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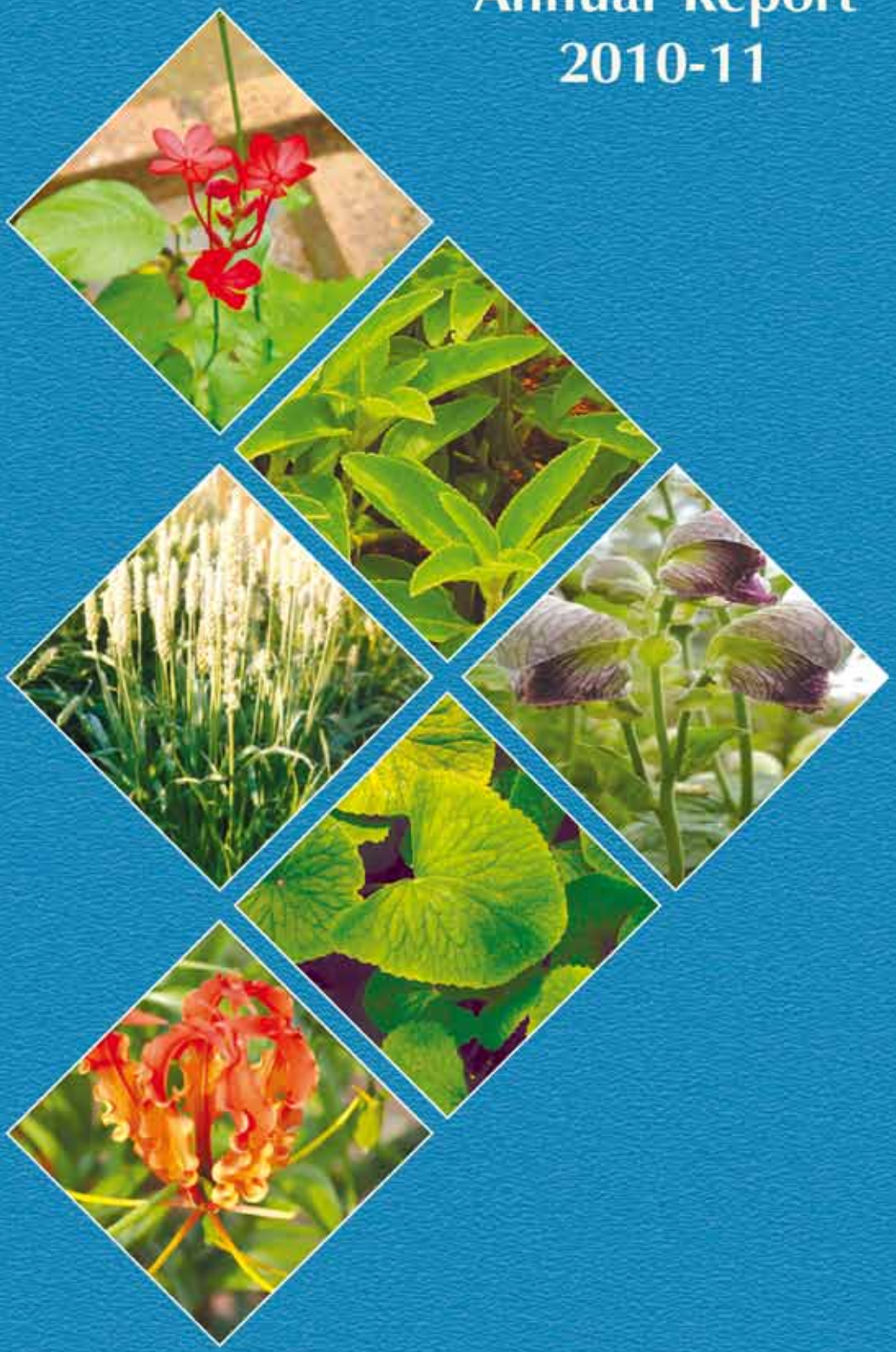
Annual Report 2010-11



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


Plumbago rosea
Coleus forskohlii
Plantago ovata
Aconitum heterophyllum
Centella asiatica
Gloriosa superba

ANNUAL REPORT
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Directorate of Medicinal and Aromatic Plants Research

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PREFACE

Medicinal and aromatic plants are used by both modern medicines and also by Indian System of Medicine (Ayurveda, Siddha, Unani and Homeopathy) in large volume. A large volume is also consumed by several traditions of tribal medicines and folk healers in India as well as other developing world. Since the bulk of the raw material is collected from the wild, the growing market demand should be taken as an opportunity and should explore the potential of the medicinal and aromatic plants for their sustainable socio-economic development. There is a strong link between sustainable utilization of the medicinal and aromatic plants resources and economic development. The current methods of indiscriminate and exploitative collection have resulted in bringing several valuable medicinal plant species to the verge of rare, endangered and threatened leading to extinction. In such a situation, it is not just the loss of a plant species but also the loss of a valuable source of income. Therefore, the need of the hour is to ensure the sustainability of the medicinal and aromatic plants. This calls for cultivation as a conservation strategy for sustainability of the medicinal and aromatic plants that would ensure health care needs of the present generation as well as the future generations to come. The ICAR through its organ Directorate of Medicinal and Aromatic Plants Research (DMAPR) is contributing its best in this area by doing basic, strategic and applied research and also coordinating the research activities of its 22 outreach partners under the All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvien (AICRP-MAPB).

Some of the contributions made by the DMAPR and AICRP-MAPB during 2010-11 those worth mentioning are: release of a new high yielding Madukaparni (Centella asiatica) variety named Vallabh-Medha; for the first time sexual plant type of Guggal (Commiphora wightii) identified; molecular characterization and apomixis in Guggal; contribution on GAP of MAP plants, etc. The DMAPR's unique website www.herbalgardenindia.org created through funding from NMPB for information sharing on availability of quality planting material from various herbal gardens has become popular and about 80 gardens have been registered. Three NAIP projects are persuaded as partner institute. In addition, it has been recognised as DUS testing centre of PPVFR Authority and reference varieties of Plantago ovata are maintained. DUS descriptor of Ashwagandha (Withania sominifera) is near completion. The DMAPR contributed in developing a unique GACP Trainers' Tool kit with the help of Food and Agriculture Organization (FAO).

The DMAPR has made a good progress in the 2010-11 not only in the national scenario but also contributed for the development of medicinal and aromatic plant sector of our friendly neighbouring country, Bhutan by developing their "Strategic road map for development of Medicinal and Aromatic Plant Sector" with the help of Food and Agriculture Organization. The Strategic Road Map received overwhelming appreciation from the FAO head quarters.

I am sure that good work initiated at the DMAPR and its AICRP-MAPB would continue to steadily progress with the whole-hearted support from our scientists, administrators and

other functionaries who would leave no stone unturned to make the country feel proud of ICAR.

I take this opportunity to place on record my heartfelt gratitude to Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR and Dr. H. P. Singh, Deputy Director General (Horticulture) for their passionate interest in medicinal plants activities and generous support in the over all 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 positive attitude shown in dealing the matters related to DMAPR at the headquarters. Thanks are also due to all the scientists of DMAPR and AICRP on MAP and Betelvine for their valuable contributions for this annual report. I appreciatively acknowledge the contributions of my colleagues, Dr. Satyanshu Kumar, Dr. K. A. Geetha, Dr. Vipin Chaudhary and Dr. R. S. Jat for their timely support in compilation and special thanks to Dr. Satyanshu Kumar for taking the burden of getting this volume printed within the deadline set by the Honb'le Director General, ICAR.

Jai Hind!

Anand **Satyabrata Maiti**

June 29, 2011

सारांश

औषधीय एवं सगंधीय पादप अनुसंधान निदेशालय तथा इसका बाह्य प्रसार कार्यक्रम, अखिल भारतीय समन्वित औषधीय एवं सगंधीय पादप तथा पानलता अनुसंधान परियोजना (ए.आई.सी.आर.पी.एम.ए.पी. व पल), औषधीय एवं सगंधीय पादप तथा पानलता पर शोधरत है । वर्ष 2010-2011 की मुख्य शोध उपलब्धियां निम्नलिखित हैं ।

धी कंवार (*एलो बारबेंडेंसिस*)

पी.डी.के.वी., अकोला पर किए गए जन्नद्रव्य मूल्यांकन में वंशरुप एकेएवी–09-01 द्वारा प्रति पौधा पत्तियों की संख्या (17.46) तथा आईसी-285630 द्वारा पत्तियों का वजन (413.75 ग्रा) सर्वाधिक प्राप्त हुआ ।

सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर 12 उत्कृष्ट पंक्तियों के मूल्यांकन में जाँच की तुलना में आईसी-112526 द्वारा सर्वाधिक ताजा पत्तियों (42203.70 किग्रा प्रति है.) का उत्पादन हुआ, तत्पश्चात एचएवी-05-08 (39731.48 किग्रा प्रति है.) का क्रम रहा ।

पी.डी.के.वी., अकोला पर किये गये परीक्षण में 2.5 टन प्रति है. वर्मीकम्पोस्ट के प्रयोग तथा 60x60 सेमी की परस्पर दूरी पर बोई गई फसल द्वारा अधिकतम प्रति पत्ति छीलन का वजन, लेटेक्स तथा अपरिकृष्ट लेटेक्स प्राप्त हुआ । डी.एम.ए.पी.आर., आणंद पर तनाव की परिस्थिति में PSII अधिकतम की क्षमता, qP तथा इलेक्ट्रान परिवहन दर घट गई तथा NP बढ़ गया ।

अशोका (*सराका अशोका*)

के.ए.यू., त्रिसूर केन्द्र पर किए गए जननद्रव्य मूल्यांकन में वंशरुप टीसीआरएस-485 (त्रिचूर) द्वारा अधिकतम छाल का उत्पादन हुआ, तत्पश्चात वंशरुप टीसीआरएस-497 (त्रिवेंद्रम) का स्थान रहा । केन्द्र पर गूटी बाँधना विधि द्वारा कायिक प्रवर्धन का मानकीकरण किया गया । एक अन्य परीक्षण में मज्जा रेशों के मूलन माध्यम के रूप में प्रयोग द्वारा अधिकतम जड़ उत्पादन हुआ तथा इनका प्रयोग गूटी बाँधन विधि में भी काफी सफल रहा ।

अश्वगंधा (*विथैनिया सोमनीफेरा*)

सी.सी.एस.एच.ए.यू., हिसार पर बारहमासी प्रकार की जननद्रव्य पंक्तियों के मूल्यांकन में संकलन 16 द्वारा उच्चत्तम जड़ उपज (1218.34 किग्रा प्रति है.) प्राप्त हुई । एक अन्य परीक्षण में चयनित 15 उत्कृष्ट पंक्तियों के मूल्यांकन में संकलन 22 द्वारा उच्चतम जड़ उपज (1416.67 किग्रा प्रति है.) प्राप्त हुई, तत्पश्चात संकलन 21 व 12 (1397.7 किग्रा प्रति है.) का क्रम रहा । केन्द्र पर 27 वार्षिक प्रकार के जननद्रव्यों का जाँच जेए-20 के साथ मूल्यांकन करने पर संकलन एचडबल्यूएस-04-03 तथा 14 द्वारा सर्वाधिक जड़ (920.84 किग्रा प्रति है.) उपज प्राप्त हुई, तत्पश्चात संकलन एचडबल्यूएस-206 (912.34 किग्रा प्रति है.) का क्रम रहा ।

डी.एम.ए.पी.आर, आणंद पर संरक्षित 140 संकलनो का उपज तथा उपज बढ़ाने वाले कारको हेतु मूल्यांकन किया गया । संकलन डीडबल्यूएस-135 (4443 किग्रा प्रति है.) तथा डीडबल्यूएस-137 (4079 किग्रा प्रति है.) की उच्च शुष्क जड़ उत्पादन देने वाले संकलनों के रूप में पहचान की गई । अब तक चयनित 191 शुद्ध पंक्तिओं का एकल पौधा चयन द्वारा पुनः शुद्धिकरण किया गया । अतिरिक्त वर्णों के साथ डीयूएस वर्णक तैयार किए गये ।

आर.वी.एस.के.वी.वी., मंदसौर पर खेतीहर प्रकार के जननद्रव्यों को एकत्रित कर इनका शुद्धिकरण किया गया तथा पत्ती के प्रकार, पत्ती की बनावट, फल का रंग तथा अन्य रूपात्मक वर्णों के आधार पर इनको सूचीबद्ध किया गया । पौधे के विभिन्न भागों में उपस्थित स्टेरॉयडस की संख्या 03 से 08 थी ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर 139 जननद्रव्यों का जाँच जेए-20 के साथ मूल्यांकन किया गया तथा 35 संकलनों द्वारा सर्वोत्तम जाँच जेए-20 की तुलना में शुष्क जड़ उपज अधिक (500 किग्रा प्रति है.) प्राप्त हुई । एक अन्य परीक्षण में केन्द्र पर नौ चयनित पंक्तियों का दो जाँच (जेए-20 तथा जेए-134) के साथ मूल्यांकन किया गया तथा पंक्ति

आरएएस-10, आरएएस-23, आरएएस-56 तथा आरएएस-37 द्वारा सर्वोत्तम जाँच जेए-134 की तुलना में अधिक (659.72 किग्रा प्रति है.) उपज प्राप्त हुई ।

ए.ए.यू., आणंद केन्द्र पर विगत चार साल के परीक्षणों के संयुक्त विश्लेषण से ज्ञात हुआ कि संकलन 2B में शुष्क जड़ उपज डबल्यूएस-100 तथा जेऐ-20 की तुलना में क्रमशः 37.78 तथा 35.15 प्रतिशत अधिक थी ।

एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर 10 टन प्रति है. किचड़ (प्रसे मड) के प्रयोग द्वारा पौधे की उचाई, जड़ की लंबाई व व्यास, ताजा व शुष्क जड़ उपज तथा गैर तंतुमय जड़े सर्वाधिक प्राप्त हुई ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर 25X5/20X5 सेमी की परस्पर दूरी पर बुवाई तथा 50:40:30 किग्रा क्रमशः एनपीके के प्रयोग द्वारा सर्वाधिक जड़ की लम्बाई व व्यास, शुष्क जड़ उपज, एलकॉइड तत्त्व तथा न्यूनतम अपरिष्कृत फाइबर तत्त्व प्राप्त हुआ ।

जे.एन.के.वी.वी., जबलपुर केन्द्र पर मैनकोजेब (0.25%) के तीन स्प्रे अल्टर्नेरिया पर्णब्लाइट रोग को कम करने में सबसे प्रभावी थे ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर विभिन्न स्त्रोतो से एकत्र जड़ के नमूनो में, एफ्लाटॉक्सीन संदूषण अनुमेय सीमा (0.016 से 0.036 ग्रा प्रति 100 ग्रा नमूना) में था । सौर ड्रायर से नमूनों को सुखाने की विधि माइक्रोबियल लोड तथा एफ्लाटॉक्सीन तत्त्व कम करने हेतु श्रेष्टतम थी ।

डी.एम.ए.पी.आर., आणंद पर किये गये परीक्षण में जड़ उपज किट प्रकोप वाले प्लाटो में, शून्य प्रकोप वाले प्लाटो की तुलना से काफी कम थी । फसल पर अब तक कुल 24 जोड़दार पैरो वाले प्राणियों की पहचान की गई । इनमें से 20 तृणभक्षी तथा 04 परभक्षी प्रजातियां थी ।

असालिया (*लेपिडियम सेटाइवम*)

सी.सी.एस.एच.ए.यू., हिसार पर किए गए जननद्रव्य मूल्यांकन में सर्वाधिक बीज उपज संकलन एचएलएस-4 (708.33 किग्रा प्रति है.) से प्राप्त हुई, तत्पश्चात् संकलन एचएलएस-3 (645.83 किग्रा प्रति है.) का क्रम रहा ।

आर.वी.एस.के.वी.वी., मंदसौर पर 15 जननद्रव्य पंक्तियो के मूल्यांकन में बीज उपज पंक्ति एमएलएस-7 (2468 किग्रा प्रति है.) में सर्वाधित थी, तत्पश्चात् एमएलएस-5 (2447 किग्रा प्रति है.) का क्रम रहा ।

एम.प.यू.ए.टी., उदयपुर केन्द्र पर 10 टन गोबर खाद्य तथा 60 किग्रा नत्रजन के तीन विभाजित खुराको में प्रयोग से सर्वाधिक बीज उपज प्राप्त हुई ।

आर.वी.एस.के.वी.वी., मंदसौर पर आल्टर्नेरिया पर्णब्लाइट के नियंत्रण हेतु छ कवकनाशीयों का मूल्यांकन किया गया तथा ट्राइफ्लोक्सिस्ट्रोबिन (0.15%) रोग कम करने में सबसे प्रभावी सिद्ध हुआ ।

अतीस (*एकोनाइटम हिट्रोफाइलम*)

व्हाई.एस.पी.यू.एच.एफ., सोलन पर 30X30 सेमी की परस्पर दूरी पर रोपण से सर्वाधिक पौधे की उचाई, पत्तियों की संख्या, जड़ की लम्बाई तथा उपज प्राप्त हुई ।

बला (*सिद्धा कॉर्डिफोलिया*)

के.ए.यू., त्रिसूर पर 15 मई को 50X25 सेमी की परस्पर दूरी पर रोपण, वर्मीकम्पोस्ट के एजोस्पींलम व पीएबी के साथ प्रयोग तथा रोपण के आठ माह पश्चात कटाई द्वारा सर्वाधिक जड़ो की संख्या व उपज तथा एफेड्रिन तत्त्व प्राप्त हुआ । जड़ उपज तथा एफेड्रिन तत्त्व खुले में बोई गई फसल में, छाया में बोई गई फसल की तुलना से बेहतर था ।

भुई आमला (*फाइलेंथस एमरस*)

ए.ए.यू., आणंद पर 01 जुलाई को 15X5 सेमी की परस्पर दूरी पर बोई गई फसल में पौधों की उचाई तथा शुष्क बायोमास पैदावार अधिक थी ।

ब्राह्मी (*बैकोपा मोनिएरी*)

आर.ए.यू., पूसा में चार पर्वसंधि वाले पौधों के, मध्य जुलाई में 10X10 सेमी की परस्पर दूरी पर रोपण द्वारा सर्वाधिक ताजा व शुष्क शाकीय उपज प्राप्त हुई । के.ए.यू., त्रिसूर में सीपीसी का एजोस्पींलम व पीएसबी के साथ प्रयोग द्वारा सर्वाधिक ताजा व शुष्क शाकीय उपज प्राप्त हुई ।

चिरायता (*स्वार्शिया चिरायता*)

व्हाई.एस.पी.यू.एच.एफ., सोलन पर एजोटोबेक्टर व वीएएम के प्रयोग से अधिकतम वृद्धि व उपज प्राप्त हुई, तथापि एमारोस्वेरिन व एमारोजेनेटिन तत्त्व की अधिकता एजोटोबेक्टर, पीएसबी व वीएएम के प्रयोग द्वारा दर्ज की गई ।

चित्रक (*प्लंबेंगो रोसिया*)

के.ए.यू., त्रिसूर पर चयनित संकलनो के मूल्यांकन से ज्ञात हुआ कि संकलन टीसीआरपीआर-521 में प्लंबेजिन तत्त्व सर्वाधिक (4.78%) था, तत्पश्चात संकलन टीसीआरपीआर-516 (3.34%) का क्रम रहा ।

कोलिअस (*कोलिअस फोर्सकोहली*)

टी.एन.ए.यू., कोयम्बटूर पर फसल में स्वच्छता, तने की कतर्न को कार्बेन्डिज्म (0.1%) में डुबोने तथा पौध रोपण के 30 दिन पश्चात मिट्टी का कार्बेन्डिज्म (0.1%) से उपचार से जड़ विगलन रोग के प्रकोप में काफी कमी आई तथा जड़ उपज बढ़ी ।

गुग्गल (*कॉम्मिफोरा व्हाईटी*)

डी.एम.ए.प.आर., आणंद पर अनुरक्षित 73 संकलनं का पौधे की बनावट, पौधे की उचाई, शाखाओं की व्यवस्था तथा अन्य आकारिकीय लक्षणों के आधार पर मूल्यांकन किया गया । विभिन्न संकलनों को मूलन सफलता के आधार पर समूहबद्ध किया गया तथा यह पाया कि विभिन्न संकलनों में मूलन शून्य से 80 प्रतिशत था ।

एक अन्य अध्ययन में प्राकृतिक आबादी के विस्तृत सर्वेक्षण तथा गुणों के विश्लेषण द्वारा किसी भी एक संकलन में लैंगिक प्रकार के पौधे की पहचान की गई ।

ईसबगोल (*प्लेंटेगो ओवेटा*)

ए.ए.यू., आणंद पर नर बांझपन उपयोग के लिए उत्परिवर्तन प्रजनन से दो मादा पंक्तियों तथा इनके संभवित अनुरक्षकों की पहचान की गई ।

डी.एम.ए.पी.आर., आणंद पर ईसबगोंल में डीयूएस वर्णकों की पहचान की गई जिनका प्रयोग पादप विविधता और कृषक अधिकार प्राधिकरण के तहत किस्मों के परीक्षण हेतु किया जा सकता है । केन्द्र पर 11 संदर्भ किस्मों की भी पहचान की गई, जोकि केन्द्र पर अनुरक्षित है । 84 जननद्रव्यों संकलनों का पुनः) शुद्धिकरण किया गया तथा इनकों जीन बैंक में अनुरक्षित किया गया । केन्द्र पर किस्मों के मूल्यांकन से ज्ञात हुआ कि संकलन डीओपी-1 द्वारा (1429 किग्रा प्रति है.) सर्वोत्तम जाँच जीआई-2 (1043 किग्रा प्रति है.) की तुलना से बीज उपज काफी अधिक थी ।

आर.वी.एस.के.वी.वी., मंदसौर पर किए गये जननद्रव्य मूल्यांकन में सर्वाधिक बीज उपज संकलन आरआई-89 से प्राप्त हुई, तत्पश्चात एमबीआई-2 का क्रम रहा ।

एम.पी.यू.ए.टी., उदयपुर पर 68 जननद्रव्य पंक्तियों का तीन जाँच जननद्रव्यों के साथ मूल्यांकन किया गया । तीस जननद्रव्य पंक्तियों द्वारा सर्वोत्तम जाँच की तुलना से अधिक बीज उपज दर्ज हुई । एक अन्य परीक्षण में 23 जननद्रव्य पंक्तियों का तीन जाँच (जीआई-2, आरआई-89 तथा संकलन-10) जननद्रव्यों के साथ मूल्यांकन में पांच वंशरूपों द्वारा सर्वोत्तम जाँच संकलन-10 की तुलना से काफी अधिक बीज उपज प्राप्त हुई ।

डी.एम.ए.पी.आर., आणंद पर प्राकृतिक जीवो की उपस्थिति वाले भूखंडो में बीज उपज, शून्य प्राकृतिक जीवो वाले भूखंडो की तुलना में अधिक थी ।

जटामंसी (*वेलेरियाना जटामांसी*)

यू.बी.के.वी., कालिम्पोंग में जून के प्रथम सप्ताह में 30X45 सेमी की परस्पर दूरी पर रोपण द्वारा अधिकतम हवाई व भूमिगत बायोमास उपज दर्ज की गई ।

जीवन्ति (*लेप्टेडेनीया रेटिक्यूलेटा*)

ए.ए.यू., आणंद पर 10 टन प्रति है. गोबर खाद के प्रयोग द्वारा अधिकतम शुष्क बायोमास उपज प्राप्त हुई ।

कालमेध (*एन्ड्रोग्राफिस पेनीकुलेटा*)

एन.डी.यू.ए.टी., फैजाबाद पर किए गये जननद्रव्य मूल्यांकन से ज्ञात हुआ कि संकलन आईसी-471918 द्वारा आईसी.-111291 (4084 किग्रा प्रति है.) तथा आईसी-211295 (3527 किग्रा प्रति है.) की तुलना में अधिक शुष्क शाकीय उपज (4935 किग्रा प्रति है.) प्राप्त हुई ।

ए.ए.यू., आणंद पर दस टन गोबर खाद प्रति है. के प्रयोग तथा 30X15 सेमी की परस्पर दूरी पर रोपण के अधिकतम शुष्क बायोमास उपज, शुद्ध लाभ तथा लागत-लाभ अनुपात प्राप्त हुआ । एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर 14 टन गोबर खाद प्रति है. तथा 10 किग्रा नत्रजन प्रति है. के एकीकृत उपयोग से अधिकतम वृद्धि व शाकीय उपज प्राप्त हुई । पी.डी.के.वी., अकोला केन्द्र पर अरहर तथा कालमेध की 2:4 पंक्ति अनुपात में अन्तराकृषि द्वारा कालमेंध की पैदावार तथा फलियों का वजन अधिकतम था ।

कलिहारी (*ग्लोरीयोसा सुपर्बा*)

टी.एन.ए.यू., कोयम्बटूर पर पत्तियों में लटों द्वारा नुकसान उस प्रयोग में सर्वाधिक था जहाँ प्रति पौधा लटो की जनसंख्या 08 थी । पूना व उथानकराई के संग्रह में पत्ती खाने वाली लटो की जनसंख्या सर्वाधिक थी ।

लौग पीपर (*पाईपर लॉगम*)

ए.ए.यू., जोरहट पर पूर्वोत्तरराज्यों, असम, मेघालय, अरुणाचल और त्रिपूरा के विभिन्न स्थानों से एकत्रित जननद्रव्यों का पर्ण आकारिकी, पर्ण रंग, पर्ण आकार तथा स्पाइक के आधार पर गुणात्मक विश्लेषण किया गया ।

पी.डी.के.वी., अकोला केन्द्र पर दस क्विंटल नीम केक तथा 100:50:50 किग्रा एनपीके के समेकित उपयोग से फलों की संख्या व वजन तथा पाईपरीन तत्त्व अधिकतम था ।

ए.ए.यू., जोरहट केन्द्र पर पूर्वोत्तरराज्यों से एकत्र जननद्रव्यों में तीन रोगो का संक्रमण पाया गया ।

मधुनाश्नी (*जिमनिमा स्लिविस्ट्री*)

जे.एन.के.वी.वी., जबलपुर पर विभिन्न मापदंडो के आधार पर जननद्रव्यों का विश्लेषण किया गया तथा यह पाया कि पत्ती की लंबाई व चौड़ाई का अनुपात 1:50 से 1:10 तक था ।

मकोय (*सोलानम नाईग्रम*)

टी.एन.ए.यू., कोयम्बटूर पर तीस संकलनों का विश्लेषण किया गया तथा औसत उपज 119 से 547.50 किग्रा प्रति है. के मध्य पाई गई । केन्द्र पर विभिन्न जननद्रव्यों के निरीक्षण में लाल फल वाले जननद्रव्यों में, काले फल वाले संकलनों की तुलना से किटों की आबादी कम थी । एक अन्य परीक्षण में पौध रोपण के 30 दिन पश्चात *स्यूडोमोनास फलुओरेसेन्स* (0.2%) का छिड़काव, तत्पश्चात डाइथेन एम-45 (0.2%) का पौधरोपण के 45 दिन पश्चात छिड़कव अल्टर्नेरिया पर्णब्लाइट की रोकथाम हेतु उत्तम था ।

मामेजव (*एनीकोस्टोमा ऑक्सिलेरीस*)

डी.एम.ए.पी.आर., आणंद पर मूल भूस्तारी के रोपण द्वारा अधिकतम उत्तरजिविता, पौध प्रति पौधा तथा शुष्क शाकीय उपज दर्ज की गई । साठ दिन के अंतराल पर कटाई से अधिकतम शाकीय उपज प्राप्त हुई, जबकि स्वार्शियामेरीन तत्त्व 75 दिन के अंतराल पर की गई कटाई में सर्वाधिक था ।

मंडूकपर्णी (*सिन्टेला एसियाटिका*)

ए.ए.यू., जोरहट पर चार पर्वसंधि वाले पौधो के मध्य जुलाई में 40X40 सेमी की परस्पर दूरी पर रोपण द्वारा सर्वाधिक ताजा शाकीय उपज प्राप्त हुई । केन्द्र पर मंडूकपर्णी के खेतीहर संग्रह में *पिथियम* प्रजाति के कारण आर्द्रगलन रोग देखा गया ।

आर.ए.यू., पूसा में वर्षा के मौसम *फयूजेरियम* प्रजाति के कारण भूस्तारी विगलन रोग देखा गया ।

अफीम (*पैपावर सोम्निफेरम*)

आर.व.एस.के.वी.वी., मंदसौर पर विभिन्न डीयूएस वर्णों के आधार पर जननद्रव्यों का गुणात्मक विश्लेषण किया गया । लेटेक्स उपज 26 से 78 किग्रा प्रति है. तथा बीज उपज 464 से 1408 किग्रा प्रति है. के मध्य थी । एक अन्य परीक्षण में 235 जननद्रव्य पंक्तियों का मूल्यांकन किया गया तथा लेटेक्स उपज 30 किग्रा प्रति है. (एमओपी-525) से 103 किग्रा प्रति है (एमओपी-535) व बीज उपज 1.7 ग्रा (एमओप-575) से 8.0 ग्रा (एनओपी-1) प्रति पौधा के मध्य थी ।

एम.पी.यू.ए.टी., उदयपुर पर 187 पंक्तियों का तीन जाँच के साथ मूल्यांकन किया गया, 48 पंक्तियों द्वारा लेटेक्स उपज सर्वोत्तम जाँच, चेतक अफीम (37.23 किग्रा प्रति है.) की तुलना से अधिक प्राप्त हुई । पांच पंक्तियों द्वारा बीज उपज सर्वोत्तम जाँच, एमओपी-540 (2065.55 किग्रा प्रति है.) की तुलना में अधिक प्राप्त हुई । एक अन्य परीक्षण में 22 बेहतर पंक्तियों का तीन जाँच के साथ मूल्यांकन किया गया, चार पंक्तियों (यूओपी-20, यूओपी-30, यूओपी-35 तथा यूओपी-79) द्वारा लेटेक्स तथा बीज उपज सर्वोत्तम जाँच की तुलना में अधिक प्राप्त हुई ।

