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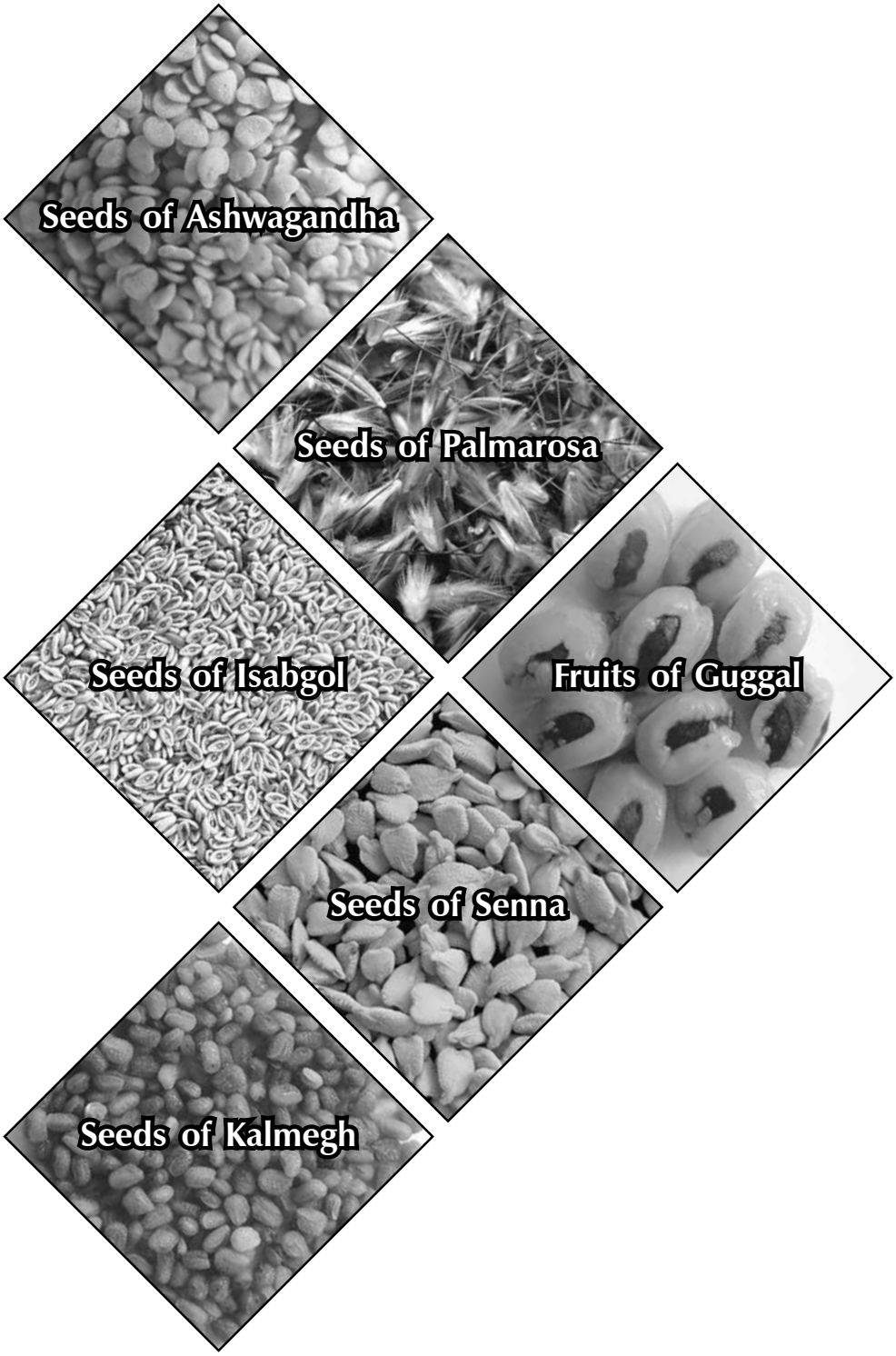
Annual Report 2008-09

भाकृअनुप
ICAR

Directorate of Medicinal and Aromatic Plants Research
Boriavi, Anand – 387 310, Gujarat, India

On the Cover:


Seeds of Ashwagandha
Seeds of Palmarosa
Seeds of Isabgol
Fruits of Guggal
Seeds of Senna
Seeds of Kalmegh

ANNUAL REPORT
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Directorate of Medicinal and Aromatic Plants Research,
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Directorate of Medicinal and Aromatic Plants Research

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CONTENTS

PREFACE

Complementary and alternative medicines (CAM) are gaining its place because of recent realisation that more than half of global population are surviving on some kind of alternative treatments in the absence of accessibility to modern medicines due to its high cost. Many medical institutions have begun integrating therapies that are not part of modern medicine into their treatment programmes. A number of medical schools are now having education curriculum on non-traditional techniques. Seeing that complementary and alternative therapies are proved effective, they are being integrated more often with modern conventional care. Basic philosophies of complementary and alternative medicine include: prevention is key to good health; your body has the ability to heal itself; learning and healing go hand in hand; holistic care.

CAM healing systems include: Ayurveda, Homeopathy, Naturopathy and Ancient medicines. These complementary and alternative medicine treatments include a large number of plant species and thereby demand of medicinal plants are growing worldwide. Sourcing of medicinal plants is generally either through collection from the forest and wild habitat or from cultivation. Research on cultivation being in the domain of ICAR, DMAPR was established to work on the requirement of the farmers for various aspects of cultivation of MAP.

Over a span of 16 years, DMAPR has slowly and steadily grown and is making its mark in the research arena of Medicinal and Aromatic Plants by its outstanding contributions such as registration of elite germplasm of Centella asiatica (INGR 08105) which is unique in terms of its morphology, high asiaticocide content and herbage yield; molecular characterisation and mode of endosperm development in guggal; sex determination of betelvine and guggal by RAPD markers; filing a process patent on aloin extraction and first report of Lema downesi *as pest of* Asparagus racemosus. *The DMAPR has also successfully launched a website www.herbalgardenindia.org, an unique effort for networking of herbal gardens through funding from NMPB. Two NAIP projects are persuaded as partner institute. In addition, it is also working as DUS testing centre of PPV&FR Authority and about to finalise the DUS descriptor for* Plantago ovata.

I am confident that good work initiated in the institute would continue with the support from our scientists, administrators and other functionaries who would make the ICAR feel proud of DMAPR.

I take this occasion to place on record my gratefulness to Dr. Mangala Rai, Secretary, DARE & Director General, ICAR and Dr. H. P. Singh, Deputy Director General (Horticulture) for their keen interest and generous support in the overall development of the institute and its activities. I am thankful to Dr. Umesh C. Srivastava, Assistant Director General (Hort. II) and Ms. Shashi Prabha Razdan, Deputy Secretary for their support at the headquarters in dealing the matters related to our institute. Thanks are also due to all the scientists of DMAPR and AINRP on MAP and Betelvine for their contributions that have been included in this annual report. Timely support received from my colleagues, Dr. Kunal Mandal, Dr. K. A. Geetha and Mr. Saravanan Raju in compilation of this volume and help of Dr. Vipin Chaudhary for Hindi translation of the summary are gratefully acknowledged.

Jai Hind!

Anand **Satyabrata Maiti**

October 17, 2009

सारांश

औषधीय एवं सगंधीय पादप अनुसंधान निदेशालय व इसका बाह्य प्रसार कार्यक्रम अखिल भारतीय औषधीय एवं सगंधीय पादप तथा पानलता अनुसंधान परियोजना, औषधीय एवं सगंधीय पौधो तथा पानलता पर शोध कार्य हेतु कार्यरत है । वर्ष 2008-2009 के दौरान औषधीय एवं संगधीय तथा पानलताओ की विभिन्न प्रजातिओं पर की गई महत्त्वपूर्ण शोध उपलब्धियां निम्नलिखित हैं ।

घी कंवार (*एलो बारबेडेंसिस*)

औ.स.प.अनु. निदेशालय, आणंद पर 4X सीटीएबी में आवश्यक परिवर्तन कर एलो जैल से अधिक मात्रा में उच्च गुणवत्ता वाले डीएनए को निकालने का मसविदा विकसित किया गया ।

सी.सी.एस.एच.ए.यू, हिसार केन्द्र पर 33 वंशरूपो का मूल्यांकन किया गया तथा यह देखा कि पत्तीयों की पैदावार 14815 से 52878 किग्रा प्रति है. के मध्य रही तथा श्लेष्मा का प्रतिशत 40.0 से 72.0 के मध्य रहा ।

इसी केन्द्र पर एक अन्य परीक्षण में तीन महीने के अन्तराल पर चार सिंचाई करने से पौधे की उपज तथा विकास में सार्थक वृद्धि हुई तथा इस सिंचाई योजना से सर्वाधिक पत्ती (24683 किग्रा प्रति है.) तथा जैल (16047 किग्रा प्रति है.) उपज प्राप्त हुई । नत्रजन की अधिकतम खुराक (60 किग्रा प्रति है.) से पौधो की उँचाई (69.0 सेमी), पत्तीयों की संख्या (12.9 प्रति पौधा), पत्तीयों को पैदावार (11002 किग्रा प्रति है.) तथा जैल उपज (7151 किग्रा प्रति है.) इत्यादि में वृद्धि हुई ।

औ.स.प.अनु. निदेशालय, आणंद पर किए गये अध्ययन में विभिन्न आर्द्रता प्रतिबल से पर्णहरित प्रदीप्ती गतिज में सार्थक परिवर्तन हुआ ।

चन्द्रशूर (*लेपिडियम सेटाइवम*)

सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर 15 जननद्रव्यों का मूल्यांकन किया गया तथा सर्वाधिक बीज पैदावार ज ननद्रव्य एचएलएस-8 (1825 किग्रा प्रति है.) से हुई, तत्पश्चात् एचएलएस-4 (1775 किग्रा प्रति है.) का क्रम रहा । आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर 13 जननद्रव्यों का मूल्यांकन किया गया तथा सर्वाधिक बीज पैदावार जननद्रव्य एमएलएस-7 (1987 किग्रा प्रति है.) से प्राप्त हुई, तत्पश्चात एमएलएस-5 (1960 किग्रा प्रति है.) का क्रम रहा ।

एस.डी.यू.ए.टी., फैजाबाद केन्द्र पर किए गये परीक्षण में 20 टन प्रति है. गोबर खाद के प्रयोग से पौधे की वृद्धि बहेतर थी । हालाकि गोबर खाद की इस खुराक के प्रयोग से अन्य खुराको की तुलना में वानस्पतिक वृद्धि प्रावस्था अधिक समय तक रही तथा कलिकाओं का निकास भी देर से हुआ । गोबर खाद की इस खुराक द्वारा सर्वाधिक बीज उपज (1324 किग्रा प्रति है.) प्राप्त हुई । विभिन्न दूरियों वाले परीक्षण में कम दूरी (30X10 सेमी) वाले परीक्षण से सर्वाधिक बीज उपज (1216 किग्रा प्रति है.) प्राप्त हुई ।

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर एक परीक्षण में दो वंशरूपो (एमएलएस-1 व एमएलएस-7) को दो पंक्ति से पंक्ति (30 तथा 45) तथा तीन पौधे से पौधे (5, 10 तथा 20 सेमी) की दुरियों के संयोजन में बोया गया तथा 30X10 सेमी की परस्पर दूरी वाले परीक्षण से दोनो वंशरूपो द्वारा सर्वाधिक बीज उपज (1800 किग्रा प्रति है.) प्राप्त हुई ।

इसी केन्द्र पर एक अन्य परीक्षण में तीन सिंचाई व्यवस्थाओ तथा चार बीज दरो का मूल्यांकन किया गया तथा चार सिंचाई (बुवाई पश्चात 0, 30, 60 तथा 75 दिवस पर) से पौधो की उँचाई (50 सेमी), शाखाओ की संख्या (16.5 शाखा प्रति पौधा) व बीज उपज (1550 किग्रा प्रति है.) सर्वाधिक प्राप्त हुई । 08 किग्रा प्रति है. की बीज

दर के प्रयोग से अधिकतम उपज (1430 किग्रा प्रति है.) प्राप्त हुई, जोकि 10 किग्रा प्रति है. बीज दर द्वारा प्राप्त उपज (1260 किग्रा प्रति है.) के लगभग बराबर थी ।

मंदसौर परिस्थिति में बुवाई की तारीख तथा बीज दर का पौधे की वृद्धि तथा बीज उपज पर सार्थक प्रभाव था । 20 अक्टूबर को बोई गयी फसल में पौधो की उँचाई (101.6 सेमी) सर्वाधिक थी, जबकि 30 अक्टूबर को बोई गयी फसल में शाखाओं की संख्या (18.3 शाखा प्रति पौधा) तथा उपज (1830 किग्रा प्रति है.) सर्वाधिक थी । फसल बुवाई हेतु 06 किग्रा प्रति है. की बीज दर अनुकूलतम पाई गयी चूकि इस दर पर बीज उपज सर्वाधिक (1700 किग्रा प्रति है.) थी ।

एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर फसल मे पर्ण अंगमारी रोग (पर्ण ब्लाइट) का प्रकोप विभिन्न परीक्षणों तथा खेतो पर सामान्यत: देखा गया । यह रोग फसल बुवाई के 40 दिन पश्चात दृष्टिगोचर हुआ । सर्द ऋतु की वर्षा पश्चात यह रोग तीव्रता से फैलने लगा । इस रोगाणु को पृथक कर इसकी पहचान *आल्टर्नेरिया आल्टर्नेरिया* के रूप में की गई । फसल बुवाई के 40 दिन पश्चात 15 दिन के अन्तराल पर मेन्कोजेब के प्रयोग से रोग का प्रकोप कम हुआ (पीडीआई=12.0) तथा सर्वाधिक बीज उपज (2000 किग्रा प्रति है.) प्राप्त हुई ।

अशोका (*सराका असोका*)

के.ए.यू., त्रिचूर केन्द्र पर 42 संकलनो के मूल्यांकन से ज्ञात हुआ कि त्रिचूर तथा त्रिवेन्द्रम से एकत्र किए गए संकलनो में विकास अधिक प्रबल था । साथ ही साथ यह भी ज्ञात हुआ कि पत्तीयों की अधिक संख्या का तने की औसत वक्ष परिधि से धनात्मक सम्बंध था ।

इसी केन्द्र पर किए गए प्रजनन संबंधी अध्ययन से ज्ञात हुआ कि परागकोश सुबह 5-6 बजे के मध्य जब फूल खुला था, स्फुटित हुआ तथा वर्तिकाग्र फूल खुलने के एक घन्टे पश्चात से ग्राही था तथा संपूर्ण दिवस ग्राही रहा । प्राकृतिक वातावरण में पेड परपरागित थे ।

औ.स.प.अनु. निदेशालय, आणंद पर कलम बांधने की चार (जैसे, फाँक या दरार, तराशी, तराशी तथा जीभी तथा बगली जीभी) तथा चश्मा चढाने की दो (चिप्पी तथा पैबंदी) विधियों का प्रयोग किया गया तथा यह पाया कि चश्मा चढाने की दोनो विधियो द्वारा तीनों ऋतुओ में चश्मा संधि बनने में सफलता नहीं मिली । जून से सितंबर माह मे कलम बांधने की तराशी तथा जीभी विधि द्वारा अधिकतम सफलता (86.67 प्रतिशत) दर्ज हुई, तत्पश्चात फाँक विधि द्वारा (73.33 प्रतिशत) सफलता दर्ज हुई । संकुरणो का कलम बाधने के एक सप्ताह पूर्व संसाधन, कलिका अंकुरण में लगा समय, अंकुरित कलिकाओ की संख्या, कलम सफलता, प्रति पौधा पत्तीयों की संख्या, कलम संधि में लगा समय इत्यादि की दृष्टि से सर्वोत्तम रहा ।

के.ए.यू., त्रिचूर केन्द्र पर सामान्यत: प्रयुक्त होने वाले अपमिश्रक (*पॉलीएलथिया लॉगीफोलिया*) में भेद करने के लिए विभिन्न गुणात्मक प्राचलो का अध्ययन किया गया । अशोका के शुष्क छाल के नमूने बाहरी सतह पर अधिक खुरदरे तथा अन्दर की सतह पर लाल थे । *पॉलीएलथिया लॉगीफोलिया* के जल अर्क में हरी प्रदीप्ती थी जो कि प्रमाणित औषधी में अनुपस्थित थी । अपमिश्रको के दो प्रदीप्ती धब्बों की तुलना में अशोका के अर्क से टीएलसी (पानी: प्रोपेनॉल =1:4) द्वारा चार प्रदीप्ती बैण्ड प्राप्त हुए ।

अश्वगंधा (*विथैनियां सोम्निफेरा*)

औ.स.प.अनु. निदेशालय, आणंद पर अश्वगंधा की दो किस्मो जेए-20 तथा जेए-134 मे विकास सम्बंधि अध्ययन किया गया तथा यह देखा कि प्रारम्भिक अवस्था में 75 दिनों तक विकास प्रक्रिया बहुत धीमी थी जो दोनों किस्मो में 90 से 150 दिन के मध्य नियमित बढने लगी । तरुण जडो में

12-डीऑक्सीविथैनोस्ट्रेमोनोलाइड तथा विथैनोलाइड-अ तत्त्व अधिक मात्रा में था तथा यह तत्त्व जडो में परिपक्वता के दौरान घटने लगा । हालाकि, जडो के शुष्क भार में वृद्धि के साथ कुल सक्रिय तत्त्व की उपज भी बढ़ी ।

एक अन्य प्रयोग में निदेशालय पर 131 संकलनो का मुल्यांकन किया गया तथा संकलन एमडबल्यूएस-312, एमडबल्यूएस-315, एमडबल्यूएस-108, आरएएस-53 तथा आरएएस-39 द्वारा सर्वोत्तम जाँच जेए-20 की तुलना में प्रति पौधा सर्वाधिक बीज व जड उत्पादन हुआ । गैस विनिमय प्राचलो के आधार पर भी ज ननद्रव्यों का वर्गीकरण किया गया ।

सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर 30 संकलनो का विभिन्न संरचनात्मक तथा जड प्राचलो के लिए मूल्यांकन किया गया तथा संकलन-15 द्वारा सर्वाधिक जड की पैदावर (253 किग्रा प्रति है.) हुई, तत्पश्चात् संकलन-29 (230 किग्रा प्रति है.) का क्रम रहा ।

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर 67 संकलन का मूल्यांकन किया तथा यह पाया कि शुष्क जड की पैदावार 121 (डबल्यूएस-90-121) से 842 किग्रा प्रति है. (एमडबल्यूएस-215) के मध्य रही ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर 139 जननद्रव्यों मूल्यांकन से ज्ञात हुआ कि जननद्रव्य आरएएस-10 तथा आरएएस-44 द्वारा शुष्क जड पैदावार (1222.22 किग्रा प्रति है.) सर्वाधिक प्राप्त हुई । 61 जननद्रव्यों द्वारा सर्वोत्तम जाँच जेए-134 की तुलना से अधिक एल्केलॉइड तत्त्व का प्रदर्शन किया गया ।

ए.ए.यू., आणंद केन्द्र पर चार चयनित पंक्तियों का मूल्यांकन किया गया तथा शुष्क जड उपज (731 किग्रा प्रति है.) चयन-2 बी से काफी अधिक प्राप्त हुई, जोकि चयन-कैरट (645 किग्रा प्रति है.) द्वारा प्राप्त उपज के लगभग बराबर थी ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर चार उन्नत पंक्तियों के मूल्यांकन से ज्ञात हुआ कि शुष्क जड उपज सर्वोत्तम जाँच जेए-20 (606.30 किग्रा प्रति है.) की तुलना में पंक्तियां, आरएएस-10 (734.70 किग्रा प्रति है.), एमडबल्यूएस-100 (649.00 किग्रा प्रति है.) तथा एमडबल्यूएस-101 (641.20 किग्रा प्रति है.) द्वारा अधिक प्राप्त हुई ।

उदयपुर केन्द्र पर एक अन्य परीक्षण में 11 पंक्तियों का मूल्यांकन किया गया तथा पंक्ति आरएएस-21, डबल्यूएस-124 तथा एमडबल्यूएस-132 को छोड कर अन्य सभी पंक्तियों से सर्वोत्तम जाँच जेए-20 की तुलना से शुष्क जड उपज अधिक प्राप्त हुई ।

ए.ए.यू., आणंद केन्द्र पर 15 अक्टूबर तथा 15 नवम्बर के मध्य बोई गई फसल से अधिक जड उपज प्राप्त हुई । बीज दर में 6-12 किग्रा प्रति है. की वृद्धि करने से परिपक्व अवस्था में फसल के विकास में सार्थक सुधार हुआ लेकिन, विभिन्न बीज दरो का जड उपज पर कोई प्रभाव नहीं पडा ।

एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर विभिन्न कार्बानिक उर्वरको, फॉस्फोरस सल्यूब्लाईसिंग बैक्टिरिया (पीएसबी) तथा इनके संयोजनो का अध्ययन किया गया । 5-10 टन प्रति है. की दर से निपडित मृदा (प्रेसमड) के प्रयोग से हरी जड उपज (770-1454 किग्रा प्रति है.) सर्वाधिक प्राप्त हुई । 10 टन प्रति है. की दर से निपडित मृदा के प्रयोग से अधिकतम शुष्क जड उपज (508 किग्रा प्रति है.) प्राप्त हुई ।

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर पौधे की वायव वृद्धि को रोकने तथा भूमिगत उपज बढाने हेतु तीन वृद्धि रोधको जैसे, टीआईबीए, साइकोसिल तथा मेलिक हाईड्रेजाइड (एमएच) का प्रयोग किया गया तथा यह पाया कि टीआईबीए में न्यूनतम पादप लंबाई के साथ वानस्पतिक वृद्धि निरोधक क्षमता सबसे अधिक थी । टीआईबीए (50 पीपीएम) के प्रयोग से सर्वाधिक जड उपज (7500 किग्रा प्रति है.) प्राप्त हुई ।

औ.स.प.अनु. निदेशालय, आणंद पर हाडा बीटल (*एपिलेक्ना वीजिन्टीऑक्टोपंक्टेटा*) की जीव परिस्थितिकी का अध्ययन किया गया । यह बीटल संपूर्ण वर्ष फसल पर पाई गई । अण्डे समूह में पत्ती की दोनो सतहो पर दिए गए । लट चार अवस्थाओं से गुजर कर प्यूपा में रूपांतरित हो गई । अण्डे से व्यस्क तक के विकास में 21-25 दिवस का समय लगा ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर विभिन्न स्त्रोतो जैसे, बाजार, खेत तथा प्रयोगिक क्षेत्र इत्यादि से एकत्रित जडों के नमूनों का रोगाणु संक्रमण तथा कार्बेन्डिज्म अवशिष्ट पता लगाने हेतु परीक्षण किया गया । जडों के नमूनो में कवकनाशी पता लगाने योग्य स्तर पर नहीं था । नमूने विभिन्न जातिओं की कवक जैसे *ट्राईकोडर्मा, पेनिसिलियलम, राईजोपस, एस्पर्जिलस, म्यूकर, फ्यूजेरियम* इत्यादि तथा *स्यूडोमोनास* जाति के जीवाणु से संक्रमित थे ।

बला (*सिद्धा कॉर्डिफोलिया*)

के.ए.यू., त्रिचूर केन्द्र पर विभिन्न अंतरालो पर फसल को काटा गया तथा यह पाया कि उपज संबंधी जडों के विभिन्न गुणों में रोपण के आठ महीने पश्चात् सार्थक वृद्धि हुई । ताजा (383 किग्रा प्रति है.) तथा शुष्क (253 किग्रा प्रति है.) जड उपज रोपण के आठ महीने पश्चात् सर्वाधिक थी । शुष्क जड उपज रोपण के ग्याराह महीने पश्चात की गई कटाई को छोड कर अन्य अन्तरालों की कटाई में लगभग बराबर थी । फसल का रोपण खुले तथा छायादार वातावरण में भी किया गया तथा यह पाया कि पौध वृद्धि खुले वातावरण में अधिक थी, परीणामतः छायादार वातावरण की तुलना से लगभग तीन गुना अधिक जड पैदा हुई ।

काली इसबगोल (*प्लेंटेगो इण्डिका*)

औ.स.प.अनु. निदेशालय, आणंद पर नत्रजन की विभिन्न खुराको तथा विभिन्न दूरियों के प्रभाव के अध्ययन में यह पाया कि नत्रजन की उच्च खुराक (35-50 किग्रा नत्रजन प्रति है.) से फसल में वानस्पतिक वृद्धि अधिक हुई, परीणामतः पौधो में उँचाई (115.5-117.3 सेमी) तथा शाखाओं की संख्या (29.0-31.5 शाखा प्रति पौधा) अधिकतम थी । प्रति पौधा सीट्टो की संख्या अधिकतम नत्रजन खुराक तथा 50 सेमी की परस्पर दूरी वाले परीक्षण में सर्वाधिक थी । नत्रजन के प्रयोग द्वारा 959-1050 किग्रा प्रति है. बीज उपज दर्ज हुई, जबकि जाँच में 692-717 किग्रा प्रति है. बीज उपज दर्ज हुई । एक अन्य प्रयोग में पाँच सिंचाई व्यवस्थाओं का परीक्षण किया गया तथा यह पाया कि अधिक सिंचाई द्वारा घनी शाखाओं के साथ वानस्पतिक वृद्धि सुदृढ थी । फसल में 4-6 सिंचाई द्वारा अधिकतम बीज (927-984 किग्रा प्रति है.) तथा भूसी उपज (4387-4751 किग्रा प्रति है.) दर्ज हुई ।

ब्राह्मी (*बैकोपा मोनिएरी*)

के.ए.यू., त्रिचूर केन्द्र पर फसल उपज बढाने हेतु विभिन्न कार्बनिक उर्वरको, जैव उर्वरको तथा इनके संयोजनो का प्रयोग किया गया तथा यह पाया कि नारियल रेशा के कम्पोस्ट के प्रयोग द्वारा ताजा (3007 किग्रा प्रति है.) तथा शुष्क (1228 किग्रा प्रति है.) उपज अधिक थी । नारियल रेशा कम्पोस्ट तथा दो जैव उर्वरको (*एजोस्पिलम* तथा पीएसबी) के सयुक्त प्रयोग द्वारा अधिकतम ताजा (3490 किग्रा प्रति है.) तथा शुष्क (1374 किग्रा प्रति है.) शाकीय उपज प्राप्त हुई । इस परीक्षण द्वारा बेकोसाइड तत्त्व भी अधिकतम (6.04 प्रतिशत) प्राप्त हुआ ।

चिरायता (*स्वार्शिया चिरायता*)

यू.बी.के.वी., कालिमपोंग केन्द्र पर तीन वृद्धि नियामको (जीए$_3$, काइनेटिन तथा आईएए) की चार सान्द्रता का बीज अंकुरण पर प्रभाव हेतु परीक्षण किया गया तथा यह पाया कि 400 पीपीएम जीए$_3$ का प्रयोग अंकुरण (52.7 प्रतिशत)

तथा अंकुरण में लगे समय (33 दिन) की दृष्टि से सर्वोत्तम था । एक अन्य प्रयोग में विभिन्न अंकुरण माध्यमों तथा जैव उर्वरको का परीक्षण किया गया तथा माध्यम जिसमें मृदा: रेत: गोबर खाद 1:2:1 के अनुपात में था, बीज अंकुरण (51.0 प्रतिशत) की दृष्टि से श्रेष्ठत्तम था । जैव उर्वरको में 02 ग्राम प्रति किग्रा मृदा की दर से *एजेटोबेक्टर* तथा पीएसबी के सयुक्त प्रयोग द्वारा 53.3 प्रतिशत अंकुरण दर्ज हुआ ।

पत्थरचूर (*कोलियस फोंस्कोहली*)

ए.पी.एच.यू., बापटला केन्द्र पर अकार्बनिक एनपीके के साथ विभिन्न कार्बनिक तथा जैव उर्वरको के संयोजनो का परीक्षण किया गया । अकार्बनिक उर्वरको तथा *एजोर्स्पिलम* व *फॉस्फोबेक्टर* के संयुक्त प्रयोग द्वारा पौधो की लंबाई (63.3 सेमी), शाखाएँ (8.4 शाखा प्रति पौधा) तथा उपज (20750 किग्रा प्रति है.) सर्वाधिक प्राप्त हुई ।

गिलोय (*टीनोस्पोरा कॉर्डीफोलिआ*)

औ.स.प.अनु. निदेशालय, आणंद पर 43 जननद्रव्यों का विभिन्न लक्षणों के लिये मूल्यांकन से ज्ञात हुआ कि प्राथमिक शाखाओं की संख्या 1.5 से 8.54, पोरी की लंबाई 7.17 से 14.44 सेमी, प्राथमिक शाखाओं का व्यास 4.17 से 7.88 मिमी तथा द्वितीयक शाखाओं का व्यास 4.18 से 7.18 मिमी के मध्य था । विमिन्न संकलनो में मांड कण के आकार के आधार पर बारंबाटता-बंटन से ज्ञात हुआ कि अधिकांश संकलनो में छोटे आकार के मांड कण थे तथा विमिन्न संकलनों में इनका आकार भिन्न था ।

निदेशालय पर एक अन्य परीक्षण में 34 संकलनो का विभिन्न लक्षणों के लिये आरएपीडी सूचको द्वारा मूल्यांकन किया गया । ओपीए, ओपीसी, आपीडी, ओपीपी तथा ओपीजे शृखंला के 100 प्राईमरों का अनुकूलता के लिये मूल्यांकन किया गया तथा ओपीसी प्राईमर में अधिकतम बहुरूपता पायी गई, तत्पश्चात ओपीए तथा ओपीडी प्राईमरों का क्रम रहा ।

ए.पी.एच.यू., बापटला केन्द्र पर किये गये प्राथमिक अध्ययन से ज्ञात हुआ कि प्रकाशम जिले के राजूगारीपेलम से एकत्र किये गये क्लोनों में अन्य क्लोनों की तुलना से संरचनात्मक तथा आर्थिक गुणों हेतु गुणवत्ता अधिक थी।

गुग्गल (*कॉमिफोरा व्हाईटी*)

औ.स.प.अनु. निदेशालय, आणंद पर विभिन्न बहुभ्रूणी क्लोनों की पहचान हेतु 30 क्लोनों के बीजों का अंकुरण किया गया तथा 09 क्लोनों में बहुभ्रूणी अंकुरण देखा गया । साथ ही साथ यह भी देखा कि असंगजननिक भ्रूणो का विकास छाल की भीतरी सतहों से प्रारभ्भ हुआ । बीजांड के माइक्रोपाइलर छोर से विकसित असंगजननिक भ्रूण प्राथमिक ही केवल भ्रूण में परिवर्तित हुई । प्रवाही कोशिकामापन अध्ययन से भी यह ज्ञात हुआ कि गुग्गल में भ्रूणपोष का विकास स्वत: तथा त्रिकसंलयन, दोनो ही तरह से हुआ ।

निदेशालय पर एक अन्य परीक्षण में गुग्गल पंक्तियों का आरएपीडी सूचकों द्वारा आण्विक विश्लेषण किया गया तथा यह ज्ञात हुआ कि संकलन जिसका सादृश्यता मेट्रिक्स मान 0.519 से 0.950 के बीच था के भीतर तथा मध्य काफी विविधता थी । सर्वोत्तम विभेदी क्षमता (12.083) ओपीएन20 प्राईमर में देखी गई तथा आरएपीडी प्राईमर सूचकांक (आरपीआई) (2.638) ओपीएन10 प्राईमर में सर्वाधिक था ।

निदेशालय पर गुग्गल में लिंग निर्धारण से जुडे सूचक का पता लगाने हेतु आरएपीडी तकनीक का प्रयोग किया गया तथा यह ज्ञात हुआ कि दो आरएपीडी सूचक, मादा निर्दिष्ट सूचक ओपीएन06_{1280} तथा उभयलिंगी निर्दिष्ट सूचक ओपीएन16_{400} द्वारा नर, मादा, तथा उभयलिंगी पौधो में प्रमाणिक्ता से भेद किया जा सकता है । एक अन्य सूचक ओपीए20 द्वारा मादा तथा उभयलिंगी से लगभग 1140 बीपी के खंड का विस्तरण हुआ ।

