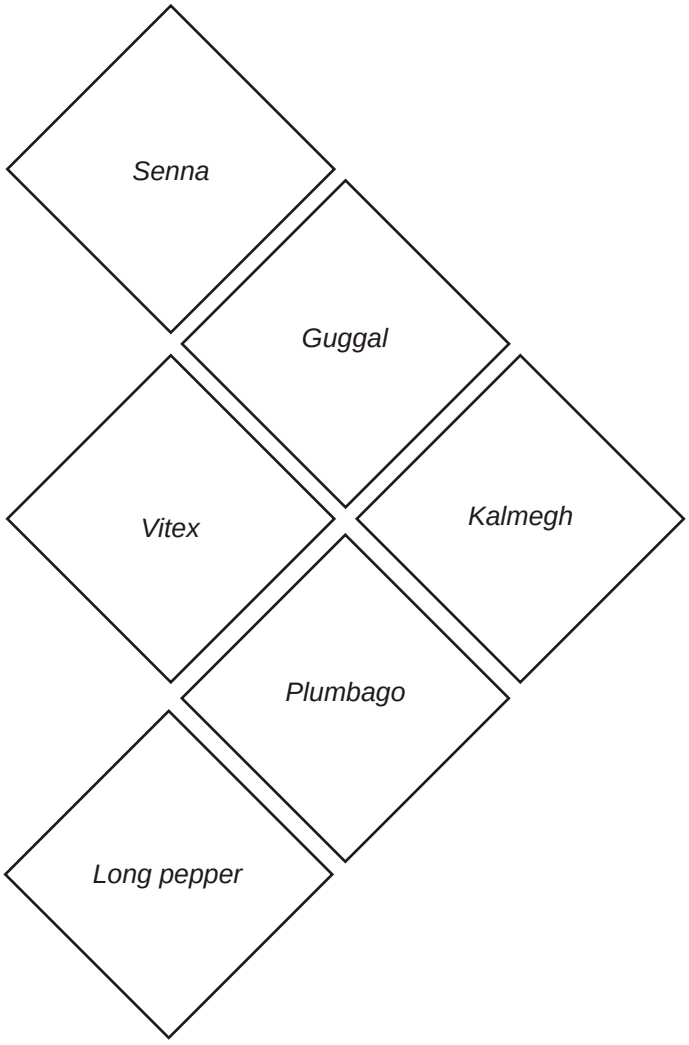
Annual Report
2006–07

भाकृअनुप
ICAR

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


Senna
Guggal
Vitex
Kalmegh
Plumbago
Long pepper

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CONTENTS

सारांश

भारतीय कृषि अनुसंधान परिषद के अंतर्गत बोरीआवी, आणंद, (गुजरात) स्थित 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 नेटवर्क परियोजना, औषधीय एवं सगंधीय पौधो पर शोध कार्य हेतु कार्यरत है । औषधीय एवं सगंधीय पौधो की विभिन्न प्रजातियों पर वर्ष 2006-2007 की महत्वपूर्ण शोध उपलब्धियां निम्नलिखित है ।

घी कंवार (ऐलो वेरा)

हिसार केन्द्र पर कुल 99 समूहों का परीक्षण किया गया, इनमें से के.सी./ओ.पी.-15, के.सी./ओ.पी.-25, के.सी./ओ.पी.-40 तथा के.सी./ओ.पी.-49 नामक जननद्रव्य (जर्मप्लास्म) में प्रति पौधा पर्ण उत्पादन स्थानीय प्रमाणित प्रजाति (चेक) एच.ए.बी.-1 की तुलना में काफ़ी अधिक पाई गई, किन्तु के.सी./ओ.पी.-15 के.सी./ओ.पी.-25, के.सी./ओ.पी.-36, के.सी./ओ.पी.-44, के.सी./ओ.पी.-53 तथा मोरनी हिल-1 प्रजातियों में लासा (म्यूसिलेज) का प्रतिशत स्थानीय प्रजाति (चेक) की तुलना में काफ़ी अधिक था ।

प्रयोगशाला मे एलो का अपरिपक्व पुष्पक्रम से सीधे प्ररोह उत्पन्न कर एलो के सूक्ष्मसंवर्धन के मसविदे (प्रोटॅकॉल) का मानकीकरण किया गया ।

विभिन्नि भौगोलिक स्थानों से पृथक किये गये चार जीवाण्वीय रोगजनको के रोगाणुजनित और जैवरासायनिक (बायोकेमिकल) आधार का तुलनात्मक अध्ययन राष्ट्रीय औषधीय एवं सगंधीय पादप अनुसंधान केन्द्र पर किया गया । हांलाकि सभी ग्राम नेगेटिव छड़नुमा थे और जॉच परत में सामान्यतया एकल प्रतित हो रहे थे तथा गोलाकार, सफेद-हल्का पीला, धुंधला समूह बनायें हुए थे जिसकी सतह चिकनी व उत्तल थी, लेकिन दस विभिन्न जैव आधारो के साथ इस जीवाणु के कल्चर की रोग जनक क्रिया में रोग जनन क्षमता के आधार पर काफी भिन्नता पाई गई । जैवरासायनिक रुप में भी उनमें भिन्नता देखी गयी ।

अशोक (साराका असोका)

त्रिचूर केन्द्र पर जॉचे गये अशोक के 42 उपजातियों (एक्सेशनों) में पौध अवस्था से ही बाह्य संरचनात्मक गुणों में काफ़ी विविधता देखी गई ।

अश्वगंधा (विथैनिया सोम्निफेरा)

हिसार केन्द्र पर इस पादप के 34 जननद्रव्यों का परीक्षण किया गया तथा विभिन्न लक्षणों जैसे, पौधे की उचाई, फल व जड़ का व्यास, पत्ती की चौडाई व लम्बाई, प्रति पौधा जड़ की उपज तथा कुल जड़ उपज में काफी विविधता दर्ज की गई । प्रति पौधा फलो (बेरी) की संख्या तथा फल का व्यास के अतिरिक्त अन्य सभी लक्षणों के लिए वंशक्रम एच.डबल्यू.एस.-04-05 को सबसे श्रेष्ठ पाया गया ।

मंदसौर केन्द्र पर 13 लक्षणों के लिए परीक्षित 119 जननद्रव्य लाईनों में काफ़ी आनुवांशिक विविधता देखी गई । जननद्रव्य एम.डबल्यु.एस.-100, एम.डबल्यु.एस.-124, एम.डबल्यु.एस.-132 तथा आर.ए.एस.-23 की जल्दी पकने वाले; एम.डबल्यु.एस.-101, एम.डबल्यु.एस.-130, एम.डबल्यु.एस.-139, एम.डबल्यु.एस.-204 तथा आर.ए.एस.-36 की मध्यम अवधी में पकने वाले और एम.डबल्यु.एस.-14, एम.डबल्यु.एस.-222, एम.डबल्यु.एस.-206 तथा आर.ए.एस.-22 की देरी से पकने वाले जननद्रव्यों के रूप में पहचान की गई । जननद्रव्य लाइन्स एम.डबल्यु.एस.-100, एम.डबल्यु.एस.-101, एम.डबल्यु.एस.-202, एम.डबल्यु.एस.-206, आर.ए.एस.-16 तथा आर.ए.एस.-41 इत्यादि की जड़े श्रेष्ठ गुणवत्ता (ग्रेड-2) वाली थी तथा एम.डबल्यु.एस.-100, एम.डबल्यु.एस.-101 तथा एम.डबल्यु.एस.-208 द्वारा अधिक शुष्क जड़ उत्पादन दर्ज किया गया ।

गत तीन वर्षो के दौरान आणंद केन्द्र पर कुल 29 उपजातियों (ऐक्सेशनों) का परीक्षण किया गया तथा इनमें से सैल-2B द्वारा एम.डबल्यू.एस.-100 की तुलना में शुष्क जड़ उपज में महत्त्वपूर्ण वृद्धि (898 किग्रा प्रति है०) दर्ज हुई ।

उदयपुर केन्द्र पर 35 (अगस्त 27 से सितंबर 2) व 37 (10-16 सितंबर) वे मौसमी सप्ताहो के दौरान बोई गई अश्वगंधा की फसल में मुख्य जड़ की लम्बाई (20.2 सेमी), शुष्क जड़ उपज (1440 किग्रा प्रति है०), बीजोंउत्पाद (740 किग्रा प्रति है०), सकल अल्कलाइड उत्पाद (5.5 किग्रा प्रति है०) के साथ शुद्ध आर्थिक लाभ (रु. 74,386 प्रति है०) तथा लागत व लाभ अनुपात (4.62) मे बढ़त दर्ज हुई जो कि 33 वें मौसमी सप्ताह (अगस्त 13-19) में बोई गई अश्वगंधा की फसल की अपेक्षा काफ़ी अधिक थी ।

अकोला केन्द्र पर विभिन्न बीज दरो (6,7,8,9 व 10 किग्रा प्रति है०) के क्षेत्र परीक्षणों में 10 किग्रा प्रति है० की बीजदर श्रेष्ठतम रही क्योंकी इस दर पर अन्य परीक्षित बीजदरों की तुलाना में पौधें की उचाई, जड़ की लम्बाई तथा उपज में सर्वाधिक दर्ज हुई, जबकि 07 किग्रा प्रति है० दर वाले प्रयोग में शाखाओं की संख्या सर्वाधिक वृद्धि पाई गई ।

हिसार केन्द्र पर अश्वगंधा की किस्मों व बीज दर का प्रभाव उसके उत्पादन एवं अन्य लक्षणों पर किये गये परीक्षणों में किस्म जे.ए.-134, किस्म जे.ए.-20 की तुलना में श्रेष्ठ थी तथा 12 किग्रा प्रति है० की बीजदर पर सर्वाधिक शुष्क जड़ उपज (51.8 किग्रा प्रति है०) प्राप्त की गई । जबकि, फैजाबाद केन्द्र पर जे.ए.-20 से अधिक उत्पादक सिद्ध हुई । इस किस्म के लिए भी 12 किग्रा प्रति है० बीजदर अधिक शुष्क जड़ उत्पाद हेतु श्रेष्ठ रही ।

ब्राह्मी (बैकोपा मोनिरी)

त्रिचूर केन्द्र पर केरल राज्य के विभिन्न प्रान्तों से एकत्र किए गये ब्राह्मी के 29 उपजातियों (ऐक्सेशनों) का परीक्षण किया गया तथा सभी के बीच काफी विविधता पाई गई । सभी ऐक्सशनो को पॉच समूहों में विभाजित किया । जैवभार उत्पादकता व अधिक बेकोसाइड की मात्रा के कारण एक्सेशन संख्या 14 की श्रेष्ठ एक्सेशन के रुप में पहचान की गई ।

चन्द्रसुर (लेपिडियम सटाइवम)

मध्य प्रदेश के मंदसौर, नीमाच, रतलाम तथा जबलपुर जिलों के किसानो के खेतो से एकत्र किये गये 09 जननद्रव्यों का बीजोंत्पादन हेतु मंदसौर केन्द्र पर परीक्षण किया गया । इनमें एम.एस.एल.-1, एम.एस.एल.-5, एम.एस.एल.-6 तथा एम.एस.एल.-7 की पहचान अधिक बीज उपज वाले नमूनों (ऐक्सेशनों) के रूप में की गई ।

चिरायता (स्वेर्टिआ प्रजा०)

कालिमपोंग केन्द्र द्वारा चिरायते की विभिन्न प्रजातियों को एकत्र करने के लिए दार्जिलिंग जनपद का व्यापक सर्वेक्षण किया गया । सुखीआपोखरी (6400 फीट समुद्र तल से उचाई) तथा सोनाडा 6800 फीट समुद्र तल से उचाई) में स्वेर्टिआ चिरायता तथा स्वेर्टिआ बाईमेक्युलेटा नामक पौधों की उच्च सघनता देखी गई ।

दोनो प्रजातियों के तुलनात्मक अध्ययन से पता चला कि दोनो प्रजातियों में पौधों की उचाई, पत्ती की व्यवस्था, आकार, लम्बाई, चौड़ाई व वर्णता; बीज के रंग व आकार तथा जड़ों की लम्बाई इत्यादि में स्पष्ट भिन्नता थी ।

इसी केन्द्र पर चिरायते के बीज अंकुरण संबंधी अध्ययन से पता चला कि स्वेर्टिया चिरायता के बीजों का अंकुरण केवल जीवाणु रहित मृदा:रेत:पत्तियों की खाद अनुपात आयतन के अनुसार 8:4:1 तथा जी.ए.-3-500 पी०पी०एम० या उसी अनुपात में मृदा:रेत:पत्तियों की खाद के साथ जी.ए. 3-700 पी.पी.एम. के मिश्रण मे ही संभव है । नवांकुरो की मृत्यु दर स्वेर्टिआ बाईमेक्युलेटा की तुलना में स्वेर्टिआ चिरायता में अत्यधिक थी ।

ईसबगोल (प्लैंटेगो ओवेटा)

डी.यू.एस. वर्णनको के प्रतिपादन हेतु 06 निस्तारित किस्मो के तुलनात्मक अध्ययन के अंतर्गत किसी भी किस्म में कोई स्पष्ट विविधता नही पाई गयी ।

एम.एस. बेसल माध्यम, जिसमें बी.ए. या के.एन. और 2-4 डी. या एन.ए.ए. विभिन्न सान्द्रता व संयोजन द्वारा पूरक पोषण युक्त है, पर व्यस्क पौधे से निकाले गये तने तथा तरुण पुष्पक्रम से चार सप्ताह के कल्चर के पश्चात कैलस उत्पत्ति प्रारम्भ हुई । कैलस की बढ़ोतरी सबसे अधिक उस माध्यम में पाई गई जिसमें 1.0 मिलीग्राम प्रति लीटर बी.ए. और 2.0 मिलीग्राम प्रति लीटर 2, 4 - डी. था । कैलस की वृद्धिदर तना एक्सप्लांट की तुलना में तरुण पुष्पक्रम से अधिक दर्ज की गयी ।

हिसार केन्द्र पर प्रमाणित (चेंक) किस्मो (जी.आई.-1, जी.आई.-2 तथा एच.आई.-5) के साथ 83 जननद्रव्य लाइनों का परीक्षण किया गया तथा इनमें से आर.आई.-08, आर.आई.-49, आर.आई.-87, आर.आई.-98, आर.आई.-99, आर.आई.-149, एच.आई.-6 तथा एच.आई.-8 द्वारा श्रेष्ठ प्रमाणित (चेंक) किस्म एच.आई.-5 की तुलना में प्रति पौधा अधिक बीज उत्पादन दर्ज किया गया ।

मंदसौर केन्द्र पर कुल 80 जननद्रव्य लाइनों का परीक्षण किया गया तथा विभिन्न लक्षणों जैसे, पौधे की उचाई, प्रति पौधा सीट्टो (स्पाइक) की संख्या, सीट्टो की लम्बाई, फूलने वाला कारक, 50 प्रतिशत पुष्पन होने के दिन तथा बीज उपज इत्यादि में उच्च स्तरीय विविधता दर्ज की गई । इनमें से 06 प्रकारो, एस.एल.एस.-48, एस.एल.एस.-51, एम.आई.बी.-6, एम.आई.बी.-7, एम.आई.बी.-1005 तथा एम.पी.एस.-50 की पहचान श्रेष्ठ वंशक्रमो के रूप में की गई ।

आणंद केन्द्र पर म्यूटेशन प्रजनन कार्यक्रम के अन्तर्गत तीन वर्षो तक ईसबगोल की 13 चयनित वंशक्रमों संकलनो (सलैक्शनों) के परीक्षण से ज्ञात हुआ कि वर्ष व सलैक्शन का परस्पर संबंध वंशक्रम पर पर्यावरण के प्रभाव को इंगित करता है । आंकड़ों के सयुक्त विश्लेषण से ज्ञात हुआ की जी.आई.-२ की तुलना में संकलन 8 व 12 द्वारा, क्रमशः 23.18 तथा 23.95 प्रतिशत अधिक बीज उत्पादन हुआ ।

उदयपुर केन्द्र पर युरिया के रूप में नत्रजन के प्रयोग से बीज, पुआल (स्ट्रा) व भूसी की उपज अन्य स्त्रोतो द्वारा नत्रजन प्रयोग (जैसे, करंज की खल, वर्मीकपोस्ट व कुक्कुट खाद) की तुलना में अधिक प्राप्त हुआ, परन्तु सांख्यिकी विश्लेषण में दोनों का प्रभाव बराबर ही रहा ।

राष्ट्रीय औषधीय एवं सगंधीय पादप अनुसंधान केन्द्र, आणंद में ईसबगोल (प्लैंटेगो इंडिका) की बुवाई 15 से 30 नवम्बर के मध्य करने से पौधों की बढ़त एवं उत्पादन में सर्वाधिक वृद्धि प्राप्त हुई ।

कालमेघ (एन्डोग्रेफिस पैनिकुलेटा)

आणंद केन्द्र पर कालमेघ के 29 सलैक्शनों का शीघ्र पुष्पन हेतु (50 प्रतिशत पुष्पन के दिनों के आधार पर) परीक्षण किया गया तथा उन्हे जल्दी व देर से पुष्पित होने वाले समूहों में वर्गीकृत किया गया । प्रमाणित (कन्ट्रोल) संकलन (87 दिवस) की तुलना में संकलन 16,17,18,20 तथा 23 (60 दिवस) शीघ्र पुष्पन तथा संकलन 3, 4 व 10 देर से पुष्पिन होने वाले संकलन थे ।

अकोला केन्द्र पर 30 x 15 सेमी. पौधे से पौधे की दूरी, पौधो की अधिक उचाई तथा ताजे व शुष्क पत्तियों की उपज के लिए उत्तम पाई गई । पौधों में पचास प्रतिशत पुष्पन के 15 वें दिन ऐन्ड्रोग्रेफोलाइड की मात्रा में महत्त्वपूर्ण वृद्धि दर्ज की गई । इसी तरह लोहे की मात्रा भी पचास प्रतिशत पुष्पन के 15 वें दिन अधिक थी जो कि पौधे की उम्र के साथ-साथ घटती गई । पादपों में दूरी व कटाई के समय के परस्पर संबंध का प्रभाव, बीजोंउत्पादन के लिए उत्तम पाया गया । साथ ही यह भी देखा गया की 30 x 30 सेमी. की दूरी तथा 50 प्रतिशत पुष्पन के 45 वें दिन कटाई, इन दोनों संयोजनात्मक उपचार से कन्ट्रोल की तुलना में बीज की उपज काफ़ी अधिक थी ।

फैजाबाद केन्द्र पर किये गये प्रयोगो से यह निष्कर्ष निकला कि गोबर की खाद (एफ.व्हाई.एम.) का 7.5 टन प्रति है. दर से उपयोग तथा बुवाई के 150 दिन पश्चात कटाई करने से कालमेघ का अधिकतम आर्थिक उत्पादन प्राप्त हो सकता है ।

मुलहठी (ग्लिसराइजा ग्लैब्रा)

हिसार केन्द्र पर क्रमशः जून 20, 2003 तथा जुलाई व जनवरी 2004 के दौरान लगाए गए पौधों को जब 2006 में उखाड़ा गया तो इनसे ताजे व शुष्क भूस्तारियों (स्टोलोन्स) की अधिकतम उपज प्राप्त हुई । बुवाई की तारीख तथा पौधे से पौधे की दूरी के परस्पर संबंध के प्रभाव बताते हैं कि ताजे तथा शुष्क दोनों प्रकार के भुस्तरियों की उपज जून 20, 2003 को 90 x 30 सेमी. की परस्पर दूरी पर बोई गई मुलहठी में अधिकतम थी ।

इसी केन्द्र पर मुलहठी में मिश्रित खेती के अध्ययन से पता चला कि खरीफ के दौरान अन्य फसलों जैसे, चना, ग्वार, लोबिया, बाजरा, राइसबीन्स, तुलसी, कालमेघ तथा अश्वगंधा इत्यादि की खेती मुलहठी के साथ की जा सकती है ।

एक अन्य अध्ययन में अकार्बनिक उर्वरक एन.पी.के. 40:40:20 किग्रा प्रति है. की दर के उपयोंग से, गोबर की खाद (एफ.व्हाई.एम.) पी.एस.बी. तथा एजोटोबेक्टर के संयुक्त उपयोंग की तुलना में ताजे व शुष्क भूस्तरियों (स्टोलेन्स) की उपज अधिक प्राप्त हुई । ग्लिसराइजीन की मात्रा दोनों ही उपचारों अर्थात एन.पी.के. (8.2%) तथा गोबर की खाद+पी.एस.बी.+एजोटोबेक्टर (8.0%) में लगभग बराबर थी ।

लांग पीपर (पाइपर लौंगम)

त्रिचूर केन्द्र पर चयनित वंशक्रमों तथा संकरो के परीक्षण में प्रमाणित (चेंक) किस्म "विश्वम" की तुलना में ऐक्सेशन संख्या 02 तथा 07 में शुष्क सिट्टा उपज अधिक दर्ज की गई ।

अफीम (पैपैवर सोम्निफेरम)

मंदसौर केन्द्र पर 104 जननद्रव्य लाइनों के परीक्षण के अंतर्गत उनकी पादप वृद्धि एवं उत्पादन इत्यादि लक्षणों में काफ़ी विविधता दर्ज की गई । वंशक्रम एम.ओ.पी.-379, एम.ओ.पी.-1057, एम.ओ.पी.-1079, एम.ओ.पी.-1080 तथा एम.ओ.पी.-1081 में कन्ट्रोल चेक वंशक्रम की तुलना में वानस्पतिक दूध की मात्रा अधिक दर्ज की गई ।

फैजाबाद केन्द्र पर चयनित 12 पेरेन्ट प्रजातियों, एन.ओ.पी.-1, एन.ओ.पी.-4, एन.ओ.पी.-02-13, एन.ओ.पी.-02-14, एन.ओ.पी.-02-15, एन.ओ.पी.-16, एन.ओ.पी.-2-41, एन.डी.-20, एन.डी.-46 तथा यू.ओ.-285 का विभिन्न संयोजनों में समागम कराया गया तथा विविध संयोजनों के 20 संकर विकसित किए गये ।

इसी केन्द्र पर किये गये एक अन्य अध्ययन से यह ज्ञात हुआ कि संकर प्रजातियों में क्रमशः एन.डी.एच.-1, एन.डी.एच.-2 तथा एन.ओ.पी.-4 से दूध, बीज व भूसी उपज अधिक प्राप्त हुई । इसी प्रकार एन.डी.एच.-1 द्वारा सर्वाधिक बीज एवं भूसी उत्पादन प्राप्त हुआ उसके बाद एन.डी.एच.-2 तथा एन.ओ.पी.-4 का क्रम रहा ।

मंदसौर केन्द्र पर दूध, बीज तथा भूसी की उपज में विविधता के लिए जाँचे गये अफीम के विभिन्न सूचकांको में महत्त्वपूर्ण अन्तर दर्ज किया गया । एन.डी.एच.व्हाई.-1 तथा एन.डी.एच.व्हाई.-2, दूध व मौरफीन की उपज के लिए श्रेष्ठ पायी गयी जबकि, एन.डी.एच.व्हाई.-2 तथा एम.ओ.एच.-2 बीज की उपज के लिए प्रमाणित (चेक) की तुलना में श्रेष्ठ थी । संकर परीक्षण के एक अन्य प्रयोग में एन.डी.एच.-1 से दूध की उपज तथा एन.डी.एच.-6 से बीज व भूसी की उपज श्रेष्ठतम कन्ट्रोल चेक एन.ओ.पी.-4 तुलना में काफ़ी अधिक दर्ज की गई ।

उदयपुर केन्द्र पर अफीम की फसल की विभिन्न अवस्थाओं जैसे, तना दीर्धकरन अवस्था, फसल बुवाई के 30 दिन पश्चात, गुच्छी अवस्था, कली अवस्था, प्रारम्भिक पुष्पावरस्था, 50 प्रतिशत पुष्पन, बिलम्बित बीजकोष

(कैप्सूल) अवस्था, बीजकोष परिपक्व अवस्था तथा फल पर चीरा लगाने के पश्चात इत्यादि पर सिंचाई करने पर गुच्छी अवस्था, तना दीर्धकरन अवस्था, कली अवस्था, 50 प्रतिशत पुष्पन अवस्था सिंचाई हेतु क्रान्तिक अवस्थाए सिद्ध हुई । इसके अतिरिक्त विभिन्न पादप कार्यकीय अवस्थाओं पर आर्द्रता तनाव, अफीम के गोंद पर पाए जाने वाले यौगिकों जैसे मौरफीन, कोडीन तथा थीबेन इत्यादि की मात्रा पर कोई प्रभाव नही डाल सका ।

इसी केन्द्र पर समन्वित पोषक तत्त्व प्रबंध के अंतर्गत अफीम-अश्वगंधा फसल चक्र में कार्बनिक स्त्रोतो के साथ किए गये अनुसंधान के परीणामों ने यह ज्ञात हुआ कि गोबर की खाद (एफ.व्हाई.एम.) की मात्रा 5-15 टन प्रति है. बढ़ाने से, प्रति पौधा पत्तियों, गोंद, बीज व बीजकोष भूसी की उपज तथा गोंद में मौरफीन, कोडीन तथा थीबेन इत्यादि की मात्रा में आशाजनक वृद्धि हो सकती है । यद्यपि प्रयोग किए गये गोबर खाद का प्रभाव पौधे की लम्बाई व प्रति पौधा बीज कोषो की संख्या के लिए केवल 10 टन प्रति है. की दर तक ही दर्ज किया गया । गोबर की खाद का गोंद में कोडीन की मात्रा पर कोई प्रभाव नही देखा गया ।

फैजाबाद केन्द्र पर अफीम की ग्राही (जवाहार अफीम 16) तथा प्रतिरोधी (गाजीपुर स्थानीय) कल्टीवरो के बाह्य संरचनात्मक लक्षणों तथा जैवरासायनिक घटकों के तुलनात्मक अध्ययन से यह ज्ञात हुआ कि संचारण करने पर ग्राही कल्टीवर में कार्बोहाइड्रेट की मात्रा प्रतिरोधी कल्टीवर की तुलना में अधिक शीघ्रता से घटने लगी थी । इसी प्रकार फिनॉल की मात्रा ग्राही कल्टीवर में संचारण के पश्चात प्रथम 18 घंटे लगातार घटती रही, जबकि प्रतिरोधी कल्टीवर में संचारण के 06 घंटे बाद फिनॉल की मात्रा में काफी वृद्धि दर्ज की गई तथा यह वृद्धि अगले 06 घंटे तक इसी स्तर पर बनी रही तत्पश्चात इसमें गिरावट दर्ज की गई और संचारण के 24 घंटे पश्चात यह सामान्य हो गई । इसके अतिरिक्त ग्राही कल्टीवर में संचारण के पश्चात पॉलिफिनाल आक्सिडेज (पी.पी.ओ.) क्रिया में नियमित गिरावट दर्ज की गई, जबकि प्रतिरोधी कल्टीवर में संचारण के 12 घंटे पश्चात् पॉलिफिनाल ऐक्सिडेज क्रिया में वृद्धि दर्ज की गई जो 18 घंटे पश्चात अधिकतम स्तर पर पहुँच गई ।

