by entering all the available species' information with digital photographs, delete unwanted information from the database and modify the existing database, etc.

Hindi Week celebrated

The official language implementation day (14 September) was celebrated by organising Hindi week during 14-21 September, 2007 in which competitions like essay writing, letter writing, general Hindi, extempore, poem recitation, etc. were organised for the staff. On 21st September, 2007 closing ceremony was organised in which Dr. Navneet Chauhan, Professor and Head, Dept. of Postgraduate (Hindi), Sardar Patel University, V.V. Nagar, Anand was invited to grace the occasion as chief guest and Dr. Satyabrata Maiti, Director and President, official language implementation committee (OLIC) chaired the session. Dr. Vipin Chaudhary, Member Secretary, OLIC presented the brief introduction of the Chief Guest to the house. Certificate and Prizes were given by the honourable Chief Guest during this occasion. Dr Chauhan in his address laid emphasis on the expression of language; he told the house that a single sentence can be presented in several ways. He advocated the maximum use of Hindi in day to day work and emphasized that liberty should be given to every person to adopt the Hindi in his own way. He was of the opinion that we can not spread Hindi by thrusting it upon others; its spread is only possible when one and all voluntarily adopt Hindi. Dr. Maiti in his presidential address expressed that for the spread of Hindi it is necessary that we all should adopt Hindi honestly; mere celebration of weeks, fortnights, months etc. will not serve the purpose. The celebration ended with vote of thanks proposed by Dr. Manish Das.

Vigilance awareness week observed

NRCMAP observed vigilance awareness week during 12-16th November 2007. The institute took initiative to bring transparency by keeping records open for verification during this period. On 14th November, one day workshop was organised at NRCMAP to create awareness about vigilance among all staff members. The function was presided over by Dr. Satyabrata Maiti, Director and all the staff members attended the workshop. The workshop started with the pledge administered to all the officials and staff. Mr. V. S. Parmar, AAO

delivered a talk on importance of vigilance in government offices. Mr. T. A. Vishwanath, AFAO presented transparency in financial matters specially related to purchases. Other staff members also expressed their views about possible causes of corruption and its removal. At the end, Dr. S. Maiti in his presidential address narrated extreme desire and materialistic thinking as the main causes of corruption in the office and the society. He told that level of corruption can be reduced by introducing transparency. The programme came to an end with the vote of thanks proposed by Dr. Vipin Chaudhary.

Annual day celebrated

Annual day was celebrated on 24th November, 2007 at NRCMAP. A humble function was organised by the staff welfare club of NRCMAP to commemorate this occasion. The staff members along with their family observed the day with great funfair. Prof. M.C. Varshneya, Vice-Chancellor, Anand Agricultural University, Anand was the chief guest of the function. In his inaugural address, he recollected his long association with NRCMAP and praised the works contributed by the institute for the medicinal plants sector. In his presidential address, Dr. S. Maiti stressed for concentration and dedication from all the staff members for lifting this institute to even greater levels. On the occasion, several friendly competitions among the staff members and lunch were arranged by staff welfare club. Prizes were distributed to the winners.

Dr. H. P. Singh, DDG (Horticulture) visited NRCMAP

Dr. H. P. Singh, DDG (Horticulture), ICAR visited NRCMAP on 22nd December, 2007. Dr. S. Maiti, Director welcomed him with presentation of a bouquet and thereafter briefed him about the ongoing research and developmental activities. Dr. Singh visited the experimental fields and herbal garden of the centre as well as the laboratories. He expressed his happiness about the facilities available in the laboratories and the quality of work done by the scientists. He met all the scientists and had an in-depth discussion on problems, research priorities and future research needs. He emphasised that the AINRPMAP should be fully utilised as complimentary research programme of the NRCMAP to bring out some meaningful research outcome in both NRCMAP as well as Networking project. He suggested that digitalisation of herbal garden information should be done at the earliest. He also pointed out the understanding of biochemistry and organic chemistry of the MAPs is very important areas

for future research. Further he opined that more number of high yielding varieties with better quality parameters needs to be developed and their production technologies should be optimised to increase the production, productivity and export of medicinal and aromatic plants. He put on record his impression as "I am happy to see an excellent infrastructural facilities developed at this centre, by personal efforts of Dr. Maiti, Director. I wish to compliment the Director and the Scientists for their efforts. But, we have to enhance our efforts for team work to achieve the excellence. Keep it up."