निदेशालय पर किये गये अध्ययन जिसके अंतर्गत *कॉमीफोरा* की चार प्रजातियों, जैसे *कॉमीफोरा व्हाईटी, कॉमीफोरा माईराह, कॉमीफोरा क्वाडेटा* तथा *कॉमीफोरा स्टॉक्सिया* के भीतर तथा मध्य अनुवांशिक संबंधो को पहचानने तथा मूल्यांकन का प्रयास किया गया तथा यह देखा कि कुल 190 बैण्ड बने जिसमें से क्रमशः 180, 10 तथा 89 बैण्ड बहरूपी, एकरूपी तथा अपूर्व थे । *कॉमीफोरा व्हाईटी* में अधिकतम (100 बिन्दुओं पर) तथा *कॉमीफोरा स्टॉक्सिया* में न्यूनतम (71 बिन्दुओं पर) विस्तरण हुआ ।

भारतीय तगर (*वेलिरियाना जटामाँसी*)

यू.बी.के.वी., कालिमपोंग केन्द्र पर तीन वृद्धि नियामकों का बीज अंकुरण हेतु परीक्षण किया गया तथा काईनेटिन (200 पीपीएम) के प्रयोग द्वारा सर्वाधिक (92.0 प्रतिशत) बीज अंकुरण हुआ ।

ईसबगोल (*प्लेंटेगो ओवेटा*)

औ.स.प.अनु., निदेशालय, आणंद पर रासायनिक घटकों के प्रयोग से कृत्रिम संकरण हेतु फूलों में विपुंसीकरण का प्रयास किया गया तथा जीए$_3$ व ईथराल द्वारा वांछित परीणाम प्राप्त हुए ।

निदेशालय पर प्रयोगशाला में अगुणित पौधों के पुर्नजनन हेतु अध्ययन किया गया । एककेन्द्रकीय तथा द्विकेन्द्रकीय लघुबीजाणुं हेतु सीट्टों के आकार का मानकीकरण किया गया । यह देखा गया कि अंधेरे में 6-8 सप्ताह के संवर्धन पश्चात् 4-11 दिवस तक 4^{o}C पर रखे गये संपूर्ण सीट्टे से एमएस माध्यम जिसमें बीए (0.5 से 1.0), आईएए (0.5-1.0), 2-4 डी (0.5 - 1.0) तीन प्रतिशत स्यूक्रोस के साथ है, अच्छा कैल्सीकरण हुआ ।

निदेशालय पर रासायनिक उत्परिवर्तजन द्वारा कृत्रिम विविधता उत्पन्न करने हेतु किए गये प्रयास से एम$_2$ पीढी में पत्ती के रंग, पत्ती की लंबाई व चौडाई, पत्ती का आकार, पौधे की ऊंचाई, सीट्टे की लंबाई, बीज के आकार, शाखाओं की संख्या, पत्ती पर रोम, पुष्पन प्रकारों, पादप प्रकारों इत्यादि गुणों के लिए कुछ प्रत्यक्ष उत्परिवर्तक देखे गये ।

ए.ए.यू., आणंद केन्द्र पर अधिकतम सीट्टो के आधार पर एम$_2$ पीढी से बीजों का चयन किया गया तथा उत्परिवर्तक चयन-11 द्वारा जाँच की तुलना में अधिक उपज प्राप्त हुई । चयन-11 द्वारा 686 किग्रा प्रति है. बीज उपज प्राप्त हुई, जोकि जाँच (जीआई-2) से लगभग 25 प्रतिशत अधिक थी ।

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर 80 संकलनो के मूल्यांकन से ज्ञात हुआ कि बीज उपज 444 (एसपीएस-9) से 1555 किग्रा प्रति है. (एमआईबी-121) के मध्य थी ।

एम.पी.ए.यू.टी., उदयपुर केन्द्र पर आठ श्रेष्ठत्तम पंक्तियों का मूल्यांकन किया गया तथा पाँच पंक्तियों, एमआईबी-124 (947.07 किग्रा प्रति है.), 45 केआर-1-6 (856.48 किग्रा प्रति है.), 60 केआर-2-5 (777.77 किग्रा प्रति है.), एचआई-1 (768.52 किग्रा प्रति है.) तथा एएमबी-29 (763.88 किग्रा प्रति है.) द्वारा श्रेष्ठत्तम जाँच जीआई-2 (759.26 किग्रा प्रति है.) की तुलना में बेहतर उपज का प्रदर्शन किया गया । एक अन्य परीक्षण में तीन उन्नत पंक्तियों का मूल्यांकन किया गया तथा सभी पंक्तियों, पालमपुर-2 (965.27 किग्रा प्रति है.), पीबी-62 (905.09 किग्रा प्रति है.) तथा गुमारी (752.31 किग्रा प्रति है.) द्वारा श्रेष्ठत्तम जाँच जीआई-2 (752.28 किग्रा प्रति है.) की तुलना से अधिक बीज उपज प्राप्त हुई ।

औ.स.प.अनु. निदेशालय, आणंद पर नत्रजन की विभिन्न मात्राओं तथा सिंचाई के विभिन्न स्तरो का एफिड (*एफिस गोसिपाई*) के प्रकोप पर प्रभाव संबंधि अध्ययन किया गया । एफिड का प्रकोप नत्रजन की अधिकतम खुराक (60 ग्रा. प्रति है.) वाले परीक्षण में सर्वाधिक था । अधिकतम एफिड की जनसंख्या (222.6 एफिड प्रति पौधा) सिंचाई व्यवस्था-4 जिसमे चार सिंचाई (फसल बुवाई के 0, 20, 40 तथा 80 दिन पश्चात सिंचाई) दि गई, में थी तथा

न्यूनतम एफिड जनसंख्या (2.7 एफिड प्रति पौधा) सिंचाई व्यवस्था-3 जिसमे भी चार सिंचाई (फसल बुवाई के 0, 20, 40 तथा 60 दिन पश्चात सिंचाई) दि गई, में थी । आणंद परिस्थिति में ईसबगोल की फसल पर दो लटे *जूनोनिया ओराईथीया* तथा *हाईपोसिड्रा स्कसोरिया* देखी गई । यह दोनो प्रजातियां ईसबगोल की फसल पर पहली बार देखी गई ।

जीवन्ति (*लेप्टेडेनीया रेटिक्यूलेटा*)

ए.ए.यू., आणंद केन्द्र पर अनुकूलतम दूरी तथा कटाई का समय पता लगाने हेतु विभिन्न दूरी तथा कटाई के समय का मूल्यांकन किया गया तथा यह पाया कि 60×60 सेमी की परस्पर दूरी (10976.1 किग्रा प्रति है.) तथा 150 वे दिवस पर कटाई (11236.5 किग्रा प्रति है.) से अधिकतम शुष्क बायोमास प्राप्त हुआ । साथ ही साथ यह भी देखा कि रोप की विभिन्न अवस्थाओं तथा विभिन्न रोपण के समय द्वारा प्राप्त बायोमास उपज में कोई सार्थक भिन्नता नहीं थी ।

कालमेघ (*एन्ड्रोग्राफिस पेनीकुलेटा*)

ए.ए.यू., आणंद केन्द्र पर पुष्पन में लगे समय के आधार पर 10 पंक्तियों का चयन किया गया तथा यह पाया की चयनित पंक्तियों में पुष्पन मे लगा समय 86.3 से 107.8 दिवस के मध्य था । चयन एके-1 द्वारा पुष्पन हेतु अधिकतम समय लगा, तत्पश्चात चयन-10 (107.5 दिवस) का क्रम रहा । शुष्क शाकीय उपज भी चयन एके-1 (3455.21 किग्रा. प्रति है.) द्वारा सर्वाधिक प्राप्त हुई ।

औ.स.प.अनु. निदेशालय, आणंद पर नर्सरी तकनीकों के मानकीकरण हेतु विभिन्न बीज दर, पंक्तियों के मध्य दूरी, गोबर खाद की खुराक तथा प्रकाश सघनता (छाया) का परीक्षण किया गया । तीन ग्राम प्रति मीटर की बीज दर से रोप की उंचाई तथा प्रतिरोपण हेतु तैयार रोप सर्वाधिक प्राप्त हुई । 15 सेमी की दूरी द्वारा प्रति क्षेत्रफल प्रतिरोपण हेतु तैयार रोप अधिकतम (852 प्रति वर्ग मीटर) प्राप्त हुई । 04 किग्रा प्रति वर्ग मीटर गोबर खाद की खुराक अधिकतम प्रति क्षेत्रफल प्रतिरोपण हेतु तैयार रोप के लिये अनुकूलतम थी । कम प्रकाश सघनता (छाया) में रोप का विकास अच्छा हुआ । छायादार वातावरण (30-75 प्रतिशत प्रकाश सघनता वाली नेट) में खुले वातावरण की तुलना से प्रतिरोपण हेतु तैयार रोप की संख्या में 26-72 प्रतिशत वृद्धि हुई ।

पी.डी.के.वी., अकोला केन्द्र पर सर्वोत्तम पौधे से पौधे की दूरी तथा कटाई का समय जानने हेतु प्रयोग किया गया । परस्पर दूरी का पादप वृद्धि तथा एड्रोग्रेफोलाईड तत्त्व पर कोई प्रभाव नहीं पडा । रोपण के 135 दिन पश्चात फसल कटाई तथा 30×15 सेमी की परस्पर दूरी द्वारा अधिकतम हरी (7324.01 किग्रा प्रति है.) तथा शुष्क (2199.40 किग्रा प्रति है.) पर्णीय उपज प्राप्त हुई । एक अन्य परीक्षण में उपज बढाने हेतु गोबर खाद की विभिन्न खुराको का प्रयोग तथा विभिन्न अंतराल पर फसल कटाई की गई । 7.5 टन प्रति है. गोबर खाद के प्रयोग से अधिकतम हरी (5173 किग्रा प्रति है.) तथा शुष्क (1788 किग्रा प्रति है.) पर्णीय उपज प्राप्त हुई । रोपण के 135 दिन पश्चात फसल कटाई से सर्वाधिक हरी (4822 किग्रा प्रति है.) तथा शुष्क (1833 किग्रा प्रति है.) पर्णीय उपज तथा एड्रोग्रेफोलाईड तत्त्व (38.5 किग्रा प्रति है.) प्राप्त हुआ । पोषक पदार्थ की सर्वाधिक खुराक देने पर एनपीके का अवशोषण अधिकतम हुआ ।

एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर कार्बनिक उर्वरको, जैव उर्वको तथा इनके संयोजनो का परीक्षण किया गया । 10 टन प्रति है. निपडित मृदा के प्रयोग से अधिकतम हरी (10654 किग्रा प्रति है.) तथा शुष्क (3515 किग्रा प्रति है.) शाकीय उपज प्राप्त हुई ।

लाँग पीपर (*पाईपर लाँगम*)

के.ए.यू., त्रिचूर केन्द्र पर अधिक सीट्रो तथा एल्कॉलाइड तत्त्व की उपज हेतु आठ चयनित वंशरूपो का मूल्यांकन किया गया तथा यह पाया कि चयन संख्या-2 (665 किग्रा प्रति है.) वर्तमान में अधिकतम उपज देने वाली किस्म विषम (508 किग्रा प्रति है.) से श्रेष्ठ थी ।

पी.डी.के.वी., अकोला केन्द्र पर किए गये परीक्षण में गोबर खाद, नीम केक तथा यूरिया के प्रयोग का फसल वृद्धि तथा उपज पर सार्थक प्रभाव पडा । 75 किग्रा प्रति है. नत्रजन का यूरिया के रूप में प्रयोग से अधिकतम फल (85.3 फल प्रति पौधा) तथा शुष्क फल उपज (323.93 किग्रा प्रति है.) प्राप्त हुई । गोबर खाद, नीम केक या यूरिया के प्रयोग का पाइपरीन तत्त्व पर कोई प्रभाव नहीं पडा ।

मकोई (*सोलेनम नाईग्रम*)

ए.पी.एच.यू., बापटला केन्द्र पर प्रजाति में न्यूनतम वर्णक विकसित किए गए तथा यह पाया कि एकत्रित सभी क्लोनों को तीन श्रेणीयो, काली बैरी युक्त रोमहिन चिकनी पत्ती वाले क्लोन, काली बैरी युक्त रोमयुक्त लहरदार पत्ती वाले क्लोन तथा लाल बैरी युक्त रोमयुक्त लहरदार पत्ती वाले क्लोन इत्यादि में बांटा जा सकता था ।

इसी केन्द्र पर एक अन्य परीक्षण में फसल वृद्धि तथा उपज बढाने हेतु विभिन्न कार्बनिक उर्वरक (गोबर खाद, नीम केक, वर्मीकम्पोस्ट), अकार्बनिक नत्रजन की विभिन्न खुराको तथा इनके संयोजनो का प्रयोग किया गया । नीम केक तथा 40 किग्रा प्रति है. नत्रजन के प्रयोग द्वारा अधिकतम उपज (3966 किग्रा प्रति है.) प्राप्त हुई । अकार्बनिक नत्रजन की उच्च खुराक द्वारा कीट व व्याधि का प्रकोप बढ गया ।

अफीम (*पैपेवर सोम्निफेरम*)

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर 235 जननद्रव्यो के मूल्यांकन में प्रति पौधा लेटक्स उपज 0.00 (पोस्ता-91) से 0.32 ग्राम (यूओ-7982 व जेए-16) के मध्य तथा बीज उपज 1.04 (एनबीआरआई-9) से 3.37 ग्राम (एमओपी-1088) के मध्य रही ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर किये गए 43 संकलनो के मूल्यांकन में यह पाय कि 16 जननद्रव्य द्वारा श्रेष्ठत्तम जाँच चेतक अफीम (27.38 किग्रा प्रति है.) की तुलना से अधिक लेटेक्स उपज प्राप्त हुई । एक अन्य परीक्षण में 10 श्रेष्ठ पंक्तियो के मूल्यांकन में यह पाया कि पाँच पंक्तियों, यूओपी-78 (31.40 किग्रा प्रति है.), यूओपी-34 (30.80 किग्रा प्रति है.), यूओपी-60 (28.75 किग्रा प्रति है.), यूओपी-43 (27.98 किग्रा प्रति है.) तथा यूओपी-83 (27.94 किग्रा प्रति है.) द्वारा जाँच चेतक अफीम (27.10 किग्रा प्रति है.) की तुलना से अधिक लेटेक्स उपज प्राप्त हुई ।

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर कुल 235 जननद्रव्य पंक्तियों का चूर्णिल मिल्ड्यू के प्रति प्रतिरोधकता के लिए मूल्यांकन किया गया तथा यह पाया कि 22 पंक्तियां इस कवक के प्रति प्रतिरोधी थी ।

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर 06 संकरो के मूल्यांकन ने दर्शाया की जाँच जेओपी-540 (46.84 किग्रा प्रति है.) की तुलना में संकर एमओएच-2 द्वारा अधिकतम लेटेक्स उपज (50.71 किग्रा प्रति है.) दर्ज हुई, तत्पश्चात एमओएच-1 (48.28 किग्रा प्रति है.) का क्रम रहा । उदयपुर केन्द्र पर दो संकरो आरओएच-36 (26.02 किग्रा प्रति है.) तथा एनडीएच (25.20 किग्रा प्रति है.) द्वारा जाँच चेतक अफीम (24.7 किग्रा प्रति है.) की तुलना से अधिक लेटेक्स उपज दर्ज हुई । फैजाबाद केन्द्र पर अधिकतम लेटेक्स उपज एनडीएच-2 (42.74 किग्रा प्रति है.) से दर्ज हुई, तत्पश्चात एनओपी-4 (38.86 किग्रा प्रति है.) का क्रम रहा ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर विकसित पाँच नये संकरो के मूल्यांकन में संकर पीएचओ-36 (29.33 किग्रा. प्रति है.), पीएचओ-33 (26.4 किग्रा प्रति है.) तथा पीएचओ-35 (25.7 किग्रा प्रति है.) द्वारा जाँच चेतक अफीम (25.5 किग्रा प्रति है.) की तुलना से अधिक उपज दर्ज हुई । फैजाबाद केन्द्र पर विकसित 06 नये संकरो का मूल्यांकन किया गया तथा संकर एनडीएच-3 (53.39 किग्रा प्रति है.) द्वारा अधिकतम लेटेक्स उपज प्राप्त हुई, तत्पश्चात संकर एनडीएच-4 (46.12 किग्रा प्रति है.) का क्रम रहा ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर अफीम तथा अश्वगंधा फसल अनुक्रम में पोषक पदार्थ प्रबंध के मानकीकरण हेतु एक परीक्षण किया गया तथा यह पाया कि पोषक पदार्थ की उच्च खुराको द्वारा फसल के विकास, उपज तथा गुणवत्ता में सार्थक वृद्धि हुई । अफीम की फसल में कार्बनिक उर्वरको की वृद्धि से आगामी अश्वगंधा फसल के विकास तथा उपज में सार्थक वृद्धि हुई, हालाकि अफीम की फसल में अकार्बनिक नत्रजन के प्रयोग का आगामी अश्वगंधा की फसल के उत्पादन तथा गुणवत्ता पर कोई सार्थक प्रभाव नहीं पडा । अश्वगंधा की फसल में 30 किग्रा नत्रजन प्रति है. के प्रयोग से जड उपज (778 किग्रा प्रति है.) तथा कुल एलक्लॉइड तत्त्व (0.55 प्रतिशत) में सार्थक वृद्धि हुई ।

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर एक परीक्षण में 06 कवकनाशीयो का चूर्णिल मिल्ड्यू के प्रति मूल्यांकन किया गया तथा देखा कि बाईलीटन कवकनाशी का काफी प्रभाव था, चूकि इसके प्रयोग से रोग सूचकांक के प्रतिशत में जाँच की तुलना में 61.43 प्रतिशत गिरावट दर्ज हुई । इस कवकनाशी के प्रयोग से लेटेक्स (25.27 किग्रा प्रति है.), बीज (416.68 किग्रा प्रति है.) तथा भूसी (596.21 किग्रा प्रति है.) उपज में वृद्धि हुई ।

पामरोजा (*सिंबोपोगन मार्टिनी*)

सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर 16 श्रेष्ठ पंक्तियों का मूल्यांकन किया गया तथा चार पंक्तियों द्वारा जाँच आरएच-49 की तुलना से अधिक तेल उपज प्राप्त हुई । पीआरएच-8-5 (86.956 लीटर प्रति है.) द्वारा सर्वाधिक तेल उपज प्राप्त हुई ।

सफेद मूसली (*क्लोरोफाइटम बोरिविलिएनम*)

औ.स.प.अनु. निदेशालय पर आरएपीडी सूचको द्वारा *क्लोरोफाईटम* की तीन प्रजातियो *(क्लोरोफाईटम बोरिविलिएनम, क्लोरोफाईटम अरुंडीनेशियम, क्लोरोफाईटम ट्यूब्रोसम)* तथा *क्लोरोफाईटम बोरिविलिएनम* के दो उच्च उपज वाले क्लोनों का अनुवांशिक संबंध पहचानने हेतु अध्ययन में दो प्रमुख क्लस्टर ज्ञात हुए, प्रथम क्लस्टर में *क्लोरोफाईटम अरुंडीनेशियम* तथा *क्लोरोफाईटम ट्यूब्रोसस* थे तथा द्वितीय क्लस्टर में मुख्य दो उपक्लस्टर थे जिसमे प्रथम उपक्लस्टर मे *क्लोरोफाईटम बोरिविलिएनम* के उच्च उपज वाले दो क्लोन तथा द्वितीय उपक्लस्टर में *क्लोरोफाईटम बोरिविलिएनम* के स्वछंद परागण वाली पौध संतति थी ।

निदेशालय पर एक अन्य परीक्षण में तना डिस्क का एक्सप्लांट की तरह प्रयोग कर *क्लोरोफाईटम अरुंडीनेशियम* के सुक्ष्म संवर्धन का मसविदा विकसित किया गया । सुक्ष्म संवर्धन से तैयार पौध का ग्रीन हाउस में कठोरीकरण पश्चात खेत में सफल रोपण किया गया जहाँ 99 प्रतिशत पौधे सफल रहे तथा उनमें प्रचुर वृद्धि तथा पुष्पन देखा गया ।

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर 24 संकलनो का मूल्यांकन किया गया तथा इनके मध्य काफी विविधता देखी गई । अधिकतम हरी मांसल जड उपज जाँच किस्म जेएसएम-405 (2449 किग्रा प्रति है.) की तुलना में एमसीबी-412 से प्राप्त हुई, तत्पश्चात एमसीबी-414 (2965 किग्रा प्रति है.) का क्रम रहा ।

सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर 11 संकलनो का मूल्यांकन किया गया तथा अधिकतम हरी जड उपज किस्म जेएसएम-405 (5593 किग्रा. प्रति है.) द्वारा दर्ज हुई, तत्पश्चात एचसीबी-2 (4815 किग्रा प्रति है.) का क्रम रहा ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर 22 नये संकलनो का मूल्यांकन किया गया तथा 09 संकलनो द्वारा जाँच एमसीबी-405 से अधिक मांसल जड उपज प्राप्त हुई ।

पी.डी.के.वी., अकोला केन्द्र पर पाँच श्रेष्ठ पंक्तियों के मूल्यांकन में पाया कि किसी भी पंक्ति द्वारा जाँच की तुलना में अधिक उपज प्राप्त नहीं हुई। एकेएसएम-01 द्वारा अधिकतम मांसल जड भार (35.55 ग्राम प्रति पौधा) प्राप्त हुआ तत्पश्चात एकेएसएम-03 (33.90 ग्राम प्रति पौधा) का क्रम रहा, जोकि जाँच जेएसएम-405 (33.65 ग्राम प्रति पौधा) द्वारा प्राप्त भार के लगभग बराबर था ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर पाँच श्रेष्ठ पंक्तियों का मूल्यांकन किया गया तथा चार पंक्तियों, आरसी-77 (4250 किग्रा प्रति है.), पीसी-2 (3806 किग्रा प्रति है.), आरसी-64 (3640 किग्रा प्रति है.) तथा सीबीआई-7 (3360 किग्रा प्रति है.) द्वारा जाँच एमसीबी-405 (3250 किग्रा प्रति है.) की तुलना में अधिक मांसल जड उपज प्राप्त हुई । आरसी-77 द्वारा अधिकतम सेपोनिन तथा सेपोजिनाइन तत्त्व प्राप्त हुआ ।

पी.डी.के.वी., अकोला केन्द्र पर वृद्धि व उपज को अनुकूलतम बनाने हेतु गोबर खाद की विभिन्न खुराको तथा दो जैव उर्वरको (*एजोटोबेक्टर* तथा पीएसबी) का मूल्यांकन किया गया । गोबर खाद के 20 टन प्रति है. के प्रयोग तथा *एजोटोबेक्टर* द्वारा उपचारित बीज से हरी (3819 किग्रा प्रति है.) तथा शुष्क मांसल जड (688 किग्रा प्रति है.) उपज में सार्थक वृद्धि दर्ज हुई । इसी प्रकार की वृद्धि सेपोनिन तत्त्व में हुई, हालाकि गोबर खाद तथा जैव उर्वरक के प्रयोग से सेपोनिन तत्त्व प्रभावित नही हुआ ।

उदयपुर केन्द्र पर विभिन्न स्रोतो जैसे बाजार, खेत तथा प्रायोगिक क्षेत्र इत्यादि से एकत्र किये गये मांसल जड के नमूनो का टीएलसी द्वारा कार्बेन्डिज्म अवशिष्ट तथा रोगाणु संक्रमण की मात्रा का पता लगाने हेतु परीक्षण किया गया । कार्बेन्डिज्म अवशिष्ट बाजार से एकत्र किये गए नमूनो में न्यूनतम (38 पीपीएम) तथा खेतो से एकत्रित नमूनो में अधिकतम (47 पीपीएम) था । नमूनो में विभिन्न प्रजातियो की कवक जैसे *ट्राईकोडर्मा, एस्पर्जिलिस, फ्यूजेरियम* तथा *म्यूकर* इत्यादि तथा *स्यूडोमोनास* जाति के जीवाणु का संक्रमण पाया गया ।

शंखपुष्पी (*कॉन्वोल्वुलस माईक्रोफाईलस*)

ए.ए.यू., आणंद केन्द्र पर शुष्क बायोमास हेतु अनुकूलतम बीज दर तथा दूरी जानने के लिए प्रयोग किया गया तथा सभी प्रायोगिक बीज दरो व दूरियों द्वारा प्राप्त शुष्क शाकीय उपज के मध्य कोई सार्थक भिन्नता नहीं थी ।

शतावर (*एस्पेरेगस रेसीमोसस*)

सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर हरियाणा के विभिन्न स्थानो से एकत्र किये गए 26 वंशरूपो का मूल्यांकन किया गया तथा वंशरूप एचएआर-03-18 (1043.21 क्विंटल प्रति है.) द्वारा अधिकतम मांसल जड उपज प्राप्त हुई । अधिकतम सेपोनिन तत्त्व एचएआर-4 से दर्ज हुई ।

औ.स.प.अनु. निदेशालय, आणंद में शतावर में फरवरी माह मे बीटल का प्रकोप देखा गया । इस बीटल की पहचान *लीमा डाउनीसी* के रूप में की गयी जोकि शतावर पर पहली बार देखी गई ।

सनाय (*केसीया आँगस्टिफोलिया*)

औ.स.प.अनु. निदेशालय, आणंद में सनाय की फसल पर सम्पूर्ण वर्ष *केटोपसिलिया पाईरेन्थी* का प्रकोप देखा गया । व्यस्क तथा अपरिपक्व अवस्थाए दोनो ही अप्रैल से सितम्बर तथा मार्च माह मे उपलब्ध थी तथा विभिन्न अवास्थाओं का प्रकोप अक्टूबर माह में आर्द्रता बढने के साथ बढ गया । तापमान में गिरावट के साथ दिसम्बर माह में जनसंख्या में कमी हो गई जोकि जनवरी तथा फरवरी माह में नगण्य हो गई । व्यस्क सम्पूर्ण वर्ष प्रजनन करते पाये गये तथा पत्ती के दोनो ओर 1:1 के अनुपात में एकल अंडे दिये । लट, प्यूपा में रूपान्तरित होने से पहले पाँच अवस्थाओं से गुजरी । अंडे से व्यस्क तक के विकास में 22-29 दिन का समय लगा ।

बच (*एकोरस कलेमस*)

ए.पी.एच.यू., बापटला केन्द्र पर आन्ध्रप्रदेश के विभिन्न स्थानो से एकत्र किए गए 11 क्लोनों का मूल्यांकन किया गया । भूस्तारी का भार 60 से 43.0 ग्राम प्रति पौधा के मध्य रहा । एकत्रित वंशरूपो में निरीक्षण तथा उपलब्ध ज्ञान के आधार पर प्रजाति के मूलभूत वर्णको का पुष्टिकरण किया गया ।

सूचना प्रबंध

वेबसाईट www.herbalgardenindia.org जोकि औ.स.प.अनु निदेशालय की एरीस सैल द्वारा एन.एम.पी.बी. की वित्तीय सहायता से विकसित की गई, का शुभारम्भ किया गया ।

निदेशालय में उपलब्ध अन्य डेटाबेसो जैसे, औषधीय एवं सगंधीय पादप संदर्भ सूचना तंत्र, औषधीय एवं सगंधीय पादप पर व्यापारी सूचना तंत्र, निदेशालय की वेबसाईट, औषधीय एवं सगंधीय पादप की डिजीटल सादृश्य लाईब्रेरी तथा औषधीय एवं सगंधीय पादप हेतु डिजीटल हर्बेरीयम इत्यादि पर जो तथ्य संगण्क मे संग्रहित है का अद्यतन किया गया ।

पानलता (*पाईपर बीटल*)

सात केन्द्रो पर जननद्रव्य अनुरक्षण तथा छ केन्द्रो पर मूल्यांकन का कार्य चल रहा है । मूल्यांकन हेतु पत्ती के गुणो, लता का विकास, कीट व व्याधि के प्रति प्रतिरोधकता, भण्डारण गुणवत्ता तथा ज्ञानेन्द्रिय सुग्राहय गुणो इत्यादि को विशेष महत्व दिया गया ।

दो केन्द्रो, ए.पी.एच.यू., बापटला तथा एम.पी.के.वी., सांगली पर संकर परीक्षण से ज्ञात हुआ कि जीएन संकर द्वारा उपज स्थानीय जाँच की तुलना में कम थी । हालाकि, संकरो में पत्ती की गुणवत्ता जैसे पत्ती का आकार (16.06×12.15 सेमी), 100 पत्तियों का ताजाभार (345.31 ग्राम) तथा सैल्फ लाइफ इत्यादि अधिक थी ।

आई.आई.एच.आर., बैंगलुरू पर संकरण का कार्य प्रगति पर था, बहुत सारे संकरण (क्रास) किए गए तथा पौधो का मूल्यांकन जारी है । 2006-07 में चयनित 10 संकरो का विभिन्न केन्द्रो पर मूल्यांकन हेतु वितरण करने के लिए गुणन किया गया । 2007-08 में तैयार संकर संतति से 10 संकरो का चयन किया गया ।

नर व मादा पौधो में लिंग पहचान से संबंधित सूचको का पता लगाने हेतु आरएपीडी तकनीक का प्रयोग किया गया । तीन नर विशेष ओपीए04_{1400}, ओपीए08_{650} तथा ओपीए02_{850} तथा दो मादा विशेष, ओपीए08_{1200} तथा ओपीसी06_{980} सूचक नर व मादा पौधो मे प्रमाणित भेद हेतु सक्षम थे । गुणितता तुलना द्वारा भी नर व मादा पौधो में भेद देखा गया ।

ए.पी.एच.यू., बापटला, बी.सी.के.वी., कल्याणी तथा एम.पी.के.वी., सांगली केन्द्रो पर समन्वित पोषक पदार्थ प्रबंध तथा समन्वित कीट प्रबंध के संयोजन से समन्वित फसल प्रबंध का एक या अधिक वर्षो के लिए अध्ययन किया गया ।

ए.पी.एच.यू., बापटला, बी.सी.के.वी., कल्याणी तथा एम.पी.के.वी., सांगली केन्द्रो पर महत्वपूर्ण रोगो के फैलाव पर जलवायु कारको के प्रभाव का अध्ययन किया गया ।

बी.सी.के.वी., कल्याणी, जे.एन.के.वी.वी., जबलपुर तथा आर.ए.यू., पूसा केन्द्रो द्वारा विकसित व्याधि प्रबन्धन तकनीको का किसानो के खेत पर सफल निदर्शन किया गया ।

ए.पी.एच.यू., बापटला केन्द्र द्वारा तंबाकू लट तथा टी.एन.ए.यू., सिरूगमानी द्वारा स्केल कीट की आर्थिक प्रभावसीमा स्तर का अध्ययन किया गया । परीणामो से ज्ञात हुआ कि प्रति पौधा तीन तंबाकू की लट सार्थक नुकसान कर सकती है तथा इस परिस्थिति में आर्थिक नुकसान से बचाव हेतु नियंत्रण शुरु करना आवश्यक बताया गया । स्केल कीट की संख्या अगर 06 स्केल प्रति 02 मीटर लता (0.33 स्केल प्रति पत्ती) से अधिक होने पर नियंत्रण आवश्यक बताया गया ।

Abbreviations used

2,4-D	2,4-Dichlorophenoxyacetic acid
AAU	Anand Agricultural University/ Assam Agricultural University
ABA	Abscisic Acid
AINRP	All India Networking Research Project
APHU	Andhra Pradesh Horticultural University
BA	6-Benzylaminopurine
BCKV	Bidhan Chandra Krishi Vishwa Vidyalaya
CCSHAU	C.C.S. Haryana Agricultural University
CFU	Colony forming unit
DAP	Days after planting
DAS	Days after sowing
DES	Diethyl sulfate
DMAPR	Directorate of Medicinal and Aromatic Plants Research
EMS	Ethylmethane Sulphonate
ETL	Economic threshold level
GA	Gibberelic acid
GAP	Good agricultural practices
GBPUAT	G.B. Pant University of Agriculture and Technology
IAA	indole acetic acid
IIHR	Indian Institute of Horticultural Research
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
KAU	Kerala Agricultural University
MAP	Medicinal and Aromatic Plants/ Months after planting
MH	Maleic hydrazide
MPKV	Mahtma Phule Krishi Vidyapeeth
MS medium	Murashige and Skoog medium
NDUAT	N.D. University of Agriculture and Technology
NPK	Nitrogen-phosphorous-potash
OUAT	Orissa University of Agriculture and Technology
PDI	Percent disease index
PDKV	P.D. Krishi Vishvidyalaya
PSB	Phosphate solubilising bacteria
RAPD	Random amplified polymorphic DNA
RAU	Rajendra Agricultural University
TIBA	Triiodobenzoic acid
TNAU	Tamil Nadu Agricultural University
UBKV	Uttar Banga Krishi Vishwa Vidyalaya
YSPUH&F	Y.S. Parmar University of Horticulture and Forestry

SUMMARY

Directorate of Medicinal and Aromatic Plants (DMAPR) and its outreach programmes, All India Networking Research Project (AINRP) on Medicinal and Aromatic Plants and AINRP on Betelvine are engaged in research on these groups of plants. Salient findings of 2008-09 are presented below:

ALOE (*Aloe barbadensis*)

A protocol was developed for the extraction of high quantity of good quality DNA from the aloe gel using 4X CTAB with major modifications at DMAPR, Anand.