पामारोज (सिंबोपोगॉन मार्टिनी)

हिसार केन्द्र पर इस सगंधीय पौधे के 16 वंशक्रमो का कुल दो कटाई के आधार पर विभिन्न लक्षणों के लिए परीक्षण किया गया तथा आर.एच.-03-35 से सर्वाधिक मात्रा में तेल उत्पादन (291.11 ली. प्रति है.) प्राप्त हुआ, तत्पश्चात आर.एच.-03-30 (282.13 ली. प्रति है.) तथा आर.एच. 03-62-1 (280.8 ली. प्रति है.) वंशक्रमों का क्रम रहा ।

चित्रक (प्लंबैगो रोजीआ)

त्रिचूर केन्द्र पर गोबर खाद (दर 10 टन प्रति है.) तथा एजोस्पीरीलम तथा पी.एस.बी. (दर 25 किग्रा प्रति है.) का संयोजनात्मक प्रयोग, अधिक जड़ उपज तथा अधिक प्लंबैजीन की मात्रा प्राप्त करने के लिए कार्बनिक खाद तथा जैव उर्वरक का श्रेष्ठतम संयोजन सिद्ध हुआ ।

इसी केन्द्र पर एक अन्य प्रयोग में सी.पी.ई. के उच्च स्तर पर सिंचाई का चित्रक की वृद्धि व उपज पर गहरा प्रभाव देखा गया । इस प्रयोग से निष्कर्ष निकाला जा सकता है कि आई.डबल्यू./सी.पी.ई. की 1.0 की दर पर सिंचाई, अधिक जड़ उपज तथा अधिक प्लंबैजीन की मात्रा के लिए उत्तम है ।

इसके अतिरिक्त त्रिचूर की परिस्थितियों में 50 x 30 सेमी. की अर्न्तपंक्ति दूरी रखने पर चित्रक से अधिकतम शुष्क पदार्थ उत्पाद के अतिरिक्त, पौधों की उचाई, पत्तियों, शाखाओं व जड़ों की संख्या तथा जड़ों की लम्बाई व चौड़ाई भी अधिकतम थी ।

सफेद मूसली (क्लोरोफाइटम बोरिविलियानम)

मध्यम शक्ति वाले मुरासिंघे तथा स्कूग माध्यम जिसमें 3.0 मिग्रा. प्रति लीटर बी.ए., 150 मिग्रा. प्रति लीटर ए.डी.एस., 0.1 मिग्रा. प्रति लीटर एन.ए.ए. तथा 3 प्रतिशत सुक्रोज (भार प्रति आयतन) 16 घंटे प्रकाश अवधि

के अंतर्गत उपलब्ध है, पर अपरिपक्व पुष्पक्रम एक्सप्लांट से सीधे प्ररोह की पुर्नोउत्पत्ति में सफलता दर्ज की गई ।

उदयपुर केन्द्र पर जाँचे गए कुल 30 सफेद मूसली के जननद्रव्यो में से नौ अर्थात्, आर.सी.-64, आर.सी.-77, पी.सी.-2, पी.सी.-3, पी.सी.-15, पी.सी.-21, पी.सी.-25, पी.सी.-30 तथा पी.सी.-31 इत्यादि में गुच्छारुपी ज ड़ उत्पादन श्रेष्ठतम प्रमाणित (चेंक) वंशक्रम सी.बी.आई.-7 से अधिक पाई गई ।

हिसार केन्द्र पर जाँचे गए कुल 11 वंशक्रमों में सी.बी.आी.-7, एच.सी.बी.-4, एच.सी.बी.-6 तथा एम.सी.बी.-414 में प्रामाणित (चेक) वंशक्रम एम.सी.बी.-405 (47.67 ग्रा. प्रति पौधा) की तुलना से काफ़ी अधिक उपज दर्ज की गई ।

मंदसौर केन्द्र पर 24 जननद्रव्यों का मूल्यांकन किया गया एवं गुणात्मक तथा संख्यात्मक दोनों ही प्रकार के लक्षणों में काफी विविधता दर्ज की गई । सैपोजिनिन की मात्रा तथा गुच्छारुपी जड़ के उत्पादन के लिए वंशक्रम एम.सी.बी.-401, एम.सी.बी.-412, एम.सी.बी.-414, एम.सी.बी.-415, एम.सी.बी.-419 तथा एम.सी.बी.-424 इत्यादि की उत्तम वंशक्रमों के रुप में पहचान की गयी ।

एक अन्य प्रयोग में यह पाया की छीली हुई जड़ों में बगैर छीली जड़ों की तुलना में सैपोनिन की मात्रा बहुत कम थी तथा यह मात्रा एक वर्ष तक, भण्डारण की अवधि बढ़ने के साथ उत्तरोत्तर घटती जा रही थी ।

खरीफ में सफेद मूसली तथा रबी में असालीया (लेपिडीयम सटाइवम) युक्त फसल प्रणाली के अंतर्गत दो वर्षो के अध्ययन के दौरान, सर्वाधिक शुद्ध मुनाफा (रु. 5 लाख) अर्जित हुआ । इसका लागत व लाभ अनुपात 1:2.49 था ।

उदयपुर केन्द्र पर भण्डारण के दौरान गुणवत्ता बढ़ाने हेतु भण्डारण के विभिन्न तरीको का प्रयोग किया गया । लकड़ी के बाक्स में 4″ सफेद मूसली की परत तथा 4″ मृदा की परत रखने से प्रतिशत वजन में न्यूनतम कमी दर्ज की गई ।

गिलोय (टीनोस्पोरा कॉर्डीफोलिआ (विल्डेनो) मियर्स)

राष्ट्रीय औषधीय एवं एगंधीय पादप अनुसंधान केन्द्र पर टीनोस्पोरा में पत्ती की लम्बाई, चौड़ाई तथा आकार में अंकुरण के 10-13 दिन के भीतर अधिकतम वृद्धि दर्ज की गई, लेकिन वृंत (पेडीकल) में अधिकतम वृद्धि 20 दन पश्चात दर्ज की गई ।

पानलता (पाईपर बीटल)

बेंगलोर केन्द्र पर नर व मादा क्लोनो के मध्य विभिन्न संयोजनो में 72 विभिन्न समागम कराये गये । संकरो में बीज अंकुरण 20 से 80 प्रतिशत के मध्य पाया गया तथा गमलों में स्थापित नवांकुरो में से सात प्रबल संकर पौधे जिनकी बेल की लम्बाई 0.1 मी. से अधिक थी का जमीन में रोपण हेतु चयन किया गया ।

ट्राइकोडर्मा विरडी के उपयोग के 80 दिन पश्चात अधिकतम जनसंख्या लगभग 80 x 103 सी.एफ.यू. प्रति ग्राम के साथ इसके भूस्तारी (राइजोस्पियर) में जीविता दर्ज की गयी । साथ ही साथ यह भी देखा गया की 50 से 60 ग्राम ट्राईकोडर्मा विरडी के टीकों से अधिकतम स्पोर उत्पन्न हुई । मुंगफली की खल या सरसो की खल इस फफूंदी के गुणन हेतु अनुकुल पाई गई ।

परियोजना के आठ केन्द्रों द्वारा अपने-अपने क्षेत्रों के लिए समन्वित फसल प्रबंध प्रस्ताव विकसित किए गये ।

पान की उपज बढाने हेतु बोर्डो मिश्रण का प्रयोग जैवनियंत्रको की तुलना में उत्तम पाया गया, लेकिन परियोजना के अधिकतर केन्द्रो पर पत्तियों की उपज बढ़ाने व रोग का प्रभाव घटाने हेतु ट्राइकोडर्मा संचारित खल (तैलिय टिकिया) के तिमाही अन्तराल पर प्रयोग, बोर्डेक्स मिश्रण के संस्तुत नियंत्रण के बराबर पाया गया ।

परियोजना के केन्द्रो द्वारा विकसित व्याधि प्रबंधन की तकनीक किसानो द्वारा अपनायी गयी व्याधि नियंत्रण की विधियों के अपेक्षा उत्तम पाई गई । बापटला, जोरहट, कल्यानी, भुवनेश्वर तथा सिरुगमानी इत्यादि केन्द्रो द्वारा पान के किसानो के खेतो पर लगाये गये प्रदर्शनो के परिणामों से यह ज्ञात हुआ कि इस तकनीक के प्रयोग से पान में व्याधि का प्रकोप कम हुआ, उपज बढ़ी तथा लागत व लाभ अनपात सुधरा ।

तैलीय खल + कार्बोफयूरान + पेनीसीलीयम लीलेसीनस के तीन या चार टीको द्वारा संचारित तैलिय खल के प्रयोग से, असम कृषि विश्वविद्यालय, जवाहरलाल नेहरु कृषि विश्वविद्यालय तथा राजस्थान कृषि विश्वविद्यालय इत्यादि केन्द्रो पर किए गए अन्य उपचारों की तुलना में रुट जड़ गाँठ सूत्रकृमि रोग का प्रभावी नियंत्रण किया गया व पत्ती की उपज में भी वृद्धि हुई ।

सूचना प्रबंध (कृषि अनुसंधन सूचना तंत्र)

वर्ष के दौरान सोफ्टवेयर विकसित करने का कार्य जारी रहा तथा वेब आधारित सोफ्टवेयर पैकेज ''डिजीटल हर्बेरीयम आफ मेडीसनल एण्ड एरोमेटिक प्लांटस'' विकसित व विमोचित किया । यह पैकेज औषधीय पौधो का अभिलेख प्रतिपादित करने के लिए एक मित्र उपयोगी तरीका है । यह डीजीटल हर्बेरीयम एक प्रमाणित, उच्च विभेदन क्षमता वाले औषधीय तथा सगंधीय पौधो के नमूनों के सादृश्यों तथा सम्बंधित तथ्यों का संग्रह है, जो कि सार्वजनिक अवलोकन हेतु उपलब्ध है तथा बहुत ही सरलता व सुगमता से वेब पर देखा जा सकता है ।

औषधीय व सगंधीय पादप संदर्भ सूचना तंत्र (Medicinal and Aromatic Plants References Information System), औषधीय व सगंधीय पादप पर व्यापारी सूचना तंत्र (Traders Information System on Medicinal and Aromatic Plants), औषधीय व सगंधीय पादप की डिजीटल सादृश्य लाइब्रारी (Digital Photo Library of Medicinal and Aromatic Plants) और औषधीय व सगंधीय पादप हेतु डिजीटल हर्बेरीयम (Digital Herbarium of Medicinal and Aromatic Plants) इत्यादि पर जो तथ्य संगणक (computer) में संग्रहीत है का (database) अद्यतन किया गया ।

संस्थान की वेबसाइट www.nrc-map.org को पुनप्रारुपित किया गया । संस्थान के बजट का लेखा-जोखा रोजाना वेबसाईट पर दर्ज किया गया तथा सूचना के अधिकार बाबत सूचना तथा अन्य प्रतिवेदनों को संस्थान की वेबसाइट पर संलग्न किया गया ।

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 । वैज्ञानिक, प्रशासनिक तथा तकनीकी कर्मचारियों की कार्यक्षमता बढ़ाने हेतु उन्हें विभिन्न प्रशिक्षणों पर भेजा गया । 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 । वर्ष के दौरान कई प्रख्यात व्यक्तियों ने संस्थान का दौरा किया । राष्ट्रीय औषधीय एवं सगंधीय पादप अनुसंधान केन्द्र के नव निर्मित आवासीय भवनों का सम्माननीय डॉ. मंगलाराय, सचिव, कृषि अनुसंधान व शिक्षा विभाग तथा महानिदेशक, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली के कर कमलों द्वारा शुभारम्भ किया गया ।

SUMMARY

National Research Centre for Medicinal and Aromatic Plants (NRCMAP) located at Anand and it's out reach programmes, All India Networking Research Project on Medicinal and Aromatic Plants and All India Networking Research Project on Betelvine are engaged in research on medicinal and aromatic plants under the aegis of ICAR. Important research findings of 2006-07 are presented below, species-wise:

ALOE (*Aloe vera*)

At Hissar out of 99 genotypes evaluated, KC/OP-49, KC/OP-15, KC/OP-25 and KC/OP-40 had significantly higher leaf yield per plant than the local check HAV-1. Whereas, KC/OP-25, KC/OP-36, KC/OP-15, Morni Hill-1, KC/OP-44 and KC/OP-53 had significantly higher mucilage per cent than HAV-1.

Protocols for in-vitro micropropogation of aloe through direct shoot regeneration from immature inflorescence has been standardized.

Pathological and biochemical basis of four bacterial pathogens isolated from varied geographical locations were compared at NRCMAP. Even though all were Gram negative rods and usually appeared single in the smear and produced circular, creamy white, translucent colonies with smooth surface and convex elevation, the pathogenicity of the cultures showed wide variability in the culture in terms of pathogenic reaction with 10 different hosts. Biochemically also they were different.

ASOKA (*Saraca asoka*)

Forty two accessions of asoka were evaluated at Trichur and wide variability was observed for morphological traits from the seedling stage itself.

ASHWAGANDHA (*Withania somnifera*)

Thirty four germplasm were evaluated at Hissar and wide range of variability was recorded for plant height, berry/plant, diameter of berry, root diameter, leaf width, leaf length, root yield per plant and total root yield. The genotype HWS-04-5 was the best for all the characters, except for number of berry/plant and berry diameter.

At Mandsaur, considerable genetic variation was observed in 119 germplasm lines for thirteen characters. Germplasm MWS-100, 124, 132, and RAS-23 were early, MWS-101, 130, 139, 204 & RAS-36 were medium and MWS-14, 222, 302, RAS-22) were late maturing. Germplasm lines MWS –100, 101, 202, 206, RAS-41, and RAS-16 had superior quality grade-2 roots and MWS-100, 101, 206 and 208 had higher dry root yield.

At Anand out of 29 accessions evaluated for last three years Sel-2B gave significantly higher dry root yield (898 kg ha^{-1}) over WS-100.

At Udaipur, sowing of Ashwagandha during 35th (August 27-Sept.2) and 37th (September 10-16) Meteorological Week (MW) significantly increased main root length (20.2 cm), dry root yield (1440 kg ha^{-1}), seed yield (740 kg ha^{-1}), total alkaloid yield (5.5 kg ha^{-1}), net monetary returns (Rs. 74386 ha^{-1}) and B:C ratio (4.62) than sowing during 33rd MW (August 13-19).

At Akola, when the seed rate of 6, 7, 8, 9 and 10 kg ha^{-1} was applied the highest values for plant height, root length and root yield were obtained at 10 kg ha^{-1} whereas, number of branches at 7 kg ha^{-1}.

At Hissar, results of the experiment on effect of varieties and seed rate on yield and its related traits revealed that the variety JA-134 was superior than JA-20 and seed rate of 12.0 kg ha^{-1} produced the highest dry root yield 51.8 kg ha^{-1}. Whereas at Faizabad, JA-20 was better yielder and seed rate of 12.0 kg ha^{-1} had higher root yield.

BRAHMI (*Bacopa monnieri*)

Twenty nine Brahmi accessions collected from different districts of Kerala were evaluated at Trichur and found considerable variation between them. They were grouped into five clusters and the accession No. 14 has been identified as superior as it yielded higher biomass and bacoside content.

CHANDRASUR (*Lepidium sativum*)

Nine germplasm, collected from farmers' field at Mandsaur, Neemuch, Ratlam and Jabalpur districts were evaluated at Mandsaur for seed yield. Lines MLS-7, MLS –1, MLS-5 and MLS-6 were identified as high yielding accessions.

CHIRAYITA (*Swertia chirayita*)

Extensive survey was conducted for collection of chirayita population in the Darjeeling district at UBKV, Kalingpong and high population density of *S. chirayita* and *S. bimaculata* was noticed at Sukhiapokhri (6,400 ft) and Sonada (6,800 ft).

Comparative study of the two species revealed that there was a distinct difference between them for plant height, leaf (arrangement, size, length, breadth and pigmentation), seed (colour and size) and root length.

Seed germination studied in chirayita at Kalimpong indicated that seeds of *S. chirayita* germinated only in sterilized soil: sand: leaf manure (8:4:1 v/v) + GA_3 500 ppm and with sterilized soil: sand: leaf manure (8:4:1 v/v) + GA_3 700 ppm. The degree of seedling mortality was extremely higher in *S. chirayita* than in *S. bimaculata*.

GUGGAL (*Commiphora wightii*)

The genetic similarity comparision of 27 accessions using biochemical marker revealed that protein-bandign pattern varied widely between the accession. It ranged from 2 (in 3 accession) to 7 (in 9 accessions) bands.

Chimical profiling of male and female plants through HPTLC, HPLC and LC-MS was done and no chemical marker to distinguish between male and female plants was observed.

ISABGOL (*Plantago ovata*)

Comparison of six released cultivars for development of DUS descriptor indicated that there was no distinct different between varieties.

Callus was initiated at NRCMAP both from stem and young inflorescence ovata derived from mature plants on MS basal medium supplemented with various concentrations and combinations of BA or Kn and 2,4-D or NAA after 4-week of culture. The maximum callus proliferation was recorded in the medium containing 1.0 mg l^{-1} BA and 2.0 mg l^{-1} 2.4-D; the rate of callus proliferation was more in young inflorescence than the stem explants.

Out of the 83 germplasm lines evaluated at Hissar along with three check varieties (GI 1, GI 2 and HI 5), RI-49, RI-149, RI-87, RI-99, RI-98 08, HI-8 and HI-6 recorded the higher seed yield per plant than the best check HI-5.

A total of 80 germplasm lines were maintained and evaluated at Mandsaur and high range of variability was noted for plant height, number of spikes per plant, length of spikes, swelling factor, days to 50% flowering and seed yield. Six lines, SLS-51, MIB-7, MIB-1005, SPS-50, MIB-6 and SLS-48 were identified as superior genotypes.

Evaluation of 13 selections from mutation breeding programme for three years at Anand showed that significant interaction between year and selection indicating the influence of environment on genotypes. Selection 8 and Selection 12 gave 23.18% and 23.95%, respectively higher seed yield over GI 2, in pooled analysis.

At Udaipur, application of nitrogen in the form of urea gave the maximum yield of seed, straw and husk as compared to applied through other sources like like karanj cake, vermicompost and poultry manure, but statistically at par.

The sowing of *Platago indica* between 15 and 30th November resulted in maximum growth and yield at NRCMAP, Anand.

KALMEGH (*Andrographis paniculata*)

Twenty nine selections of kalmegh were evaluated for earliness based on days taken to 50 % flowering at Anand. Selections 16, 17, 18, 20 and 23 were early (60 days) compared to control (87 days) and selections 3, 4 and 10 were late maturing.

At Akola, the spacing of 30 x 15 cm had significantly higher plant height, fresh and dry foliage yield. Significantly higher andrographolide content was recorded at 15 days after 50% flowering. The iron content was significantly higher with harvest at 50% flowering and the content successively decreased with the increase in plant age. The interaction effect of spacing and harvesting time was found significant for seed yield. Significantly higher seed

yield than control was observed with the treatment combination of 30 x 30 cm spacing and harvest at 45 days after 50% flowering (209 kg ha-1).

At Faizabad, it was observed that application of FYM @ 7.5 t ha-1 and harvesting at 150 DAS gave maximum economic yield in kalmegh.

LAL CHITRAK (*Plumbago rosea*)

At Trichur, combined application of FYM @ 10 t ha-1 with Azospirillum and PSB @ 25 kg ha-1 was the best combination of organic manures and biofertilisers for obtaining maximum root yield and plumbagin content.

Irrigation at higher levels of CPE had pronounced effect on growth and yield at Trichur. It could be concluded that irrigation @ IW/CPE of 1.0 was found to be optimum for higher root yield and plumbagin content.

Spacing of 50 x 30 cm had taller plants with higher number of leaves, number of branches, number of roots, longest roots and the highest root girth besides the highest dry matter production at Trichur.

LIQUORICE (*Glycyrrhiza glabra*)

At Hissar, the maximum fresh and dry stolon yield was obtained from June 20, 2003 planting followed by July and January, 2004 plantings when uprooted in 2006. The interaction effect between date of sowing and plant spacing for both fresh and dry stolon yield indicated that plantation on June 20, 2003 with 90×30 cm spacing produced maximum yield.

Intercropping studies in liquorice indicated that during kharif season, crops like green gram, cluster bean, cowpea, pearl millet, ricebean, Tulsi, Kalmegh and Ashwagandha could be cultivated at Hissar.

Fresh and dry stolon yield were maximum in inorganic fertiliser of NPK @ 40:40:20 kg ha-1 than FYM + PSB + Azotobactor at Hissar. Maximum glycyrrhizin content of 8.2 % in NPK treatment was statistically at par with the FYM + PSB + Azotobactor (8.0%).

LONG PEPPER (*Piper longum*)

At Trichur, evaluation of selected genotypes including hybrids showed that Accession No.2 and Accession No.7 recorded significantly higher dry spike yield compared to the check variety Viswam.

OPIUM POPPY (*Papaver somniferum*)

At Mandsaur, 104 germplasm lines were evaluated and high range of variability was recorded for different growth and yield characters. Genotypes, MOP-379, MOP-1057, MOP-1079, MOP-1080 and MOP-1081 recorded higher latex yield than control.

Ten selected parents namely, NOP 02-13, NOP 02-14, NOP 02-15, NOP 02-16, NOP

02-41, NOP-1, NOP-4, ND-20, ND-46 and UO-285 were crossed in various combinations and 20 hybrids were developed at Faizabad.

At Faizabad, significantly higher latex yield was recorded in NDH-1 followed by NDH-2 and NOP-4. Significantly higher seed and husk yields were recorded in the hybrid NDH-1 followed by NDH-2 and NOP-4.

At Mandsaur, the variances for latex, seed and husk yield showed significant difference among the opium poppy entries tested. NDHY-1 and NDHY-2 were superior for latex and morphine yield, whereas, for seed yield, NDHY-2 and MOH-2 were superior to check. In an another trial of hybrid evaluation significantly higher latex yield was recorded in NDH-1 and seed and husk yields in NDH-6 than the best control NOP-4.

At Udaipur, irrigations were given to opium poppy at different stages viz., stem elongation, 30 days after sowing, rosette, bud, flower initiation, 50% flowering, late capsule, capsule maturity and at after lancing. The critical stages of irrigation were at rosette stage, stem elongation, bud and 50% flowering. Further, moisture stress at various physiological stages did not influence morphine, codeine and thebaine content of opium gum.

The results of experiment on integrated nutrient management in opium poppy-ashwagandha crop rotation involving organic sources at Udaipur indicated that increasing levels of FYM from 5 to 15 t ha^{-1} significantly increased leaves per plant, gum, seed yield, capsule husk yield, morphine and thebaine content of gum. However, response of applied FYM was noted upto 10 t ha^{-1} for plant height and capsules per plant. Codein content of gum was not influenced by FYM application.

Comparison of morphological features and biochemical constituents of both susceptible (Jawahar Aphim-16) and resistant (Ghazipur Local) cultivars of opium poppy at Faizabad showed that upon inoculation, carbohydrate content decreased faster in susceptible as compared to resistant cultivar. Similarly, in susceptible cultivar there was continuous decline in phenol content in the first 18 h after inoculation, whereas in resistant cultivar, after 6 h of inoculation, there was significant increase in phenol content and it was maintained up to next 6 h. Later the phenol content reduced and reached the normal level 24 h after inoculation. Further, in susceptible cultivar polyphenol oxidase (PPO) activity showed steady decline after inoculation, while in resistant cultivar, PPO activity showed increasing trend 12 h after inoculation and reached to maximum level at 18 h after inoculation.

PATCHOULI (*Pogostemon cablin*)

Short duration drought stress on 4 months old patchouli plants (tissue cultured and rooted cutting) had considerable reduction in leaf water potential and diurnal pattern of photosynthesis.

A protocol for propagation using single leaf has been standardised. The 4^{th} pair of leaf from the appex was the best for production of plantlets.

PALMAROSA (*Cymbopogon martini* var. *motia*)

Sixteen genotypes were evaluated for various characters at Hisar and on the basis of total of two cuts (harvests), genotype RH-03-35 recorded the highest oil yield (291.11 l ha^{-1}) followed by RH-03-30 (282.13 l ha^{-1}) and RH-03-62-1 (280.8 l ha^{-1}).

SAFED MUSLI (*Chorophytum borivillianum*)

Direct shoot regeneration was achieved from immature inflorescence explants of on half-strength Murashige and Skoog (MS) medium supplemented with 3.0 mg l^{-1} BA, 150 mg l^{-1} Ads, 0.1 mg l^{-1} NAA and 3% (w/v) sucrose under a 16-h photoperiod.

Out of 30 safed musli germplasm evaluated at Udaipur, nine genotypes viz. RC-77, PC-2, RC-64, PC-3, PC-25, PC-21, PC-15, PC-31 and PC-30 had higher fasciculated root yield over the best check CBI-7. Similarly, out of eleven genotypes evaluated at Hisar, CBI-7, HCB-6, HCB-4 and MCB-414 had significantly higher yield than the check MCB-405.

Twenty-four germplasm were tested at Mandsaur and wide range of variability was recorded in both qualitative and quantitative characters. MCB-414, MCB-412, MCB-401, MCB-419, MCB-415 and MCB-424 were identified as superior genotype for fasciculated root yield and sapogenine content.

The peeling and storing study showed lowest saponin content in peeled roots than unpeeled roots and successively decreased with increased storage period up to 1 year.

Based on two years study, cropping system comprising Safed Musli in Kharif season and Asalio (*Lepidium sativum*) in Rabi season gave the highest net profit (Rs. 5 lakhs) with CBR 1:2.49.

At Udaipur, in order to increase keeping quality, various methods were used for storage and that lowest percentage of weight loss was recorded from the treatment applied with wooden box containing 4″ layer of musli + 4″ layer of soil.

TINOSPORA (*Tinospora cordifolia*)

Leaf length, breadth and area attained maximum value within 11-13 days after its emergence; however, pedicel reached maximum growth after about 20 days at NRCMAP.