Women cell

All the women staff of the institute had regular meetings under the aegis of Women cell created in NRCMAP, wherein issues related to their welfare were discussed. They also actively participated in all the functions of the institute and took part in all the developmental activities. They believed in equal and consistent contribution towards making NRCMAP a pioneer institute.

Right to Information

NRCMAP is committed to provide transparency in all its activities. While maintaining transparency, the NRCMAP geared itself for becoming responsiveness to the Right to Information Act, 2005 of Govt. of India. The information on Right to Information Act and reports have been appended to the institute website and is regularly updated. Besides, the institute has tried to satisfactorily respond to the various requests received seeking information under the Right to Information Act within the stipulated time frame.

Our New Colleagues

Dr. Vipin Chaudhary, Senior Scientist (Entomology) joined on 09.04.2007

Mrs. Smitha G. R., Scientist (Horticulture) joined on 17.05.2007

Library

During the year the library information system was kept upto date by continuing the subscription of several national and international journals and procuring of different books and magazines. The library served and fulfilled the needs of the scientists, staff as well as the students and research scholars from other educational Institutions. The data base on CDROM like CAB, Agris are also available in the library. A total 1449 books and subscription of 16 national and 6 international journals related to medicinal and aromatic plants besides the Abstract CDs, Annual Reports from ICAR institutes, Research highlights/ Proceedings, thesis etc. are available.

Transfer

Dr. O. P. Aishwath, Scientist Senior Scale (Soil Science) transferred on promotion as Senior Scientist to NRC on Seed Species, Ajmer on 05.07.2007

TRAINING AND EDUCATION

DISSERTATION DONE BY STUDENTS

The following students carried out their dissertation work for partial fulfilment of the M.Sc. degree during 2007-08.

Name of the student and institute Discipline & College	Title of thesis/project work	Guide
Mr. Urvik Dhagat, M.Sc., Food Biotech, P.G. Department of Home Science, S.P. University, V.V. Nagar, Anand	Assessment of Genetic relationships among seven species of *Plantago* Linn. using Random Amplified Polymorphic DNA (RAPD) markers	Dr. (Ms.) Sanghamitra Samantaray, Senior Scientist (Biotechnology)
Trupti G. Patel, Department of Bioscience, Sardar Patel University, V.V.Nager 388120. Gujarat.	Studies on infection process by *Corcosporella tinosporae* on *Tinospora cordifolia*	Dr. Kunal Mandal, Senior Scientist (Plant Pathology)
Mital P. Patel, Department of Bioscience, Sardar Patel University, V.V.Nager 388120, Gujarat	Role of different enzymes in pathogenesis by *Pectobacterium chrysanthemi* causing soft root disease of aloe	
Patel Rinkal G., Department of Bioscience, Sardar Patel University, V.V.Nager 388120.	Biochemical studies on anthraquinone glycosides of *Aloe barbedensis* Miller.	Mr. Saravanan Raju, Scientist Sr. Scale (Plant Physiology)