Thirty three genotypes evaluated at CCSHAU, Hisar showed that leaf yield ranged from 14815 to 52778 kg ha^{-1} and the mucilage ranged from 40.0 to 72.0%.

Crop responded well in terms of increased plant growth and yield in four irrigations at an interval of three months at CCSHAU, Hisar. Maximum leaf (24683 kg ha^{-1}) and gel (16047 kg ha^{-1}) yields were recorded in this irrigation schedule. Highest level of N (60 kg N ha^{-1}) maximised plant height (69.0 cm), leaf number (12.9 plant^{-1}), leaf yield (11002 kg ha^{-1}) and gel yield (7151 kg ha^{-1}).

Leaf chlorophyll fluorescence kinetics varied significantly under various moisture stress in a study at DMAPR, Anand.

ASALIO (*Lepidium sativum*)

Fifteen germplasm evaluated at CCSHAU, Hisar showed that highest seed yield was in genotype HLS-8 (1825 kg ha^{-1}), followed by HLS-4 (1775 kg ha^{-1}). Thirteen germplasm tested at RVSKVV, Mandsaur showed that highest seed yield was in MLS 7 (1987 kg ha^{-1}) followed by MLS 5 (1960 kg ha^{-1}).

At NDUAT, Faizabad FYM (20t ha^{-1}) produced better plant growth however, extended the vegetative growth phase. Highest seed yield (1324 kg ha^{-1}) was obtained from this FYM dose. Among the different spacing tried, close spacing (30x10 cm) produced maximum seed yield (1216 kg ha^{-1}).

At RVSKVV, Mandsaur two genotypes (MLS-1, MLS-7) were grown in combinations of two row spacing (30 and 45) and three plant spacing (5, 10 and 20 cm). Seed yield was highest at 30x10 cm spacing (1800 kg ha^{-1}) for both the genotypes.

At RVSKVV, Mandsaur three irrigation schedules and four seed rates were tested. Highest plant height (50 cm), number of branches (16.5 plant $^{-1}$) and seed yield (1550 kg ha^{-1}) was obtained from four irrigations (0, 30, 60 and 75 DAS). Use of 8 kg ha^{-1} seed rate produced maximum yield (1430 kg ha^{-1}) which was at par with 10 kg ha^{-1} seed rate (1260 kg ha^{-1}).

Under Mandsaur conditions, both sowing dates and seed rates had significant effect on growth and seed yield. Plant height was maximum (101.6 cm) when sown at October 20 but, number of branches (18.3 plant^{-1}) and grain yield (1830 kg ha^{-1}) were maximum at October 30 sowing. Optimum seed rate was found to be 6 kg ha^{-1} with maximum seed yield (1700 kg ha^{-1}).

At NDUAT, Faizabad a leaf blight disease was common under experimental plot and also in farmers' field. The disease appeared approximately 40 days after sowing (DAS) and

disease spread was faster after winter shower. The pathogen was isolated and identified as *Alternaria alternata* (Fr.) Keissler. Application of mancozeb three times at 15 days interval starting from 40 DAS produced lowest disease severity (PDI=12.0) and highest seed yield (2000 kg ha^{-1}).

ASHOKA (*Saraca asoca*)

Forty two accessions of Asoka evaluated at KAU, Trichur showed that accessions collected from Thrissur and Trivandrum had vigorous growth. It was also found that higher number of leaves had positive association with mean girth of stem.

Reproductive biology carried out in the species at KAU, Trichur showed anther dehisced at the time of flower opening, between 5-6 am Stigma was receptive one hour after flower opening and continued to be receptive for the full day. In natural condition, trees were cross pollinated.

Four methods of grafting (cleft, whip, whip and tongue and side tongue) and two methods of budding (chip and patch) were compared at DMAPR, Anand. Budding methods failed to show bud union in all the three seasons tested. Whip and tongue grafting performed during June-September showed highest success (86.67%) followed by cleft grafting (73.33%). Pre-curing of scion one week before grafting was found best with high grafting success.

Different quality parameters were studied at KAU, Trichur to differentiate commonly used adulterant, *Polyalthia longifolia*. Ashoka dried bark samples were more rough on outer surface and reddish on inner side. Water extract of *P. longifolia* had milky green fluorescence which was absent in authentic drug. Extract from ashoka produced four fluorescent bands on TLC (water: propanol = 1:4) compared to two fluorescent spots by the adulterant.

ASHWAGANDHA (*Withania somnifera*)

Growth study conducted in two ashwagandha varieties, JA 20 and JA 134 at DMAPR, Anand showed that growth was very slow in the initial period up to 75 days and it steadily increased from 90 to 150 DAS in both the cultivars. Young roots had higher 12-deoxywithanostramonolide and withanolide A and these decreased during maturity of the roots. However, the total active ingredients yield increased due to the increase in dry weight of root.

One hundred and thirty one accessions evaluated at DMAPR, Anand showed accessions MWS 312, MWS 315, MWS 108, RAS 53 and RAS 39 had significantly higher seed yield and root yield per plant than the best check, JA 20. Germplasm were also classified based on gas exchange parameters.

Thirty accessions evaluated for various morphological and root parameters at CCSHAU, Hisar showed that highest root yield was in Acc. 15 (253 kg ha^{-1}), followed by Acc. 29 (230 kg ha^{-1}).

Sixty seven accessions evaluated at RVSKVV, Mandsaur showed that dry root yield ranged from 121 kg ha^{-1} (WS-90-121) to 842 kg ha^{-1} (MWS- 215).

One hundred and thirty nine germplasm evaluated at MPUAT, Udaipur showed maximum dry root yield in RAs-10 and RAs-44 (1222.22 kg ha^{-1}). Sixty one germplasm exhibited higher alkaloid content than the best check JA-134.

At AAU, Anand four selected lines were evaluated and dry root yield was significantly higher in Sel 2B (731 kg ha^{-1}) which was at par with Sel- Carrot (645 kg ha^{-1}).

Four advanced lines were evaluated at MPUAT, Udaipur and three lines *viz*., RAS-10 (734.70 kg ha^{-1}), MWS-100 (649.00 kg ha^{-1}) and MWS-101 (641.20 kg ha^{-1}) showed higher dry root yield against best check JA-20 (606.30 kg ha^{-1}).

In another trial at MPUAT, Udaipur eleven lines were evaluated and lines except RAS-21, WS-124 and MWS-132 recorded higher dry root yield than the best check JA- 20.

At AAU, Anand sowing between October 15 and November 15 produced higher root yield. Increasing the seed rate from 6–12 kg ha^{-1} improved plant stand at maturity however, root yield was not influenced by different seed rates.

Different organic manures and phosphorous solubilising bacteria (PSB) and their combinations were used at NDUAT, Faizabad. Application of 5–10 t pressmud ha^{-1} produced maximum fresh root yield (770–1454 kg ha^{-1}). Highest dry root yield was obtained from 10 t ha^{-1} pressmud (508 kg ha^{-1}).

Three growth retardants *viz*. TIBA, cycocil and maleic hydrazide (MH) were used at RVSKVV, Mandsaur. TIBA showed highest vegetative growth suppressing activity with minimum plant height. Highest root yield was associated with application of 50 ppm TIBA (7500 kg ha^{-1}).

Bionomics of spotted beetle (*Henosepilachna vigintioctopuntata*) was studied at DMAPR, Anand. Beetle population was found throughout the year in the field. Eggs were laid in batches on both sides of leaves. The grubs passed through four instars before transforming into pupae. Developmental period from egg to adult emergence was 21-25 days.

Root samples collected from market, farmers' field and experimental field were tested for presence of microbial contaminants and carbendazim residues at MPUAT, Udaipur. None of the samples showed detectable level of fungicide in the root. Different fungi belonging to genera *Trichoderma*, *Penicillium*, *Rhizopus*, *Aspergillus*, *Mucor* and *Fusarium* and bacterium from genus *Pseudomonas* were detected from the samples.

BALA (*Sida cordifolia*)

At KAU, Trichur crop was harvested at different ages. The yield attributing root characters were significantly higher at 8 months after planting (MAP). Fresh (383 kg ha^{-1}) and dry (253 kg ha^{-1}) root yields were highest at 8 MAP. Dry root yield was at par for all the harvesting age except 11 MAP. The crop was also grown under shade and open conditions. Plant growth was significantly higher at open condition resulting ~3 times higher root yield than shade.

BLACK ISABGOL (*Plantago indica*)

In a field study conducted at DMAPR, Anand, it was observed that higher nitrogen (35-50 kg N ha^{-1}) induced better vegetative growth resulting maximum plant height (115.5-

117.3 cm) and branches (29.0-31.5 plant-1). Maximum spike plant-1 was obtained from highest N dose at 50 cm row spacing. Control plot produced 692–717 kg ha-1 seed while N application resulted 959–1050 kg ha-1 seed yield. Among five different irrigation levels tested, higher irrigation resulted better vegetative growth having more branches. Four to six irrigations produced higher straw (4387–4751 kg ha-1) and seed (927–984 kg ha-1) yields.

BRAHMI (*Bacopa monnieri*)

Different organic manures and bio-fertilisers and their combinations were tested at KAU, Trichur to increase yield. A combination of coir pith compost along with two biofertilisers (azospirillum and PSB) produced highest fresh (3490 kg ha-1) and dry (1374 kg ha-1) herbage yields. Bacoside content was also found to be highest (6.04%) with this treatment.

CHIRAYITA (*Swertia chirayita*)

Effect of three plant growth regulators (GA_3, kinetin and IAA) on seed germination was tested at UBKV, Kalimpong. GA_3 at 400 ppm was found to be the best with respect to germination (52.7%) and minimum germination time (33 days). A media composition of 1:2:1 (soil : sand : FYM) was best with higher seed germination (51.0%). Among the bio-fertilisers, combined application of 2 g kg-1 soil each of *Azotobactor* and PSB showed 53.3% germination.

COLEUS (*Coleus forskohlii*)

Different organic manures and bio-fertiliser combinations were tried in addition to inorganic N-P-K forms at APHU, Bapatla. Inorganic fertiliser and combination of *Azospirillum* and *Phosphobacter* application produced highest plant height (63.3 cm), branches (8.4 plant-1) and yield (20750 kg ha-1).

GILOI (*Tinospora cordifolia*)

Characterisation of forty three germplasm conducted at DMAPR, Anand showed that number of primary branches varied from 1.5 to 8.54, internode length varied from 7.17 to 14.44 cm, diameter of primary branches varied from 4.17 to 7.88 mm and diameter of secondary branches varied from 4.18 to 7.18 mm. Majority of the accessions were having small starch granules of varied shapes.

At DMAPR, 34 accessions were characterised using RAPD markers. One hundred primers from OPA, OPC, OPD, OPP and OPJ were screened for optimisation, out of which maximum polymorphism was found in OPC followed by OPA and OPD primers.

Preliminary studies at APHU, Bapatla showed that clones collected from Rajugaripalem of Prakasam district had maximum values of morphological and economic traits, compared to the other clones.

GUGGAL (*Commiphora wightii*)

Seed germination of 30 clones conducted at DMAPR, Anand showed nine clones as polyembryonic. The apomictic embryo initials developed from the micropylar end of the ovule only, differentiated into embryos. Flow cytometric study showed that endosperm development in the species occured both by autonomously as well as by triple fusion.

Molecular characterisation using RAPD markers of guggal conducted at DMAPR, Anand showed a wide variation within and among the accessions having similarity matrix value ranged from 0.519 to 0.950. Best resolving power (12.083) was observed in the primer OPN20. The maximum RAPD primer index (RPI) (2.638) was observed for the primer OPN10.

RAPD technique used to find out markers linked to sex determination in the species at DMAPR, Anand showed two RAPD markers *viz*., female-specific marker $OPN06_{1280}$ and hermaphrodite-specific marker $OPN\ 16_{400}$ together can reliably differentiate the male, female and hermaphrodite plants. A third marker, OPA20 amplified a ~1140bp fragment from female and hermaphrodite.

The study conducted to identify and assess the genetic relationship within and among four species of *Commiphora viz*. *C. wightii* , *C. myrrha*, *C. caudata* and *C. stocksiana* at DMAPR, Anand showed a total of 190 bands, of which 180, 10 and 89 bands were polymorphic, monomorphic and unique, respectively in nature. Maximum of 100 loci was amplified in case of *C. wightii* and minimum (71) in *C. stocksiana*.

INDIAN VALERIAN (*Valeriana jatamansi*)

Three different plant growth regulators were tested at UBKV, Kalimpong for seed germination. Kinetin (200 ppm) produced maximum (92.0%) seed germination.

ISABGOL (*Plantago ovata*)

Emasculation of flowers for artificial hybridisation using chemical agents was tried at DMAPR, Anand and desirable results were obtained with GA_3 and ethrel.

A study was undertaken for regeneration of *in vitro* haploid plants at DMAPR, Anand. Size of the spike was standardised for the uninucleate and binucleate microspores. It was observed that the whole spike kept for 4-11 days at 4° C showed better response for callusing in MS media containing BA (0.5-1.0), IAA (0.5-1.0) and 2,4-D (0.5-1.0) with 3% sucrose in dark after 6-8 weeks of culture.

Artificial creation of variation through chemical mutagens initiated at DMAPR, Anand showed some visible variants (mutants) for leaf colour, leaf length and breadth, leaf shape, plant height, spike length, seed size, number of branches, hairs on leaf, flowering types and plant types in M_2 generation.

At AAU, Anand also, seeds from M_2 generation were selected on the basis of maximum number of spikes and mutant Sel 11 gave superior yield over the check. Seed yield was 686 kg ha^{-1} in Sel 11 compared to the GI 2 where the seed yield was 546 kg ha^{-1} which was about 25% more over the check.

Eighty accessions evaluated at RVSKVV, Mandsaur showed that seed yield ranged from 444 kg ha^{-1} (SPS-9) to 1555 kg ha^{-1} (MIB-121).

At MPUAT, Udaipur eight superior lines were evaluated and five lines *viz*. MIB-124 (949.07 kg ha^{-1}), 45 Kr-1-6 (856.48 kg ha^{-1}), 60 Kr-2- 5 (777.77 kg ha^{-1}), HI-1 (768.52 kg ha^{-1}) and AMB-29 (763.88 kg ha^{-1}) exhibited higher seed yield compared to the best check, GI-2 (759.26 kg ha^{-1}). In another trial, three advanced lines were evaluated and all the three lines *viz*., Palampur-2 (965.27 kg ha^{-1}), PB-62 (905.09 kg ha^{-1}) and Gumary (752.31 kg ha^{-1}) recorded higher seed yield compared to the best check, GI-2 (752.28 kg ha^{-1}).

Aphid (*Aphis gosypii*) infestation was recorded in a field trial conducted at DMAPR, Anand on effect of different dosages of nitrogen and irrigation levels. Crop received 60 kg N ha^{-1} had highest aphid incidence. Mean aphid population $plant^{-1}$ was 222.6 (at irrigation schedule 0, 20, 40, and 80 DAS). Lowest aphid population (2.7 aphids $plant^{-1}$) was associated with control plot from irrigation schedule of 0, 20, 40 and 60 DAS. Two species of caterpillars, *Junonia orithya* L. and *Hyposidra successaria* Walker, were observed at DMAPR, Anand. Both the species are first report of these pests in this crop.

JIVANTI (*Leptadaenia reticulata*)

Dry biomass production was maximum in 60 x 60 cm spacing (10976.1 kg ha^{-1}) and harvesting at 150 days (11236.5 kg ha^{-1}) at AAU, Anand. It was also found that neither different seedling age nor planting dates showed significant differences in terms of biomass yield.

KALMEGH (*Andrographis paniculata*)

Ten lines were selected based on days to flowering at AAU, Anand and it was found that days to flowering varied from 86.3 to 107.8 days among the selected lines. Selection AK-1 took maximum days to flowering, followed by Sel 10 (107.50 days). Dry herbage yield was also significantly higher in AK 1 (3455.21 kg ha^{-1}).

At DMAPR, Anand different seed rate, row spacing, FYM dose and shade were tried to standardise nursery techniques. Seedling height and seedlings ready for transplanting were maximum at seed rate of 3 g m^{-1}. Highest number of seedlings ready for transplanting was produced at 15 cm spacing (852 m^{-2}). Optimum FYM dose in terms of highest seedings ready for transplanting from unit area was 4 kg m^{-2}. Better seedling growth was achieved under shade. Seedbeds under the shade (30–75% shade net) produced 26–72% more number of seedlings ready for transplanting compared to open conditions.

A field trial was conducted at PDKV, Akola to determine best plant spacing and harvesting age. Plant growth and andrographolide content did not differ due to different spacing. Planting at 30 x 15 cm and harvesting at 135 DAP produced highest fresh (7324.01 kg ha^{-1}) and dry (2199.40 kg ha^{-1}) foliage yields. Different FYM levels and harvesting age were also tried to maximise yield. Highest fresh (5173 kg ha^{-1}) and dry (1788 kg ha^{-1}) leaf yields were obtained from 7.5 t FYM ha^{-1}. Harvesting at 135 DAP produced highest fresh (4822 kg ha^{-1}) and dry (1833 kg ha^{-1}) leaf yields as well as andrographolide yield (38.5 kg ha^{-1}). NPK uptakes reached maximum at the highest nutrient dose.

Different doses of organic manures and bio-fertilisers and their combinations were tested at NDUAT, Faizabad. Maximum fresh (10654 kg ha^{-1}) and dry (3515 kg ha^{-1}) herbage yields were obtained with the application of 10 t pressmud ha^{-1}.

LONG PEPPER (*Piper longum*)

Eight selected genotypes were evaluated at KAU, Trichur for high spike and alkaloid yields. It was found that Acc.No.2 was superior (665 kg ha^{-1}) to the existing high yielding variety 'Viswam' (508 kg ha^{-1}).

At PDKV, Akola application of FYM, neem cake and urea significantly influenced the growth and yield. Maximum fruits (85.3 $plant^{-1}$) and dry fruit yield (323.93 kg ha^{-1}) were

produced from 75 kg N ha^{-1} through urea. Piperin content was not affected by application of FYM, neem cake or urea.

MAKOI (*Solanum nigrum*)

At APHU, Bapatla minimal descriptor was developed in the species and it revealed that the entire accessions collected could be categorised into three groups *viz.,* plants of smooth leaf without trichomes bearing black berries, plants of wavy leaf with trichomes bearing black berries and plants of wavy leaf with trichomes bearing red berries.

Different organic manures (FYM, neem cake and vermicompost), inorganic nitrogen doses and their combinations were tested at APHU, Bapatla to maximise growth and yield. Highest yield was obtained from neem cake + 40 kg N ha^{-1} (3966 kg ha^{-1}). Higher inorganic nitrogen dose increased disease and insect attack.

OPIUM POPPY (*Papaver somniferum*)

Two hundred and thirty five germplasm evaluated at RVSKVV, Mandsaur showed that latex yield plant^{-1} varied from 0.00 g (Posta-91) to 0.32 g (UO-7982& JA-16). Seed yield ranged from 1.04 g (NBRI-9) to 3.37g (MOP-1088).

Forty three accessions evaluated at MPUAT, Udaipur showed that 16 germplasm had higher latex yield over the best check Chetak Aphim (27.38 kg ha^{-1}). In another trial, ten superior lines evaluated showed that five lines, *viz*., UOP-78 (31.40 kg ha^{-1}), UOP-34 (30.80 kg ha^{-1}), UOP-60 (28.75 kg ha^{-1}), UOP-43 27.98 kg ha^{-1}) and UOP-83 (27.94 kg ha^{-1}) exhibited higher latex yield over Chetak Aphim (27.80 kg ha^{-1}).

A total of 235 germplasm lines were screened against powdery mildew at RVSKVV, Mandsaur. Twenty two lines were found resistant.

Six hybrids tested at RVSKVV, Mandsaur showed that Hybrid MOH-2 recorded significantly higher latex yield (50.71 kg ha^{-1}) followed by MOH-1 (48.28 kg ha^{-1}) compared to check JOP-540 (46.84 kg ha^{-1}). At Udaipur, two hybrids *viz*; ROH-36 and NDH recorded higher latex yield (26.02 kg ha^{-1}, 25.20 kg ha^{-1}) over Chetak Aphim (24.7 kg ha^{-1}). At Faizabad, highest latex yield was in NDH-2 (42.74 kg ha^{-1}) followed by NOP-4 (38.86 kg ha^{-1}) .

Five newly developed hybrids evaluated at MPUAT, Udaipur showed that three hybrids *viz*. PHO-36, PHO-33 and PHO-35 recorded high latex yields (29.33 kg ha^{-1}, 26.4 kg ha^{-1} and 25.7 kg ha^{-1}) over Chetak Aphim (25.5 kg ha^{-1}). Six new hybrids developed at Faizabad centre were also tested. Maximum latex yield was in hybrid NDH-3 (53.39 kg ha^{-1}) followed by NDH-4 (46.12 kg ha^{-1}).

To standardise nutrient management for opium poppy and ashwagandha crop sequence, an experiment was carried out at MPUAT, Udaipur. Increasing levels of nutrients significantly increased growth, yield and quality. Increase in organic matter to opium poppy significantly increased different growth parameters and yield of succeeding ashwagandha crop. However, inorganic nitrogen to opium poppy did not influence productivity and quality of succeeding ashwagandha significantly. Application of 30 kg N ha^{-1} to ashwagandha significantly increased root yield (778 kg ha^{-1}) and total alkaloids content (0.55%).

Six fungicides were tested against powdery mildew at RVSKVV, Mandsaur. Bayletan was most effective with 61.43% reduction in percent disease index compared to control. Latex

(25.27 kg ha-1), seed (416.68 kg ha-1) and husk (596.21 kg ha-1) yields were also highest with this chemical.

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

Sixteen superior lines were evaluated at CCSHAU, Hisar showed that four lines yielded significantly higher oil yield against the check RH-49. The highest oil yield was observed in PRH 8-5 (86.956 lt ha-1).

SAFED MUSLI (*Chlorophytum borivilianum*)

Studies carried out for identification and establishment of genetic relationships in three species of *Chlorophytum (C. borivilianum*, *C. arundinaceum* and *C. tuberosum*) and two high yielding clones of *C. borivilianum* using RAPD markers at DMAPR, Anand showed two major clusters *viz.*, the first major cluster constituted *C. arundinaceum* and *C. tuberosum*, and the second major cluster composed of two subclusters; the first subcluster represented the two high yielding clones of *C. borivilianum* whereas the second subcluster represented open pollinated seedling progenies of *C. borivilianum*.

A protocol was developed at DMAPR, Anand for micropropagation of *C. arundinaceum* using stem disc as explant. Micropropagated plantlets were hardened in the green house and successfully established in the field where 99% of the plants survived showing luxuriant growth and flowered.

Twenty-four accessions evaluated at RVSKVV, Mandsaur showed wide range of variability among the accessions. Maximum fresh fasciculated root yield was in MCB-412 followed by MCB-414 (2965 kg ha-1) compared to 2449 kg ha-1 fresh fasciculated root yield in the check variety JSM–405 .

Eleven accessions were evaluated at CCSHAU, Hisar and the highest fresh root yield was recorded in JSM-405 (5593 kg ha-1), followed by HCB-2 (4815 kg ha-1).

At MPUAT, Udaipur twenty two new accessions were evaluated and nine accessions yielded higher fasciculated root yield over the check, MCB-405.

Five superior lines were evaluated at PDKV, Akola and it was found that none of the lines could record superior yield than the check. AKSM-01 recorded highest fasciculated root weight (35.55 g plant-1) followed by AKSM-03 (33.90 g plant-1) which were at par with check JSM- 405 (33.65 g plant-1).

Five superior lines were evaluated at MPUAT, Udaipur and four lines *viz.*, RC-77 (4250 kg ha-1), PC-2 (3806 kg ha-1), RC- 64 (3640 kg ha-1) and CBI-7 (3306 kg ha-1) produced higher fasciculated root yield over the check, MCB-405 (3250 kg ha-1). RC- 77 recorded maximum saponine and sapogenine contents.

Different doses of FYM and two different bio-fertilisers were tested at PDKV, Akola to optimise growth and yield. Application of 20 t ha-1 FYM and seed treatment with azotobacter recorded significantly higher fresh (3819 kg ha-1) and dry (688 kg ha-1) fleshy root yields. Similar trend was also observed in saponin yield however, sapnoin content was not influenced due to FYM and biofertilisers.

Fleshy root samples collected from market, farmers' field and from experimental field were analysed for carbendazim residue and microbial load. Market samples contained

minimum carbendazim residue (38 ppm) while farmers' field sample contained highest residue (47 ppm). Different fungi *Trichoderma*, *Aspergillus*, *Fusarium* and *Mucor* and a bacterial (*Pseudomonas*) genera were detected.

SANKHPUSHPI (*Convolvulus microphyllus*)

An experiment was conducted at AAU, Anand to determine optimum seed rate and spacing for dry biomass. All the seed rates and spacing produced non-significant difference in dry herbage yield.

SATAVARI (*Asparagus recemosus*)

Twenty six genotypes collected from different places of Haryana were evaluated at CCSHAU, Hisar and the highest fresh fasciculated root yield was obtained in HAR-03-18 (1043.21 q ha^{-1}). The highest saponin content was recorded in HAR-4.

The crop was observed infested with a beetle in the month of February at DMAPR, Anand. The beetle was identified as *Lema downesi* Baly and is reported for the first time on this crop from India.

SENNA (*Cassia angustifolia*)

Caterpillar of *Catopsilia pyranthe* was found infesting the crop at DMAPR, Anand. The adults as well as other immature stages were common during April to September and March. However, prevalence of different stages increased with the increase in humidity, reaching maximum during October (high humidity and less rains). The population started dwindling with the decrease in temperature from December onwards and reached zero level during January and February. The adult bred throughout the year. Eggs were laid singly on both the side of leaves in the ratio of 1:1. The larvae passed through five larval stages before transforming into pupa. Development period from egg to adult emergence was 22-29 days.

VACH (*Acorus calamus*)

Eleven clones were collected from various parts of Andhra Pradesh and evaluated at APHU, Bapatla. Rhizome weight varied from 60 to 43.0 g $plant^{-1}$. Based on the literature and observations made in collected germplasm, a minimal descriptor was also developed in the species.

ARIS Cell

A web based network on herbal garden in India was developed and hosted at www.herbalgardenindia.org by the DMAPR, Anand with funding from NMPB.

Different databases developed earlier like Medicinal and Aromatic plants References Information System, Traders Information system on Medicinal and Aromatic plants, Website of DMAPR, Digital Photo Library of Medicinal & Aromatic Plants, Digital Herbarium of Medicinal & Aromatic Plants in India were maintained and updated.

AINRP on Betelvine

Germplasm are maintained in seven centres and evaluated in six centres. Major emphasis for evaluation was given on leaf characteristics, vine growth, resistance to pest and diseases, keeping quality and organoleptic properties while evaluating the betelvine germplasm.

Hybrid evaluation conducted at two centres viz. APHU, Bapatla and MPKV, Sangli showed that GN hybrid did not show higher yield than their local checks. However, hybrid recorded significantly higher leaf quality such as leaf size (16.06 x 12.15cm), fresh weight of 100 leaves (345.31 g) and shelf life.

At IIHR, Bangalore, hybridisation was in full progress. A large number of crosses were made and the seedlings are in evaluation trial. Ten hybrids selected were multiplied for distribution to other centres for evaluation. Another ten selections were made from the hybrid progeny raised during 2007-08.

RAPD technique was used to find out markers linked to sex determination in male and female plants at DMAPR, Anand. Three male-specific RAPD markers $OPA04_{1400}$, $OPA08_{650}$ and $OPN02_{850}$ and two female-specific markers $OPA08_{1200}$ and $OPC06_{980}$ were found to reliably differentiate the male and female plants. Ploidy comparison also showed the differences in male and female plants.

Integrated crop management (ICM) combining INM and IPM was studied for one more year in APHU, Bapatla; BCKV, Kalyani; and MPKV, Sangli centres.

Epedemiological studies of important diseases were conducted at three centres (APHU, Bapatla; BCKV, Kalyani; MPKV, Sangli).

Demonstration of disease management technology developed by the centres in the farmers' field was successfully carried out by BCKV, Kalyani; JNKVV, Jabalpur and RAU, Pusa.

Economic threshold level (ETL) for tobacco caterpillar was studied at APHU, Bapatla and scale inscet at TNAU, Sirugamani. Results showed that presence of three larvae of tobacco caterpillar plant^{-1} can cause significant yield loss at which control measures need to be initiated to avoid economic loss. It was also found that crop was not affected up to 6 scales per 2 m vine (0.33 scales leaf^{-1}). Control measures required if it crossed this threshold level.

Introduction

From the dawn of human civilisation, plants have been used as a source of medicinal resource. Use of medicinal plants for different ailments have been modified, tested and standardised according to practitioners' wisdom. Hence, over a period of time use of these drugs have been monitored by population. Usually, this wisdom flows through generations for use by others. However, influence of modern science and other geo-political situation caused harm to this flow. Modern medicine took over as the only available method of medication. In the process, many information got lost or, distorted. However, people have started becoming familiar with side effects of modern medicines and its failure to manage the entire health system. Accordingly, appreciation for the traditional medicine started gaining popularity in the new world.

This phenomenon warrants for increased demand for many medicinal and aromatic plants (MAP). It is beyond the limit of the traditional source of these plants – forests to meet this increased demand. Moreover, people's awareness for quality drug also requires the plants production be standardised. Hence, cultivation of these plants becomes evident. However, cultivation of the wild species requires many aspects to be worked upon to ensure the quality of MAP.

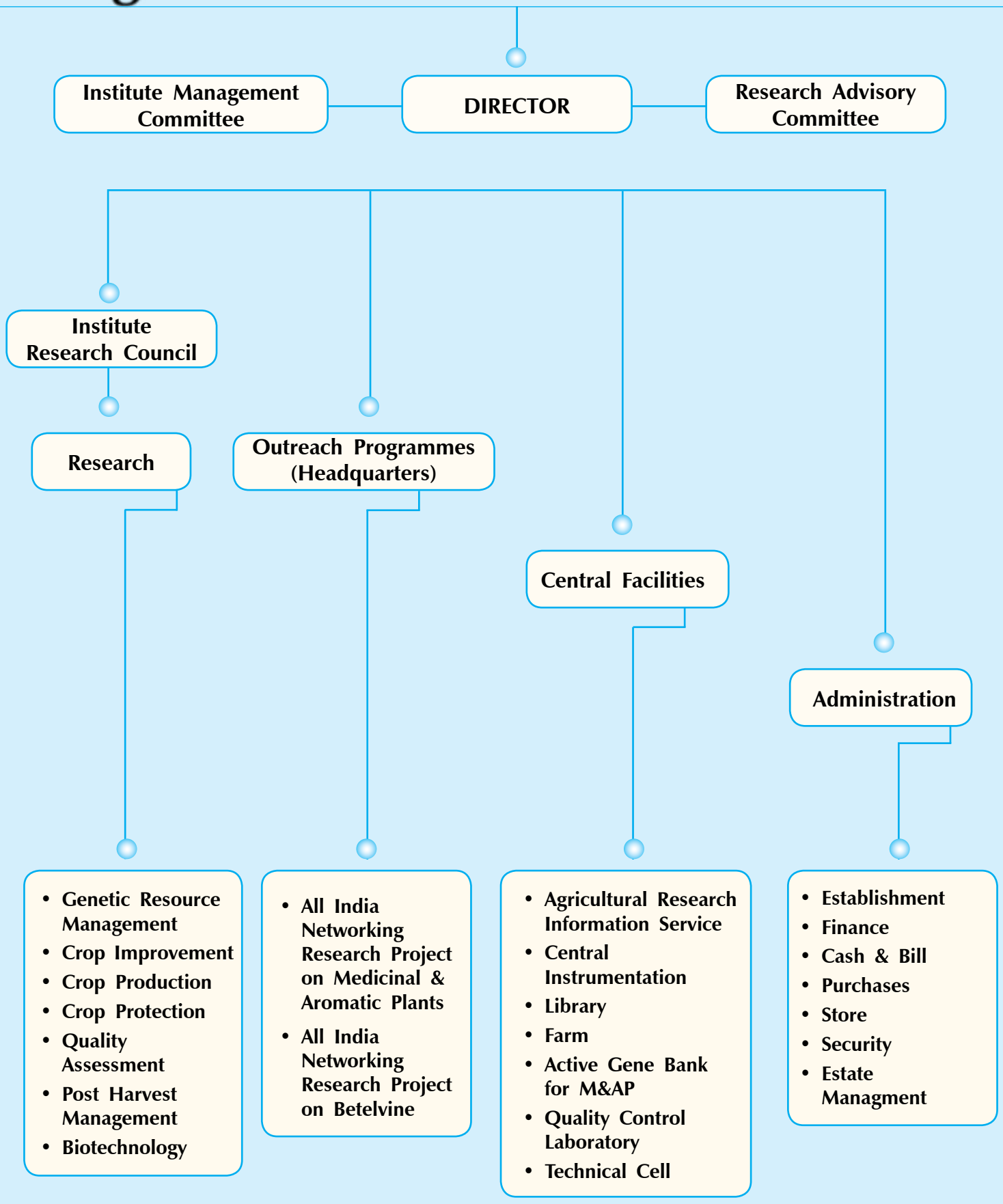
It is essential that the plants should be domesticated and their genetic resources must be conserved. Better plant types need to be selected from the available germplasm in terms of productivity and quality. The cultivation method needs to ensure high productivity to meet the demand as well as retain the medicinal properties intact. Hence, various aspects like growth habit, growth environment, soil types, irrigation and fertilisation application schedules and sowing and harvesting times are to be standardised. Disease and pest problems in the standing crops and harvested material are to be managed to keep the product safe for consumption. A newer dimension of traceability of the drug has also being thought to be added. This requires data recording and certification on all aspects from production to processing to handling. It will be easy to trace and plug the problem, if any.