BETELVINE (*Piper betle*)

At Bangalore 72 different crosses were made between the male and female clones in different combinations. Seed germination in hybrids ranged from 20 to 80% and from the seedlings established in the pots, seven vigorous hybrids whose vine length was above 1m were selected for field planting.

Rhizosphere survival of *Trichoderma viride* was recorded with maximum population of approx. 80 x 10^3 cfu/g at 80 days after application. Fifty to sixty gram inocula of *T. viride* were found to produce the highest spore production. Ground nut oil cake/mustard oil cake was favorable for multiplication of the fungus.

The integrated crop management package has been developed for different regions.

Application of Bordeaux Mixture was found superior in comparison to bio control agent in increasing yield, but the application of *Trichoderma* inoculated oil cake at quarterly interval was found statistically at par with the recommended control of Bordeaux mixture in increasing leaf yield and in reducing the disease incidence in most of the AINRP centres.

The disease management technology developed by the AINRP centers was superior to the practices followed by the farmers in controlling Betelvine diseases. The demonstrations conducted by Bapatla, Jorhat, Kalyani, Bhubaneshwar and Sirugamani centres in the fields of betelvine farmers resulted in reduction of diseases incidence, increase in yield and better cost benefit ratio.

Application of oil cakes + carbofuran + three or four inoculations of *P. lilacinus* inoculated oil cakes effectively controlled the root knot nematode and increased leaf yield compared to other treatments at AINRPB centres of AAU, JNKVV and RAU.

Information Management (*ARIS*)

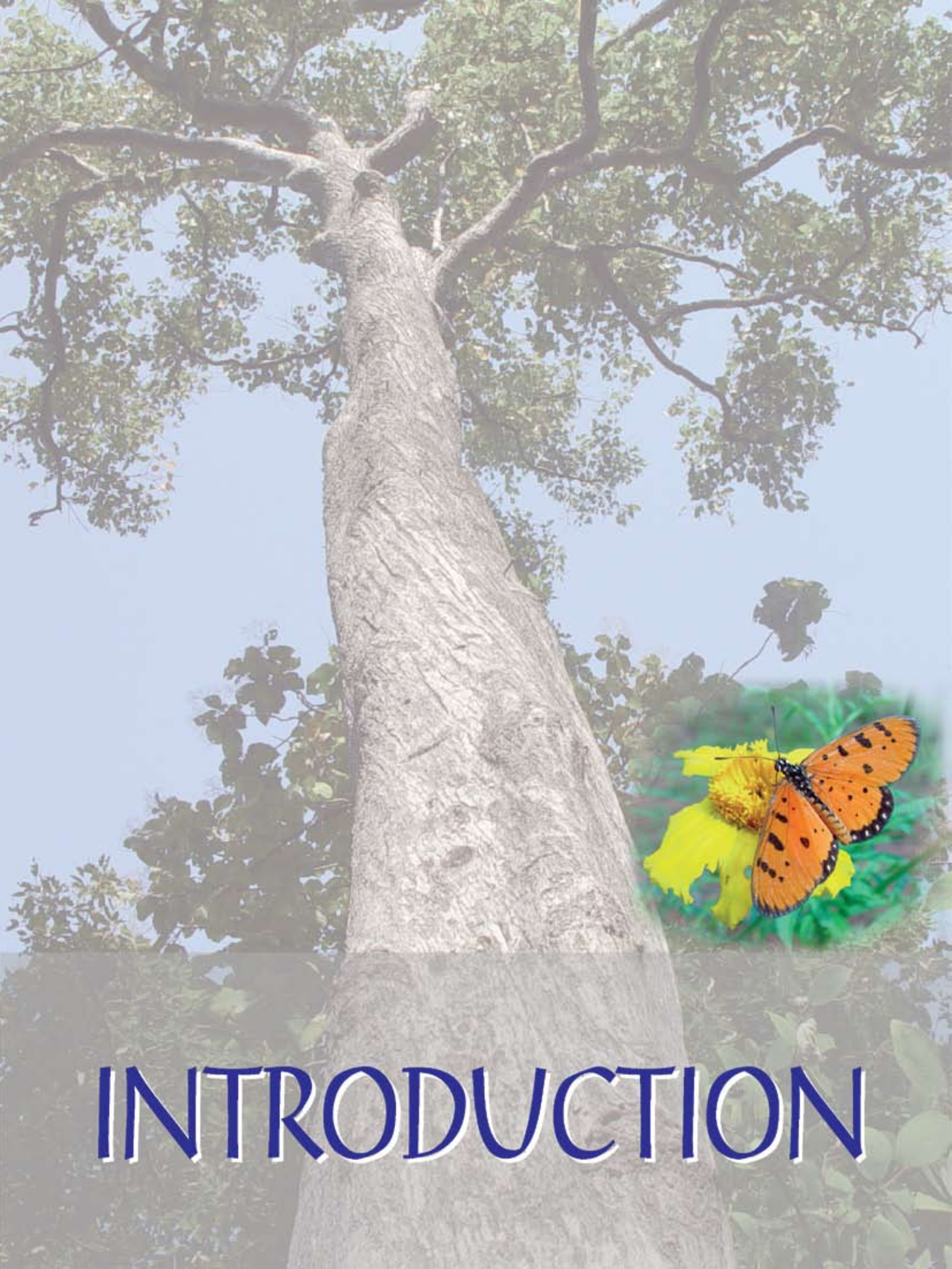
During the year, attempts are being continued for developing a software package and developed and launched the web based software package entitled "Digital Herbarium of Medicinal & Aromatic Plants in India". This package is user-friendly method of maintaining the records of medicinal and aromatic plants This Digital Herbarium is an authenticated collection of high resolution images of medicinal and aromatic plant specimens with their associated taxonomic data, which is easily accessible to the public.

Databases on Medicinal and Aromatic Plants References Information System, Traders Information system on Medicinal and Aromatic plants, Digital Photo Library of Medicinal & Aromatic Plants and, Digital Herbarium of Medicinal & Aromatic Plants in India have been updated and maintained.

The institute website www.nrc-map.org was redesigned and updated in regular intervals. The budget expenditure details have been posted on daily basis. The right to information act information and reports has been appended to the institute website.

Other Activities

The Centre holds meetings of SRC, RAC, IMC and regular monthly meetings to monitor the research and developmental activities. Scientific, administrative and technical staff members were sent for training to increase their work efficiency. NRCMAP family also observed the Hindi week, Annual Day, Independence Day, Republic Day, Vigilance Day, Sadbhavana Day and other important occasions with full coordination and spirit. The workers of Medicinal and Aromatic Plants and Betelvine published several research publications. A notable number of distinguished personalities visited the institute. The newly constructed NRCMAP residential quarters have been opened by Dr. Magala Rai, our honorable DG, ICAR, New Delhi.



INTRODUCTION

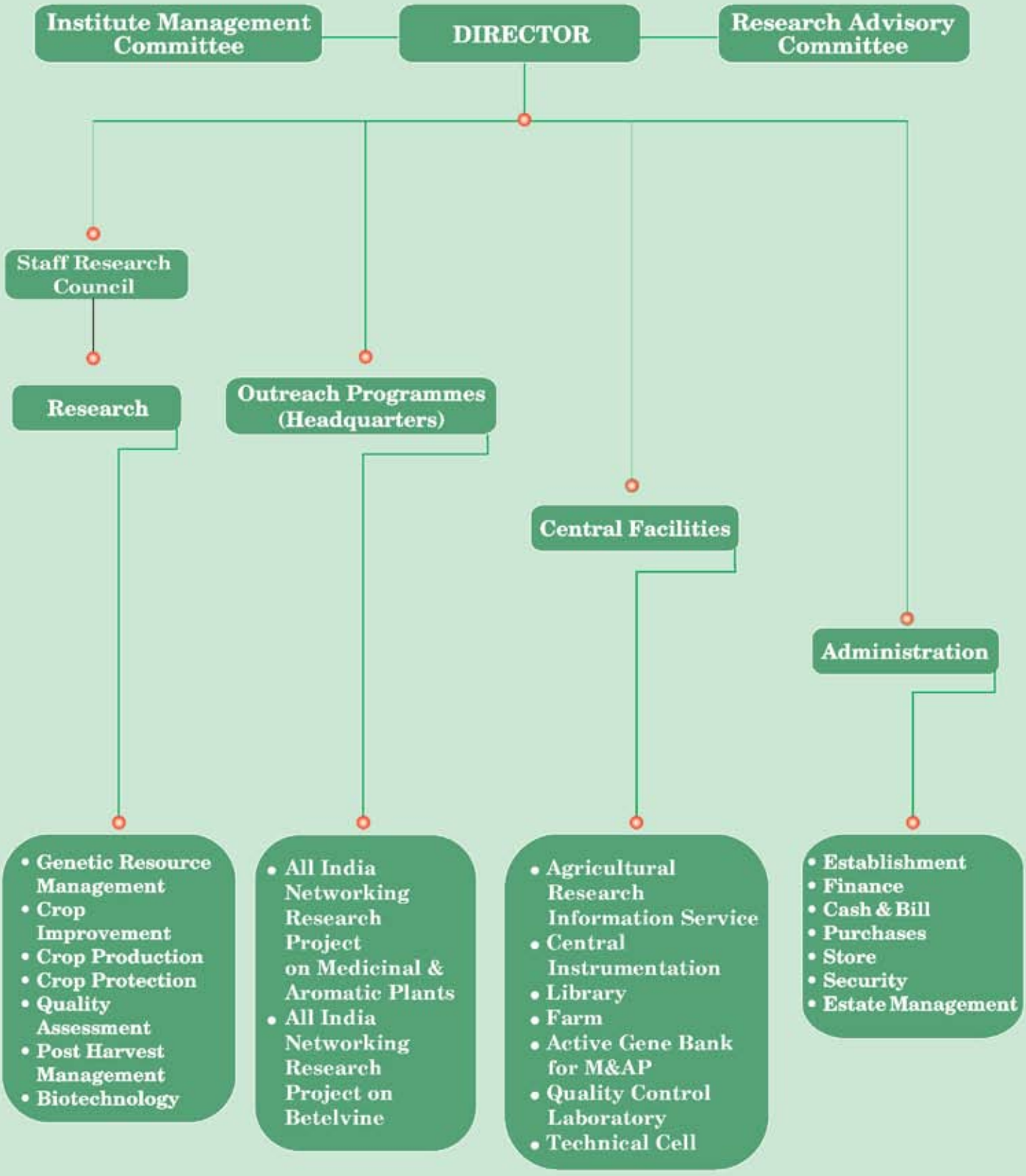
Traditional medicaments, derived from plants for thousands of years, are now yielding their secrets and finding important roles in modern medicine. More than three quarters of the world's population relies mainly on plants and plant extracts for health care. Of the 250,000 higher plant species on earth, more than 80,000 are having medicinal value. Traditional medicine is widespread throughout the world; it is an integral part of each individual culture. India's use of plants for health care dates back close to 5000 years. About 8000 herbal remedies have been codified in the Ayurveda, which is in use in many dispensaries today.

World population in the current growth rate is likely to reach 11.5 billion by the year 2020. Rise in population, inadequate supply of drugs in certain parts of the world, prohibitive cost of treatment for common ailments, side effects of several allopathic drugs in current usage and development of resistance to currently used drugs for infectious disease have lead to increased emphasis on the use of plant materials as source of medicines for the wide variety of human ailments. India due to its wide range of geographical, ecological and biological diversities possesses many species that are directly or indirectly used as sources of herbal, allopathic or homeopathic medicines. However, many of these plant species are facing threats of extinction due to over and improper exploitation, habitat loss, fragmentation and degradation of land, urbanization pressure and our ignorance about them. On other hand, the increasing global demand for herbal medicine and products warrants accelerated cultivation, marketing and conservation of medicinal plant. Hence, the scientific study of traditional medicines, derivation of drugs through bioprospecting and systematic conservation of the concerned medicinal plants are of great importance. The major draw back in this area is scarcity of comprehensive and authoritative information on medicinal plants, which hinders an assessment of their status of availability, implementation activities necessary for preserving their habitat and monitoring the effect of rehabilitative efforts. Unless a concerted effort is made to record the knowledge of practitioners of indigenous medicines, it is very likely that vital information on plant usages, their characteristics and habitats will be lost.

Further, medicinal and aromatic plants (MAP) have considerable potential both in national and international market. Our country has to increase its contribution to meet the growing demand by supplying high quality MAPs and its products. It will help earning foreign exchange and strengthen the economy of the country and there are tremendous possibilities of increasing the production and trade of MAP, both for internal consumption and export. But it calls for an integrated and continuous effort in conservation, sustainable utilization, cultivation, maintenance and production of medicinal plant resources. In India, efforts are already initiated for conservation of medicinal plants in-situ and ex-situ conservation for example under ex-situ conservation, a number of field and seed gene bank has been created. Hundreds of plant and medical based central and state Government research institutions including NGOs are involved in research activities on MAPs (but isolated manner) and adding knowledge day by day.

Since the establishment of National Research Centre for Medicinal and Aromatic Plants (NRCMAP) by the Indian Council of Agricultural Research (ICAR) on 24th November, 1992 systematic and sincere efforts are being made to bring a vital change in some identified MAPs. Even though struggled initially, NRCMAP along with its out reach programme on All India Networking Research Project on Medicinal and Aromatic Plants (AINRPMAP) and All India Networking Research Project on Betelvine (AINRPB) has unfurled its wing on functioning

Organisational Structure



mode and continuing several steps toward the vibrant research on some selected MAPS with the following mandates, mandate crops and objectives.

Mandate

- Develop appropriate production, protection and processing technologies 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 breeder's stock.
- Act as a National Repository for the genetic resources of some important medicinal and aromatic plants.
- Coordinate research under the All India Coordinated 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

- Isabgol (*Plantago ovata* Forsk.)
- Senna (*Cassia angustifolia* Vahl.)
- Ashwagandha (*Withania somnifera* Dunal.)
- Liquorice (*Glycyrrhiza glabra* Linn.) *
- Guggal (*Commiphora wightii* (Arn.) Bhandari)
- Aloe (*Aloe barbadensis* Mill.)
- Safed musli (*Chlorophytum borivilianum* Santapau & Fernades.
- Lemongrass (*Cymbopogon flexuosus* Nees ex. Steud Wats.)
- Palmarosa (*Cymbopogon martini* Stapf. Var. *motia*)

(* Instead of this *Tinospora cordifolia* is being included now)

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 corps, 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

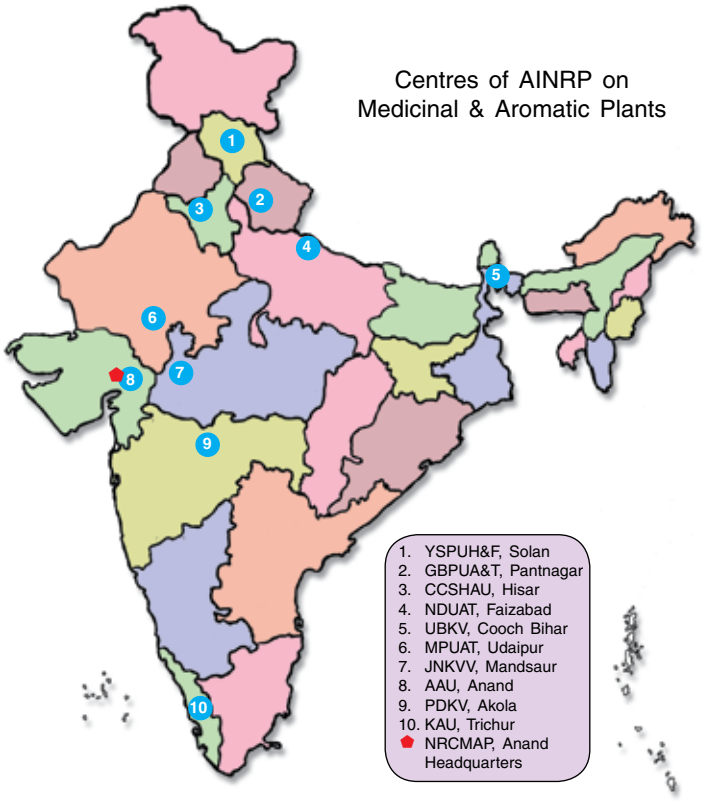
The head quarters of two All India Networking Projects such as All India Networking Research Project on Medicinal and Aromatic Plants (AINRPMAP) and All India Networking Project on Betelvine (AINRPB) are housed in the NRC. The Director is also responsible for coordination and monitoring of research work in these two projects as Project Co-ordinator in addition to his duties. There are ten centers in SAUs under AINRPMAP and eight centers in SAUs participating under AINRPB.

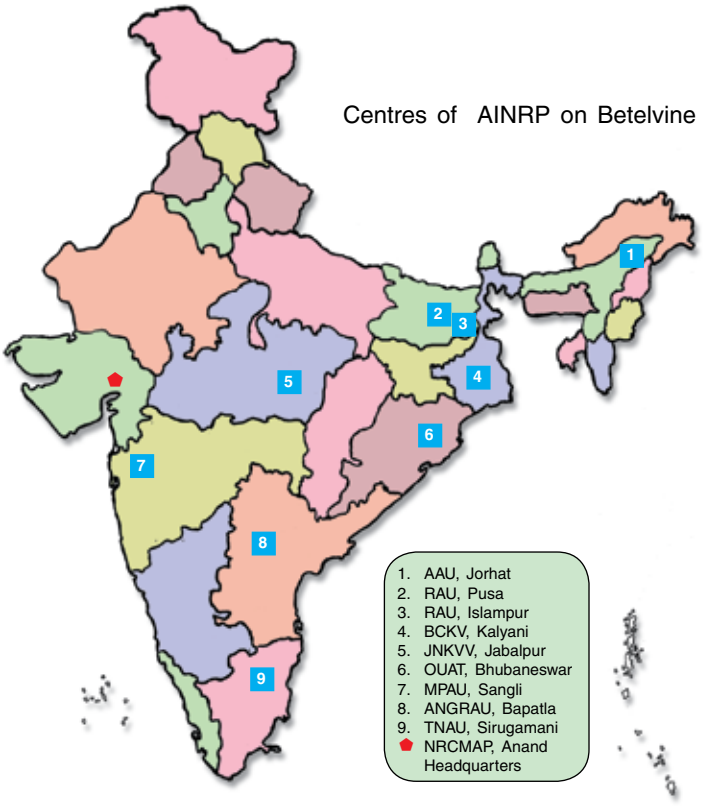
The different centres under the AINRPs are as follows:

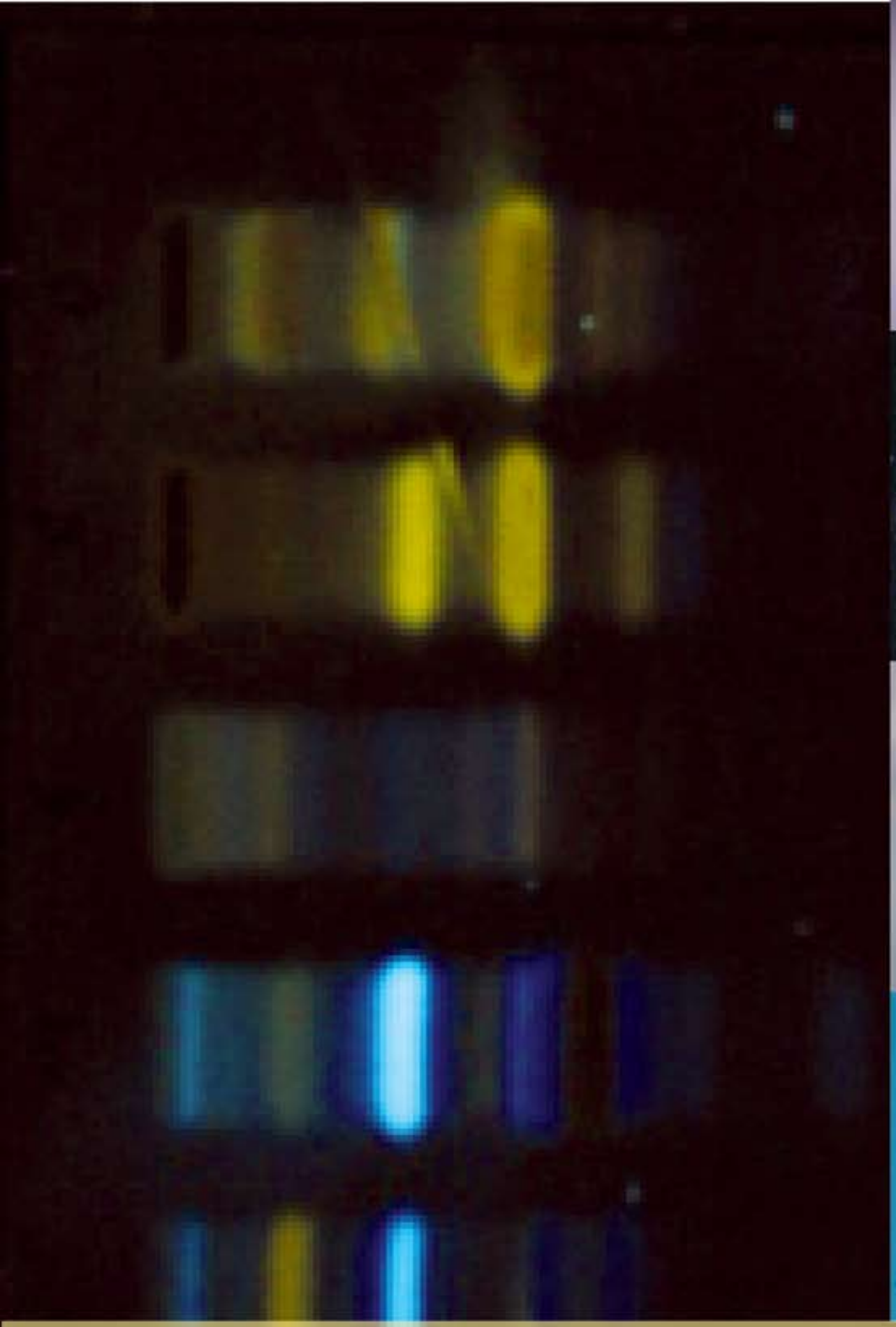
AINRPMAP	AINRPB
Y.S. Parmar University of Horticulture & Forestry (YSPUH&F), Solan	Assam Agricultural University (AAU), Jorhat
G.B. Pant University of Agriculture & Technology (GBPUA&T), Pantnagar	Rajendra Agricultural University (RAU), Pusa
C.C.S. Hariyana Agriculture University (CCSHAU), Hisar	Rajendra 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	A.N.G. Rajendra Agricultural University (ANGRAU), Bapatla
P.D. Krishi Vishwavidyalaya (PDKV), Akola	Tamil Nadu Agriculture University (TNAU), Sirugamani
Kerala Agricultural University (KAU), Trichur	

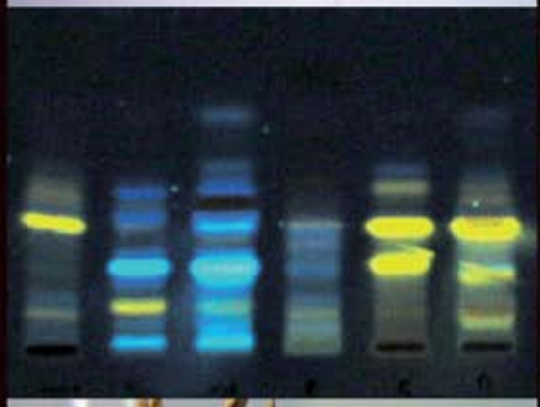
BUDGET PROFILE

Head	Expenditure (Rs. in lakhs)
Non Plan Expenditure	97.98
Plan Expenditure	
• NRCMAP • AINRP on Medicinal & Aromatic plants • AINRP on Betelvine	230.45 143.00 66.00
Ad-hoc Schemes	
• Project on Betelvinejp • Project on tissue culture • Project on Digital herbarium	0.84 2.21 4.83
Externally Funded projects	
• DBT project on Patchouli • Project from IBPGRI • DUS Testing • Good Agricultural Practice for MAPs • Mega-Seed Project	1.62 0.68 0.95 0.17 27.70


Centres of AINRP on
Medicinal & Aromatic Plants
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. AAU, Jorhat
2. RAU, Pusa
3. RAU, Islampur
4. BCKV, Kalyani
5. JNKVV, Jabalpur
6. OUAT, Bhubaneswar
7. MPAU, Sangli
8. ANGRAU, Bapatla
9. TNAU, Sirugamani
NRCMAP, Anand
Headquarters





RESEARCH ACHIEVEMENTS

RESEARCH ACHIEVEMENTS

ALOE (*Aloe vera*)

Aloe barbadensis is an important medicinal plant of India belongs to the family Liliaceae. It often found to grow along roadsides and waste places and prefers dry areas. It is a native of North Africa, Canery Islands and Spain and is growing wild on different parts of India. Apart from other medicinal products, the mucilaginous gel from the leaf is extracted and processed for use in several cosmetics. Demand for such products has increased tremendously during the last few years and hence its large-scale cultivation has been initiated in some states. However, the main bottleneck faced by the farmers is lack of quality planting material, which is due to low multiplication rate.

Evaluation of germplasm

Nineteen germplasm lines of aloe collected from Haryana, Delhi, Rajasthan and Punjab were evaluated along with the local check HAV-1 for various characters at CCSHAU, Hissar. Genotype KC/OP-49 recorded the highest leaf yield per plant (1625.0 g) followed by KC/OP-15 (1395.0 g), KC/OP-25 (1375.0 g) and KC/OP-40 (1325.0 g) against HAV-1 (1150.0 g). The plant height ranged from 10.00 to 68.00 cm; leaf length 9.00 to 60.50 cm; leaf width 3.00 to 8.50 cm; leaf weight per plant 105.0 to 185.0 g; leaves per plant 3.0 to 7.0; suckers per plant 3.0 to 9.0 and mucilage from 37.0 to 70.0%. Six genotypes viz. KC/OP-25, KC/OP-36, KC/OP-15, Morni Hill-1, KC/OP-44 and KC/OP-53 yielded significant and higher mucilage per cent against the check HAV-1.