TRAINING GIVEN TO STUDENTS

The following students underwent one month training at NRCMAP

Name and address of the student	Topic of Training	Guide
Ansuj Sharma T-13, Shastri Nagar, Ajmer, Rajasthan	Plant Pathological Methods	Dr. Kunal Mandal, Senior Scientist (Plant Pathology)
Ms. Pratiksha A. Prajapati, B.Sc. (Biotechnology), Anand Mercantile College of Science and Technology, Anand	Micropropagation, DNA isolation, purification and quantification in some important medicinal plants	Dr. (Ms.) Sanghamitra Samantaray, Sr. Scientist (Biotechnology)
Ms. Hiral B. Shukla, B.Sc.(Biotechnology),Anand Mercantile College of Science and Technology, Anand	Micropropagation, DNA isolation, purification and quantification in some important medicinal plants	
Ms. Nilofer Naquvi, B.Sc. (Biotechnology), N.V. Patel College of Pure and Applied Science, V.V. Nagar	Micropropagation, DNA isolation, purification and quantification in some important medicinal plants	
Mr. Parag jain, B.Sc. (Biotechnology),N.V. Patel College of Pure and Applied Science, V.V. Nagar	Micropropagation, DNA isolation, purification and quantification in some important medicinal plants	
Mr. Krishna Chaitanya, M.Sc. (Biotechnology),Aacharya Nagarjun University, Guntur, Andhra Pradesh	Molecular Characterisation of *Tinospora cordifolia* Miers. through RAPD Markers	
Mr. Sk. Mohd. Hussain, M.Sc., (Biotechnology),Aacharya Nagarjun University, Guntur, Andhra Pradesh	Molecular Characterisation of *Commiphora wightii* (Arnott.) Bhandari through RAPD Markers	
Mr. Jigar D. Patel, B.Sc. (Biotechnology),M.B. Patel Science College, Anand	Micropropagation, DNA isolation, purification and quantification in some important medicinal plants	
Mr. Shipra Jaiswal, M.Sc. (Biotechnology),Maharshi Dayanand Saraswati University, Ajmer, (Rajasthan)	Micropropagation, DNA isolation, purification and quantification in some important medicinal plants	
Ms. Sucheta Ghorai, M.Sc. (Botany), S.P. University , V.V. Nagar, Anand	Isozyme profile, SDS-PAGE and ISSR in some important medicinal plants	

PUBLICATIONS

Research papers

NRCMAP, Anand

Chandel P., K. A. Geetha and S. Maiti. 2007. Reproductive biology of *Convolvulus microphyllus* (Convolvulaceas)-A memory stimulating drug plant of Ayurveda. *Indian Journal of Genetics and Plant Breeding* **67**: 257-263.

Mandal K., N. A. Gajbhiye and S. Maiti. 2007. Fungicidal management of downy mildew of Isabgol (*Plantago ovata*) simulating farmers' field-conditions. *Australasian Plant Pathology* **36**: 186-190.

Vadodaria H. K., S. Samantaray and S. Maiti. 2007. Micropropagation of *Glycyrrhiza glabra* Linn.: an important medicinal plant. *Journal of Cell and Tissue Research* **7**: 921-926.

NDUAT, Faizabad

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YSPUH&F, Solan

Mehra T. S., R. Raina, P. Chandra, Y. Sharma and R. Chand. 2007. Enhancing rootstock biomass production in *Picrorhiza kurroa* through growth regulator treatment. *Indian Forester* **133**: 1096.

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performance of Ashwagandha (*Withania somnifera* Daud) accessions in middle Gujarat condition India. *Asian Journal of Horticulture* **2**: 117-121.

Patel D. H., K. V. Patel, M. A. Patel, N. V. Upadhyay, N. H. Punjani and S. Sriram. 2007. Effect of different harvest schedule on total dry herbage yield of Shankhpushpi (*Convolvulus microphyllus* L) Sieb. *Asian Journal of Horticulture* **2**: 10-12.

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CCSHAU, Hisar

Kumar A., Bikram Singh and J. S. Hooda. 2006. Influence of sowing time and crop geometry on yield of Kalmegh (*Andrographis paniculata*). *Haryana Journal of Agronomy* **22**: 186-188.

Yadav O. P., O. Sangwan, P. K. Verma, M. K. Deen and C. S. Tyagi. 2006. Genetic correlation and path coefficient studies for fasciculated root yield in Satavar (*Asparagus racemosus* Willd.). *Haryana Agricultural University Journal of Research* **36**: 97-100.

MPUAT, Udaipur

Sharma S. S. and R. K. Samota. 2007. Some New Fungal Diseases of *Aloe barbadensis* Mill. *Indian Phytopathology* **60**:277.