To ensure this, FAO advocates development of good agricultural and collection practices for this group of plants. Directorate of Medicinal and Aromatic Plants Research (DMAPR) and its partner State Agricultural University (SAU) centres under the aegis of All India Networking Research Project on Medicinal and Aromatic Plants (AINRPMAP) as well as All India Networking Research Project on Betelvine (AINRPB) are ushering to fulfil this goal. This report presents the salient findings of the research conducted during 2008-09 at DMAPR and its outreach programmes by these organisations.

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 breeders' stock.
- Act as a National Repository for the genetic resources of some important medicinal and aromatic plants.

Organisational Structure



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

Mandate Crops

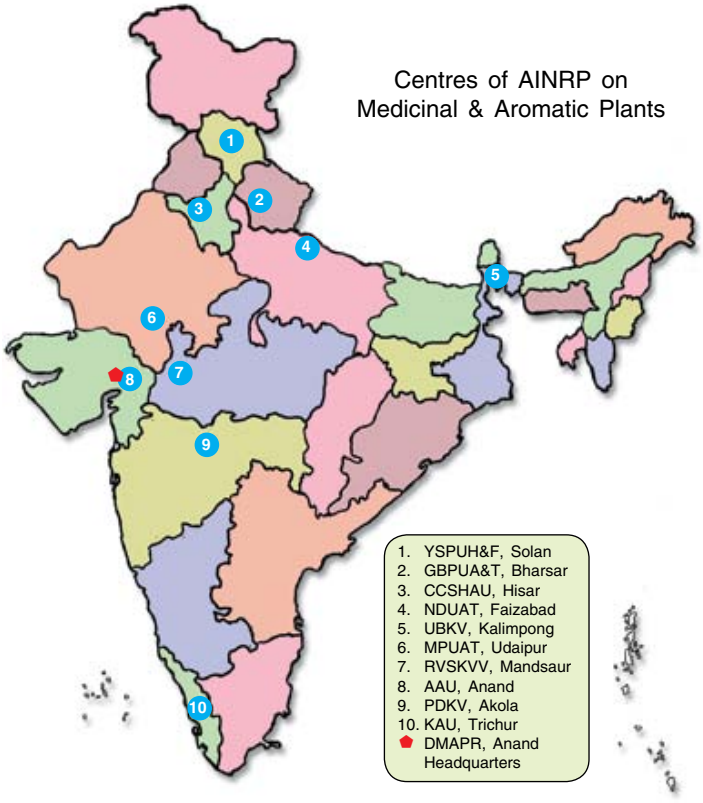
- Aloe (*Aloe barbadensis* Mill.)
- Ashwagandha (*Withania somnifera* Dunal.)
- Giloi (*Tinospora cordifolia* (Willd.) Hook f. & Thoms.)
- Guggal (*Commiphora wightii* (Arn.) Bhandari)
- Isabgol (*Plantago ovata* Forsk.)
- Lemongrass (*Cymbopogon flexuosus* Nees ex. Steud Wats.)
- Palmarosa (Cymbopogon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

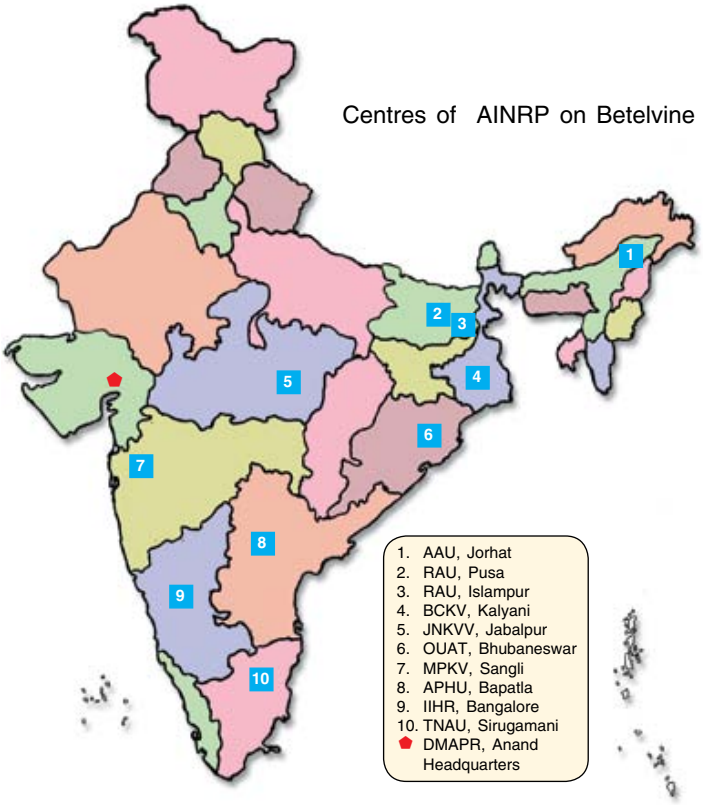
Objectives

- To identify plants which need attention of agricultural scientists and to collect, maintain and evaluate the identified plants.
- To carry out those basic researches on the chosen crops, which are useful to develop their GAP.
- To coordinate the activities of the centres of AINRP on Medicinal & Aromatic Plants and Betelvine 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 DMAPR.
- To develop partnership between this research centre and private sector, NGOs and farmers' associations/progressive farmers interested in promoting the use of herbal medicines.

Outreach Programmes

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


Centres of AINRP on
Medicinal & Aromatic Plants
1. YSPUH&F, Solan
2. GBPUA&T, Bharsar
3. CCSHAU, Hisar
4. NDUAT, Faizabad
5. UBKV, Kalimpong
6. MPUAT, Udaipur
7. RVSKVV, Mandsaur
8. AAU, Anand
9. PDKV, Akola
10. KAU, Trichur
DMAPR, 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. MPKV, Sangli
8. APHU, Bapatla
9. IIHR, Bangalore
10. TNAU, Sirugamani
DMAPR, Anand
Headquarters

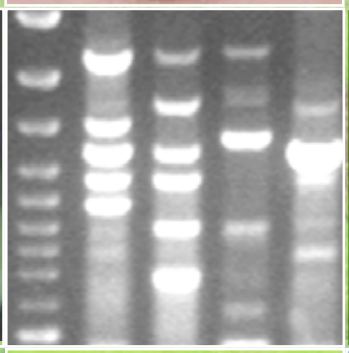
responsible for coordination and monitoring of research work in these two projects as Project Co-ordinator in addition to his duties. There are ten centers in SAUs under AINRPMAP and nine centers in SAUs and one centre at IIHR, Bangalore are participating under AINRPB.

The different centres under the AINRPs are as follows:

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

BUDGET PROFILE

Head	Expenditure (Rs. in lakhs)
Non Plan Expenditure	172.20
Plan Expenditure	
• DMAPR • AINRP on Medicinal & Aromatic plants • AINRP on Betelvine	225.00 200.00 95.00
Ad-hoc schemes	
• IPR Management	1.94
Externally funded projects	
• NMPB Funded Projects • DUS testing • NAIP • National Horticulture Mission • Revolving fund scheme	9.57 3.76 11.15 0.05 1.12



Research Achievements

ALOE (*Aloe barbadensis*)

It belongs to the family Liliaceae and is a native of Africa, Canary Islands, Spain and Mediterranean countries which has spread and naturalised to other parts of the world including India. The characteristic bitter taste of aloe possesses many medicinal properties. The leaves are alterative, stomachic, aphrodisiac, cathartic, emmenagogic, astringent, antidotal, anthelmintic and hepatic stimulant. Aloe gel gives cooling effect and acts as a moisturising agent. It is thus included as basic raw material in preparation of creams, lotions, and shampoos.

DNA extraction protocol

DMAPR, Anand: An efficient DNA extraction protocol was developed for large quantity and good quality DNA from the gel of *A. barbadensis* using 4X CTAB with major modifications. The isolated DNA had normal spectra in which the A_{260}/A_{280} ratios were 1.6-1.7. Agarose gel eletrophoresis also demonstrated no evidence of protein and RNA contamination and confirmed that the DNA was of high molecular weight compared with undigested λ DNA; the yield ranged between 10 and 20 μg gram^{-1} of gel.

Collection and evaluation of germplasm

CCSHAU, Hisar: Thirty three genotypes including HAV-1 as check were evaluated for yield and yield contributing characters. Plant height ranged from 40.0 cm (HAV-04-4) to 69.3 cm (KC/OP-33); leaf length varied from 37.3 cm (HAV-04-4) to 53.3 cm (KC/OP-33); leaf width from 5.7 cm (HAV-04-5) to 11.0 cm (IC-112526); fresh leaf weight plant^{-1} ranged from 533.3 g (HAV-04-5) to 1900.0 g (IC-112526) and leaves plant^{-1} from 4.3 (HAV-04-4) to 10.3 (KC/OP-23). Leaf yield ranged from 14815 kg ha^{-1} (HAV-04-5) to 52778 kg ha^{-1} (IC-112526) and the mucilage ranged from 40.0% (KC/OP-33) to 72.0% (IC-112567).

Effect of irrigation and planting methods on growth and yield

CCSHAU, Hisar: A field trial was conducted to standardise irrigation requirement and planting methods. The crop was grown as rainfed or, irrigated twice (during summer and winter) or, thrice (at 4 months interval) or, four times (at 3 months interval). Planting was done in the beginning of August either on flat bed, ridges or, raised beds. Irrigation levels created significant differences in the different parameters observed. However, planting methods did not have any significant effect. After 12 months of planting, highest plant height was observed with three–four irrigations (68.8–72.5 cm). Highest leaf yield was recorded with four irrigations (24683 kg ha^{-1}), followed by three irrigations (20104 kg ha^{-1}). Leaf gel yield also showed similar trend with 16047 and 13067 kg ha^{-1}, respectively from these treatments.

Effect of nitrogen and phosphorous fertilisation on growth and yield

CCSHAU, Hisar: In a factorial experiment four levels of nitrogen (0, 20, 40 and 60 kg ha^{-1}) and three levels of phosphorous (0, 15, and 30 kg ha^{-1}) were tested. Plant growth

observations recorded one year after plantating showed that nitrogen significantly influenced plant height, leaf length, number of leaves plant^{-1}, leaf yield and gel yield. Maximum plant height (69.0 cm), leaf number (12.9 plant^{-1}), leaf yield (11002 kg ha^{-1}) and gel yield (7151 kg ha^{-1}) were observed in 60 kg N ha^{-1}. However, phosphorous levels failed to show any significant difference on any of the parameters studied.

Effect of soil moisture stress on chlorophyll fluorescence kinetics

DMAPR, Anand: A study was conducted to understand the response of aloe to progressive soil moisture deficit and its effect on physiological functions and chlorophyll fluorescence kinetics. Soil moisture stress was imposed to pot grown plants by withholding water for 90 days. Chlorophyll fluorescence kinetics was monitored in the young, mature and older leaves. Maximum quantum efficiency (Fv/Fm) was 0.73, 0.76 and 0.70 in the young, mature and older leaves of control plants, respectively. It did not alter significantly in all the leaf types. Photosystem II (PSII) maximum efficiency (Fv'/Fm') reduced marginally in the young and older leaves compared to mature leaves. PS II efficiency factors were 0.13, 0.11 and 0.12 in the young, mature and older leaves of control plants, respectively and drastically reduced under stress. Both photochemical and non-photochemical quenching quotients altered significantly under stress. There was 60% reduction in the photochemical quenching in all leaf types at the end of the treatment period. Large increase in non-photochemical quenching of 26.79%, 17.53% and 56.51% in young, mature and older leaves were recorded, respectively. Electron transport rate in stressed plants reduced by 69.6%, 54.0% and 62.1% in young, mature and older leaves, respectively compared to control plants.

ASALIO (*Lepidium sativum*)

It is a small herbaceous annual herb of family Brassicaceae. The species is believed to be originated in the high land region of Ethiopia and Eritrea which was later introduced to Europe and western Asia. The crop is grown during rabi season in the selected areas of India mainly as seed crop and also for salad purposes. The plant is used in the treatment of asthma, coughs, and bleeding piles. The leaves are mildly stimulant and diuretic. The seeds are galactogogue, laxative and diuretic. Mucilage obtained from the seeds soothes irritation of the intestines in cases of dysentery and diarrhoea.

Evaluation of germplasm

CCSHAU, Hisar:Fifteen germplasm were evaluated and it was found that plant height ranged from 98.0 to 137.5 cm; branch plant^{-1} ranged from 6.5 to 12.5; seed yield plant^{-1} varied from 3.63 to 35.11 g; seed yield ranged from 1335 to 1825 kg ha^{-1} and 1000-seed weight ranged from 1.65 to 2.45 g. The highest seed yield was recorded in genotype HLS-8 (1825 kg ha^{-1}), followed by HLS-4 (1775 kg ha^{-1}), HLS-3 (1742 kg ha^{-1}), HLS-11 (1715 kg ha^{-1}) and HLS-1 (1695 kg ha^{-1}).

RVSKVV, Mandsaur:Thirteen germplasm were collected from farmers' field of Madhya Pradesh and were tested for seed yield and yield contributing characters. The highest seed

yield was recorded in MLS 7 (1987 kg ha-1) followed by MLS 5 (1960 kg ha-1), MLS 1 (1933 kg ha-1) and MLS 6 (1733 kg ha-1). The mean plant height ranged from 75.0 cm (MLS 1) to 96.0 cm (MLS 13) and number of branches per plant ranged from 15.0 (MLS 2) to 26.0 (MLS 13). Maximum 1000 seed weight was recorded by MLS 6 and MLS 8 (1.86 g) followed by MLS 10 (1.84 g) and MLS 4 (1.83g).

Effect of FYM and spacing on seed yield

NDUAT, Faizabad: The experiment was laid out to find out optimum dose of FYM and spacing for growth and seed yield. Three FYM doses (0, 10 and 20 t ha-1) and three spacing (30x10, 30x15 and 30x20 cm) were tested. Significantly higher plant height (111.9 cm) was attained due to highest FYM dose than other treatments. Branches were also maximum (23.1 plant-1) in this treatment. Higher FYM dose extended the vegetative growth phase and bud initiation was delayed compared to others. It started at 88 DAS compared to 82 DAS in case of control. Different spacing produced non-significant differences in terms of plant height. However, maximum branches (22.9 plant-1) were produced from 30x15 cm spacing. Bud initiation was earlier in 30x10 cm spacing where, it started at 83 DAS. Significantly highest seed yield (1324 kg ha-1) was obtained with the application of 20 t FYM ha-1 compared to other treatments. Among the different spacing tried, close spacing (30x10 cm) produced maximum seed yield (1216 kg ha-1).

Effect of spacing on growth and yield

RVSKVV, Mandsaur: Two genotypes (MLS-1, MLS-7) were grown in combinations of two row spacing (30 and 45 cm) and three plant spacing (5, 10 and 20 cm). Plant height was significantly highest (50–60 cm) when grown at closer plant spacing for all row spacing and genotypes. However, reverse was the trend for number of branches. Seed yield was highest at 30x10 cm spacing (1800 kg ha-1) for both the genotypes. However, it was at par with the yields obtained at 45x5 cm in MLS-1 (1500 kg ha-1) and MLS-7 (1700 kg ha-1).

Effect of irrigation and seed rates on the growth and yield

RVSKVV, Mandsaur: A field experiment was conducted to standardise irrigation schedule and seed rate. Three irrigation schedules were followed (i) at 0 and 30 days after sowing (DAS), (ii) at 0, 30 and 60 DAS and (iii) 0, 30, 60 and 75 DAS; while four seed rates (8, 10, 12 and 15 kg ha-1) were applied. Highest plant height (50 cm), number of branches (16.5 plant -1) and seed yield (1550 kg ha-1) were obtained from four irrigations. Seed yield was 37.78% and 77.14% higher compared to three and two irrigation schedules, respectively. Higher seed rate increased plant height, highest (50.6 cm) being at 15 kg ha-1. However, number of branches showed reducing trend with increasing seed rate. Seed yield was maximum (1430 kg ha-1) with 8 kg ha-1 seed rate. However, it was at par with next higher seed rate (1260 kg ha-1).

Effect of sowing dates and seed rates on the growth and yield

RVSKVV, Mandsaur: To standardise the seed rate at varying sowing dates, the crop was sown at 10 days interval between 10 October and 20 November with a seed rate of 6, 8 or 10 kg ha-1. Both sowing dates and seed rates had significant effect on growth and seed yield. Plant height was maximum (101.6 cm) when sown at October 20 which

was at par with that of October 10 sowing (95.0 cm). Number of branches (18.3 plant^{-1}) and grain yield (1830 kg ha^{-1}) were maximum at October 30 sowing and was also at par with November 10 sowing (1700 kg ha^{-1}). Increasing seed rate increased the plant height but, reduced number of branches. Optimum seed rate was found to be 6 kg ha^{-1} with maximum seed yield (1700 kg ha^{-1}).

Leaf blight disease and its control

NDUAT, Faizabad: A leaf blight disease was commonly observed in experimental plots and also in farmers' field. The disease appeared late, approximately 40 days after sowing. The infection first appeared on leaves and then spread to stem and seeds. The spots on the leaves were initially circular and brown in colour. These later coalesced and formed irregular patches without definite margin. In older lesions, centre of the spots became greyish in colour with dark brown margins. Similar elongated spots were also observed over the stems. After winter rains, the disease spread was faster and covered 75-80% of the stem area and caused heavy defoliation. Surface of the seeds turned dark brown to blackish. The seeds either germinated to produce sick seedlings or, failed to germinate. The pathogen was isolated and identified as *Alternaria alternata* (Fr.) Keissler. The pathogenicity of the fungus was confirmed by inoculating the potted plants.

To manage the disease, a field trial was conducted with foliar application of both contact (mancozeb) and systemic (propacanozole) fungicides. The foliar sprays were applied following various schedules starting first spray at 40 DAS. Both the fungicides significantly reduced disease severity and increased seed yield. Application of mancozeb three times at 15 days interval produced lowest disease severity (PDI=12.0). However, it was at par with three applications of propaconazole at 40, 55 and 70 DAS and two applications of mancozeb at 40 and 55 DAS which produced PDI of 13.0 and 14.6, respectively. In terms of seed yield, three application of mancozeb was best (2000 kg ha^{-1}) and was at par with all fungicide spray schedules when any of the fungicides was applied at least twice.

ASHOKA (*Saraca asoca*)

The plant belongs to the family Caesalpiniaceae. It is a small evergreen tree of about 9 m height. Flowers are orange or orange-yellow, turning vermilion, arranged in corymbose panicles. The plant is a native of India, Srilanka, Bangladesh and Myanmar. In India, it is distributed in the central and eastern Himalayan foot hills and also in western peninsular India. The species is becoming rare throughout the country. The astringent bark is stimulant in effect on the endometrium and ovarian tissues and used for the treatment of menustrual pains, and menorrhagia due to uterine fibroids.

Evaluation of germplasm

KAU, Trichur: Forty two accessions were maintained and evaluated. Results revealed lot of variability for many of the morphological traits from seedling onwards.The accessions

collected from Thrissur and Trivandrum showed vigorous growth represented by its increased height, number of leaves and higher girth of the stem. It was also found that higher number of leaves had positive association with mean girth of stem. IC 566487 and IC 566492 started flowering after two years of planting. Out of the 42 accessions, 24 accessions were selected for assessing the tannin content and its relationship with bark characters.

Reproductive biology

KAU, Trichur: Reporoductive biology was studied in the species. Flower opend between 5 to 6 am, irrespective of the genotype, age of the tree and prevailing climatic conditions. Anther dehisced at the time of flower opening, between 5-6 am, anthers dehisced by longitudinal slits. Stigma was receptive one hour after flower opening and continued to be receptive for the full day. Pollen was creamy white, tricolpate and round with smooth exine. Average size of pollen was with 31.18 µm length and 30.4 µm breadth. In sucrose solution, pollen germination recorded was 45%. In natural conditions, trees were cross pollinated. Percentage of pod set under open pollination was 42.5%. Self pollination was also present to a very small extent in bagged inflorescence. Percentage of pod set under selfing was 4.37%. Pollinators causing pollination were identified mainly as ants. Wind also played role to a very small extent causing cross pollination. On attaining full maturity, pods were green in colour with seed number pod^{-1} varying from 2 to 5. Average fruit size was 3.3 cm x 2.3 cm.

Effect of different methods and season of grafting on propagation

DMAPR, Anand: Four methods of grafting (cleft, whip, whip and tongue and side tongue grafting) and two methods of budding (chip and patch budding) were tested on one year old seedlings as rootstocks. The scions were procured from eight year old tree. The scions were pre-cured one week before grafting/budding. The grafting was performed during different seasons (January-March, June-September and October-December) in a year to standardize the best season of grafting. After grafting, the plants were kept under poly-house with intermittent mist to the grafted plants.

Two budding methods tried, failed to show bud union in all the three seasons. Also, none of the grafting methods showed any success in graft union when performed during the month of January to March.

Among different grafting methods performed during the month of June-September, whip and tongue grafting showed highest grafting success (86.67%) followed by cleft grafting (73.33%). However, 26.67% success in cleft grafting was achieved in October–December followed by whip grafting (13.33%) and side tongue grafting (6.67%). Minimum time taken for bud sprout was in whip grafting (9.7 days) during June–September, followed by whip and tongue grafting (12 days). During October–December, cleft grafting produced maximum number of buds sprout graft^{-1} followed by whip and tongue grafting during June–September. However, maximum number of leaves per graft was observed in whip and tongue grafting during June–September followed by cleft grafting. Whip tongue grafting during June–September took minimum time for graft union.

Effect of pre-curing of scions on graft union

DMAPR, Anand: Pencil thickness stems were selected and pre-cured at 1, 2, 3 and 4 weeks before cleft grafting during the month of June–July . In control plants, the scions were pre-cured immediately before grafting. Pre-curing made 1 week before grafting produced bud sprout in minimum time (18 days), highest number of bud sprouts (2.1), highest number of plants with graft union, highest grafting success (75.0%), highest number of leaves per plant (11.3) and minimum days for graft union (31.4). The next best treatment was pre-curing 2 weeks before grafting with 60% success. However, pre-curing done before 4 weeks of grafting did not show any positive results. It was also observed that the dormant buds in the scions started sprouting in the mother plant when pre-cured scions left in the mother plant for more than two weeks.

Standardisation of air layering

DMAPR, Anand: During monsoon season, one year old, brown blotched, pencil thick (8-10 mm) shoots were selected from two–three year old mother plants. Leaves were removed from the base of the selected shoot and 2.5–3.0 cm notch per girdle was made in the inter-nodal region. Two concentrations of IBA (2500 and 4000 ppm) along with control were tried for propagation through air layering. IBA solutions were smeared over the notched area and immediately covered with handful of moist rooting media prepared using locally available materials (soil: saw dust: coir pith: sand: cow dung; 1:1:1:1:1) and finally wrapped with polythene sheet and tightly tied at both the ends. The rooting of air layers started after forty five days. Rooting of the air layered stem was achieved both in IBA treated and also in control plants. However, use of IBA at both concentrations (2500 and 4000 ppm) had maximised the rooting percentage and other rooting parameters. Higher rooting success (90%) was achieved in IBA treated stems compared to control (80% success). Other parameters such as, number of primary and secondary roots, length of roots; longest root, root girth were also positively influenced by IBA treatment.

Quality assessment and differentiation of raw drug

KAU, Trichur: To differentiate commonly used adulterant, *Polyalthia longifolia*, different quality parameters were studied. Fresh bark pieces were collected from authentic *S. asoca* and *P. longifolia* trees. Bark pieces were oven dried at 40° C before further study. Bark from both the species were brownish grey in colour however, former was channelled, with raised horizontal lines of lenticels, circular lenticels, transversely ridged, sometimes cracked. *P. longifolia* bark was comparatively smooth with nonconspicuous lenticels or no lenticels. Inner bark of *S. asoca* was red or reddish brown in colour with longitudinally and tightly packed fibres. Hence it was easy to cut into fine pieces longitudinally. The adulterant was dark brown inner bark with rich criss-cross fibres. Dried bark (1 g) was overnight soaked in 10 ml water and this was used for further differentiation. Under visible light, extract from *S. asoca* appeared yellowish brown compared to pale sandal, cloudy of *P. longifolia* extract. Under UV (365 nm), dark green appearance with no green flourescense or, slight flourescense on surface layers of the solutions was observed for *S. asoca* samples. It produced four fluorescent bands on TLC (water : propanol, 1:1) and was positive to haemagglutination. Other sample produced very good milky green fluorescence under UV light, two fluorescent bands on TLC and was negative to haemagglutination.

ASHWAGANDHA (*Withania somnifera*)

The plant belongs to the family Solanaceae. Roots are used in preparation of vital tonics. The active ingredients that attribute to the medicinal properties are the alkaloids present in the roots. The crop is cultivated in the north western region of Madhya Pradesh. It is a late kharif crop and grown in sandy loam soil. It is also recognised as a folk remedy for a number of diseases *viz*. arthritis, asthma, bronchitis, adenopathy, anthrax, cancer, cold, cough, cystitis, debility, diarrhoea, dropsy, hypertension, inflammations, piles, tumors, typhoid, uterosis, etc.

Growth studies

DMAPR, Anand: Growth study was conducted in two varieties, JA 20 and JA 134 at 15 days interval starting from 30 DAS to 165 DAS. Growth was very slow in the initial period up to 75 days and it steadily increased from 90 to 150 DAS in both the cultivars. JA 20 had more dry matter than JA 134 for leaf, stem, root and fruits. Study of biomass partition showed that initial dry matter was from root and leaves and in the later stage (after 90 days), the dry matter content was mainly from fruits and leaves. Young roots had more 12-deoxywithanostramonolide and withanolide A content per unit root weight. The trend showed that during maturity of the roots, the content of active ingredients decreased. However, the total active ingredients yield increased due to the increase in dry weight of root.

Evaluation of germplasm

DMAPR, Anand: One hundred and thirty one accessions were evaluated along with two check varieties, JA-20 and JA-134. Considerable variability was observed for these characters among the germplasm. Root yield ranged from 0.49 to 11.76 g plant^{-1}. Accessions MWS-312, MWS-315, MWS-108, RAS-53 and RAS-39 had significantly higher seed yield as well as root yield per plant than the best check, JA-20. Study on gas exchange parameters in the germplasm at 150 DAS showed that accessions MWS-218, MWS-13, RAS-16, RAS-135, RAS-39, MWS-227, RAS-55, MWS-214, RAS-10 and MWS-301 could be grouped under high photosynthetic group and RAS-143, MWS-336, RAS-140, MWS-304, MWS-314, MWS-100, RAS-136, RAS-138 and MWS-311 were high respiration lines. Accessions having high photosynthetic rate had moderate respiration rate and *vice versa*. Transpiration rate ranged from 2.82 to 7.07 mmol H_2O m^{-2} S^{-1} and conductance ranged from 0.11 to 0.40 mol H_2O m^{-2} S^{-1}. The total chlorophyll content varied from 0.327 to 3.139 mg g^{-1} and 15 germplasm had higher value than the best check, JA-20 (2.074 mg g^{-1}). Similarly the ratio of chlorophyll a/b also varied significantly among the germplasm lines ranging between 2.83 and 8.29.

CCSHAU, Hisar: Thirty accessions were evaluated for various morphological and root parameters. Plant height varied from from 75.7 (Acc. 10) to 117.0 cm (Acc. 29); root length 24.5 cm (Acc. 14) to 48.9 cm (Acc. 28); root diameter 1.5 (Acc. 10) to 2.7 cm (Acc. 24);

branches plant-1 3.2 (Acc. 4) to 4.9 (Acc. 26); berries plant–1 162.0 (Acc. 20) to 715.9 (Acc. 29) and dry root yield 520 kg ha-1 (Acc. 17) to 253 kg ha-1 (Acc. 15). The highest root yield was observed in Acc. 15 (253 kg ha-1), followed by Acc. 29 (230 kg ha-1), Acc. 28 (227 kg ha-1), Acc. 21 (190 kg ha-1) and Acc. 30 (180 kg ha-1).

RVSKVV, Mandsaur: Sixty seven accessions of Mandsaur and fifty two from Udaipur were evaluated for thirteen different characters. Wide range of variability was observed among the accessions. Plant height ranged from 21.2 cm (MWS-311) to 38.5 cm (RAS-35). The plants were classified on the basis of branching pattern *viz.,* biparous and triparous. Plants were either bushy or erect. Berry colours were yellow, orange and red. On the basis of duration of plant maturity, plants were classified into three groups *i.e.* early (150-165 days), medium (165-180 days) and late (180-195 days). Most of the accessions fell either in medium or in late maturity groups. Length and diameter of roots ranged from 10.3 cm to 18.0 cm and 2.3 mm to 6.3 mm, respectively. Dry root yield ranged from 121 kg ha-1 (WS-90-121) to 842 kg ha-1 (MWS- 215). Seed yield ranged from 133 kg ha-1 (WS-90-127) to 844 kg ha-1 (MWS-317).

MPUAT, Udaipur: One hundred and thirty nine germplasm along with two checks *viz*., JA-20 and JA-134 were evaluated for dry root yield and other quantitative and qualitative traits. Maximum dry root yield was in RAS-10 and RAS-44 (1222.22 kg ha-1). Sixty one germplasm exihibited higher alkaloid content than the best check JA-134 (0.45%). Total alkaloid content ranged from 0.16 (RAS-91 & RAS-109) to 0.66 % (RAS-11, RAS-30, RAS-21, RAS-63, RAS-75, RAS-102, RAS-121, RAS-128 & RAS-129).

Initial evaluation of superior lines

AAU, Anand: Four selected lines were evaluated along with two check varieties (WS 100 and JA 20). Plant height was significantly higher in Sel 4B (53.9 cm), which was at par with all the other entries except the check JA-20. Root girth was highest in Sel 2B (3.74 cm) which was at par with the check WS 100 (3.32 cm). Dry root yield was significantly higher in Sel 2B (731 kg ha-1) which was at par with Sel- Carrot (645 kg ha-1).

MPUAT, Udaipur: Four advanced lines along with two checks *viz*, JA-20 and JA- 134 were evaluated for dry root yield and yield contributing traits, maturity traits and total alkaloid content. Three lines *viz*., RAS-10 (734.70 kg ha-1), MWS-100 (649.00 kg ha-1) and MWS-101 (641.20 kg ha-1) recorded higher dry root yield against best check JA-20 (606.30 kg ha-1). The dry root yield ranged from 734.7 kg ha-1 (RAS- 10) to 570.80 kg ha-1 (JA-134). Out of four genotypes only one genotype (MWS-100) recorded higher alkaloid content (0.38%) than the checks JA-20 and JA-134 (0.35% each). Alkaloid content varied from 0.27 (RAS-10) to 0.38% (MWS-100).