एक अन्य परीक्षण में 15 टन गोबर खाद, 50 किग्रा नत्रजन के समतुल्य अरंडी केक तथा 50 किग्रा नत्रजन प्रति है. के अफीम की फसल में प्रयोग से पत्तियों की संख्या तथा बीज व कैप्सूल भूसी की उपज सर्वाधिक थी तथा अफीम-अश्वगंधा फसल प्रणाली में उत्तरवर्ती अश्वगंधा फसल पर उल्लेखनीय अवशिष्ट प्रभाव दिखा ।

आर.वी.एस.के.वी.वी., मंदसौर पर फेनामीडोन (0.15%) का प्रयोग मृदुरोमिल मिल्डयू के नियंत्रण हेतु काफी प्रभावी सिद्ध हुआ।

एम.पी.ए.यू.टी, उदयपूर पर मूल विगलन रोग के वाहक की *सिलिंड्रोक्लैडियम* प्रजा. के रुप में पुष्टि की गई । यह मृदा जनित रोग है जो गर्मीयों में माइक्रोस्क्लेरोटिया के रुप में रहता है तथा स्थानीय रुप से मिट्टी या पौधे के मलबे द्वारा फैलता है ।

सफेल मूसली (*क्लोरोफाइटम बोरिविलिएनम*)

पी.डी.के.वी., अकोला में फसल के प्रजनन व्यवहार के अध्ययन से पता चला की प्रफुल्लन का समय सुबह 4.00 से 4.30 के मध्य था तथा अधिकतम 76.54 प्रतिशत जीवंत पराग सुबह 10.00 बजे देखे गए । विपुंसीकरण तथा संकरण तकनीको को भी मानकीकृत किया गया । प्रजाति, पर-परागण प्रकार की प्रजाति थी तथा चार किटो को परागण करते देखा गया । एक अन्य परीक्षण में दस वंशरूपों का जाँच एमसीबी-405 के साथ उपज हेतु प्रारंभिक मूल्यांकन किया गया तथा मांसल जड़ उपज व सैपोनिन तत्त्व संकलन एकेएसएम-08 में सर्वाधिक पाया गया, तत्पश्चात संकलन एकेएमएम-07 का क्रम रहा ।

आर.वी.एस.के.वी.वी., मंदसौर पर 24 पंक्तियों का परीक्षण किया गया तथा संकलन एमसीबी-412 में जाँच किस्म जेएसएम-405 (2599 किग्रा प्रति है.) की तुलना से अधिक (3434 किग्रा प्रति है.) ताजा मांसल जड़ उपज पाई गई ।

एम.पी.यू.ए.टी., उदयपुर केन्द्र पर विभिन्न स्त्रोतो से एकत्र जड़ के नमूनो में एफ्लाटॉक्सीन संदूषण अनुमेय सीमा (0.018 से 0.042 ग्रा प्रति 100 ग्रा नमूना) में था । सौर ड्रायर से नमूनों को सुखाने की विधि माइक्रोबियल लोड तथा एफ्लाटॉक्सीन तत्त्व कम करने हेतु श्रेष्टतम थी ।

शतावर (*एस्पेरेगस रेसीमोसस*)

एन.डी.य.ए.टी., फैजाबाद पर जननद्रव्य के 24 संकलनों के मूल्यांकन से ज्ञात हुआ कि संकलन एनडीएएस-14 द्वारा अधिकतम ताजा (57290 किग्रा प्रति है.) तथा शुष्क (5729 किग्रा प्रति है.) मांसल जड़ उपज प्राप्त हुई ।

सनाय (*केसिया ऑगस्टीफोलिया*)

ए.ए.यू., आणंद पर विगत तीन वर्षो के प्रयोगों के आधार पर एएलएफटी-2 द्वारा सर्वाधिक शुष्क पत्ती उपज (1834 किग्रा प्रति है.) प्राप्त हुई, जोकि त्रिणवेली सेना किस्म से 71.4 प्रतिशत तथा सोना किस्म से 53.56 प्रतिशत अधिक थी ।

एम.पी.के.वी., राहुरी पर 20 जुलाई को 30X45 सेमी की परस्पर दूरी पर बुवाई तथा 05 टन प्रति है. गोबर खाद के पीएसबी के साथ प्रयोग द्वारा अधिकतम पौधे की उचाई, ताजा व शुष्क पत्तियों की संख्या, एलएआई, सिनोसाइड तत्त्व तथा पत्ती उपज प्राप्त हुई ।

शंखपुष्पी (*कॉवोल्वुलस माईक्रोफाईलस*)

ए.ए.यू., आणंद पर दस टन गोबर खाद के प्रयोग द्वारा अधिकतम शुष्क बायोमास उपज दर्ज की गई ।

स्वीट वुडर्वम (*आर्टिमिशिया एनुवा*)

डी.एम.ए.पी.आर., आणंद पर 45X45 सेमी की परस्पर दूरी पर रोपण तथा पूर्ण पूष्पन अवस्था पर कटाई द्वारा सर्वाधिक पत्ती व कुल शाकीय उपज, कटाई सूचकांक, पत्ती से तने का अनुपात, तेल व आर्टिमिसिन तत्त्व उपज दर्ज की गई ।

तुलसी (*ऑसिमम सेंक्टम*)

एन.डी.यू.ए.टी., फैजाबाद पर 06 टन प्रति है. नीम केक के प्रयोग द्वारा अधिकतम पौधे की उचाई, शाखाओं की संख्या, ताजा व शुष्क उपज दर्ज हुई ।

पानलता (*पाईपर बीटल*)

आई.आई.एच.आर., बैगलुरु पर 25 बांग्ला क्लोनो (मादा) का पत्ती की पैदावार हेतु मूल्यांकन किया गया तथा क्लोन बांग्ला (एमपी) द्वारा अधिकतम उपज 40.58 लाख पत्तियां प्रति है. प्राप्त हुई ।

चयनित जनको के मध्य संकरण जारी रहा तथा केन्द्र पर नये संकरणो के भी प्रयास किए गए ।

संकरो के प्रदर्शन का मूल्यांकन किया गया और प्रथम वर्ष के आंकड़ों से ज्ञात हुआ कि संकर एचव्हाई-06-4 द्वारा अधिकतम पत्ती उपज (262.5 पत्तिया प्रति लता) प्राप्त हुई । विभिन्न जनको में स्वर्ण कपुरी द्वारा अधिकतम पत्ती उपज 242 पत्तियां प्रति लता दर्ज हुई ।

बीज अंकुरण अध्ययन के परिणामों से ज्ञात हुआ कि पानलता के बीज ठंडे तापमान के प्रति संवेदनशील है ।

आर.ए.यू., इस्लामपुर पर 15 लाख पौधे, वर्मीकम्पोस्ट दस टन प्रति है. तथा एजोटोबेक्टर व फोस्फोबेक्टर, प्रत्येक 10 किग्रा प्रति है. का प्रयोग अच्छी संख्या में बेहतर आकार व वजन की बिक्री योग्य पत्तियों के उत्पादन हेतु आदर्श पाया गया । इस प्रयोग में पाद विगलन रोग का प्रकोप भी कम था । एकीकृत फसल प्रबंध विधि द्वारा अधिक संख्या में बिक्री योग्य पत्तियों का उत्पादन हुआ तथा *फाइटोफ्थोरा* विगलन रोग का प्रकोप भी कम रहा ।

ए.प.एच.यू., वेक्टारमंनागुडम पर *फाइटोफ्थोरा* पाद विगलन रोग के अध्ययन में रोग का सुबह की सापेक्ष आद्रता तथा वर्षा से सार्थक सकारात्मक संबंध था । बी.सी.के.वी., कल्याणी में सभी भविष्यवाणी समीकरणों में अनुमानित मान मूल मान के समान थे । यह पाद विगलन व पर्णाचित्ती रोग के लिए ज्यादा सटीक थे । केन्द्र पर तीन एल्यूरोडीड मक्खियां पानलता पर देखी गई । ए.पी.एच.यू., वेक्टारमंनागुडम पर पानलता व इसके सहारे में माइटस, छेदक तथा पत्ती खाने वाली लटो का प्रकोप देखा गया ।

Abbreviations used

AAU	Anand Agricultural University/ Assam Agricultural University
ABA	Abscisic Acid
AICRP	All India Coordinated Research Project
APHU	Andhra Pradesh Horticultural University
BAU	Birsa Agricultural University
BCKV	Bidhan Chandra Krishi Vishwa Vidyalaya
CCSHAU	Chaudhary Charan Singh Haryana Agricultural University
CFU	Colony forming unit
Chl	Chlorophyll
CPC	Coir pith compost
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
FYM	Farm yard manure
GA	Gibberelic acid
GAP	Good agricultural practices
GBPUAT	G.B. Pant University of Agriculture and Technology
IAA	Indole acetic acid
IBM	Indole butyric acid
IDM	Integrated disease management
IGKVV	Indira Gandhi Krishi Vishwa Vidyalaya
IIHR	Indian Institute of Horticultural Research
ISSR	Inter short sequence repeats
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
KAU	Kerala Agricultural University
MAP	Medicinal and Aromatic Plants
MDH	Malate dehydrogenase
MPKV	Mahatma Phule Krishi Vidyapeeth
NAA	Naphthalene acetic acid
NDUAT	Narendra Dev University of Agriculture and Technology
NPK	Nitrogen-phosphorous-potash
NPQ	Non-photochemical quenching
OUAT	Orissa University of Agriculture and Technology
PDI	Percent disease index
PDKV	Dr. Punjabrao Deshmukh Krishi Vishwavidyalaya
PSB	Phosphate solubilising bacteria
PSII	Photosystem II
Q	Quintal (100kg)
qP	Photochemical quenching
RAPD	Random amplified polymorphic DNA
RAU	Rajendra Agricultural University
RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
SLA	Specific leaf area
SLW	Specific leaf weight
TNAU	Tamil Nadu Agricultural University
UBKV	Uttar Banga Krishi Vishwa Vidyalaya
VAM	Vesicular aurbuscular mycorhiza
YSPUH&F	Dr. Y.S. Parmar University of Horticulture and Forestry

Summary

Directorate of Medicinal and Aromatic Plants Research (DMAPR) and its outreach program All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRP-MAPB) are engaged in research on medicinal and aromatic plants and betelvine. Salient findings of 2010-2011 are presented below:

ALOE (*Aloe barbadensis*)

At PDKV, Akola, evaluation of germplasm showed that AKAV-09-01 recorded significantly highest number of leaves plant^{-1} (17.00) and IC - 285630 recorded highest leaf weight (413.75g). Evaluation of 12 elite lines at CCSHAU centre showed highest fresh leaf yield (kg ha^{-1}) in IC-112526 (42203.70), followed by HAV-05-08 (39731.48) against the check HAV-1 (39537.04).

At PDKV, Akola, application of 2.5 t vermicompost ha^{-1} and sowing at 60x60 cm spacing produced highest peel weight, latex and crude latex leaf^{-1}. At DMAPR, Anand, stress conditions reduced the efficiency of PSII maximum (Fv/Fm), $_{q}$p and electron transport rate and increased the NPQ.

ASOKA (*Saraca asoca*)

Evaluation of germplasm at KAU, Thrissur showed that TCRSA485 (Thrissur) followed by TCRSA497 (Trivandrum) had maximum bark yield. Vegetative propagation by air layering was also standardised at the centre. In experiment coir pith as rooting media produced more roots and was highly successful for air layering.

ASHWAGANDHA (*Withania somnifera*)

At CCSHAU, Hisar, characterization and evaluation of perennial type of germplasm lines showed highest root yield (kg ha^{-1}) in Acc. 16 (1218.34). In another evaluation trial of 15 selected elite lines showed highest root yield (kg ha^{-1}) in Acc. 22 (1416.67), followed by Acc. 21 and Acc. 12 (1397.7). Characterization of 27 annual type germplasm including check JA - 20 at the centre showed highest dry root yield (kg ha^{-1}) in HWS-04-3 and Selection-14 (920.84) followed by HWS-206 (912.34). At DMAPR, Anand, 140 Ashwagandha accessions were evaluated for yield and yield attributing characters. DWS 135 (4443 kg ha^{-1}) and DWS 137 (4079 kg ha^{-1}) were identified as high dry root yielders. One hundred and ninety one pure line selections were further purified by single plant selection. DUS descriptors were prepared with additional characters. At RVSKVV, Mandsaur, cultivated type of Ashwagandha germplasm were collected, purified and catalogued based on plant type, leaf pattern, berry colour and other morphological characters. Number of steroids present in different plant parts varied from 3 to 8. At MPUAT, Udaipur, 139 germplasm were evaluated along with JA20 as check variety and thirty five accessions exhibited higher dry root yield over the best check JA20 (500 kg ha^{-1}).

At AAU, Anand, varietal evaluation showed that dry root yield in Sel. 2B was highest which was 37.78% and 35.15 % higher than WS100 and JA20, respectively, in pooled analysis of four years of experimentations. At MPUAT, Udaipur, nine selected lines were evaluated along with two checks (JA20 and JA134) and lines RAs10, RAs23, RAs56 and RAs37 out yielded the best check JA134 (659.72 kg ha^{-1}).

At NDUAT, Faizabad, application of press-mud at 10 t ha^{-1} produced maximum plant height, root length and diameter, fresh and dry root yield and non-fibrous roots. Sowing at 25x5/20x5 cm spacing and application of 50:40:30 kg NPK ha^{-1} produced highest root length and diameter, dry root and seed yield, alkaloid content and least crude fibre content at MPUAT, Udaipur.

At JNKVV, Jabalpur for the management of Alternaria leaf blight of Ashwagandha three sprays of Mancozeb (0.25%) was found most effective in reducing the disease incidence.

At MPAUT, Udaipur, aflatoxin contamination was well under the permissible limits (0.016 – 0.036 g/100g sample) in the root samples collected from various sources. Drying in solar dryer was the best in minimizing the microbial load and aflatoxin concentration.

At DMAPR, Boriavi, highly significant difference was observed in root yield of Ashwagandha in the insect pest infested and un-infested plots. A total of 24 arthropods was recorded and identified on Ashwagandha, of which 20 were phytophagous and 04 were predatory species.

ASALIO (*Lepidium sativum*)

At CCSHAU, Hisar, evaluation of germplasm showed highest seed yield (kg ha^{-1}) in HLS-4 (708.33) followed by HLS-3 (645.83). At RVSKVV, Mandsaur, evaluation of fifteen germplasm lines showed highest seed yield in MLS-7 (2468 kg ha^{-1}) followed by MLS-5 (2447 kg ha^{-1}).

At MPUAT, Udaipur, application of 10 t FYM and 60 kg N ha^{-1} in three split doses (1/3rd at sowing+1/3rd at 25 DAS+1/3rd at 45 DAS) produced maximum seed yield.

At RVSKVV, Mandsor, among the six fungicides evaluated against Alternaria leaf blight, Trifloxystrobin (0.15%) was most effective in reducing diseases.

ATIS *(Aconitum heterophyllum)*

Planting at 30x30 cm spacing recorded higher plant height, number of leaves, root length and root yield at YSPUHF, Solan.

BALA (*Sida cordifolia*)

At KAU, Thrissur, planting on 15th May at 50x25 cm spacing, application of vermicompost along with *Azospirillum*+PSB and harvesting after eight months of planting recorded the maximum number of roots, root yield and ephedrine content. Also, the root yield and ephedrine content were better under open growing condition then shade.

BHUMI AMALAKI (*Phyllanthus amarus*)

Sowing on 1st July at 15x5 cm spacing recorded higher plant height and dry biomass yield at AAU, Anand.

BRAHMI (*Bacopa monnieri*)

Planting in mid July with 4-node plants at RAU, Pusa, and at 10x10 cm spacing and application of CPC along with *Azospirillum*+PSB at KAU, Thrissur, produced maximum fresh and dry herbage yield.

CHIRAYITA (*Swertia chirayita*)

Application of *Azotobacter*+VAM produced maximum growth and yield, however, amaroswerin and amarogentin content was higher with the application of *Azotobacter*+PSB+VAM at YSPUHF, Solan.

CHITRAK (*Plumbago rosea*)

At KAU, Thrissur, evaluation of selected accessions showed that accession TCRPR521 had maximum plumbagin content (4.78%), followed by TCRPR516 (4.34%). But no significant differences were observed in the dry root yield among the accessions.

At KAU, Thrissur, application of 10t FYM ha^{-1} along with *Azospirillum* and *Azospirillum*+PSB produced maximum number of leaves and branches, and plant height and dry matter, respectively.

COLEUS (*Coleus forskohlii*)

At TNAU, Coimbatore, treatment involving sanitation + dipping stem cuttings in Carbendazim (0.1%) + one drench with Carbendazim (0.1%) on 30 DAP was most effective in reducing the incidence of root rot disease and increasing root yield.

GUGGAL (*Commiphora wightii*)

At DMAPR, Anand, seventy three accessions maintained were characterized based on plant architecture, plant height, branching pattern and other morphological characters. The accessions were also grouped based on rooting and it was found that rooting varied from zero to more than 80% among the different accessions.

Detailed surveys of natural plant populations and their characterization study at DMAPR, led to the identification of sexual plant types from one of these accessions.

ISABGOL (*Plantago ovata*)

At AAU, Anand, mutation breeding for male sterility utilization identified two female lines and their possible maintainers. At DMAPR, Anand, DUS descriptors were identified in Isabgol, which can be used for testing varieties under the Protection of Plant Varieties and Farmers' Right Authority (PPVFRA). Eleven reference varieties were also identified and maintained at the centre. Eighty-four germplasm accessions were further purified and maintained in the gene bank. In a varietal evaluation trial at the centre, DPO-1 showed significantly higher yield (1429 kg ha^{-1}) than the best check variety GI-2 (1043 kg ha^{-1}). At RVSKVV, Mandsaur, germplasm evaluation showed highest seed yield in RI-89 followed by MBI-2 (1083 kg ha^{-1}). At MPUAT, Udaipur, sixty eight germplasm lines were evaluated along with three checks and thirty germplasm lines recorded higher seed yield over the best check RI-89 (1250 kg ha^{-1}).

At MPUAT, Udaipur, twenty three lines were evaluated along with three checks *viz*., GI-2, RI-89 and Sel-10 and five genotypes exhibited significantly higher seed yield over the best check Sel-10 (1643.51 kg ha^{-1}).

At DMAPR, Boriavi, seed yield was significantly high in plots having natural enemies of insect pests in comparison to plots with nil natural enemies under controlled conditions.

JATAMANSI (*V. jatamansi*)

At UBKV, Kalimpong, planting in the first week of June at 30x45 cm spacing recorded higher aerial and underground biomass yield.

JEEVANTI (*Leptadenia reticulata*)

At AAU, Anand, application of 10 t FYM ha^{-1} produced maximum dry biomass yield.

KALMEGH (*Andrographis paniculata*)

At NDUAT, Faizabad, evaluation of germplasm showed IC-471918 had the highest dry herbage yield (4935 kg ha^{-1}) as compared to IC-111291 (4084 kg ha^{-1}) and IC-211295 (3527 kg ha^{-1}).

At AAU, Anand, application of 10 t FYM ha^{-1} and planting at 30x15 cm spacing produced maximum dry biomass yield, net return and cost: benefit ratio. Integrated use of 14t FYM and 10kg N ha^{-1} recorded maximum growth and herbage yield at NDUAT, Faizabad. Pigeon pea:kalmegh intercropping at 2:4 row proportion recorded maximum pod weight and yield of kalmegh and efficient in the utilization of area x time dimensions of the system at PDKV, Akola.

KALIHARI (*Gloriosa superba*)

At TNAU, Coimbatore, damage to the crop due to defoliating caterpillars was maximum when the pest larvae population was 08 $plant^{-1}$. Defoliators' population was maximum in Pune and Uthankarai collection.

LONG PEPPER (*Piper longum*)

At AAU, Jorhat, gemplasm collected from different places of Assam, Meghalaya, Arunachal Pradesh and Tripura were characterized based on leaf morphology leaf colour, leaf size and spike characters.

Integrated use of 10q neem seed cake and 100:50:50 kg NPK ha^{-1} produced maximum number and weight of fruits and piperine yield at PDKV, Akola.

At AAU, Jorhat, incidence of three diseases were recorded.

MADHUNASHINI (*Gymnema sylvestre*)

At JNKVV, Jabalpur, germplasm were characterized based on different parameters and it was found that length breadth ratio of leaf ranged from 1:50 to 1:10.

MAKOI (*Solanum nigrum*)

At TNAU, Coimbatore, thirty accessions were characterized and it was found that mean yield ranged from 119 to 547.50 kg ha^{-1}. Germplasms with red fruits harboured minimum pest population as compared to accessions with black fruits. In another trial spraying of *Pseudomonas fluorescens* (0.2%) at 30 DAP followed by Dithane M-45 (0.2%) spray at 45 DAP was found most effective for the management of *Alternaria* leaf blight.

MAMEJO (*Enicostemma axillaris*)

At DMAPR, Anand, planting with rooted suckers recorded higher survivability, plantlets plant^{-1} and dry herb yield, and harvesting at 60-days interval produced maximum dry herb yield, whereas, swertiamarin content was maximum at 75-day interval.

MANDUKAPARNI (*Centella asiatica*)

Planting in mid July with 4-node plants at the 40x20 cm spacing recorded maximum fresh herbage yield at AAU, Jorhat. Damping off disease due to *Pythium* sp. with varying degree of intensity in some of the cultivated collections was observed.

At RAU, Pusa stolon rot due to *Fusarium* sp was recorded during rainy season. Besides, diverse range of culturable fungal species were found associated in rhizosphere and phylloplane.

OPIUM POPPY (*Papaver somniferum*)

At RVSKVV, Mandsaur, characterization of germplasm was done based on various DUS characters. Latex yield (kg ha^{-1}) ranged from 26 to 78 and seed yield ranged from 464 to 1408 kg ha^{-1}. At RVSKVV, Mandsaur, 235 germplasm lines were evaluated and it was found that latex yield ranged from 30 (MOP-525) to 103 kg ha^{-1} (MOP-535). Seed yield per plant ranged from 1.7 (MOP-575) to 8.0g (NOP-1). At MPUAT, Udaipur, 187 lines were evaluated along with three checks and 48 lines exhibited higher latex yield over the best check, Chetak Aphim (37.23 kg ha^{-1}), five lines exhibited higher seed yield over the best check MPO-540 (2055.55 kg ha^{-1}). Evaluation of 22 improved lines along with three checks showed four lines *i.e.,* UOP20, UOP30, UOP35 and UOP79 superior for latex yield and seed yield over the best check.

At MPUAT, Udaipur, application of 15 t FYM, castor seed cake (equivalent to 50 kg N) and 50 kg N (urea) ha^{-1} to opium poppy produced maximum number of leaves, seed and capsule husk yield of opium poppy, and also showed remarkable residual effects on the succeeding crop of ashwagandha in the opium poppy-ashwagandha cropping system.

At RVSKVV, Mandsaur, sectin (Fenamidone) at a concentration of 0.15% was most effective in control of downy mildew. At MPAUT, Udaipur the causal organism for root rot was confirmed as *Cylindrocladium* sp., a soil borne pathogen over summer as microsclerotia and locally spread through soil and/or plant debris.

SAFED MUSLI (*Chlorophytum borivilianum*)

At PDKV, Akola, study of breeding behaviour of the crop showed that time of anthesis was at 4.00 to 4.30 am. Maximum pollen viability of 76.54 % was observed at 10.00 am. Emasculation and crossing techniques were also standardized. The species was found as a cross pollinated type. Four types of insects were observed, as pollinating agents. Preliminary yield trial of ten genotypes along with one check MCB-405 showed that fasciculate root yield and saponin content were recorded significantly higher in AKSM-08 followed by AKSM-07. At RVSKVV, Mandsaur, twenty-four lines were tested and maximum fresh fasciculate root yield was observed in MCB-412 (3434 kg ha^{-1}) as compared to the check variety JSM-405 (2599 kg ha^{-1}).

At MPAUT, Udaipur, aflatoxin contamination was well under the permissible limits (0.018 – 0.042 g/100g sample) in the root samples collected from various sources and among drying methods solar dryer drying was the best in minimizing the microbial load and aflatoxin concentrations.

SATAVARI (*Asparagus racemosus*)

At NDUAT, Faizabad, evaluation of 24 accessions of germplasm revealed maximum fresh fleshy root yield in NDAS-14 (57290 kg ha^{-1}). Dry fleshy root yield was also highest in NDAS-14 (5729 kg ha^{-1}).

SENNA (*Cassia angustifolia*)

At AAU, Anand, based on three years of experimentation, ALFT-2 recorded highest dry leaf yield of 1834 kg ha^{-1} which was 71.4% higher than the variety Tinnevely Senna and 53.56 % higher than Sona variety. Planting on 20th July at 30x45 cm spacing and the application of 5 t FYM ha^{-1} along with PSB produced maximum plant height, number of fresh and dry leaves, LAI, sennocide content and leaf yield at MPKV, Rahuri.

SHANKHPUSHPI (*Convolvulus microphyllus*)

At AAU, Anand, application of FYM at 10 t ha^{-1} recorded higher dry biomass yield.

SWEET WORMWOOD (*Artemisia annua*)

At DMAPR, Anand, planting at 45x45 cm spacing and harvesting at full bloom stage recorded highest leaf and total herbage yield, leaf harvest index, leaf to stem ratio, oil yield and artemisinin yield.

TULSI (*Ocimum sanctum*)

Application of neem seed cake at 6t ha^{-1} recorded maximum plant height, number of branches, fresh and dry herbage yield at NDUAT, Faizabad.

BETELVINE (*Piper betle*)

At IIHR, Hirrehalli, twenty-five Bangla (female) clones were evaluated for leaf yield and the clone Bangla (MP), produced maximum yield (40.58 lakh leaves ha^{-1}). Hybridisation was continued among the selected parents and new crosses were also attempted at the centre. Performance of hybrids was evaluated and first year data showed that hybrid Hy 06-4 produced maximum leaf yield (262.5 leaves vine^{-1}). Among the parents, Swarna Kapoori recorded higher leaf yield of 242 leaves vine^{-1}. The results of seed germination study indicated that the betel vine seeds are sensitive to cold temperature.

At RAU, Islampur, population density of 1.5 lakh plants application of vermicompost at 10t ha^{-1} and *Azotobacter* and phosphobacter each at 10 kg ha^{-1} found ideal to harvest good number of marketable leaves of better size and weight, also recorded less incidence of foot rot disease. ICM practices recorded higher yield of marketable leaves and less incidence of *Phytophthora* rot.

Demonstration of disease management technology developed by AAU, Jorhat; JNKVV, Jabalpur; RAU, Pusa; APHU, Venkataramanngudem; MPKV, Rauri and BCKV, Kalyani revealed that the technology developed by the centres was superior over the farmers practice, as high yield and low disease incidence was achieved with centres' technology.

AT APHU, Venkataramanngudem, epidemiological studies on *Phytophthora* foot rot disease revealed a significant positive correlation with morning relative humidity and rainfall, whereas, at Kalyani in all the prediction equation the estimated value was similar to that of original value in most of the observations. It was more accurate on foot rot and leaf spot diseases than leaf rot disease.

Three aleyrodid flies were reported from betelvine at Kalyani, whereas, mites, borers and leaf eating caterpillars were the major arthropods associated with betelvine and its support at APHU, Venkataramannagudem. Among various treatments, soil drenching with NSKE 5% + NSKE 5% spray significantly reduced the incidence of *Spodoptera litura* and stem borer on *Sesbania*.

Information management (ARIS)

Updation of various database developed at the DMAPR continued. National online examination centre for 100 users has been created at the Directorate under the NAIP funded project.

General Information

The DMAPR hold meetings of IRC, RAC and IMC to monitor the research and developmental activities. A national conference on "Biodiversity of medicinal and aromatic Plants: collection, characterization and utilization" and biennial group meeting of AICRP-MAPB to review the work of various centers for the biennium were also organized. Dr. S. Ayyappan, Director General, ICAR, and Secretary, DARE, Govt. of India visited the Directorate and expressed his happiness for the facilities available at directorate and quality work done by the scientists. The DMAPR scientists visited Bhutan and also a six member high level team of royal government of Bhutan visited the directorate for exchange of knowledge on MAP. Scientists of the directorate provided the consultancy services on Good Agricultural Practices (GAP) on MAP through a FAO sponsored project. Several farmers, students and MAP growers visited the directorate for technical know-how. Exhibitions on MAP were also organized to disseminate the technology developed. The directorate family also celebrated Independence day, Hindi week, Annual day, and Republic day.

Introduction

Introduction

The World Health Organisation (WHO) defines a medicinal plant as *"any plant, which, in one or more of its organs, contains substances that can be used for therapeutic purposes, or which are precursors for chemo pharmaceutical semi synthesis"*. This definition distinguishes those plants that are already scientifically tested from those used in various traditional systems of medicine. Modern medicine uses about 7000 plus single compounds that are having their origin to medicinal plants. A few examples are: Aspirin, Quinine, Reserpine, L-Dopa, Ephedrine, Picrotoxin, Vincristine, Vinblastine and Taxol, which are extensively prescribed. At present, about 25% of the prescribed medical drugs in the developed countries are plant based, which is as high as 75% in the developing countries. The volume of consumption of codified or uncodified herbal remedies is higher than the modern medicines and the trend is on the rise due to their negligible side effects in one hand and easy accessibility in other hand.