Micropropogation through direct shoot regeneration from immature inflorescence

The protocol for rapid micropropagation from immature inflorescence explant was developed at NRCMAP. Direct shoot bud regeneration was obtained from the immature inflorescence in MS medium containing 1.0 mg l^{-1} Kn, 1.0 mg l^{-1} BA + 0.01 ml NAA, 0.2 ml GA_3 and 3% sucrose after 22-24 days of culture. Among three types of explants (terminal, middle and basal segment) used, terminal and middle segment of the inflorescence showed positive response for initiation of shoot buds, whereas, basal portion did not show any response irrespective of all the media tested. Initially, the intact floral buds in the inflorescence segments enlarged within 2-week of culture on MS basal medium supplemented with (1.0-2.0 mg l^{-1}) BA, (1.0-2.0 mg l^{-1}) Kn, (0.01-0.1 mg l^{-1}) NAA and 0.1 mg l^{-1} GA_3 (Fig. 1). Subsequently, shoot primordia developed from the floral buds and later, the whole inflorescence axis was covered with clusters of well developed shoots after 4-week of culture. Medium fortified with kinetin or BA did not promote shoot bud regeneration. There was no sign of shoot initiation in the absence of growth regulators. Among the different media tested, explants cultured on MS medium supplemented with 1.0 mg l^{-1} BA, 1.0 mg l^{-1} Kn, 0.01 mg l^{-1} NAA, 0.1 mg l^{-1} GA_3 and 3% sucrose showed the highest frequency of shoot

bud differentiation response. Optimum regeneration frequency (60-80 %) was observed in terminal segment as compared to middle ones on MS medium containing 1.0 mg l^{-1} BA, 1.0 mg l^{-1} Kn, 0.01 mg l^{-1} NAA, 0,1 mg l^{-1} GA_3. The average number of shoot buds/ explant increased 2-fold at the end of two passages (8 weeks) of initial culture on similar medium; the shoots attained a height of ~3.0 - 4.2 cm.

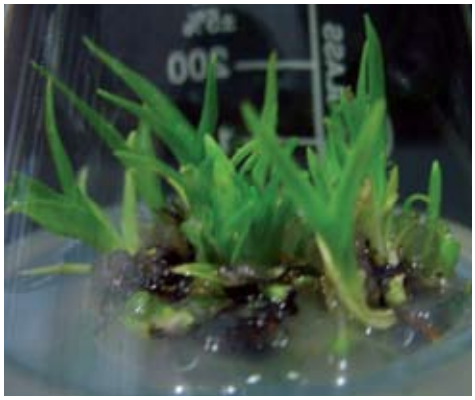


Fig. 1 Shoot bud multiplication from Aloe inflorescence

After multiplication, micro shoots (ca.1-2 cm) were cultured on half strength MS basal salts supplemented with different concentrations of auxins and 1% (w/v) sucrose for induction of rooting. All the cultures were incubated at 25±2°C under 16-h photoperiod. A high percentage (98.6%) shoots rooted in the medium containing ½ MS with 0.1 mg l^{-1} of IAA. Roots emerged in 8 days that developed into a good root system within 10 days of culture at higher concentration of IBA (0.50 mg l^{-1}), NAA (0.5 mg l^{-1}) and IAA (0.5 mg l^{-1}), though rooting was formed but less as compared to IAA (0.1 mg l^{-1}).

After 10 days of rooting the plantlets were transferred to pots containing sterilised soil:sand (1:1, v/v) and kept in room temperature. After 4 days, the pots were shifted to net house (75% light) where the temperature and relative humidity were recorded 25°C and 50% respectively in day time. After 15 days about 98% plants survived when the potted plants were kept outside. Thereafter, the plants were transferred to the field after 5-d and showed luxuriant growth. Among the different potting mixture tried for acclimatization, no significant difference was found.

Rapid clonal multiplication protocol through multiple shoot induction has been already standardised taking the shoot bud as explant. However, there is still possibility of generating somaclonal variations due to several factors mainly for repeated subculture. Therefore, a study was made to assess the genetic stability of micropropagated plants and the source plants through RAPD markers. Optimum conditions for DNA extraction from in vitro as well as field grown plants for reproducible PCR amplification were done. Out of twenty different decamers tested, nine primers produced good amplification products that were monomorphic across all the micropropagated plants. There were no polymorphic DNA fragments among the micropropagated plants derived from shoot bud explant; the amplified products exhibited similarities among all the in vitro micropropagated plants as well as the source plant.

Pathological and biochemical comparison of four bacterial pathogens

Four pathogenic *Erwinia* that were known to cause rotting symptoms on leaves were compared by different morphological, pathological and biochemical characters at NRCMAP. The bacteria used in the study were *E. carotovora* subsp. *carotovora* (Ka3a, from Yugoslavia), *E. chrysanthemi* (PD2145, PD2098, from Caribbean Island) and *E. chrysanthemi* (IMI389157 from India).

All the cultures produced circular, creamy white, translucent colonies with smooth surface and convex elevation. All the bacteria tested were Gram negative rods and usually appeared single in the smear. On YDC plates all the cultures produced creamy white colonies without any pigmentation.

Pathogenicity of the cultures was tested on 10 different hosts (cucumber fruit, potato tuber, cauliflower curd, tomato fruit, carrot fleshy root, onion bulb, dieffenbachia leaf, Aloe barbadensis leaf, *A. pyrreyi* leaf and *A. chinensis* leaf). Results showed wide variability in the culture in terms of pathogenic reaction.

A total of 46 different biochemical tests were performed to characterise the bacterial cultures. Among them, 9 tests detected the differential reactions. IMI389157 was positive for lipolytic activity though others were not. Ka3a produced negative reactions for gas production from D-glucose, indole test, utilization of arabinose, utilization of sodium tartarate as carbon source and sensitivity to erythromycin whereas others were positive. In contrast, this culture could utilize lactose and cellobiose as carbon sources when other three were unable to grow.

Lipid profiles of the test bacteria indicated differences in the composition of their cell. The culture, IMI389157 produced seven bands while six bands each were observed in rest three cultures. All the cultures had at least four common lipid fractions. They appeared at Rf values 0.06, 0.24, 0.32 and 0.65. Comparison of the banding pattern and relative area for each band revealed that the cultures PD2098 and PD2145 did not differ in terms of the Rf values of the individual lipid bands. They possessed six fractions (Rf values 0.06, 0.18, 0.24, 0.31, 0.43 and 0.64). IMI389157 culture also had similar banding pattern that of the early two and had an extra band towards the base line (Rf 0.13). However, Ka3a produced different banding pattern. It had similarity with IMI389157 in having the extra band towards the base line. However, it differed with all other cultures in having a unique band towards the end point (Rf 0.61). This culture was also different from other three in the overall band intensities.

ASOKA (*Saraca asoka*)

Asoka is a small evergreen tree belongs to the family Caesalpiniaceae and is a sacred tree of Hindus and Buddhists. It occurs almost throughout India upto an altitude of 750 m. Bark containing tannin and catechol is useful in menorrhagia due to fibroids, leucorrhoea and haemorrhagic dysentery. Leaves are paripinnate and used in impure blood. Flowers are orange to orange-yellow, very fragrant in dense axillary corymbs. The dried flowers are used against diabetes and haemorrhagic dysentery and seeds are used for treating bone fractures.

Collection and evaluation of germplasm

Forty two accessions of asoka were evaluated at Trichur and lot of variability was observed for morphological traits from the seedling stage itself. The seedling vigour and further growth

depended mainly on the place where accessions were collected. It was observed that the accessions collected from Trichur (Acc.No.1) and Trivandrum (Acc.No.27) showed vigorous growth represented by its increased height, number of leaves and higher girth of the stem. It was also recorded that higher number of leaves have a positive association with mean girth of stem. Accessions collected from Trichur district recorded more height followed by higher number of leaves and higher girth compared to the germplasm collected from Trivandrum.

ASHWAGANDHA (*Withania somnifera*)

Ashwagandha is on of the important medicinal plants commercially cultivated in north western region of Madhya Pradesh for long period as a dry land crop in late kharif season. It belongs to the family Solanacea. The withaniols, somnifirin and several other alkaloids present in the roots and to some extent leaves and seeds are used in Ayurvedic and Unani medicines particularly for hiccups, bronchitis, rheumatism, dropsy, several female disorders, stomach and lung inflammation and skin diseases. The development of high yielding verities with high alkaloid content is the future thrust area for research.

Evaluation of germplasm

Thirty four germplasm were evaluated at Hissar and wide range of variability was recorded for plant height, berry/plant, diameter of berry, root diameter, leaf width, leaf length, root yield per plant and root yield. Genotype HWS-04-5 was found to be superior for all the characters, except for number of berry per plant and berry diameter. Plant height ranged from 27.3 cm (WS-90-105) to 115.0 cm (HWB-04-5), berry per plant from 44.0 (HWS-04-1) to 383.33 (WS-213), diameter of berry from 5.0 (HWS-04-2) to 8.0 mm (WS-202), root length from 9.0 (WS-204) to 24.0 cm (Hisar local & WS-90-125), root diameter from 8.50 (WS-90-136) to 30.33 mm (HWS-04-5), leaf width from 2.5 (JA-20) to 6.90 cm (HWS-04-4-1), leaf length from 6.85 cm (WS-90-127) to 14.25 cm (HWS-04-5), root yield per plant from 11.0 g (WS-90-136) to 247.50 g (HWS-04-5). Highest root yield per plant was recorded in genotype HWS-04-5 (247.50 g) followed by HWS-04-2 (141.00 g) and Hisar local (131.00 g) against checks JA-134 (30.50 g) and JA-20 (21.00 g).

One hundred nineteen germplasm were evaluated for thirteen different characters at Mandsaur. Considerable variability was observed for most of the characters. MWS-100, 124, 132, and RAS-23 were early (150-165 days), MWS-101, 130, 139, 204 & RAS-36 were medium (165-180 days) and MWS-14, 222, 302, RAS-22) were late maturing (180-195 days). Germplasm lines MWS –100, 101, 202, 206, RAS-41, and RAS-16 had superior quality grade-2 roots, while, MWS-100, 101, 206 and 208 had higher dry root yield.

Evaluation of selection/accessions

Twenty nine accessions of ashwagandha were evaluated at Anand along with the check, WS

100. Pooled analysis of three year experiments showed that accession, Sel.-2B gave significantly high dry root yield (898 kg ha-1) over the existing variety WS-100 (620 kg ha-1).

In an another experiment at Anand using six high yielding ashwagandha selections (1 UB, 4 UB, 4 B, 15 Bharuch, 13 Carrot and 10 WS 20) along with two check varieties i.e., JA 20 and WS 100, the dry root yield differences during 2006-07 were non significant. However, pooled analysis of data of four years indicated that Selection 4B, 13 Carrot and 15 Baruch performed significantly superior to both the checks and yielded 21.24%, 30.89% and 21.62% increased dry root yield respectively, over the better check WS 100 (dry root yield 518 kg ha-1).

Four genotypes, each from Anand, Udaipur and two from Mandsaur were tested along with local check JA-134 at Mandsaur. Significantly higher dry root yield was recorded in MWS-101(722 kg ha-1) followed by MWS-100 (685 kg ha-1), which were superior to local check (592 kg ha-1). Similarly, significantly higher seed yield was recorded in MWS-101 (685 kg ha-1) and MWS-100 (620 kg ha-1) as compared to local check JA-134 (592 kg ha-1). Over all performance indicated that MWS-101 and MWS-100 were superior genotypes.

Effect of varying sowing and harvesting durations on productivity and quality

At Udaipur, sowing of Ashwagandha during 35th (August 27- Sept.2) and 37th (September 10-16) Meteorological Week (MW) significantly increased main root length (20.2 cm), dry root yield (1440 kg ha-1), seed yield (740 kg ha-1), total alkaloid yield (5.5 kg ha-1), net monetary returns (Rs. 74386 ha-1) and B:C ratio (4.62) than sowing during 33rd MW(August 13-19). In contrast, delay in sowing from 33rd to 37th MW significantly reduced plant height and crude fibre content of roots. Further, sowing during 37th MW was statistically superior over both 33rd and 35th weeks, when judged in terms of main root yield. Interestingly, total alkaloid content (0.384-0.390 %) of roots was not influenced due to various sowing dates. Variety JA-134 was superior than JA-20 and local as it had higher values for main root length (21.9 cm) and diameter (9.9 mm), dry root (1500 kg ha-1), seed yield (730 kg ha-1), total alkaloid content of roots (0.436 %) and its yield (6.6 kg ha-1), net returns (Rs. 77056 ha-1) and B:C ratio(4.76). Variety JA-20 was also found superior to local, when judged on these parameters. However, a reverse trend was noted in case of root: shoot ratio and crude fibre content of roots, which were significantly higher in local followed by JA-20 and JA-134. Harvesting during 7th (February 12-18) and 9th MW (February 26-March 4) resulted in higher main root length (21.2 cm), diameter (9.9 mm), dry root (1500 kg ha-1), and seed yield (740 kg ha-1), net returns (Rs. 78433 ha-1) and B:C ratio (4.9) compared to harvesting during 3rd (January 15-21) and 5th MW (January 29-February 4), though variation between former two was non significant. However, harvesting during 7th MW was found the most appropriate compared to all other weeks, when judged in terms of total alkaloid yield (5.7 kg ha-1). In general, delay in harvesting from 3rd to 9th week reduced total alkaloid content and increased root: shoot ratio along with crude fibre content of roots significantly.

Studies on seed requirement

At Akola, seed rate of 10 kg ha-1 significantly influenced plant height (39.4 cm) when compared with seed rate of 6, 7, 8, 9 kg ha-1. Number of branches (4.72 plant-1) was

significantly higher with seed rate of 7 kg ha^{-1}, while the lowest (3.15 plant^{-1}) was recorded with seed rate of 9 kg ha^{-1}. Longest root (16.52 cm) was recorded with the seed rate of 10 kg ha^{-1}. The girth of the root was found to decrease with increase in the seed rate and significantly the lowest root girth of 0.65 cm was observed with the seed rate of 10 kg ha^{-1}. However, significantly the higher root yield of 603 kg ha^{-1} was obtained with seed rate of 10 kg ha^{-1}.

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

At Hissar, results of the experiment on effect of varieties and seed rate on yield and it's related traits revealed that dry root weight (1.35 g plant^{-1}), fresh root (970 kg ha^{-1}) and dry root yield (398 kg ha^{-1}) were significantly superior in JA-134 compared to JA-20, respectively. The fresh and dry root yields were 15.8 and 23.6% higher in JA-134 than JA-20. Final plant population (3.23 lakh ha^{-1}) was significantly more with increased seed rates from 6.0 kg ha^{-1} to 12.0 kg ha^{-1}. The maximum root length of 12.9 cm was recorded with seed rate of 12 kg ha^{-1}, whereas, reverse trend was observed in case of root diameter and dry root weight. Seed rate of 12.0 kg ha^{-1} produced 51.8 and 17.5% higher dry root yield compared to seed rates of 6 and 8 kg ha^{-1}, respectively.

Effect of variety and seed rate on vegetative growth and root yield

At Faizabad, a study was conducted with objective to find out the suitable variety and optimum quantity of seed for sowing to harvest maximum root yield with two varieties, viz. JA-20 and JA-134 and 4 levels of seed rate as 6, 8, 10 and 12 kg ha^{-1}. Results revealed that there was non-significant effect of variety and seed rate on plant height. However, maximum plant height of 30.24 cm was recorded with 12 kg ha^{-1} seed rate. The variety JA 20 had taller plants (27.3 cm) than JA 134 (25.4 cm), however, number of branches per plant was non significant. The lowest days to maturity (172.43) was observed in less seed rates (6 kg ha^{-1}) and the variety JA-20 matured earlier (171.94 days). Fresh root yield varied significantly due to varieties and different seed rates and maximum of 1086 and 703 kg ha^{-1}, respectively was obtained with the application of 8 kg ha^{-1} seed rate, and genotype JA-20 produced more fresh and dry root yield of 1041 and 674 kg ha^{-1}, respectively.

BRAHMI (*Bacopa monnieri*)

Brahmi, a member of Scrophulariacea family is a creeping, branched succulent herb distributed in wet and marshy lands through out India. The whole herb is the source of the ayurvedic drug 'Brahmi' and used for various memory improving herbal preparations including 'brahmighritam'. Raw drug is mainly collected from the wild. It is used in improving memory and intelligence and also in the treatment of dermatosis, anaemia, diabetics and insanity. Bacoposide is the major active ingredient of the drug.

Collection and evaluation of germplasm

Twenty nine accessions collected from different districts of Kerala were evaluated at KAU, Trichur. The collected accessions were grouped in to five clusters and viz., fifteen accessions in Cluster I, three each accessions in clusters II and III, two accessions in cluster IV and six accessions in V cluster. It was also found that some of the accessions collected from different regions were included in same cluster which indicated that there was no parallelism with geographical sources. Plants having shorter internodes with fleshy bigger size leaves contained more therapeutically important constituent i.e., Bacoside - A. Similarly, non-flowering and late flowering accessions had more Bacoside - A. Accessions collected from coastal regions have higher biomass and higher Bacoside content. Accession No. 14 was identified as superior as it yielded higher biomass and Bacoside content.

CHANDRASUR (*Lepidium sativum*)

The plant belongs to family Brassicaceae and is an annual herb of about 15-45 cm tall. Leaves are entire or variously lobbed or pinnatisect. Flowers are small and white arranged in racemes. The species is a native of Ethiopia and introduced to Europe and Asia. It is cultivated in selected parts of Rajasthan, Gujarat, M.P. and Tamil Nadu for seeds. The seeds are galactagogue, laxative and diuretic. The mucilage obtained from the seeds is used against intestinal irritations. The leaves are also used for medicinal purposes as a stimulant and diuretic and liver diseases. It is also used as salad for treating anaemia.

Evaluation of germplasm

Nine germplasm, collected from farmers' field at Mandsaur, Neemuch, Ratlam and Jabalpur districts were tested for seed yield and other yield contributing characters. The highest seed yield was recorded in MLS-7 (1857 kg ha^{-1}), which was followed by MLS –1 & MLS-5 (1825 kg ha^{-1}) and MLS-6 (1667 kg ha^{-1}). While, maximum test seed weight (1000 seed weight) was recoded in MLS-3 and MLS-7 (2.5 g) followed by MLS-1 (2.4 g).

CHIRAYITA (*Swertia chirayita*)

It is an erect annual herb belongs to family Gentainaceae. It is distributed in temperate Himalayas from Kasmir to Bhutan. The plant is propagated by seeds. Dried herbage portion is used as raw drug. The drug is extremely bitter in taste. The bitter tonic made from the raw drug improve bile secretion and used foir the treatment of bronchial asthma, liver disorders, and anaemia. The active ingredient of the raw drug include ophelic acid, glucosides, ophenols, etc.

Survey and Collection of different *Swertia* spp.

Extensive survey was conducted for the collection and study of chirayita population in the Darjeeling district at Kalingpong. High population density of *S. chirayita* and *S. bimaculata* was noticed at Sukhiapokhri (6,400ft) and Sonada (6,800ft). Medium population of *S. chirayita* and high population of *S. bimaculata* were found at Lava (7,200ft) and Ghoom (7,400ft). Low population of both species was found at Rimbick (6,800ft), Algara (5,600ft) and Takdah (5,500ft). However, chirayita plant of both species was not seen at Kalimpong (4,200ft), Mirik (5,000ft), Pedong (4,500ft) and Mongpoo (4,000ft).

Comparative study of the two species revealed that plant height of *S. chirayita* is 2.5-3.0 ft and in *S. bimaculata* it is 2.5-3.5 ft. Leaves of *S. chirayita* are opposite, lanceolate, 8-13 cm length, 2-3 cm breadth and dark-purple pigmentation on the lower surface of the leaf and on the stem. While, *S. bimaculata* leaves are opposite, oval shaped and yellowish green in colour, 7-11 cm length, 3-3.5 cm breadth, without any pigmentation on leaf and only nodal pigmentation found on the stem. In both the species flowering occurs on second fortnight of September to second week of October and flower colour is light yellowish with purplish pigmentation in the inner side of the petals. Seed colour is brownish in *S. chirayita* and blackish in *S. bimaculat* and seed size is very small and smooth in *S. chirayita* while, it is comparatively larger and easily separable in *S. bimaculata*.

Studies on seed germination

At Kalimpong, seeds of *S. chirayita* germinated only in sterilized soil: sand: leaf manure (8:4:1 v/v) + GA3 500 ppm and Sterilized soil: sand: leaf manure (8:4:1 v/v) + GA3 700 ppm. Seeds of the treated plot germinated after ten months. *S. chirayita* could be cultivated under the steep slope of the hills in the climatic range between 2°C and 18°C. Plant should be grown under cool and shady place.

Both *S. chirayita* and *S. bimaculata* seedlings were procured from the forest division and maintained at the farmer's field in Lava. A minor part of *S. chirayita* and *S. bimaculata* seedlings procured from the forest division of Darjeeling and Lava were being maintained at Kalimpong also. The degree of mortality was extremely higher in *S. chirayita* than in *S. bimaculata*. Seed germination studies revealed that in Lava growth of plant was more vigorous than in Kalimpong research station.

GUGGAL (*Commiphora wightii*)

Guggal is a small tree, endemic to drier tract of Rajasthan and Gujarat belongs to the family Burseraceae. As the plant generally dies after tapping of gum the natural habital of this plant is shrinking and hence it is entered in the endangered category of the Red Data Book. Now efforts are being made by different agency including forest department to preserve guggal in its natural form. The oleo-gum-resin obtained by tapping the plant is highly priced for its two major sterols viz. gugglusterone-Z and gugglusterone-E and is used as in indigenous drug against rheumatism, arthritis, etc.

Evaluation of germplasm lines through biochemical marker

A preliminary study was conducted to assess the genetic similarity among 27 accessions using biochemical markers such as buffer soluble proteins and two isozymes namely peroxidase (PRX) and catalase at NRCMAP.

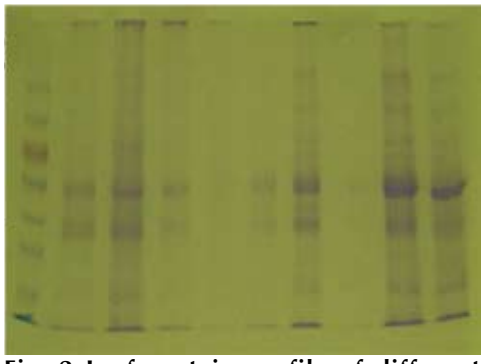


Fig. 2 Leaf protein profile of different accessions of Guggal

These accessions were subjected to the studies on the polymorphism in buffer soluble proteins using SDS-PAGE. Two bands obtained in 18 accessions showed monomorphism having the molecular weight of 24 and 33 kDa. A common band was observed in nine accessions of molecular weight of 33 kDa; however, polymorphic bands were found in many of the accessions tested (Fig 2). A total of 9 types of proteins were observed with the molecular weights ranges from 11-130 kDa.

Isozyme profiles of two different enzymes namely PRX, catalase were used for studying genetic relationship among 27 accessions. The catalase showed the least number of isozymes among the two enzymes tested, showing only 27 forms and all of them were found in different accessions. The Rf value ranged from 0.3 – 0.346. Though not a single band was found to be monomorphic, a band of 0.033 and 0.28 Rm value here shared by 7 accessions and 4 accessions relatively. High degree of polymorphism in buffer soluble proteins could help in utility for genetic characterization. The protein-banding pattern varied widely from accessions to accessions. The minimum number of bands (2) was observed in 3 accessions and the maximum number (7) was observed in another 9 accessions. A total number of 45 isozymes were resolved in the peroxidase enzyme with a wide range of Rf value from 0.016 to 0.654. Not a single band was found similar among all the accessions. The variation in band resolution revealed wide diversity shared by all the accessions also varied widely revealing a wide variation in their genetic set up.

Chemical profiling of male and female plants

An experiment was undertaken at NRCMAP to identify chemical markers distinguishing male and female plants. the study was initiated by taking one plants each belonging to male and female morphotypes. Chemical profiling was done through HPTLC, HPLC and LC-MS methods. With HPTLC, good separation of the chemical constituents from barks could be achieved using a mobile phase consisting of chloroform and methanol (9.7:0.3). However, it did not decipher any marker also it failed to separate guggulsterone E and Z. Hence, another mobile (petroleum ether and ethyl acetate in the ratio of 3:1) was tried which produced separable bands for guggulsterone E and Z, though no distinguishable chemical marker could be seen. However, quantitative variations were observed between male and female plants.

HPLC profiling was done by using C-18 column and mobile phase methanol and water in ratio of 65:35. It resolved optimum numbers of compounds but failed to indicate presences of any chemical marker to distinguish between male and female plants.

In LC-MS as well male female plant bark extracts did not show any specific and major different in masses (molecular weight compound).

ISABGOL (*Plantago ovata*)

Isabgol is an important medicinal crop traditionally grown as rabi crop in Rajasthan, Gujarat and Madhya Pradesh as the required cool and dry climate usually prevails during growth in this region. It belongs to the family Plantaginaceae. Husk is medicinally useful against constipation and irritation in the digestive tract. India is the sole exporter of isabgol husk in the international market. Creation of genetic variability, development of high yielding varieties with downy mildew disease resistance and also increased yield through production and protection management, are important research areas in this crop. Apart from traditional isabgol (blond psyllium), black psyllium (Plantago indica) is also has market demand and work has been initiated in this species also.

DUS testing

During the rabi season of 2006-07, six varieties viz Gujarat Isabgol-1, Gujarat Isabgol-2, Gujarat Isabgol-3 (from Anand), Haryana Isabgol-5 (from Hisar), Jawahar Isabgol-4 (from Mandsaur) and Niharika (from CIMAP, Lucknow) were sown and evaluated for DUS descriptors. None of the Isabgol varieties was having any morphological marker to distinguish varieties. During the period of the growth phase of the crop no distinguishing character/s specific to a variety was observed. However, a number of variability within the varieties in terms of plant height, number of branches per plant, number of spikes per plant and spike length were observed and it was common to all the varieties. In Niharika, mayuri mutant type was also observed and its frequency ranged from 4-11 in different replications. Since Niharika is a mutant variety, it seems that the variety is not stable. Based on the spike length, the varieties were categorized into three groups i.e., plants having spike length (length of the longest spike in a plant) below 5 cm, 5 to 6 cm and above 6.0 cm.

Induction of callus from different types of explants

Callus was initiated both from stem and young inflorescence derived from mature plants on MS basal medium supplemented with various concentrations and combinations of BA or Kn and 2,4-D or NAA after 4-week of culture. The maximum callus proliferation was noted in the medium containing 1.0 mg l^{-1} BA and 2.0 mg l^{-1} 2.4-D; the rate of callus proliferation was more in young inflorescence than the stem explants. Other auxin (NAA) tested was not efficient to induce callusing. When the concentrations of 2,4-D and BA were increased, the rate of callus growth decreased and the calli became more compact.