In another trial, eleven lines alongwith two checks viz, JA-20 and JA-134 were evaluated for higher root yield, yield contributing traits, maturity traits and total alkaloid content. Lines except RAS-21, WS-124 and MWS-132 recorded higher dry root yield than the best check JA- 20. The maximum dry root yield was in RAS-15 (916.70 kg ha-1) followed by RAS-7 (888.90 kg ha-1) , WS-90-140 and RAS-48 (875.00 kg ha-1). Dry root yield in check JA-20 was 740.7 kg ha-1. None of the genotypes exihibited higher alkaloid content than the best check, JA-20 (0.38%).

Effect of seed rate and sowing date on growth and yield

AAU, Anand: An experiment was conducted to determine the optimum sowing time and seed rate to maximise yield and quality. Sowing was started from September 30 and continued till November 30 at 15- days interval while seed rates of 6, 8, 10 and 12 kg ha^{-1} were used. Plant height at maturity, root length and root girth were not influenced by sowing date or seed rate. However, plant stand at harvest and dry root yield were maximum when sown at October 30 – November 15. Sowing at October 15 produced 475 kg ha^{-1} dry root yield. Increasing the seed rate improved plant stand at maturity, maximum being with a seed rate of 12 kg ha^{-1}. However, root yield was not influenced by different seed rates.

Effect of organic amendments on growth and yield

NDUAT, Faizabad: Effect of FYM (5–10 t ha^{-1}), vermicompost (2.5–5 t ha^{-1}), pressmud (5–10 t ha^{-1}), phosphorous solubilising bacteria (PSB) (10 kg ha^{-1}) and combination of lower doses of the organic manures with 10 kg ha^{-1} PSB along with control were compared in a field experiment. Different treatments produced significant difference in number of branches $plant^{-1}$ and it ranged between 2.2 and 2.8. Application of 10 t FYM ha^{-1} or 5 t pressmud ha^{-1} produced 2.8 branches $plant^{-1}$. Root length also significantly varied due to various treatments and treatment combinations of FYM, vermicompost and bio-fertilisers. Root length was maximum from 5 t vermicompost (15.9 cm) or pressmud (15.7 cm). However, 5–10 t pressmud ha^{-1} produced maximum root diameter (0.8-0.9 cm). Fresh root yield ranged from 770–1454 kg ha^{-1}. Maximum fresh root production was recorded from application of 10 t ha^{-1} pressmud followed by 10 t ha^{-1} FYM (1324 kg ha^{-1}). Dry root yield also followed the same trend and significantly highest yield was obtained from 10 t ha^{-1} pressmud (508 kg ha^{-1}) application.

Effect of growth regulators on root yield

RVSKVV, Mandsaur: To suppress the above-ground growth and thereby increasing root yield, different plant growth regulators were applied. Three chemicals *viz.,* TIBA (50, 100 and 150 ppm) cycocil (250, 500 and 750 ppm) and maleic hydrazide (MH) (100, 150 and 200 ppm) were used along with control. TIBA had highest growth suppressing activity with minimum plant height. Plants attained 20-25 cm height at 50–100 ppm concentrations of this chemical. MH did not have significant effect on growth modification compared to control. Branches were lowest with all concentrations of TIBA and highest concentration of cycocil. Highest root yield was associated with 50 ppm TIBA (7500 kg ha^{-1}).

Bionomics of spotted beetle

DMAPR, Anand: Beetle population was found throughout the year in the field. The life cycle study of *Henosepilachna vigintioctopuntata* was undertaken under laboratory condition during August–September. Field collected male and female adults were reared at room temperature (30–35°C). Eggs were laid in batches on both sides of leaves. The grubs passed through four instars before transforming into pupae. Developmental period from egg to adult emergence was 21-25 days. The larvae were provided with fresh leaves daily. Based on skin casting. different instars were identified. Eggs were bright yellow in colour, laid in 4–5 batches, up to 40 eggs per batch. The eggs were elliptical in shape

measuring 1–1.5 mm in length. The eggs hatched into first instar grub which measured 1.35 (1–1.5) mm in length. These were yellow in colour and entire body was covered with characteristic spines. First instar lasted for 3-4 days. II–instar grub grew to 2.9 (2.5–3) mm. Segmentations were more clear at this stage. It lasted for 2–3 days. III–instar grub grew to a length of 3.9 (3.5–4.0) mm. Segmentations were distinct. It lasted for 3–4 days. Fourth instar grub grew to 5.2 (4.5–5.5) mm. It lasted for 4-5 days. The fourth instar grubs stopped feeding and congregated themselves at one location in Petri dish and by attaching itself at one point transformed into pupae. The pupae measured 4.3 (4–4.5) mm in length. Adult emerged after 4–5 days, which gained its original dark brown colour and pattern in 4–5 hours.

Monitoring of fungicide residue and microbial load

MPUAT, Udaipur: Root samples were collected from market, farmers' field and from experimental field. The samples were dried and analysed for carbendazim residue using TLC. None of the samples showed detectable level of fungicide in the root. Market samples collected from Neemach and Mandsaur showed presence of different fungi belonging to genera *Trichoderma*, *Rhizopus*, *Aspergillus*, *Mucor*, *Fusarium* and bacterium from genus *Pseudomonas*. Samples from farmers' field showed presence of *Trichoderma*, *Rhizopus* and *Fusarium* apart from bacterium *Pseudomonas*. Experimental field samples had *Penicillium*, *Aspergillus* and *Fusarium*.

BALA (*Sida cordifolia*)

Bala is an annual herb and a member of Malvaceae family. There are four different varieties *viz. bala*, *atibala*, *nagabala* and *mahabala* of which *bala* is most widely used. *Sida cordifolia* is considered as the source of raw drug bala in North India, while in South India *Sida rhombifolia* is accepted as the source of the raw drug. All the *Sida* species are widely distributed as a weed in the tropical and subtropical regions of India. The root of the species is used as the raw drug for the treatment rheumatism, facial paralysis, general debility, sciatica, headache, uterine disorders, etc.

Effect of harvesting age on root yield

KAU, Trichur: The crop was harvested at monthly interval starting from 6 to 14 months after planting (MAP). Harvesting age significantly influenced plant height, number of branches, number of roots, root length and root diameter. Plant height and number of branches were increasing with increase in duration of crop and thereafter declined. Plant height was maximum at 9 MAP (110.1 cm) and number of branches was highest at 8 MAP (23.5 plant^{-1}). The yield attributing characters such as number of roots (15.3 plant^{-1}), root length (34.8 cm) and root girth (3.6 cm) were significantly higher at 8 MAP. Accordingly, fresh (383 kg ha^{-1}) and dry (253 kg ha^{-1}) root yields were highest at 8 MAP. However, statistically similar fresh root yield was also obtained at 7 MAP (320 kg ha^{-1}) and 9 MAP (364 kg ha^{-1}) as well. Dry root yield was at par for all the harvesting age except 11 MAP.

Effect of shade on growth and yield

KAU, Trichur: The crop was grown under shade and open conditions. Results suggested that the growth characters such as plant height and canopy spread were significantly higher under open condition compared to shade. Plant height was 87.6 cm at open conditions compared to 47.8 cm under the shade. Similarly, average canopy spread was 130.3 cm at open which was 27.2% higher than that of shade. Significantly higher number of roots (14.9 plant^{-1}), root length (28.2 cm) and root girth (3.7 cm) were observed under open conditions. Fresh and dry root production was 8.75 and 5.96 g plant^{-1} under open conditions which were ~3 times more then that of the shade conditions.

BLACK ISABGOL (*Plantago indica*)

Black isabgol is an annual herb of family Plantaginaceae, naturally distributed in Europe, North Africa, south-west Asia, eastwards to Iran and the mountains of Tian Shan. The species is introduced to India recently and is cultivated in limited scale in drier tracts of India. Mucilaginous seed coat and seed are medicinally important and are used against constipation and gastro-intestinal irritations. The swelling property of the mucilaginous polysaccharide of husk is responsible for the medicinal property. Mucilage is composed of xylose, arabinose and galactouronic acid.

Effect of spacing and nitrogen dose on growth and yield

DMAPR, Anand: An experiment was conducted with three doses of nitrogen (0, 25, 35 and 50 kg) and two spacing (50 x 15 cm and 60 x 15 cm) and crop growth and yield were monitored. Higher nitrogen induced better vegetative growth as maximum plant height (115.5-117.3 cm) and branches (29.0-31.5 plant^{-1}) were recorded when 35-50 kg N ha^{-1} was applied. Number of spikes was also more in higher N doses. Maximum spike plant^{-1} was obtained from highest N dose at 50 cm row spacing. However, it was similar with other spacing receiving 35-50 kg N ha^{-1}. Straw yield was positively influenced by N and all N doses produced similar yield which was significantly higher than control. Identical trend was seen in case of seed yield. Control plot produced 692–717 kg ha^{-1} seed, while N application resulted 959–1050 kg ha^{-1} seed yield. A possible reason for lower seed yield was lower test weight in control (1.29-1.32 g) compared with N treatments (1.40-1.46 g). Harvest index was however, maximum with 35-50 kg N ha^{-1} (1.80-20.0%). Hence, two spacing tested did not have influence on growth and yield but nitrogen dose of 35-50 kg ha^{-1} had.

Effect of irrigation levels on growth and yield

DMAPR, Anand: Five different irrigation levels were evaluated for the growth and yield. Irrigation level varied between 2-6 applications. Irrigations were scheduled at 25 days interval starting from sowing. Higher irrigation resulted better vegetative growth with taller plants having more branches. Plots irrigated 4-6 times produced plant height of 116.9-123.9 cm

while, 2-3 irrigations resulted 86.0-102.3 cm plant height. Similar trend was observed in the case of number of branches plant^{-1}, spikes plant^{-1} and yield. As a result, irrigating the crop 4-6 times produced higher straw (4387–4751 kg ha^{-1}) and seed (927–984 kg ha^{-1}) yields. Harvest indices also were similar in these treatments which varied between 19.2 and 19.3% compared to significantly lower values of 14.9-16.4% at 2-3 irrigations.

BRAHMI (*Bacopa monnieri*)

Brahmi, a member of Scrophulariacea family is a creeping, branched succulent herb distributed in wet and marshy lands throughout 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.

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

KAU, Trichur: An experiment was conducted to standardise organic manures and biofertilisers application for maximising growth and yield. Three different organic manures – FYM, vermicompost and coir pith and biofertilisers, *Azospirillum* or, PSB and their combinations were used. Different growth parameters such as branch length, leaf number, number of branches and internode length, did not show significant variation due to different organic manures or biofertilisers used. However, fresh (3007 kg ha^{-1}) and dry (1228 kg ha^{-1}) yields were maximum when coirpith compost was applied. Vermicompost also produced comparable fresh (2889 kg ha^{-1}) biomass. Considering all combinations, application of coir pith compost along with two biofertilisers produced highest fresh (3490 kg ha^{-1}) and dry (1374 kg ha^{-1}) herbage yields. Bacoside content was also found to be highest (6.04%) with this treatment. The combined application of organic manures with biofertilizers also resulted in highest nitrogen (1.12%) and phosphorous (0.13%) contents in the plants.

CHIRAYITA (*Swertia chirayita*)

It is an erect annual herb belongs to family Gentianaceae. It is distributed in temperate Himalayas, from Kasmir to Bhutan. Dried herbage portion is used as raw drug. The drug is extremely bitter in taste. It is also known as brown or white chirayita to distinguish it from 'green chirayita' (*Andrographis paniculata*). The bitter tonic made from the raw drug improves bile secretion and used for the treatment of bronchial asthma, liver disorders, and anaemia. Cultivation also has been initiated in the species and seeds are used for propagation.

Studies on the extent of natural variation

YSPUHF, Solan: Two-year old plants from open pollinated seeds (Solan population) were used for the study of extent of natural variation. Five different morphological variants were identified from these seedling progenies *viz.,* plants with opposite and decussate phyllotaxy (common type), plants with mostly opposite/decussate phyllotaxy but with few successive nodes showing only opposite phyllotaxy, plants with small cauline leaves, plants with large cauline leaves (common type) and plants with opposite and weakly decussate phyllotaxy.

Seed germination with different growth regulators

UBKV, Kalimpong: An experiment was conducted to optimise seed germination. Mature seeds were treated with three plant growth regulators (GA_3, kinetin and IAA) at four concentrations (100, 200, 300 and 400 ppm). Treated seeds showed better germination over untreated seeds. Germination of the seeds under controlled condition was found to be low (below 23.0%). GA_3 400 ppm was found to be the best with respect to germination (52.66%) and minimum germination time (33 days). This was followed by 400 ppm kinetin treated seed (43.33% germination, 39 days germination time), 300 ppm GA_3 and 300 ppm kinetin treated seed.

Effect of different media and bio-fertilisers on seed germination

UBKV, Kalimpong: Different germination media and biofertilisers were tested. Germination media were prepared by mixing soil, sand and FYM in different proportions along with azotobactor and/or, PSB. Germination percentage and onset of germination varied with various soil compositions. Study revealed that media composition of 1:2:1 (soil : sand : FYM) was best with higher germination (51.0%) and was followed by 1:1:2 combination (47.3 % germination). However least seed germination was observed with 2:1:1 media composition (29.0%). Among the bio-fertilisers, combined application of azotobactor and PSB (both at 2 g kg^{-1} soil) showed slightly higher germination (53.3%) compared to any one biofertiliser. Application of 2 g kg^{-1} PSB was better for seed germination (41.7 %) compared to 2 g kg^{-1} azotobactor (34.0 %).

COLEUS (*Coleus forskohlii*)

The crop is native to tropical Africa and belongs to family Lamiaceae. It is a pungent-aromatic herb with stem much branched from the woody base. It is found in dry barren hilly areas of India, cultivated in some parts of south Gujarat, Rajasthan, Maharashtra, Karnataka and Tamil Nadu. The tuberous roots contain forskohlin and are used for the preparation of drugs against hypertension, glaucoma, asthma, congestive heart failures and certain types of cancers. It contains volatile oil (diterpenes) also.

Effect of nutrients and bio-fertilizers on growth and yield

APHU, Bapatla: An experiment was conducted to determine optimum organic manures and bio-fertiliser combinations for growth and yield. For one ha area four organic doses

such as 10 t FYM, 1 t vermicompost, 1t neem cake, combination of 5 t FYM + 0.5 t FYM, 5 t FYM + 0.5 t vermicompost were tried apart from inorganic dose of 30-50-50 kg N-P-K ha^{-1}. Biofertilisers used were 2 kg ha^{-1} *Azospirillum*, 2 kg ha^{-1} *Phosphobacter* and combination of both. Among the major nutrient sources, inorganic NPK produced maximum branches (7.7 plant^{-1}) and fleshy root yield (18780 kg ha^{-1}). Bio-fertilisers also had significant positive effect on growth and yield. All bio-fertiliser treatments produced significantly more plant height and branches than control. Fleshy root yield was maximum with combination of azospirillum and phosphobacter (18770 kg ha^{-1}). Hence, inorganic fertiliser and combination biofertiliser application produced highest plant height (63.3 cm), branches (8.4 plant^{-1}) and yield (20750 kg ha^{-1}).

GILOI (*Tinospora cordifolia*)

The plant belongs to family, Menispermaceae and widely distributed in India, Bangladesh and Sri Lanka. The species is a wonderful immunomodulator in terms of modern medicine. Mature stem is reported to be acrid, bitter, hot, restorative, aphrodisiac and alleviative of all the three *doshas* or morbidities and also used as digestive tonic. It cures fever, jaundice, thirst, burning sensation, diabetes, piles, skin ailments, respiratory disorders, neurological diseases and improves intellect. Starch ('Giloe-ka-sat' or 'Guduchi satva') extracted from the dry stems is used as tonic against several diseases causing debility.

Germplasm collection, maintenance and evaluation

DMAPR, Anand: Characterisation of forty three germplasm was carried out. Study of stem characters among the genotypes showed that number of primary branches varied from 1.5 to 8.54, internode length varied from 7.17 to 14.44 cm, diameter of primary branches varied from 4.17 to 7.88 mm and diameter of secondary branches varied from 4.18 to 7.18 mm. Starch granules were classified based on size into five classes *viz.,* very small, small, medium, big and very big. Frequency distribution of starch granules based on size in different accessions showed that majority of the accessions were of having starch granules of small size (perimeter 46.0-75.0 μm, L1: 10.0-25.0 μm and L2: 11.0-20.0 μm). Starch shape was also varied among different accessions. Starch granules were eccentric type in the species.

Out of the 43 accessions, 34 were characterised using RAPD markers. One hundred primers from OPA, OPC, OPD, OPP and OPJ were screened for optimisation, out of which maximum polymorphism was found in OPC followed by OPA and OPD primers.

APHU, Bapatla: Thirteen clones were collected and maintained. Preliminary studis of the clones showed that clone collected from Rajugaripalem of Prakasam district had maximum values for morphological and economic traits, compared to the other clones. Average number of branches per plant was 11, stem girth was 3.0 cm, internodal length was 7.0 cm, petiole length was 6.0 cm and leaf size was 7.0 x 8.5 cm in this clone.

GUGGAL (*Commiphora wightii*)

Guggal or, Indian bdellium belonging to Burseraceae family is an endangered species in India. Mostly it is endemic to arid region and found in wild form in the drier parts of Rajasthan and Gujarat. The plants are small trees or shrubs up to 3–5 m height, the branches are crooked, knotty, aromatic and end in sharp spines. Guggal gum or, oleo-gum-resin obtained by incision of the bark is the economic product. The gum is highly effective in the treatment of obesity, arthritis and other diseases. Death after tapping made this plant rare.

Study of apomixis and polyembryony

DMAPR, Anand: Seed germination of 30 clones of guggal was carried out to identify different polyembryonic lines of guggal. Nine clones comprising 31% of the clones showed polyembryonic seed germination, wherein seeds produced either three or four seedlings per seed.

Histological studies of apomictic develoment of the embryo from flowers of up to 30 days after anthesis (DAA) were conducted. It was found that apomictic initials develpoed even from 2 DAA at chalazal end of the ovules. In later stages *i.e.* 10 DAA onwards, apomictic embryo initials were found developing from the micropylar end of the ovules. Apomictic development initiated from the inner layers of the inner integument. None of the apomictic initials developed from the chalazal end of the ovules were found to develop into embryo. Apomictic embryo initials developed from the micropylar end of the ovule only were found differentiated into embryos.

Flow cytometric analysis of ovules for endosperm development

DMAPR, Anand: The study was conducted in three lines (two female lines and one hermaphrodite line) to find out whether the endosperm is developed in autonomous pathway or sexual pathway (by triple fusion). Developing ovules were analysed by flow cytometry. Presence of 2X, 4X cells and 2X, 3X and higher ploidy level of cells in different ovules were observed in these lines. Interestingly, in the hermaphrodite line, majority of the endosperm development was autonomous, even though there was assured pollen availability and in one female line, there was comparatively more triple fusion.

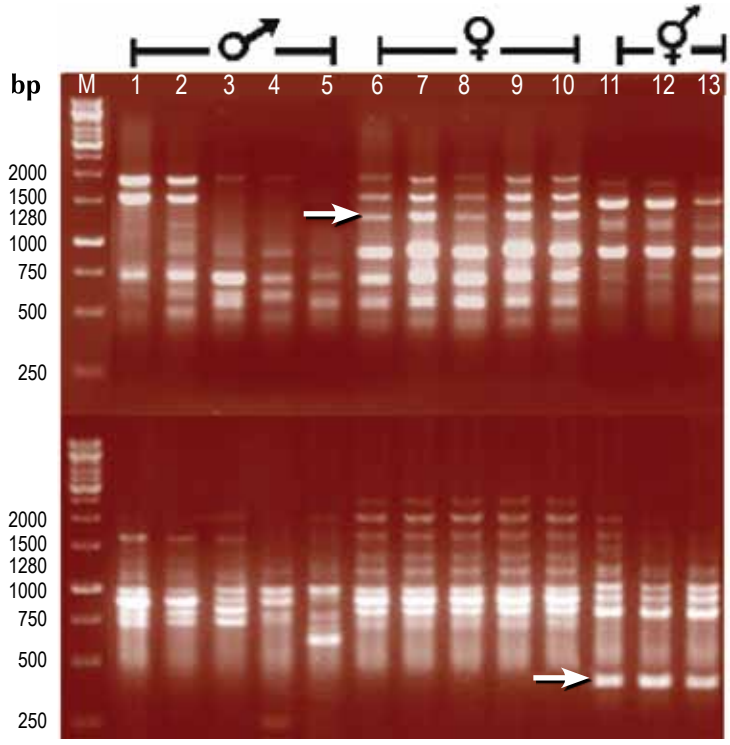
Molecular characterisation using RAPD markers

DMAPR, Anand: Molecular characterisation using RAPD markers of guggal lines was done to establish genetic relationships between and among the germplasm collections. Twenty six lines of Gujarat and 24 lines from Rajasthan were used for the study. In Gujarat accessions, among the fifty primers tested of which fourteen primers (OPA04, OPA05, OPA09, OPA20, OPN03, OPN05, OPN06, OPN09, OPN10, OPN12, OPN15, OPN16, OPN20 and OPP03) produced a total of 114 bands; 108 bands were polymorphic and 20 bands were unique in nature. The range of amplicons varied from 200 bp to >3000bp. The resolving power

of the primers varied from 0.405 to 1.81, while the primer index varied from 0.359 to 0.499. Best Resolving Power (1.81) was observed in the Primer OPP03. The maximum RAPD Primer Index (RPI) (0.499) was observed for the Primer OPN 20 and the minimum (0.3598) was in OPN 03. A wide variation was observed within and among the germplasm showing the distance ranged from 0.69 to 0.94 using Jaccards' similarity matrix. Out of fifty primers tested for genetic relationship of 24 accessions in Rajasthan collections, fifteen primers (OPA04, OPA09, OPN02, OPN06, OPN08 , OPN10, OPN12, OPN13, OPN14, OPN15, OPN16, OPN20, OPP03, OPP06 and OPP08) resulted in the amplification of 92 bands out of which 69 bands were polymorphic; 23 bands were monomorphic and 4 bands were unique in nature. The range of amplicons varied from 200 bp to >3000bp. The dendrogram using Jaccards' similarity coefficient showed a wide variation within and among the accessions tested having the similarity matrix value ranged from 0.519 to 0.950. Best Resolving Power (12.083) was observed in the Primer OPN20. The maximum RAPD Primer Index (RPI) (2.638) was observed for the Primer OPN10.

Study of RAPD markers linked to sex determination

DMAPR, Anand: Random Amplified Polymorphic DNA (RAPD) technique was used to of find out markers linked to sex determination in the species. Three bulks of DNA were made in each, one from male, one from female and another from hermaphrodites, by pooling an equal volume of DNA samples from each individual contributing to the bulk segregant analysis. Sixty different random decamer primers were screened with the three bulks to identify markers associated with sex expression of which only three primers were found to be associated with sex expression. These three primers were then tested with individual plant DNA samples where sex-associated RAPD markers were identified. A ~1280bp fragment from the primer OPN06 was found to be present in all the female individuals and absent in all the male and hermaphrodite plants. In another primer, a ~400 bp amplification product from the primer OPN 16 was present only in the hermaphrodite individuals. Thus the two RAPD markers, female- specific marker $OPN06_{1280}$ and hermaphrhrodite-specific marker $OPN\ 16_{400}$ together can reliably differentiate the male, female and hermaphrodite plants. The third marker, OPA20 amplified a ~1140bp fragment from female and hermaphrodite.



Female and hermaphrodite specific molecular markers in guggal

Study of genetic relationship in *Commiphora* spp. using RAPD markers

DMAPR, Anand: A study was conducted to identify and assess the genetic relationship within and among four species of *Commiphora viz*., *C. wightii* , *C. myrrha*, *C. caudata* and *C. stocksiana*. One hundred primers (OPA, OPC, OPJ, OPN, OPT series) were tested out of which 19 primers showed polymorphism. A total of 190 bands were produced from which 180, 10 and 89 bands were polymorphic, monomorphic and unique, respectively in nature. Maximum (0.944) PI was in OPC 20 and maximum RP was found in OPA 20. The fragment size ranged from 330-~3000 bp. Maximum of 100 loci were amplified in case of *C. wightii* and minimum (71) in *C. stocksiana*.

INDIAN VALERIAN (*Valeriana jatamansi*)

Indian valerian belongs to family Valerianaceae is a perennial herb of about 45 cm height and rootstock is thick, nodular and aromatic. The species is distributed in the Himalayan region. It is propagated by seeds. The plant is aphrodisiac, antiseptic, cardiac, stimulant, carminative, diuretic, emmengogue, expectorant, febrifuge, nervine tonic and sedative. Roots of the species are useful in diseases related to eye, blood, liver and spleen. Roots are also used in aromatic industry. Raw drug is collected mainly from the wild since cultivation is not yet popularised.

Effect of plant growth regulators on seed germination

UBKV, Kalimpong: Three different plant growth regulators (GA_3, kinetin and IAA) were tested to standardise seed germination. The growth regulators were applied at three concentrations (50, 100 and 200 ppm). Seed germination under controlled conditions was 64.0%. Kinetin (200 ppm) was best to increase seed germination producing 92.0% germination. This was followed by 200 ppm GA_3 and IAA with 86.3% and 75.3% seed germination, respectively. Seedling emergence period also reduced with 200 ppm kinetin treated seed compared to other treatments. Untreated control showed minimum germination with maximum germination time.

ISABGOL (*Plantago ovata*)

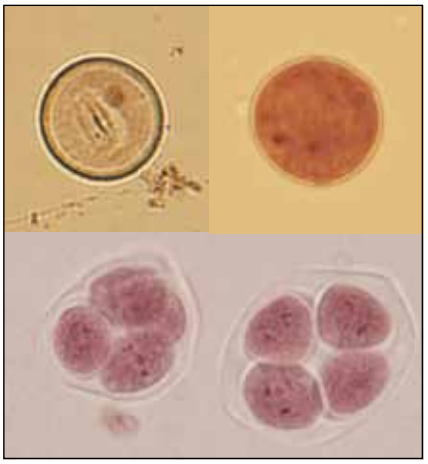
The plant belongs to the family Plantaginaceae. Seed coat or, 'psyllium husk' of trade is medicinally important. The husk is used against constipation and gastro-intestinal irritations. The swelling property of the mucilaginous polysaccharide of husk is responsible for the medicinal property. It is cultivated during rabi season in the drier tracts of North Gujarat, adjoining Rajasthan and Madhya Pradesh over an area of about 1, 00,000 ha. India is the leader in isabgol production and largest exporter of husk.

Studies on development of functional male sterility

DMAPR, Anand: Emasculation of flowers for artificial hybridisation is a difficult task in Isabgol since the size of the flowers is very small. Hence, preliminary attempt was made to develop an alternative method of emasculation for developing an artificial emasculation technique using five (ABA, Ethrel, GA_3, IAA and sodium azide) chemical hybridizing agents. Desirable results were obtained with GA_3 and Ethrel, however ethrel treatment caused very poor seed setting on pollination with fertile pollen as compared to control. Further, the higher and repeated dose of ethrel resulted in stunted plant growth and poor development of inflorescence.

Haploid production through anther culture

DMAPR, Anand: A study was undertaken for *in vitro* regeneration of haploid plants. Developmental stage of microspore was studied to establish a correlation between the spike/ floral bud size with the uninucleate/ binucleated stage of the pollen grains. A comparison was made between freshly collected spike and the spike fixed in FAA. Unopened flower buds were used in either case. Better visibility of microspore was observed in material fixed in FAA than the freshly collected floral buds. After measuring the length of the spike and floral bud of different sizes, the anthers taken out from the floral buds were squashed in microscopic slide followed by staining with 2% acetocarmine. It was observed that spike length less than 5 mm showed early tetrad or late tetrad stage of microspores. However, uninucleate stage of microspore was found in the anthers of 0.9 to 1.5 cm long spikes; uninucleate microspores were observed in the 2nd whorl up to the 6th whorl from the base of the spike of 0.9 cm; whereas up to 1.5 cm spike showed uninucleate micropspores in the 4th whorl onwards up to nearly 8th to 9th whorls from the base of the spike. Binucleate microspore was seen in the 1st whorl to 4th whorl from the base of the spike depending on the size of the bud.



Nuclear behaviour during isabgol pollen development

Accordingly, the anthers taken out from freshly collected or 4° C treated floral buds from the spike were cultured in devised media like MS, Nitsch and LS supplemented with different types and concentrations of growth hormones along with various concentrations and types of sugars for callusing/ somatic embryogenesis which were incubated in dark /16-h photoperiod. It was observed that the whole spike kept for 4-11 days at 4 °C showed better response for callusing in MS media containing BA (0.5-1.0), IAA (0.5-1.0), 2,4-D (0.5-1.0) with 3% sucrose in dark after 6-8 weeks of culture.

Mutation breeding

DMAPR, Anand: Genetic variability available in isabgol is very low and hence artificial creation of variation through chemical mutagens like DES, EMS and colchicine were initiated. In M_2 generation, some visible variants (mutants) were observed for leaf such as colour (yellow, light green, dark green), length (long, short and medium), width (broad, normal

and narrow), shape (curly and normal), plant height (short, medium and tall), spike length (short, medium and long), seed size (small and large), number of branches (no branches up to > 50 branches per plant), hairs on leaf (less and dense), early flowering (45 to 55 days after sowing), early maturity (90 to 100 DAS), plant type (compact and open). Selfed seeds were harvested from these plants for further study in the next generation. Considerable variation was observed for quantitative traits also. Colchicines and DES produced more variance than EMS for maximum plant height, total spike length and secondary branches per plant. Whereas, EMS had more variance for mature spikes per plant, mature seed yield and total seed yield per plant.

AAU Anand: Seeds from M_2 generation were selected on the basis of maximum number of spikes to screen the available elite accessions for higher yield. Plants having spike number one hundred and above were selected. Thirteen selections were made and evaluated along with check variety GI 2. Based on seed yield among the thirteen selections, one selection *i.e.*, Sel 11 gave superior yield over the check. Seed yield was 686 kg ha^{-1} in sel 11 compared to the GI 2 where the seed yield was 546 kg ha^{-1} which was about 25% more yield over the check.

Evaluation of Germplasm

RVSKVV, Mandsaur: A total of 80 accessions maintained at Mandsaur were evaluated for various morphological and yield characters. Results showed wide range of variability among the accessions. Plant height ranged form 22.0 cm (MIB-1007) to 39.0 cm (SPS-3). Length of spikes varied from 4.1cm (SLS-64) to 8.6cm (MIB-124). Days to 50% flowering ranged from 50 days (MIB-10) to 72 days (SPS-22). Number of spikes per plant ranged from 10.0 to 21.6. Seed yield ranged from 444 kg ha^{-1} (SPS-9) to 1555 kg ha^{-1} (MIB-121). The highest seed yield was in MIB-121 (1555 kg ha^{-1}) followed by MIB-7 (1444 kg ha^{-1}), MIB-6 (1313 kg ha^{-1}), MIB-5, SPS-25 and RI- 9709 (1222 kg ha^{-1}).

Initial evaluation trial

MPUAT, Udaipur: Eight superior lines along with two checks *viz*., GI-2 and RI- 89 were evaluated for higher seed yield and swelling factor. Five lines *viz*. MIB-124 (949.07 kg ha^{-1}), 45 Kr-1-6 (856.48 kg ha^{-1}), 60 Kr-2- 5 (777.77 kg ha^{-1}), HI-1 (768.52 kg ha^{-1}) and AMB-29 (763.88 kg ha^{-1}) exhibited higher seed yield against the best check GI-2 (759.26 kg ha^{-1}). Seed yield ranged from 671.29 kg ha^{-1} (MIB-125) to 949.07 kg ha^{-1} (MIB-124). Swelling factor ranged from 9.00 cc g^{-1} (RI-129) to 11.70 cc g^{-1} (GI-2). None of the genotypes recorded higher swelling factor than the best check GI-2 (11.70 cc g^{-1}).

