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Annual Report 2009-10

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

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Directorate of Medicinal and Aromatic Plants Research

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PREFACE

Everywhere we walk in nature, we are surrounded by medicinal plants growing uncared. Some plants among them are great edible, supply nutrients as well as strengthen our various VITAL systems to protect from numerous diseases. It is truly surprising that many useful medicinal plants are pulled out or poisoned or destroyed in our agricultural operations and if a careful planning is done, many of those could find a better use. The year 2010 has been declared by the United Nations as International year of Bio-diversity. There will be lot of celebrations and awareness meetings and discussions worldwide to reiterate once again that we are an inseparable entity of nature; our future is tightly linked with biodiversity, the places we live and our surrounding environments, all over the world.

Sourcing of medicinal plants as raw drug for the industry is generally either through collections from the forest and wild habitat which contributes about 85% of the requirement or from cultivation, that contributes hardly 15% of the demand. Research on cultivation is in the domain of ICAR in India. DMAPR is an institution, established by the ICAR for concentrating on research of medicinal and aromatic plants cultivation for production and supply of quality raw drug to the industries with an ultimate goal to reduce the pressure on biodiversity available in forests by reducing the pressure on collection. Sustainability in availability of MAP for the ever growing future generation is a challenge to mankind. DMAPR is committed to contribute their best in this challenging field.

Over of a span of 17 years, DMAPR has slowly and steadily progressed and is making its presence felt in the research arena of Medicinal and Aromatic Plants by its some of the worth mentioning contributions such as registration of seven elite germplasm of five species, which are unique in terms of their quality parameters; filed two patents within such a short span of existence; enlightening the secrets of nature in molecular characterization and apomixis in guggal; sex determination of few species by RAPD markers; contribution on GAP of MAP plants, etc. The DMAPR has also successfully launched and maintained an unique website www.herbalgardenindia.org, for giving support to various partners of networking of herbal gardens through funding from NMPB. Two NAIP projects are persuaded as partner institute. In addition, it is also working as DUS testing centre of PPV&FR Authority and finalized the DUS descriptor for Plantago ovata which will promote the release of new varieties in Isabgol.

I am convinced that good work initiated in the directorate would continue with the whole-hearted support from our scientists, administrators and other functionaries who would leave no stone unturned to make the ICAR feel proud of DMAPR.

I take this occasion to place on record my gratefulness to Dr. Mangala Rai, Formerly Secretary, DARE & Director General, ICAR, Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR and Dr. H. P. Singh, Deputy Director General (Horticulture) for their ardent interest and liberal 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 the personal care they are taking at the headquarters in dealing the matters related to our institute. Thanks are also due to all the scientists of DMAPR and AICRP on MAP and Betelvine for their valuable contributions for this annual report. Timely support received from my colleagues, Dr. Kunal Mandal, Dr. K. A. Geetha, Dr. Vipin Choudhary and Mr. Saravanan Raju in compilation of this volume and Dr. Kunal Mandal in getting this volume printed within the deadline set by the Honb'le Director General, ICAR, are also gratefully acknowledged.

Jai Hind!

Anand **Satyabrata Maiti**

June 29, 2010

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 पौधो तथा पानलता पर शोधरत है । वर्ष 2009-2010 की मुख्य शोध उपब्लिध्यां निम्नलिखित है ।

घी कंवार (*एलो बारबेडेंसिस*)

पत्ती की पैदावार के आधार पर पी.डी.के.वी., अकोला तथा सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर क्रमशः एकेवीए-09-01 तथा आईसी-112526 पंक्तियों की श्रेष्ठतर पंक्तियों के रूप में पहचान की गई । औ.स.प.अनु.नि., आणंद पर जुलाई (वर्षा के मौसम में) माह में की गई रोपाई से अधिकतम वजन, जैल तत्त्व तथा पत्ती से स्त्रावित तत्त्व प्राप्त हुआ । इसी प्रकार हिसार केन्द्र पर बारंबार सिंचाई (तीन माह के अन्तराल से) द्वारा पौधो में विकास तथा उपज अधिकतम थी । उठी हुई क्यारीयों पर रोपाई, विकास व उपज की दृष्टि से सर्वोत्तम सिद्ध हुई ।