Although global trade in medicinal plants is increasing in increasing rate in the recent past, the market is still secretive and unregulated. A substantial part of this trade is not recorded in official trade statistics mainly because of either plants are not identified individually or their medicinal values are not separated from their medicinal use from other uses. However, it is estimated that annual growth rates of this sector is averaging from 5% to 15%. The herbal food supplement market is estimated to have even a higher growth rate of 25%. A similar trend may be envisaged for the herbal cosmetics market.

The export data of AYUSH (Department of Ayurveda, Yoga & Naturopathy, Siddha and Homeopathy) products and herbals during last five years also reiteriated the growth rate (Figure 1). Growth rate of AYUSH product grew at the rate of 30 % per year in value terms during last fve years. Even if we consider the herbals alone it has increased at a rate to 17 % per year. Therfore, industry is having a good growth rate and it can continue to grow in next plan at the rate of 15%. Similar results have been recorded in individual crops like isabgol, senna and betel leaves, where growth rate was 16%, 20% and 27% respectively so far export is concerned.

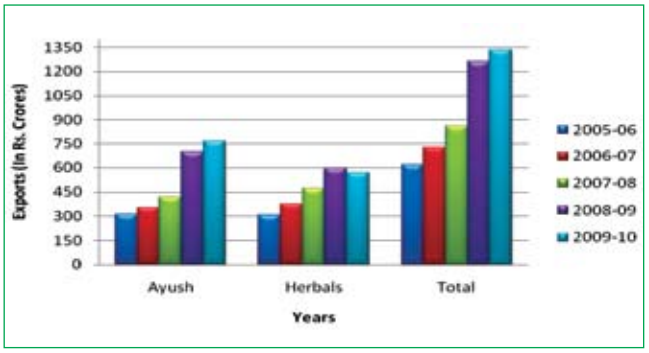
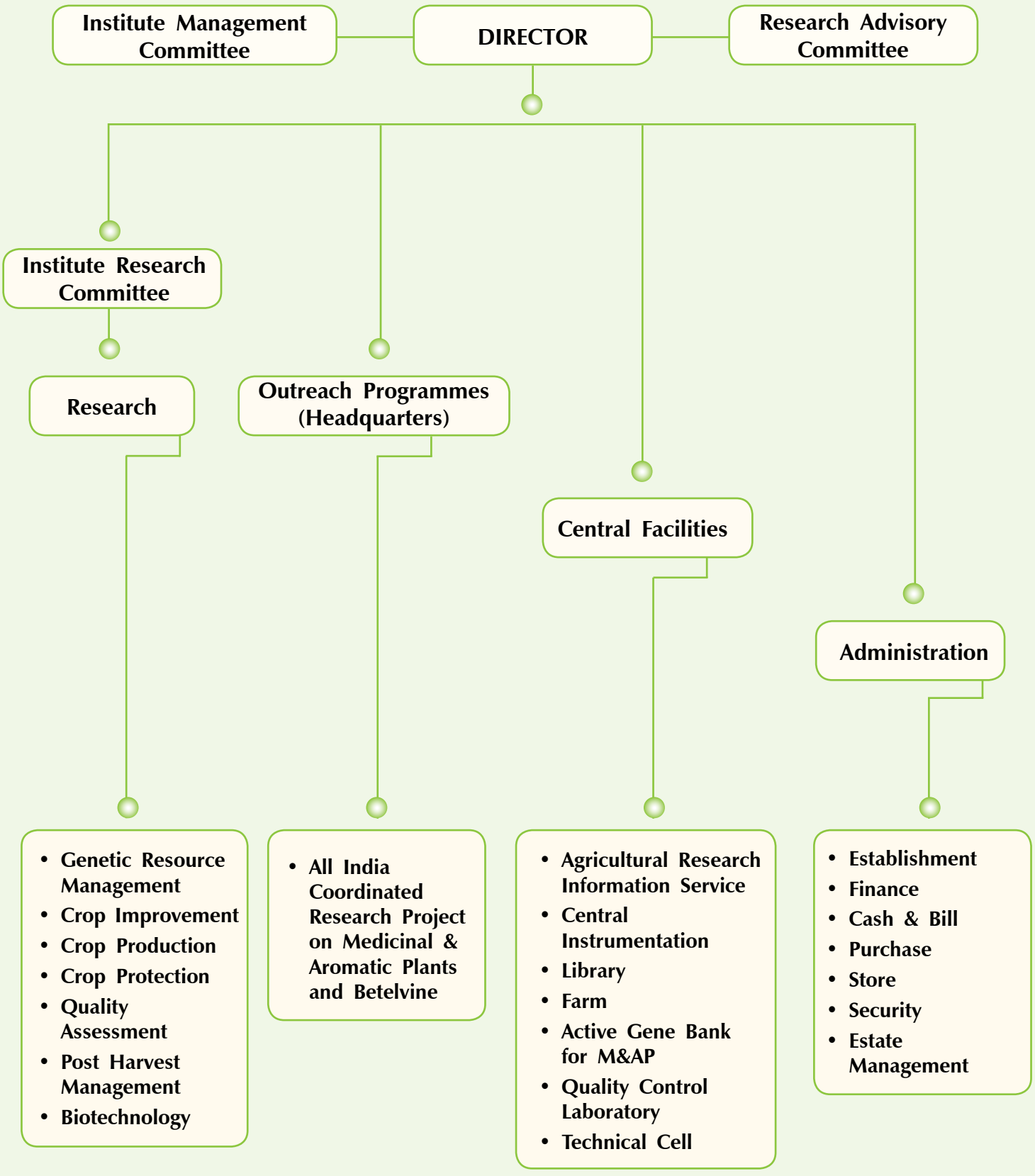


Fig 1. Exports of India's AYUSH & Herbals (₹ in crore) Source: DGCIS Pharmexicl Research

India is rich in medicinal plant biodiversity and form. A bulk of raw material is derived either from forest or from cultivation to fulfil the demand of local industries as well as for export. It also provides gainful employment. Since the bulk of the raw material is collected from the wild, the current methods of indiscriminate and exploitative collection have resulted in bringing several valuable medicinal plant species to the verge of rare, endangered and threatened leading to extinction. In such a situation, it is not just the loss of a plant species but also the loss of a valuable source of income. Therefore, the need of the hour is to ensure the sustainability of the medicinal plants. This calls for cultivation as a conservation strategies for sustainability of the medicinal plants that would ensure health care needs of the present generation as well as the future generations to come.

Keeping the pace of growth in Medicinal and Aromatic Plants (MAP) sector, the ICAR through its organ Directorate of Medicinal and Aromatic Plants Research (DMAPR) is engaged in basic and strategic research in developing Good Agricultural Practices (GAP), improved varieties,

Organisational Structure



defining quality assessment parameters and quality assessment methods keeping the resourcing of quality raw drugs with traceability in fore front. Its outreach programme named All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRP-MAPB) which operates in 22 centres mostly in State Agricultural University (SAU) is engaged in refining the location specific GAP as well as developing the location specific varieties. Newer crops are being brought under the fold of cultivation not only to assure the supply but also to assure the uniform quality which is the demand of the premium brand products of the industries.

Mandate

- Development of 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.
- To act as a National Repository of the genetic resources of selected important medicinal and aromatic plants.
- To coordinate research under the All India Coordinated Research Project on Medicinal, Aromatic Plants and Betelvine (AICRP-MAPB).
- To act as 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.)

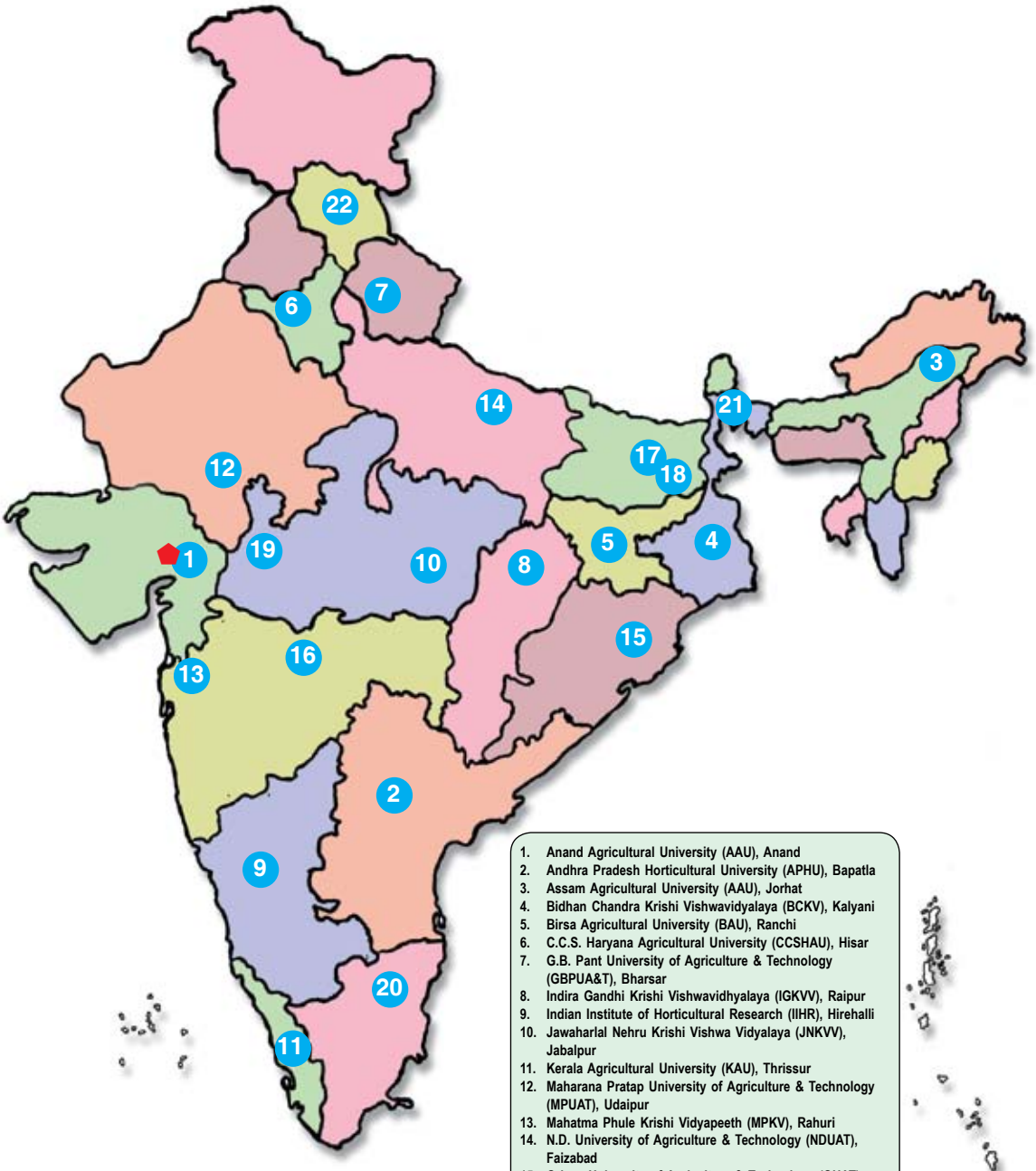
Objectives

- 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 mandate crops for developing their Good Agricultural Practices (GAP).
- To coordinate the research activities of the centres of AICRP on Medicinal & Aromatic Plants and Betelvine located at various agro-climatic zones of India.
- To provide quality planting material and technology developed,testing and refinement by the centres of the co-ordinated project and DMAPR.
- To develop partnership between the directorate and private sectors, NGOs and farmers' associations/progressive farmers interested in promoting the herbal culture.

Outreach programmes

All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRP-MAPB) is located at DMAPR and the Director, DMAPR is also responsible for coordination

Centres of AICRP on Medicinal & Aromatic Plants and Betelvine



1. Anand Agricultural University (AAU), Anand
2. Andhra Pradesh Horticultural University (APHU), Bapatla
3. Assam Agricultural University (AAU), Jorhat
4. Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Kalyani
5. Birsa Agricultural University (BAU), Ranchi
6. C.C.S. Haryana Agricultural University (CCSHAU), Hisar
7. G.B. Pant University of Agriculture & Technology (GBPUA&T), Bharsar
8. Indira Gandhi Krishi Vishwavidhyalaya (IGKVV), Raipur
9. Indian Institute of Horticultural Research (IIHR), Hirehalli
10. Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur
11. Kerala Agricultural University (KAU), Thrissur
12. Maharana Pratap University of Agriculture & Technology (MPUAT), Udaipur
13. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri
14. N.D. University of Agriculture & Technology (NDUAT), Faizabad
15. Orissa University of Agriculture & Technology (OUAT), Bhubaneswar
16. P.D. Krishi Vishwavidyalaya (PDKV), Akola
17. Rajendra Agricultural University (RAU), Islampur
18. Rajendra Agricultural University (RAU), Pusa
19. Rajmata Vijayraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Mandsaur
20. Tamil Nadu Agricultural University (TNAU), Coimbatore
21. Uttar Banga Krishi Vishwavidyalaya (UBKV), Kalimpong
22. Y.S. Parmar University of Horticulture & Forestry (YSPUH&F), Solan

DMAPR, Anand Headquarters

and monitoring of research work of the project as Project Co-ordinator. There are 21 centres in State Agricultural Universities and one ICAR centre at IIHR, Hirehalli under ICAR. The centres of AICRP-MAPB are as follows:

1. Anand Agricultural University (AAU), Anand
2. Andhra Pradesh Horticultural University (APHU), Bapatla
3. Assam Agricultural University (AAU), Jorhat
4. Bidhan Chandra Krishi Viswavidyalaya (BCKV), Kalyani
5. Birsa Agricultural University (BAU), Ranchi
6. C. C. S. Haryana Agricultural University (CCSHAU), Hisar
7. G. B. Pant University of Agriculture & Technology (GBPUAT), Bharsar
8. Indira Gandhi Krishi Vishwavidyalaya (IGKVV), Raipur
9. Indian Institute of Horticultural Research (IIHR), Hirehalli
10. Jawaharlal Nehru Krishi Viswa Vidyalaya (JNKVV), Jabalpur
11. Kerala Agricultural University (KAU), Thrissur
12. Maharana Pratap University of Agriculture & Technology (MPUAT), Udaipur
13. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri
14. N. D. University of Agriculture & Technology (NDUAT), Faizabad
15. Orissa University of Agriculture & Technology (OUAT), Bhubaneshwar
16. Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola
17. Rajendra Agricultural University (RAU), Islampur
18. Rajendra Agricultural University(RAU), Pusa
19. Rajmata Vijayraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Mandsaur
20. Tamil Nadu Agricultural University (TNAU), Coimbatore
21. Uttar Banga Krishi Viswavidylaya (UBKV), Kalimpong
22. Dr. Y. S. Parmar University of Horticulture & Forestry (YSPUHF), Solan

Budget profile

Head	Expenditure (₹ in lakh)
Non Plan Expenditure	**215.09**
Plan Expenditure	**300**
AICRP on MAP & Betelvine	330
Externally funded projects	
DUS (PPV&FR A)	4.87
Central Sector Scheme	0.72
Revolving Fund Scheme	2.09
NMPB	
Networking of Herbal gardens Guggal project Seed standard and seed sterilization Bael project	2.37 6.92 2.02 1.22
NAIP Projects	
NAIP on apomixis	3.89
NAIP on ecogeography	16.48
NAIP on ARS/NET online examination centre	25.05

Research Achievements

ALOE (*Aloe barbadensis*)

A. barbadensis belongs to family Liliaceae, is indigenous to African countries and naturalized in India. The plant is perennial herb with fleshy leaves and condensed stem. Flowering occurs in winter months and the inflorescence stack is about 90-150 cm long with orange flowers. Leaves contain gel (polysaccharides) and its exudates contain aloins which are pharmaceutically active. Gel has a cooling and moisturizing action and hence used in cosmetic industries, aloins and aloe emodine are used as pain killer and purgative. The crop is under cultivation in Gujarat, Rajasthan, Tamil Nadu, Madhya Pradesh, Andhra Pradesh and Uttar Pradesh. Raw material is collected both from wild and cultivation for the industry. Suckers are used as propugalates. About 15- month old plants are harvested.

Maintenance and evaluation of germplasm

CCSHAU, Hisar: Twelve genotypes including HAV-1 as check were evaluated for selection for higher yield and quality. The plant height ranged from 42.00 cm (TC-1) to 58.93 cm (HAV-1); leaf length ranged from 37.67 cm (TC-1) to 52.33 cm (HAV-07-9); leaf width ranged from 5.67 cm (TC-1) to 8.0 cm (HAV-04-4); suckers plant^{-1} ranged from 1.00 (IC-1-112273) to 2.33 (KC/OP-33 & HAV-04-4); leaves plant^{-1} ranged from 5.33 (IC-112273) to 7.67 (HAV-04-3); spine distance on leaves ranged from 2.00 cm (TC-1) to 3.10 cm (HAV-1); fresh leaf yield plant^{-1} (g) ranged from 4.69 (TC-1) to 1519.33 (IC-112526); fresh leaf yield (kg ha^{-1}) ranged from 13027.78 (TC-1) to 42203.70 (IC-112526); and the mucilage (%) ranged from 49.33 (TC-1) to 61.33 (HAV-04-4). The highest fresh leaf yield (kg ha^{-1}) was in genotype IC-112526 (42203.70), followed by HAV-05-08 (39731.48) against the check HAV-1 (39537.04).

PDKV, Akola: Seven genotypes collected from Maharashtra region and eight genotypes from DMAPR, Boriavi (Anand), Gujarat were evaluated. No variation in terms of qualitative attributes was observed except light red spine colour in AKAV – 09-10. Genotype IC 285630 recorded the highest plant height (58.75cm) followed by genotype IC 112527 (55.94 cm). Genotype AKAV-09-01 recorded significantly highest number of leaves plant^{-1} (17.00) which was at par with IC- 285629 and IC-285630 (14.25). IC- 285630 recorded significantly highest leaf weight (413.75g). No significant differences were observed in number of suckers per plant and leaf width.

Effect of spacing and organic manures

PDKV, Akola: The experiment was conducted with three spacings (60x30, 60x45 and 60x60 cm) and four levels each of two organic manures (vermicompost at 2.5 and 5 t ha^{-1} and FYM at 5 and 10 t ha^{-1}) to find out the effect on growth and yield. The number of leaves per plant, leaf length, leaf width, leaf thickness were not influenced significantly by various spacings, manure applications or by interactions of spacing x manure at harvest. Planting at 60x60 cm spacing and the application of 5 t ha^{-1} vermicompost produced significantly

more number of suckers (8.47 plant^{-1}). Planting at 60x60 cm and application of 2.5 t ha^{-1} vermicompost recorded significantly higher leaf weight (479 g plat^{-1}), peel weight (192 g leaf^{-1}), latex (2.67 g leaf^{-1}) and crude latex (1.03 g leaf^{-1}) content. However, the gel weight (291 g leaf^{-1}) was significantly more when planted at 60x30 cm with 2.5 t vermicompost ha^{-1} application.

Effect of soil moisture stress on chlorophyll fluorescence kinetics

DMAPR, Anand: The study was conducted to test the effect of soil moisture deficit on physiological functions and chlorophyll fluorescence kinetics of young, mature and older leaves. Results showed that the efficiency of PSII (Fv/Fm) was reduced marginally in the young and older leaves compared to mature leaves under stress conditions. The PSII efficiency factors (Phi PS2); 0.134, 0.114 and 0.123 for young, mature and older leaves, respectively were also reduced drastically under stress conditions. Both the photochemical and non-photochemical quenching quotients were altered significantly under stress. A reduction of 60% in $_{q}$p in all leaf types and increase of 26.79%, 17.53% and 56.51%, in NPQ in young, mature and older leaves, respectively were recorded under stress. Electron transport rate was also reduced up to 69.60%, 53.99% and 62.11% in young, mature and old leaves, respectively.

ARJUN (*Terminalia arjuna*)

T.arjuna belongs to family *Combretaceae*, is a tree and mainly distributed in central India,eastern,western and southern. It has a buttressed trunk and light brown peeling bark. Leaves are 10–25 cm long and 4–9 cm broad. A pair of glands is present on the leaf blade close to the tip of the petioles. Bark of the tree is considered as cardio-tonic and is prescribed in the form of powder along with milk and sugar or in the form of decoction. The astringent property of the bark is used to treat diarrhoea. It is also applied as paste for curing pimples and other minor skin eruptions. Common adulterants of the raw drug are barks of other Terminalia spp., Sterculia urens and Lagerstroemia flos-regina.

Evaluation of bark quality

PDKV, Akola: The leaves, fruits and stem bark of *Arjuna* (*Terminalia arjuna*) trees of different age groups were collected during December 2010 for the assessment of their total tannin and phenol content. Tannin content in bark of 20-25 year old plants was in the range of 16.8-21.3 % with the mean value of 18.99 %, whereas its content in12-14 year old plant was in the range of 17.3-24.8 % with the mean value of 20.62 %. Tannin content reduced (18.3-19.2 %) as the age of the plants lowered to 8-10.

Fruits of 20-25 year old plant had 7.2-12.4 % tannin content with an average of 9.0%, whereas it was in the range of 7.2-15.2 % with an average of 11.85% in 12-14 year old plants. Tannin content (13.75%) was recorded comparatively higher in fruits of 8-10 years

old trees.Tannin content of 20-25 old year trees was estimated in the range of 11.3-21.4 % with an average of 17.42 %. It varied from 15.2 to19.2 % with an average of 17.28 % in 12-14 years old trees. Trees of 8-10 years old showed comparatively lower content (12.6-17.2 %) of tannin in leaves.

ASALIO (*Lepidium sativum*)

L.sativum is a fast-growing, edible annual herb belongs to family *Brassicaceae* which is botanically related to mustard, sharing similar tangy flavour and aroma. The plant can reach a height of 60 cm, with many branches on the upper part. The white to pinkish flowers are only 2 mm across, clustered in branched racemes. The species is endemic to England, France, the Netherlands and Scandinavia and also commercially cultivated in these countries. The seeds are commonly used in the system of Ayurveda to prevent post-natal complications. An easily grown plant, it succeeds in most soils and cultivated as rabi crop in India. The seeds of *L. sativum*, known as Chandrasura in Sanskrit, are described as tonic and alterative, and useful in hiccup, diarrhoea, and skin disease disordered from blood.

Evaluation of germplasm

CCSHAU, Hisar: Twenty two germplasm lines were evaluated for eight characters namely days to 50% flower initiation, plant height (cm), branches/plant, number of leaf let/leaf, leaf let length (cm), leaf breadth (cm), leaf length (cm) and seed yield (kg ha^{-1}). The days to flowering ranged from 47.5 days (HLS-21) to 76 days (HLS-6). The plant height ranged (cm) from 107.00 (HLS-3) to 124.00 (HLS-20); branches/plant ranged from 7.00 (HLS-18) to14.50 (HLS-4); number of leaf let 5.10 (HLS-18) to 6.75 (HLS-19); leaf let length (cm) 4.10 (HLS-9) to 5.85 (HLS-4); leaf breadth (cm) 2.55 (HLS-18) to 3.55 (HLS-10); leaf length (cm) 16.00 (HLS-19) to 27.50 (HLS-9) and seed yield (kg ha^{-1}) 263.89 9 (HLS-10) to 708.33 (HLS-4). The minimum days to flowering was observed in genotype HLS-18 (47.50) followed by HLS-19 (50.50) where as genotype HLS-5 took maximum days to flower (76.50) followed by HLS-6 (76.00). Highest seed yield (kg ha^{-1}) was recorded in the genotype HLS-4 (708.33) followed by HLS-3 (645.83), HLS-16 (625.00) and HLS-21 & HLS-15 (597.22). HLS-10 was tall with ovate leaves where as HLS- 15 and HLS were dwarf with ovate leaves. A considerable variability was recorded in selected lines for leaf shape, size and length.

RVSKVV, Mandsaur: Fifteen germplasm lines collected from farmers' field of Mandsaur, Neemuch, Ratlam and Jabalpur districts were tested for seed yield and its contributing characters. The highest seed yield was in MLS-7 (2468 kg ha^{-1}) followed by MLS-5 (2447 kg ha^{-1}), MLS- 3(2426 kg ha^{-1}), MLS- 12 and MLS-13 (2374 kg ha^{-1}). The lowest seed yield was in MLS-15 (1677 kg ha^{-1}). The plant height ranged from 63cm (MLS-7) to 109 cm (MLS-12) and number of branches ranged from 8 (MLS-13) to 12 (MLS-9). Maximum seed test weight (1000 numbers) was in MLS-5 (1.98 g) followed by MLS-7(1.96 g) and MLS-4, and MLS-12 (1.92 g). The lowest test seed weight was 1.78 g (MLS-9).

Effect of FYM and inorganic nitrogen

MPUAT, Udaipur: The experiment was conducted with two levels of FYM (5 and 10 t ha^{-1}), three levels of nitrogen (20, 40 and 60 kg ha^{-1}) and three times of application of nitrogen (1/2 at sowing+1/2 at 25 DAS, 1/2 at sowing+1/4 at 25 DAS+1/4 at 45 DAS and 1/3 at sowing+1/3 at 25 DAS+1/3 at 45 DAS). The one year's result revealed that seed yield increased with the increasing levels of FYM and N and the time of application of N. The maximum seed yield was recorded with the application of 10 t FYM ha^{-1} (17 q ha^{-1}) and 60 kg N ha^{-1} applied at three times at 1/3 at sowing+1/3 at 25 DAS+1/3 at 45 DAS (19 q ha^{-1}).

Management of *Alternaria* leaf blight

RVSKVV, Mandsaur: Efficacy of six fungicides viz; zineb (0.25%), mancozeb (0.3%), propiconozole (0.2%), COC (0.25%), cuman-L (0.3%) and trifloxystrobin (0.15%) were evaluated against Alternaria leaf blight of chandrasur. Spraying of fungicides was started at the first appearance of the disease symptom and was repeated twice at 10 days interval. The observation of disease intensity was recorded 10 days after the last spray. Results revealed that all the fungicidal treatments were significantly superior over the control for reducing disease and increasing seed yield. However, trifloxystrobin (0.15%) was most effective against Alternaria leaf blight, as seed yield (1936.33 kg/ha) was recorded maximum and PDI (18.50) was minimum in this treatment followed by propiconazole (seed yield: 1857.00 kg/ha; PDI: 23.00) and mancozeb (seed yield: 1698.00 kg/ha; PDI: 32.50).

ASHOKA (*Saraca asoca*)

S.asoca is a medium sized, evergreen tree belonging to family *Caesalpiniaceae*. Flowers are orange-yellow and tender shoots are bronze coloured. It is distributed throughout India particularly in humid areas. The plant is considered as sacred tree of Hindus and Buddhists. Asoka bark is widely used in Indian medicines for the treatment of female disorders. Flowers are also used for the treatment of bleeding piles and skin diseases. The activity of the drug is due to the presence of steroidal compound, tannins and calcium salt.

Evaluation of germplasm

KAU, Thrissur: Observations were recorded on various growth parameters of 42 accessions of the plant after two years of planting for various characters like height of the plant, number of leaves and stem girth. DNA finger printing for the various accessions were carried out and catalogued. It was also found that the seedling vigour and further growth depended mainly on the place from where the accessions were collected. The accessions collected from Thrissur and Trivandrum showed vigourous growth represented by its increased height, number of leaves and higher girth of the stem. It also showed higher number of leaves

which have a positive association with mean girth of stem. Accessions collected from Thrissur district recorded more height followed by higher number of leaves and higher mean girth compared to accessions collected from Trivandrum. TCRSA485 (Thrissur) followed by TCRSA497 (Trivandrum) have maximum bark yield. Maximum tannin content was recorded (4%) by TCRSA467and TCRSA474 collected from Thrissur.

Evaluation of rooting media for air layering

KAU, Thrissur: A preliminary study was conducted on vegetative method of propagation of Ashoka through air layering. The air layers were prepared during December to January on 9 to 12 months old pencil thick branches. Different rooting media i.e. moist coir pith (coir pith+urea), moist moss and potting mixture (1:1:1) were tried. Roots were emerged from the ringed portion after 40 to 60 days. The rooting media recorded variable response to the number of roots and success rate, and found that the moist coir pith rooting media produced more number of roots and was highly successful for air layering.

Evaluation of bark quality

A high performance liquid chromatography (HPLC) method have been developed for assessing the quality of the crude drug preparations from bark of Asoka. Also, developed techniques can be utilized for the floor level quality testing of market samples of raw bark samples of Asoka. TLC method was used for assessing the quality of 22 market samples of Asoka bark collected from markets of Kerala state.

ASHWAGANDHA (*Withania somnifera*)

W.somnifera belongs to family *Solanaceae* and is a wonder herb with multiple remedial properties. Roots are used in preparation of vital tonics. It is used against stress and in treating senile dysfunctions. Its effect on controlling the effects of anxiety, depression, phobias, alcoholic paranoia, schizophrenia, etc is clinically established and well accepted. The active ingredients that attributed to the medicinal property are the alkaloids and steroidal lactones present in the roots. Among the various alkaloids, withanine is the main constituent. The leaves contain steroidal lactones, which are commonly called withanolides. The crop is cultivated in the north western region of Madhya Pradesh, Rajasthan and Gujarat. However, it has recently spread in other states also. It is a late kharif crop and grown in marginal and submarginal lands having 7.5 to 8.0 soil pH.

Varietal evaluation

MPUAT, Udaipur: Nine selected lines identified for superior yield and quality were evaluated along with two checks (JA20, JA134). The observations for plant height, number of primary branches, root length, root diameter, flowering, maturity, alkaloid content and dry root

yield were recorded. The dry root yield ranged form 538.19 kg ha-1 (RAs48) to 729.17 kg ha-1 (RAs10). It was found that lines RAs10, RAs23, RAs56 and RAs37 out yielded the best check JA134 (659.72 kg ha-1). Line RAs38 had the highest plant height (52.3cm) and highest root length (23.8cm) among all the test entries and the check varieties.