Sharma S. S., A. Joshi and M. P. Sharma. 2007. Integrated management of Opium poppy downy mildew through seed treatment, planting time, sulphur nutrient and optimum Metalaxyl sprays. *Journal of Mycology and Plant Pathology* **37**:641.

Yogi, G. N. and G. S. Chouhan. 2007. Effect of irrigation schedules and brassinosteroid levels on growth parameters and yield of blond psyllium (*Plantago ovata* Forsk.). *Journal of Medicinal and Aromatic Plant Sciences* **29**:57-59.

RAU, Pusa

Singh S.P. and D.K. Dwivedi. 2007. Impact of zinc boron and iron on yield and economics of ginger. *Indian Journal of Agricultural Sciences* **3**:136-138.

Dwivedi D.K. and S.P. Singh. 2007. Effect of nutrient integrated biofertilizer, vermicompost and mustard oil cake + organic on betelvine crop. *The Asian Journal of Hortticulture,* **2**:102-105.

BOOKS/ BOOK CHAPTERS

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Transformation through Public-Private Partnership-An Interface (Ed. S. Ayappan, Pitam Chandra and S. K. Tandon) pp. 31-34.

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Maiti S. and K. A. Geetha. 2007. Medicinal and Aromatic Plants in India. *In:* NSDLe-book [http://nsdl.niscair.res.in/handle/123456789/742].

NDUAT, Faizabad

Chakravorti D. K. 2008. Downy mildew of opium poppy. *In:* Crop Discussion - Identification and Management - A colour Handbook (Eds. L.V. Gangawane and V.C. Khilare), Daya Publishing House, Delhi, pp. 134-136.

CCSHAU, Hisar

Verma P. K., O. P. Yadav, Y. Kumar, J. S. Hooda, Anil Kumar and R. Karwasra, 2007. Thermo- and photo-sensitivity of medicinal and under-utilized plants. (Eds. S.K. Sethi, R.S. Waldia, A.K. Chhabra and Y. Jindal), pp. 116-119.

MPUAT, Udaipur

Charak A. S., G. S. Chouhan, H. K. Sumeria and R. C. Dadheech. 2007. Improved production agrotechniques for blond psyllium cultivation. *In:* "Multitherapic medicinal and special plants, Vol.1, (Eds. Karan Singh, M.L. Jakhar and Dhirendra Singh) Avishkar Publishers & Distributors, Jaipur (Raj.),pp 203-6.

POPULAR ARTICLE

Bharsar

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SEMINAR/CONFERENCE/SYMPOSIA PAPERS AND ABSTRACTS

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Maiti, S. 2007. Opportunities for expanding the cultivation of MPs. *In:* Workshop on Potential of Minor forest produce (MFP) based industry in Gujarat at Ahmedabad Management Association (AMA), Ahmedabad on 06 July, 2007.

Maiti, S. 2007. Opportunities for expanding the cultivation of MPs. *In:* National Workshop on "Potential and Planning for Conservation and Development of Commercially Important Medicinal Plants in the North-Eastern India" during 12-13 July, 2007 at Imphal.

Maiti, S. and K. A. Geetha 2007. Current Concern of Bio-diversity of Medicinal Plants in India. *In:* National Consultation Workshop on Agro biodiversity Hot spots and Access and benefit Sharing at Annamalai Nagar during 19-20 July, 2007.

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Maiti, S. 2007. Role of plant pathology in achieving global food security. Delivered at Prof. S. B. Chattopadhyay Memorial Lecture in the Symposium held at BCKV, Kalyani on 29 November, 2007.

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AAU, Anand

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CCSHAU, Hisar

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content in powder of *Asparagus racemosus* tubers with different drying and storage methods. *In:* Proceedings "XIth International Asparagus Symposium" held at Horst, The Netherlands" from June 16-19, 2005, (Editors: J. H. Mulder and P.J.M. Lavrijsen), Acta Horticulturae Number 776, pp. 261-265, ISHS 2008.