Evaluation of advanced lines

MPUAT, Udaipur: Three advanced lines along with two checks *viz*., GI-2 and JI-4, were evaluated for higher seed yield and swelling factor. All the three lines *viz*., Palampur-2 (965.27 kg ha^{-1}), PB-62 (905.09 kg ha^{-1}) and Gumary (752.31 kg ha^{-1}) recorded higher seed yield against the best check GI-2 (752.28 kg ha^{-1}). Seed yield ranged from 671.29 kg ha^{-1} (JI-4) to 965.27 kg ha^{-1} (Palampur-2). Only one line, namely PB-62 had higher swelling factor (10.50 cc g^{-1}) over the best check GI-2 (9.83 cc g^{-1}). The swelling factor ranged from 9.33 cc g^{-1} (Palampur-2 and Gummary) to 10.50 cc g^{-1} (PB-62).

Effect of nitrogen and irrigation on aphid incidence

DMAPR, Anand: In a field trial, effect of different dosages of nitrogen (N_0, N_{15}, N_{30}, N_{45}, N_{60}) and irrigation levels (I_1-three irrigations at 0, 20 and 40 DAS; I_2-four irrigations at 0, 20, 40, 60 DAS; I_3-four irrigations at 0, 20, 40, 80 DAS and I_4-five irrigation at 0, 20, 40, 60, 80 DAS besides irrigation at the time of sowing) on aphid (*Aphis gosypii*) infestation was observed. The crop was sown in the third week of November and the infestation of aphids was first observed in the third week of January. Weekly observation on the incidence of aphid was taken from third week of January to first week of March. Aphid incidence was less during first week of observation, it gradually increased and became maximum in fourth week. Thereafter population started dwindling and became zero after eighth week of observation. A positive correlation between the aphid population and nitrogen dose was observed. Crop receiving 60 kg N ha^{-1} had highest aphid incidence. Mean aphid population plant^{-1} was 222.6 (at irrigation schedule 0, 20, 40, and 80 DAS). Lowest aphid population (2.7 aphids plant^{-1}) was associated with control plot from irrigation schedule of 0, 20, 40 and 60 DAS. More population of aphids was observed in the plots treated with higher dosages of nitrogen and correspondingly predatory pressure was also more in these plots.

New pest infestation

DMAPR, Anand: Two species of caterpillars were observed at Anand. These were identified as *Junonia orithya* L. and *Hyposidra successaria* Walker. Stray incidence of these caterpillars was observed at vegetative growth stage. Both the caterpillars were feeding on the leaves but latter one was also causing the damage at nodal part from where new branches arise. Both the species are reported for first time on this crop.

JIVANTI (*Leptadaenia reticulata*)

Jivanti is a perennial climber of family Asclepiadaceae, distributed in the sub-Himalayan tracts of Punjab and Uttar Pradesh and throughout the Deccan peninsula up to an altitude of 900 m and found particularly in hedges. The plant is stimulant and leaf, root and whole plant are used for the treatment of skin affections such as ringworm, wounds, nose and ear disorders, asthma, cough and in the treatment of habitual abortion in women. The bark, leaves and the whole plant are used to improve decreased milk flow in ruminants. The whole plant is also used to stimulate heat and prevent abortion. The leaves are used to treat eye diseases in swine. Stigmasterol and sitosterols are the active principle of the species.

Effect of spacing and harvesting frequency on yield

AAU, Anand: A field experiment was conducted to determine the optimum spacing and harvesting time. Sowing was done during kharif season (June 30). Different plant spacing (30, 60, 90 and 120 cm) at row spacing of 60 cm were tried and harvesting age of 90, 120 and 150 DAP were followed. Dry biomass produced was maximum when planted at 60 x 60 cm spacing (10976.1 kg ha^{-1}) and harvested at 150 DAS (11236.5 kg ha^{-1}).

Effect of seedling age and time of planting on yield

AAU, Anand: Seedlings of different age (20, 40 or, 60 DAS) were planted between July 1 to August 1 at 15 days interval to determine optimum seedling age and planting time under Anand conditions. Dry biomass of 4384–4690 kg ha^{-1} was produced when seedlings of 60–20 DAS age were used for planting. Planting during July 1 – August 1 produced 4091–4938 kg ha^{-1} dry biomass. However, neither different seedling age nor planting dates showed significant differences in terms of biomass yield.

KALMEGH (*Andrographis paniculata*)

The species is a branched annual herb belongs to family Acanthaceae and is distributed mainly in the plains from Himachal Pradesh to Assam and southwards throughout peninsular India. The plant is popularly known as 'king of bitters' or 'green chirayita'. It is grown as transplanted crop during kharif. The whole herbage is medicinally important and reputed for its hepato-protective action. It is also used for the treatment of influenza, diabetis, cholera and itches. Andrographolide is the active principle having the therapeutic action.

Evaluation of selection

AAU, Anand: Ten lines were selected based on days to flowering and were evaluated for yield and yield contributing characters. Days to flowering varied from 86.25 to 107.75 days among the selected lines. Selection AK-1 took maximum days to flowering, followed by Sel 10 (107.50 days) while Sel 2 took minimum days to flowering. Dry herbage yield was also significantly higher in AK 1 (3455.21 kg ha^{-1}). Plant height was found significantly higher in AK1 (76.0 cm) which was at par with Sel 3 (75.6 cm). Number of branches was maximum in Sel 3 (18.6) which was at par with selections AK 1 (17.3), Sel 4 (17.0) and Sel 1(16.9).

Standardisation of nursery technique

DMAPR, Anand: To standardise nursery technique, different seed rates, row spacing, FYM dose and shade were tried. Among six seed rates (0.5, , 2, 3, 4 and 5 g seed m^{-1}) tested, seedling height (7.2 cm) was maximum with lowest seed rate while maximum seedlings ready for transplanting (779.3 m^{-2}) were produced from highest seed rate. However, similar number of seedlings ready for transplanting was produced up to a seed rate of 3 g m^{-1}. Five different row spacing (5, 7.5, 10, 12.5 and 15 cm) along with broadcasting were tested. Seed rate used for the study was 3 g m^{-1}. Varying row spacing had significant effects on all the parameters observed. Increased spacing produced better seedling growth. Hence, highest number of seedlings ready for transplanting was produced at 15 cm spacing (852 m^{-2}). However, it was statistically similar with 10–12.5 cm row spacing or broadcast method. Considering lower seed requirement for unit area and seedling growth parameters, 15 cm row spacing was found optimum. FYM application positively influenced seedling growth. Maximum seedling height with maximum leaves was

obtained with 14 kg m^{-2} FYM application. Similar trend was observed with fresh and dry seedling weights. However, optimum FYM dose in terms of highest transplant ready seedlings from unit area was 4 kg m^{-2}. Three grades of shade nets (30%, 50% and 75%) and open conditions were compared for seedling growth. Better seedling growth was achieved under shade, as discerned by seedling height, leaf number and fresh and dry seedling weights. With respect to production of number of seedlings ready for transplanting, all shade categories significantly performed better than the open conditions. Seedbeds under the shade produced 26–72% more number of seedlings ready for transplanting compared to open conditions.

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

PDKV, Akola: A field trial was conducted to determine best plant spacing and harvesting age. The crop was grown at three spacing (30 x 15, 30 x 30 and 30 x 45 cm) and harvested at 15 days interval between 90 to 150 DAP. Plant height, number of branches, seed yield and andrographolide content did not differ due to different spacing. However, highest fresh (6145.95 kg ha^{-1}) and dry (1845.63 kg ha^{-1}) foliage yields and total andrographolide yield (38.49 kg ha^{-1}) were obtained in closest spacing. Harvesting time significantly influenced growth and quality. Plant height increased at 105 days after planting (DAP) compared to earlier date but thereafter did not show significant change. Branches were maximum at 135-150 DAP. Fresh (5778.66 kg ha^{-1}) and dry (1735.34 kg ha^{-1}) foliage yields were maximum at 120 DAP. However, this was at par with those of 105-135 DAP. Maximum seed yield (197.20 kg ha^{-1}) was obtained at 135 DAP. Andrographolide content (2.44%) and yield (37.98 kg ha^{-1}) maximised at 105 DAP. However, andrographolide yield was similar with that of 120 and 135 DAP. Fresh and dry foliage yields were significantly influenced by interactions. Planting at 30 x 15 cm and harvesting at 135 DAP produced highest fresh (7324.01 kg ha^{-1}) and dry (2199.40 kg ha^{-1}) foliage yields, both were at par with those obtained at 105 and 120 DAP from same spacing.

Effect of FYM doses and harvesting age on yield and quality

PDKV, Akola: A field trial was conducted to study the growth, yield and quality as influenced by different FYM levels and harvesting age. Application of FYM significantly influenced the fresh and dry foliage yields and andrographolide content. Highest fresh (5173 kg ha^{-1}) and dry (1788 kg ha^{-1}) leaf yields were obtained from 7.5 t FYM ha^{-1} and it was at par with those of 5 t ha^{-1}. Significantly highest andrographolide content was obtained from 5 t FYM ha^{-1} (2.55%) but, its yield was higher at 7.5 t FYM ha^{-1} (41 kg ha^{-1}), which was at par with that of 5 t FYM ha^{-1} (40.12 kg ha^{-1}). Harvesting time also had significant influence on herbage and andrographolide yields. Fresh (4822 kg ha^{-1}) and dry (1833 kg ha^{-1}) leaf yields as well as andrographolide yield (38.5 kg ha^{-1}) were highest at 135 DAP. Interaction effect was nonsignificant for all the parameters. NPK uptakes reached maximum at the highest nutrient dose. Plants removed 18.89, 6.14 and 11.74 kg NPK ha^{-1} when received 7.5 t FYM ha^{-1}. It was closely followed by FYM dose of 5 t ha^{-1} (17.67 kg N, 5.73 kg P and 10.86 kg K ha^{-1}). Crop age also influenced uptake of N and P. The crop harvested at 135 DAP removed 16.18 kg ha^{-1} N and 5.34 kg ha^{-1} P. However, K uptake was not influenced by crop age.

Effect of organic amendments on growth and yield

NDUAT, Faizabad: A field experiment was conducted with FYM (5–10 t ha^{-1}), vermicompost (2.5–5 t ha^{-1}), press mud (5–10 t ha^{-1}), PSB (10 kg ha^{-1}) and combination of lower doses of the organic manures with 10 kg ha^{-1} PSB along with a control to study their effect on growth and yield. Plants did not vary significantly in terms of height due to different nutrients. Maximum primary branches (11.5 plant^{-1}) was observed with the application of 10 t press mud ha^{-1} which was at par with the combination of 5 t press mud ha^{-1} + 10 kg ha^{-1} PSB (10.9 plant^{-1}). Significantly highest fresh (10654 kg ha^{-1}) and dry (3515 kg ha^{-1}) herbage yields were obtained with the application of 10 t press mud ha^{-1}.

LONG PEPPER (*Piper longum*)

It belongs to family Piperaceae. It is an evergreen subscandent herb distributed in moist deciduous to evergreen forests at an altitude of 500-1500 m. It is globally found in Indo- Malaysia region. In India the species is distributed in the moist tropical areas of Eastern Himalayas and other hilly regions of Western Ghats in Kerala and Tamil Nadu. Flowering occurs in September to November and also from March to June. Fruits (mature unripe) and roots are used as medicine. Roots are known as 'pipplamool' under trade.

Evaluation of selected genotypes

KAU, Trichur: Eight selected genotypes were evaluated for high spike and alkaloid yields based on plant height, number of branches, fruit morphology and yield and piperine content along with check variety (Viswam), hybrid (Kanjoor X Nilambur) and local check. It was found that Acc.No.2 was superior (665 kg ha^{-1}) to the existing high yielding variety 'Viswam' (508 kg ha^{-1}). Number of branches had positive association with dry weight. Fresh weight and size of the spike had positive association with piperin content, number of fruits and length of fruits. Analysis on the association of the characters towards the fruit yield indicated that tall plants with maximum number of fruiting branches produced higher fruit yield. Accession 2 is proposed by Zonal Research Extension and Advisory Committee for farm trial along with Viswam and local check in 3 locations in each district Trichur, Palakkad and Ernakulam.

Effect of FYM, neem cake, and urea on yield and quality

PDKV, Akola: A field experiment was conducted to find out the effect of different organic and inorganic nitrogen sources on yield and quality. Application of FYM, neemcake and urea significantly influenced the growth and yield. Maximum fruits (85.3 plant^{-1}) were produced from 75 kg N ha^{-1} through urea, this was at par with other treatments like 50 kg N ha^{-1} (81.5 plant^{-1}), 15 q ha^{-1} neem cake (77.0) and 15 t ha^{-1} FYM (71.0). Dry fruit yield was also highest in 75 kg N ha^{-1} through urea (323.93 kg ha^{-1}). However, it was at

par with all above mentioned treatments. Piperin content was not affected by application of FYM, neem cake or urea.

MAKOI (*Solanum nigrum*)

It is an annual herb of family Solanaceae which grows up to 1 m tall with an erect glabrous or sparsely pubescent stem. It is found throughout India as weed in open, disturbed habitats. All parts of the plant are considered demulcent, alterative, cardiotonic and laxative. It is used for the treatment of dropsy, piles, enlargement of liver and spleen. Leaves contain riboflavin, nicotinic acid and vitamin C. The immature green fruits of the plants contain a number of steroidal glycoalkaloids *viz*. solamargine, solasonine, α-solanigrine, etc.

Germplasm collection, maintenance and evaluation

APHU, Bapatla: Plants collected locally (*i.e.,* Bapatla of Guntur District) recorded higher morphological and economic traits. Minimal descriptor was developed in the species and it revealed that the entire clones collected could be categorised into three groups *viz*., plants of smooth leaf without trichomes bearing black berries, plants of wavy leaf with trichomes bearing black berries and plants of wavy leaf with trichomes bearing red berries. Plant height varied from 30 cm (Ongole, AP) to 60 cm (collections from Bapatla, AP; Trissur, Kerala; Sirugamani, TN). Three types of plant growth habit were found among the collected germplasm, *viz*., erect, semi-erect and spreading. Number of primary branches varied from 2 to 8. Leaf tips were either acute or obtuse. Leaf size varied from 5.0 x 3.0 cm to 12.5 x 4.5 cm. Leaf pubescence was either present or absent among the germplasm. Stem colour was brown or green and all the germplasm were having white flower colour. Biomass yield varied from 145 g plant^{-1} (collection from Chinthapalli) to 560 (collection from Damaramadugu, AP).

Effect of organic and inorganic nutrients on growth and yield

APHU, Bapatla: An experiment was conducted to study the effect of different levels of organic and inorganic nutrients on yield. Among the organic manures 10 t FYM ha^{-1}, 1 t neem cake ha^{-1} and 1 t vermicompost ha^{-1} were applied. Four inorganic fertiliser doses 80, 60, 40 and 20 kg N ha^{-1} along with a common basal dose of 40 kg P and 50 kg K ha^{-1} were tried. Organic manures produced significant difference in yield and maximum was with neem cake while lowest was with FYM. However, higher yield was associated with lower nitrogen dose. Plant height was maximum with neem cake + 40 kg N ha^{-1} (32.3 cm) which was at par with lower nitrogen (20 and 40 kg) doses + FYM/neem cake applied plots and all vermicompost treated plots. Similar trend was also seen in case of number of branches. Highest yield was obtained from neem cake + 40 kg N ha^{-1} (3966 kg ha^{-1}). This was followed by same nitrogen dose from vermicompost (3780 kg ha^{-1}) and FYM (2996 kg ha^{-1}), all being at par. Higher inorganic nitrogen dose also increased disease and insect attack.

OPIUM POPPY (*Papaver somniferum*)

The plant belongs to family Papaveraceae. It is a rabi season crop and its cultivation is restricted by the Narcotics Department under licensing system. In India this herb is grown commercially as annual crop in restricted areas in few districts of Madhya Pradesh, Rajasthan and Uttar Pradesh. Latex collected from the capsule is medicinally important. The latex of immature fruit contains several alkaloids like morphine, codeine, noscapine, narcein and papaverine. It is used as pain killer, anti-depressant, sedative, anti-tussive and smooth muscle relaxant. Seeds are used for culinary purposes.

Evaluation of germplasm

RVSKVV, Mandsaur: Two hundred and thirty five germplasm were maintained and evaluated for thirteen different qualitative and quantitative characters. Plant height ranged from 65.0 cm (MOP-1079) to 111.0 cm (IC-95), Leaf length varied from 12.3 cm (ND-35) to 23.5 cm (UOP-590) and breadth of leaf varied from 5.6 cm (MOP-508) to 9.6 cm (MOP-409). Leaves were serrated or non-serrated. Number of leaves per plant varied from 10 (MOP-187) to 19 (MOP-518) and flower colour varied from white, pink and violet. Peduncle type was either hairy or non-hairy. Length of capsule varied from 28.1mm (ND-10) to 43.5mm (MOP-529) where as breadth of capsule varied from 25.5mm (MOP-510) to 42.5mm (MOP-574). Latex yield per plant varied from 0.00 g (Posta-91) to 0.32 g (UO-7982& JA-16). Seed yield ranged from 1.04 g (NBRI-9) to 3.37 g (MOP-1088).

MPUAT, Udaipur: Forty three accessions collected from the Chittoregarh, Udaipur, Baran and Jhalawar district of Rajasthan were evaluated alongwith three checks *viz*., Chetak Aphim, IC-42 and MOP-540 for higher latex yield, seed yield and other traits. Only 16 germplasm exhibited higher latex yield over the best check Chetak Aphim (27.38 kg ha^{-1}). The latex yield ranged from 12.22 kg ha^{-1} to 55.20 kg ha^{-1}. Fifteen germplasm recorded higher seed yield over the best check MOP-540 (305.55 kg ha^{-1}). The maxium seed yield was in MOP-138 (555.56 kg ha^{-1}), followed by MOP-144 and MOP-145 (444.44 kg ha^{-1}).

Initial evaluation trial

MPUAT, Udaipur: Ten superior lines alongwith three checks *viz*., Chetak Aphim, IC-42 and MOP-540 were evaluated for latex yield, seed yield, husk yield and morphine content. Latex yield varied from 20.30 (MOP-9) to 31.40 kg ha^{-1} (UOP-78). Five lines, *viz*., UOP-78 (31.40 kg ha^{-1}), UOP-34 (30.80 kg ha^{-1}), UOP-60 (28.75 kg ha^{-1}), UOP-43 27.98 kg ha^{-1}) and UOP-83 (27.94 kg ha^{-1}) exhibited higher latex yield over the best check Chetak Aphim (27.80 kg ha^{-1}). None of the lines exihibited higher morphine content over the best check Chetak Aphim (15.24%). MOP-9 showed higher seed yield (680.60 kg ha^{-1}) over the best check IC-42 and MOP-540 (666.70 kg ha^{-1}). Husk yield ranged from 361.07 kg

ha-1 (UOP-57) to 648.15 kg ha-1 (MOP-540). None of the lines recorded higher husk yield over the best check MOP-540 (648.15 kg ha-1).

Evaluation of hybrids

RVSKVV, Mandsaur: Six hybrids (two from M.P., two from Rajasthan and two from U.P.) along with local check (JOP-540) and national check (IC-42) were tested. Hybrid MOH-2 recorded significantly higher latex yield (50.71 kg ha-1) followed by MOH-1 (48.28 kg ha-1) compared to check JOP-540 (46.84 kg ha-1). Significantly higher seed yield was in MOH-2 (705 kg ha-1) followed by ROH-36 (637 kg ha-1) compared to local check JOP-540 (547 kg ha-1). Hybrid ROH-36 recorded significantly superior husk yield (718 kg ha-1) as compared to check JOP-540 (645 kg ha-1). Morphine content ranged from 10.4% (ROH-36) to 14.6% (NDHY-2) where as morphine yield ranged between 4.017 kg ha-1 (IC-42) and 7.006 kg ha-1 (NDHY-2).

MPUAT, Udaipur: Six hybrids alongwith three checks *viz*., Chetak Aphim, IC-42 and MOP- 540 were evaluated. Two hybrids *viz*., ROH-36 and NDH 1 recorded higher latex yield (26.02 kg ha-1, 25.20 kg ha-1) over the best check Chetak Aphim (24.7 kg ha-1). None of the hybrids recorded higher morphine content over the best check MOP-540 (16.15%). All the hybrids except ROH-42 (421.3 kg ha-1) gave higher seed yields over the best check MOP-540 (569.44 kg ha-1). Only one hybrid, namely NDH-1 recorded higher husk yield (708.33 kg ha-1)over the best check Chetak Aphim (703.70 kg ha-1).

NDUAT, Faizabad: Six hybrids developed at various centers *viz.,* NDH-1 and NDH-2 from Faizabad, MOH-1 and MOH-2 from Mandsaur and ROPH-36 and ROH-42 from Udaipur were tested against two checks *i.e.* NOP-4 and IC-42. Significant differences were observed for latex yield among the hybrids. Maximum latex yield was in NDH-2 (42.74 kg ha-1) followed by NOP-4 (38.86 kg ha-1) and NDH-1 (37.92 kg ha-1). Seed yield ranged from 1540 kg ha-1 to 1131 kg ha-1. Maximum seeds yield was in NDH-2 (1131 kg ha-1) followed by NOP-4 (1116 kg ha-1) and NDH-1 (972 kg ha-1). Maximum husk yield was in NOP-4 (927 kg ha-1) followed by NDH-2 (822 kg ha-1) and NDH-1 (685 kg ha-1).

Evaluation of superior crosses

MPUAT, Udaipur: Five newly developed hybrids alongwith three checks *viz*. Chetak Aphim, IC-42 and MOP- 540 were evaluated. Among the hybrids, three hybrids *viz*. PHO-36, PHO-33 and PHO-35 recorded high latex yields (29.33 kg ha-1, 26.4 kg ha-1 and 25.7 kg ha-1) over the best check Chetak Aphim (25.5 kg ha-1). None of the hybrids exihibited higher morphine content over the best check MOP-540 (15.06 %). Morphine content ranged from 13.04 % (PHO-36) to 15.06 % (MOP-540). Only one hybrid namely PHO-35 (666.70 kg ha-1) recorded higher seed yield over the best check MOP-540 (662.96 kg ha-1). Three hybrids *viz*., PHO-35, PHO-36 and PHO-34 recorded higher husk yields (777.80 kg ha-1, 759.35 kg ha-1 and 749.99 kg ha-1) over the best check MOP- 540 (734.30 kg ha-1).

NDUAT, Faizabad: Six new hybrids developed at the centre were tested against two checks *i.e*., NOP-4 and IC-42. Maximum latex yield was in hybrid NDH-3 (53.39 kg ha-1) followed by NDH-4 (46.12 kg ha-1) and NDH-5 (42.09 kg ha-1). Maximum seed yield was recorded in NDH-5 (1180 kg ha-1) followed by NDH-4 and NDH-3 (1119 kg ha-1and 1112 kg ha-1). Maximum husk yield was recorded in the hybrid NDH-5 (867 kg ha-1) followed by NDH-3 and NDH-2 (854 kg ha-1and 824 kg ha-1).

Germplasm screening for powdery mildew resistance

RVSKVV, Mandsaur: A total of 235 germplasm lines were screened against powdery mildew. Twenty two lines (MOP-187, MOP-217, MOP-278, MOP-508, MOP-510, MOP-511, MOP-519, MOP-525,MOP-1054, MOP-1055, MOP-1057, MOP-1077, MOP-1079, MOP-1081, MOP-1085, IC-114, NC-4, NC-57955, ND-40, UO-17682, UO-1495, UOP87) were found resistant.

Integrated nutrient management in opium poppy – ashwagandha crop rotation

MPUAT, Udaipur: Opium poppy is a nutrient exhaustive crop while ashwagandha requires very low fertility. Hence, to standardise nutrient management for this crop when grown in a sequence, an experiment was carried out. Nutrient was applied to opium poppy either through FYM (5, 10 and 15 t ha^{-1}), castor cake (to provide 25 and 50 kg N ha^{-1}) or, inorganic fertiliser (25 and 50 kg N ha^{-1}). Subsequent ashwagandha crop received either 25 or 50 kg N ha^{-1}. Increasing levels of FYM significantly increased leaf number $plant^{-1}$, seed and husk yields and morphine and thebaine contents in latex. However, plant height (91.0 cm) and latex yield (40.23 kg ha^{-1}) increased significantly only up to 10 t FYM ha^{-1}. Higher dose of castor cake significantly increased plant height (91.8 cm), leaf number (14.4 $plant^{-1}$) and latex (40.86 kg ha^{-1}), seed (8.04 kg ha^{-1}) and husk (10.09 kg ha^{-1}) yields. Morphine (12.47%) and thebaine (1.97%) contents in latex were also higher at higher castor cake application. Higher nitrogen through urea significantly increased plant height (93.3 cm), leaf number (14.6 $plant^{-1}$), capsule number (1.6 $plant^{-1}$) and yields of latex (39.70 kg ha^{-1}), seed (8.61 kg ha^{-1}) and husk (9.77 kg ha^{-1}).

Increase in FYM levels from 5 to 15 t ha^{-1} to opium poppy significantly increased seed yield, root length, root diameter, total alkaloids content and total alkaloids yield of roots of succeeding ashwagandha crop though, root yield was not influenced. Application of higher castor cake to opium poppy significantly increased root diameter (7.6 mm), root yield (743 kg ha^{-1}), seed yield (850 kg ha^{-1}) and root total alkaloids content (0.57%) in succeeding ashwagandha crop. Application of different doses of nitrogen through urea to opium poppy did not influence productivity and quality of succeeding ashwagandha significantly. However, Application of 30 kg N ha^{-1} to ashwagandha significantly increased root yield (778 kg ha^{-1}), total alkaloids content (0.55%) and total alkaloids yield (431.5 kg ha^{-1}).

Efficacy of selected fungicides against powdery mildew

RVSKVV, Mandsaur: Six fungicides *viz*., contaf (0.1%), karathane (0.1%), bayletan (0.1%), wettable sulphur (0.3%), thiophinate methyl (0.2%) and carbendazin (0.15%) were tested against powdery mildew. Spraying was started at the first appearance of the disease symptoms and was repeated twice at 10 days interval. The observations of disease intensity were recorded 10 days after the last spray. Fungicidal treatments were significantly superior over the control for reducing disease intensity and increasing latex, seed and husk yields. Bayletan was most effective with 61.43% reduction in percent disease index compared to control. However, efficacy of thiophenate methyl and carbendazim was also similar which produced 23.59 and 24.20 PDI, respectively. Latex (25.27 kg ha^{-1}), seed (416.68 kg ha^{-1}) and husk (596.21 kg ha^{-1}) yields were also highest with bayletan. Control plots produced minimum latex (17.33 kg ha^{-1}), seed (244.40 kg ha^{-1}) and husk (374.40 kg ha^{-1}) yields.

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

Palmarosa is a perennial grass belongs to family Poaceae. There are two varieties of palmarosa – *motia* and *sofia* from which the oil can be extracted . Oil of palmarosa is obtained from the floral shoots and aerial parts and it has good demand in export. The major component, geraniol is used in perfumery, cosmetics and soaps and also used in flavouring tobacco. It also contains myrcene, linalool, geranyl acetate, dipentene and limonene. The distribution of the species in the forest of central India is continuously reduced due to over exploitation and loss of the forest lands. The species is under cultivation in selected parts of the country.

Evaluation of superior lines

CCSHAU, Hisar: Sixteen superior lines were evaluated along with the check RH-49. Plant height ranged from 232.4 to 269.2 cm; internodes plant^{-1}, 12.9 to 16.1; internode length, from 14.9 to17.5 cm; culm diameter, from 5.3 to 6.4 mm; leaf length, from 30.3 to 35.3 cm; leaf breadth, from 2.6 to 3.3 cm; flag leaf length, from 14.2 to 20.3 cm; flag leaf breadth, from 1.6 to 2.6 cm; tillers plant^{-1}, from 23.0 to 54.4; inflorescence bearing tillers plant^{-1}, from 22.3 to 54.1; inflorescence length, from 53.9 to 82.9 cm; fresh herb yield plant^{-1}, from 708 g to 1189 g; fresh herb yield, from 178.14 to 306.88 q ha^{-1}; oil content, from 0.19 to 0.34% and oil yield, from 41.595 to 86.956 lt ha^{-1}. Four lines yielded significantly higher oil yield against the check RH-49. The highest oil yield was observed in PRH 8-5 (86.956 l ha^{-1}), followed by PRH-8-7 (76.935 l ha^{-1}), PRH-8-9 (78.750 l ha^{-1}) and PRH 8-12 (74.926 l ha^{-1}).

SAFED MUSLI (*Chlorophytum borivilianum*)

Safed musli is an annual herb of family Liliaceae. *C. borivilianum, C. arundinaceum* and *C. tuberosum* are used under the trade name 'safed musli'. Fascicualated roots of the plant are medicinally important. Saponins present in the root are the active ingredient and is used for the preparation of many vital tonics. It is a kharif crop and requires humus rich soil. Overexploitation of the species from its natural habitats made its status threatened in nature. The commercial cultivation became popular in the last decade and now the crop is cultivated in central India and reached up to Southern parts of the country.

Study of genetic relationship in *Chlorophytum* spp. using RAPD markers

DMAPR, Anand: Studies were carried out for identification and establishment of genetic relationships in three species of *Chlorophytum (C. borivilianum*, *C.arundinaceum* and *C.*

tuberosum) and two high yielding clones of *C. borivilianum* using RAPD markers. One hundred primers were tested to distinguish three species and two lines and to select a reduced set of primers. The selected primers were used for identification and also to evaluate genetic relationship among them. A total of 454 distinct bands, ranging from 0.25-3.0 kbp, were amplified by using 47 selected decamer primers. The genetic similarity was evaluated on the basis of presence or absence of bands, which revealed a wide range of variability within the species. The cluster analysis indicated that three species of *Chlorophytum* and two clones of *C. borivilianum* formed two major clusters. The first major cluster constituted *C. arundinaceum* and *C. tuberosum*, and the second major cluster composed of two subclusters; the first subcluster represented the two high yielding clones of *C. borivilianum* whereas the second subcluster represented open pollinated seedling progenies of *C. borivilianum*.

In vitro propagation of *Chlorophytum arundinaceum*

In vitro* multiplication of *C. arundinaceum

DMAPR, Anand: A protocol was developed for micropropagation of *C. arundinaceum* using stem disc as explant. Within 10-12 days of culture, 11-13 shoot buds proliferated from a single stem disc culture on ½ MS medium containing (1.0-1.5 mg l^{-1}) BA, (2.0- 2.5 mg l^{-1}) NAA and 3% sucrose. Maximum multiple shoot induction was obtained on ½ MS medium containing (2.5-3.0 mg l^{-1}) BA, (0.01-0.1 mg l^{-1}) NAA and 3% (w/v) sucrose. Addition of adenine sulphate (25-50 mg l^{-1}) enhanced the rate of multiplication under a 16-h photoperiod. Though shoots rooted on ½ MS medium supplemented with 0.1 mg l^{-1} IBA or IAA and 2% (w/v) sucrose, rooting was found to be best in 0.25 IBA within 8-10 days of culture. Micropropagated plantlets were hardened in the green house and successfully established in the field where 99% of the plants survived showing luxuriant growth and flowered.

Collection and evaluation of germplasm

RVSKVV, Mandsaur: Twenty four accessions were evaluated and wide range of variability was noticed among the accessions. Length of leaves varied from 12 (MCB-403) to 25 cm (MCB-416) and breadth of leaves ranged from 15 (MCB-409) to 26 mm (MCB-405). Colour of anther ranged from yellow to light yellow and sometimes light green. Length of fleshy root ranged from 4.2 (MCB-401) to 8.7 cm (MCB-421). Root diameter ranged between 5.2 (MCB-401) and 8.1 mm (MCB-417). Fresh weight of root ranged from 2000 kg ha^{-1} (MCB-401) to 3332 kg ha^{-1} (MCB-412). Maximum fresh fasciculated root yield was in MCB-412 followed by MCB-414 (2965 kg ha^{-1}) compared to 2449 kg ha^{-1} fresh fasciculated root yield in the check variety JSM – 405.

CCSHAU, Hisar: Eleven accessions were evaluated. The range of root length was from 10.5 (RC-64) to 14.3 cm (MCB-405); root diameter ranged from 7.0 (MCB-412) to 8.2 mm (HCB-6); number of roots $plant^{-1}$ from 11.5 (MCB-412) to 26.0 (MCB-405); fresh root yield $plant^{-1}$, from 31.0 g (MCB-412) to 75.5 g (MCB-405) and fresh root yield from 2296 kg ha^{-1} (MCB-412) to 5593 kg ha^{-1} (MCB-405). The highest fresh root yield was recorded

in variety MCB-405 (5593 kg ha^{-1}), followed by HCB-2 (4815 kg ha^{-1}), HCB-6 (4482 kg ha^{-1}) and CBI-7 (4037 kg ha^{-1}).