Characterization and evaluation of germplasm lines

CCSHAU, Hisar: Perennial type of germplasm lines

The perennial type of Ashwagandha consisting of 30 accessions were characterized based on various morphological and root yielding parameters viz., plant height (cm), root length (cm), root diameter (cm), branches/plant, number of berries and dry root yield (kg ha-1). Plant height ranged from 39.50 cm (Acc. 11) to 104.50 cm (Acc. 22); branches/plant from 1.50 (Acc. 5) to 50 (Acc. 28); number of berries 29.00 (Acc. 26) to 222.00 (Acc. 22) root length 15.50 cm (Acc. 10) to 27.50 cm (Acc. 28); root yield 283.33 kg ha-1 (Acc. 10) to 1218.34 kg ha-1 (Acc. 16). The highest root yield (kg ha-1) was recorded in Acc. 16 (1218.34), followed by Acc. 30 (1190.00), Acc. 27 (1133.33), Acc. 8, Acc. 24 & Acc. 29 (1076.67) and Acc.13 (1048.33).

In another trial, 15 selected elite lines from the germplasm were evaluated for various yield and morphological characters. It was found that plant height (cm) ranged from 55.67 (JA-20) to 94.00 (Acc. 22); branches/plant 2.00 (Acc. 29) to 4.67 (Acc. 28); number of berries 97.00 (JA-20) to 295.67 (Acc. 21), root length (cm) 20.33 (Acc. 8) to 37.33 (Acc. 9); root diameter (cm) 1.73 (Acc. 5) to 2.33 (Poshita), berries diameter (mm) 4.00 (Acc. 28) to 6.67 (Poshita), root yield plant-1 (g) 13.33 (J-134) to 25.00 (Acc. 22), root yield (kg ha-1) 755.56 (JA-134) to 1416.67 (Acc. 22). The highest root yield (kg ha-1) was in Acc. 22 (1416.67), followed by Acc. 21 & Acc. 12 (1397.7), Acc. 9 (1378.89), and Acc. 28 (1360.00) against the check (Poshita 1246.67).

Annual type of germplasm lines: The annual type germplasm consisting of 27 genotypes including check JA-20 were evaluated. Plant height (cm) ranged from 62.50 (WS-220) to 92.00 (WS-206); branches from 1.0 (WS-224 and 136) to 4.5 (WS-204 and 205); root length (cm) from 14.50 (WS-218) to 22.50 (Selection-13); root diameter (cm) from 1.05 (WS-224) to 1.90 (Selection-14); berry diameter (mm) from 5.00 (WS-204) to 7.00 (WS-90-103); berries/plant from 76.00 (Selection-3) to 316.00 (WS-90-103); dry root yield plant-1 (g) from 5.0 (WS-224 and WS-90-125) to 18.1 (HWS-04-3 and Selection-14) and root yield (kg ha-1) from 283.33 (WS-90-125) to 920.84 (HWS-04-3 and Selection-14). The highest dry root yield (kg ha-1) was in HWS-04-3 and Selection-14 (920.84) followed by HWS-206 (912.34), WS-90-127 (878.14) and WS-201 (782.00).

DMAPR, Anand: A total of 140 Ashwagandha germplasm accessions were maintained and were evaluated for yield and its yield attributing characters in augmented design. Significant differences were observed for most of the characters among germplasm. Dry root yield ranged from 0.63 to 12.74 g plant-1. IC-283662, IC-310595, RAS–139, IC–286632, IC–283966, and IC-310620 (B) showed significantly higher root yield than JA 20 (6.89 g plant-1) used as check. Yield trial was conducted in 14 selected pure lines and two lines DWS 135 (4443 kg ha-1) and DWS 137 (4079 kg ha-1) were identified with significantly higher dry root yield than the check varieties, JA 20 (2650 kg ha-1) and JA 134(1950 kg ha-1).

MPUAT, Udaipur: A total of 139 germplasm were evaluated along with JA20 as check variety. Observations were recorded for individual germplasm for plant height, number of primary branches, days to 50% flowering, days to 75% maturity, root length, root diameter, dry root yield and total alkaloid content. Observations on non metric traits *viz*., root type (woody/ starchy), berry colour (yellow/red) and plant type (erect/spreading) were also recorded. The dry root yield varied from 208 kg to 1042 kg with overall mean of 431 kg ha^{-1}. Thirty five accessions exhibited higher dry root yield over the best check JA20 (500 kg ha^{-1}). It was also found that twenty seven germplasm were having woody type root while the rest were having starchy type root.

RVSKVV, Mandsaur: Cultivated type of Ashwagandha crop is grown as a late kharif crop where as wild types are naturally grown in wild. Cultivated species are annual and early maturing type where as wild species are perennial in nature and late maturing type. Germplasm were collected, purified and catalogued based on plant type, leaf pattern, berry colour and other morphological characters. The different plant types identified were erect or bushy types; biparous or triparous types of branching, ovate or oblong leaf types, hairy or non hairy leaf surfaces, yellow, orange or red berry colour, small, medium or large berry sizes and short or long type of persistent calyx. Number of steroids present in different plant parts varied from 3 to 8.

Breeding for high quality and high yield

DMAPR, Anand: Forty hybrid crosses made during last year in line x tester using 4 females (MWS 302, C-55, MWS 313 and RAS 33) and 10 males (MWS 10, MWS 131, MWS 132, MWS 205, MWS 324, MWS 328, Red berries, RAS 23, RAS 27 and RAS 34) were evaluated along with their parents. 191 pure line selections made during last year were further purified by single plant selection. DUS descriptors were prepared with additional characters.

Effect of spacing and nutrients levels on yield

MPUAT, Udaipur: The experiment was conducted with six spacings (20x5, 20x10, 25x5, 25x10, 30x5 and 30x10 cm) and three NPK levels (30:20:10, 40:30:20 and 50:40:30 kg ha^{-1}). The two year's result revealed that root length (18.74 cm), total alkaloid content (0.495%) and alkaloid yield (5.50 kg ha^{-1}) were maximum at closer spacing of 20x5 cm, however, root diameter (9.72 mm) and seed yield (22 q ha^{-1}) was maximum at wider spacing of 30x10 cm. Whereas, the dry root yield (11 q ha^{-1}) was recorded highest at 25x5 cm spacing during both the years of the study. Further, the application of 50:40:30 kg NPK ha^{-1} recorded maximum root length (18.17 cm), root diameter (9.53 mm), dry root yield (11 q ha^{-1}), seed yield (20.5 q ha^{-1}), total alkaloid content (0.489%) and alkaloid yield (5.41 kg ha^{-1}). Planting at closer spacing (20x5 cm) and the application of higher doses of NPK (50:40:30 kg ha^{-1}) recorded the least crude fibre content.

Effect of organic nutrient sources on yield

NDUAT, Faizabad: Eleven combinations of three organic manures (FYM, vermicompost and pressmud) and one biofertilizer (PSB) at different levels were tried to find out the best organic nutrient management practices. The pooled data of three years result revealed that

the application of the pressmud at 10 t ha-1 recorded maximum plant height (36.6 cm), however, the number of branches per plant (4.0) was maximum with FYM at 10 t ha-1. The maximum root length (17.3 cm) and root diameter (0.8 cm) were recorded with the application of pressmud at 10 t ha-1. Application of pressmud at 10 t ha-1 also recorded the highest fresh root yield (14 q ha-1), dry root yield (5 q ha-1) and non-fibrous roots (86.3%) followed by FYM 10 t ha-1.

Chemical screening of germplasm and purified lines

DMAPR, Anand: Three withanolides, withaferin-A, 12-deoxywithastramonolide and withanolide, content were quantified in dried root of one hundred and forty germplasms and twenty two purified lines of Ashwagandha using HPLC method. Germplasms had withaferin-A, 12-deoxywithastramonolide and withanolide-content in the range of 0.002-0.178, 0.102-0.498 and 0.204 -1.037 mg/g respectively. For purified lines, Withaferin-A and 12-deoxywithastramonolide and withanolide-content ranged from 0.006-0.149, 0.006-0.638 and 0.125-1.750 mg/g respectively. Content of Withaferin-A was maximum in DWS-44 (1.40 mg/g) and minimum in DWS-146 (0.115 mg/g). 12-deoxywithastramonolide content was maximum in DWS-23 (0.638) and minimum in DWS-55 (0.006 mg/g). Similarly, Withanolide - A was maximum in DWS-139 (1.750 mg/g) and minimum in DWS-55.

Assessment of the economic yield loss due to insect pests

DMAPR, Anand: Effect of insect pests infestation on root yield and total alkaloid contend in ashwagandha (WS-134) was evaluated by comparing yield of dry root. Paired plot experiment (sprayed and unsprayed) with 15 replications keeping buffer plots in between was carried out. Periodic spray of insecticide (alternatively, Profenophos and monocrotophos) was made to maintain the crop pest free. Yield measurement was made by harvesting the crop from central area of each plot after maturity of crop. Highly significant difference was observed between treated and untreated plots, as in untreated plots 165.99 kg/ha dry root yield was realized against 229.83 kg/ha in treated, revealing a direct effect of pest infestation on economic yield. Similarly, seed yield was also more in treated plots (503.38 kg/ha) than untreated (436.40 kg/ha).

Incidence of Arthropods

DMAPR, Anand: A total of 24 arthropods was recorded and identified on Ashwagandha at Anand, Gujarat, of which 20 were phytophagous species viz., Coleopteran (03), Lepidopteran (03), Hemipteran (04), Homopteran (04), Orthopteran (03), Dipteran (02), & Acari (01) and four predatory species viz., *Coccinella transversalis, Cheilomenes sexmaculatus, Chrysopa* sp and crab spider. The sequential occurrence of arthropods revealed the presence of mealy bug (*Phenacoccus solenopsis*) through out the crop growth stages (i.e from vegetative growth stage to maturity), whereas, Coleopteran (*Epilachna vigintioctopuntata, Cyrtozemia dispar*, *Corynodes peregrinus*) and Lepidopteran (*Helicoverpa* Sp, Hairy caterpillars, *Hyposidra successaria*) pests were recorded during early crop growth stage (i.e. Ist week of September) and remained on the crop upto October and December, respectively. The sucking pests were seen associated when temperature were comparatively low (28 ^{o}C or less) i.e mites (*Tetranychus urticae*) during 3rd week of October to 4th week of November, aphids (*Aphis*

gossypii) during January - February, true bugs (*Graptostethus servus, Spilostethus pandurus, Aspongopus janus, Nazara viridula*) and tree hoppers (*Otinotus oneratus, Leptocentrus Taurus*) during 2nd week of November to 1st week of January etc. Infestation of epilachna beetle, mite, mealybug and aphid were uniform and severe, whereas, that of true bugs, tree hoppers, Lepidopterans etc were sporadic and less severe.

Management of Aternaria leaf blight

JNKVV, Jabalpur: A field trial for the management of Alternaria leaf blight of Ashwagandha caused by *Alternaria alternata* was conducted. Fungicidal spray was done after 40 days of sowing, when disease started appearing and was repeated twice at an interval of 15 days. All the fungicides tested were effective in reducing the disease incidence, however, Mancozeb (0.25%) was found to be most effective, as disease incidence was lowest (12.6 PDI) followed by Propconazole (13.9 PDI) and Zineb (14.00 PDI).

Post harvest, microbial load, aflatoxin and standardization of drying methods

Root samples collected from the market, farmers' stock and experimental plots was analysed for microbial load and aflatoxin contamination. Five genera (*Trichoderma, Rhizopus, Penicillium, Aspergillus* and *Fusarium*) of fungi and two bacterium (*Pseudomonas* sp. and *Bacillus* sp.) were found associated with the root samples. The Fungal and bacterial microbes were dominant in farmer's samples followed by market and experimental samples. The Aflatoxin contamination was well under the permissible limits (0.016 – 0.036 g/100g sample). Drying in sun, solar dryer, oven (40, 60$\pm$1^{o}C) and indoor were assessed to standardize the drying process for Ashwagandha roots for minimising microbial load and aflatoxin concentration. Results revealed that drying in solar dryer is the best in bringing down the moisture level, which keeps microbial load and aflatoxin production under check.

ATIS (*Aconitum heterophyllum*)

A. heterophyllum is a member of Ranunculaceae. It is a tall herb commonly found in sub-alpine zones of western Himalayas at altitude of 2500 to 3900 m. Leaves are heteromorphus, ovate or orbicular-cordate; flowers are bright blue in panicled recemes. Seeds are obpyramidal, blakish brown. Roots are used as drugs which contain alkaloids. These are used in the treatment of hysteria and throat diseases. They are astringent and prescribed in infant diarrhoea.

Effect of planting spacing

YSPUHF, Solan: Experiment was laid out with five planting spacings (5x5, 10x10, 15x15, 20x20 and 30x30 cm) for two years. The results revealed that planting at 30x30 cm spacing recorded significantly higher plant height (cm), number of leaves per plant, root length (cm) and root yield (g plant-1) during 2009 and 2010.

BALA (*Sida cordifolia*)

S. cordifolia is an annual herb belongs to family Malvaceae. There are four other species used in medicine, however, *S. cordifolia* is most widely used. *S. cordifolia* is considered as the source of raw drug bala in North India while in South India *S. rhombifolia* is accepted as the source of the raw drug. All the Sida species are widely distributed as a weed in the cultivated fields of tropical and subtropical regions of India. Cultivation in limited scale has been initiated in other species in some parts of India. The root of the species is used as raw drug for the treatment of rheumatism. It imparts strength to the body and is useful in the treatment of facial paralysis, general debility, sciatica, headache, uterine disorders, etc.

Effect of organic manures and biofertilizers

KAU, Thrissur: The experiment was conducted with three different organic manures (FYM, coir pith compost and vermicompost) and three biofertilizers (*Azospirillum*, PSB and *Azospirillum*+PSB each at 1 kg ha^{-1}). The analysis of two year's result revealed that the application of CPC along with biofertilizers (*Azospirillum*+PSB) produced tallest plants (93.23 cm) which was comparable with vermicompost applied with *Azspirillum*+PSB. Application of vermicompost with *Azospirillum*+PSB recorded the highest plant girth (3.79 cm) and number of branches per plant (35). Root length did not show consistent variation. However, application of vermicompost with *Azospirillum* recorded significantly higher root length. Whereas, the maximum number of roots and fresh root yield were recorded with the application of vermicompost along with *Azspirillum*+PSB. Application of CPC along with *Azospirillum*+PSB recorded the highest fresh shoot weight (168 g plant^{-1}) and biomass production (180 g plant^{-1}).

Effect of shade

KAU, Thrissur: The data compared under open and shaded situation clearly revealed that the crop performance was better under open conditions. The growths as well as yield attributing characters were significantly superior and almost doubled under open condition compared to shade. The fresh as well as dry root yield decreased by about 75% when it was grown under shaded condition. The open conditions also enhanced the quality in terms of ephedrine content (0.013%).

Effect of planting dates and spacing

KAU, Thrissur: The crop was planted at four times on monthly interval between 15th May and 15th August, following four different spacings (50x25, 50x50, 75x50 and 100x75 cm). The result of two year's data reveled that the seedlings planted on 15th May recorded

highest dry matter production (137 g plant^{-1}), yield (466 kg ha^{-1}) and ephedrine content (0.010%) which were significantly superior compared to other dates of planting. The effect of different planting spacings showed that the performance of individual plant was better under wider spacings, however, the yield per hectare was significantly higher at closer spacings. The planting at 50x25 cm recorded about three fold increase in dry yield (728 kg ha^{-1}) over planting at 50x50 cm. Closer spacing at 50x25 cm also produced higher ephedrine content (0.016%) which was 250% more compared to wider spacing.

Effect of harvesting stages on yield and quality

KAU, Thrissur: The experiment was harvested at nine different stages starting from 6th month after planting to 14th month after planting. The results from two year's pooled data revealed that the root weight (7.58 g plant^{-1}), fresh root yield (649 kg ha^{-1}) as well as dry root yield (445 kg ha^{-1}) were significantly superior when the crop was harvested at 8 months after planting and recorded a decreasing trend thereafter. Harvesting at 8 months after planting had the highest ephedrine content (0.027%) which is almost doubled compared to other stages of harvest.

BHUI AMLAKI (*Phyllanthus amarus*)

P. amarus is a small herb of about 60 cm height belonging to family *Euphorbiaceae*. The species is distributed throughout India and grows as weed in cultivated fields. The whole herb is used for the preparation of medicine. It is bitter in taste and is used mainly for the treatment of jaundice. It is also used in dyspepsia, diarrhea and dysentery. The herbage portion contains the bitter principle phyllanthin which is responsible for the therapeutic action. The species is not under regular cultivation and the raw drug is mainly collected from wild. However, the plant can be propagated by direct sowing of seeds in the field. The plant can be raised as a rain fed crop. Four to five months old plants are harvested, dried and used as raw drug.

Effect of spacing and date of sowing on yield

AAU, Anand: Performance of the crop growth and yield was evaluated under three dates of sowing (1st July, 15th July and 1st August) and spacings (broadcasting, 15x5 and 30x5 cm). The result revealed that planting dates and spacings significantly influenced the growth characters and yield. The maximum plant stand was recorded in 1st August sowing by broadcasting. Whereas, the maximum plant height (57 cm) was recorded when sown on 1st July at 15x5 cm spacing. Significantly higher dry biomass yield was obtained when the crop was sown at 1st July (2217 kg ha^{-1}) followed by sowing at 1st Aug (2145 kg ha^{-1}). Sowing at 15x5 cm spacing also recorded significantly higher dry biomass yield (2311 kg ha^{-1}) followed by broadcasting (1938 kg ha^{-1}).

BRAHMI (*Bacopa monnieri*)

B. monnieri belonging to family *Scrophulariacea* is a creeping, succulent highly branched herb and is commonly found in marshy places throughout India up to an elevation of 1300 m. The whole herbage is the source of Ayurvedic drug 'Brahmi' which is an important ingredient of several Ayurvedic preparations. It is used as astringent, diuretic, laxative, tonic for the heart and nerves and often used in Ayurveda to improve memory. It is propagated by stem cuttings. Bacoposide is considered to be the major active ingredient in this plant.

Effect of planting time and number of node per cuttings on yield

RAU, Pusa: The experiment was conducted with five dates of planting starting from mid May to mid July at 15 day-interval with different number of node per cuttings from 2 to 4. The data showed that crop planted in mid July with 4-node plants recorded maximum herbage yield (297 q ha^{-1}). Planting earlier in the months of May and June and with 2 or 3-node plants were found to reduce the total herbage yield.

Effect of organic manures and biofertilizers on yield

KAU, Thrissur: The experiment was conducted with three organic manures (FYM, coir pith compost and vermicompost) and three biofertilizers (Azospirillum, PSB and Azospirillum +PSB each at 1 kg ha^{-1}). The two year's result revealed that the application of CPC along with Azospirillum+PSB recorded significantly more vine length and the number of leaves. However, the internodal length was maximum with the application of FYM and Azospirillum+PSB. The data showed that biomass production (29 g $plant^{-1}$) and dry herbage yield (10.95 g $plant^{-1}$) were recorded highest with the combined application of CPC and Azospirillum+PSB.

Effect of spacing on yield

KAU, Thrissur: Four different planting spacings (10x10, 20x10, 20x20 and 40x20 cm) were tried for two years to test the effect on growth and yield. The pooled data of two years showed that the planting at 10x10 cm spacing recorded significantly highest fresh herbage (7.5 t ha^{-1}) and dry herbage (2.2 t ha^{-1}) yield. However, the bacoside content (3.97%) was recorded highest at a spacing of 20x10cm which was significantly superior compared to other spacings.

CHIRAYITA (*Swertia chirayita*)

S.chirayita belonging to family *Gentianaceae*, is an erect herb which is distributed in temperate Himalayas from Kashmir to Bhutan. The plant is propagated by seeds. It grows well in moist,

temperate forests of Himachal Pradesh and Eastern Himalayas. Dried herbage portion is used as raw drug. Flowering occurs in July to October and the raw drug is collected when the capsules are fully formed. The drug is extremely bitter in taste. The active ingredient of the raw drug includes ophelic acid, glucosides, etc.

Effect of time of sowing on seed germination

UBKV, Kalimpong: The study was conducted with six dates of sowing at monthly interval from first fortnight of January to first fortnight of July to test the effect on seed germination. The seeds sown in the first fortnight of January, February and March failed to germinate due to low temperature conditions. However, sowing in the first fortnight of April showed few percentage of germination. Further, the results are awaited from the crop sown in the month of May and June.

Effect of biofertilizers on yield and quality

YSPUHF, Solan: Three combinations of biofertilizers (*Azotobacter*+PSB, *Azotobacter*+VAM and *Azotobacter*+PSB+VAM) were applied at three stages (at the time of nursery sowing, transplanting and at nursery sowing as well as at transplanting). The results revealed that the application of *Azotobacter*+VAM at both nursery and transplantation stages significantly increased plant height (182 cm) and plant biomass (207 and 47 g of fresh and dry, respectively), however, the highest amaroswerin (46 mg) and amarogentin (129 mg) content per plant were recorded with the application of *Azotobacter*+PSB+VAM applied at the time of nursery sowing.

TLC profiling of five *Swertia* species.

YSPUHF, Solan: The plant materials of the five *Swertia* species namely, *S. chirayita, S. cordata, S. alata, S. purpurascens and S. angustifolia* were sequentially extracted with petroleum ether, chloroform and methanol to get three extracts. Comparative TLC profiles of three extracts of above five species were investigated. Although, a number of spots were observed in TLC profile of petroleum ether and chloroform extracts, two distinct spots of amarogentin and amaroswerin were observed as distinct spots only in methanol extract of *swertia chirayita*. Red coloured spots of amarogentin and amaroswerin were observed on spraying the TLC plates with fast red B salt solution.

Quality analysis of the market samples of *S. chirayita*

YSPUHF, Solan: Eleven market samples of *S. chirayita* received from different centers of the project were analyzed by TLC. Amarogentin, was present in three samples only. Further research work is in progress to establish the factors for the absence of amarogentin in remaining eight samples.

CHITRAK (*Plumbago rosea*)

P. rosea belonging to *Plumbaginaceae* is perennial, sub acandent shrub well distributed in Peninsular India. Leaves are ovate, glabrous; flowers are rorse cloloured in elongated spike; produce no fruits. Plants are propagatd by stem cuttings. Roots are used as Ayuervedic drug which contain Plumbagin. The roots stimulate digestive process.

Evaluation of selected accessions

KAU, Thrissur: Nine selected accessions along with local check were evaluated for various morphological characters, yield and quality. Analysis of the various morphological traits and plumbagin content of the selected accessions showed that significant variability existed in all the characters studied. Accession TCRPR521 had maximum plumbagin content (4.78%), followed by TCRPR516 (4.34%). But no significant differences were observed in the dry root yield among the accessions.

Effect of organic manures and biofertilizers on yield

KAU, Thrissur: The experiment was conducted with three organic manures (FYM, coir pith compost and vermicompost) and three biofertilizers (*Azospirillum*, PSB and *Azospirillum*+PSB). The pooled data analysis of two years showed that the combined application of FYM at 10 t ha^{-1} along with *Azospirillum* produced significantly maximum number of leaves (59.3) and number of branches (9.5). However, the application of FYM at 10 t ha^{-1} along with *Azospirillum*+PSB produced significantly tallest plants (39 cm) and the highest dry matter (57.7 g $plant^{-1}$). The root length was not influenced significantly due to different manures and biofertilizers.

COLEUS (*Coleus forskohlii*)

C. forskohlii belonging to family Lamiaceae is grown mainly in south India. It is propagated by stem cuttings. The tuberous roots are of commercial importance which produce a diterpenoid, froskolin. Although synthesis of froskolin has been reported, but till now main source of it is through roots of *C. forskohlii* either collected from wild or form cultivated source. Leaves are tick velvety which is used against stomach ailments.

Management of root rot disease

TNAU, Coimbatore: A field trial for management of root rot disease of coleus was conducted at farmer's field. The experiment was laid in RBD with eight treatments including control, each was replicated three times. The observation of diseases intensity was recorded at 40 and 90 days after planting. Results revealed that the treatment (T1) involving sanitation +

dipping stem cuttings in Carbendazim (0.1%) + one drench with Carbendazim (0.1%) on 30 DAP recorded the maximum reduction of root rot disease incidence over control (76.50 and 72.72 per cent at 45 and 90 DAP, respectively). This was at par with the treatment (T3) consisting of soil application of Zinc sulphates 20 kg/ha + drench with (Neem cake + *Trichoderma viride* mixture) at 50g/plant where reduction of root rot disease incidence was 73.73 and 70.11 per cent over control at 45 and 90 DAP, respectively. The tuberous root yield also corroborates with above results and it was maximum (5787 kg/ha) in treatment no. 01 (T1) followed by treatment no. 03 (T3) (5759 kg/ha).

GILOE (*Tinospora cordifolia*)

T. cordifolia is a member of family *Menispermaceae*, and is a deciduous perennial climber distributed throughout tropical India. The species produces a lot of aerial roots. It is propagated by stem cuttings as well as seeds. The stem and leaves are medicinally used as raw drug. Giloe stem is a common constituent of a number of Ayurvedic vital tonics for the treatment of general debility, dyspepsia, fevers and urinary diseases. Starch present in the stem along with alkaloids is the active principle of the species. Leaf also contains a number of alkaloids. Leaf is used for the treatment of gout, jaundice and rheumatism. Raw drug is mainly obtained from the wild habitats of the species. The plant is not under regular cultivation and it is grown as a climber on trees in the wild. One year old plants are ready for use as raw drug. The stem is collected from the wild and used for starch extraction which has high demand in Ayurvedic industries.

Isolation, identification and quantification of major chemical constituents

DMAPR, Anand: *T. cordifolia* accessions were distributed in two major clusters consisting of 24 and 10 accessions. HPTLC profile of methanolic extract prepared from the stem of accessions showed that IC 310608 had ten bands. Similarly, chloroform extract of NMRM 15 showed 15 bands. However, no correlation between the geographical distribution of the accessions and HPTLC profile was established.

GUGGAL (*Commiphora wightii*)

C. wightii is a perennial shrub or small size tree of about 5 m height belonging to family *Bursearaceae*. It is a slow growing plant with crooked and knotty branches ending in sharp spines. The species contains male, female and hermaphrodite plants in the population. Propagation is done by stem cuttings as well as by seeds. The oleo- gum-resin of guggal is known to be highly effective in the treatment of obesity, arthritis and several other diseases in Ayurveda. The species is included in the Red data book (IUCN) since the species is overexploited in the country. Africa

and Asia are the centres of origin of Commiphora spp. In India, Guggal is distributed in dry areas of Gujarat, Rajasthan and Madhya Pradesh. 'Guggal gum' usually called in trade is a mixture of resins and gum, water and volatile oil. Guggulosterol and guggulsterone are the important active ingredients of the gum resin used in modern medicine.

Survey, collection and characterization of germplasm

DMAPR, Anand: Four surveys, three in Gujarat and one in Rajasthan were conducted. Forty accessions were added this year. A total of 73 accessions are maintained in the field gene bank, of which 47 are from Gujarat and 26 from Rajasthan; 61 females, nine males and three hermaphrodites. All the accessions from Rajasthan are females. Population in Himmatnagar of Gujarat was found to be females and bigger in size; height >4m and girth >45 cm. However population in Kutchh and Padra area of Vadodara showed variability in sex. Plant height of Kuchh populations also varied greatly, from 30 cm to 4.0 m.

Three distinguished plant types were identified viz., erect, semi-erect, drooping (spreading). Plant height varied from 112.50 to 210.00 cm; plant spread varied from 340.00 to 1015.00 cm; number of secondary branches varied from 2.00 to 8.50; diameter of secondary branches varied from 56.21 to 23.23 mm; number of spines per m of secondary branch varied from 6.86 to 44.70 and number of fruits per meter of branches varied from 25.86 to 16.27.

Response of genotypes on rooting of stem cuttings

DMAPR, Anand: Seventy two accessions were used for vegetative propagation by stem cuttings without any hormone application. The study showed variable response of accessions in rooting. Accessions were categorised into four groups viz. first group: no rooting (12 accessions); second group: up to 25% rooting (37 accessions); third group: 26 to 50 % rooting (12 accessions) and fourth group: >50% rooting (11 accessions). Two accessions viz., GUJ 11 and GUJ 17 produced >80 % rooting.

Sexual plant type identified

DMAPR, Anand: *C. wightii* is characterized by the occurrence of apomixis, polyembryony and autonomous endosperm. Even though, the species includes males, females and hermaphrodites, no evidences of sexuality could be detected so far. Detailed surveys of natural populations and their characterization, led to identification of sexual plant types from one of these accessions. Evidences were collected to support the sexuality of the putative sexual accession. Controlled pollination experiments showed fruit set in pollinated plant type. Flow cytometry data confirmed the development of endosperm by triple fusion. Histological study of the developing seeds of the identified accession showed origin of embryo from the egg cell. RAPD analysis of the seedlings from the accession showed variability among them and also differed from mother plant. Identification of sexual plant type would help for the creation of variability and scopes for further crop improvement programmes.

Screening of Guggal germplasm collected from Rajasthan for Z-guggulsterone content

DMAPR, Anand: Z - guggulsterone content in twenty two germplasms of guggal collected from Rajasthan ranged from 0.56-4.19 mg/g, with maximum content in DMAPR CW 52 and minimum in DMAPR CW 65. Four germplasms namely DMAPR CW 53, DMAPR CW 67. DMAPR CW 50 and DMAPR CW 60 had Z-guggulsterone content 3.84, 3.73,3.54 and

3.48 mg/g, respectively. The resin and gum fractions were separated using ethyl acetate. Golden colour resin and brown colour oleo- gum resin were obtained. E and Z-guggulsterone were estimated in golden colour resin and brown colour gum. Z-guggulsterone content was higher than E-guggulsterone in both golden colour resin and brown colour gum.