HUMAN RESOURCE DEVELOPMENT

Education & Training

Name	Details	Date
Dr. P. Manivel, Principal Scientist (Plant Breeding)	Training on leadership and Personality Development at NAARM, Hyderabad	5-12th July, 2007
Dr. Manish Das, Sr. Scientist (Plant Physiology)	Training on validation and determination of seed standards on Medicinal and Aromatic Plants., New Delhi	4-8th February, 2008
Dr. Geetha K. A., Sr. Scientist (Plant Breeding)	Training on protection of Plant Varieties Procedures, Methodology at NAARM, Hyderabad	3rd-6th October, 2007
Dr. Vipin Chaudhary, Sr. Scientist (Entomology)	Team Building Workshop cum Training at NAARM, Hyderabad	12-15th December, 2007
Mr. Saravanan Raju,	Training on recent trends in chromatography at M/s Spinco Biotech, Ahmedabad	12th February 2008
Mr. N. S. Rao, Scientist (Sr. Scale) (Computer Application)	Training on networking Essentials for Information Management in Agriculture at NAARM, Hyderabad	16-25th October, 2007
Dr. G. Sridhar, Scientist (Plant Physiology)	MDP on Harnessing Intellectual Property for strategic competitive and collaborate Advantage at IIM, Ahmedabad	10-12th March, 2008
Mr. N. J. Ganatra, Sr. Clerk Mrs. S. H. Nair, T-2 (Laboratory Technician)	Training on Intelligent Reporting System at NAARM, Hyderabad	30-31 August, 2007

Important Meetings attended by the Director

- Attended the first meeting of Expert Committee on Preparation of Guidelines of Research Results at National Biodiversity Authority, Chennai on 12-14 June, 2007.
- Participated in the group meeting of stake holders at NBPGR, New Delhi on 25th July, 2007 as preparatory to National Workshop on Production and Standardisation of Quality Seed/Planting Material of Medicinal Plants.
- Attended the Expert Committee meeting to evaluate the Access, Patent, Transfer of Research Results and Material Transfer Application at NBA, Chennai held on 13th August, 2007.
- Attended the NAIP meeting at IARI, New Delhi during 20-22 August, 2007.
- Participated in the second meeting of Expert Committee on Preparation of Guidelines on Publication of result of Research at NBA, Chennai on 10 October, 2007.
- Attended a meeting under project "Development of Good Agricultural and Collection Practices (GACP) for Medicinal Plants" at NMPB, New Delhi on 11 October, 2007.
- Attended the Special Interactive Workshop on Administrative and Financial Matter at NIANP, Bangalore on 26 October, 2007.
- Participated in the 10th meeting of the Task Force on 'Biotechnology based programme for women' held at DBT, New Delhi during 30-31 October, 2007.
- Attended the 11th meeting of the Task Force on 'Biotechnology based programme for women' at DBT, New Delhi on 12 December, 2007.
- Chaired plenary session during the National Symposium on Plant Protection - Technology Interface at BCKV, Kalyani on 27-30 December, 2007.
- Attended the Project Screening Committee meeting at NMPB, New Delhi on 17 January, 2008.
- Participated inaugural Function of the National Workshop on Spices & Aromatic Plants as guest held at Agricultural Research Station, Mandor on 06 February, 2008.

Distinguished visitors

- Prof. K. V. Peter, Chairman, RAC on 24 April, 2007
- Dr. Mohan Lal Sharma, PCCF, Govt. of Gujarat on 25 April, 2007
- Sh. R. V. Asari, Addl. PCCF, Govt. of Gujarat on 25 April, 2007
- Dr. G. L. Kaul, Ex-Vice Chancellor, AAU, Jorhat on 07 May, 2007
- Dr. B. R. Tyagi, Chairman, QRT, NRCMAP & AINRPMAP on 23-25 May, 2007
- Dr. R. Krishnan, Member, QRT, NRCMAP & AINRP MAP on 23-25 May, 2007
- Dr. P. Das, DDG (Ag. Extn.), ICAR, New Delhi on 16 June, 2007
- Thakur Randhir Singh, President, Aromatic & Medicinal Plants Growers Association of