Evaluation of germplasm

Eighty three germplasm lines were evaluated along with three check varieties viz., GI

1, GI 2 and HI 5 for five characters, namely, plant height (cm), branches per plant, spikes per plant, spike length and seed yield per plant (g) at Hissar. The plant height ranged from 30.33 to 41.00 cm; branches per plant from 3.00 to 6.67; spikes per plant 17.09 to 23.17; spike length from 2.70 to 4.60 cm and seed yield per plant from 1.37 to 8.96 g. The highest seed yield per plant was in RI-49 (8.96 g) followed by RI-149 (8.82 g), RI-87 (7.98 g), RI-99 (7.83 g), RI-9808 & HI-8 (7.12 g) and HI-6 (6.88 g), as against the best check HI-5 (5.86 g).

A total of 80 lines of Isabgol were maintained at Mandsaur were evaluated for six characters. High range of variability was noted for plant height, which ranged form 26.8 (SLS-65) to 38.7 cm (JI-4), number of spikes per plant 10.4 (SLS-51) to 35.8 (SLS-16), length of spikes from 3.1 cm (GI-1) to 9.3 cm (SPS-8), swelling factor from 5.0 ml g^{-1} (MIB-2) to 9.0 ml g^{-1} (SLS-16), days to 50% flowering 52 (SLS-10) to 74 days (SLS-67), seed yield 517 (SPS-2) to 1675 kg ha^{-1} (SLS-51). SLS-51, MIB-7, MIB-1005, SPS-50, MIB-6 and SLS-48 were identified as superior genotypes.

Evaluation of selections from mutation breeding programme

Thirteen selections from mutant progenies were evaluated along with the check variety GI 2 at AAU, Anand. Pooled analysis of three years experimentation showed significant interaction between year and selection indicating the influence of environment on genotypes. Selection 8 and Selection 12 gave 23.18% and 23.95% higher seed yield over GI 2, in pooled analysis.

Response to nitrogen applied through various organic and inorganic sources

At Udaipur, seed (1206 kg ha^{-1}), straw (2772 kg ha^{-1}) and husk (383 kg ha^{-1}) yields, swelling factor (11.250 cc g^{-1}) and husk recovery (31.75 %) remained maximum, when nitrogen was applied in the form of urea. However, few sources like karanj cake, vermicompost and poultry manure were found at par with that of urea when compared in terms of seed yield. In case of straw yield, castor cake and karanj cake were found at par with urea, while only karanj cake was found at par with urea in case of husk yield.

Plantago indica

Influence of different dates of sowing on growth and development

At NRCMAP an experiment was carried out to study the influence of different dates of sowing on growth and development. Five dates of sowing were tried from 30th October to 30th December at 15 days interval. Shoot, leaf and root growth were recorded at three stages (55, 70 and 85 DAS) of crop growth including LAI. Growth was influenced due to different dates of sowing. Plant height increased in all the treatments at all the stages and the mean increase was in the range of 21.5-103.8 cm from 55 to 85 DAS. November 30th sowing had the maximum plant height, leaf area per plant, leaf area index and number of branches per plant. Stem and root growth rather followed a different trend showing maximum growth either in early panting than late planting. Shoot and root growth rate was non significant for most of characters except for root dry matter between different dates of sowing. But economic yield was significantly varied with different dates of sowing and maximum yields were obtained in November 30th sowing followed by November 15th sowing.

Influence of different spacing on growth and development

At NRCMAP six diffrent spacing (50 x 15 cm, 60 x 15 cm, 65 x 15 cm, 70 x 15 cm, 75 x 15 cm and 80 x 15 cm) were tried to study the influence of different spacings on growth and development including yield. For growth analysis were taken at 55, 65, 75 and 90 days after sowing. The spacing of 60 x 15 cm produced more growth in terms of plant height, leaf growth and dry matter accumulation in leaf, stem and root. Consequently seed yield was also highest at this spacing followed by spacing of 50 x 15 cm and 65 x 15 cm.

Kalmegh (*Andrographis paniculata*)

Kalmegh is an annual herb belongs to the family Acantaceae. Leaf and stem are used as bitter tonic possess antityphoid and antibiotic properties for treatment of dysentery, cholera, diabetes, consumption, influenza, bronchitis, swelling and itches, plies and gonorrhoea. Kalmegh is cultivated in limited areas of several parts of India as a Kharif crop. Collection and evaluation of the germplasm, understanding the reproductive biology, development of good agricultural practices including stress physiology, post harvest behaviour, etc. are some of the important areas for research.

Evaluation of selections

Twenty nine selections of Kalmegh based on flowering habit were evaluated at AAU, Anand. The selections were classified as late and early flowering based on days taken to 50 % flowering. Selections 3, 4 and 10 took significantly more number of days (>100days) while, selection 16, 17, 18, 20 and 23 were early (60 days) compared to control (87 days). The biomass yield was high in some of the late flowering types (mean yield 3363 kg ha^{-1}) as against in early type (mean yield 3084 kg ha^{-1}) and in the check (mean yield 3064 kg ha^{-1}).

At Anand, maximum plant height (57.4 cm) was obtained in culture Faizabad among three cultures studied viz. Anand, General and ND-1. Dry weight of leaves (207.4 g per 10 plants) was also found to be maximum in the same culture. On the contrary, number of branches per plant (10.98) was maximum in culture ND-1. Dry weight of leaves (254.6 g per 10 plants) was however, found maximum at full bloom stage (75 DAS) followed by 178.5 g per 10 plants and 177.1 g per 10 plants at initiation of flowering (60 DAS) and initiation of pod (90 DAS), respectively.

Effect of spacing and time of harvesting on foliage and seed yield

At Akola, the spacing of 30 x 15 cm had significantly higher plant height (54.8 cm), fresh (6460 kg ha^{-1}) and dry foliage yield (1940 kg ha^{-1}). Non significant effect of spacing was noticed on the seed yield, andrographolide and iron content. However, total yield of andrographolide (42.3 kg ha^{-1}) and iron (1465.21g ha^{-1}) was also recorded significantly highest with plant spacing of 30 x 15 cm as compared to 30 x 30 and 30 x 45 cm spacing. Significantly higher fresh (5462 kg ha^{-1}) and dry foliage yield (1638 kg ha^{-1}) was recorded with the harvesting time

at 60 days after 50% flowering. However it was at par with harvesting at 45 days after 50% flowering. The seed yield (200 kg ha^{-1}) was significantly highest at 45 days harvest after 50% flowering; however, it was at par at 30 days harvest after 50% flowering. Significantly higher Andrographolide content (2.38 %) was recorded at 15 days harvest after 50% flowering, however, it was at par with 30 days harvest after 50% flowering and 45 days harvest after 50% flowering. The iron content (86.22 ppm) was significantly higher with harvest at 50% flowering and the content successively decreased with the increase in harvesting time. The lowest content (71.66 ppm) was recorded at 60 days harvest after 50% flowering. The interaction effect of spacing and harvesting time was found significant in respect of seed yield and significantly highest seed yield was observed with the treatment combination of 30 x 30 cm spacing and harvest at 45 days after 50% flowering (209 kg ha^{-1}).

Effect of FYM and harvesting time on herbage yield

At Faizabad, a trial was conducted with 4 levels of FYM viz., 0, 2.5, 5.0 and 7.5 t ha^{-1} and 3 dates of harvesting viz., 120, 135 and 150 days after sowing (DAS). The observations were recorded for plant height, number of primary branches per plant, fresh herbage yield and dry herbage yield. Maximum plant height (59.45 cm) was recorded when applied with FYM @ 7.5 t ha^{-1}. Different dates of harvest had no significant effect on plant height and number of branches. However, maximum number of branches (12.48 plant^{-1}) was also recorded at FYM @ 7.5 t ha^{-1}. There was significant difference in fresh herbage yield with the application of various doses of FYM. The maximum average fresh herbage yield 17386 kg ha^{-1} was recorded with the application of FYM @ 7.5 t ha^{-1} followed by 1568 kg ha^{-1} with FYM @ 5.0 t ha^{-1}. The minimum herbage yield of 11643 kg ha^{-1} was recorded in control. Harvesting at 150 DAS was found to be significantly superior in increasing herbage yield with an average of 17386 kg ha^{-1}. Maximum average dry herbage yield of 6760 kg ha^{-1} was obtained when applied with FYM @ 7.5 t ha^{-1} and found significantly superior than other treatments. Harvesting at 150 DAS again found significantly superior with average yield of 6092 kg ha^{-1}. On the basis of 3 years of experimentation (2004-06), it could be concluded that with application of FYM @ 7.5 t ha^{-1} and harvesting at 150 DAS, maximum economic yield could be obtained.

Lal Chitrak (*Plumbago rosea*)

The plant belongs to family Plumbaginaceae and is a perennial shrub of about 1.5 m tall. Flowers are red coloured, borne in elongated spikes. The plant flowers through out the year. It is distributed in the Peninsular India, West Bengal and Orissa. In Ayurveda and Unani medicine, the root is used to promote appetite and stimulate digestive processes. The freshly harvested roots are cured before using for the drug preparations. Recently, the species is brought to regular cultivation in selected parts of South India and hence work on developing cultivation practices has been initiated in the species.

Influence of organic manures and biofertilizers on growth, yield and quality

At Trichur, the treatment of FYM @ 10 t ha^{-1} with Azospirillum and PSB gave the highest plumbagin content of roots (6.79%) which was on par with FYM @ 15 t ha^{-1} + Azospirillum (6.38%) and is followed by treatment of FYM @ 15 t ha^{-1} + Azospirillum + PSB (6.08%). Application of FYM @ 10 t ha^{-1} with Azospirillum and PSB @ 25 kg ha^{-1} was the best combination of organic manures and biofertilizers for maximum root yield and plumbagin content in plumbago with respect to quality.

Irrigation scheduling

An experiment was conducted at Trichur to study the effect of different irrigation schedules on growth, yield and quality of plumbago. The leaf number increased from 47.65 to 58.60 with increase in irrigation from IW/CPE from 0.25 to 1.0. The root number also followed the same trend. The highest dry matter production of 90 g plant^{-1} was also obtained for plants irrigated at IW/CPE of 1.0. The root length increased with decrease in frequency of irrigation from CPE of 0.25 to 1.25 (30.02-43.35 cm). However, the highest root yield was obtained from IW/CPE of 1.0 (2.105 t ha^{-1}). The plumbagin content was 2.95% when plants were irrigated at IW/CPE of 1.0 which was at par with IW/CPE of 0.75 (2.72%).

Effect of spacing on growth

At Trichur, the plants planted at a spacing of 50 x 30 cm produced taller plants (19.85 cm) with higher number of leaves (59.62 plant^{-1}), number of branches (5.95 plant^{-1}), number of roots (11.95 plant^{-1}), longest roots (40.85 cm) and the highest root girth (3.57 cm). The dry matter production was also highest at a spacing of 50 x 30 cm (181 g plant^{-1}). With respect to quality, the highest plumbagin content of 3.42% was also obtained with the plants at a spacing 50 x 30 cm followed by spacing of 50 x 40 cm (3.22%).

LIQUORICE (*Glycyrrhiza glabra*)

Liquorice is a hardy herb or undershrub with thick rootstock having many branched stems or roots and belongs to the family Papilionaceae. The crop is grown well under Haryana condition. The dried underground stems and roots constitute the drug which contains glycyrrhizic acid is responsible for the therapeutic action and used as expectorant. Liquorice extracts are also used as a condiment or as flavouring for tobacco, confectionery, beverages, jams and marmalades. Ammoniated glycyrrhizin, a product of liquorice extract is used as flavour in sweet sauces, reconstituted vegetable proteins, chocolates, chewing gum and diet colas.

Effect of different auxins on better rooting

Though the protocol for micropropagation of liquorice was developed, the survivality was very poor due to poor rooting. Therefore, the effect of auxins of different types and

concentrations was tried and the best rooting was observed in the microshoots cultured on ½ MS + 0.1 mg l^{-1} IAA/IBA + 1% sucrose.

Effect of planting dates and spacing on yield and quality

Stolon yield was recorded from a three year crop at Hissar. Maximum fresh (33935 kg ha^{-1}) and dry (10841 kg ha^{-1}) stolon yield was obtained from planting of June followed by July (27669 and 8921 kg ha^{-1}) and January (23981 and 7662 kg ha^{-1}) planting. The lowest yield was achieved from August (14974 and 4784 kg ha^{-1}) planting. The interaction effect between date of sowing and plant spacing for fresh stolon yield revealed that planting of liquorice on June 20 with 90×30 cm spacing produced maximum yield (11694 kg ha^{-1}). Glycyrrhizin content (%) was recorded in the order of 6.5, 7.25, 7.50, 8.0 and 7.40 during planting in January, February, March, June, July and August, respectively. The respective values among plant spacing were 7.24 (75×30 cm), 7.30 (75×45 cm), 7.40 (90×30 cm) and 7.48 (90×45 cm).

Response to organic fertilization

At Hissar, results indicated that fresh (2654 kg ha^{-1}) and dry stolon yield (847 kg ha^{-1}) were maximum in inorganic treatment of NPK @ 40:40:20 kg ha^{-1} followed by treatment of FYM + PSB + Azotobactor giving respective values of 2533 kg ha^{-1} and 802 kg ha^{-1}. Maximum glycyrrhizin content of 8.2 % in NPK treatment was statistically at par with the FYM + PSB + Azotobactor (8.0%).

LONG PEPPER (*Piper longum*)

Long pepper is shade loving climber belongs to the family Piperaceae. The plant is naturally found growing in the warmer parts of the country. The matured female spikes and root are used as drug in Indian System of Medicines against diarrhoea, indigestion, jaundice, urticaria, abdominal disorders, hoarseness of voice, asthma, cough, piles, malarial fever, worms, sinusitis, cough, bronchial asthma and other respiratory disorders. The crop is commercially cultivated in well drained soil and humid climate in the states of Maharashtra, West Bangal, Kerala, etc.

Evaluation of selections

At Trichur, evaluation of selected genotypes including hybrids showed that Accession No.2 and Accession No.7 recorded significantly higher dry spike yield compared to the check variety Viswam. Increased photosynthetic rate exhibited by the plant also reflected with higher spike yield. Height of the plant as well as number of branches showed positive correlation with dry weight. Fresh weight of the spike had high correlative response with high piperine content, number of spikes and length of spikes. There was positive association of size of spike with piperine content.

OPIUM POPPY (*Papaver somniferum*)

Opium poppy is an erect annual herb about 1 m high with long stalk and globular capsule and belongs to the family Papaveraceae. It is commercially cultivated as rabi season crop in specific pockets of Madhya Pradesh, Uttar Pradesh and Rajasthan through licensing from Central Bureau of Narcotics, Government of India. The latex derived from the capsule contains many medicinally important alkaloids. Several analgesic, sedative, antispasmodic, hypnotic and anaesthetic drugs are manufactured form the opium latex, seeds also find its use for culinary purposes. Conservation and characterization of genetic diversity, development of improved cultivars and agro-technology for them, management of downy mildew disease, etc. are major research areas of this crop.

Evaluation of germplasm

At Mandsaur, 104 germplasm lines were evaluated for different qualitative and quantitative characters. High range of variability was recorded for different growth and yield characters taken for the study. Genotypes, MOP-379, MOP-1057, MOP-1079, MOP-1080 and MOP-1081 recorded the highest latex yield. Higher seed yield was in MOP-511, MOP-529, MOP-533, MOP-581, MOP-1055, MOP-1069, MOP-1319, ND-1419, ND-2001 and NC-59555. Whereas, morphine content ranged from 12.9% (P4 x P10) to 16.7% (MOP-585) and high morphine content was observed in MOP-409, MOP-507, MOP-508, MOP-517, MOP-519, MOP-529, MOP-585, MOP-1055, MOP-1056, MOP-1078, MOP-1082, MOP-1083, MOP-1087, MOP-1090, ND-1146, UO-177-2.

Hybridization and performance of selected hybrids

Ten selected parents namely NOP 02-13, NOP 02-14, NOP 02-15, NOP 02-16, NOP 02-41, NOP-1, NOP-4, ND-20, ND-46 and UO-285 were crossed in various combinations to develop hybrids having high latex yield coupled with high morphine content and resistance to downy mildew at Faizabad. Twenty hybrids were developed in various combinations. The developed hybrids will be tested for desirable traits.

Performance of already developed six hybrids from different centers viz., NDH-1 and NDH-2 (Faizabad), MOPH-1 and MOP-2 (Mandsaur) and ROH-36 and ROH-42 (Udaipur) were tested along with local checks NOP-4 and JOP 540 respectively as local checks at Faizabad and Mandsaur and national check IC-42. At Faizabad, significantly higher latex yield was recorded in NDH-1 (46.57 kg ha-1) followed by NDH-2 (36.32 kg ha-1) and NOP-4 (34.94 kg ha-1). Latex yield was 34.94 and 22.40 kg ha^{-1} respectively, in the check varieties NOP-4 and IC-42. Significantly higher seed yield was also recorded in the hybrid NDH-1 (1194 kg ha-1) followed by NDH-2 (982 kg ha-1) and NOP-4 (957 kg ha^{-1}). Husk yield was also significantly higher in the hybrid NDH-1 (914 kg ha-1) which was followed by NDH-2 (699 kg ha-1) and NOP-4 (697 kg ha-1).

At Mandsaur also the variances for latex, seed and husk yield showed significant

difference among the entries tested. NDHY-1 and NDHY-2 were found superior for latex and morphine yield, whereas, for seed yield, NDHY-2 and MOH-2 were found superior to check.

In another trial of hybrid evaluation using six hybrids developed at Faizabad, i.e. NDH - 1 (NOP-1 X ND20), NDH-2 (UO-285 x ND-20), NDH-3 (NOP-1 x ND-46), NDH-4 (UO285 X ND-46), NDH-5 (NOP-4 x ND-46) and NDH-6 (NOP-4 x ND-20), against two checks (NOP-4 and IC-42), it was found that NDH-1 yielded significantly higher latex (47.00 kg ha^{-1}) which was at par with NDH-6 (43.40 kg ha^{-1}) and NDH-4 (43.12 kg ha^{-1}). Seed yield was significantly higher in the hybrid NDH-6 (1187 kg ha^{-1}) which was at par with NHD-1 (1071 kg ha^{-1}. Significantly higher husk yield was in NDH-6 (843 kg ha^{-1}) followed by NDH-1 (712 kg ha^{-1}) and NDH-3 (680 kg ha^{-1}). Hhybrids NDH-1, NDH-3, NDH-4 and NDH-6 performed better than the best check (NOP-4).

Identification of critical growth stages with respect to moisture stress

At Udaipur, plant height (95.03 cm), capsules per plant (1.67 $plant^{-1}$), gum yield (51.34 kg ha^{-1}), seed yield (1357 kg ha^{-1}) and husk yield (1240 kg ha^{-1}) were recorded highest when 8 irrigations at stem elongation 30 days after sowing (SE), rosette 45 DAS (R), bud 58 DAS (B), flower initiation 70 DAS (FI), 50% flowering 85 DAS, late capsule 98 DAS (LC), capsule maturity 108 DAS (CM) and at after lancing 120 DAS (AL) were given except seed yield which was maximum when 7 irrigations were given escaping after lancing period. However, seven irrigations were also given escaping at SE, R, B, FI, 50% flowering, LC, CM and at AL and the above parameters were marginally effected over 8 irrigations.

However, plant height and gum yield were not influenced when irrigation was escaped at flower initiation, late capsule, capsule maturity and after lancing stages as these treatments were at par with irrigating the crop at recommended schedule. Escaping at rosette stage (45 DAS) was found to be most critical for lowering plant height and gum yield. Other critical stages, when judged in terms of latex yield and plant height, were stem elongation, bud and 50% flowering. Number of capsule was not influenced when irrigation was escaped at stem elongation, flower initiation and capsule maturity stages as these were at par with recommended irrigation schedule. Seed yield was also not influenced due to escaping irrigation at bud and capsule maturity stages. In this respect, flower initiation stage was found most critical. Same trend was observed with respect to husk yield but the most critical stage in this regard was rosette. Further, data showed that moisture stress at various physiological stages did not influence morphine, codeine and thebaine content of opium gum.

Integrated nutrient management in Opium poppy-Ashwagandha crop rotation involving organic sources

At Udaipur, increasing levels of FYM from 5 to 15 t ha^{-1} significantly increased leaves per plant (88.1-94.1 cm), gum (42.4-50.9 kg ha^{-1}), seed (10.5-13.4 q ha^{-1}), capsule husk yield (10.2-12.4 q ha^{-1}), morphine (10.8-12.9%) and thebaine content (1.8-2.0%) of gum. However, response of applied FYM was noted up to 10 t ha^{-1} only, when judged in terms of plant height and capsules per plant. Codein content of gum was not influenced by FYM application. Castor cake, equivalent to 50 kg N ha^{-1} significantly increased leaves per plant (15.6), capsules per plant (1.6), gum (48.5 kg ha^{-1}), seed (12.3 q ha^{-1}), capsule husk yield

(11.8 q ha^{-1}), morphine (12.2%) and thebaine content (1.9 %) of gum compared to castor cake equivalent to 25 kg N ha^{-1}. Application of 50 kg N ha^{-1} through urea significantly increased plant height, leaves per plant (16.0), capsules per plant (1.6), gum (49.9 kg ha^{-1}), seed (12.6 q ha^{-1}), capsule husk yield (12.0 q ha^{-1}), morphine (12.3%) and thebaine content (2.0%) of gum compared to 25 kg N ha^{-1}.

Morphological and biochemical comparison between downy mildew susceptible and resistant cultivars

An experiment was conducted at Faizabad to identify host factors that impart resistance against downy mildew pathogen. Morphological features and biochemical constituents of both susceptible (Jawahar Aphim-16) and resistant (Ghazipur Local) cultivars of opium poppy were investigated. All the experiments were conducted on three months old plants of cultivar (susceptible) and (resistant). The plants were grown aseptically in a net house and three months old seedlings were used for the study.

In susceptible JA-16, within 6 h of inoculation, the conidia not only germinated but also considerable elongation in germtube could be noticed. By 12 h ramification of hyphae was noticed and after 24 h on inoculation infection pegs were found to enter the host through stomatal openings. In Ghazipur Local, at 6 h of inoculation, conidial germination was visible however, germtube was very small; even after 12 h it remained stunted in growth. However after 24 h, a moderate elongation of germ tube was noticed.

Average number of stomata per microscopic field in resistant cultivar was 21.5 while it was marginally higher (22.00) in susceptible cultivars. However, the difference was statistically non-significant. The size of the stomata in susceptible cultivar (53.61 × 28.04 μm) was significantly bigger compared to resistant ones (50.47 × 22.96 μm). There was no significant difference in the average thickness of wax layer on leaf surface.

Upon inoculation, carbohydrate content showed decreasing trends in both the cultivars. However, the decrease was faster in susceptible one compared to Ghazipur Local. In JA-16 within 6 h of inoculation, leaf carbohydrate content decreased about 50% and by next 6h it reached to 4 mg g^{-1} only. However, after that, as measured at 18 and 24 h after inoculation, carbohydrate level was maintained in that level. In resistant cultivar, decrease in carbohydrate content was nonsignificant up to first 12 h of inoculation. However, at 18 h it was 16 mg g^{-1} that was maintained till 24 h after inoculation.

In susceptible cultivar there was continuous decline in phenol content in the first 18 h after inoculation and it reached to 99.64 μg g^{-1}. After that there was a significant increase at 24 h after inoculation. In resistant cultivar, after 6 h of inoculation, there was significant increase in phenol content (792.64 μg g^{-1}) and it was maintained up to next 6 h. Later the phenol content reduced and reached the normal level (138.86 μg g^{-1}) by 24 h after inoculation.

In susceptible cultivar polyphenol oxidase (PPO) activity showed steady decline after inoculation. After 6 h of inoculation PPO activity was 91 unit g^{-1} that reached to 15 unit g^{-1} at 24 h after inoculation. However, in resistant cultivar, PPO activity showed increasing trend 12 h after inoculation and reached to maximum level (69 unit g^{-1}) at 18 h after inoculation.

Patchouli (*Pogostemon cablin*)

The plant belongs to family Lamiaceae and is a perennial, branched, aromatic herb with soft, opposite, serrated egg shaped leaves and square stems. The plant grows up to 90-100 cm and flowers during the month February to March. The oil extracted from the leaves has a fresh green slightly harsh aroma, as the oil ages it may considerably become sweeter and balsamic. Patchouli oil is used as a base in perfumery industry, and it is gaining more importance in aromatherapy. In India the crop is cultivated in coastal areas of South India, West Bengal, Assam, Karnataka and coastal regions of Gujarat.

Effect of drought stress on physiological parameters and leaf gas exchange

At NRCMAP an experiment was conducted to study the effect of short duration drought stress on patchouli with respect to the physiological parameters like leaf potential, canopy temperature, leaf photosynthesis, leaf respiration and other related parameters to study the performance of tissue culture raised plants and rooted cuttings of patchouli. Four-month-old plants were given drought stress by withholding of irrigation for two weeks and the changes in physiology of plants were studied. The plants maintained canopy temperature below the ambient temperature (34°C) under irrigated conditions. However, the canopy temperature reached 36°C and 38°C in tissue cultured plants and rooted cuttings respectively when not irrigated. The leaf water potential was maintained at –1.0 Mpa under irrigated condition. There was a considerable reduction in leaf water potential under drought stress in both tissue cultured and rooted cuttings. It was observed that the leaves maintained the leaf water potential by reduced leaf area development and shedding of older leaves by senescence to instead of wilting of active leaves. There were considerable changes in the diurnal pattern of photosynthesis in different soil water availability condition. The reduction in leaf photosynthesis was prominent in drought conditions in both tissue cultured plants and rooted cuttings measured during morning and evening hours.

Single leaf propagation

Attempts were made at NRCMAP for raising plants from single leaf to increase the multiplication ratio from single source of planting material. Leaf pairs of different nodes from the stem apex were used to find out the suitable leaf for the propagation of patchouli using this technique. The pairs from the top 2nd to 5th pair were used for the study. Among the different pairs the 4th pairs of leaves rooted early (7.33 days), followed by 3rd pair (9.0days), 2nd pair (9.33 days) and 5th pair (10.33 days). Among the leaf pairs, the days taken for shoot initiation was found earlier in 4th pair (14 days) followed by 5th (16 days), 3rd (17 days) and 2nd pair (20 days). The survival of plantlets after 30 and 45 days were also observed. The 4th pair was found to have highest percent of survival at 30 (93.33%) and at 45 days (72%). The lowest percent of survival was found in 5th pair at 30 (23.67%) and at 45 days (12.67%). Among the leaf pairs, the maximum plantlet height at the time of planting was observed in 4th pair (15.20 cm) and lowest plantlet heights were found

in 2nd pair (7.20 cm). The dry weight of plantlets at the time planting was found highest in 4th pair (0.6 g) and lowest dry weight of plantlets were observed in 2nd pair (0.27g). It was concluded that the 4th pair of leaf was best for the propagation of patchouli for the production of plantlets from leaf.