हिसार की परिस्थितिओं में 60 किग्रा नत्रजन तथा 30 किग्रा फॉसफोरस ऑक्साइड प्रति है० के प्रयोग से पत्तियों की पैदावार सर्वाधिक थी । एन.डी.यू.ए.टी., जबलपुर केन्द्र पर पौधों में *फ्यूजेरियम सोलेनाई* के कारण पर्ण चित्ती रोग देखा गया ।

अर्जुन (*टर्मिनेलिया अर्जुना*)

पी.डी.के.वी., अकोला केन्द्र पर अक्टुबर माह के दौरान की कटाई में 20-25 वर्ष पुराने पेडों की छाल में 20.58 से 22.60 प्रतिशत टैनिन तत्त्व आंका गया ।

चन्द्रशूर (*लेपिडियम सेटाइवम*)

सी.सी.एच.एस.ए.यू., हिसार केन्द्र पर किए गए जननदव्य मूल्यांकन में वंशरूप एचएलएस-5 (2048.21 किग्रा प्रति है०) से अधिकतम बीज उपज प्राप्त हुई । इसी प्रकार आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर वंशरूप एमएलएस-7 (1941 किग्रा प्रति है०) द्वारा अधिकतम बीज उपज प्राप्त हुई । इसी केन्द्र पर एक अन्य परीक्षण में बुवाई की विभिन्न तिथिओं तथा बीज दर का विकास, *आल्टर्नेरिया* रोग के प्रकोप तथा बीज उपज पर सार्थक प्रभाव था । अकार्बनिक नत्रजन का फसल पर प्रभाव कम था, तथा मंदसौर परिस्थितओं में मात्र 20 किग्रा प्रति है० नत्रजन की खुराक बीज उपज हेतु उत्तम थी । मेनकोजैब नामक संस्पर्श कवकनाशी के तीन बार पत्तीयों पर छिडकाव से रोग में काफी कमी दर्ज हुई, जिसके परिणामस्वरूप बीज उपज में वृद्धि हुई । प्रोपीकोनाजोल नामक तंत्र कवकनाशी कम प्रभावी था ।

अशोका (*सराका अशोका*)

के .ए.यू., त्रिचूर केन्द्र पर किए गए जननद्रव्य मूल्यांकन में 1.8 से 4.0 प्रतिशत टैनिन तत्त्व पाया गया तथा संकलन आईसी-566467 व आईसी-566468 में टैनिन तत्त्व की मात्रा अधिकतम थी । आरएपीडी सूचकों द्वारा किए गए आणविक विश्लेषण के आधार पर जननद्रव्यों को विभिन्न समूहों में बाटा गया । पुष्पन व्यवहार संबंधी अध्ययन में यह पाया की फरवरी माह में अधिकतम प्रति पेड पुष्पक्रम की संख्या 90 थी । तापमान तथा पुष्पन व्यवहार के सहसंबंध अध्ययन से ज्ञात हुआ की उच्च तापमान का पुष्पन व्यवहार पर सकारात्मक प्रभाव था ।

औ.स.पा.अनु.नि., आणंद पर *सराका अशोका* से प्राप्त औषधि का, इसके अपमिश्रक (*पॉलीएलथिया लॉगीफोलिया*) से त्वरित पहचान तथा प्रमाणीकरण हेतु स्कार सूचक विकसित किया गया ।

अश्वगंधा (*विथैनिया सोमनीफेरा*)

औ.स.पा.अनु.नि., आणंद पर दो संकरो, आरएएस-137 तथा आरएएस-10 द्वारा सर्वोत्तम जाँच जेए-20 की तुलना से काफी अधिक जड़ उपज प्राप्त हुई । निदेशालय पर ही एक नपुंसक नर पौधों की पहचान की गई । आरएपीडी सूचको के प्रयोग से जननद्रव्यों के आणविक विश्लेषण के मसविदे का मानकीकरण किया गया ।