ISABGOL (*Plantago ovata*)

P. ovata belongs to family Plantaginaceae whose eed coat is known as 'isabgol husk' or 'psyllium husk' under trade. It is a rabi crop, which requires cool and dry climate in its growing season. India is the sole exporter of isabgol husk in the international market. The swelling property of the seed coat or husk after absorption of water is the cause of its use as a famous medicine against constipation and gastrointestinal irritations. In addition, it is used in food industries for the preparation of ice creams, candy, etc. The country earns on an average Rs. 300 crores annually from its export. It is a cultivated in North Gujarat, adjoining Rajasthan and Madhya Pradesh over an area of about 1, 00,000 ha. A number of high yielding varieties are available in the crop for cultivation. Seed coat (husk) is removed by specially fabricated machines.

Mutation breeding: male sterility

AAU, Anand: Efforts to study naturally available male sterile plants in populations were not fruitful. Hence seeds of Isabgol, Variety GI-2, were irradiated with fast neutron. Male sterile plants identified were handled by sib mating. During Rabi 2010, two female lines and their possible maintainers were identified.

Germplasm evaluation

DMAPR, Anand: 84 isabgol germplasm accessions were further purified and maintained.

MPUAT, Udaipur: Sixty eight germplasm lines were evaluated along with three checks. The observations were recorded for individual line for different morphometric traits *viz*., plant height, number of branches/plant, spike length, number of effective spikes/plant and seed yield while the observations on days to 75% flowering, days to 75% maturity and swelling factor were recorded on plot basis. Thirty germplasm lines recorded higher seed yield over the best check RI-89 (1250 kg ha^{-1}) and over grand mean (1304 kg ha^{-1}). Seed yield ranged from 521 kg ha^{-1} (HI-6) to 2187 kg ha^{-1} (DM-10). Considerable variability for spike length was recorded in the germplasm which ranged from 3.3 cm (MIB-122) to 7.3 cm (DM-2).

In an another trial 23 lines were evaluated along with three checks *viz*., GI-2, RI-89 and Sel-10 for yield and yield contributory traits. Five genotypes *viz*. PS-17, MIB-124,P-6, Palampur-2 and PB-6-1 exhibited significantly higher seed yield over the best check Sel-10 (1643.51 kg ha^{-1}) and over the grand mean of the trial (1532.22 kg ha^{-1}). Seed yield ranged from 1250 kg ha^{-1} (GI-2) to 1805.55 kg ha^{-1} (PS-17). Swelling factor varied from 9.8 cc g^{-1} (Ahmedabad) to 11.5 cc g^{-1} (MIB-123).

RVSKVV, Mandsaur: Eighty lines of Isabgol were evaluated for six characters. Results showed wide range of variability among the lines. Plant height ranged form 26.0 cm (SLS-53) to

39.0 cm (SPS-69). Days to 50% flowering ranged from 58 to (SPS-10) 76 (SPS-23) and the length of spikes varied from 3 cm (SPS-1) to 6 cm (MIB-8). The seed yield ranged from 500 kg ha^{-1} (SPS-1) to 1111 kg ha^{-1} (RI-89). The highest seed yield was in RI-89 followed by MBI-2 (1083 kg ha^{-1}), SLS-65 (1055 kg ha^{-1}), SPS-4 (1028 kg ha^{-1}), SPS-19, SLS-16 and MIB-1007 (1000 kg ha^{-1}).

Varietal evaluation

DMAPR, Anand: Out of three entries (DPO-1, DPO-4 and Sel. 10) evaluated with two check varieties (GI-2 and Niharika), DPO-1 showed significantly higher yield (1429 kg ha-1) than the best check variety GI-2 (1043 kg ha-1) which was 37% higher (Fig 2).

Fig 2. DPO 1 isabgol line

Development of tetraploid

DMAPR, Anand: The colchicines induced polyploid lines were tested for its ploidy level using ploidy analyzer. Out of 77 lines tested 72 were identified as tetraploid and were maintained.

DUS descriptor of Isabgol

DMAPR, Anand: Characters were identified which would be used for DUS testing of varieties under the Protection of Plant Varieties and Farmers' Right Authority (PPVFRA). DUS characters identified were plant growth habit, leaf breadth, leaf colour, leaf pubescence, spike arrangement in the plant, arrangement of flowers on spike, type of peduncle, peduncle axis and anther type (Fig.3 and 4). For all these characters lines developed at DMAPR would be used as reference varieties. Reference varieties are plant type: erect (DMAPR PO1) and spreading (DMAPR PO2); leaf breadth: narrow (DMAPR PO5), medium (DMAPR PO1, DMAPR PO2, DMAPR PO3) and broad (DMAPR PO9); under leaf colour types: whitish green (DMAPR PO 8), yellowish green (DMAPR PO5) and green (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO6, DMAPR PO7); leaf pubescence: sparse (DMAPR PO5), medium (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO6, DMAPR PO7 and dense (DMAPR PO 8); spike arrangement: compact (DMAPR PO3) and spreading (DMAPR PO4); inflorescence peduncle: branched (DMAPR PO6) and unbranched (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO5), axis of the inflorescence: completely filled (DMAPR PO1,

Fig 3. DUS characters of plant type

Fig 4. DUS characters of inflorescence type

DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO5, DMAPR PO6) and partially filled (DMAPR PO7); flowers on the spike: completely compressed on the axis (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4) or protruded (DMAPR PO5, DMAPR PO11), anthers: normally filled (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO6, DMAPR PO7, DMAPR PO8, DMAPR PO9) and shrivelled (DMAPR PO10).

Assessment of economic loss caused by aphids

DMAPR, Anand: Potential of predators in checking the infestation of aphids (*Aphis gosypii*) by comparing yield in isabgol (GI-2) was evaluated. Paired plot design with 15 replications was used. Buffer row was kept in between treatments. The treatment plots after receiving infestation of aphids and removal of natural enemies already present was covered with very fine mesh to check the further entries of natural enemies. Periodic monitoring of natural enemies and their removal was made. Yield measurement was made by harvesting the crop leaving the boarder rows in each plot. Highly significant difference was observed between treatment and control, as in control (natural i.e. aphids and natural enemies undisturbed) 695.42 kg/ha yield was realized against 612.24 kg/ha in treatment (aphids without natural enemies), revealing that conservation of natural enemies can play an important role in containment of aphid population. But when the performance of natural enemies was compared with insecticidal treatment, it was low, as with insecticidal treatment yield of 762.35 kg/ha was realized against 695.42 kg/ha with natural enemies.

JATAMANSI (*Valeriana jatamansi*)

V. jatamansi belongs to family *Valerianaceae* and is a perennial herb of about 45 cm height and rootstock including rhizome is thick,nodular and aromatic.The species is distributed in the Himalayan region. Roots of the species are useful in diseases related to eye, blood,liver and spleen.Leaves are used for the treatment of headache. Roots are also used in aromatic industry. Raw drug is collected mainly from the wild since cultivation is not yet popularized.

Effect of planting time and spacing on yield

UBKV, Kalimpong: The crop was planted on first week of June and July at three spacings (30x20, 30x30 and 30x45 cm) and recorded observations at five stages (6th, 9th, 12th, 15th and 18th month after planting). Time of planting failed to produce any significant effect on aerial biomass production (g plant^{-1}) at all the stages except at 15th month stage. However, planting in the first week of June recorded numerically higher biomass at all the stages of observation. The planting spacing significantly influenced the aerial biomass at all the stages except at 18th month stage. The highest aerial biomass was recorded with 30x45 cm spacing at all the five stages. The maximum underground biomass, fresh underground rhizome and root biomass were recorded with the planting in the first week of June except at 15th month stage of observation and planting at the spacing of 30x45 cm.

JIVANTI (*Leptadenia reticulate*)

L.reticulate is a perennial climber belongs to family *Asclepiadaceae* It is distributed in sub Himalayan tracts of India mainly in Punjab, Uttar Pradesh and throughout Deccan peninsula up to 900 m. The plant is galactogogue, cooling, nutritive, aphrodisiac, stimulant, diuretic, and eye tonic. It is also useful to cure eye-diseases, seminal debility, general weakness, cough, dyspnoea, fever, asthma, constipation, sore throat, and gonorrhea. It promotes health and vigour, improves voice and alleviates the three *doshas* – *vata*, *pitta* and *kapha*.

Effect of organic nutrient sources on yield

AAU, Anand: The experiment was conducted with six sources of organic nutrients (10 t FYM, 5 t poultry manures, 2 t vermicompost, 2 t caster seed cake, 2 t neem seed cake ha^{-1}, and *Azotobactor*+Phosphate culture 1 litre ha^{-1} each and repeated after 1 month of sowing and after each cutting). Application of different organic nutrient sources significantly influenced the dry biomass yield, and was recorded highest with the application of FYM at 10 t ha^{-1} (6780 kg ha^{-1}) followed by 2 t caster seed cake (6038 kg ha^{-1}) and 5 t poultry manure (5876 kg ha^{-1}).

KALIHARI (*Gloriosa superba*)

G. superba belonging to Liliaceae is a climbing herb commonly found in the forests throughout India upto 2000 m. Stems are slender, annual arising from a perennial, fleshy tuberous rhizome. Rhizomes are cylindrical, bifurcated usually V-shaped with two limbs equal or unequal in length. It flowers with great profusion in rainy season. The alkaloid, colchicine is extracted from roots as well as from seeds. It is used for treatment of variety of diseases such as gastro-intestinal disorders, colic, chronic ulcers and piles. It is widely cultivated now in Tamil Nadu, Maharashtra and Himachal Pradesh.

Damage Assessment

TNAU, Coimbatore: An experiment was initiated to assess damage caused by defoliating caterpillars (Lily caterpillar, *Polytela gloriosae;* Semilooper, *Plusia signata* and Tobacco caterpillar, *Spodoptera litura*) at four population levels (2, 4, 6, 8 nos. first instar larvae). Each of the population level was replicated four times. The plants were caged after larval release and data on damage were assessed on 5th and 15th day after release. Results revealed that with the increase in population intensity of damage also increased, maximum per cent of affected leaves was recorded from the treatment where the larval population was maximum (08 nos.). Mean per cent of affected leaves by *P. gloriosae* was 40.14, *P. signata,* 32.47 and *S. litura,* 34.25 per cent at a population level of 08 larvae per plant.

Damage caused by these defoliators was also assessed in Coimbatore, Moolanoor and Oddansathram, where it is commercially cultivated. The damage was estimated maximum (21.55%) by *P. gloriosae*.

Germplasm of *G. superba* maintained at Medicinal Plants Park were screened for insect pests and it was observed that germplasms collected from Pune and Uthankarai recorded the maximum defoliators' population as well as maximum defoliation (38 and 32%, respectively). (Table 1).

Table 1: Biology of defoliators

Parameters	*P. gloriosae*	*P. signata*	*S. litura*
Fecundity (Eggs/ Female)	35.00	321.40	750.00
Egg period (days)	3.50	2.60	4.20
Hatchability (%)	80.38	76.71	82.04
Total larval duration (days)	17.50	14.50	16.50
Pupal duration (days)	12.50	8.40	8.80
Per cent adult emergence	78.40	80.75	78.64

KALMEGH (*Andrographis paniculata*)

A. paniculata is a highly branched annual herb, belongs to family *Acanthaceae*. Kalmegh grows erect to a height of 30 to 110 cm in moist shady places with glabrous leaves and white flowers having pink-purple spots on the petals. In *Ayurveda* the drug has been described as antipyretic and hepatoprotective. Cold infusion of the drug is mentioned in *Sushruta Samhita* for fever and liver disorders. Kalmegh contains bitter principle andrographolide, a bicyclic diterpenoid lactone. The species is cultivated in selected parts of the country as a *kharif* crop.

Evaluation of germplasm

NDUAT, Faizabad: Ten different accessions of Kalmegh were evaluated to find out a suitable genotype for eastern Uttar Pradesh. On the basis of average value of three years (2008-09, 2009-10 & 2010-11), plant height ranged from 55.19 to 63.15 cm. IC-211295 recorded the maximum mean plant height (63.15 cm) followed by IC- 471894 (60.83cm) and IC-471917 (58.87cm) while, minimum mean plant height (55.19 cm) was in genotype IC-111288. From three years of experimentation average data for number of branches per plant ranged from 20.73 to 27.47. The highest mean number of branches was recorded in the genotype IC-471919 (27.47) followed by IC-471918 (24.55) and IC-471894 (23.67), while lowest was in genotype IC-211295 (20.73). Fresh herbage yield varied from 7210 to 11856 kg ha^{-1}. Maximum mean fresh herbage yield was in genotype IC- 471918 (11856 kg ha^{-1}), followed by IC-111291 (10484 kg ha^{-1}) and IC-211295 (9415 kg ha^{-1}). Minimum mean fresh yield was in accession IC-471919 (7210 kg ha^{-1}). Dry herbage yield varied from 2462 to 4935 kg ha^{-1}. The accession IC-471918 gave better dry herbage yield (4935 kg ha^{-1}) as compared to IC-111291 (4084 kg ha^{-1}) and IC-211295 (3527 kg ha^{-1}), while minimum dry herbage yield was in accession IC-471919 (2462 kg ha^{-1}). From overall results it was found that amongst ten genotypes tested, accession IC-471918 performed best in all respects, on the basis of three years of experimentation.

Effect of different organic manures and spacings on yield

AAU, Anand: The experiment was conducted for thee years (2007-08 to 2009-10) with different organic manures (FYM, castor seed cake and vermicompost) and spacings (30x15, 30x30, 30x45 and 30x60 cm) to test the effect on growth and yield. Result of three year's pooled data showed that application of organic manures either FYM, castor seed cake or vermicompost did not bring any significant improvement in the plant height, dry biomass yield and andrographolide content, however, higher biomass yield (5080 kg ha^{-1}) was recorded with the application of 10 t FYM ha^{-1} followed by 1 t castor seed cake ha^{-1}. Planting at 30x15 cm spacing recorded significantly higher plant height (88 cm) and dry biomass yield (5686 kg ha^{-1}). The andrographolide content was not influenced with different spacings, however, maximum was recorded at 30x60 cm spacing (1.41%). The economic analysis revealed that the net return (Rs.1,57,898 ha^{-1}) and cost:benefit ratio (7.09) were highest with the application of 10 t FYM ha^{-1} and planting at 30x15 cm spacing. Application of organic manures also influenced the organic carbon and available NPK content in the soil.

Standardization of doses of FYM and inorganic nitrogen

NDUAT, Faizabad: An experiment was conducted with six levels of FYM (6, 8, 10, 12, 14 and 16 t ha^{-1}) along with five levels of inorganic nitrogen (10, 20, 30, 40 and 50 kg ha^{-1}) for two years. The inorganic nitrogen was applied as 50% basal and rest in two equal splits at 20-30 and 50-60 days after transplanting. Result of two year's data showed that the application of FYM at 14 t ha^{-1} along with 10 kg N ha^{-1} recorded maximum plant height (60.1 cm), fresh weight (244.25 g) and dry weight (95.54 g) of leaves per plant and fresh weight (463.23 g) and dry weight (230.19 g) of stem, however, the maximum number of branches per plant was recorded with the application of 6 t FYM+50 kg N ha^{-1}. The highest fresh herbage (76.74 q ha^{-1}) and dry herbage (33.89 q ha^{-1}) yields were obtained with the application of 14 t FYM+10 kg N ha^{-1}, followed by 6 t FYM+50 kg N ha^{-1}.

Intercropping with pigeon pea

PDKV, Akola: Pigeon pea:kalmegh intercropping at different row proportions (1:2, 2:1, 3:3, 2:2, 2:4 and 4:2) was tested and compared with sole crops. The results revealed that height of kalmegh and pigeon pea was not influenced significantly due to intercropping at various row proportions. However, the number of branches and dry weight per plant of kalmegh was significantly higher in 2:1 row proportion of pigeon pea:kalmegh intercropping and remained at par with sole crop of kalmegh. Among various row proportions, intercropping at 2:4 row proportion showed significantly more seed yield (4.11 g $plant^{-1}$), herbage yield (1524 kg ha^{-1}) and pigeon pea equivalent yield (1251 kg ha^{-1}) of kalmegh which was at par with 4:2 row proportion. Whereas, the pods and grain yield per plant of pigeon pea was significantly higher in the 4:2 row proportion. The compatibility study of intercropping system at different row proportions revealed that the pigeon pea+kalmegh at 4:2 row proportion showed maximum land equivalent ratio (1.67), relative crowding co-efficient (3.92), relative competitive ratio (0.66) and the aggressivity index (-0.10). However, the land equivalent co-efficient (0.43) and area time equivalent ratio (1.28) were highest in the 2:4 row proportion which was more or less similar to 4:2 row proportion.

Seasonal activity of insect pests

TNAU, Coimbatore: The crop was found infested with three defoliators (Leaf roller, grasshopper and hairy caterpillar). The activity of leaf roller was observed throughout crop growth stages, with peak activity (9 nos per plant) at the vegetative stage of the crop during the first week of December and slowly declined in subsequent weeks. No incidence was observed during the last fortnight of March. The maximum of 3 hairy caterpillars per plant were observed during the first and second weeks of December.

KUTKI (Picrorhiza kurroa)

P. kurroa belonging to family *Scrophulariaceae* is a perennial herbs distributed in the alpine Himalayas. Plants are elongated, stout with creeping rootstock mainly found at an altitude of 2700-4500 m. Leaves are radical, spathulate, sharply serrated; flowers are white to pale blue purpale in a dense in a terminal spicate raceme; fruits are capsule. Dried rhizome and roots are used as drug. It is used either as adulterants or substitute of Indian Gentian (*Gentiana kurroa*)

Isolation and purification of iridoid glycosides and standardization of analytical method

YSPUHF, Solan: Dried roots and rhizomes of Kutki were refluxed with methanol to get methanol extract. Methanol extract was used for silica gel (60-120 mash) column chromatography. Two iridoid glycosides picroside-I and picroside-II were isolated and purified by crystallization. Both the compounds were also quantified in root, rhizome and leaves samples using HPLC. Picroside - I content was maximum (5.53%) in leaves, followed by rhizomes (0.67%) and roots (0.35%). Similarly, rhizomes had maximum (5.03%) Picroside-II content followed by roots (3.798%) and leaves (0.70%).

LONGPEPPER (*Piper longum*)

P. longum is a member of family *Piperaceae* and is a slender aromatic perennial climber distributed in Central Himalayas, Assam, Khasi hills, Bengal, Western Ghats and Andaman and Nicobar Islands. Mature green fruits and roots are used as the raw drug. India imports a large quantity of raw drug from Malaysia and Singapore. The fruits are used as spice also. It has a pepper like taste. Piperine and piplartine are the two important alkaloids responsible for the therapeutic action. In addition, the raw drug contains a number of essential oils. Raw drug is collected both from the wild and cultivated areas. The crop is under cultivation in parts of Maharashtra, Kerala, Assam and Tamil Nadu. Stem cuttings are used as propagating material. After eight month of planting, fruits are ready for harvesting and in the third or fourth year entire

plants are uprooted and thicker stem parts and roots are also harvested. The harvested products are sun-dried and used.

Collection, characterization and evaluation of germplasm

AAU, Jorhat: Gemplasms were collected from different places of Assam, Meghalaya, Arunachal Pradesh and Tripura and their actual geographical locations along with the elevations were also noted. It was found that the *P. longum* was distributed in a wide range of elevations of North-East India. On the basis of the elevations where *P. longum* were distributed, the species distribution can be grouped into three, *viz*. *P. longum* of plains *i.e*. Khetri, Chenga, Mirza, Senabor, Rongjuli, Kahikuchi of Assam and Nagichera of Tripura where elevation ranges from 32.0 m to74 m; *P. longum* of foot hills *i.e.* Manik Ganz, East Garo Hills, Meghalaya, elevation is 81.0 m and *P. longum* of hills of Arunachal Prodesh (Namgui, EL 230.12m) and Meghalaya (New Zirang EL 405.0 m).

Studies on leaf morphology showed that leaf tip was acute to acuminate, margins were entire and leaf base was round, cordate, acute or cuneate. Leaf colour varied from green, pale green or dark green. There was variation on leaf size within the different accessions collected. The leaf size of the Hill variety (Meghalaya and Arunachal Pradesh) was slightly larger than those of the plains and the foot hill varieties were medium in size. The internode also showed variations in length. The Mirza, Nagicherra, Manik Ganz and Rongjuli variety showed shorter leaf length (6.2 cm to 7.8 cm) than those of others (9.8 cm to 12.7 cm).

Number of spikes per plant was lowest in Nagichera, Tripura collections (18.3) and highest in Kahikuci, Assam collections (55.0). The length and breadth of spikes varied from place to place being lowest in Senabar, Khetri and Assam (1.72 X 0.39 cm) and highest was in New Zirang, Meghalaya (3.20 X 0.48 cm). The fresh weight of 6 months old *P. longum* plants collected from different locations of N.E. India did not show much variation while dry weight showed variation among the germplasm.

Microscopic observation showed lot of variation among the germplasm in the leaf epidermal cell morphology and stomatal characteristics. The size of the epidermal cells, both on upper and lower surface varied in all the collections. Size of the stomata did not vary much both on the upper and lower surface among the germplasm. Number of stomata and stomatal index also showed a lot of variation among the germplasm. Highest number of stomata was on the lower surface than that of the upper surface.

Integrated nutrient management

PDKV, Akola: Nine different combinations of organic and inorganic nutrient sources including control were tested to find out the optimum nutrient recommendation for long pepper. The result reveled that the application of nutrients through different sources viz., FYM, neem seed cake and chemical fertilizers significantly influenced the growth as well as yield of the crop except plant height and piperine content. The number of fruits (63.5 plant^{-1}) and dry weight of fruits (15.75 g plant^{-1} and 436 kg ha^{-1}) were significantly highest with the application of 100:50:50 kg NPK along with 10 q neem seed cake ha^{-1}. The piperine content (5.75%) was found non-significant. However, total piperine yield (24.62 kg ha^{-1}) was significantly higher with the application of 100:50:50 kg NPK + 10 q neem seed cake ha^{-1} which was on par with100: 50:50 kg NPK+10 t FYM ha^{-1}.

Disease incidence

AAU, Jorhat: Incidence of three diseases *viz*. *Anthracnose* & Marginal leaf blight, *Cercospora* leaf spot and *Phytophthora* leaf rot at varying degrees were recorded in the North East India collection of *P. longum*. Anthracnose and marginal leaf blight ranging from 3.2 to 9.4% were recorded in all the varieties, whereas, *Carpospores* leaf spot were recorded in all the collections except in Namgui, Nagichera, and New Zirag collection of Arunachal, Tripura and Meghalaya, respectively and *Phytophthora* leaf rot were recorded only in three varieties from. Namgui, Arunachal (6.8%), New Zirang (5.9%) and Manik Ganz (7.4%) of Meghalaya.

MADHUNASHINI (*Gymnema sylvestre*)

G. sylvestre is a member of family *Asclepiadaceae* and a woody climber. It is distributed in Deccan Peninsula extending to parts of northern and western India. It is occasionally cultivated as medicinal plants. Leaves are opposite, usually eleptical or ovate; flowers are small yellow in umbellate cymes. Leaves are used as stomachic, stimulants, laxative and diuretic. It is also used as remedy for diabetes.

Collection, characterization, evaluation and maintenance of germplasm

JNKVV, Jabalpur: Germplasms collected from various locations of Madhya Pradesh were characterized based on different parameters. Data recorded on morphological parameters revealed that leaves of all the germplasm were of opposite type with short petiole. Length of the leaves (L) ranged from 6.3 cm to 4.3 cm; leaf breadth (B)ranged from 4.2 to 3.0 cm and L:B ratio of leaf ranged from 1:50 to 1:10. Tips of the leaves were ovate acuminate with smooth margin and cordate base. Colour of the leaf was dark green and pale green on upper and lower surface, respectively. The stem colour was light green in all the entries. Internodal distance of the stem ranged from 9.5 to 6.5 cm. vine length from 69.9 cm to 268 cm.

MAKOI (*Solnaum nigrum*)

S. nigrum is a herb or perennial shrub belongs to family *Solanaceae*. It reaches to a height of 30–120 cm, leaves ovate to heart-shaped, with wavy or large-toothed edges; both surfaces hairy or hairless. The flowers have petals greenish to whitish, recurved when aged and surround prominent bright yellow anthers. The berry is dull black or purple-black. Taken internally in very small amounts, the leaves strongly promote perspiration and purge the bowels the next day. The juice of the fresh herb is sometimes used to treat fever and allay pain. Externally, the juice or an ointment prepared from the leaves can be used for skin problems and tumors. The berries are poisonous, but boiling apparently destroys the toxic substances and makes them usable

as preservatives in jams and pies. The fruit is used as a cosmetic, rubbing the seeds on the cheeks removes freckles. The fruit has also been used for diabetes treatment. Decoction of stalk, leaves and roots are good for wounds and cancerous sores. Freshly prepared extract of the plant is effective in the treatment of cirrhosis of the liver and also serves as an antidote to opium poisoning.

Characterization, evaluation and maintenance of germplasm

TNAU, Coimbatore: Thirty accessions were collected from various places sources of Tamil Nadu and characterized. The observations on morphological and yield characters were recorded. Variability was observed for various characters among the germplasm. Among the characters studied, high variability for plant height and yield was observed. The mean plant height ranged from 23.50 to 90.50 cm and the mean yield ranged from 119 to 547 kg ha^{-1}. Among the entries, the highest leaf length breadth ratio was observed in *(Sn-R-5)* followed by *(Sn-R-4)*.

Screening of germplasm against sucking and defoliating insects

TNAU, Coimbatore: For exploring the bio-diversity of insects in medicinal and aromatic plants the germplasms of S. nigrum was screened for sucking and defoliating insects and it was observed red fruited accessions harboured minimum pest population as compared to accessions with black fruits. The population of aphids was recorded maximum (12.9 aphids per plant) in accession Sn B1, while mealy-bugs population was maximum (9.8 mealy bugs per plant) in Sn B3 and that of mites (12.6 mites per cm^2) in Sn B1. Among defoliators, leaf miner damage was recorded in accessions Sn B1 and Sn B2, rest of the accessions were totally free from the infestation of defoliators (hadda beetle, semilooper, tobacco caterpillar and leaf miner).

Management of *Alternaria* leaf blight disease

TNAU, Coimbatore: An experiment for management of Alternaria leaf blight disease in S. nigrum was conducted with seven treatments. The observation of disease intensity was recorded at 30, 45 and 60 days after planting. All the treatments were effective in reducing the disease incidence over control, but maximum disease reduction over control was recorded in treatment involving spraying of pseudomonas fluorescens (0.2%) at 30 DAP followed by dithane M-45 (0.2%) spray at 45 DAP.

Seasonal activity of insect pests on *Solanum trilobatum*

TNAU, Coimbatore: The leaf feeder, hadda beetle and grasshoppers were observed in the crop throughout the crop growth period, whereas, the sucking pests such as mealybugs and stink bugs were observed during December, at vegetative stage of the crop only. The maximum population of hadda beetle (5 nos/plant) was recorded during the first week of December.

MAMEJO (*Enicostemma axillaris)*

M. axillaris is a perennial herb belongs to family *Gentianaceae*. The species is distributed in India at altitude of about 450 m. Leaves are opposite, sessile, linear-oblong with white flowers arranged in whorled axillary clusters. The plant is very bitter and is used as an

anthelmintic in Ayurveda. The shade dried and powdered whole plant is taken as cooling agent. It is also considered to have tonic, stomachic and laxative properties and is also used in the treatment of diabetes. Decoction of the herbage is given to treat fever, jaundice, ulcers, etc,. The bitter principle which is responsible for its therapeutic action includes, glucosides, swertiamarin, alkaloids, ophelic acid and tannins. The species is also used as an adulterant of Chirayita (*Swertia chirayita*). The plant is not under regular cultivation and the raw drug is collected from the wild habitats.

Performance of direct sowing of suckers and rooted suckers

DMAPR, Anand: Suckers were kept in the mist chamber for 45 days for rooting and compared with the direct planting of suckers. Results showed that after one month of planting there was 100% survival of rooted suckers compared to direct planted suckers (up to 60%). The number of plantlets produced per plant was higher from the rooted suckers (3-6.4 plant^{-1}) than direct planted suckers (1.4-3 plant^{-1}). Average dry herb yield at first harvest was also higher from the rooted suckers (646 kg ha^{-1}) as compared to direct planted suckers (136 kg ha^{-1}). However, after 6th harvest the herbage yield become on par in both the methods.

Effect of spacing on yield

DMAPR, Anand: The rooted suckers were planted at different spacings (30x15, 30x20, 30x25 and 30x30 cm). The first harvest was done at ten months after planting and subsequently at two months interval. The results of twelve harvests revealed that there was no significant effect of different spacings on herb yield.

Standardization of harvesting frequency for optimum yield

DMAPR, Anand: The experiment was laid out with four harvesting intervals at 30, 45, 60 and 75 days. The first harvest was done five months after transplanting at 50% leaf senescence. The results showed the maximum dry herb yield (8073 kg ha^{-1}) was recorded when harvested at 60-day interval whereas the swertiamarin content (17.6%) was maximum in the produce harvested at 75-day interval.

Isolation, identification and structure elucidation of chemical compounds

DMAPR, Anand: Swertiamarin, a major bioactive compound first isolated and described from *Swertia* species was identified also to be present in *E.axillaris*. A rapid HPLC method has been developed for identification and quantification of swertiamarin.

MANDUKAPARNI (*Centella asiatica*)

C. asiatica is a member of family *Apiaceae* and is a prostrate slightly aromatic, perennial herb commonly found as a weed in rice fields. The species is widely distributed in India.