PALMAROSA (*Cymbopogon martini* var. *motia*)

Palmarosa is a tall perennial tufted hedge, native of most parts of subtropical India and belongs to the family Poaceae. It is an important aromatic plant cultivated for its essential oils extracted from floral shoots and aerial parts. The palmarosa oil is rich in geraniol, which is used in perfumery, soap and cosmetics. It is native of most parts of subtropical India and grows well in a wide variety of soils which are devoid of water logging. The distribution of the species in the forest of central India is continuously reduced due to over exploitation and loss of the forestlands.

Evaluation of germplasm

Sixteen genotypes were evaluated for various characters at Hisar and it was found that the culm diameter ranged from 0.29 to 0.62 cm, internodes per culm 8.2 to 11.4, leaf blade length 18.50 to 25.0 cm, leaf blade width 1.67 to 2.47 cm; flag leaf length 9.34 to 12.66 cm, flag leaf width 0.87 to 1.25 cm, tillers per plant 21.75 to 146.50, inflorescence bearing tillers 5.0 to 60.84, panicle length 28.65 to 62.50 cm, panicles per tiller 5.67 to 9.17, spikelet length 1.62 to 2.19 cm, plant height 151.0 to 193.5 cm, fresh herb yield per plant 38.3 to 1700.0 g, fresh herb yield 151.850 to 399.800 q ha^{-1} and oil yield 33.405 to 159.910 l ha^{-1}. On the basis of total of two cuts (harvests), genotype RH-03-35 recorded highest oil yield (291.11 l ha^{-1}) followed by RH-03-30 (282.13 l ha^{-1}) and RH-03-62-1 (280.8 l ha^{-1}).

SAFED MUSLI (*Chlorophytum borivillianum*)

Safed musli is a herbaceous pant widely distributed in the forests of Maharashtra, Gujarat, Rajasthan and Madhya Pradesh and belongs to the family Liliaceae. The dried root powder which contains saponins as active principles is used as tonic and aphrodisiac drug. Extensive collection of the material from the forests has dwindled the natural population and the growing demand of this crop leads to initiation of its commercial cultivation in kharif in places having warm and humid climatic conditions and adequate soil moisture throughout the crop growth. Conservation and characterization of the genetic diversity, development of proper cultivation technology, easy quality estimation methods, etc. are the major research areas in this crop.

Evaluation of germplasm

Fifteen high yielding selections were evaluated at Anand along with the check RC-5. Selection AMVI – II was found to be promising with 73.68% increased fresh fasciculated root yield over the check RC-5. This accession yielded the highest in all the years of testing and also in pooled analysis. This has been recommended by AAU Research Council as a new variety with the suggested name, Anand Safedmusli-1(ASM-1).

Eleven genotypes were evaluated for various characters against the check MCB 405 at Hissar. Leaf length ranged from 12.20 to 21.60 cm; leaf width from 1.40 to 2.13 cm; leaves per plant from 9.30 to 21.23; fasciculated roots per plant from 6.3 to 19.73; fasciculated root length from 6.20 to 11.97 cm; fasciculated root diameter from 0.54 to 0.71 cm; fasciculated root yield per plant from 32.33 to 80.67 g and days-to-flower from 27.47 to 43.67 days. Significantly highest fasciculated root yield per plant was recorded in CBI-7 (80.67 g), followed by HCB-6 (69.00 g) and HCB-4 (68.33 g) against the check MCB-405 (47.67 g).

Twenty-four germplasm were tested at JNKVV, Mandsaur and wide range of variability was recorded in both qualitative and quantitative characters. Colour of anther, ranged from yellow to light yellow and sometime light green in few genotypes. Length of fleshy root ranged from 3.4 cm (MCB-418) to 9.4 cm (MCB-412), root diameter 3.4 mm (MCB-404) to 8.1 mm (JSM-405), fresh weight of root 1422 kg ha^{-1} (MCB-418) to 2644 kg ha^{-1} (MCB-414). MCB-414, MCB-412, MCB-401, MCB-419, MCB-415 and MCB-424 were identified as superior genotype for fasciculated root yield and sapogenine content.

Evaluation of advanced lines

Three genotypes viz, Anand Safed musli (ASMV-II), Mandsaur safed musli (MCB-412 and MCB-414) along with local check - Jawahar Safed musli (JSM-405) were tested at Mandsaur. Analysis of variance indicated significant differences for fasciculated root yield per hectare, length of fascicualted root and number of root per plant. Maximum fasciculated root yield was recorded in MCB-414 (2370 kg ha^{-1}) which was followed by MCB-412 (2207 kg ha^{-1}) and ASMV-II (2181 kg ha^{-1}), which was significantly superior to local check JSM-405 (1881 kg ha^{-1}). The disease reaction of root indicated that the entry MCB-414 identified as a resistant genotypes followed by JSM-405 moderately resistant and ASMV-II and MCB-412 are susceptible genotypes.

Rapid micropropagation protocols

Direct shoot regeneration was achieved from immature inflorescence explants on half-strength MS medium supplemented with 3.0 mg l^{-1} BA, 150 mg l^{-1} Ads, 0.1 mg l^{-1} NAA and 3% (w/v) 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 terminal 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.

Shoots were rooted on half-strength basal MS medium supplemented with half-strength

MS medium, 0.1 mg l^{-1} IAA and 2% (w/v) sucrose. Micropropagated plantlets were hardened in the green house and successfully established in the soil where 90% of the plants survived.

Studies on post harvest storage of fasciculated roots as planting material

At Udaipur, in order to increase keeping quality various methods were used for storage. Results revealed that lowest percentage of weight loss (26.7%) was recorded from the treatment applied with wooden box containing 4″ layer of musli + 4″ layer of soil, followed by wooden box containing 4″ layer of musli + 4″ layer of sand (27.5%), earthen pot containing 1 kg roots mixed with 1kg sand and mud plastering (28.4%). Similar trend was observed in case of number of healthy roots and dry roots. However, the least number of diseased roots (2.37%) were found in the treatment earthen pot containing 1 kg roots mixed with 1 kg sand and mud plastering followed by wooden box containing 4″ layer of musli + 4″ layer of sand (2.50%).

Effect of variety and spacing on vegetative growth and root yield

At Faizabad, an experiment was carried out to evaluate the effect of variety and spacing on vegetative growth and root yield with 2 varieties (MCB-405 and MCB- 412) grown at 3 spacing (10, 15 and 20 cm). Number of fasciculated roots per plant varied significantly due to variety and spacing. Variety MCB-405 gave higher number of fasciculated roots per plant (16.22), while MCB-412 gave 14.34 fasciculated roots only. Spacing of 20 cm gave maximum number of fasciculated roots (16.61) per plant. However, maximum fasciculated roots length of 12.5 cm was recorded at 15 cm spacing. There was non-significant effect of varieties and spacing on fasciculated roots diameter; however, MCB-412 produced more fasciculated roots diameter (0.71 cm) than MCB- 405 (0.64 cm). Maximum average fresh fasciculated root yield was recorded with variety MCB- 405 (4468 kg ha^{-1}). Significantly higher fresh fasciculated root yield (4994 kg ha^{-1}) was obtained due to closer spacing of 10 cm as compared to other spacings. Perusal of data revealed that variety MCB- 405 produced more dry fasciculated root yield with average production of 861 kg ha-1. Significantly higher dry fasciculated root yield of 823 kg ha^{-1} was noted at closer spacing of 10 cm with average dry fasciculated root yield of 974 kg ha^{-1}.

SENNA (*Cassia angustifolia*)

Senna is an important export oriented medicinal crop belongs to Leguminosae. Leaves containing sennosides are used as laxative and find place both in Indian system of medicines and modern pharmacopoeia. It is grown as rainfed crop and is highly sensitive to high rainfall and water logging. Hence, it is not recommended for high rainfall zone. This is suitable for the drier regions and traditionally cultivated in Gujarat, Rajasthan, Tamil Nadu, etc. Development of high yielding varieties and good agricultural practices are researchable areas in this crop.

Screening of accessions

Thirteen accessions were evaluated at Anand along with the check variety ALFT 2 and it was found that none of the accessions could out-perform the check variety. However, dry leaf yield of accession ASNTL (805.30 kg ha-1) was at par with the check (970.94 kg ha-1).

TINOSPORA (*Tinospora cordifolia*)

Tinospora is a glabrous, climbing, succulent shrub with corky grey dotted bark and belongs to the family Menispermaceae. The mature stem is acrid, bitter, hot, restorative, aphrodisiac and used as a digestive tonic. In India it is distributed almost throughout extending from Himalayas down to Southern part of Peninsular India. Leaf length, breadth and area attained maximum value within 11-13 days after its emergence; however, pedicel reached maximum growth after about 20 days.

Growth studies of the species

Growth studies in four male (IC 310601, IC 310605, IC 283958& NRC TC 1) and four female plants (NMRM 13, 14, 15 & 16) was conducted at NRCMAP. It was found that leaf length, breadth and area attained maximum value within 11-13 days after its emergence, however, pedicel reached maximum growth after about 20 days. Growth rate did not differ significantly between male and female plants.

In another study in different germplasm, it was found that the accessions can be grouped into six different classes (leaf area below 10, 10-25, 25-40, 40-55, 55-70, Above 70) based on leaf area (cm^2).

DNA isolation method for molecular characterization

A method has been standardised for tinospora at NRCMAP that produce DNA suitable for molecular biological applications. DNA was isolated following the CTAB method with little modification. Three gram fresh, young leaf tissue was grounded with 2% insoluble PVP to a fine powder in a mortar with repeated addition of liquid nitrogen. The extraction buffer (4% CTAB; 1.4 M Nacl; 20 mM Na_2EDTA, pH 8.0; 100 mM Tris-HCl pH 8.0, 2% ß-Mercaptoethanol) was used. The mixture was emulsified with an equal volume of chloroform : Isoamyl alcohol (24:1). After centrifugation at 10,000 rpm for 20 min at room temperature, the upper aqueous phase was pipetted out and mixed with equal volume of chilled isopropanol by quick inversion. The precipitated nucleic acid was spooled out, washed twice with 70% ethanol followed by air drying and dissolved in TE buffer. Thereafter, the crude DNA was purified by addition of RNAse followed by Phenol, Chloroform , Isoamyl alcohol series. Then the quality and quantity were checked by loading the DNA in 0.8% agarose gel alongside diluted uncut DNA as standard and electrophorsed. Good quality of DNA was obtained for molecular characterization.

Other Project

Protocol developed for organogenesis via callus culture in *Vitex trifolia*

Callus was initiated from stem, leaf and petiole explants derived from matured plants of Vitex trifolia on half strength MS medium supplemented with 2.5-3.0 mg l^{-1} BA, 0.1-0.5 mg l^{-1} NAA, 2.0-2.5 mg l^{-1} 2,4-D, 0.1-0.5 mg l^{-1} TDZ and 3% sucrose. Initially, small whitish calli developed on the cut ends within 10-12 d of inoculation which subsequently covered the entire surface of the explant. There was no sign of callus formation when explants were cultured in media without auxins or cytokinins. The ½ MS medium containing 3.0 mg l^{-1} BA , 0.1 mg l^{-1} NAA and 3% sucrose promoted callus growth. Also rapid callus induction was obtained in the medium ½ MS + 0.5 mg l^{-1} TDZ + 100 mg l^{-1} Ads + 3% sucrose. Developed calli from the leaf and stem explants proliferated very fast and these were soft or gelatinous depending on the TDZ level. The rate of growth of callus was faster in the first 4 weeks of culture after which it declined

After 4 weeks in the callusing medium, the calli were subcultued in the media containing different concentrations of BA or TDZ and NAA, GA_3, Ads for shoot bud regeneration. The calli differentiated into green nodular structures which developed into dark green shoot buds in the ½ MS media supplemented with 3.0 mg l^{-1} BA + 0.1 mg l^{-1} NAA + 3% sucrose (Fig. 3). Kineitn or BA alone did not induce any morphogenetic response. The addition 0.5 mg l^{-1} GA_3 along with 150 mg l^{-1} of adenine sulphate (5 mg l-1) in the culture medium, however, resulted in quick growth of shoot bud within 4 weeks of culture. The percentage of shoot bud regeneration and the frequency of regenerated shoots $culture^{-1}$ varied in stem and leaf explants.

Fig. 3 Shoot bud regeneration from *V. trifolia* callus

Leafy shoots regenerated from callus were cultured on ½ MSmedium with or without growth regulators. A high percentage of rooting (88%) was observed on ½ MS media supplemented with 0.25 mg l^{-1} IBA and 2% sucrose after 11-12 days of culture. Root initials formed within 7-9 days which developed a good root system in 11-12 days. Root initiation was achieved on medium containing either NAA or IAA (0.25 mg l-1)) but with intervening callus at the cut end of the shoot. Thereafter, the rooted plantlets were transferred to pots containing sterilised soil : sand : well decomposed manure (1:1:1; v/v) and kept in green house for acclimatization. After one month, about 98% plants survived when the potted plants were kept outside.

GERMPLASM HOLDING OF MEDICINAL AND AROMATIC PLATS

Germplasm status of NRCMAP field gene bank

Sl. No.	Species	No. of accession
1	*Aloe* spp.	55
2	*Andrographis paniculata*	59
3	*Asparagus* spp.	37
4	*Cassia angustifolia*	5
5	*Chlorophytum borivilianum*	54
6	*Commiphora* spp.	73
7	*Cymbopogon flexuousus*	13
8	*Phyllanthus* spp.	13
9	*Tinospora cordifolia*	38
10	*Tribulus terrestris*	7
11	*Urgenia* spp.	6
12	*Withania somnifera*	11
13	*Plantago* spp.	8
	Total	**379**

INFORMATION MANAGEMENT (ARIS)

Digital Herbarium of Medicinal & Aromatic Plants in India

During the year, attempts were continued for updating a client module for a software package entitled "Digital Herbarium of Medicinal & Aromatic Plants in India".

The client module in the software package consists of an option called "uploading client data". Using this option, the client can also contribute medicinal & aromatic plants information to the digital herbarium master database. 'Uploading client data' allows the client to enter the species information such as scientific name, botanical name, use, image, collector, etc., into the client database. The information will be sent to the administrator and it will be stored in the client database. The 'administrator', module consists of three options for client database such as "Add", "Delete" and "Update". The first one allows appending the client database in to master database. The administrator can delete the client information from client database using the "Delete" option, as these information is not valid. The administrator can modify the client data and append the same to the master database using the "Update" option. After that, the digital herbarium will allow to access this information by the clients.

Databases:

The following databases have been updated and maintained:

- Medicinal and Aromatic plants References Information System

- Traders Information system on Medicinal and Aromatic plants
- Digital Photo Library of Medicinal & Aromatic Plants
- Digital Herbarium of Medicinal & Aromatic Plants in India
- Institute website

Website

The institute website www.nrc-map.org was redesigned and updated at regular intervals. The budget expenditure details have been posted on daily basis. The information on RTI act and reports has been updated.

ALL INDIA NETWORKING RESEARCH PROJECT ON BETELVINE

All India Networking Research Project on Betelvine is in operation in ten centers. Nine of these centres are in operation in various state agricultural universities and one in IIHR, Bangalore. The Isalmpur centre under RAU, Bihar is working exclusively on production technology of Maghai pan. The CHES (IIHR) at Chetali, Bangalore is working on betelvine germplasm conservation and breeding of betelvine through hybridization of elite betelvine germplasm material. A multidisciplinary team of about 25 scientists of various disciplines such as Plant Breeding, Agronomy, Horticulture, Plant Pathology and Entomology are working in research on various aspects of Crop Improvement, Crop Production, Crop Protection, Post Harvest Physiology, etc. Emphasis was given for development of 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
ANGRAU, Bapatla	51	51
AAU, Jorhat	14	14
BCKV, Kalyani	39	39
IIHR (ICAR), Chetali	100	-
JNKVV, Jabalpur	20	20
MPAV, Sangli	28	28
OUAT, Bhubaneswar	40	40
RAU, Pusa	20	20
RAU, Islampur	16	16
TNAU, Sirugamani	45	45

The germplasm were evaluated for their leaf characteristics, vine growth characters, resistance to pest and diseases, keeping quality and organoleptic properties.

Hybrid Evaluation Trial

At Sirugamani, it was found that only GN1 hybrid (Godi Bangla X Kapoori Nasik) exhibited normal vigour. Other three hybrids did not show any hybrid vigour rather growth was inferior to ruling varieties. GN1 produced marketable leaves of 34.68 lakh leaves ha^{-1} weighing about 295.00g/100 leaves. The other three hybrids viz., P1, P2 and GB (OP) expressed hybrid depression and produced unmarketable leaves of poor quality, thus not suited for cultivation. GN1 hybrid will be tested in the farmers' fields for its adaptability.

Hybridisation Programme

Flowering was observed in 16 female clones and 13 male clones at Chetali. Continuous flowering was observed in female clone SGM1 and male clone Swarna Kapoori. Kappoori Arvi and Kapoori Bhambla started flowering during the month of March. A total of 72 different crossings were made during the year. The detail of harvesting of seeds and seedling establishment is given below.

Right stage to harvest the fruit is when it turns brownish green and soft. The ripened fruits were harvested when they turn soft and the seeds were extracted.

Seeds from dried fruits on the vine were collected since air dried fruits and air dried seeds showed poor germinability.

Extracted seeds were germinated at room temperature.

Seed germination ranged from 20 to 80% among the progenies tested.

Emergence of radicle was observed at 11-15 days after imbibition.

Germinated seeds were transferred to germinating trays filled with sterile cocopeat and seedlings emerged at 15-20 days time.

Seedlings of 4-6 leaf stage transferred to polybags filled with potting mixture and cocopeat.

The seedlings later transferred to pots till their field planting.

Vigorous hybrid seedlings selected for field planting at Chetali

Hybrid	Vine length (cm)	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)
SGM1/Swarna Kapoori-1	135	6.3	5.9	4.5
SGM1/Swarna Kapoori-2	118	5.9	5.4	3.3
SGM1/Swarna Kapoori-3	101	6.5	5.5	3.8
SGM1/Swarna Kapoori-5	108	5.9	4.9	3.9
Simarali Babna (Local)/Kapoori Vuyuru-2	175	5.9	5.4	6.2
Simarali Babna/Swarna Kapoori-1	170	8	7	6.2
Simarali Babna/Kapoori Vuyuru-1	156	7.5	4.3	4.0

Efficacy of bio-fertilizers

Various bio fertilizers like azotobacter, phosphobacter and azosprillum were applied in combination with other organic manures like vermicompost and inorganic fertilizers to study the efficacy of bio-fertilizers on growth, yield, shelf life and organoleptic quality. Two levels of azotobacter (5 kg and 10 kg) were used. Azotobacter or azosprillum + phosphobacter, vermicompost, MOC+Urea (1:1) were applied in combination with NPK to betelvine for their effect on vine growth, yield and keeping quality of betel leaf.

At Pusa, application of vermicompost registered the highest production of crop in term of total number of leaves, fresh weight of hundred leaves, and leaf area and all other treatments did not result in appreciable increase in leaf yield. It was also noted that increase in urea dose (200 kg ha^{-1}) resulted in maximum disease incidence and poor keeping quality of leaves.

Amongst different treatments, vermicompost (10 t ha^{-1}) had marked effect on number of branches, vine growth (12.15 cm), leaves (25.15 lakh ha^{-1}) with more number of branches (22.15) over other treatments. Though, phytophthora foot rot severity is lesser in all microbial bio- fertilizer in comparison to oil-cakes and urea.

Integrated Crop Management

At Jorhat, the incidence of disease was significantly less in the treatments where *Trichoderma* and Bordeaux mixture were applied. Final soil status indicated the fixation of phosphorus as well potash in the soil leading to build up of both the nutrients. The retention of K was higher in plant population with combination of *Trichoderma* and Bordeaux mixture. The farmers' practices resulted in lower return compared to INM and IPM approach because of adopting lower plant population as well disease, nutrient and irrigation management aspects.

The results showed that the treatment consisting of optimum plant population (1,00,000 plants ha^{-1}) + recommended fertilizers (Neem cake + Urea (1 : 1) providing 200 kg N, 100 kg P_2O_5 and 100 kg K_2O ha^{-1}), irrigation (100% replenishment of CPE) and application of Bordeaux mixture (4 drenches and 8 sprays) recorded significantly higher leaf yield of 39.15 lakh ha^{-1} at Bapatla.

At Kalyani, highest fresh mass of 100 leaves (407.14 g) and leaf yield (44.44 lakh ha^{-1}) were recorded in treatment consisting of plant population of 1,50,000 vines ha^{-1} with application of 200kg N in splits of organic form + 100 kg P_2O_5 + 100 kg K_2O + Irrigation at 100% replenishment of CPE + Bordeaux mixture application (4 D+ 8S) + recommended insecticides if required. In the same treatment, lowest incidence of leaf & foot rot caused by *Phytophthora* sp. and leaf spot caused by *Colletotrichum capsici* was observed. Incidence of leaf & foot rot and leaf spot were recorded highest in control treatment (farmer's practice). The cost: benefit ratio being highest in the Farmer's practice.

At Jabalpur, maximum vine elongation per month (15.58) number of leaves (36.25 ha^{-1}), length of inter-node (7.54 cm) and weight of 100 leaves (618.65 g) were observed with treatment consisting of Best plant population + 200 kg nitrogen in four splits in organic form + 100 kg P_2O_5 + 100 kg K_2O + irrigation at 100% replenishment of CPE + 4 applications of *Trichoderma viride* + Sanitation + recommended insecticides. The maximum

disease incidence (15.30%) and minimum keeping quality (9.82 days) of leaves were noted in farmers practice.

At Bhubaneswar, application of 150 kg nitrogen + 100 kg P_2O_5 + 125 kg K_2O + irrigation at 100% replenishment of CPE + Bordeaux mixture application (4D +8S) + recommended insecticides gave higher vine elongation (28.2 cm), number of laterals (2.0) and the leaf yield (45 lakh ha^{-1}) with larger leaves (14 x 11 cm), fresh weight of 100 leaves (292 g) and less disease incidence. The shelf life of leaves was better in farmers' practice with an organo leptic rating of 2.6.

At Pusa, the treatments one, 50 lakh plants ha^{-1} + 200: 100: 100 kg ha^{-1} N: P_2O_5: K_2O (4 -splits) as organic + irrigation + 4 application of Trichoderma viride + sanitation + organic insecticide and another, 1.50 lakh plants ha^{-1} + 200: 100: 100kg ha^{-1} N:P_2O_5: K_2O (4 -splits) as organic + irrigation + 3 drenching of Bordeaux mixture (1%) and 6 sprays of BM (0.5%) + sanitation + organic insecticide gave superior yield over farmers' practice. Higher disease incidence and shorter shelf life was noticed under farmers' practice. Although other parameters such as vine growth, fresh weight and leaf area remained un-affected, integrated crop management fetched higher benefit as compared to farmers' practice.

Nutrient uptake studies

Nutrient uptake studies carried out at different centers 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 betel leaf quality. The performance of betelvine crop under different centers with the optimum nutrient application is given below.

At Kalyani, the results showed that yield and growth parameters were maximum in cases of nutrient dose NPK (kg ha^{-1}) = 150: 50: 50 (N = oilcake). Chemical analysis of plants showed that plants from treatment - NPK (kg ha^{-1}) = 200: 100: 100 (N= oilcake + urea) contained highest N & P percent. But, where NPK (kg ha^{-1}) = 200: 100: 100 (N = FYM) were applied, plants contained highest K. Soil analysis showed that lowest residual P & K were obtained in treatment NPK (kg ha^{-1}) = 150: 50: 50 (N = oilcake + urea) were applied. Low residual N in soil was found in treatment - NPK ((kg ha^{-1}) = 200: 100: 100 (N = oilcake + urea).

At Jabalpur, N, P and K uptake was highest under the treatment where NPK applied at the rate of 200 (oil cake): 100: 100 kg ha^{-1}. The uptake of N, P_2O_5 and K_2O were 156.25, 68.56 and 82.55 kg ha^{-1} whilst they were lowest (120.25, 38.25 and 48.56 kg ha^{-1}) under NPK application @ 150 (FYM): 50: 50 kg ha^{-1}. Application of NPK @ 200: 100: 100 kg ha^{-1} as FYM resulted in highest uptake of nutrients. N, P and K uptake were 272.30, 45.20 and 136.76 kg ha^{-1} respectively. However, soil nutrient status was maximum under the application of NPK @ 200: 100: 100 kg ha^{-1} as oilcake : urea. The treatment receiving nutrient dose of 200: 100: 100 as N, P_2O_5 and K_2O significantly superior yield as compared to the treatments which received comparatively lower dose of nutrient whether applied in the form of organic or combination of organic: inorganic. It was also noted that crop with significantly better vine growth, marketable leaves, leaf area, fresh weight and return/rupee investment was produced with higher supply of nutrient. A correlation between higher dose of nutrient, nutrient-uptake, nutrient balance and production was also recorded. Inclusion of inorganic form of nutrient resulted in poor keeping quality and less

disease resistance. The shelf life of leaves was significantly higher in control plot (crop with no supply of nutrient) where disease severity was also reduced, but yield was significantly poor and showed negative balance of nutrient in the soil.

At Sirugamani, the treatment consisting of 150 as FYM , 50 P_2O_5 and 50 K_2O kg ha-1 application recorded highest leaf yield of 40.19 lakh ha-1 and recorded maximum organic carbon content (0.53%) during second year. The available N was high in the treatment having NPK of 150 (oilcake + urea): 50:50. kg ha-1.

Effect of plant population

At Pusa, it was observed that plant population density had no effect on vine elongation and no. of leaves. However marketable leaves increased significantly due to rise in plant density, but resulted in the reduction in leaf size, shelf life and benefit: cost ratio. The plant population @1.5 lakh plant ha-1 was quite economical and superior to other treatments.

At Islampur, amongst four plant spacing, maximum vine elongation, populations (9.35), no. of branches (18.35) and no. of leaves ha-1 (26.75 lakh ha-1. recorded with 1.5 lakh ha-1 plant population. The phtophthora foot rot incidence increased with increasing plant population.

Assessment of optimum level of organic carbon content

At Jorhat, optimum level of organic carbon was assessed in different cultivation practices followed in Assam i.e. closed type, semi closed type and open type in three locations (Ambagan, Lengeri, Borhola) at fifteen different sites. Percent organic carbon varies from 0.56 to 0.78 in different betelvine gardens and it was medium in terms of available nitrogen. Soil type at Borhola village was predominantly silty clay loam with high organic carbon content (ranges from 0.67 to 0.78%). The available P_2O_5 (ranging from 43.8 to 48.8 kg ha-1) and K_2O (ranging from 105.5 to 108.2 kg ha-1) were highest among the locations.