India, Jammu on 04 August, 2007

- Dr. (Mrs.) S. Chaphalkar, Director, Vidya pratishtha's School of Biotechnology, Vidyanagar, Baramati on 04 August, 2007
- Dr. K. V. Ramana, ADG (Hort. II), ICAR, New Delhi on 04 August, 2007
- Dr. Bali Ram Tyagi, Chairman, QRT, NRCMAP & AINRP on MAP on 04 August, 2007
- Dr. S. P. Tiwari, DDG (Education), ICAR, New Delhi on 25 October, 2007
- Dr. S. Edision, Director, CTCRI, Trivandrum on 20 December, 2007
- Dr. H. P. Singh, DDG (Horticulture), ICAR, New Delhi on 22 December, 2007
- Dr. T. P. Tiwari, Project Director & ADG (ARIS), ICAR, New Delhi on 12 March, 2008
- Dr. G. B. Singh, Ex. DDG (NRM), ICAR on 15 March, 2008
- Dr. A. Bandyopadhyay, National Coordinator, NAIP, New Delhi on 17 March, 2008

PERSONNEL

NRCMAP

Director

Dr. Satyabrata Maiti

Scientific

Dr. P. Manivel, Principal Scientist (Plant Breeding)

Dr. (Ms.) Sanghamitra Samantaray, Senior Scientist (Biotechnology)

Dr. Manish Das, Senior Scientist (Plant Physiology)

Dr. Kunal Mandal, Senior Scientist (Plant Pathology)

Dr. (Ms.) K. A. Geetha, Senior Scientist (Plant Breeding)

Dr. Vipin Chaudhary, Senior Scientist (Entomology)

Mr. Saravanan Raju, Scientist Senior Scale (Plant Physiology)

Mr. N. A. Gajbhiye, Scentist Senior Scale (Organic Chemistry)

Mr. N. Srinivasa Rao, Scientist Senior Scale (Computer Application)

Dr. Gutam Sridhar, Scientist (Plant Physiology)

Mrs. Smitha G.R., Scientist (Horticulture)

Administrative

Mr. V. S. Parmar, Assistant Administrative Officer

Mr. T. A. Vishwanath, Assistant Finance & Accounts Officer

Mr. Suresh Patelia, Personal Assistant

Mr. Raghunathan K., Sr. Clerk

Mr. N. J. Ganatra, Sr. Clerk

Ms. R. M. Vasava, Sr. Clerk

Mr. S. U. Vyas, LDC

Mr. V. P. Rohit, LDC

Technical

Mrs. P. U. Pandit, T-5 (Technical Officer)

Mr. A. P. Trivedi, T-5 (Technical Officer)

Mrs. D. R. Chellani, T-4 (Senior Cartography Assistant)

Mr. B. K. Mishra, T-2 (Laboratory Technician)

Mr. S. B. Prajapati, T-2 (Field Assistant)

Mr. Shankar R. Patel, T-2 (Field Assistant)

Mrs. S. H. Nair, T-2 (Laboratory Technician)

Mr. R. B. Koli, T-2 (Driver)

Mr. H. A. Khatri, T-2 (Driver)

Mr. J. M. Padhiyar, T-2 (Pump House Operator)

Mr. M. B. Vagri, T-2 (Field Assistant)

Mr. K. R. Patel, T-1 (Tractor Driver)

AINRP on MAP

Project Coordinating Cell Headquarters

Dr. Satyabrata Maiti, Project Coordinator

AAU, Anand

Dr. S. Sriram, Research Scientist (Plant Breeding)

Dr. N. V. Upadhyay, Associate Research Scientist (Plant Physiology)

Dr. D. H. Patel, Asstt. Research Scientist (Selection Grade) (Agronomy)

Mr. P. B. Patel, Asstt. Research Scientist (Selection Grade) (Plant Pathology)

CCSHAU, Hisar

Dr. O. P. Yadav, Sr. Scientist (Plant Breeding)