It is propagated both by stolons as well as by seeds. It is used for the treatment of leprosy, skin diseases and to improve memory. It is also used against cholera, ulcers, bronchitis, leucorrhoea and kidney troubles. Asiaticoside, indocentelloside, thankuniside are the major glycosides responsible for the medicinal properties. The plant can be cultivated by using runner stocks. Humus rich soil and partial shade are suitable for cultivation. Herbage can be harvested from six month onwards. The harvested herbage is shade dried or used a fresh for raw drug purposes.

Effect of spacing on yield and morphological variation

AAU, Jorhat: Three different planting spacings (40x20, 20x20 and 20x10 cm) were tried to find out the effect on yield and morphological variations. The result revealed that there was no significant influence of plant spacings on the internode length at different positions (base, mid and tip), however, the maximum length (9.62 cm) was recorded at the spacing of 20x10 cm. The fresh herbage yield was influenced significantly at different spacings and recorded highest (21 q ha^{-1}) at 40x20 cm, followed by 20x20 cm (14 q ha^{-1}) and 20x10 cm (4 q ha^{-1}) spacings.

Effect of planting time and number of node per cutting on yield

RAU Pusa: The experiment was conducted with five dates of planting starting from mid May to mid July at 15 day-interval and with different number of node per cutting from 2 to 4. The data showed that crop planted in mid July with 4-node plants recorded maximum herbage yield (66 q ha^{-1}). Planting earlier in the months of May and June and with 2 or 3-node per cutting were found to reduce the total herbage yield.

Effect of shade on growth and yield

DMAPR, Anand: Two shades (25 and 67%) were compared with full light intensity, and recorded observations on chlorophyll content, water potential, gas exchange, quantum efficiency and leaf characteristics. Different light intensities have variable response on all these parameters. The highest total chlorophyll and a and b content and the lowest a:b ratio were recorded under 67% shade. The water potential declined steadily after 6 hrs in 25% shade and open light compared to 67% shade. The net photosynthesis and gas exchange decreased with increasing shade levels, however, the decrease was negligible in 67% shade. The quantum efficiency (Fv/Fm of PSII) did not showed any significant changes under open light and shade conditions implying that light intensity did not alter the primary photochemistry. Leaf characteristics (size, petiole length, dry weight, SLA and SLW) were significantly affected at different light intensities. Leaf size increased from 2 to 4 times under shade. Petiole length and leaf dry weight also increased under shade and were higher under 67% shade conditions. Shade increased the specific leaf area whereas, decreased the specific leaf weight.

Disease incidence

AAU, Jorhat: Damping off disease with varying degree of intensity in some of the cultivated collections of Mandukaparni was observed. The pathogen was isolated and Koch's postulate was conducted. The Pathogen was identified as *Pythium* species.

RAU, Pusa: Stolon rot was recorded in *Centella asiatica* during rainy season (July – August). The fungus *Fusarium* sp was frequently isolated from the diseased specimen, purified and pathogenicity of the fungus was established. Diverse range of culturable fungal species was found associated in rhizosphere and phylloplane of *C. asiatica*. The fungi in rhizosphere and phylloplane were identified on the basis of morphological and cultural characters. Four fungi viz., *Fusarium* sp., *Aspergillus niger, A. fumigatus* and *A. sydowii* were identified in rhizosphere and seven viz., *Pythium* sp. *Fusarium* sp, *Pestalosia* sp., *N. sphaerica, Alternaria alternata, A. tetraspora* and *A. Geophila* in phylloplane.

MUSKDANA (*Abelmoschus moschatus*)

A. moschatus belonging to family *Malvaceae* is an erect annual or biennial herb of about 1.8 m height distributed wild all over hill regions of Andhra Pradesh and Karnataka and in the foot hills of Himalayas. Leaves are polymorphic, lower, ovate to acute and upper, palmettely 3-7 lobed. Flowers are bright yellow, large, solitary axillary. Fruits are capsule, 6.5-7.5 cm long having black musk-scented seeds.

Seasonal activity of insect pests

TNAU, Coimbatore: Six defoliators (leaf roller, leaf miner, looper, semi looper, ash weevil and grass hopper) and three sap suckers (red cotton bug, spiralling whitefly and leaf hoppers) were found associated with Muskdana. The peak activity of looper, semilooper, leaf miner, grasshopper and leaf roller was registered in the vegetative phase of the crop during December and declined thereafter. But the incidence of ash weevil was initiated during the third week of December and attained peak during March. The maximum population of sap suckers, red cotton bugs (4/plant), spiraling whiteflies (07/plant) and leaf hoppers (02/plant) was recorded during the first week of December.

OPIUM POPPY (*Papaver somniferum*)

P. somniferum is an annual herb belongs to family *Papaveraceae*. The latex collected from the capsule otherwise known as opium is medicinally important. Opium and poppy seeds are extracted from this species. Seeds are also used for culinary purposes. Opium is the source of many opiates, including morphine, thebaine, codeine, papaverine, and noscapine. The Latin botanical name means, the "sleep-bringing poppy", referring to the sedative properties of the species. Opium poppy is the only species of *Papaveraceae*

that is an agricultural crop grown on a large scale. It is a rabi sown crop and its cultivation in India is regulated by the Narcotics Department under licensing system. Seeds of opium poppy are important food item and the source of poppy seed oil, healthy edible oil that has many uses. The plant is under cultivation in Uttar Pradesh, Rajasthan and Madhya Pradesh.

Germplasm evaluation

RVSKVV, Mandsaur: Two hundred and thirty five germplasm lines were evaluated for thirteen different qualitative and quantitative characters. Higher range of variability was recorded among the characters. Plant height ranged from 71.0 cm (MOP-519) to 115.0 cm (IC-7), leaf length varied from 13.2 cm (UOP-68) to 28.5 cm (NOP-4) and leaf breadth varied from 5.8 cm (NC-57955) to 10.1 cm (MOP-525). Type of leaf was serrated in IC-1, MOP-518, MOP-519, Posta -149 and JOP-539 and non serrated in MOP-187, JA-16, JOP-540, ND-4,ND-11. Number of leaves per plant varied from 10 (ND-22) to 23 (UOP-1), flower colour varied from white in MOP-8, IC-1 and JOP-540, rani colour in ND-38, IC-42, ND-47 and Posta-149, pink in MOP-187,NOP-1, queen pink in IC-19 and Violet in ND-4 and UOP-221. Length of capsule varied from 22.2 (MOP-540) to 45.4 (ND-47) where as breadth of capsule varied from 17.4mm (UOP-28) to 49.8mm (ND-21). Latex yield ranged from 30 kg ha^{-1} (MOP-525) to 103 kg ha^{-1} (MOP-535). MOP-217, MOP-509, MOP-535, NC-57955, ND-26, ND-31, ND-1001, Shyama, UOP-31, UOP-45, UOP-48, UOP-60, UOP-68 and UOP-490 gave more than 80 kg ha^{-1} latex.

Seed yield per plant ranged from 1.7 g (MOP-575) to 8.0g (NOP-1) and MOP-516, MOP-571, MOP-1054, MOP-516, IC-42, JOP-540, NOP-1, NOP-11, NOP-549, NC-57259, ND-16, ND-17, ND-20, UOP-45, UOP-61 and UOP-72 recorded maximum seed yield *i.e.* more than 6.0 g $plant^{-1}$.

MPUAT, Udaipur: One hundred and eighty seven lines were evaluated along with three checks. The observations were recorded for individual line for plant height, peduncle length, number of effective capsule/plant, stem diameter, days to 50% flowering, dry latex yield, seed yield, husk yield and morphine content. A total of 48 lines exhibited higher dry latex yield over the best check, Chetak Aphim (37.23 kg ha^{-1}). Latex yield ranged from11.67 kg ha^{-1} (UOP27) to 64.43 kg ha^{-1} (MPO119). Only five lines exhibited higher seed yield over the best check MPO540 (2055.55 kg ha^{-1}) while 57 lines exhibited higher seed yield over Chetak Aphim (1361.11 kg ha^{-1}). Days to 50% flowering ranged from 88 days to 102 days with as early as 88 days to flower in few lines. All the lines were subjected to phytochemical analysis for morphine content.

Varietal evaluation

MPUAT, Udaipur: A total of 22 improved lines were evaluated along with three checks *viz*., Chetak Aphim, IC42 and MOP540 for traits like latex, seed and husk yields and other yield contributing traits. Among the checks, Chetak Aphim identified as best check for latex yield (42.65 kg ha^{-1}), seed yield (1491.08 kg ha^{-1}) and husk yield (1469.13 kg ha^{-1}). However, its seed yield was slightly lower than the over all mean (1674.03 kg ha^{-1}). All the lines flowered between 88 to 97 days which was at par with the checks. Four lines *i.e.,* UOP20, UOP30, UOP35 and UOP79 were superior for latex yield and seed yield over the best check and overall mean. Nine lines showed superiority for latex yield and 11 genotypes showed superiority for seed yield over the best check, Chetak Aphim and over the grand mean.

In another trial, ten improved lines along with three checks *viz*.; Chetak Aphim, IC42 7 MOP540 were evaluated for yield and quality traits together with resistance to diseases. Three lines *viz*.; UOP34, UOP53 and MOP 9 were at par with the best check IC 42 (37.23 kg ha^{-1}) for latex yield. Latex yield ranged from 22.93 kg ha^{-1} (UOP78) to 37.23 kg ha^{-1} (IC42). One line (UOP53) was at par with the best check IC 42 (1255.55 kg ha^{-1}) for seed yield. Seed yield ranged from 796.29 kg ha^{-1} (UOP57) to 1255.55 kg ha^{-1} (IC 42). However, none of the lines out yielded the best check Chetak Aphim for husk yield. Morphine content (%) ranged from 10.79 (UOP 57) to 12.42(MOP540, Check). Three genotypes exhibited higher morphine content over the mean of the experiment (11.68%).

Integrated nutrient management in opium poppy-ashwagandha crop rotation

MPUAT, Udaipur: In order to find out the integrated nutrient management practices for opium poppy-ashwagandha crop rotation, an experiment was conducted from rabi 2006-07 to 2010-11. The three year's result revealed that the application of FYM at 15 t ha^{-1}, castor seed cake equivalent to 50 kg N ha^{-1} and 50 kg N ha^{-1} through urea individually to opium poppy significantly increased leaves per plant, seed yield and capsule husk yield during three years of experimentation. Further, results showed that the residual effect of FYM at 15 t ha^{-1} and castor seed cake equivalent to 50 kg N ha^{-1} applied to opium poppy was observed on succeeding crop of ashwagandha, which were evident from the significant increase in root and seed yield, total alkaloids content and yield and the reduction in crude fibre content of ashwagandha. However, application of different doses of nitrogen through urea to opium poppy did not influence productivity and quality of succeeding ashwagandha crop significantly. Application of 30 kg N ha^{-1} directly to the ashwagandha crop through urea increased root yield, alkaloids content and alkaloids yield of ashwagandha and reduced crude fibre content.

Studies on root rot disease

MPAUT, Udaipur: Studies on the characterization, identification and etiology of root rot fungi (*Cylindrocladium sp.*) of Opium poppy was continued this year also. The root rot is a serious problem in opium poppy for last 3-4 years and it has caused remarkable loss (40%) to crop at vegetative, flowering, capsule formation and at the lancing stage. The causal organism was found to be *Cylindrocladium* sp. and Koch's postulates for the same has been proved. The causal agent is a soil borne pathogen, produces light brown to dark brown thick walled microsclerotia; cylindrical, light brown conidia (30-40 X 7.5-15 µ and have 3-5 septa), clavate vesicles (5-15 µ wide) and conidiophores. The fungus over summer asmicrosclerotia and locally spread through soil and/or plant debris. Soils which receives over doses of fertilizers, high irrigation or rich in moisture content and high in organic matter favours the disease development. Soil type also plays an important role in disease development. Clay loam soil is good for the development of disease and survival of the pathogen followed by loam soil rich in organic matter. The root rot is highly sensitive to temperature. Temperature between 22-28 ^{o}C favours the disease development, whereas, temperature below 15 ^{o}C and over 35 ^{o}C is not conducive for the development of disease.

Management of downy mildew

RVSKVV, Mandsaur: Sectin (Fenamidone) a potential fungicide against downy mildew was evaluated for the management of downy mildew of opium poppy caused by *Pernospora arborescence*. Efficacy of sectin in four different concentrations of (0.1 %, 0.125 %, 0.15% and 0.2 %) was evaluated against downy mildew on a susceptible opium cultivar JA-16 in a replicated field trial laid in RBD with four replications. The sectin was sprayed thrice at 35, 55 and 75 days after sowing and the disease incidence were recorded before lancing period. Results revealed that 0.15% and 0.2% concentration of sectin were more effective then other concentration (0.1% and 0.125 %), as PDI was less and latex, seed and husk yield was more in these treatments. The latex (76.89 kg/ha), seed (1483.33 kg/ha) and husk (1140.3 kg/ha) yield was maximum in the treatment where sectin at a concentration of 0.15% was applied.

PALMAROSA (*Cymbopogon martinii*)

C. martinii is a tall perennial herb of family *Poaceae*. It is distributed in most parts of subtropical India. Distillation of herbs with the flowering parts yields sweet scented oil which is rich in geraniol. The oil has high demand in perfumery, soap, cosmetics and blending tobacco products industries. The species is under cultivation in central, western and southern states of India. Areas where moist and warm climate persists throughout the year are favourable for its cultivation. The plantation can be raised by directly broadcasting of seeds or by nursery raised seedlings. The nursery raised seedlings are planted during monsoon season from late June to mid August, depending upon the monsoon. The crop is harvested when it is of about 4 months age and in full bloom stage. Palmarosa plantations remain productive for about 4 years.

Development of essential oil repository

DMAPR, Anand: A repository of Cymbopogon essential oil has been developed. Oils from fourteen Cymbopogon species/varieties were distilled and deposited as standards.

SADABHAR (*Catharanthus roseus*)

C. roseus is a member of family *Apocynaceae*. It is an erect much branched annual to perennial herb of 30-90 cm height commonly grown in gardens through out India. Leaves are oblong-eleptical, acute rounded apex, glossy; flowers are fragrant, white to pink purpalin axillary cymose clusters; seeds are oblong, minute and black. Plants are mainly cultivated for its rich source of alkaloids. This is a source of many oncolytic drugs.

Seasonal activity of insect pests

TNAU, Coimbatore: Seasonal activity of entomo-fauna associated with sadabhar was monitored during various crop growth stages (vegetative, flowering & fruiting). Incidence of sucking pests (stink bug & aphids) was mainly observed from third week of January to March. The maximum activity of stink bug (4 / plant) was recorded in third week of Jan and thereafter it started declining, whereas, activity of aphids started from the second week of February and gradually increased thereafter. Among defoliators, activity of grasshoppers was observed throughout the crop growth stages whereas, leaf miner was observed during December and *Catharanthus* sphingid during December and February.

SAFEDMUSLI (*Chlorophytum borivilianum*)

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

Studies of breeding behaviour

PDKV, Akola: The flowers are arranged in a raceme inflorescence, which emerged from center of the plant. The average length of inflorescence was 25 cm. The flowering axis was about 1/3 length of inflorescence. The flowers were white in colour having six tepals. About 25 to 35 flowers were observed in an inflorescence and were arranged away from one another.

Each flower consisted of 6 stamens. The anthers were generally yellow in colour. Ovary is 3 lobed with style in green colour. Style was longer than stamens having length 1.5 to 2.0 cm. The stigma was placed away from the anthers, and white in colour. Seeds were very small and black in colour, enclosed in capsules. In each capsule, there were about 6-12 seeds with test weight of 0.310g.

Time of anthesis was at 4.00 to 4.30 am. Fully opened flowers were observed at 4.30 to 5.00 am. Maximum pollen viability of 76.54 % was observed at 10.00 am, where the temperature and humidity percentage was 27.5˚C and 90%, respectively. Emasculation and crossing techniques were also standardized. The species was found as a cross pollinated type. Four types of insects were observed, as pollinating agents. The insect activity was found to be maximum during 7.30 to 9.00 am.

Evaluation of germplasm

PDKV, Akola: Eleven genotypes along with one check *viz* MCB 405 were evaluated for different morphological characters and yield. Genotype AKSM– 08 produced highest number of fleshy roots per plant (11.60), followed by AKSM– 11 (11.20). Root length was maximum in AKSM– 01 (7.76 cm), followed by AKSM– 09 (7.13 cm). Highest root girth was in AKSM– 08 (8.17 mm), followed by AKSM– 07 (7.79 mm). AKSM– 08 showed highest root yield per plant (29.00 g) followed by AKSM– 11 (27.00 g) and AKSM– 10 (26.80 g).

RVSKVV, Mandsaur: Twenty-four lines were tested during the year. Wide range of variability was noticed among the germplasm lines. Length of leaves varied from 12 cm (MCB-423) to 26 cm (MCB-416). Breadth of leaves ranged between 17 mm (MCB-407) and 28 mm (MCB-403). Colour of anther ranged from yellow to light yellow and sometime light green in few entries. Length of fleshy root ranged from 4.2 cm (MCB-410) to 8.4 cm (MCB-421). Root diameter ranged between 5.8 mm (MCB-423) and 9.6 mm (MCB-414). Fresh weight of fleshy root ranged from 1433 kg ha^{-1} to 3434 kg ha^{-1}. Maximum fresh fasciculated root yield was in MCB-412 (3434 kg ha^{-1}) followed by MCB-414 (3234 kg ha^{-1}), MCB-419 (3034 kg ha^{-1}), MCB-406 (3011 kg ha^{-1}) MCB-408 (2822 kg ha^{-1}), MCB-409 (2812 kg ha^{-1}) and MCB-421 (2778 kg ha^{-1}) as compared to the check variety JSM-405 (2599 kg ha^{-1}).

Preliminary yield trial

PDKV, Akola: In another trial, ten genotypes along with one check MCB-405 were evaluated. AKSM- 04 recorded significantly higher number of fasciculated roots per plant, which was at par with AKSM-06. Length of roots was significantly higher in AKSM-01 (9.61 cm) than the other genotypes, where as the root girth was significantly higher in AKSM-08 (8.05 mm), which was at par with AKSM-05 and AKSM-04. Fasciculated root weight, root yield and saponin content were recorded significantly higher in AKSM-08 followed by AKSM-07.

Post harvest, microbial load, aflatoxin and standardization of drying methods

MPAUT, Udaipur: Seven genera (*Trichoderma, Rhizopus, Penicillium*, *Aspergillus, Sclerotium*, *Rhizoctoniai* and *Aspergillus*) of fungi and two bacterium (*Pseudomonas* sp. and *Bacillus* sp.) were found associated with the root samples collected from the market, farmers' stock and experimental plots. The aflatoxin contamination was well under the permissible limits (0.018 – 0.042 g/100g sample). Drying methods (sun, solar dryer, oven (40, 60 $\pm$ 1 ^{o}C) and indoor) were assessed to standardize the drying process for safed musli roots for minimising microbial load and Aflatoxin concentration. Results revealed that solar dryer drying was the best for drying in such a way that microbial load and Aflatoxin production was minimum. Moreover, whiteness in safed musli roots was also retained in solar dryer drying samples.

SATAVARI (*Asparagus racemosus*)

A. racemous is a creeper grows to 1 to 2 meters length belonging to family Liliaceae and is common throughout India and the Himalayas. It has fleshy fibrous root system that taper at both ends. The roots are used in Ayurvedic medicine, as an anodyne,

aphrodisiac and galactogogue. Satavari is considered to be the main Ayurvedic rejuvenating female tonic for overall health and vitality. In the Ayurveda, *A. racemosus* is commonly mentioned as a rasayana drug in Ayurveda which promotes general well being of an individual by increasing cellular vitality or resistance. The reputed adaptogenic effect of Satavari is attributed to its concentration of saponins.

Evaluation of germplasm

NDUAT, Faizabad: Twenty four accessions were evaluated to find out a better genotype having high fleshy root yield. The data was recorded at 30 months after planting (MAP). Number of fleshy roots per plant ranged from 197.00 to 413.30 which varied significantly among the germplasm. The maximum number of fleshy roots per plant (413.30) was in NDAS-13 followed by NDAS-23 (396.70) and NDAS-17 (394.70). The minimum number of fleshy roots per plant was noted in NDAS-11 (197.00). Length of fleshy roots varied significantly and ranged from 19.10 cm to 31.10 cm. Highest length of fleshy roots was in NDAS-17 (31.10 cm) followed by NDAS- 21 (30.43 cm) and NDAS-23(28.90 cm). The lowest length was in NDAS-15 (19.10 cm.). Differences in the diameter of fleshy roots were statistically non-significant. Fresh yield of the fleshy roots varied significantly and ranged from 16960 to 57290 kg ha^{-1}. Maximum fresh fleshy root yield was in NDAS-14 (57290 kg ha^{-1}) followed by NDAS-13 (50115 kg ha^{-1}) and NDAS-17 (47550 kg ha^{-1}). Minimum fresh fleshy root yield was in NDAS-18 (16960 kg ha^{-1}). Dry fleshy root yield varied significantly and ranged from 1597 to 5729 kg ha^{-1}. NDAS-14 performed better (5729 kg ha^{-1}) followed by NDAS- 13 (5061 kg ha^{-1}) and NDAS-17 (4724 kg ha^{-1}). Minimum dry fleshy root yield was in NDAS-18 (1597 kg ha^{-1}).

Senna (*Cassia angustifolia*)

C. angustifolia belongs to family *Caesalpiniaceae*. There are two species of *Cassia viz., C. angustifolia* and *C. acutifolia* (*C. senna)* which are known under the common name 'senna'. *C. angustifolia* is native to India and cultivated mainly in India and Pakistan. *C. angustifolia* is native to tropical Africa and cultivated in Egypt, Sudan and elsewhere. Senna is recognised by British and US pharmacopoeias. Leaves, tender pods and flowers are medicinally important. The glucosides, sennosides A and B are the major active principles responsible for the therapeutic action of the crop. It is useful in habitual costiveness. It lowers bowels, increases peristaltic movements of the colon by its local action upon the intestinal wall. It is used as expectorant, wound dresser, antidysentric, carminative and laxative. It is also useful in loss of appetite, hepatomegaly, spleenomegaly, indigestion, malaria, skin diseases, jaundice and anaemia. Seeds are used for propagation and it is normally cultivated as post kharif crop.

Assessment of late flowering variety ALFT 2

AAU, Anand: Based on three years of experimentation, ALFT-2 recorded highest dry leaf yield of 1834 kg ha^{-1} which was 71.4% higher than the variety Tinnevely Senna and 53.56

% higher than Sona variety. Variety ALFT-2 had vigourous growth with more number of branches and distinctly late flowering characters.

Effect of organic manures and PSB on yield

MPKV, Rahuri: Different levels of FYM and vermicompost tested along with PSB. The data revealed that the application of organic nutrient sources significantly influenced the growth as well as yield contributing characters. The significantly highest plant height (58 cm), number of fresh (13) and dry (10) leaves, LAI (0.26), sennocide content (5.25%) and leaf yield (260 q ha^{-1}) were recorded with the application of FYM at 5 t ha^{-1} along with PSB followed by FYM at 8 t ha^{-1}+PSB.

Effect of spacing on yield

MPKV, Rahuri: The experiment was conducted with five spacings (30x30, 30x45, 45x15, 45x30 and 45x45 cm) and found that spacings significantly influenced the growth and yield attributes and yield of the crop. Significantly maximum plant height (43.25 cm), number of fresh (17.75) dry (13.25) leaves and leaf yield (182 q ha^{-1}) was recorded when sown at 30x45 cm spacing. However, the higher LAI (0.54) was recorded at 45x15 cm and the sennocide content (6.25%) at 30x30 cm spacings.

Effect of sowing time on yield

MPKV, Rahuri: The crop was planted on five dates at 10-day interval between 10th July and 20th August and observed for growth and yield. The planting on 20th July recorded significantly higher number of fresh (21.25) and dry (12.75 cm) leaves, leaf area index (0.42) and leaf yield (232 q ha^{-1}), however, the plant height (51.75 cm) was maximum when planted on 30th July.

SHANKHUPUSHPI (*Convolvulus microphyllus*)

C. microphyllus is a slender or suberect herb of family *Convolvulaceae*. Leaves are subsessile and 1.2-2.5 cm long. The typical corolla of the species is described as wide, funnel shaped, pale rose or rose yellow or pale to bright rosy. Flowers are axillary solitary or in fascicles. The plant is distributed in cultivated as well as open areas throughout India. In Indian Systems of medicine (ISM) i.e "Ayurveda", "Unani" and "Siddha", Shankhpushpi is reported to be an important memory vitalizing drug plant. The herbage including leaves and stems is the source of raw drug.

Effect of organic nutrient sources on yield

AAU, Anand: The experiment was conducted with six sources of organic nutrients (10 t FYM, 5 t poultry manures, 2 t vermicompost, 2 t caster seed cake, 2 t neem seed cake ha^{-1} and *Azotobactor*+Phosphate culture each at 1 litre ha^{-1} and repeated after 1 month of sowing and after each cutting). Among different organic sources, application of FYM at 10 t ha^{-1} recorded significantly higher dry biomass yield (10977 kg ha^{-1}) in two cuttings.

Sweet wormwood (*Artemisia annua*)

A. annua is an annual herb belongs to family *Asteraceae*. The species is native to temperate Asia and naturalized throughout the world and introduced to India and now it is cultivated in selected parts of the country. It is a branched, glabrous herb with sweetly aromatic odour. Leaves are bi-or tri-pinnatified, linear to lanceolate. The flower heads are yellow, arranged in loose panicles. The plant contains artemisinin which is highly effective in curing malaria. Plants contain essential oils which are used in perfumery, cosmetics, dermatology and also have fungicidal properties. The whole herbage is used for oil extraction and oil content increases during flowering season.

Effect of spacing on yield

DMAPR, Anand: The crop was transplanted at five different spacings (30x45, 30x60, 45x45, 45x60 and 60x60 cm) during the second week of February and harvested at full bloom stage in the month of October. The highest fresh herb (31.26 t ha^{-1}) and dry herb (8.59 t ha^{-1}) yield, fresh leaf (17.85 t ha^{-1}) and dry leaf (4.12 t ha^{-1}) yield, leaf harvest index (25.45), leaf to stem ratio (0.276), oil yield (48.57 kg ha^{-1}) and artemisinin yield (2.176 kg ha^{-1}) were recorded with the planting at 45x45 cm spacing.

Effect of harvesting stages on yield

DMAPR, Anand: The crop was harvested at four phenological stages viz. vegetative, pre-bloom, bloom and post-bloom, and found that the herb yield (35.05 t ha^{-1}), oil content (6.44 g per kg of leaves) and artemisinin content (0.544 mg g^{-1}) was maximum when crop was harvested at full bloom stage.

Developmental stages and essential oil quality

DMAPR, Anand: Chemical compositions of the essential oils of leaves collected at different harvesting stages (vegetative, pre-bloom, bloom and post-bloom stages), flowers and stem were determined. Sixty seven compounds including trace compounds were identified in oil. Oil percentage 1,8 cineole and trans β-farnesene content increased with the progress of growth stage. Camphor content was maximum at vegetative stage, and β - carophyllene, germacrene D content were maximum at pre bloom stage. Analyzed essential oils were deposited in essential oil repository of the directorate.

TULSI (*Ocimum sanctum*)

O. sanctum is an erect highly branched aromatic perennial herb of family *Lamiaceae*. Two plant types are commonly available, one is with green leaves and the other one is with purple leaves. It is distributed throughout India and is also under cultivation. Leaves, flowers and occasionally the whole plant are medicinally used to treat heart diseases, leucoderma, asthma,

bronchitis and fever. The leaves and tender parts of the shoots are economically important and yield essential oil. The essential oil obtained have immense value in aroma industry. The chemical constituents of the oil are monoterpenes,sesquiterpenes and phenols with their alcohol, esters, aldehydes, etc. The propagation is mainly done by seeds. Nursery raised seedlings are transplanted to the field at the onset of monsoon. Freshly harvested material is distilled for oil extraction.

Effect of organic nutrient sources on yield

NDUAT, Faizabad: Three organic nutrient sources (FYM, mahua seed cake and neem seed cake) each at three levels were tested to find out the effect on herbage yield. The pooled analysis of two year's result revealed that the application of neem seed cake at 6 t ha^{-1} recorded maximum plant height (117.9 cm), number of branches (21.63 $plant^{-1}$), fresh herbage (193 q ha^{-1}) and dry herbage (52 qha^{-1}) yield followed by FYM at 10 t ha^{-1}.