A survey was conducted by Kalyani Centre at Bhander Khola, Dist. 24 pgs. (N) During the month of December, 2006. During the survey period, crop characteristics, soil characteristics, fertilizer application and disease and pest infestation were recorded from 10 farmers' field and soil samples were collected from those barejas for analysis. The farmers' mainly used Mustard oil cake. None of them were using Super phosphate, Muriate of Potash and Micro-Nutrients except one for supplying the nutrients to the crops. The organic carbon (%) content, total N (%), total P_2O_5 kgha-1 and total K_2O kg ha-1 of different borajas ranged from 0.49-0.78%, 0.014- 0.042%, 4.4-196.46 Kg/ha and 168.3 – 382.8 Kg/ha respectively. The pH of above soil ranged from 6.78 – 8.13.

Ten soil samples were collected from three betelvine growing areas to assess the optimum level of organic carbon content in betelvine cultivation by Jabalpur centre. It was found that betelvine farmer of Pateria, has applied nitrogen in the from of urea and oil cake to the tune of 265 kg ha-1 which resulted in maximum organic carbon content (1.3%) among the locations tested and got maximum leaf yield (42.52 lakh ha-1). Minimum leaf yield (33.25 lakh ha-1) was associated with application of 155 kg nitrogen in the form of oil cake and resulting 0.6% organic carbon content.

Roving survey was carried out at different farmers' fields of Anlo village in Niali block

by Bhubaneswar centre. The organic carbon content was ranging from 0.59% to 0.80% among the locations.

Survey was carried out in 10 different adapted farmer's field at Poigaiputhur and Thanneerpalli by Sirugamani centre. Observations were made out in betelvine variety SGM BV-2. Among the fields recorded the highest leaf yield (40.45 lakh ha-1) during second year and an increased shelf life of 12.76 days during second year. The organic carbon content of the soil was also high in betelvine field of Mr.Arumugam.

Efficacy of BD (Bio-dynamics) + EM (Effective micro-organism)

Efficacy of bio-dynamics along with effective micro-organism on betelvine crop was studied at Pusa. BD500 (cow horn dung) preparation was applied @ 62.5g ha^{-1} in the month of October and BD501 (cow horn silica) was applied @ 2.5g ha^{-1} applied in the month of October. The results showed that significantly higher growth parameters such as vine elongation, marketable leaves, fresh weight, keeping quality, and production were noticed in plot which received BD + EM + 100kg N ha^{-1} as FYM as compared to other treatments while application of 100 kg N as FYM registered lowest leaf yield among the different treatments. The untreated crop had very poor growth and yield. Better keeping quality with low disease were recoded in all the organic treatments including control, but significantly inferior in plot receiving only inorganic form of nutrient. All the treatments registered more profitable B : C ratio than control.

Crop regulation through staggered lowering

To increase the harvest of betel leaves in the lean period, a technique named staggered lowering was standardized. The results showed that significant improvements in crop growth and yield were noticed by this technique in various centers. At Jorhat, there was no significant difference in vine elongation, number of branches per plant, fresh weight and keeping quality of the leaves. However, significant differences were observed in yield, disease incidence and net return during February & September lowering and July & November lowering compared to other lowering periods. February & September lowering gave highest net return (2.49 lakh ha^{-1} y^{-1}).

At Kalyani, the results showed that leaf yield was found highest (33.30 lakh ha^{-1}) in treatment where July and November lowering was done and it was statistically at par with February and June lowering. The lowest (27.81 lakh ha^{-1}) leaf yield was recorded in August and December lowering and it was statistically at par with September and January lowering. The lowest (6.66%) leaf spot disease was recorded in September and January lowering and it is at par with February and June lowering (8.02%).

Epidemiological studies of leaf and vine rot disease caused by *Phytophthora* sp.

Phytophthora stem and leaf rots

At Bapatla, the disease development was monitored continuously in the field and after 1% disease under natural epiphytotic condition. Simple correlation between percent disease incidence and weather parameters showed that the disease incidence had significant negative relation with minimum temperature and evening relative humidity, while it has non-significant

negative correlation with maximum temperature and rain fall. Similarly the disease incidence had non-significant positive correlation with morning relative humidity.

The meteorological data and the percent *Phytophthora* foot rot disease incidence were subjected to multiple regression analysis. Results revealed that all weather parameters collectively influenced the disease incidence to an extent of 64.76%. After removing of maximum temperature, minimum temperature, morning relative humidity and rainfall the R2 value was 0.3271, which indicated that the effect of evening relative humidity on the disease to an extent of 32.71% while the other four parameters together influenced the disease to an extent of 32.05%.

The step down analysis revealed that for 1% decrease in evening relative humidity there was an increase of 0.3% increase in disease.

The multiple regression equation worked out for foot rot disease.

$$Y = 96.32 - 1.1645\ X1 - 0.7748\ X2 - 0.2665\ X3 - 0.2289\ X4 + 0.0412\ X5$$

At Kalyani, stepwise multiple regression analysis of percent disease incidence irrespective of varieties was made. Among the five meteorological factors evening RH was more responsible for increase the disease severity or spread of the disease. The partial regression co-efficient of evening RH was highly significant in all the transformation models.

The results of *Phytophthora* foot rot disease severity, the prediction equation showed that the step wise multiple regression analysis of original PDI is highly accurate and viable for disease prediction and the prediction equation of Phytophthora foot rot is Y= -0.26+0.0048 evening RH.

At Jabalpur, results indicated that the incidence of disease recorded in the second week of June with (0.05%). The disease index increases gradually and reached to (30.66) in second week of September when the difference between maximum and minimum temperature is less and humidity is ranging from 88 to 92%. Similarly the average sun shine hours are ranging from 1.9 to 3.3 hours. In the month of October the incidence of stem rot increased and it was recorded to reach from 12.33% to 30.66%. The disease development is positively correlated with relative humidity, rainfall, number of rainy days with number of cloudy days.

At Bhubaneswar, the influence of weather parameters like minimum temperature, afternoon RH, rainfall and number of rainy days exhibited significantly positive correlation contributing towards percent disease incidence of vine rot during most part of the year. Weather parameters such as BSH (bright sun shine hours) and evaporation showed negative correlation with vine rot disease incidence in betelvine.

The regression analysis of percent disease incidence with the weather parameters reveal that evaporation, morning RH, afternoon RH and rainfall contributed 29.22%, 20.97%, 22.83% and 17.64% respectively towards disease development. The adjusted R2 value from the regression equation suggests that the weather parameters as a whole contributed to 79.3% of disease incidence.

At Sirugamani, the disease incidence of *Phytophthora* foot rot / wilt was recorded at weekly intervals in the variety Kapoori. The results revealed that weather factors viz., minimum temperature, relative humidity and rainfall had positive effect on the disease

incidence. While the other factors like maximum temperature and number of rainy days had negative correlation with the disease incidence.

Leaf rot caused by *Phytophthora* sp.

At Kalyani, the results showed that evening RH (minimum) highly responsible and statistically significant for disease severity. Residual sum of square and standard error of estimate showed that original data used for prediction equation is best suited for forewarning of disease severity. So the prediction equation is Y= -0.32+0.006 min. RH. Here also RH-min is positively and highly correlated with disease severity.

At Bhubanewswar, the correlation matrix revealed that there was significant influence of weather parameter being positively influenced by the minimum temperature, Afternoon RH and number of rainy days. The correlation of other parameters like maximum temperature, bright sun-shine hours and evaporation contribute negatively in the leaf rot disease incidence.

In the regression analysis of percent disease incidence (PDI) with weather parameters, it is observed that the amount of rainfall contributed to the extend of 35.69% followed by BSH (25.97%), morning RH 8.89% and afternoon RH 5.31%.

Anthracnose of betelvine

At Jorhat, the anthracnose disease appeared in the last week of May and lasted up to 2nd week of October. The maximum and minimum temperature, morning relative humidity and rainy days had significant positive co-relation and evening relative humidity and rainfall had negative co-relation on the incidence and spread of the disease. However, the number of rainy days had positive co-relation.

The Regression equation is fitted as below:

Y = – 29.69293 + 1.71 Max. temp.- 0.03 Min. temp + 0.36 Mor. RH - 0.67 Evn. RH - 0.04 RF + 1.40 R days (R2 = 0.65403).

At Bhubanewswar, The development of anthracnose disease was significantly positive only by influence of afternoon RH, negative correlation was showed by BSH. The regression analysis of PDI, 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 parameter in the development of anthracnose was only 31.1%.

Bacterial leaf spot

The bacterial leaf spot was observed one week after the appearance of the anthracnose i.e. in the first week of Juneand it was lasted up to 2nd week of October at AAU, Jorghat. The correlation studies revealed that maximum and minimum temperature, morning relative humidity and number of rainy days had significant positive correlation and evening relative humidity and rainfall had negative correlation with the disease incidence and development.

The Regression equation is fitted as below:

y = – 170.110 + 1.50 Max. temp.+ 1.59 Min. temp + 1.28 Mor. RH - 0.37 Evn. RH - 0.02 RF + 0.49 R days (R2 = 0.701406).

At Kalyani, step wise multiple regression analysis of leaf spot of betelvine showed that

RH-min was also highly responsible for spread of the disease severity. The comparison variables among three prediction equations showed that Gompertz transformation model was best suited for disease prediction. This was confirmed by high co-efficient determination (R2), adjusted co-efficient determination (Adj R2) and low residual sum of squares (RSS) and standard error of estimate (SE est.) value. Hence, the prediction equation for disease forewarning of leaf spot disease is Y = 2.252 + 0.006 RHmin + 0.016Tmin + 0.024 RHmax. Here with increase in RHmin, Tmin and RHmax disease severity will be increased.

At Jabalpur, disease was recorded from second week of June on the first appearance of the disease and progressive disease development was recorded up to the month of October. The disease index of bacterial leaf spot increase gradually and it reached to peak when rainfall is more but from the month of September the incidence of bacterial stem infection increases and it was recorded maximum in the month of October. In correlation studies except maximum temperature all other factors are positively related with the disease development in bacterial infection of betelvine.

Integrated disease management of *Phytophthora* foot rot

At Jabalpur, results indicates that the lowest disease incidence and vine death due to phytophthora foot rot and leaf rot (7.0%) and vine death due to bacterial infection (7.5%) were recorded were four drenching of B.M. applied followed by proper sanitation + pre-monsoon application of Bordeaux mixture + application of biological agent after one month application of Bordeaux mixture and second application of Bordeaux mixture two months after first application of Bordeaux mixture. In case of four drenches of Bordeaux mixture the disease incidence and per cent vine death were also reduced but it was lesser profitable than integrated disease management. Highest yield was recorded in integrated disease management (37.55 lakh leaves ha^{-1}) whilst the control produced lowest leaf yield (31.43 lakh ha^{-1}).

At Pusa, the results showed that all the treatments showed marked suppression of disease over control. However sanitation of crop accompanied with drenching of BM (1%) followed by soil application of bio-agent (inoculated in mustard-cake) along with 2nd drench of BM (1%) was found most effective in suppression of Phytophthora rot.

At Islampur, amongst six treatments, treatment comprising of sanitation, 2 drenching of BM 1% and one soil application of *T. viride* (5 kg ha^{-1}) proved effective in reducing *Phytopthora* foot rot incidence to 8.5% as against 28.50% in control and increased betel vine leaf yield of 34.50 lakh ha^{-1} as against 21.50 lakh ha^{-1} in control.

At Sirugamani field sanitation ccompanied by soil drench of Bordeaux mixture (1%) at pre-monsoon period followed by soil application of biological agent (*Trichoderma viride*) after 30 days of drenching and second drenching of Bordeaux mixture (1%) after 60 days of first drenching were found to be superior to other treatments in respect of suppression of *Phytophthora* foot rot /wilt incidence of betelvine. The maximum CB ratio of 1:2.51 was obtained where field sanitation + one soil drenching of Bordeaux mixture (1%) at pre monsoon + Soil application of *T. viride* after 30 days + second drench of Bordeaux mixture (1%) after 60 days of first drenching were applied.

Standardization of inoculums for mass multiplication of Trichoderma

The results indicated that 60 gms of unit inocula produced more number of spores and

colony forming units (cfu) on 10 kg oil cake at Bapatla.

At Jabalpur, cheapest and fast mass multiplication of *Trichoderma viride* was recorded in maize, jawar and wheat grains. In these cereals maximum growth/coverage of grains by *Trichoderma viride* was recorded after 15 to 21 days of incubation. Fifty and sixty grams of inoculums were found to be best in producing highest spore concentration and colony farming units when 10 kg of inoculated mustard oil cake was incubated for 60 days.

At Sirugamani, 80 and 90 g inoculums were found to be optimum for obtaining higher spore production through sorghum grains and oil cake.

Rhizosphere competence and survival period of *Trichoderma harzianum*

It was found that initial population of the *Trichoderma* was very low through out the year in betelvine gardens at Jorhat. The population density of *Trichoderma* was increased significantly after application of *Trichoderma* sp. having 10^7cfu. The population density was increased significantly after twenty days of application of *Trichoderma harzianum*. After 40 days of application of *Trichoderma harzianum* the population density was declined steadily in all the treatments and it was least after 80 days of application, however the reduction was low and gradual in the July and April application.

At Bapatla, there was significant increase in *Trichoderma* population of rhizosphere soil unto 40 days after addition of talc formulation of *Trichoderma viride*, after 60 days the population started declining.

At Kalyani, it was found that biocontrol agent *Trichoderma* sp should be applied in soil at 80 days intervals to obtain the optimum efficacy to control the major fungal diseases of betelvine.

The population of *Trichoderma* sp. in the rhizosphere region increased with increasing days after application from 20 to 80 days at Sirugamani. At 0 days of application, Trichoderma population in the range of 6.70 cfu g^{-1} was observed. The maximum population of 83.70 x 10^3 cfu g^{-1} was recorded at 80 days after application.

Demonstration of disease management technology in the farmer's field

Jorhat centre conducted demonstration of disease management technology developed by the centre in the farmer's fields. In all the sites of farmers practice the incidence of Basal rot (*Sclerotium rolfsii*, 12.1%) was more at Ambagan, Nagaon District. The leaf spot complex (*Colletotrichum* and *Xanthomonas*, 10.3%) and leaf rot (*Phytophthora*, 7.5%) were recorded in the farmers' field while all the diseases showed significant reduction under improved techniques over the farmer's practices. Yield, fresh weight and net return also produced significantly higher result in the improved technique. A net return of Rs. 4.38 lakh ha^{-1} were earned in improvved technique in comparison to Rs.2.71 lakh ha^{-1} in the farmers' practice.

Disease management technologies developed in Jorhat centre were compared with the farmer's practice in Borhola, Jorhat district. Higher mean incidence of leaf spot complex (*Colletotrichum* and *Xanthomonas*, 17.8%) and leaf rot (*Phytophthora*, 9.0%) and basal rot (11.2%) were observed in the farmers' field. Significant reduction of all the diseases was recorded in the improved technologies over the farmers' practices. Yield, fresh weight and net return also produced significantly higher

result in the improved technique. A net return of Rs. 6.21 lakh ha^{-1} were earned in improved technique in comparison to Rs.5.07 lakh ha^{-1} in the farmers' practice.

At Lengeri, Sibsagar District, occurrence of leaf spot complex (*Colletotrichum* and *Xanthomonas*, 11.3%), leaf rot (*Phytophthora*,9.0%) and basal rot (8.4%) were higher in the farmers practice. The reduction of all the diseases was highly significant in improved techniques over the farmer's practice. On an average of Rs. 3.31 lakh ha^{-1} of net return were earned in improved technique over the farmers' practices of Rs. 2.32 lakh ha^{-1}.

At Bapatla centre, the data on the percent disease incidence, percent disease index, leaf yield and fresh weight of 100 leaves was recorded. The experimental results revealed that there was significant difference between the technology developed by the centre and farmer's practice with respect to percent disease incidence, percent disease index and leaf yield by the end of 2nd year.

Demonstration of disease management technology developed by the centre in the farmer's field was conducted in six farmers' field at Simurali, Nadia by Kalyani centre. The technology consisted of field sanitation & the application of Bordeaux mixture at pre monsoon + after one month biocontrol agent + one application of Bordeaux mixture 2 month after first Bordeaux mixture application. The farmers' disease management practices were application of B mixture as and when required specially at the initiation of diseases. The results revealed that disease incidence and yield parameters recorded were statistically superior to the farmers' management practices at 1% level of significance

Field demonstration trials were conducted in ten locations of different farmer's field by the Jabalpur centre. It was observed that technologies generated by the center found significantly superior to farmer's practice.

Two demonstrations each were made in village Anlo of Niali Block and Village Dagara of Baliapal Block with 'Godi bangla' and 'Bali pan' respectively as test varieties by the Bhubaneswar centre. One demonstration was taken up at village Raipur in Barang Block. It was found that adoption of technology developed at the centre gave superior results over farmer practice in controlling the disease there by giving an increased yield.

Similarly, the results of field demonstrations of disease management at 3 different places by Sirugamani centre showed superiority of improved technologies over the farmer's practices.

Crop loss assessment due to insect pests and mites

a) Tobacco caterpillar

To assess the cumulative loss in leaf yield by the tobacco caterpillar, a trial was undertaken at Bapatla. The results showed that plots protected against tobacco caterpillar with neem oil 0.5% spray significantly lower mean leaf damage of 4.37% where the unprotected plots recorded 18.73%. The cumulative number of leaves harvested ha^{-1} during the period of pest infestation was 5.24 and 4.30 lakh in protected and check plots respectively. The percent loss in leaf yield was estimated to be 18.01% net monetary gain of Rs.4299/- ha^{-1} with a cost benefit ratio of 1: 3.12 was recorded by controlling the pest.

b) Mites

To assess loss due to mites spraying of wettable sulphur 0.3% two times at fortnight interval during December was done at Bapatla. The protected plots had lower mite damage with a mean mite incidence of 4.49 as against 14.02 in untreated plots. A total loss of 21.32% in leaf yield was recorded with a net monetary gain of Rs. 6025/- ha^{-1} and a cost benefit ratio of 1: 5.02 by keeping the pest under check.

At Sirugamani centre, the plots protected with wettable sulphur 0.15% spray significantly number of mites leaf^{-1} ranging from 0.00 – 0.13 with a mean of 0.06 as against 0.13 to 2.44 with a mean of 0.82 in unprotected plots. Monetary loss due to red spider mite damage in treated area ha^{-1} was Rs. 10,450/- and monetary loss due to red spider mite damage in untreated area ha^{-1} was Rs.42,800/-. Approximately 40% on an average loss of marketable leaves was due to red spider mite in untreated plots and 14.54% loss of marketable leaves due to red spider mite in treated plot and the cost benefit ratio was 1:13.94.

d) Scale insect

At Sirugamani, the results revealed that the plots protected with Chlorpyriphos 0.04% spray recorded the least number of linear scale insect leaf^{-1} ranging from 0.01-0.04 with a mean of 0.03 as against 0.26-1.20 with a mean of 0.85 in untreated plots from April to August.

e) Black fly and white fly

A study was taken up for assessment of crop loss due to the attack of aleyrodid fly complex (white fly and black fly) on betelvine variety Simurali Deshi (Bangla) at Kalyani. Assessment of crop loss due to the attack of aleyrodid fly complex (white fly and black fly) on betelvine variety Simurali Deshi revealed that there was a reduction in direct leaf yield to the tune of 10.52% for a mean population of 31.70 flies vine-1. Overall monetary loss was 36.84% for five month period.

Screening of betelvine cultivars against whitefly

At Kalyani, the results showed that there were great differences among the entries for whitefly infestation level. Twenty three betelvine cultivars were screened in field condition against whitefly. Kalipatti and Simurali Sanchi and Halisahar Sanchi were moderately resistance; Harishpur Bangla, Bilhari, Godi Bangla and Kadwa showed moderately susceptible. Rest 16 cultivars were highly susceptible.

Population fluctuation of different mite species in betelvine garden

The mite spp. of nine groups has been recognized from recent observations on betelvine at Kalyani. Among the species observed only destructive nature of Brevipalpus phoenicis has been observed. The characteristic symptoms of this mite on betelvine were blackish lesions at the ventral surface especially near the margins of the leaf. Gradually the blacken spots spread al over the leaf that eventually enhanced maturity and drying of the leaf. The matured leaves were severely infected than the younger leaves. The phytophagous mite, Brevipalpus phoenicis was observed to persist in the baraj condition through out the year maintaining varying population level. Higher population was recorded in the month of March-June period and in October. The highest population was observed during May in both the young and

mature leaves. The small reddish, dorso-ventrally flat mite was found to feed at the ventral surface of leaves producing characteristic patches on the feeding site that reduces growth and vigour of the plant as well as reduces market price of the leaves.

Management of mites

At Bapatla, the plots treated with Abamectin 0.3 ml l^{-1} recorded minimum damaged leaves (5.25%) followed by wettable sulphur 0.3% + Neem oil 0.5% (6.16%), Dicofol 5 ml l^{-1} (6.65%) and wettable sulphur 0.3% + NSKE 5% (7.06%) where as untreated plots recorded 21.33% damaged leaves. Higher leaf yield of 7762.5 bundles ha^{-1} was recorded when Abamectin 0.3 ml l^{-1} was sprayed with an extent of 47.93% increase in leaf yield over check.

The trial was conducted with SGM-1 variety at Sirugamani centre. The population of red spider mite was counted at peak incidence on three leaves viz., lower, middle and upper leaves in 10 randomly selected vines for each replication and the treatments were imposed. Wettable sulphur + NSKE 5% recorded maximum reduction of red spider mite (83.50%). The combination of wettable sulphur 0.15% + azadirachtin 0.03% was found to be best treatment for effective management of mites and thereby reducing number of damaged leaves (4.82 lakh ha-1). Based on CB ratio the conventional miticide viz., wettable shlphur was found to be highly effective for the management of mites in betelvine.

Screening for pest resistance

a) Tobacco caterpillar

At Bapatla centre, pungent varieties recorded lower incidence of tobacco caterpillar with 3.71 to 31.47% damaged leaves as against 6.59 to 37.77% damaged leaves in non-pungent varieties. Among pungent varieties, Kalipathi (Maharashtra) (31.47%), Nov Bangla (Orissa) (23.72%) and Black leaf (A. P.) (22.10%) recorded above 20% of damaged leaves. Among non-pungent varieties Kapoori (Vuyyuru) (A. P.) (6.59%) and Patchaikodi (T. N.) (11.24%) recorded lesser percentage of damaged leaves.

b) Mites

Mite incidence ranged from 18.51% to 53.33% and 30.95% to 67.79% in pungent and non-pungent cultivars respectively at Bapatla centre. Among pungent germplasm, lower mite incidence was recorded in Ramtek Bangla (Maharashtra) (18.51%) and Awamipan (W. B.) (19.17%). Similarly in non-pungent germplasm, Meethapan (12.90%) and Gangeri (A. P.) (22.03%) recorded lower infestation due to mites.

Non preference to host found to play key mechanism towards infestation by pests viz., linear scale insect and red spider mite. Phenolic compound methyleugenol found to influence the dynamics of red spider mite in kapoori and SGM BV2.

Management of insect pests of live standards

a) Leaf eating caterpillars

At Bapatla, mean incidence revealed the significant superiority of all treatments tested over check in reducing the incidence of leaf eating caterpillars. Minimum larval population

and percent plant damage was recorded in the plots treated with chlorpyriphos 0.05% which was followed by monocrotophos 0.05% spray. Among the safer insecticides NSKE 5% spray + NSKE 5% soil drenching recorded 7.66, followed by neem oil 0.5% spray + neem oil 2% soil drenching (7.91) and cartap hydrochloride 0.1% (8.16). All are at par with each other and found to be better in reducing the incidence of leaf eating caterpillars against 13.08 larvae in untreated check. Similarly minimum percent of damaged plants were observed in plots treated with cartap hydrochloride @ 0.1% (35.36%) followed by NSKE 5% + NSKE 5% soil drenching (37.46%) and Neem oil 0.5% spray + Neem oil 2% soil drenching (39.53%).

b) Stem borer

Chlorpyriphos 0.05% proved to be effective with lowest percent of infested plants (7.37%) followed by monocrotophos (0.05%) (7.86%) at Bapatla center. Among safer insecticides cartap hydrochloride @ 0.1% spray recorded significantly lower incidence of stem borer (11.35) which was followed by neem oil 0.5% spray + neem oil 2% soil drenching and NSKE 5% spray + NSKE 5% soil drenching. All the three treatments were on par with each other. Reduction in pest damage over check to an extent of 43.67% was recorded in the plots treated with cartap hydrochloride where as the plots treated with chlorpyriphos 0.05% and monocrotophos (0.05%) recorded 63.42% and 60.99%.

At Sirugamani, neem seed kernel extract 5% spray thrice at monthly interval was found to suppress the steem weevil *Alcidodus bubo* followed by *Beauveria bassiana* 5 g (1.8 x 106 spores per spray) twice at 15 days interval.

Fixing ETL for linear scale insect

There were significant differences in number of scales vine^{-1} with respect to various treatments. Maximum population vine^{-1} occurred to vines infested with 10 linear scales vine^{-1} followed 7, 5, 3 & 1 linear scales vine-1. In the control plots, where betelvine was protected by spraying chlorpyriphos 0.04% recorded only 2% damage was observed and the leaf yield was highest (62.67 leaves vine^{-1}). The mean leaf yield (61.33 and 60.00 leaves vine^{-1}) in plants released with initial load of 1,3 & 5 scales respectively vine^{-1} was at par with control indicating that betelvine could tolerate low levels of linear scale population without adversely affecting yield. The leaf yield recorded from vine released with 5 linear scales were drastically lower and on par with 1 & 3 released scales. The leaf yield recorded from vines released with 7 & 10 scales were significantly lower than 5 scales vine^{-1}. The results of the present study indicate that L. cornutus was an important pest of betelvine which cause significant yield loss when the population of scales is above 5 scales vine^{-1} (0.25 scales leaf^{-1}). At higher population, the marketable yield loss is substantial. It was evident from the study that the betelvine could tolerate infestation of L. cornutus of the attack is upto 5 scales 2m^{-1} vine (0.25 scales leaf^{-1}) without affecting yield where the age of the crop is one and half year after lowering.