MPUAT, Udaipur: Twenty two new accessions along with check MCB- 405 were evaluated. Fasciculated root yield ranged from 2000 kg ha^{-1} (RC-86) to 4611 kg ha^{-1} (PC-15). Nine accessions *viz*., PC-15 (4611 kg ha^{-1}), PC-30 (4556 q ha^{-1}), PC- 26 (4333 kg ha^{-1}) PC-17, PC-19 and PC-32 (4000 kg ha^{-1}), CBI-7 (3722 kg ha^{-1}), PC-6 and PC-31 (3444 kg ha^{-1}) produced higher fasciculated root yield over the check MCB-405 (3331 kg ha^{-1}).

Initial evaluation trial

PDKV, Akola: Five superior lines were evaluated along with check variety JSM 405 for different morphological and yield characters. Average length of roots was significantly higher in AKSM- 01 (8.97 cm) compared to the check JSM- 405 (7.15 cm), while AKSM- 02 recorded highest average girth of fasciculated roots (7.7 mm) followed by AKSM- 03 (7.6 mm). Differences in fasiculated root weight were also statistically significant among the lines however; none could record superior yield than the check. AKSM- 01 recorded highest fasciculated root weight (35.55 g plant^{-1}) followed by AKSM-03 (33.90 g plant^{-1}) which were at par with check JSM- 405 (33.65 g plant^{-1}).

MPUAT, Udaipur: Five superior lines along with check *viz*., MCB-405 were evaluated for higher fasciculated root yield. Four lines *viz*., RC-77 (4250 kg ha^{-1}), PC-2 (3806 kg ha^{-1}), RC- 64 (3640 kg ha^{-1}) and CBI-7 (3306 kg ha^{-1}) produced higher fasciculated root yield over the check MCB-405 (3250 kg ha^{-1}). The saponine content ranged from 4.5 (RC-64) to 6.1 (RC-77) and sapogenine content ranged from 0.26 % (CBI-7) to 0.41 % (RC-77). RC- 77 recorded maximum saponine and sapogenine content.

Effect of FYM and bio-fertilisers on growth, yield and quality

PDKV, Akola: Three levels of FYM (1, 10 and 20 t N ha^{-1}) and two different bio-fertilisers (*Azotobacter* and PSB) were tested for growth and yield. Application of FYM and seed treatment with biofertilizers had non-significant effect on fleshy roots plant^{-1}, fleshy root length and girth. Whereas, fresh and dry root yields showed significant differences. Application of FYM 20 t ha^{-1} and seed treatment with azotobacter recorded significantly higher fresh (3819 kg ha^{-1}) and dry (688 kg ha^{-1}) fleshy root yields. However, these were at par with all the treatments when 10 t or more FYM ha^{-1} were applied. Similar trend was also observed in saponin yield which was highest in the combination of 20 t FYM ha^{-1} and seed treatment of azotobacter and PSB (42.56 kg ha^{-1}). However, sapnoin content was not influenced due to FYM and biofertilisers.

Monitoring of fungicide residue and microbial load

MPUAT, Udaipur: Fleshy root samples were collected from market, farmers' field and from experimental field. Dried samples were analysed for carbendazim residue using TLC. Market samples contained minimum carbendazim residue (38 ppm) while farmers' field sample contained highest residue (47 ppm). Experimental field sample contained 43 ppm of carbendazim residue. In the market samples, *Trichoderma*, *Aspergillus*, *Fusarium* and *Pseudomonas* were major microbial contaminants. Farmers' field samples showed presence of *Trichoderma*, *Aspergillus*, *Fusarium* and *Mucor* as the major microbes while *Pseudomonas*, *Aspergillus* and *Fusarium* were dominant in experimental field samples.

SANKHPUSHPI (*Convolvulus microphyllus*)

It is an annual herb of family Convolvulaceae. The botanical identity of shankhpuspi is highly controversial. The species is distributed throughout India in wastelands and forests. Raw drug is collected from the wild since no cultivation is practised in the species. It has high content of alkaloids such as convolvine, convolamine, phyllabine, covolidine, confoline, convoline, subhirsine, convosine, etc. than other species. The whole herbage is used for the medicinal purposes and is used for the preparation of nervine tonics.

Effect of seed rate and spacing on yield

AAU, Anand: An experiment was conducted to determine optimum seed rate and spacing in terms of dry biomass. Four different seed rates (2, 4, 6 and 8 kg ha^{-1}) and four row spacing (30, 45, 60, 90 cm) along with broadcasting were tried. The crop was harvested thrice at 90 days interval. All seed rates except the lowest one maintained significantly higher plant stand. Different seed rates produced 8354–9069 kg ha^{-1} dry herbage however, these did not significantly differ among different treatments. Among the different spacing, lowest herbage yield was obtained from 45 cm row spacing (8155 kg ha^{-1}) while highest was from 30 cm (9150 kg ha^{-1}). However, the difference was not significant.

SATAVARI (*Asparagus recemosus*)

It is a perennial spiny climber belongs to the family Liliaceae. It is distributed throughout tropical and subtropical India. Fasciculated roots are medicinally important. It contains saponins and is used for the treatment of dysentery, tumours, rheumatism and kidney and liver disorders. Powdered roots are a common ingredient of a number of vital tonics, which are believed to cure sexual weaknesses, leucorrhoea and increase lactation in feeding mothers. Dried tuberous roots have ulcer healing properties or cytoprotection.

Collection, characterisation and maintenance of germplasm

CCSHAU, Hisar: Twenty six genotypes collected from different places of Haryana were evaluated for fasciculated root yield and saponin content. The highest fresh fasciculated root yield was in HAR-03-18 (1043.21 q ha^{-1}), followed by HAR-03-17 (932.10 q ha^{-1}), HAR-4 (920.50 q ha^{-1}), HAR-6 (754.32 q ha^{-1}), HAR-03-4 (744.57 q ha^{-1}) and HR-8 (734.45 q ha^{-1}). Saponin content ranged from 3.88% (HAR-03-16) to 5.89% (HAR-4). The highest saponin content was recorded in HAR-4, followed by HAR-03-7 (5.86%), HAR-6 (5.62%), HAR-03-2 (5.55%), HAR-8 (5.53%) and HAR-2 (5.40%).

First report of satavari beetle

DMAPR, Anand: The crop was observed infested with a beetle in the month of February. Both adults and grubs were found to cause damage in the apical part of growing tip of vine. During March, grubs were in more number (10-12 grubs) in the apical part whereas, during April the numbers of adults were more. The beetle was identified as *Lema downesi* Baly and is reported for the first time on this crop from India.

SENNA (*Cassia angustifolia*)

The species belongs to Caesalpiniaceae family and is a native of Yemen and Saudi Arabia. The crop is cultivated in drier tracts of Rajasthan, Gujarat and Tamil Nadu. Leaves and tender pods are used as natural laxative both in modern as well as in traditional systems of medicine. It increases the peristaltic movement of the colon. The laxative principles are two glycosides, *viz*. sennoside A and sennoside B, besides it also contains β-sterol and flavonols kaempferol, kaempferin and isorhamnetin.

Catopsilia pyranthe infestation

DMAPR, Anand: Caterpillar of *Catopsilia pyranthe* was found infesting the crop throughout the year at DMAPR, Anand. Monthly population of different stages – egg, larvae, pupa and adults was recorded by screening five randomly selected plants.

The adults as well as other immature stages were common during April to September and March. However, with the increase in humidity in June, number of eggs and larvae was slightly more. Same level of infestation continued up to July-August. Maximum rain was received during September hence maximum infestation of larvae was observed during October due to high humidity and less rains. The adult population was abundant during this month and correspondingly eggs and larvae were also very high. The population started dwindling with the decrease in temperature from December onwards and reached zero level during January and February. In March, with the increase in temperature, activity of adults was seen and stray incidence of egg laying was also observed but no immature stages were seen.

Bionomics of *Catopsilia pyranthe*

DMAPR, Anand: Life cycle of *C. pyranthe* was studied. The adult bred throughout the year. Several overlapping generations were observed on the crop. Pairing takes place in air. Pest life cycle study was undertaken in laboratory during September–October, when fresh eggs along with leaves were brought to laboratory and placed in Petri dish at room temperature. Daily observation on the life-history sequence and length of larvae were recorded. Different instars were identified based on skin casting.

Eggs were laid singly on both the side of leaves in the ratio of 1:1. The eggs were erect, fusiform (tapered at both end) laid singly on leaf, whitish in colour initially and turned

creamy-white after one day, 2–3 mm in length, incubation period was 3–4 days and larvae hatched out by breaking egg shell. It passed through five larval stages before transforming into pupa. Development period from egg to adult emergence was 22–29 days. The first instar larvae started feeding immediately after hatching. It fed mainly by scraping paranchymatous tissue of leaves leaving behind venation. It grew to the length of 4.7 (4.0–6.0) mm with cylindrical shape and pale green colour. Damaging potential of first instar larvae is less. But when present in exceedingly high proportion, removal of paranchymatous tissue along with chlorophyll due to gregarious feeding habit, affected the plant growth. It lasted for 2–3 days. Second instar larvae grew to the length of 10.3 (9.0–13.0) mm. Body colour was pale green with a less pronounced lateral yellow line, abdominal prolegs were less distinct. Damaging potential was more than earlier instar as it started feeding from margin of leaves. This stage lasted for 2–3 days. Third instar larvae grew to the length of 15.5 (14.0–17.0) mm. Visually, it was pale green with more pronounced lateral yellow line. Abdominal prolegs were distinct and clearly visible. Food requirement was more than second instar as it started devouring whole leaflet leaving behind midrib only. Third instar lasted for 2–4 days. Forth instar larvae were having green body colour with broad and distinct lateral yellow line. The insect grew to the length of 21.9 (20.0–25.0) mm. Abdominal prolegs became distinct and clearly visible. Damaging potential was maximum as food requirement was more and defecation frequency was also quick. This stage lasted for 3–4 days. Fifth instar larvae grew to the length of 32.2 (30.0–35.0) mm. Body colour was green, lateral yellow line broad and distinct and segmentation was clearly visible. Abdominal prolegs were distinct and clearly visible. Damaging potential was highest and this instar lasted for 4–5 days. During pre-pupation stage the larvae stopped feeding and became thick and reduced in length, 27.1 (24–30) mm. The prepupation stage lasted for one day. Before transformation into pupa, the prepupa attached itself to the entire length of body on the substratum. The pupa appeared like a shell. Its length was 20.9 (20–23) mm and diameter at the broadest part was 7.6 (7–8) mm. Pupal stage lasted for 6–7 days. After hatching, adults kept it attached on the support and after hardening of wing it started flying.

VACH *(Acorus calamus)*

The species is a native of Europe belongs to family Araceae. It is a small perennial aromatic herb grown naturally in marshy fields and well distributed throughout India. The species is cultivated in some parts of India mainly in Andra Pradesh and Tamil Nadu. The rhizomes are cylindrical or somewhat compressed. The dried rhizomes constitute the commercial raw drug of 'Calamus'. Asarone a and b, acoric acid and choline are the major active principle of the raw drug. It is believed to improve memory power and intellect.

Germplasm collection, maintenance and evaluation

APHU, Bapatla: Eleven clones were collected from various parts of Andhra Pradesh and evaluated for their morphological and agronomical traits. Clone collected from Munipalle

of Guntur district recorded maximum leaf length (65 cm) and clone from Kalyani showed minimum leaf length (52.5 cm). Rhizome weight varied from 60 g plant^{-1} in clone collected from Munipalle of Guntur district to 43.0 g plant^{-1} in clone collected from Warangal district of Andra Pradesh. Leaf width varied from 1.3 cm (Gadipalli collection) to 1.8 cm (Nagireddigudem). Based on the literature and observations made in germplasm collected, minimal descriptors were also developed in the species.

Germplasm holding

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

Germplasm maintained at DMAPR

Sl. No.	Crop/Species	No of Accessions
1	*Aloe* spp.	55
2	*Andrographis paniculata*	60
3	*Asparagus* spp.	44
4	*Chlorophytum borivilianum*	54
5	*Commiphora* spp	110
6	*Desmodium gangeticum*	11
7	*Gymnema sylvestre*	09
8	*Phyllanthus* spp	13
9	*Plantago* spp.	58
10	*Tinospora cordifolia*	35
11	*Urgenia* spp	12
12	*Withania somnifera*	111
	Total	**572**

Germplasm maintained at different AINRP on MAP centers

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

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

Intellectual Property Rights

Elite line of mandookaparni registered

A distinct elite plant type of mandookaparni (*Centella asiatica*), collected from Faizabad, Uttar Pradesh was characterised at DMAPR. The new plant type having accession No. IC 561247 was bigger in leaf size and superior to the local plant type in yield and quality. Fresh herbage yield was about three times more in the elite plant type compared to local plant type. Asiaticoside was 1.62% in the registered material while local type had 1.47% active principle. Characterisation based on molecular markers also revealed the distinctness of IC 561247 and it is registered as INGR No. 08105 as an elite germplasm with superior yield and quality.

Patent filed on a new aloin extraction method

A process patent (No. 1261/MUM/2008) has been filed by DMAPR at Indian Patent Office, Mumbai for preparation of pure aloin from Aloe (*Aloe barbadensis*) through extraction and purification. Aloin (aloin A) is the major active principle in aloe. It is a pharmaceutically important compound and utilized for the production of various drug intermediary compounds**.** The new method is easy to perform and can be used for extraction of aloin of high quality from fresh, sun dried, oven dried or freeze dried leaf exudates. The method is also quicker, efficient (recovery up to 90%) and cost effective (most of the solvent used can be recovered for reuse). Aloin purity of more than 90-95% can be achieved by this method hence, suitable for industrial purposes.

ARIS Cell

Networking of herbal gardens in India

A web based network on herbal gardens in India was developed and hosted at www.herbalgardenindia.org with funding from NMPB. The website was developed using Tomcat6 as application server, Struts' 2.0 as application framework, Java Script as front-end and MySQL 6.0 as back-end. The network maintained information on gardens, species information based on plant habits *viz*., herb, shrub, tree as well as climber available in herbal gardens, number of plants maintained in each species with quality parameters identified, availability of planting material, etc., based on information given by the participating member herbal gardens. Data on herbal gardens were collected from individual herbal gardens maintained by various governments and non-government organisations of India through the help of NMPB and different state forest departments. At present a total of 70 herbal gardens across the country registered as members.

The software package was divided into three main modules such as 'User', 'Member' and 'Administrator'. The 'User' of this herbal gardens network has the access of decentralised information on all the available herbal gardens in India. The 'Member' of this herbal

gardens network has the access to the website for updating their data from time to time. The 'Administrator' has the control to create a new member herbal garden in the network, manage the database based on the information given by the participating member herbal gardens, delete unwanted information and modify the existing database, etc.

The home page of this website consisted of 4 main 'User' sub-modules viz., 'Gardens', 'Species', 'Search' and 'Login'. The 'Gardens' sub-module gives the list of all registered member herbal gardens and the number of species available at the respective garden within the parenthesis. Each herbal garden gives details of the respective herbal garden with the sub menu *viz*., 'Tree species', 'Shrub species', 'Herb species' and 'Climber species', wherein one can search the availability of medicinal species based on species habit. One can also search the availability of a desired medicinal species in different member herbal gardens through the 'Species' sub-module. Each species gives the details such as type of species, botanical name, common name, synonyms, family name, local names and the table having the details such as name of the herbal garden, number of plants maintained, quality parameters identified, and quantity of planting material/seed production at various herbal gardens. The 'Search' sub-module consisted of various search options such as 'City wise', 'State wise', 'Species wise', 'Scientific name wise', 'Common name wise', 'Local name wise', 'Family wise' and 'Advance search'. Members of this herbal garden network have the access to the website for adding and updating their data from time to time through the 'Login' module.

The networking of herbal gardens has a number of advantages such as one can access information on availability of species, planting material, etc., at various herbal gardens. This would also facilitate the collectors to approach nearby garden for the material.

Databases maintained

During the year, attempts were made for updating the databases like Medicinal and Aromatic plants References Information System, Traders Information System on Medicinal and Aromatic plants, Website of DMAPR, Digital Photo Library of Medicinal and Aromatic Plants and Digital Herbarium of Medicinal and Aromatic Plants in India.

ALL INDIA NETWORKING RESEARCH PROJECT ON BETELVINE

Betelvine (*Piper betle*) a perennial, dioecious, evergreen creeper of family Piperaceae. The plants favour tropical forest conditions that provide cool shaded conditions with high humidity and warm temperature. Betelvine is cultivated in India, Bangladesh, Srilanka, and to a limited extent in Pakistan, Malaysia, Thailand, Indonesia, Maldives, Vietnam, and Papua New Guinea. In India, it is commercially cultivated over 45,000 ha as cash crop. Betel leaf has many medicinal properties and is used in Indian System of Medicine to cure indigestion, stomach ache, diarrhoea, flatulence and to heal wounds, scales and burns, swelling due to sprains, bruises, respiratory disorders, sore throat, constipation, boils and gum sores. Investigations have confirmed that leaves contain a chemical called hydroxy-chavicol: a phenolic compound that exhibited suppression of induced mutagenesis.

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

Germplasm collection, maintenance and evaluation

Germplasm maintained, evaluated and catalogued at different centres are presented:

Germpalsm collections at various Betelvine centres

Centres	Total collections	Catalogued
APHU, Bapatla	51	51
AAU, Jorhat	14	14
BCKV, Kalyani	42	42
IIHR, Bangalore	101	-
JNKVV, Jabalpur	20	20
MPKV, Sangli	28	28
RAU, Pusa	20	20

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

Hybrid evaluation trial

APHU, Bapatla: Evaluation of hybrids with local checks was carried out and it was observed that local variety Tellaku Ponnur performed better than GN hybrid with respect to vine elongation month^{-1} (41.46 cm), number of laterals vine^{-1} (11.44) and leaf yield (37.59 lakh ha^{-1} yr^{-1}). However, GN hybrid recorded significantly superior leaf characters *viz.*, petiole length (7.30 cm), leaf size (16.06 x 12.15cm), fresh weight of 100 leaves (345.31 g) and leaf shelf life.

MPKV, Sangli: Krishna Pan recorded significantly more leaf yield (28.11 lakh ha^{-1}) followed by local Kapoori. The GN hybrid produced significantly lower leaf yield 16.62 (lakh ha^{-1} yr^{-1}). The fresh weight of 100 leaves and keeping quality of leaves were significantly maximum in GN hybrid (297.86 g and 18.57 days). The leaf size was larger in GN hybrid (18.5 x 10.5 cm^2) as compared to Krishna Pan and Kapoori local.

Hybridization

IIHR, Bangalore: Hybridization in betelvine was carried out involving 25 female and 19 male parents. The clones like Halisahar Sanchi and Karapaku among female clones and Pachhaikodi and CARI 6 among male clones which showed some degree of resistance to various diseases were also included in the hybridization programme. Maximum numbers of fruits were harvested from the female parents, Bangla nagaram (30) and Simurali Bhabna (local) (30) followed by SGM 1 (22).

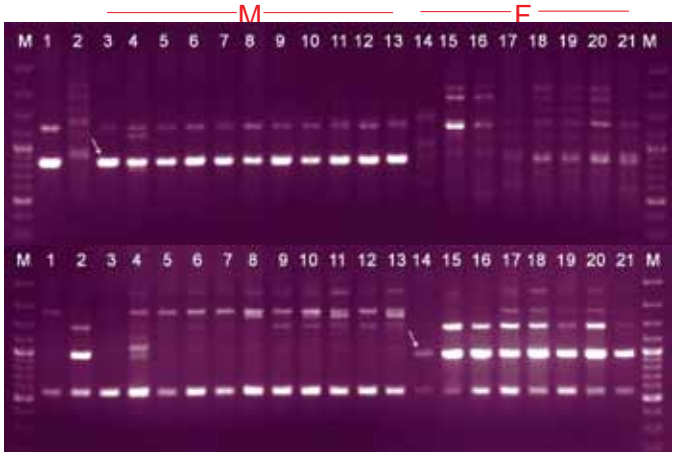
The seed germination percent varied from 12.0 to 65.2% among the crosses. In total, 1693 hybrid seedlings from 89 different crosses were raised and maintained. Maximum number of hybrid seedlings were raised from the crosses with SGM1 (783) followed by Simurali Bhabna local (216). Wide variability was observed for many morphological traits like plant vigour, leaf size, leaf shape, leaf color, petiole length, internodal length and stem pigmentation. Vigorous hybrid seedlings were selected for further multiplication.

Ten hybrids selected during 2006-07 were multiplied for distribution to the other centers for evaluation. Another ten selections were made from the hybrid progeny raised during 2007-08. A total of 200 hybrids from 33 crosses were field planted for further evaluation. Among the hybrids planted during 2006-07, lateral production was observed in three hybrids and only one hybrid 06-1 (SGM1/ Swarna Kapoori) flowered and produced female flowers. This is the first hybrid, which flowered at 21 months after planting.

Inter specific hybridization

Attempts were made for developing interspecific hybridisation between *P. betle* and *P. colubrinum*, a phytophthora resistant species and *P. betle* X *P. hamiltonii* (Awanipan). Fruit set was observed in the crosses where *P. colubrinum* was used as the male parent and Simurali Bhabna (local) as female parent. However, immature fruit drop was recorded. The crosses between *P. betle* X *P. hamiltonii* were not at all successful even though various standard methods reported for improveing fruit set in other crops were followed.

Sex determination by RAPD analysis



Male and female specific molecular markers in betelvine

DMAPR, Anand: Random Amplified Polymorphic DNA (RAPD) technique was used to find out sex linked markers in male and female plants. Two bulks of DNA were made drawing one each from male and female, by pooling an equal volume of DNA samples from each group of individual contributing to the bulk segregant analysis. Fifty different random decamer primers were screened with the two bulks to identify markers associated with sex expression of which only four primers were found to be associated with sex expression. These four primers were then tested with individual plant DNA samples where sex-associated RAPD markers were identified. A ~1400bp and ~ 850 bp fragment from the primer OPA04 and OPN 02, respectively was found to be present in all the male individuals and absent in all the female plants. In another primer, a ~980 bp amplification product from the primer OPC 06 was present only in the female individuals. A common primer OPA 08 showed both male and female specific markers of 650 bp and 1200 bp, respectively. Thus, the three male- specific RAPD markers $OPA04_{1400}$, $OPA08_{650}$ and $OPN02_{850}$ and two female-specific markers $OPA08_{1200}$ and $OPC06_{980}$ can reliably differentiate the male and female plants.

Crop regulation through staggered lowering

APHU, Bapatla: Vine elongation month^{-1} (cm) and leaf yield (lakh ha^{-1}) were found highest in plots of February and June lowering. Minimum percent disease incidence on leaf rot caused by *Phytophthora* sp. and leaf spot caused by *Colletotrichum capsici* was also recorded in February and June lowering treatments.

Integrated Crop Management (INM+IPM)

APHU, Bapatla: Treatment having optimum plant population + recommended fertilizer *i*.e. Neem cake + Urea (1 : 1) at 200 kg N, 100 kg P_2O_5 and 100 kg K_2O/ha, irrigation for 100% replenishment of CPE and application of Bordeaux mixture (4 drenches and 8 sprays) recorded significantly superior leaf yield (45 lakh leaves ha^{-1}) and lower disease incidence (21%) compared to other treatments.

BCKV, Kalyani: Vine elongation month^{-1} (cm), fresh weight of 100 leaves (gm) and leaf yield (lakh ha^{-1}) were recorded highest in treatment having 1,50,000 plant population + 200 kg N in splits of organic form +100 kg P_2O_5 + 100 kg K_2O (ha^{-1} yr^{-1}) + Irrigation at 100% replenishment of CPE + Bordeaux mixture application (4 Drenching and + 8 Spraying) + recommended insecticides whenever required. However, maximum leaf area (cm^2) (172.23 cm^2) and lowest incidence of leaf rot caused by *Phytophthora sp* were found in Farmers' practice.

MPKV, Sangli: The treatment having best plant population + 200 kg nitrogen in splits in organic form + 100 kg P_2O_5 + 100 kg K_2O + irrigation at 100% replenishment of CPE + 4 applications of *Trichoderma* + sanitation + recommended insecticides recorded

significantly more leaf yield (48.03 lakh ha^{-1}). However, fresh weight of 100 leaves and keeping quality were found significantly more in farmers' practice (local) (FYM 50 t ha^{-1} + neem cake 1 t ha^{-1}). Incidence of foot rot (%) in the farmers' practice was 25.69%.

Assessment of organic carbon content in Betelvine gardens

APHU, Bapatla: It was observed that the increase in organic carbon content in the soil increased the leaf yield and quality. Leaf yield showed significantly positive correlation with organic carbon content of the soil and plant height, while it showed non-significant positive correlation with all other soil and growth parameters.

MPKV, Sangli: assessment of organic carbon content in the betelvine fields of farmers of Arvi village (Kore gaon Taluk), Ankal khop village (Paluse Taluk), Vitthal Nagar village (Valwa Taluk) and Bedga village (Miraj Taluk) were carried out and the initial organic carbon content ranged from 0.48% to 0.82% in these areas. In the field which received 381 kg ha^{-1} N through FYM and oil cake resulted in maximum organic carbon content (0.70%) and produced maximum leaf yield (72 lakh ha^{-1}).

Epidemiological studies of different diseases

MPKV, Sangli: Epidemiological studies of fungal and bacterial diseases of betelvine were done at the centre. It was observed that *Phytophthora* foot rot and *Phytophthora* leaf spot diseases were appeared in the 22nd and 23rd meteorological week (June) respectively, while anthracnose and bacterial leaf blight were appeared in 21st (May) and 27th (July) meteorological week respectively. The simple correlation between percent disease incidence and weather parameters showed that the *Phytophthora* wilt, *Phytophthora* leaf spot and bacterial leaf blight were negatively correlated with maximum temperature and positively correlated with minimum temperature, morning humidity, evening humidity and rainfall. The anthracnose disease was positively correlated with maximum temperature, minimum temperature and humidity and negatively correlated with evening humidity and rainfall.

APHU, Bapatla: Epidemiological studies conducted on *Phytophthora* foot rot disease indicated that percent disease incidence had significant positive correlation with morning relative humidity and rainfall and have non-significant positive correlation with minimum temperature and evening relative humidity, while it had non-significant negative correlation with maximum temperature. Multiple regression equation worked out for foot rot disease is

$$Y = -21.11 - 1.8320\ X_1 + 0.6849\ X_2 + 1.0669\ X_3 - 0.3640\ X_4 + 0.3048\ X_5$$

BCKV, Kalayani: Results revealed that among the five considered meteorological factors, minimum temperature and maximum RH were more responsible for increase in disease incidence or spread of foot rot and leaf rot diseases.

Rhizosphere competence and survival period of *Trichoderma*

APHU, Bapatla: Significant increase in mean colony forming units of rhizosphere soil up to 40 days after addition of *T. viride* talc formulation was observed.

BCKV, Kalyani: Application of *Trichoderma* sp. remained active in the soil for 60 days at 10^7 CFU which decreases below 10^7 CFU thereafter.

Demonstration of disease management technology in the farmers' field

BCKV, Kalyani: Disease management technology developed by the centre in the farmers' field was conducted in eight farmers' field at Simurali, Nadia. Treatment included sanitation

and application of Bordeaux mixture at pre monsoon + after one month, biocontrol agent + one application of Bordeaux mixture two months after first Bordeaux mixture application was demonstrated. The results revealed that disease incidence was low and yield was higher in the plots applied with the disease management technology developed by the centre.

JNKVV, Jabalpur: Technology generated by the centre was found to be superior over the farmers' practice in terms of number of leaves per plant (36.1), weight of 100 leaves (6.50 g), vine death due to *Phytophthora nicotianae* var. *parasitica* and bacterial infection (18.00 and 17.00%) on leaves.

RAU, Pusa: The crop under ICM package was healthier having low incidence of *Phytophthora* rot (6.6-7.3%PDI), and produced better quality leaves with longer shelf life (14-16 days), whereas crops under farmers' practice produced poor quality leaves with 9-12 days shelf life and recorded higher incidence of *Phytophthora* rot (12.7-15.6% PDI).

Fixing ETL for important insect pests

APHU, Bapatla: Presence of three tobacco caterpillar larvae per plant caused significant yield loss at which control measures needed to be initiated to avoid economic loss.

TNAU, Sirugamani: Scale insect (*Lepidosaphus cornutus*) was an important pest which caused significant yield loss. Betelvine could tolerate infestation of *L. cornutus* attack up to 6 scales per 2 m vine (0.33 scales leaf^{-1}) without affecting yield where the age of the crop is more than two years and one lowering had been carried out. The control resources should be started before the threshold level for effective suppression of linear scale insect where the cost benefit ratio is higher.

Residue analysis of chlorpyrifos and dichlorvos in leaves

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

Monitoring for biodiversity of pests and natural enemies and their identification

APHU, Bapatla: Fixed plot survey was conducted at Chinthalpudi. Observations on seasonal occurrence of pests and natural enemies were recorded and submitted for identification. Leaf eating caterpillar complex on *Sesbania* consisted of *Eurema hecabae*, *Hyposidra successaria, Mauruca testulalis and Spodoptera litura* during October. Stem borer *i.e Azygophleps scalaris* activity was more during September. Red spider mites were dominant during August to November. Spiders and *Coccinellids* were the dominant natural enemies in Betelvine ecosystem.

BCKV, Kalyani: Two aleyrodid flies namely, *Singhiella* (*Dialeurodes*) *pallida* (Singh) and *Aleurocanthus rugosa* Singh occurered sympatrically. Recently one more blackfly had been reported from the centre. The black fly was primarily identified as a species of *Aleurocanthus* which has been confirmed as a new species.

General Information

COMMITTEE MEETINGS

Research Advisory Committee

The Sixth RAC meeting of DMAPR was held on July 8, 2008 under the Chairmanship of Dr. B.R. Tyagi, Retired Deputy Director, CIMAP. Other members of the committee who attended the meeting were Dr. A.A. Farooqui, Retired Proffessor & Head, Division of Horticulture, UAS, Bangalore; Dr. S.K. Pareek, Pr. Scientist, NBPGR, New Delhi; Dr. Umesh Srivastava, ADG (Hort. II), ICAR, New Delhi; Dr. I.L. Kothari, Professor, Deptartment of Biosciences, S. P. Univ., Vallabh Vidyanagar and Dr. Satyabrata Maiti, Director, DMAPR, Anand. The proceedings of the meeting started with presentation of bouquet to the Chairman and Members of the RAC and the welcome note proposed by Dr. S. Samantaray, Member Secretary, RAC. Dr. Tyagi in his opening remarks expressed that scientists should frame well focused objectives and work on multidisciplinary collaborative research projects, which would give an opportunity for publishing good quality papers and getting recognition. He motivated the scientists to initiate open house discussion of their research programmes. Dr. S. Samantaray, Member-Secretary appraised the house about the action taken on suggestions made in the last RAC meeting. Dr. Maiti, made an comprehensive presentation on the progress of research work since February 2007. He emphasised, though there was shortage of scientific and technical staff, the institute tried its level best to achieve the set targets. The Committee offered some useful suggestions for future work of the Directorate. The meeting ended with vote of thanks proposed by Dr. P. Manivel, Pr. Scientist, DMAPR.

Institute Research Council (IRC)

The seventeenth IRC meeting was held on July 10-11, 2008 under the chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. The meeting was attended by the all scientific staff of DMAPR. It started with welcome note by Dr. P. Manivel, Member Secretary, IRC. Major achievements of previous six months were also highlighted in the meeting that a patent application had been filed by DMAPR and a unique germplasm of mandookparni (*Centela asiatica*) had been registered with NBPGR. All the project leaders presented their work done report. Discussion was done on 13 projects. These covered crops like aloe, ashoka, ashwagandha, giloi, guggal, harde, isabgol, safed musli and senna. The projects dealt on crop improvement, production, protection and quality management aspects apart from computer application.