Dr. V. K. Madan, Phytochemist

GBPUA&T, Bharsar

Dr. M. K. Karanwal, Asstt. Prof. (Plant Breeding)

Dr. M. S. Negi, Asstt. Prof. (Medicinal & Aromatic Plants)

Dr. L. B. Yadav, Asstt. Prof. (Plant Pathology)

JNKVV, Mandsaur

Dr. Hari Patidar, Principal Scientist (Plant Breeding)

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Dr. S. N. Mishra, Sr. Scientist (Phytochemistry)

Dr. R. S. Chundawat, Sr. Scientist (Agronomy)

KAU, Trichur

Dr. V. V. Radhakrishnan, Professor (Plant Breeding)

Dr. Latha A., Asstt. Prof. (Agronomy)

Dr. Beena C.S., Asstt. Prof. (Phytochemistry)

MPUAT, Udaipur

Dr. G. S. Chouhan, Professor (Agronomy)

Dr. S. S. Sharma, Assoc. Prof. (Plant Pathology)

Dr. Arunabh Joshi, Assoc. Prof. (Phytochemistry)

Dr. R. B. Dubey, Assoc. Prof. (Plant Breeding)

NDUAT, Faizabad

Dr. D. Ram, Assoc. Prof. (Horticulture)

Dr. O. P. Singh, Professor (Plant Breeding)

Dr. D. K. Chakrabarti, Assoc. Prof. (Plant Pathology)

PDKV, Akola

Dr. S. G. Wankhade, Assoc. Prof. (Agril. Chemicals & Soil Science)

Dr. (Mrs.) Varsha V. Tapre, Assoc. Prof. (Agronomy)

Shri R.B. Sarode, Asstt. Prof. (Plant Breeing)

UBKV, Kalimpong

Dr. Dhiman Mukherjee, Asstt. Prof. (Agronomy)

Dr. Soumendra Chakraborty, Asstt. Prof. (Genetics & Plant Breeding)

YSPUH&F, Solan

Dr. Romesh Chand, Sr. Scientist (Phytochemistry)

Dr. R. Raina, Sr. Scientist (Plant Breeding)

Dr. Meenu Sood, Scientist (Phyto-chemistry)

Dr. Yashpal Sharma, Asstt. Scientist (Plant Breeding)

AINRP on Betelvine

Project Coordinating Cell headquarters

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Dr. K. Sireesha, Asst. Professor (Entomology)

Smt. B. Tanuja Priya, Asst. Professor (Horticulture)

BCKV, Kalyani

Dr. Basudeb Dasgupta, Professor (Plant Pathology)

Dr. B. K. Das, Assoc. Prof. (Entomology)

Mr. D. K. Sengupta, Assoc. Prof. (Horticulture)

IIHR, Bangalore

Dr. T. Vasantha Kumar, Principal Scientist (Horticulture)

Dr. (Mrs.) Hima Bindu, Sr. Scientist (Plant Breeding)

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Dr. R.K. Chaurasia, Professor (Plant pathology)

Dr. U. K. Khare, Professor (Plant Pathology)

Dr. R. K. Shrivastava, Associate Professor (Horticulture)

MPKV, Sangli

Dr. S. R. Zangre, Assoc. Prof. (Plant Pathology)

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Dr. R. G. Jadhav, Asstt. Prof. (Horticulture)

OUAT, Bhubaneshwar

Dr. K. K. Patnaik, Assoc. Prof. (Horticulture)

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Dr. Vijay Mohan, Asstt. Prof. (Plant Pathology)

Dr. Brahmadev Prasad Singh, Asstt. Prof. (Entomology)

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Dr. D. K. Dwivedi, Asstt. Prof. (Agronomy)

Dr. P. K. Jha, Asstt. Prof. (Plant Pathology)

TNAU, Sirugamani

Dr. S. M. Jalaluddin, Professor (Entomology)

Prof Pon.Chockalingam, Professor (Horticulture)

Dr. Sangeetha Panickar, Asstt. Professor (Plant Pathology)


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