Management of insect on Sesbania (live support for betelvine)

At ANGRAU centre, mean data on leaf damage indicated a minimum leaf damage of 8.18% was recorded in plots treated with chlorpyriphos 0.05% followed by cartap hydrochloride with 9.78% other effective treatments were Nomuraea rileyi @ 5 g l-1, NSKE 5% and neem oil 0.5%. An increased leaf yield of 23.83% over check was recorded by controlling the pest with cartap hyclorochloride 0.1% during pest infestation.

GENERAL INFORMATION

COMMETTEE MEETINGS

Research Advisory Committee

Research Advisory Committee meeting of NRCMAP was held on 5th April, 2006. The meeting was presided over by Prof. K. V. Peter, Vice Chancellor, Kerala Agricultural University, Thrissur. The meeting started with the welcome address by Dr. (Mrs.) S. Samantaray, Sr. Scientist (Biotechnology), NRCMAP and Member Secretary of RAC. Dr. Peter appreciated the work done in the institute during last one year period. Dr. Sushil Kumar, Ex-Director, CIMAP, Lucknow advised that the Centre should focus on development of package of practices and elite planting material of selected MAPs. Dr. O. P. Srivastava, Ex-Director, Institute of Agricultural Sciences, BHU, Varanasi highlighted the need for balanced nutrition of MAPs. Dr. Satyabrata Maiti, Director, NRCMAP made an elegant presentation on the research work done since February 2005. The Chairman and members appreciated the presentation and deliberated upon the presentation which led to some useful recommendations for further progress of the Centre.

Patchouli farmers' meeting and training

Training workshop was conducted at NRCMAP on 7th April 2006 for interested farmers on patchouli cultivation. During the training, farmers interacted with Dr. A.P. Singh (Member Sec., State Medicinal Plants Board), Mr. B.S. Sajwan (CEO, National Medicinal Plants Board) and Dr. S. Maiti (Director, NRCMAP) and got clarified their doubts regarding the funding and government support for the patchouli cultivation. A field visit was also organized for patchouli farmer's field for imparting hands on training for growing patchouli under Gujarat conditions.

Review meeting of DBT sponsored patchouli project

The monitoring committee meeting of DBT-sponsored project on "Biotechnological approaches for production and cultivation of patchouli" was held on 13th April 2006 at NRCMAP. Dr. Satyabrata Maiti, Director, NRCMAP presided over the meeting. Dr. Mohd. Aslam, Principal Scientific Officer, DBT, New Delhi, Dr M.R. Heble, Principal Scientific Advisor, KET, Dr. Anupama Wagle, Principal investigator, KET along with members of different participating centre including Dr.B.B.Jadav (KKV), Mr. C.K.Venugopal (UAS, Dharwad), Dr.Ravi Bhat (CPCRI, Kasargode) and Mr. Saravanan Raju (NRCMAP) attended the meeting. The research works undertaken at various centres and the progress report was presented in the meeting. The research results were critically discussed along with future plan of action for different centres in the meeting. A field trip was also arranged for the participants to a patchouli farm at Adas village.

AINRPMAP group meeting

Sixteenth group meeting of the All India Networking Research Project on Medicinal and Aromatic Plants was held at Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola during 30th October – 2nd November, 2006. Dr. S. V. Sarode, Director of Research, PDKV, Akola in his welcome address in the inaugural function highlighted the contribution made

by the University in popularizing medicinal and aromatic plants cultivation in the state by helping the farmers to take its cultivation as an alternative crop. Dr. S. Maiti, Project Coordinator presented the salient achievements made by the various coordinating centres during last two years. Dr. K. V. Ramana, Assistant Director General (Horticulture II), ICAR highlighted the prospect of the project in the ICAR considering the future of these crops. He emphasized that number of crops be increased considering demand of large number of species. Dr. Gautam Kalloo, DDG (Hort. & CS), in his inaugural address suggested that a total shift is required in the Project focusing rural sector. He advised that every care has to be taken towards differentiating between evaluation and characterization leading to conservation and finally in developing a variety. He suggested to select four or five most important medicinal plants and to make a research chain for varietal development. Further, he emphasized on molecular characterization of medicinal plants. Also he reiterated that phyto-chemicals that were effective against the common ailments like rabbies, snake bites, stone formation in kidney, dog bites, scorpion bites, blood pressure, etc may be identified. Dr. Sharadraoji Nimbelkar, Vice Chancellor, PDKV, Akola in his Chairman's address, appraised the achievements made by the University. He confirmed that no stone would be left unturned for further improvement of the quality of research in MAPs. The researchers from different centers took part in the deliberations for three days. Salient outcome, recommendations and future research programmes were presented in the plenary session. The function came to an end with the vote of thanks proposed by Dr. S. Maiti.

Group meeting of AINRP on Betelvine

The 21st Group meeting of the AINRP on Betelvine was held at Assam Agricultural University, Jorhat. In the inaugural session, Dr. A. K. Pathak, Director of Research, AAU, welcomed the delegates and thanked the ICAR authority for choosing AAU for this group meeting. In his address he gave a brief description of the prospects and opportunities of Betelvine cultivation. Dr. K. V. Ramana, ADG (Hort. II), ICAR presented prospect of the project at length and reaffirmed the cooperation of ICAR for making such an old network more result oriented and also assured that in the event of AINRP on Betelvine getting merged with the AINRP on Medicinal & Aromatic Plants, ICAR would strengthen the already existing set up. Dr. Satyabrata Maiti, Project Co-ordiantor, AINRP on Betelvine presented salient achievements made by the various coordinating centers during 2004-06. Dr. S. S. Baghel, Vice Chancellor, AAU, Jorhat delivered the inaugural address. He was overwhelmed by the success of this 25 years old project and expressed his surprise of the achievements made by the project. He informed that it was a rarest opportunity for him to get an exposure of such a wonderful crop. He expressed that betelvine could play wonder in upliftment of our social as well as economical status. The inaugural session ended with the vote of thanks proposed by Prof. P. K. Dutta, Head, AINRP on Betelvine, AAU, Jorhat.

Research review and Staff Research Council meeting

The 13th Staff Research Council (SRC) meeting of the institute was held between 29th June to 5th July, 2006 and the 14th SRC meeting was conducted on 15th December, 2006 under the chairmanship of Dr. Satyabrata Maiti, Director, NRCMAP. Member Secretary, Dr. Manish Das, earlier presented the action taken report and appraised the development of every meeting. Individual scientist particularly Principal Investigators presented their progress

reports, results and work done in their respective projects in SRCs. Also a few new project proposals were presented and discussed thoroughly. Several modifications were suggested and finally incorporated in the proposals. New projects were finally modified and approved in SRC Dr. Maiti urged that technical part of the experiment should be taken very seriously and activity milestones should be followed for every experiment mentioned in the project.

OTHER ACTIVITIES

Annual day celebrated

Annual Day was observed on 29th November 2006. A humble function was organized by the staff welfare club (SWC) of NRCMAP to commemorate this occasion. The staff members along with their family observed the day with great fanfare. During the inaugural ceremony. Dr. R.N. Pal former DDG (Hort.), ICAR was felicitated by a momento by the Director, Dr. S. Maiti. In the inaugural address Dr. R.N. Pal recalled the long association with this growing institute and expressed his satisfaction for all the contributions made by the institute in the field of medicinal and aromatic plants research. 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 SWC.

Hindi week celebrated

In its endeavor to enhance the use of Hindi in day to day official work. NRCMAP organized Hindi Week from 11 to 16 September, 2006.

On 16th September, 2006 during closing ceremony, Sh. V. K. Malik, Principal, Kendrya Vidyalaya, Vallabh Vidhyanagar, 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. At the outset, Sh. V. S. Parmar, Asstt. Admi. Officer welcomed the Chief Guests and the distinguished audience and presented a brief introduction of Chief Guest to the house. Different competitions of poem recitation and debate were organized, which were evaluated by chief guest himself.

Sh. Malik in his speech pointed about the extent of people from north to south usually made their expression in Hindi. He also laid emphasis on, how the Hindi words are correlated with Sanskrit and English. Dr. Maiti in his presidential address informed the house about the origin and development of Hindi language. He opined that for the development of any country it is mandatory that it respect other languages also. He reiterated that the development and dissemination of Hindi is a must so that common people accept us. The celebration ended with vote of thanks proposed by Dr. O. P. Aishwath, Member Secretary, OLIC.

Vigilance awareness week observed

The NRCMAP observed vigilance awareness week from 31st October to 6th November 2006 by keeping records open for verification to bring transparency which would root out the corruption to a greater extent. On 7th November one day workshop was organised at

NRCMAP to create awareness about vigilance among all staffs which was presided over by Dr. Satyabrata Maiti, Director and all staff members attended the workshop. The workshop started with the pledge administered to all the officials and staffs, which was followed by a brief introduction on the objectives of establishing CVC by Dr. (Mrs.) Sanghamitra Samantaray, Senior Scientist. Mr. V.S. Parmar, Assistant Administrative Officer delivered a talk on purchase procedure and the purpose of establishing CVC and Mr. T.A. Vishwanath, Assistant Finance and Accounts Officer highlighted the power and function of CVC. At the end, Dr. S. Maiti in his presidential address narrated the main cause of corruption in the office and the society. He told that level of corruption was reduced day by day by citing the example of booking the railway tickets through internet. He emphasized that materialistic mind makes the people to become more corrupt for which the moral and ethical values of the people are being deteriorated in the society. Finally, he requested all the staff members to help combat corruption from all corners of the society.

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 used to be 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 a transparent approach for the various activities undertaken by it. While maintaining transparency, the NRC geared itself for undertaking responsiveness to the Right to Information Act, 2005 of Govt. of India. The institute has already developed its website as www.nrc-map.org which was redesigned and updated in regular intervals. The budget expenditure details have also been posted on daily basis. The information for Right to Information Act and reports has been appended to the institute website. Besides the institute has tried to satisfactorily respond to the various letters received seeking information under the Right to Information Act within the stipulated time frame.

Our New Colleagues

Mr. Naresh Ganatra, Sr. Clerk joined on 17.4.2006

Dr. P. Manivel, Principal Scientist (Plant Breeding) joined on 24.3.07

Promotion

Dr. K. Mandal joined as Sr. Scientist (Plant Pathology) through selection w. e. f. 6.3.07

Dr. Geetha K. A. joined as Sr. Scientist (Plant Breeding) through selection w. e. f. 28.3.07

Transfer

Dr. P. P. Joshi, Principal Scientist transferred to CIFE, Mumbai on 29.5.2006

Mr. Shyamji Shukla, Sr. Clerk transferred to NBAIM, Mau Nath Bhanjan, on 24.4.2006

Dr. Deepa Bhagat, Scientist SS (Organic Chemistry) transferred to Project Directorate of Biological Control, Bangalore on 27.3.07.

Sports

NRCMAP participated in ICAR Zonal Tournament (Western zone) met held at Central Arid Zone Research Institute, Jodhpur from 20-24th February, 2007.

Library

During the year the library information system was kept up to date by continuing the subscription of several National and International Journals and procuring of different books and magazines. The library serves and fulfills 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.

PUBLICATIONS
Research papers (Medical and Aromatic Plants)

NRCMAP, Anand

Geetha, K.A., Josphin and S. Maiti. 2007. Gender instability in Tinospora cordifolia – an immunomodulator. Current Science 92:591-592.

Maiti, S., and K. A. Geetha. 2006. Herbs, spices and cancer. In Handbook of Herbs and Spices. Ed. By K. V. Peter Volume 3: Woodhead Publishing Limited, U.K.

Maiti, S. 2006. Guide on medicinal and Aromatic Plants of SAARC countries: India Chapter. SAARC Agricultural Information Center, Dhaka, Bangladesh pp. 727.

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 (1): 921-926.

PDKV, Akola

Wankhade, S.G., M.R. Kale, P.P. Khode, S. A. Agashe and S.A. Bhuyar. 2006. Studies on control of chlorosis in Safed Musli (*Chlorophytum borivilianum*). PKV Res. J. 30 (2): 154-157.

Wankhade, S.G., M.R. Kale, S.A. Agashe, P.P. Khode. 2006. Post harvest deterioration of Andrographolide content in herb powder of Kalmegh (*Andrographis paniculata*). PKV Res, J. 30 (2): 162-164.

NDUAT, Faizabad

Vishwakarma, S., D. Ram, Vishwanath and R. Singh. 2006. Effect of planting time, method and spacing on plant growth and root yield of Safed Musli (*Chlorobhytum borivilianum* Sunts Fer.), Journal of Recent Advance in Applied Science Vol. 21 (1&2): pp. 37-40.

AAU, Anand

Upadhyay, N.V., K.V. Patel, S.J. Macwan, D.H. Patel and S. Sriram. 2006. Effect of MH-30 and cycocel on growth and dry root yield of Aswagandha. Asian Journal of Horticulture. 2 (1): 121 -123.

Presentations in Conferences/Symposia/Seminars/other forum

AAU, Anand

Sriram S., A.A. Deore and M.A. Patel. 2006. Identification of potential accessions of *Aloe vera* for cultivation under central Gujarat condition. Second World Ayurved Congress, Pune. November 10-12, 2006.

Sriram S., N.H. Punjani. 2006. The dilemma of medicinal plants cultivation. Second World Ayurved Congress, Pune. November 10-12, 2006.

NDUAT, Faizabad

Ojha, C.M., O.P. Singh, and R.J. Gupta. 2006. Performance of spacing and nitrogen doses on vegetative growth and grain yield of Isabgole (*Plantago ovata*). Proceeding of 'National Conference on New Vistas in Microbiology and Plant Sciences', Gurukul Kangri University, Hardwar, September 19-20, 2006. pp. 30-30.

Ojha, C.M., O.P. Singh and T.P. Singh. 2006. Ethobotanical studies on some medicinal herbs commonly used by the local people of Vindhyan hills of U.P. Proceeding of 'National Conference on New Vistas in Microbiology and Plant Sciences', Gurukul Kangri University, Hardwar, September 19-20, 2006. pp. 30-31.

Singh O.P. and S.K. Singh. 2006. Genetic divergence in germplasm of opium poppy (*Papaver somniferum* L.). Proceeding of 'National Conference on New Vistas in Microbiology and Plant Sciences', Gurukul Kangri University, Hardwar, September 19-20, 2006. pp. 31.

Vishwakarma, S., D. Ram, J. Prasad and Vishwanath. 2006. Effect of optimum plant spacing under different planting system on root growth and yield of Safed Musli (*Chlorobhytum borivilianum* Sunts Fer.). Abstracts of National Seminar on Management of Medicinal and Aromatic Plants in Farming systems perspective held on Directorate of Extension C.S. Azad University of Agri. & Tech., Kanpur on March 20-22, 207.

Kalimpong

Mukherjee, D. 2006. Value of medicinal plants in the context of hilly tracts of Darjeeling district. (In) Proc. of 5th Refreshers course in Agricultural Sciences. July 29, 2006 – August 18, 2006. B.H.U., Varanasi, pp 5-7.

Book chapter

CCSHAU, Hisar

Verma P.K., O.P. Yadav, Y. Kumar, J.S. Hooda, Anil Kumar and R. Karwasra. 2006 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.

Research papers (Betelvine)

OUAT, Bhubaneswar

Acharya, B., S.K. Mishra, A. Acharya and K.B. Mahapatra. 2005. Biological control of *Corynespora cassicola* (Berk, Curt.) causing leaf spot disease in betelvine (*Piper betel* L.). The Orissa Journal of Horticulture 33 (1): 102-103).

MPKV, Sangli

Pawar V.P., M.S. Shirke, S.G. Magdum and B.M. Kamble. 2006. Response of betwlvine (*Piper betel* L.) to different planting densities and spacing. Indian Journal of Arecanut, Spices & Medicinal plants 8 (1): 10-12.

Pawar V.P., M.S. Shirke, S.G. Magdum and B.R. Majan. 2006. Effect of sources of nitrogen on growth, yield and shelf life of betelvine 2006 J. Maharashtra agric. Univ. 31(2): 144-145.

HUMAN RESOURCE DEVELOPMENT

Education & Training

Name	Course	Date
Dr. Manish Das, Sr. Scientist Plant Physiology	Leadership and Personality Development at NAARM, Hyderabad.	14-20 June, 2006
Dr. (Mrs.) Sanghamitra Samantaray, Sr. Scientist	Leadership and Personality Development at NAARM, Hyderabad.	14-20 June, 2006
Dr. O.P. Aishwath, Scientist (Sr. Scale) Soil Science	Summer School on Advances in Agriculture Research Project Management at NAARM, Hyderabad.	1-21 June, 2006

Name	Course	Date
Mr. N.S. Rao, Scientist (Sr. Scale) Computer Application & Public Information Officer	National Workshop on "The right to Information Act, 2005 (RTI)" at Mumbai.	23-24 June, 2006
Mr. Raghunadhan K., Asstt. Public Information Officer	National Workshop on "The right to Information Act, 2005 (RYI)" at Mumbai.	23-24 June, 2006
Mr. Suresh Patelia, PA to the Director	Training on Information Bank Software at NBPGR, New Delhi.	12 June, 2006
Dr. Manish Das, Sr. Scientist (Plant Physiology)	Training on DUS testing of Essentially derived and special purpose varieties at IARI, New Delhi.	5th – 14th September, 2006
	Training on Basic seed standards at IARI, New Delhi.	14th – 16th September, 2006
Dr. O.P. Aishwath, Scientist (Sr. Scale) (Soil Sciences)	National Seminar on Development of soil science – 2006 & 71st Annual Convention of ISSS.	10th – 13th November, 2006
Dr. Gutam Sridhar, Scientist (Plant Physiology)	International Seminar on Intellectual Property Education and research at NALSAR University of `Law, Hyderabad.	16th – 17th November, 2006
Mr. N.S. Rao, Scientist (Sr. Scale) (Computer Application)	Workshop on Right to Information Act at ISTM, New Delhi.	4th – 8th December, 2006
Dr. K. Mandal, Scientist (Sr. Scale) (Plant Pathology)	Winter School on Molecular detection of seed borne disease and seed health status as global perspective at AAU, Anand.	12th December 2006 to 1st January, 2007
Ms. K. A. Geetha, Scientist (Sr. Scale) (Plant Breeding)	GIS based decision support system for sustainable agriculture, at NAARM, Hyderabad	1-21 March, 2007

Director's Visits in Meetings/Seminars

- Details of Training/Refresher Course/Summer/Winter Institutes/Seminars Conferences/ Symposia/Workshops attended by Dr. Satyabrata Maiti, Director, NRCMAP within India and on deputation abroad
- To attend Reality check Workshop of Measures of Impact of Science and Technology in India: Agriculture and Rural Development at AAU, Anand on 16.5.2006.
- To attend a Training Workshop on Value Chains at TNAU, Coimbatore on 5-9 June, 2006.
- To make a presentation before the National Medicinal Plants Board on Good Agricultural Practices of Medicinal Plants at New Delhi on 20.6.2006
- To participate in the meeting of the Seed Production in Agricultural Crops and Fisheries held at NASC Complex, New Delhi on 27-28 June, 2006.
- To make a presentation in the Seminar on Study on Technology status on Isabgol based industry at Jakaranda Hall, India Habitat Centre, New Delhi on 30.6.2007.
- To review their two research project on medicinal plants as requested by the Biotechnology Unit of Andhra Pradesh Netherlands Biotechnology Programme, Hyderabad on 6-7 July, 2006.
- To participate in the Brainstorming meeting on "Bio-technology options for natural resource management and improving livelihood of the SC/ST populations" at Jaypore, Orissa on July 24-26, 2006.
- To chair the Session "Pesticide Use Efficiency" in the National Symposium on Improving Input Use Efficiency in Horticulture held at Bangalore during 10-11 August, 2006.
- To attend meeting of the Sub Group-I : Medicinal Plants of the Steering Committee on AYUSH for the 11th Five Year Plan at NMPB, New Delhi on 18.8.2006.
- Participated in the DUS testing programme for Medicinal, Aromatic and Seed Spice plants held at CIMAP, Lucknow during 21-22 August, 2006.
- To attend meeting of the Subgroup on Ornamental, Medicinal & Aromatic crops to formulate the XI Plan proposals at IARI, New Delhi on 6.9.2006.
- To attend the medicinal plants workshop (IPGRI) at IPGRI, Kuala Lumpur during 16-17, October 2006.
- To attend Interactive Workshop on Planting Material and Rejuvenation of Horticulture Crops on 23.10.2006 at NASC, New Delhi
- To attend a meeting for discussion regarding thrust areas for research and development on medicinal plants held at NMPB, New Delhi on 28.12.2006.
- To attend review meeting of Seed project at NASC Complex, New Delhi on 1-2 March, 2007.

DISTINGUISHED VISITORS

- Dr. K. V. Peter, VC, KAU and Chairman, RAC on 5.4.2006
- Dr. Sushil Kumar, Ex-Director, CIMAP, Lucknow & Member, RAC on 5.4.2006
- Prof. O. P. Srivastava, Director, IAS, BHU & Member, RAC on 5.4.2006
- Mr. A. V. Guram, Asst. General Manager, NABARD, Nadiad on 7.4.2006
- Mr. B. S. Sajwan,IFS, CEO, NMPB, New Delhi on 7.4.2006
- Dr. A. P. Singh, Member Secretary, SMPB, Gandhinagar on 7.4.2006
- Dr. D. J. Patel, Ex.Principal, BACA, AAU, Anand on 7.4.2006
- Dr. Anupama Wagle, PI, The Kelkar Education Trusts, Mumbai on 13.4.2006
- Dr. Mohd. Aslam, Principal Scientific Officer, Department of Biotechnology, Govt. of India, New Delhi on 13.4.2006
- Dr. S. Sriram, Head, AINRP on MAP, AAU, Anand on 4.5.2006
- Officers from National Horticultural Mission, GOI, New Delhi on 10.6.2006
- Prof. P. Das, Project Director, MSSRF, Jeypore on 17.6.2006
- Prof. L. K. Vaswani, Director, IRMA, Anand on 22.6.2006
- Dr. Mohammed Hassan Al-Masry, Deputy Director of Horticulture Research Institute, Agricultural Research Centre (ARC) for Extension & Training, Cairo, Egypt during 14th – 30th September, 2006.
- Dr. V. V. Sadamate, Advisor (Agriculture), Planning Commission, Government of India, New Delhi on 7.10.2006
- Dr. Ashok A. Patel, Director of Extension Education, AAU, Anand on 7.10.2006
- Dr. Adriana R. Alercia, Germplasm Information Specialist, IPGRI, Rome, Italy on 12.10.2006
- Dr. R. N. Pal, Ex-DDG(Hort.), ICAR on 29.11.2006
- Dr. S. D. Sharma, Director, IASRI, Pusa, New Delhi on 2.12.2006
- Dr. S. N. Saha, Ex. Joint Director, NAARM, Hyderabad on 2.12.2006
- Dr. D. J. Patel, Ex. Principal & Dean, BACA, AAU, Anand on 2.12.2006
- Dr. A. M. Shaikh, Principal & Dean, BACA, AAU, Anand on 2.12.2006
- Dr. P. H. Bhatt, Ex. Director of Research, GAU, Anand on 2.12.2006
- Dr. G. Kalloo, Former DDG (H), ICAR on 18.1.2007
- Dr. S. P. Ghosh, Ex-DDG (H), ICAR, New Delhi and Chairman, QRT, Betelvine on 23-25 February, 2007
- Dr. P. P. Reddy, Ex- Director, IIHR, Bangalore and Member, QRT, Betelvine on 23-25 February, 2007
- Dr. Mangala Rai, Secretary, DARE & DG, ICAR on 14.3.2007
- Dr. J. S. Samra, DDG (NRM), ICAR, on 14.3.2007
- Prof. M. C. Varshneya, Vice Chancellor, AAU, Anand on 14.3.2007
- Dr. S. Nagarajan, Chairperson, PPV&FRA, Govt. of India, New Delhi on 19.3.2007
- Dr. B. S. Yadav, Chairman, QRT, AICRP on Nematode on 24.3.2007

PERSONNEL

NRCMAP

Director

Dr. Satyabrata Maiti

Scientific

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

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

Dr. Manish Das, Senior Scientist (Plant Physiology)

Dr. Kunal Mandal, Senior Scientist (Plant Pathology)

Dr. (Ms.) K. A. Geetha, Senior Scientist (Genetics)

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

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

Mr. Srinivasa Rao, Scientist Sr. Scale (Computer Application)

Dr. Gutam Sridhar, Scientist (Plant Physiology)

Administrative

Mr. V. S. Parmar, Assistant Administrative Officer

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

Mr. Suresh Patelia, Personal Assistant

Mr. K. Raghunathan, Assistant

Mr. Shyamji Shukla, Sr. Clerk (upto 24.4.2006)

Mr. N.J. Ganatra, Sr. Clerk (from 17.4.2006)

Ms. R. M. Vasava, Sr. Clerk

Mr. S. U. Vyas, LDC

Mr. V.P. Rohit, LDC

Technical

Ms P. M. Purohit, T-5 (Technical Officer)

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

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

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

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

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

Ms. S. S. Nair, T-2 (Laboratory Technical)

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

Mr. H. A. Khatri, T-2 (Tractor 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

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

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Dr. V. K. Madan, Assoc. Prof. (Phytochemistry)

Dr. O. P. Yadav, Asstt. Prof. (Plant Breeding)

Dr. Anil Kumar, Asstt. Agronomist (Sr. Scale)

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Dr. R. M. Srivastava, Asstt. Prof. (Entomology)

Dr. Mukesh Karanwal, Asstt. Prof. (Plant Breeding)

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

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

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Shri. H. B. Kale, Assoc. Prof. (Agronomy)

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Dr. Dhiman Mukherjee, Asstt. Prof. (Plant Breeding)

Dr. Subhandu Jash, Asstt. Prof. (Plant Pathology)

YSPUH&F, Solan

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

Dr. Meenu Sood, Asstt. Prof. (Agronomy)

AINRP on Betelvine

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ANGRAU, Bapatla

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BCKV, Kalyani

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

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Dr. T. Vasantha Kumar, Principal Scientist (Plant Breeding)

Dr. (Mrs.) Himabindu, Scientist Sr. Scale (Plant Breeding)

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Dr. S. K. Sengupta, Scientist (Horticulture)

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Dr. V. P. Pawar, Asstt. Prof. (Horticulture)

OUAT, Bhubaneshwar

Dr. S. K. Mishra, Professor (Plant Pathology)

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

RAU, Islampur

Dr. R. K. P. Sinha, Assoc. Prof. (Plant Pathology)

RAU, Pusa

Dr. B. P. Yadav, Assoc. Prof. (Plant Pathology)

Dr. U. S. Singh, Asstt. Prof. (Nematology)

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

TNAU, Sirugamani

Dr. S. Md. Jalaluddin, Assoc. Prof. (Entomology)