Institute Management Committee

The Institute Management committee (IMC) meeting was held on February 13, 2009 under the chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. The meeting was attended

by Dr. B. G. Bagle, Head, CHES, Godhra; Dr. S. Samantaray, Sr. Scientist (Biotechnology); Dr. M. Das, Sr. Scientist (Plant Physiology); Dr. K. Mandal, Sr. Scientist (Plant Pathology); Mr. R. T. Thakar, AAO and Mr. T. A. Vishawanath, AFAO as members. Dr. Maiti welcomed all the members and highlighted two salient achievements of the institute – registration of a unique germplasm of *Centella asiatica* and filing of a patent on aloin extraction and purification from *Aloe vera*. Action taken on the earlier recommendations was presented and discussion on new agenda items took place. The committee reviewed the various research and developmental activities of the institute. The meeting ended with the vote of thanks to the Chair.

GROUP MEETINGS

AINRPMAP

Biennial group meeting of the AINRPMAP was held at Kerala Agricultural University, Trichur during November15-17, 2008. The Inaugural session started with welcome address by Dr. D. Alexander, Director of Research, KAU wherein he highlighted the contributions made by KAU in popularising medicinal and aromatic plants cultivation in the state by motivating farmers and providing technology. Dr. U. C. Srivastava, Assistant Director General (Horticulture II), ICAR highlighted the achievements made by the AINRPMAP. He also made a mention about the positive step taken by the council in merging the AINRP on Betelvine with the AINRPMAP to increase its reach to different niche of the country.

Dr. Satyabrata Maiti, Project Coordinator, AINRPMAP presented salient achievements made by various Co-coordinating centres during last two years. He informed that under the project research was carried out on various aspects of crop production and improvement with a view to ultimately develop Good Agricultural Practices without compromising the quality and safety of the raw drug. A multidisciplinary team of 34 scientists of various disciplines such as Plant Breeding, Horticulture, Agronomy, Plant Pathology and Phyto-chemistry are engaged in research at 10 centres of the project.

Dr. M. K. Sheela, Director of Extension and Dr. P. K. Rajeevan, Associate Dean, KAU expressed their views on the cultivation of medicinal and aromatic plants in Kerala. Mr. Rajaji Mathew Thomas, MLA and Executive Member of the KAU delivered the inaugural address. He informed that Kerala has age old tradition of using medicinal and aromatic plants and maintains vast diversity of these species. He suggested that plants useful against most critical diseases should be identified and researched upon. Some ayurvedic products made by the University were released by the dignitaries.

The project scientists of different disciplines from different centres took part in the deliberations for three days. Salient outcome, recommendations and future research programmes were presented in the plenary session held on November 17, 2008. The function came to an end with the vote of thanks proposed by Dr. S. Maiti.

Some of the important recommendations emerged from the group meeting were: (i) Farmers of south-eastern Rajasthan should sow ashwagandha during September 10-16 and harvest during February 12-18 for higher productivity, profitability and quality of roots, (ii) After harvesting, fleshy root of safed mulsi (for planting material) should be stored in wooden box containing 4 inch layer of musli overlapped by 4 inch layer of soil, (iii) Critical growth stages in opium poppy with respect to moisture stress in descending order (from most to least critical) are rosette (45 DAS), flower initiation (70 DAS), late capsule (98 DAS), 50% flowering (85 DAS), stem elongation (30 DAS), bud (58 DAS), after lancing (120 DAS) and capsule maturing (108 DAS). These may be taken into consideration while scheduling irrigation under limited availability of water and (iv) Under Trichur conditions, Brahmi should be harvested after every 5 months for higher herbage yield and bacoside content.

AINRP Betelvine

Twenty second group meeting of workers from AINRP on Betelvine was organised at BCKV, Kalyani during December 13-15, 2008. The function started with the welcome address by Prof. S. K. Sanyal, Director of Research, BCKV. He also highlighted prospects and opportunities of betelvine cultivation. Dr. U. C. Srivastava, ADG (Hort. II), ICAR presented prospect of the project and reaffirmed the cooperation from ICAR for making this old network more result oriented.

Dr. Satyabrata Maiti, Project Co-ordiantor, AINRP on Betelvine presented salient achievements made during 2006-08 by ten coordinating centres located in eight Agricultural Universities. A multidisciplinary team of about 26 scientists of various disciplines such as Plant breeding, Horticulture, Plant Pathology, Entomology, and Agronomy were working in on various aspects of Crop Improvement, Crop Production, Crop Protection, etc. Major emphasis was given on water management, organic farming and development of IPM for major insect pests and diseases. Breeding for elite betelvine varieties was initiated at IIHR. Hybrid seeds were obtained from several crosses. He highlighted that crop management technologies developed by the Centres were demonstrated in the farmers' fields and were found superior.

In the inaugural address Dr. R. K. Samanta, Vice Chancellor, BCKV congratulated the betelvine workers for the achievements made by the AINRP. He urged the Betelvine workers to work in such a way that common man should be benefited by our efforts.

Work done report by the project scientists from different centres was presented at different technical sessions. The group felicitated Prof. Chitreshwar Sen, former Head, Department of Plant Pathology, BCKV for his outstanding contribution to plant pathology in

general and betelvine research in particular. Salient outcome, recommendations and future research programmes were presented in the plenary session held on 15 December. The project proposed integrated crop management package as: maintenance of recommended plant population, application of recommended NPK (200:100:100 kg/ha), irrigation to replenish 100% of CPE, maintenance of sanitation, soil drench of Bordeaux mixture at the time of planting followed by soil application of *Trichoderma* (after one month) and one more soil drench of Bordeaux mixture. This package produced better betel leaves as well as satisfactory control of diseases in comparison to farmers' practice. The function came to an end with the vote of thanks proposed by Dr. S. Maiti.

OTHER ACTIVITIES

Hindi Week: DMAPR celebrated Hindi Week during September 15-22, 2008. Different competitions were organized among the staff members to promote the use of Hindi in the day-to-day official work. On September 22 a function was organised under the chairmanship of Dr. Satyabrata Maiti. Sh. D. C. Agrawal, Retired Principal, Kendriya Vidyalaya, Vallabh Vidyanagar was present as chief guest of the function.

Vigilance Awareness Week: The DMAPR observed vigilance awareness week from November 3-7, 2008 by keeping records open for verification to bring transparency in the functioning of the institute.

Annual Day: Annual Day was observed on November 24, 2008. The staff welfare club of DMAPR organised a function to commemorate this occasion. The staff members along with their family observed the day with great fanfare.

Networking of herbal gardens

The online website http://www.herbalgardenindia.org, developed by DMAPR was launched in the International Symposium on Afforestation of Medicinal Trees at 3rd World Ayurveda Congress and Arogya 2008 held at Jaipur on December 20, 2008 by the honourable Chief Guest Thiru N. Selvaraj, Minister for Forests, Government of Tamil Nadu. The website will help in sharing the information for effective utilisation of public and private funded herbal gardens. Dr. Satyabrata Maiti, Director, DMAPR, Anand made a presentation on the various information retrieval options of the website before distinguished guests like Shri. B.S. Sajwan, CEO, NMPB; Prof. M. C. Varshneya, V.C., AAU, Anand and international and national delegates.

Network project on medicinal and aromatic plants' seed testing launched

A collaborative network research project on "Formulation of seed standards and standardisation of seed testing protocols in medicinal and aromatic plants" was launched at DMAPR on 28 February, 2009. The function was chaired by Dr. Mohan Lal Sharma, PCCF, Gujarat. Dr Satyabrata Maiti, Director, DMAPR; Dr. Rajendra Gupta, Expert, NMPB; Dr. S. K. Pareek, Principal Scientist, NBPGR and

Expert, NMPB; Sh. R. V. Asari, Addl. PCCF, Gujarat and Sh. Kaboolchand, CCF, Gujarat were the other dignitaries present. The project launching meeting was also attended by scientists of DMAPR and AAU, Anand and personnel from Gujarat Forest Department. The function started with welcome address by Dr. Maiti. He highlighted the contribution made by DMAPR and its collaborating centres in the field of MAP. Prof. S. S. Parihar, Division of Seed Technology, IARI, New Delhi and coordinator of the project highlighted the need of such collaborating project on MAP seeds. He highlighted in brief the concept of the project. He also added that availability of high quality seeds was fundamental to the success of agriculture since crop production relies heavily on high quality seeds. Dr. Parihar further added that "Formulation of Seed Sandards in Medicinal and Aromatic Plants" was an important issue figured in agenda item of the 14th Technical Committee Meeting of Central Seed Certification Board. He emphasised that fundamental knowledge about mechanism underlying in seed development, germinability, dormancy and storability was required to improve the performance of seed. Dr. Rajendra Gupta stated that Government of India prescribed seed standards were notified for more than 95 crops *viz*. cereals, millets, pulses, etc. However no such standards were available for medicinal crops and hence this kind of project was timely and promising at this juncture. The objectives of the project are (1) to standardise and subsequent revalidation of seed testing protocols and (2) to formulate the 'Seed Standards' on the basis of market survey and testing of a large number of samples. The project at present will work on 21 species such as bael (*Aegle marmelos*), ajwain (*Ammi majus*), akarkara (*Anacyclus pyrethrum*), malariabuti (*Artemisia annua*), beladona (*Atropa belladonna*), kusum (*Carthamus tinctorius*), patang (*Caesalpinia sappan*), aparajita (*Clitoria ternatea*), sankhpuspi (*Convolvulus microphyllus*), viabidang (*Embelia ribes*), khurasani ajawain (*Hyoscymus niger*), Mehndi (*Lawsonia inermis*), chandrasur (*Lepidium sativum*), jivanti (*Leptadaenia reticulata*), velvet bean (*Mucuna pruriens*), bhui amla (*Phyllanthus amarus*), chitrak (*Plumbago zeylanica*), Babchi (*Psoralia corylifolia*), manjistha (*Rubia cordifolia*), silaras (*Silybum marianum*) and jojoba (*Simmondsia chinesis*). The programme came to an end with vote of thanks proposed by Dr. Manish Das, Sr. Scientist, DMAPR.

Farmer-Industry meet

A farmer-Industry meet was organised at DMAPR on March 9, 2009. Representatives from the essential oil industry led by Dr. Shivam Varshney, Director, Som Extracts Ltd, Noida along with Mr. Vinoo Assar, Mohini Perfumers Pvt. Ltd., Mumbai; Mr. Kamlesh Shah, Anant Fragrance Pvt. Ltd., Ahmedabad and others attended the meet. More than ten farmers practicing or interested in aromatic crops cultivation were major participants of the meeting. The meeting started with an address by Dr. Satyabrata Maiti, Director, DMAPR and welcoming the guests by presentation of bouquet. Later Dr. Vershney informed the state of aroma industry in the country and demand of natural fragrance. He emphasised that some crops like artimisa, mint, etc which were not yet cultivated in Gujarat extensively could also be tried. Principal part of the meeting was interaction between the industry

and farmers. Individual farmers shared their experiences, clarified doubts and expressed their needs. The meeting ended with the vote of thanks proposed by Dr. K. Mandal, Sr. Scientist, DMAPR.

Awards and Recognition

"Ploidy distinction in male and female plants of betelvine – a study by flow cytometry" by Arun K. Phurailatpam, K. A. Geetha and Satyabrata Maiti received the best poster award at National Seminar on Piperaceae – harnessing agro-technologies for accelerated production of economically important piper species, held at Indian Institute of Spices Research, Calicut during November 21-22, 2008.

"Prospects of open access to Indian agricultural research: a case study of ICAR" by G. Sridhar and G. Aneeja bagged best paper award in the 8th Indian Science Communication Congress (ISCC-2008) held at Chennai, Tamil Nadu during December 10-14, 2008. The theme of the Congress was on Media Convergence and Knowledge Revolution.

Women Cell

Women staff members of the institute had regular meetings under the aegis of Women cell created at DMAPR under the Chairperson, Dr. (Ms.) S. Samantaray, Sr. Scientist (Biotechnology). Issues related to their welfare were discussed in the meetings.

Right to Information

DMAPR continued with its principle of maintaining transparency in all its activities. Enforcement of Right to Information Act, 2005 of Govt. of India has been done with letter and sprit. All information related to the Right to Information Act are regularly posted in the website of DMAPR. Besides, the institute has also satisfactorily responded to the various requests received seeking information under the Right to Information Act within the stipulated time frame.

OTHER INFORMATION

New Colleagues

Sh. Vinay Kumar joined as Scientist (Biotechnology) on July 5, 2008

Sh. R. T. Thakar joined on deputation as AAO on Septemeber 22, 2008

Dr. Abirami joined as Scientist (Horticulture) on September 29, 2008

Transfer

Sh. V. S. Parmar, AAO transferred to CIFE, Mumbai on promotion as AO on August 30, 2008

Dissertation done by students

Student's Name and Address	Title of Dissertation	Guide
Mr. Manojkumar, Rungta College of Science & Technology	Characterization of germplasm of *Commiphora wightii* (Arnott.) Bhandari : analysis using RAPD marker	S. Samantray, Senior Scientist (Biotechnology)
Mr. Tarunkumar Patel, Rungta College of Science & Technology	Micropropagation and molecular characterization of *Chlorophytum* spp.	
Ms. Nibedita Rana, P.G. Department of Botany & Biotechnology, Berhampur, Orissa	Genetic diversity analysis of *Andrographis* (Burm.f.) Nees. using molecular markers	
Ms. Deepika Satapathy, P.G. Department of Botany & Biotechnology, Berhampur, Orissa	Asessment of genetic relationship among (*Commiphora wightii* (Arnott.) Bhandari using RAPD Markers	
Ms. Archana Manjari Jena, P.G. Department of Botany & Biotechnology, Berhampur, Orissa	Identification of sex in betelvine (*Piper betle* L.) using molecular markers	
Ms. Sweta H. Patel, B.R.D. School of Biosciences, S. P. University, V.V.Nagar	Assessment of pre-treatment effects on germination, vigour and emergence of some medicinal plants	Dr. Manish Das, Senior Scientist (Plant Physiology)
Mr. Bharat Shah, B.R.D. School of Biosciences, S. P. University, V.V.Nagar	Pathogenesis of *Artemisia annua* by *Alternaria alternata* causing leaf blight disease	Dr. K. Mandal, Senior Scientist (Plant Pathaology)
Ms. Sonal Shah, B.R.D. School of Biosciences, S. P. University, V.V.Nagar	Effect of soil moisture stress on growth physiology and phytochemical constituents of ashwagandha (*Withania somnifera*)	Mr. R. Saravanan, Scientist (SG) (Plant Physiology)

Training imparted to students

Student's Name and Address	Topic of training programme	Guide
Mr. Mihir J. Patel, N.V. Patel College of Pure and Applied Sciences, V.V.Nagar	Techniques like micropropagation and DNA isolation, purification and quantification some important medicinal plants	Dr. Sanghamitra Samantaray, Sr. Scientist (Biotechnology)
Mr. Anand H. Nakhva, N.V. Patel College of Pure and Applied Sciences, V.V.Nagar	Techniques like micropropagation and DNA isolation, purification and quantification some important medicinal plants	
Ms. Deepti M. Davla, St. Xavier's College, Gujarat University, Ahmedabad	Techniques like micropropagation and DNA isolation, purification and quantification some important medicinal plants	

Student's Name and Address	Topic of training programme	Guide
Ms. Shilpa R. Gurmani, B.R.D. School of Biosciences, Sardar Patel University, V.V.Nagar	Techniques like micropropagation and DNA isolation, purification and quantification some important medicinal plants	Dr. Sanghamitra Samantaray, Sr. Scientist (Biotechnology)
Mr. Dhawal B. Upadhyay, B.R.D. School of Biosciences, Sardar Patel University, V.V.Nagar	Techniques like micropropagation and DNA isolation, purification and quantification some important medicinal plants	
Ms. Khosha Y. Shelat, Anand Mercantile College of Science, Anand	Techniques like micropropagation and DNA isolation, purification and quantification some important medicinal plants	
Mr. Maulik H. Patel, Anand Mercantile College of Science, Anand	Techniques like micropropagation and DNA isolation, purification and quantification some important medicinal plants	

Human Resource Development (Education & Training)

Name	Details	Date
Dr. P. Manivel, Principal Scientist (Plant Breeding) Mr. T.A. Vishwanath, AF&AO Mr. R.T. Thakar, AAO	Training workshop for consortia partners on "Procurement related matter and financial management system under World Bank funded project of NAIP" at CIFE, Mumbai	January 4-6, 2009
Dr. K. A. Geetha, Senior Scientist (Plant Breeding)	Training on ovule clearing technique at NRCPB, New Delhi under NAIP	January 13-16, 2009
Dr. L. Saravanan, Scientist (Entomology)	Winter school training on "Modern trends in Pest Management" at TNAU, Coimbatore	February 13-March 5, 2009
Dr. Mahesh V. Kawale, Research Associate (Botany)	Training/workshop on "Taxonomy, reproductive biology and conservation" at CEMDE, University of Delhi.	February 18-27, 2009

Distinguished Visitors

- Dr. K. M. Bujarbaruah, DDG (AS), ICAR, New Delhi on May 15, 2008.
- Dr. B. R. Tyagi, Chairman, RAC on July 8, 2008.
- Dr. A. A. Farooqi, Member, RAC on July 8, 2008.
- Dr. S. K. Pareek, Member, RAC on July 8, 2008.
- Dr. Umesh C. Srivastava, ADG (Hor. II) on July 8, 2008.
- Prof. I. L. Kothari, Member, RAC on July 8, 2008.
- Sh. Chaman Kumar, Addl Secretary & FA, DARE, New Delhi visited on November 24, 2008.
- Dr. C. D. Mayee, Secretary, ASRB, New Delhi visited on December 4, 2008.

- Dr. N. N. Singh, Vice Chancellor, Birsa Agricultural University, Ranchi on December 5, 2008.
- Dr. S. K. Nanda, Principal Secretary, Forest & Environment, Govt. of Gujarat, Gandhinagar on December 5, 2008.
- Dr. M. L. Sharma, PCCF, Govt. of Gujarat, Gandhingar on December 5, 2008.
- Sh. B. N. Shrivastava, Addl. PCCF, Govt. of Gujarat, Gandhingar on December 5, 2008.
- Sh. R. V. Asari, Addl. PCCF (D&M), Govt. of Gujarat, Gandhingar on December 5, 2008.
- Dr. R. K. Samanta, Vice Chancellor, Bidhan Chandra Krishi Viswavidyalaya, Kalyani on December 6, 2008.
- Dr. Pitam Chandra, ADG (PE), ICAR, New Delhi on January 17, 2009.
- Dr. S. D. Kulkarni, PD, SPUC, CIAE, Bhopal on January 17, 2009.
- Prof. J. P. Khurana, Dept. of Plant Molecular Biology, New Delhi on February 17, 2009.
- Prof. D. R. Sharma, Ex. Director of Research, Dr. YSPUH&F, Solan on February 17, 2009.
- Dr. K. A. Singh, Director, IG&FRI, Jhansi on February 23, 2009.
- Dr. Mohan Lal Sharma, PCCF, Govt. of Gujarat, Gandhinagar on February 28, 2009.
- Dr. R. V. Asari, Addl. PCCF (D&M), Govt. of Gujarat, Gandhinagar on February 28, 2009.
- Dr. Rajendra Gupta, Retd. Project Coordinator, AICRP on MAP, New Delhi on February 28, 2009.
- Dr. S. Nagarajan, Chairperson, PPV&FRA, Govt. of India, New Delhi on March 4, 2009.

Important Meetings attended by the Director

- Attended the Expert Committee meeting to evaluate the Access, Transfer of Research Results, IPR and Third Party Transfer Applications held on April 8, 2008 at National Biodiversity Authority (NBA), Chennai.
- Attended the first meeting of Expert Committee on Medicinal Plants held on April 15, 2008 at NBA, Chennai.
- Attended 12th meeting of the Task Force on Biotechnology based programme for women held during April 21-22, 2008 at DBT, New Delhi.
- Attended the project launching meeting of networking project on Bael sponsored by the NMPB at KAB II, New Delhi on May 14, 2008.
- Attended the ICAR Regional Committee (VI) meeting at CAZRI, Jodhpur during June 26-27, 2008.
- Participated in the Expert Committee meeting to evaluate the access, patent, transfer of research results and material transfer applications on July 16, 2008 at, NBA, Chennai.
- Attended the meeting on "Licensing of ICAR Plant Varieties/Hybrids/Inbred Lines for commercial use by Private Seed agencies" held at Sugarcane Breeding Institute, Coimbatore on July 28, 2008.
- Attended a meeting for Finalization of QRT Guidelines proposed by Dr. H. K. Jain Committee held on August 1, 2008 at PIU, NAIP, KAB-II, New Delhi

- Attended the XIth Plan EFC meeting held on August 8, 2008 at ICAR, Krishi Bhavan under the Chairmanship of the Secretary, DARE & DG, ICAR.
- Attended 12th meeting of the Task Force on Biotechnology based programme for women held at DBT, New Delhi during August 21-22, 2008.
- Attended the NAIP stakeholders' workshop as an Expert at Andhra University, Vishakhapatanam during August 25-26, 2008.
- Attended the Dasmula Workshop at Gandhinagar on October 6, 2008.
- Attended NMPB Review meeting of Guggal Project at Gandhinagar on October 7, 2008.
- Participated in the Expert Committee meeting to evaluate the access, patent, transfer of research results and material transfer applications on November 11, 2008 at NBA, Chennai.
- Participated and chair a Session in the National Seminar on Piperaceae at IISR, Calicut during November 21-22, 2008.
- Attended the 4th Scientific Advisory Committee meeting at PPV&FRA, New Delhi on December 1, 2008.
- Attended the International Conclave on Medicinal Plants for ASEAN and BIMSTEC countries and presented a paper on the Guidelines on Good Agricultural and Field Collection Practices of Medicinal Plants in Technical Session-I on December 11, 2008 at Imphal.
- Participated in the World Ayurveda Congress & Arogya held at Jaipur on December 20, 2008 and presented a paper on 'Researchable issues in tree species improvement of medicinal plants.'
- Participated in the Review Meeting of the ICAR Seed Project at NASC Complex, New Delhi during January 5-6, 2009.
- Attended the ICAR Directors' Conference at New Delhi during January 14-16, 2009.
- Made presentation on NMPB projects on January 15, 2009 at NMPB, New Delhi
- Participated in the Expert Committee meeting to evaluate the access, patent, transfer of research results and material transfer applications on January 23, 2009 at NBA, Chennai.
- Delivered a lecture in the workshop on Scope and Prospects of Farmer – Industry Linkages for Promotion of Medicinal and Aromatic Plants at Dr. PDKV, Akola on February 10, 2009.
- Attended a financial review meeting of DUS Testing project at PPVFRA, New Delhi on February 25, 2009
- Attended the XIX meeting of Germplasm Registration Committee at NBPGR, New Delhi on March 13, 2009.
- Attended the first meeting of the 'Technological innovations for commercial exploitation of *Morinda citrifolia* as livelihood option for island farmers' at KAB II, New Delhi on March 13, 2009.

PUBLICATION

Research Papers

DMAPR, Anand

Mandal, K., R. Saravanan and S. Maiti. 2008. Effect of different levels of N, P and K on downy mildew (*Peronospora plantaginis*) and seed yield of isabgol (*Plantago ovata*). *Crop Protection* 27: 988-995.

Samantaray, S. and S. Maiti. 2008. Rapid plant regeneration and assessment of genetic fidelity of *in vitro* raised plants in *Aloe barbadensis* Mill. Using RAPD markers. *Acta Botanica Gallica* 155: 427-434.

Samantaray, S., K. P. Hidyath and S. Maiti. 2009. An isolation protocol of genomic DNA from *Commiphora wightii* (Arnott.) Bhandari: an endangered medicinal plant. *International Journal of Integrative Biology* 6: 127-131.

Samantaray, S., V. Saroj Kumar and S. Maiti. 2009. Direct shoot regeneration from immature inflorescence cultures of *Chlorophytum arundinaceum* and *Chlorophytum borivilianum*. *Biologia* 64: 305-309.

Saravanan, R., S. Krishti, N.A. Gajbhiye and S. Maiti. 2008. Influence of light intensity on gas exchange, herbage yield and andrographolide content in *Andrographis paniculata* (Nees.). *Indian Journal of Horticulture* 65: 220-225.

Saravanan, R., S. Krishti, N.A. Gajbhiye and S. Maiti. 2009. Effect of plant population and soil moisture stress on herbage yield and andrographolide content in *Andrographis paniculata*. *Indian Journal of Horticulture* 66: 120-125.

AAU, Anand

Patel D. H., M. A. Patel, K. V. Patel, N.V. Upadhyay and S. Sriram. 2008. Quick and cost effective post harvest processing of safedmusli (*Chlorophytum borivillianum*). *International Journal of Plant Science* 3: 202-203.

Patel D. H., N. V. Upadhyay, M. A. Patel, K. C. Dalal, S. J. Macwan and S. Sriram. 2008. Effect of date of incision for gum production in guggal *Commiphora wightii* Arnott (Bhand). *The Indian Journal of Research and Education in Indian Medicine* 4: 7-10.

Patel D. H., N. V. Upadhyay, M. A. Patel, S. J. Macwan and S. Sriram. 2008. Effect of organic manure and spacings on fasciculated root yield of safed musli (*Chlorophytum borivillianum*). *Indian Journal of Agricultural Research* 42: 31-36.

Upadhyay N. V., D. H. Patel, S. J. Macwan, M. A. Patel, S. A. Patel, N. H. Punjani and S. Sriram. 2008. Studies on the effect of removal of inflorescence (topping) on yield and yield attributes of safedmusli (*Chlorophytum borivilianum*). *The Indian Journal of Research and Education in Indian Medicine* 4: 57-59.

BCKV, Kalyani

Das B. K. and S. K. Mallick. 2009. Assessment of yield loss due to Aleyrodid flies [*Singhiella pallida* (Singh) and *Aleurocanthus rugosa* Singh] and control of *Singhiella pallida* (Singh)

in betelvine (*Piper betle* L.) ecosystem. *Environment and Ecology* 27:1157-1160.

Dasgupta B., B. Mohanty, P. K. Dutta and S. Maiti. 2008. Phytophthora diseases of betelvine (*Piper betle* L.): a menace to betelvine crop. *SAARC Journal of Agriculture* 6: 71-89.

Datta P., B. Dasgupta, C. Sengupta and D. K. Sengupta. 2009. Epidemiological studies of stem rot of betelvine caused by *Phytophthora parasitica* under closed conservatory condition in West Bengal. *Journal of Crop and Weed* 5: 258-259.

Mohanty B. and B. Dasgupta. 2008. Management of foot rot of betelvine (*Piper betle*) caused by *Phytophthora parasitica* by using safer fungicides. *Journal of Mycopathological Research* 48: 81-84.

CCSHAU, Hisar

Kumar A., S. Kumar, V. K. Madan and V. Phogat. 2008. Potential of kalmegh (*Andrographis paniculata* Wall ex. Nees) under north Indian conditions. *Indian Journal of Arecanut, Spices and Medicinal Plants* 10: 134 -137.

PDKV, Akola

Wankhade S. G., R. B. Sarode, S. V. Gholap and S. B. Nandanwar. 2008. Saponin content in safed musli (*Chlorophytum borivilianum)* as influenced by peeling of roots. *The Asian Journal of Experimental Chemistry* 3: 79-81.

RAU, Pusa

Dwivedi D. K., R. Kumar and S. Das. 2008. Effect of population density on growth, yield, nutrient uptake, soil health and economics in betelvine crop. *Environment and Ecology* 26:1183-1185.

MPUAT, Udaipur

Padiwal N. K., B. S. Rana, O. P. Ameta, G. S. Chouhan and K. S. Rupawat. 2008. Management of Tobacco Caterpiller, *Spodoptera litura* Fabricius and grey weevil in soybean. *Indian Journal of Entomology* 70:100-108.

Padiwal N. K., O. P. Ameta, B. S., Rana and G. S. Chouhan. 2008. Evaluation of management schedules against jassid, *Amrasca kerri* Pruthi and white fly (*Bemisia tabaci*) in soybean [*Glycine max* (L.) Merill]. *Pestology* 32: 54-60.

Sharma R. S., G. S. Chouhan, A. Joshi, and D. D. Sharma. 2008. Effect of varying sowing and harvesting dates on yield and yield traits of ashwagandha (*Withania somnifera* Dunal.) varieties. *Journal of Medicinal and Aromatic Plant Sciences* 30:139-141.

YSPUH&F, Solan

Mehra T. S., R. Raina, P. Chander and R. Chand. 2008. Effect of pollination methods on seed yield and colchicines content in glory lily (*Gloriosa superba*). *Indian Forester* 134: 549-553.

Singh J., R. Raina and A. Rajasekaran. 2008. Role of GA_3 application and time of seed sowing on seed germination of *Hypericum perforatum* L. *Indian Forester* 134:481-486.

Books/Book Chapters

DMAPR, Anand

Das, M. 2008. Impact of climate change on medicinal plants, *In*: Impact Assessment of Climate Change for Research Priority Planning in Horticultural Crops, S.S. Lal, P.M. Govindakrishnan, V.K. Dua, J.P. Singh and S.K. Pandey (eds.), Published by Central Potato Research Institute & ICAR, Shimla, India, 2008, pp 185-190.

Das, M., S. Raju and G. Sridhar. 2008. Medicinal plants: physiology and secondary metabolism *In*: Golden Jubilee Conference on Challenges and Emerging Strategies for Improving Plant Productivity., Indian Society for Plant Physiology, New Delhi, India, pp 88-93.

Maiti, S. and K. A. Geetha. 2009. Safed Musli. Published by Indian Council of Agricultural Research, New Delhi. p 44.

NDUAT, Faizabad

Ram D. and Mishra, V. Mahua ki Bagvani. Army Printing Press, Sadar Cantt, Lucknow. 10 p.

BCKV, Kalyani

Das B. K. and S. K. Mallick. 2008. Screening of betelvine cultivars for resistance to betelvine whitefly, *Singhiella pallida* (Singh) (Aleyrodidae: Hemiptera) and new host plant records for *Singhiella pallida* (Singh). *In: Piperaceae Crops- Technologies and Future Perspectives,* (Eds. K.S. Krishnamurthy et al.) Indian Institute of Spices Research, ICAR, Calicut, Kerala. p. 369.

Dasgupta B. and S. Maiti. 2008. Research on betelvine diseases under AINP on betelvine. *In: Piperaceae Crops - Technologies and Future Perspectives* (Eds. K.S. Krishnamurthy et al.) Indian Institute of Spices Research, ICAR, Calicut, Kerala. pp. 270 -279.

CCSHAU, Hisar

Kumari B., V. K. Madan and C. Bhan. 2009. Analytical Methods for Pesticide Residue Analysis. Published by the Department of Chemistry & Physics, CCS HAU, Hisar. pp. 1-109.

Madan V. K., B. Kumari and C. Bhan. 2009. Experiments in Chemical Kinetics and Surface Chemistry. Published by the Department of Chemistry & Physics, CCS HAU, Hisar. pp. 1-106.

MPUAT, Udaipur

Chouhan G. S., A. Joshi, S. K. Khandelwal and N. K. Padiwal. 2008. Organic farming practices for medicinal and aromatic plants. *In*: Organic Farming for Sustainable Agriculture, Himanshu Publications , Udaipur. pp.121-133.

Papers Presented in Seminars/Conferences/Symposia

DMAPR, Anand

Geetha, K.A., A. Phurailatpam and S. Maiti. Current status of genetic resources of *Piper betle* in India. *In:* "National Seminar on Piperaceae – Harnessing Agro-technologies for Accelerated Production of Economically Important *Piper* species" at Calicut during Feb 9-10, 2008 pp 235-240.

Maiti, S. and K. A. Geetha. Researchable issues for improvement of medicinal tree species. *In:* "International Symposium on Afforestation of Medicinal trees at 3rd World Ayurveda and Arogya 2008" at Jaipur on December 12, 2008.

Phurailatpam, A., K. A. Geetha and S. Maiti. Ploidy distinction in male and female plants of betelvine - a study by flow cytometry. *In:* "National Seminar on Piperaceae – Harnessing Agro-technologies for Accelerated Production of Economically Important *Piper* species" at Calicut during February 9-10, 2008.

Das, M., R. Saravanan and G. Sridhar. 2008. *In:* "Medicinal plants: Physiology and Secondary Metabolism. *In*: Golden Jubilee Conference on Challenges and Emerging Strategies for Improving Plant Productivity" at New Delhi during November 12-14, 2008.

Saravanan, R. and S. Maiti. 2008. Agronomic manipulations for crop production in *Piper betle*. *In:* National Seminar on Piperaceae. 'Harnessing Agro-Technologies for Accelerated Production of Economically Important Piper Species' at Calicut, Kerala during November 21-22, 2008.

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