Survey of insect pests and diseases of medicinal and aromatic plants

Diseases

Plant	Diseases and Symptoms	Pathogen	Disease intensity
RVSKVV, Mandsor			
Mahanim (*Ailanthus excelsa*)	Powdery Mildew white powdery mass develop on the upper upper and lower surface of leaf and young stem	*Oidium ailanthi*	-
Chandrasur (*Lepidium sativam)*	Alternaria Blight dark brown to black spot seen on leaf, stem, branches and fruits	*Alternaria alternata*	-
	Downy Mildew infection develop under surface of leaves and on stem	*Pernospora sp.*	-
Chota Gokharu (*Tribulus Terrestris)*	Downy Mildew symptom develops on lower surface of leaves	*Pernospora sp*	-
Mulhati (*Glycyrrhiza glabra*)	Powdery mildew white powdery patches develop in lower side of leaves	*Leviellula taunca*	-
Isabgol (*Plantago ovata*)	Downy Mildew symptom develops on leaves and ear head	*Pernosfora sp*	-

Ashwagandha (*Withania somnifera*)	Alternaria Blight light to dark brown ring spot seen on leaves	*Alternaria alternata*	-
	Orobanche occur in small patches and Look stunted	*Orobanche ramosa*	-
Stevia	Collor rot water soaked lesions on stem, yellowing at the tips of the leaves	*Sclerotium rolfsii*	-
Sweet wormwood (*Artemisia annua*)	Alternaria blight minute brown spot on leaf	*Alternaria alternate*	-
Mint	Leaf spot infection appears in the form of round to oval, dark brown spot on the upper surface	*Alternaria alternata*	-
Sarpgandha (*Rauvolfia serpentina*)	Leaf spot minute brown spot on leaf	*Cercospora rauvolfiae*	-
	Anthracnose dark brown spot on leaf		-
UBKV, Kalimpong			
Valeriana jatamansi	Stem rot	*Screrotinia sclerotiarum*	severe
GBPUAT, Bharsar			
Swertia sp (*C. ciliate & C. cordata*)	Leaf spot symptoms start as a pin head light brown spots later increase in size, spherical to oval in shape, scattered over whole leaf blade	*Alternaria alternata*	severe
Digitalis lanata	Leaf blight pin head light brown spots on the tip or margin of the leaves was first observed, which later increase in size, and cover whole leaf blade	*Cladosporium tenuissimum*	severe
MPUAT, Udaipur			
Safed musli (*Chlorophytum borivilianum*)	Root rot *Phyllactinia* leaf spot	*R. solani, F.solani*	moderate
Ashwagandha (*Withania somnifera*)	Damping off and root rot	*Pythium* sp. *Rhizoctonia* sp. *Fusarium solani*	moderate
Isabgol (*Plantago ovata*)	Downy mildew, *Alternaria* blight	*Pseudoperonospora plantaginis* *Alternaria alternata*	moderate
APHU, Venkataramanngudem			
Vach (*Acorus calamus*)	Leaf spot	*Helminthosporium microsporum*	-
Makoi (*Solanum nigrum*)	Damping off	*Pythium* sp	-

Coleus forskohlii	Root rot	*Rhizoctonia sp*	-
Giloe (*Tinospora cordifolia*)	Leaf spots	*Pseudocercospora* sp & *Alternaria tenuissima*	-

Insects

Plant/crop	Local name	Scientific name	Family	Order	Pest Status
BCKV, Kalyani					
Rauvolfia serpentina	Oleander hawk moth	*Daphnis nerii*	Sphingidae	Lepidoptera	sporadic
Alstonia scholaris	Pyralid leaf folder	*Parotis marginata*	Pyralidae	Lepidoptera	severe
Mimosops elengi	Pyralid leaf webber	*Indomyrlaea (Nephopteryx) eugraphella*	Pyralidae	Lepidoptera	severe
Aristolochia indica	Spiny caterpillar	*Atrophaneura (Pachliopta) aristolochiae*	Papilionidae	Lepidoptera	severe
Boerhavia diffusa	Sphingid	*Hippotion sp*	Sphingidae	Lepidoptera	sporadic
Tinospora cordifolia	Fruit sucking moths	*Othreis maternal & O. fullonia*	Noctuidae	Lepidoptera	sporadic
Tylophora indica		*Dichromia sagitta*	Noctuidae	Lepidoptera	severe
Alstonia scholaris	gall inducing psylloid	*Pseudophacopteron sp.*	Phacopteronidae: Psylloidea	Hemiptera	severe
APHU, Venkataramanngudem					
Tinospora cordifolia	Red spider mite	*Tetranychus sp.*	Tetranychidae	Acari	severe
Solanum nigrum	Epilachna beetle	*Henosepilachna vigintioctopunctata*	Coccinellidae	Coleoptera	sporadic
	Mealy bugs	*Coccidohystrix insolita*	Pseudococcidae	Hemiptera	severe
	Red cotton bugs	*Dysdercus cingulatus*	Pyrrhocoridae_	Hemiptera	-
	Shoot and fruit borer	*Leucinodes orbanalis*	Pyralidae	Lepidoptera	-
	Cotton aphid	*Aphis gossypii*	Aphidideae	Hemiptera	-
	White fly	*Bemisia tabaci*	Aleyrodidae	Hemiptera	-

BETELVINE (*Piper betle*)

P. betle is a member of *Piperaceae* family. It is a perennial dioecious evergreen creeper cultivated in India for its leaves mainly used for chewing. Stems are semi-woody, climbing by short adventitious roots; leaves are broadly ovate to oblong ranging 5 to 20 cm. Leaves are used in the treatment of various respiratory catarrhs and as local application either by gargle or inhalation in diphtheria. The essential oil and extracts of leaves expressed activity against many gram positive and negative bacteria. In India it is cultivated in about 50000 ha and a large quantity of leaves are exported.

Germplasm evaluation

IIHR, Hirrehalli: Twenty-five Bangla (female) clones were evaluated for leaf yield. The clone Bangla (MP), produced maximum yield (40.58 lakh leaves ha^{-1}) followed by Godi Bangla, SGM-1 and Bangla Nagaram with an yield of 35.33, 34.01 and 31.92 lakh leaves ha^{-1}, respectively. Among male clones, CARI-6 gave highest yield (30.96 lakh leaves ha^{-1}) followed by Swarna Kapoori (22.26 lakh leaves ha^{-1})

Flowering behaviour

IIHR, Hirrehalli: Flowering was recorded in 18 male clones and 46 female clones during 2010-11. The collections IIHR BV 106, 104, 96-1, 103 and 100 produced male catkins where as IIHR BV 96 put forth female catkins. IIHR BV 96 though a female clone produced lanceolate leaves and 96-1 being a male clone produced ovate leaves with cordate base. These traits were different from the generally observed lanceolate leaves in males and ovate leaves in females. Flowering was not observed in IIHR BV 29 (Kakair) and IIHR BV 23 (Meetha pan) which have not put forth lateral branches.

Hybridisation

IIHR, Hirrehalli: Hybridisation was continued among the selected parents and new crosses were also attempted. Five Andaman collections (one female and four male clones) were utilized in the breeding programme since theses accessions showed less disease incidence and good plant vigour.

With an objective of developing backcross population, flowering hybrids were crossed to their respective parents (male parent for female hybrids and female parent in case of male hybrids). In total nine back crosses were carried out involving seven female hybrids and two male hybrids. Fruit setting was recorded in all the crosses. Fruits were harvested from six back crosses attempted. The number of seeds per fruit showed great variation from 11 to 63. The seed germination in the back crosses ranged from 10.11 in Hy 07-25/Swarna Kapoori to 34.51% in HY 07-37/Swarna Kapoori. Other crosses HY 07-26/Swarna Kapoori and Hy 07-33/Vasani Kapoori recorded 29.7, 26.6 % germination, respectively. In the back crosses, SGM1/07-32, SGM1/06-4, involving the male hybrids low germination was recorded *i.e.,* 10.93, 15.23 %. Lower germination observed in the back crosses may be due to the effect of inbreeding.

Few crosses involving hybrids and varieties were also attempted to study the possibility of raising hybrid seedlings where inter-varietal crosses did not yield good results. Fourteen different crosses were carried out consisting of eight hybrids (seven female & one male), four female clones and three male clones. Fruit setting was observed in all the crosses. Seed germination was also studied in the seeds collected from these crosses. The germination varied from 20.28 (Mysore Local/Hy06-4) to 82.11% (Simarali Babna/Hy 06-4). The hybrid between Karapaku/HY 06-4 recorded 30.61% germination. The crosses between hybrids and collections from the Andaman region HY 06-1/CARI 6, HY06-1/BV 96-1 and HY 07-37/ BV 103 recorded 54.27, 74.96 and 34.50 % germination, respectively.

Hybridisation between hybrids was also attempted to develop double hybrid populations. Twelve double crosses were carried out involving ten female hybrids and four male hybrids. Fruit set was observed in all the crosses attempted.

Interspecific hyridisation between *P. betle* and phytophthora resistant P. *colubrinum* was continued. The clones Bangla Nagaram, Simrali Babna, Bangla Ganamala were pollinated with the pollen of P. *colubrinum*.

Performance of hybrids: Eight hybrids and four parental lines field planted under areca nut garden, with a spacing of 100x60 cm during July 2009 were evaluated for different growth and leaf traits. Vine length varied from 158 to 362 cm. Among the lines, leaf length ranged from 7.35 to 12.57 cm where as leaf breadth varied from 4.05 to 9.75 cm. The number of harvestable leaves per vine varied from 54 to 262.5. Hybrids 06-1, 06-4 and 06-11 were vigourous with suitable leaf traits. Among the hybrids, only Hy 06-4 produced lateral branches. First year evaluation data showed that among the hybrids Hy 06-4 recorded maximum leaf yield (262.5 leaves vine^{-1}) followed by Hy 06-1 (175 leaves/vine). Among the parents, Swarna Kapoori recorded higher leaf yield of 242 leaves vine^{-1} followed by SGM 1 (180.2). The leaf size and shape of the laterals varied distinctly between these hybrids.

Twenty-three selected hybrids were also planted under shade net house (simulating bareja conditions) during January 2010 for assessing their response. All the hybrids recorded good growth under shade net conditions. Vine length among the hybrids ranged from 83 to 234 cm, leaf length from 6.50 to 15.76 cm, leaf breadth from 4.77 to 11.12 cm. Hybrids 06-1, 08-64, 06-10, 06-4 and 07-1 produced bigger leaves and they also produced higher number of leaves per vine 38, 32, 38, 40 and 37, respectively.

The hybrids 06-1, 06-4, 06-11 showed good plant growth and vigour both in field and shade net conditions.

Seed germination after storage

IIHR, Hirrehalli: Seed storage studies showed that the seeds stored for one month at 4^{o}C recorded no germination. The seeds stored at 8-10^{o}C and at room temperature for one month recorded 15 to 30% germination. The results indicated that the betel vine seeds are sensitive to cold temperature.

Agronomic practices

Efficacy of biofertilizers on yield

RAU, Islampur: The experiment was conducted with seven treatment combinations where, biofertilizers (*Azotobacter* 5 and 10 kg ha^{-1}, Phosphobacter 10 kg ha^{-1} and *Azotobacter* 5

kg+Phosphobacter 5 kg ha-1) were compared with organic manure (vermicompost 10 t ha-1) and inorganic+organic sources (urea:oilcake; 1:1)) and control. The one year result revealed that the application of vermicompost at 10 t ha-1 recorded higher crop growth parameters viz. number of branches per vine (21), vine elongation (10.22 cm month-1) and marketable leaves (22.90 lakh ha-1) as well as weight of 100 leaves (194 gm) followed by urea+oilcake. However, among biofertilizers, *Azotobacter* and phosphobacter each at 10 kg ha-1 performed better individually than in combination (*Azotobacter* 5 kg+phosphobacter 5 kg ha-1). The disease incidence (foot rot disease) varied from 5.47 to 9.80% and reduced appreciably with the different treatments in order of; vermicompost 10 kg ha-1 < *Azotobacter* 10 kg ha-1 < phosphobacter 10 kg ha-1 < *Azotobacter* 5 kg + phosphobacter 5 kg ha-1 < *Azotobacter* 5 kg ha-1 < urea + oil cake < control.

Effect of plant population on yield

RAU, Islampur: Three plant populations (1.50, 1.75 and 2.0 lakh plants ha-1) were compared with the farmer's practices. One year result showed that population density at 1.50 lakh plant ha-1 recorded maximum number of branches per vine (13.80), vine elongation per month (9.00 cm) and weight of 100 leaves (195 gm). However, plant population of 1.75 and 2.0 lakh plant ha-1 recorded maximum number of marketable leaves per plant of 20.60 and 21.20 lakh ha-1, respectively. Higher population of 1.75 and 2.0 lakh plant ha-1 reduced the size and weight of the leaves which fetched low market price and returns. Therefore, population of 1.5 lakh plant ha-1 was found ideal to harvest good number of marketable leaves of better size and fresh weight which can fetch the higher market price. Population density of 1.5 lakh plant ha-1 also recorded the lower incidence of diseases then at higher plant population.

Effect of integrated crop management (ICM) practices

RAU, Pusa: The most effective ICM practices including INM (200:100:100 kg NPK ha-1 +vermicompost+oil cake) and IDM (sanitation+soil drenching with 1% bordeaux mixture followed by incorporation of 500 kg mustard seed cake ha-1 inoculated with *Trichoderma viride* 5 kg after 30 days of sowing and again drenching with bordeaux mixture after 60 days of 1st drenching) were tested at the 25 farmers' field at six different locations of Lakhua (5 farmers), koithia (4 farmers), Bhagwatpur (3 farmers), Muriyaro (5 farmers) and Chandchaur (5 farmers) panchayats in samastipur and Baligaon (3 farmers) panchayat in Vaishali districts. The comparative study of crop performance under ICM practices and that of farmer's practices at all the locations showed that ICM practices registered higher yield of 17.5-22.6 lakh marketable leaves ha-1 as compared to farmer's practice (8.2-12.8 lakh marketable leaves ha-1). The crop under ICM practices was quite healthier up to December having low incidence of *Phytophthora* rot (2.5-9.2% PDI) and produced better quality leaves with longer shelf life (15-16 days). Whereas, crops under farmer's practice produced poor quality leaves with 9-12 days shelf life and recorded higher incidence of *Phytophthora* rot (10.3-15.9% PDI).

Demonstration of disease management technology in the farmer's field

AAU, Jorhat: Demonstration cum training on Betelvine disease management was conducted at Pachim Chuba, Sipajhar Block in Mangaldoi District; at Bhitorkaliyani, Thengal Gaon,

Nilip Block in Karbi Anglong District, at Buragohaikhat, Morongi Block in Golaghat District and at Bamunipathar, Hatbar and Jakhalabandha in Nagaon District. Disease incidences was low in the fields where AAU technology was adopted and correspondingly yield and net returns were also significantly high in such fields. In Buragohai khat, Morongi Block of Golaghat District a net return of Rs. 13.79 lakhs/ha was achieved with AAU technique in comparison to Rs.11.28 lakhs/ha in the farmers' practice.

APHU, Venkataramanngudem: Demonstration of integrated disease management technology developed by the AICRP centre in farmer's fields revealed that IDM technology significantly reduced the disease incidence with a significant increase in yield of 18.5% over the farmer's practice.

BCKV, Kalyani: Disease management technology developed by the centre was demonstrated in fifteen farmers' fields at Simurali, Nadia and Taldaha, Nadia. The results revealed that disease incidence and yield parameters recorded in most of the farmer's demonstration plots were statistically superior to the farmer's management practices at 1 and 5% level of significance.

JNKVV, Jabalpur: Field demonstration trials were conducted at ten locations of different farmer's field. Observation at all the demonstration plots for percent vine death a (16.8 to 24.8 % in centre's technology and 26.8 to 37.8% in farmers practice), No. of leaf per plant (29.5 to 35.6 in centre's technology and 23.8 to 26.5 in farmers practice), weight of 100 leaves (610.5 to 648.1 g in centre's technology and 498.3 to 592.7 g in farmers practice), per cent disease intensity of different disease etc. revealed that the technology developed by the center was superior over the farmers practice.

MPKV, Rauri: Demonstration of disease management technology developed by the centre in Betelvine of farmer's field revealed that the improved management package has significant impact on control of disease. Significant increase in fresh weight of 100 leaves (320 g), mean yield of leaves (120.13 lakh/ha), and net return (Rs. 3,94,770/ha) and C:B ratio of 1:1.97 was achieved with adoption of centre's technology as compared to farmer practice.

RAU, Pusa: The Integrated crop management (INM+IDM) technology developed by the centre was tested in 25- farmers' field at six different locations in Samastipur and Vaishali district. The technology developed by center was superior than farmers practice at all the locations, as yield of 17.5-22.6 lakh marketable leaves/ha was realised from center's technology as compared to farmers practice (8.2-12.8 lakh marketable leaves/ha). Moreover, fields where Center's technology was adopted the crop was quite healthier with low incidence of *Phytophthora* rot (2.5-9.2% PDI), and produced better quality leaves with longer shelf life (15-16 days). Whereas, crops under farmers practice produced poor quality leaves with 9-12 days shelf life and recorded higher incidence of *Phytophthora* rot (10.3-15.9% PDI).

Epidemiological studies

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

$$Y = -21.11 - 1.8320\ X1 + 0.6849\ X2 + 1.0669\ X3 - 0.3640\ X4 + 0.3048\ X5$$

Testing and validation of developed epidemiological models

BCKV, Kalyani: The prediction equation for disease incidence were prepared by compiling the results of year 2007-08, 2007-09 and 2009-10 on disease incidence of foot rot, leaf rot and leaf spot of betelvine on three varieties (Ghanagette, Simurali Deshi and Simurali Bhavna) with the meteorological parameters like Tmax, Tmin, RH max, RHmin and rainfall and were further fitted against the disease incidence of foot rot and leaf rot in 2010-11 using the effective meteorological parameters of the same year for validation of these equations and models. The results showed poor estimated value during initial disease incidence. Among the three diseases (foot rot, leaf rot and leaf spot) the estimated value of foot rot incidence was nearer to original value. It was observed that in all prediction equation like Logit, Gompertz and Percent transformation, the estimated value was similar to that of original value in most of the observations. It was more accurate on foot rot and leaf spot diseases than leaf rot disease. The prediction equations which were prepared for three varieties were also showed some accuracy in predicting the disease incidence. All the diseases recorded (Foot rot, leaf rot and leaf spot) irrespective of varieties in all the weeks of observations except in 2nd, 4th, 12th, 13th, 17th and 24th, all the transformations model were effective in predicting the disease to some extent.

Aleyrodids in betelvine

BCKV, Kalyani: Three aleyrodid flies namely, *Aleurocanthus bucktoni* Sundararaj & Pushpa, 2010. *Singhiella* (*Dialeurodes*) *pallida* (Singh) and *Aleurocanthus rugosa* Singh so far reported from betelvine. The latter two occur sympatrically.

Incidence and management of insect pests

APHU, Venkataramannagudem: Mites and tobacco caterpillar were reported to be the major pest on betelvine. Crop loss due to tobacco caterpillar and mites was 21.0 and 19.0%, respectively. It was observed that incidence of tobacco caterpillar and mite was less in pungent varieties than non-pungent cultivars. ETL for tobacco caterpillar (*Spodoptera litura*) was also worked out at 03 larvae/plant. Besides, the main crop, the support crop of sesbania was found to infest by stem borer (*Azygophleps scalaris*), leaf eating caterpillars viz., *Eurema hecabae, Hyposidra successaria, Mauruca testulalis and S. litura* and red spider mite. Activity of leaf eating caterpillars was more during August to September, while that of stem borer during September and October followed by Red spider mites during November and December.

Minimum larval population and per cent plant damage was recorded in the plots treated with chlorpyriphos 0.05% followed by monocrotophos 0.05% spray. Stem borer infestation in sesbania was less when sprayed with monocrotophos 0.05% followed by chlorpyriphos 0.05% and less mite infested leaves were recorded when sprayed with Dicofol 5 ml/lt followed by wettable sulphur 0.3% + Neem oil 0.5%. Soil drenching with NSKE 5% + NSKE 5% spray significantly reduced the incidence of *S. litura* and stem borer on sesbania.

Plant Genetic Resources

Germplasm of medicinal and aromatic plants maintained at DMAPR

Sl. No.	Species	No. of Acessions
1	*Aloe spp.*	55
2	*Andrographis paniculata*	60
3	*Asparagus spp.*	48
4	*Cassia angustifolia*	27
5	*Chlorophytum borivilianum*	54
6	*Commiphora wightii*	110
7	*Cymbopogon martinii*	07
8	*Desmodium gangeticum*	36
9	*Gymnema sylvestre*	43
10	*Plantago ovata*	84
11	*Tinospora cordifolia*	35
12	*Urgenia spp*	12
13	*Withania somnifera*	141
	Total	712

Germplasm of medicinal and aromatic plants maintained at AICRP centres

Sl. No.	Crop	Centre	Accessions
1	*Aloe barbadensis*	AAU, Anand BCKV, Kalyani CCSHAU, Hisar IGKV, Raipur IIHR, Bangalore NDUAT, Faizabad PDKA, Akola	30 02 42 07 42 16 18
2	*Acorus calamus*	APHU, Bapatla TNAU, Coimbatore	11 13
3	*Andrographis paniculata*	AAU, Anand CCSHAU, Hisar NDUAT, Faizabad	20 13 19
4	*Asparagus spp.*	AAU, Anand JNKVV, Jabalpur NDUAT,Faizabad	6 15 23

Sl. No.	Crop	Centre	Accessions
5	*Bacopa monnieri*	KAU, Thrissur	29
6	*Cassia angustifolia*	AAU, Anand	17
7	*Chlorophytum borivilianum*	AAU, Anand CCSHAU, Hisar MPUAT, Udaipur RVSKVV, Mandsaur PDKV, Akola	20 12 4 21 13
8	*Commiphora wightii*	AAU, Anand MPUAT, Udaipur	33 16
9	*Cymbopogon martinii*	CCSHAU, Hisar	65
10	*Cymbopogon spp.*	CCSHAU, Hisar KAU, Thrissur NDUAT, Faizabad	40 20 14
11	*Gymnema sylvestre*	CCSHAU, Hisar	8
12	*Lepidium sativum*	AAU, Anand	
13	*Mandukparni (Centella asiatica)*	AAU, Jorhat BCKV, Kalyani TNAU, Coimbatore	10 06 20
14	*Mucuna spp.*	AAU, Anand IIHR, Bangalore	20 112
15	*Nelumbo nucifera*	KAU, Thrissur	24
16	*Ocimum sanctum*	AAU, Anand CCSHAU, Hisar	17 12
17	*Papaver somniferum*	NDUAT, Faizabad MPUAT, Udaipur RVSKVV, Mandsaur	35 187 90
18	*Piper longum*	AAU, Jorhat BCKV, Kalyani KAU, Thrissur OUAT, Bhubneshwar	10 04 14 14
19	*Plantago ovata*	AAU, Anand CCSHAU, Hisar MPUAT, Udaipur	55 83 68
20	*Plumbago rosea*	KAU, Thrissur	25
21	*Saraca asoca*	KAU, Thrissur	42
22	*Silybum marianum*	AAU, Anand	10
23	*Solanum nigrum*	APHU, Bapatla TNAU, Coimbatore	12 28
24	*Tinospora cordifolia*	AAU, Anand APHU, Bapatla BCKV, Kalyani CCSHAU, Hisar	6 13 03 20

Sl. No.	Crop	Centre	Accessions
25	*Withania somnifera*	AAU, Anand CCSHAU, Hisar IIHR, Bangalore IGKV, Raipur MPUAT, Udaipur PDKV, Akola RVSKVV, Mandsaur	40 28 190 22 139 08 31
26	*Vetiveria zizaniodes*	CCSHAU, Hisar KAU, Thrissur NDUAT, Faizabad	50 37 14

Germplasm of betelvine maintained at AICRP centres

Centres	Total collection	Catalouged
APHU, Bapatla	61	61
AAU, Jorhat	10	10
BCKV, Kalyani	61	61
IIHR, Hirehalli	98	98
MPKV, Rahuri	28	28
OUAT,Bhubneshwar	21	21
RAU,Pusa	20	20
RAU,Islampur	16	16

Studies on seed physiology

Ashwagandha (*Withania somnifera)*

Effect of storage duration on seed germination

DMAPR, Anand: Seeds of cv. WS 20 and WS 134 were tested for germinability and vigour index I & II after one year and two years of storage. Results revealed that after one year of storage, germination was significantly increased in both the varieties (WS 20- 87%) and (WS 134- 92%) compared with the seeds after crop harvest. However, after two years of storage there was decline in germination by 17 and 23% in WS 20 and 10 and 14% in WS 134 compared to after crop harvest and after one year of storage, respectively. Vigour index I and II also followed the similar trend and declined sharply after two years of storage in both the cultivars.

Enzymatic activity of seeds

DMAPR, Anand: Seeds (WS-134) were soaked in water and GA_3 for 12 h and incubated for different periods (1, 3 and 6-day after set for germination) and at temperatures (15,

25 and 35 °C). The results revealed that amylase (α and β) activity was more pronounced when seeds were treated with GA_3 as compared to seeds without any treatment. Activity was at its maximal when incubated for six days. Whereas, activity was more at 35 °C as compared to 25 and 15 °C on 6-days incubation followed by incubation for 3 days.

Milk thistle (*Silybum marianum)*

Enzyme and protein activity of seeds

DMAPR, Anand: The α- and β-amylase activity in seeds were examined by spectrophotometric method and found that α-amylase activity increased rapidly after 12 hrs of imbibition till onset of germination (2 days). In cotyledons, α-amylase activity increased after 2 days of onset and thereafter decreased sharply at 4 days after onset and so was the case in growing axis. In cotyledons and growing axis of germinating seeds the α-amylase activity decreased while, β-amylase activity increased. Whereas, Malate dehydrogenase activity increased in imbibing seeds till onset of germination. MDH activity also increased in growing cotyledons and axis at 4 days after onset of germination which was significant at 20 °C as compared to 25 and 30 °C. Protein content was also maximum at onset after imbibition and so as in cotyledons and in growing axis, however, at 4 days after onset protein content decreased in both cotyledons and growing axis.

Senna (*Cassia angustifolia)*

Effect of storability on seed germination and mean germination time

DMAPR, Anand: A preliminary study was carried out with freshly harvested (one month old) to five years old seeds and tested for germination percentage and time. The study revealed that the freshly harvested seeds and up to 9 months of storage were resulted in higher germination. Higher seed germination was recorded in bold sized seeds as compared to small seeds up to two years of storage. When the hard seeds were set for germination with H_2SO_4 for 5 minutes gave 98-70% germination after two to five years of storage. Seed germination time was delayed in freshly harvested and in both small and bold size seeds under control condition, but with increase in storage time it germinated between 2-3 days. After water soaking for 24 hrs seeds of both the size germinated faster while the hard seeds took 2-6 days for initiation of germination. Sulphuric acid treatment affected the onset of germination in both the types of seeds, and the seeds started to germinate within 1-3 days.

Intellectual property rights

Vallabh Medha- A high yielding cultivar of *Centella asiatica*

DMAPR, Anand: The performance of newly identified plant type was compared with a local type. Since it is a shade loving plant, the trial was conducted under shade and open conditions. Results showed that the species is well adapted to 25 to 50 % shades.

Based on high yield of asiaticoside yield per unit area, new plant type (IC 561247) was registered as INGR no. 08105 as superior germplasm stock at NBPGR in 2009. The same genetic material was tested in a larger area and identified as variety on the basis of stable

performance over the years. It was dedicated to the nation with the name "Vallabh Medha" (*Vallabh* to respect Sardar Vallabhbhai Patel - the Iron Man of India in whose birth place DMAPR is located and *Medha* stands for the memory improving efficiency of *C. asiatica*) during the 18th All India Co-ordinated Research Project on Medicinal & Aromatic Plants and Betelvine held at Mahatma Phule Krishi Vidyapeeth, Rahuri during November 8-11, 2010 (Fig. 5).

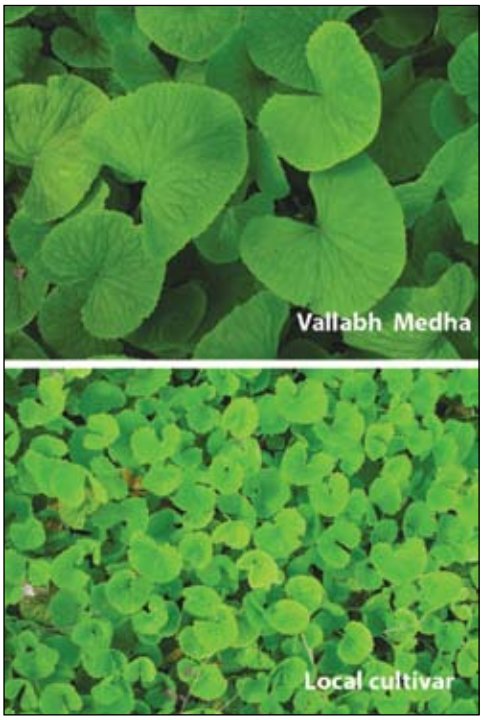


Fig. 5. Field view of Vallabh-Medha in comparison to local cultivar

"Vallabh Medha" is a single plant clonal selection and bigger in size in all the morphological characters studied. Plant height and inter node length were about three times higher and leaf area was more than 4.5 times higher compared to the local cultivar. Study of the physiological parameters showed that photosynthetic rate was higher in Vallabh – Medha, however, the rate of respiration was little lower in the new variety. The number of leaves per plant was almost same in the elite line and the local cultivar. RAPD molecular markers (Fig. 6) also revealed the distinctness of Vallabh –Medha and the Chromose number of the two species was found as 2n= 2x=18

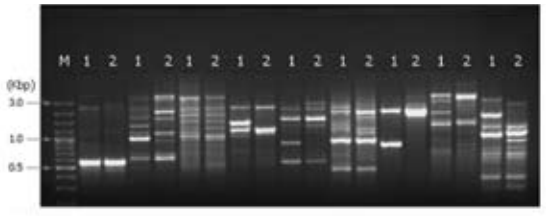


Fig. 6. Comparative RAPD banding pattern of Vallabh-Medha (1) and local cultivar (2) alongwith 100 bp DNA ladder (M)

Vallabh Medha is superior in fresh and dry herbage yield (Fig. 7). Mean fresh herbage yield was 123.31 q ha^{-1} and dry herbage yield was 21.13 q ha^{-1} compared to 20.50 and 3.92 q ha^{-1} respectively in the local cultivar.

Chemical quality was compared on the basis of active ingredients asiaticoside, madecassic acid and asiatic acid contents. Chemical content in Vallabh Medha was little low comparing to the local cultivar. However, the total yield per ha of the constituents was higher in Vallabh Medha than local cultivar (Fig. 8).

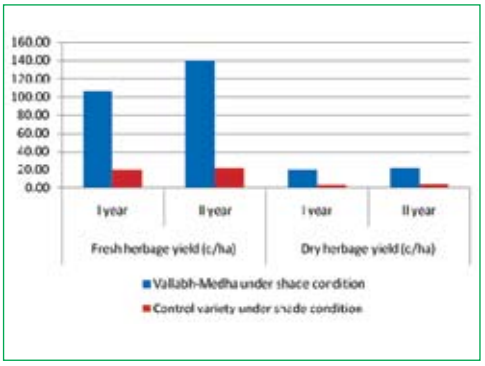


Fig. 7. Yield performance of Vallabh-Medha and local cultivar

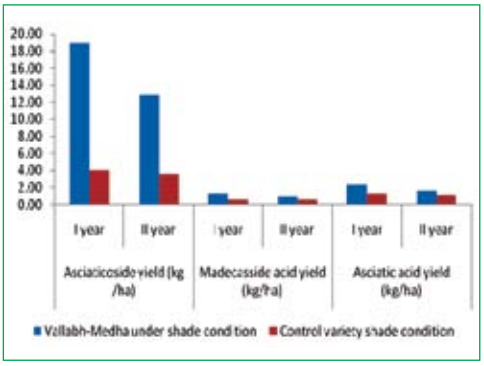


Fig. 8. Yield of bioactive molecules Vallabh-Medha and local cultivar

Information management (ARIS)

National online examination centre

Facility of national online examination centre for 100 users sitting capacity has been created at the directorate under the NAIP funded project entitled "Developing, Commissioning, Operating and Managing an Online System for NET/ARS - Prelim Examination" funded by ASRB, ICAR, New Delhi.

Databases

Updating of the software based applications such as Networking of herbal gardens in India (www.herbalgardenindia.org.in), Website of DMAPR (www.dmapr.org.in), Digital Herbarium of Medicinal and Aromatic Plants in India (www.dmapr.org.in:8080/dhmap/Home.jsp), Open Access Journal of Medicinal and Aromatic Plants (www.oajmap.in), Institute Management Information System and Digital Photo Library of Medicinal and Aromatic Plants etc is continuously being carried out by the ARIS cell of the directorate.

General Information

GENERAL INFORMATIONS

Committee meetings

Research Advisory Committee (RAC)

Eighth Research Advisory Committee meeting was held on January 12,2010 at DMAPR under the chairmanship of Dr. B. R. Tyagi, Ex Deputy Director, CIMAP, Lucknow. Dr A. A. Farooqui, Ex Prof and Head, Division of Horticulture, UAS, Bangalore, Dr. P. L. Tandon, Ex Principal Scientist, PDC, Bangalore, Dr. U. C. Srivastava, ADG (Hort. II), ICAR, New Delhi, Dr. I. L. Kothari, Ex Prof and Head, Department of Biosciences, SP University, V. V. Nagar and Dr. S. Maiti, Director, DMAPR, Anand attended the meeting. At the outset of meeting, Dr (Mrs.) S. Samantaray, Sr. Scientist DMAPR and Member Secretary, RAC, welcomed the Chairman and members of RAC. Dr. S. Maiti presented work done report of the last year. Chairman and other members appreciated the progress made by the directorate and congratulated the director and scientists of DMAPR. After detailed deliberations, RAC suggested some important recommendations for further progress of the centre. The meeting ended with vote of thanks by Dr. P. Manivel, Principal Scientist, DMAPR.

Institute Research Committee (IRC)

The 19th IRC was held during July 20 - 21 2010 under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR, Boriavi. The chairman at the outset welcomed the newly joined scientists, Mr. R. Nagaraja Reddy, Scientist (Plant Breeding) and Dr. B. B. Basak, Scientist (Soil Science) before starting the proceedings. A report on suggestions and advice by honourable Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR during his visit to the directorate on April 4, 2010 was presented by Dr. P. Manivel, Member Secretary. The Chairman in his remarks requested all the scientists to initiate the action to take care of the DG's suggestions. He further emphasized also to concentrate on the issues related to preparation of XII five year plan. Thereafter, the action taken report of the last IRC recommendations was presented by Member Secretary. The progress of research covering the different aspects of medicinal and aromatic plants such as germplasm characterization, plant breeding crop production, crop physiology, crop protection, quality management and information technology during 2009-10 was presented by the Scientists. The findings of research projects and targets to be accomplished during next year were thoroughly discussed. Some new project proposals were also presented and after detailed discussions modifications were suggested for new research proposals. The chairman in his concluding remarks mentioned that "we should prioritize works and focus them so as to meet the emerging challenges." He also wished that our institute should become a role model for other institutes in ICAR.

Institute Management Committee (IMC)

The 21st and 22nd IMC meeting was held on August 9, 2010 and March 14, 2011, respectively at DMAPR under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. Dr A. M. Sheikh, Dr. K. G. Patel, Dr. G. G Rao, Dr. R. S. Kurothe, Dr. Vipin Chaudhary, Sh. Rajnish Awasthi, Sh. Mangal Singh and Sh. R. T. Thakar were the others members present during the meeting. A brief report of progress achieved by the directorate and action taken report of the last meeting were presented by Sh. Thakkar, Member Secretary. Agenda items, research and development activities of the directorate was discussed by the committee members.

EXTENSION ACTIVITIES

Institute visit

During the year more than eight hundred visitors including farmers, students and individuals interested in cultivations of MAPs visited the directorate. Farmers were mainly form three states namely, Rajasthan (180), Madhya Pradesh (88) and Gujarat (38). Students (340) were from Ayurvedic and Pharmacy Colleges. Visitors showed keen interest in know – how of agro-technology of different MAPs, their utilization and ready availability of planting materials.

Quality planting material supply

During the year, revenue of ₹ 1.95 lakh was generated through the sale of planting materials of MAPs from general farm of DMAPR. In addition to that, seeds (Isabgol 250 kg, Asalio 1560 kg, Aswagandha 30 kg, Senna 10 kg, Ggaur 1394 kg and Moong 107 kg), suckers (Aloe 2200), plants (Guggal 75, Ashwagandha 50 and 1342 of other medicinal plants) of targeted and non targeted MAPs were also sold under Revolving Fund Scheme to end users.

Exhibition

An exhibition depicting technology developed by DMAPR and its our reach programme was organised the in 5th National Conference on Krishi Vigyan Kendra-2010 at MPUA&T, Udaipur during Dec. 22-24, 2010. Use of agro-techniques of different medicinal plants with special reference to mandated crops of the directorate were explained to the visitors.

Consultancy services

A two member team of Drs. Kunal Mandal and Smitha, G. R**.** provided consultancy on Good Agricultural Practices (GAP) on Medicinal and Aromatic Crops in FAO sponsored project, "Organic Production of Under-utilized Medicinal, Aromatic and Natural Dye Plants (MADP) Programme for Sustainable Livelihoods in South Asia". They visited BAIF Institute of Rural Development (BIRD-K), Tiptur, Karnataka during September 19-22, 2010 and provided technical assistance to MADP project partners in adopting Good Agriculture Practice (GAP) of medicinal and aromatic plants especially for three cropps .i.e. Patchouli, Ashwagandha, Kalmegh. Drs Vipin Chaudhary and Smitha, G. R. also visited MADP project sites at Bhubneshwar (Orissa) during November 29- December 01, 2010. Training and suggestions for GAP in selected medicinal and aromatic plants (viz., lemongrass, mint, kalmegh, tulsi, kali musli and shatavar) were provided for implementing the project to Sambandh Arogyam and Health and Development Initiative (HDI), two NGOs. The team members also visited fields cultivated with these crops. The beneficiaries were also briefed about gaps observed in these crops and suggestions for removing gaps.

OTHER ACTIVITIES

Dr. S. Ayyappan, Director General, ICAR visited DMAPR

Dr. S. Ayyappan, Director General, ICAR, and Secretary, DARE, Govt. of India visited DMAPR, Boriavi, Anand on April 4, 2010.To mark as a symbol of GREEN INDIA, GREEN ICAR, he planted an Ashoka (*Saraca asoca*) tree and visited the Field Gene Bank at Lambhvel and also main experimental fields at Boriavi campus. He met with field staffs and expressed his appreciation in maintaining the research farm. The conservation efforts of the directorate for maintaining the germplasms of two vulnerable species namely Guggal and Ashoka were shown to him in the field. He spoke expressing happiness for the facilities available at the directorate and the quality of work being done by the scientists of the directorate. He opined that quality of raw drug supply and product development from the directorate would be the second step for commercialization of the medicinal plants. Later in the evening, he addressed all the staff in a meeting. Wide ranging suggestions were putforth to him for the betterment of the directorate and also to increase the visibility outside the world. He advised that initiative in making linkages with farmers and industries, organizing brain storming discussions with experts and other stake holders would be helpful for drawing the future roadmap. Along with these activities, he also suggested that directorate should target developing technologies for utilization of the waste and degraded lands for cultivation of medicinal plants. At the end of meeting, Dr. V.S.Rana, Sr. Scientist and Secretary, MAPAI proposed vote of thanks.

Hindi week celebrated

The official language implementation day was celebrated on September 14, 2010 at the directorate followed by organizing Hindi Week from September 14-21, 2010 under the aegis of Official Language Implementation Committee (OLIC). During the entire week several competitions were organized as part of directorate's endeavor to enhance the use of Hindi in day to day work and to make its official use comfortable. The competitions organized during the week included essay writing, letter writing, general Hindi, poem recitation, general knowledge quiz and extempore speech. On the last day of the week, the closing ceremony was organized. Sh. Prashant V. Kambli, Branch Manager, LIC of India, Anand graced the occasion as Chief Guest. Sh. Anand Prakash Rai, PGT (Hindi), Kendryia Vidyala, V.V. Nagar, Anand was the Guest of Honour and Dr. Satyabrata Maiti, Director and President, OLIC chaired the session. In concluding session two competition viz., poem recitation and extempore speech were organized. Both the competitions were evaluated by the Chief Guest. Runners and winners of the various competitions were presented the certificate and prizes. The session and weeklong celebrations concluded with vote of thanks proposed by Dr. Manish Das.

XVIII Group meeting of AICRP-MAPB

The XVIII group meeting of AICRP-MAPB was held at Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri during November 8–11, 2010. The inaugural session started with welcome address by Dr. S. G. Borkar, Head, Department of Plant Pathology, MPKV. Dr. Satyabrata Maiti, Project Coordinator presented the salient achievements made by the scientists at the 22 Coordinating centres spread all over the country. Identification of unique germplasm of chirayta (*Swertia chirayita*) at Solan, development of production technology for bala (*Sida cordifolia*) at Trichur, detection of pathogenic *Cylindrocladium* sp. in root rot disease of opium poppy at Udaipur and inter-specific hybridisation in betelvine at IIHR, Bangalore were some of the noteworthy achievements. The Project Coordinator also informed that centers working on betelvine undertook large scale demonstration of integrated crop management at farmers' field. Dr. Subhash Mehetre, Director Research, MPKV in his presidential address expressed his thankfulness to the ICAR for giving an opportunity to host this group meeting at Rahuri. He informed that in India about 960 species of medicinal plants are estimated to be in trade of which 178 species have consumption levels in excess of100 t. He further informed that the domestic trade of AYUSH industry is ₹ 80 to 90 billion. The Indian medicinal plants and their products also account about ₹ 10 billion in export. He suggested that to improve production of medicinal plants farmers are need to be motivated which could be achieved through measures like establishing well organised markets, providing quality planting materials and agro-techniques, etc. Scientists from the participating centres presented their experimental results during three days of deliberations in four different technical sessions. Technical programmes for the next year were formulated after thorough discussions. The plenary session was held on November 11, 2010 under the Chairmanship of Dr. Vijay Mehta, VC, MPKV. Reports of all the technical sessions were presented and approved after thorough discussion. The chairman released a new variety of *Centella asiatica* "**Vallabh Medha"** for general cultivation and congratulated the team who developed it. He also released the hand out of "Vallabh Medha". At the end of the session, Dr. S. Maiti felicitated the Chairman and Co-chairman of the technical sessions by presenting memento. The programme came to an end with the vote of thanks proposed by him.

National conference on biodiversity of medicinal and aromatic plants

National conference on "Biodiversity of Medicinal and Aromatic Plants: Collection, Characterization and Utilization" was held during November 24-25, 2010 at Anand Agricultural University, Anand. The conference was organised by Medicinal and Aromatic Plants Association of India (MAPAI) in association with DMAPR and AAU, Anand. Dr. C. L. Patel, Chairman, Charutar Vidya Mandal, was the Chief Guest in the

inaugural session. At the outset, Dr. Satyabrata Maiti, President, MAPAI and Director, DMAPR welcomed the dignitaries and explained the theme of the conference. He mentioned that, the year 2010 was declared as international year of biodiversity by the UN and to highlight the issues related with the biodiversity of MAP, the conference was organised. Dr. C. L. Patel emphasised the need for proper documentation of the MAP. He also highlighted the utility of traditional medicines in modern era. Dr. A. R. Pathak, guest of honour and Vice Chancellor, Navsari Agricultural University, mentioned about the use of proper package of practices for harnessing optimum potential of MAP. He also stressed the need for adoption of post-harvest technologies for quality MAP. Dr. A. M. Sheikh, Vice Chancellor, AAU, Anand, in his presidential address mentioned about the conservation and characterisation need of the traditional MAP. The session ended with the vote of thanks proposed by Dr. V. S. Rana, Secretary, MAPAI. During two days of deliberations, participants from different parts of the country presented their work in four different technical sessions viz., (i) Biodiversity: distribution and collection ; (ii) Biodiversity: characterisation and conservation; (iii) Biodiversity: utilisation and (iv) Biodiversity: policy issues. Two progressive farmers, Sh. Bhaskarbhai Patel and Sh.Mahobat Singh were also felicitated during the conference for their effort towards conservation of MAPs. The meeting ended with the plenary session with a demand from the participants to make this conference an annual event for the MAPAI activities.

FAO funded project on GACP tanning toolkit

A unique GACP training material was developed jointly by the FAO and DMAPR (ICAR) using a variety of communication tools, such as a film and an illustrated booklet to deliver the GACP principles, standards and guidelines in a format that will enable easy adoption by farmers and collectors, particularly in less developed areas with low literacy levels.

This toolkit was developed under a project implemented by FAO in India and Bhutan with the grant support from the International Fund for Agriculture Development (IFAD).

The GACP training toolkit comprises of the following which are also available in www.dmapr.org.in website:

	**Trainer's Manual**: It is a comprehensive yet simple booklet for trainers and contains guidelines to plan an effective GACP training session using various tools and techniques.
	**GACP Video**: Presents the key principles of GACP with a voiceover narrated in English. This can be effectively utilized by the GACP trainer to create awareness among farmers and collectors about the usefulness of adopting GACP.
	**Illustrated cause-effect training tool**: An innovative and unique training tool for trainers to facilitate analytical discussions on various GACP issues during a training session.
	**Illustrated booklet**: It is a take-away booklet for trainees (farmers and collectors). The simple and easy to use booklet uses illustrations to explore the key GACP principles as depicted in the video and other training tools.

Bhutan visit by DMAPR scientists

The Food and Agricultural Organization (FAO) constituted a study team to Bhutan to prepare ***A Strategic Road Map for Developing the Medicinal and Aromatic Plants Sectors in Bhutan*** with six members, Dr. Satyabrata Maiti, Director, DMAPR as team leader, Dr. K. A. Geetha, Sr. Scientist (Plant Breeding), DMAPR, Dr. D. Maity, Associate Professor, Calcutta University, Mr. Ugyen Dorji, Commodity Coordinator, MAP and Spices Program, RGOB, Mr. Tshitila, MAP Specialist, RNR RDC Yusipang, RGOB, and Mr. Yoenten Norbu, Forest Officer, Non Wood Forest Products Section, RGOB as members. The team visited Bhutan during November 29-December 10,2010 and interacted with National Post Harvest Centre at Paro, Institute of Traditional Medicine Services, Research and Development Centre Yusipang, CFC funded project on Medicinal Plants and Herbs sites, Research and Development Centre Wengkhar, Yakpugang CFC project site, Community forest group collecting medicinal plants at Kalapang and Dozam, National Biodiversity Centre, Department of Agricultural Marketing and Cooperatives and Bio Bhutan. They also interacted with all the stake holders in a brainstorming session on the last day wherein an interim strategy was presented by the Team leader. The final report was well appreciated by the Lead Technical Unit (LTU) of the Medicinal, Aromatic and Dye Plants project at FAO Hq. Rome.

A delegation of royal government of Bhutan visited DMAPR

A six member high level team of Royal Government of Bhutan comprising of Mr Ugyen Dorji, Commodity Coordinator, Horticulture Division, Department of Agriculture, Mr Tshitila, MAP Specialist, RNR RDC Yusipang, Mr Lakey, Sr. Horticulture Officer, Horticulture Division, Department of Agriculture, Mr Dechen Tshering, Sr. Post Production Officer, National Post Harvest Centre, Department of Agriculture, Ms Singye Dem, Extension Supervisor, Horticulture Division, Department of Agriculture, Mr Karma Pelden, Research Officer, RNR RDC Yusipang visited DMAPR on March 12, 2011.The team visited the Field Gene Bank at Lambhvel, main experimental fields at Boriavi campus and laboratories. A scientific interaction meeting with the scientists of DMAPR was also organized. Dr. Saytabrata Maiti, Director, DMAPR in his presentation highlighted the role of ICAR in medicinal and aromatic plants (MAP) research. He specifically mentioned about role good agricultural practices (GAP), good manufacturing practices (GMP) and certification standard developed with the support of NMPB in context of global trade of MAPs. Further, he mentioned that GAP is not mandatory but voluntary at the moment.

Women cell

Women staff members of the directorate had regular meetings under the aegis of Women cell created at DMAPR, chaired by Dr. Vandana Joshi, Principal Scientist (Economic Botany). Issues related to their welfare were discussed in the meetings. International Women's Day was also celebrated at the Directorate on March 8, 2011.On this occasion, a lecture on "Art of Living" was organized. A voluntary donation collected from DMAPR staff was given to Hindu Anath Ashram, Nadiad for education of orphan children.

Right to information cell

All information related to the Right to Information (RTI) Act is regularly posted on the website of DMAPR. Besides that, the directorate has also satisfactorily responded to the requests received for seeking information under RTI act within the stipulated time frame. Dr. Vandana Joshi, Principal Scientist (Economic Botany) has been designated as Transparency Officer of the directorate.

DMAPR team participates in ICAR western zonal sports meet at Jhansi

A nine member team of DMAPR participated in ICAR Zonal Sports meet (Western Zone) held at Jhansi during February 15-19, 2011. Dr. Smitha, G. R. Scientist (Horticulture) was nominated as the Chief-de-mission. She won six gold medals, two silver medals and was adjudged the Best Athlete (Women) of the tournament. Further to her credit, she also received the "Best sports person of the tournament" award for overall performance in the tournament. After return, the team members were felicitated at the directorate.

Awareness of IPR and business planning training organized

One day training programme for awareness of IPR and business planning was organized at DMAPR by Zonal Technology Management-Business Planning and Development for Western Zone, CIFE, Mumbai on January 06, 2011.Scientistific personnel and research fellows of the directorate participated in the training programme. Details of IPR related aspects, their protection and planning for developing business from a technology generated were discussed with the participants.

Distinguished visitors

- Dr S. Ayyappan, Secretary, DARE & Director General, ICAR, New Delhi on April 4, 2010
- Dr Swapan K Dutta, Deputy Director General (Crop Science), ICAR, New Delhi on April 4, 2010
- Dr S .K. Sharma, Director, NBPGR, New Delhi on April 5, 2010
- Dr T.K. Adhya, Director, CRRI, Cuttack on April 5,.2010
- Prof. P. K. Agrawal, National Professor, ICAR New Delhi on April 5, 2010
- Dr C. Devakumar, ADG (EPD), ICAR New Delhi on April 26, 2010
- Dr Bengali Baboo, National Director, NAIP, ICAR New Delhi on May 25, 2010
- Dr M.S. Mudakar, World Bank, Washington DC, USA on May 25, 2010
- Prof. M.C. Varshneya, Ex. Vice Chancellor, AAU, Anand on July 23, 2010
- Dr S. Ganeshan, Ex. Director, TBGRI on July 24, 2010
- Dr G.G. Rao, Joint Director, CSSRI Regional Station, Bharuch on August 9, 2010
- Dr A.R. Pathak, Vice Chancellor, Navsari Agricultural University, Navasari on September 4,.2010
- Dr B. Venkateswarlu, Director, CRIDA, Hyderabad on September 22, 2010
- Ms. Avantika Singh, IAS, District Development Officer, Anand on September 24, 2010
- Dr C.D. Mayee, Chairman, ASRB, New Delhi on December 14, 2010
- Dr M.M, Anandraj, Project Coordinator, AICRP on Spices, IISR ,Calicut on December 14, 2010
- Dr Manjit Singh, Director, Directorate on Mushroom Research, Solan on December 14, 2010
- Prof. H.D. Kumar, Ex. Professor of Botany, BHU, Varanasi on January 24, 2011.
- Dr P. R. Kumar, Ex. Director, DRMR, Bharatpur on March 9, 2011
- A delegation from Royal Government of Bhutan on March 12,2011
- Dr D.M. Hegde, Director, DOR, Hyderabad on March 21, 2011

Deputations/meetings attended by the Director

- Brainstorming session at NAARM, Hyderabad for discussion on ICAR Perspective Plan (ICAR 2030) on April 12, 2010.
- Workshop/interaction program for NABCB assessor at IIHMR, Dwarka, Delhi on April 15, 2010
- Visited the project site at Guwahati for assessing its progress as a Task Force member of the Department of Biotechnology, Government of India, New Delhi on April 30, 2010.
- XXI meeting of Plant Germplasm Registration Committee at NBPGR, New Delhi on May 18, 2010.
- NMPB Technical Committee meeting at the QCI office, New Delhi on May 31, 2010.
- Meeting to review the guidelines for financial support for organizing seminar/symposium and support for publication of Scientific Journals at Krishi Bhawan, New Delhi on June 30, 2010

- MADP project partners meeting at India International Centre, New Delhi on July1, 2010.
- Review meeting on Biotechnology Research at NRCPB, New Delhi during July 26-27, 2010.
- Review of the guidelines for financial support for organizing seminar/symposium and support for publication of Scientific Journals at Krishi Bhawan, New Delhi on July 27, 2010
- Workshop to review the conduct of DUS test for the period 2007-10 at NAARM, Hyderabad on August 11, 2010.
- Selection committee meeting for Plant Genome Saviour Community Award 2009-10 at NASC complex, New Delhi during August19-20, 2010.
- Selection committee meeting as DG's Representative at ASRB, New Delhi on August 25, 2010 .
- Meeting to review the guidelines for financial support for organizing seminar/ symposium and support for publication of Scientific Journals at Krishi Bhawan, New Delhi on 30.8.2010.
- Fourth Annual Review meeting of ICAR Niche Area of Excellence: Project Monitoring and Evaluation on September 1, 2010.
- Presentation of the NMPB funded Guggal project in the review meeting at NMPB, New Delhi on September 7, 2010.
- 2nd International Summit-cum-Exhibition of Processed Food, Agribusiness and Beverages at New Delhi on September16, 2010.
- 16th meeting of the Task Force on Biotechnology based programme for Women at DBT, New Delhi on September 23, 2010.
- MADP Partners meeting at FAO, New Delhi on September 24, 2010.
- Meeting of the ICAR Regional Committee No. VI at SK RAU, Bikaner during October 21-22, 2010.
- The 1st meeting of the 'Task Force for Medicinal & Aromatic Plants' at NMPB, New Delhi on October 27,2010.
- The meeting of Standardization of Good Agricultural Practices at NMPB, New Delhi on October 27, 2010.
- Visit to Bhutan as Team Leader of the Committee to provide technical assistance to Royal Government of Bhutan on systematic development of medicinal, aromatic and natural dye plants (MADP) section in Bhutan during November 29 – December 10, 2010 under the consultancy project between DMAPR, Anand and FAO.
- MADP partners meeting at Jukaso Inn, Sunder Nagar, New Delhi on December 13, 2010.
- Selection Committee meeting at ASRB, New Delhi as a representative of the DG, ICAR on December 30, 2010.
- Delivered Padmanava Panda Memorial Oration lecture on Organic Farming at OUAT, Bhubaneswar on January 18, 2011.
- Selection committee meeting at ASRB, New Delhi as DG's nominee on February 5, 2011
- DBT review meeting at Gandhigram on February 10, 2011.
- Interface of ICAR Directors with the Vice Chancellor of SAUs on February 23, 2011 at NASC, New Delhi .

- Directors Conference at NASC, New Delhi on February 24, 2011.
- Review meeting of DUS test centers & Projects at PPVFRA, New Delhi on February 25, 2011.
- Review meeting under the Chairmanship of DDG (Horticulture) at KAB II, New Delhi on March 8, 2011.
- Interaction meeting with the RAC, Chairman and DDG (Hort.) at KAB II, New Delhi on March 9, 2011.
- Review meeting of NMPB at New Delhi on March 11, 2011.
- 17th meeting of the Task Force on Biotechnolgy based programme for women at DBT, New Delhi on March 16, .2011.
- Led the delegation of Royal Government of Bhutan at FAO office, New Delhi and visit to Som Extract Limited at Ghaziabad along with delegation on March 24, 2011.

Human resource development

Name	Details	Date
Sh. Vinay Kumar	Training on molecular tools for crop improvement at ICRISAT, Patancheru, Hyderabad	May 9-22, 2010
Sh. N. Srinivas Rao	Strengthening statistical computing for NARS at CIFE, Mumbai	June 16-17, 2010
Dr Nagraj Reddy	Researcher's Training- SAS: An Overview at CIFE, Mumbai	November 15-20, 2010
Dr. Vipin Choudahary	SAS: An Overview at B.A. College of Agriculture, Anand	December 18-23, 2010
Ph.D degree awarded		
Smitha, G.R. University of Agricultural Sciences, GKVK, Bangalore	Title of thesis : Standardization of organic cultivation and propagation through stem cuttings in long pepper *(Piper longum Linn.)* and *Stevia* (*Stevia rebaudiana* (Bertoni) Hemsl)	September 02, 2010
N.A.Gajbhiye Sant Gadge Baba Amravati University, Amravati	Title of thesis : Phytochemical investigation of Aloe species	February 05, 2011

Dissertation by students at DMAPR

Student's name and Institute / University	Degree	Title of the thesis	Guide/ Co-guide
Amita I. Patel	M.Sc.	Morphological, anatomical and physiological characteristics of male sterile and fertile plants of Ashwaghandha (*Withania somnifera* (Dunal)]	Dr. P. Manivel
Kinjalben Balbantbhai Patel Department of Biosciences SP University, Vallabh Vidyanagar, Anand	M.Sc.	Effect of pollination on apomixis in Commiphora wightii (arnott.) Bhandari	Dr. K.A.Geetha

PUBLICATIONS

Research papers

DMAPR, Anand

Das, M. (2010) Performance of Asalio (*Lepidium sativum* L) genotypes under semi arid condition of middle Gujarat, *Indian J Plant Physiology*, **15**: 84-89.

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UBKV, Kalimpong

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YSPUH, Solan

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TNAU, Coimbatore

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YSPHU, Solan

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PERSONNEL

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Satyabrata Maiti, M.Sc. (Ag.), Ph.D

Scientific

P. Manivel, M.Sc. (Ag.), Ph.D., Principal Scientist (Plant Breeding)

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Sanghamitra Samantaray, M.Sc., Ph.D., D.Sc., Senior Scientist (Biotechnology), transferred to CRRI, Cuttack on May 07, 2010

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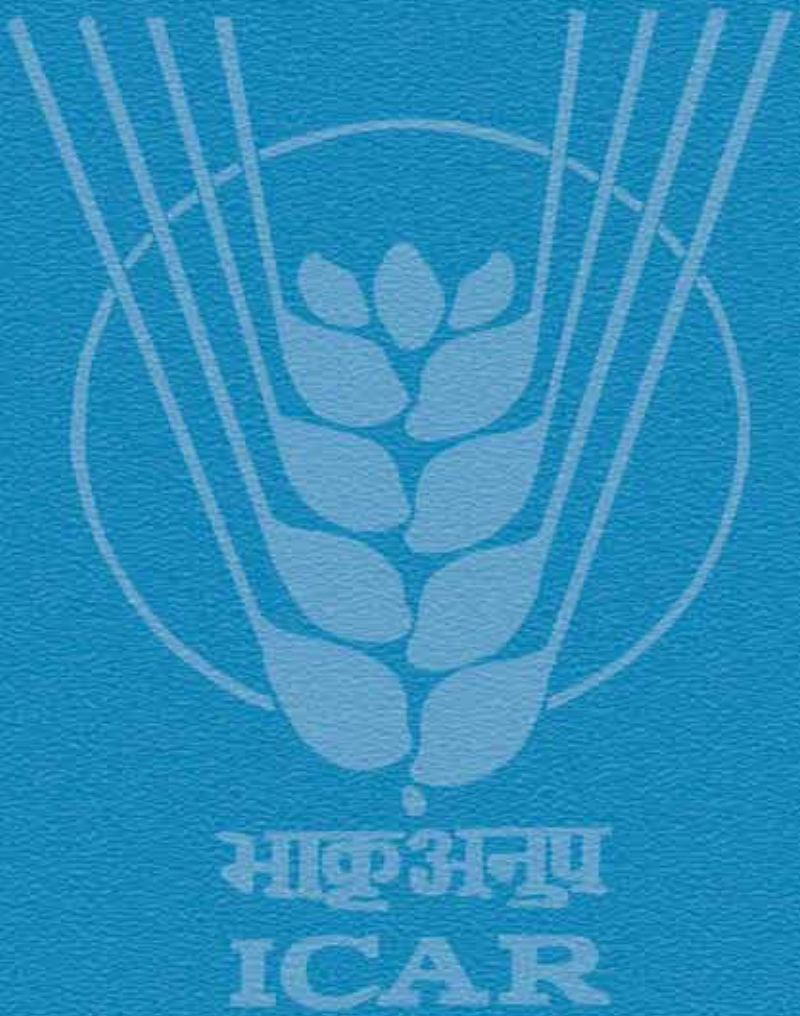

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