सी.सी.एच.एस.ए.यू., हिसार केन्द्र पर संकलन 29 में अधिकतम जड़ उपज (1250 किग्रा प्रति है०) देखी गई । एम.पी.यू.ए.टी., उदयपुर केन्द्र पर आरएएस-93 (1111 किग्रा प्रति है०) द्वारा श्रेष्ठतम जाँच जेए-20 तथा जऐ-134 की तुलना से शुष्क जड़ का उत्पादन काफी अधिक प्राप्त हुआ ।

गोबर खाद, अरण्डी की खली तथा आकार्बनिक उर्वरक से प्रयुक्त पूर्ववर्ती (अफीम की फसल) फसल के पोषक तत्त्वों के अवशिष्ट का आगामी अश्वगंधा की फसल के विकास तथा उपज पर काफी प्रभाव पडा, तथा पूर्ववर्ती फसल जिसमें 15 टन प्रति है० गोबर खाद का प्रयोग हुआ था आगामी अश्वगंधा फसल द्वारा सर्वाधिक शुष्क जड़ का उत्पादन हुआ । विभिन्न कार्बनिक उर्वरकों (गोबर खाद, वर्मीकम्पोस्ट तथा प्रेस मड) तथा जैवखाद (पीएसबी) का विभिन्न वृद्धि प्राचलों पर सार्थक प्रभाव रहा, लेकिन विभिन्न उपचारों में ताजा तथा शुष्क जड़ उपज में कोई भेद नही था । एम.पी.यू.ए.टी., उदयपुर केन्द्र पर सघन दूरी वाले परीक्षणों में शुष्क जड़ उपज अधिक थी । कीटों के प्रकोप का फसल उपज पर सार्थक प्रभाव था । औ.स.प.अनु.नि., आणंद में फसल पर हाडा बीटल (*एपीलेक्ना विजेन्टिओक्टोपंक्टेटा*) की जनसंख्या अक्टुबर माह के तृतीय व चौथे सप्ताह में अधिकतम थी, जो कि सिर्दियों के दौरान (दिसंबर तथा जनवरी) नगण्य हो गई तथा फरवरी माह के द्वितीय सप्ताह में पुनः बढ़ गई । आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर 14 पंक्तियों के रासायिनिक विवरण से ज्ञात हुआ की विथैनोलाइड तत्त्व की दृष्टि से इन पंक्तियों में काफी विविधता विद्यमान थी । हरियाणा में बाजार के एकत्र जड़ के विभिन्न नमूनों में कुल एल्केलॉइड तत्त्व 0.22 से 0.31 प्रतिशत के मध्य था तथा एफ्लाटॉक्सीन संदूषण 0.035 तथा 0.063 प्रतिशत के मध्य था ।

बला (*सिद्धा कॉर्डिफोलिया*)

के.ए.यू., त्रिचूर केन्द्र पर 50x25 सेमी की परस्पर दूरी के मध्य बोई गई फसल द्वारा अधिकतम ताजा तथा शुष्क जड़ का उत्पादन हुआ, साथ ही साथ मई व जून के रोपण द्वारा अधिकतम उपज प्राप्त हुई ।

भुई-आमला (*फाईलेंथस एमरस*)

ए.ए.यू., आणंद पर 15x5 सेमी की परस्पर दूरी तथा जुलाई माह में की गई बुवाई द्वारा अधिकतम शाकीय उपज प्राप्त हई ।

ब्रह्मी (*बाकोपा मोनिएरी*)

ए.ए.यू., आणंद केन्द्र पर अधिक पौधे से पौधे की दूरी (40x40 सेमी) वाले परीक्षण में शाकीय वृद्धि सर्वोत्तम थी, किन्तु शाकीय उपज 10x10 सेमी की परस्पर दूरी वाले परीक्षण में अधिकतम थी ।

चिरायता (*स्वर्शिया चिरायता*)

व्हाई.एस.प.यू.ह.फ., सोलन केन्द्र पर किए गये परीक्षण में चुटाई द्वारा पौधे के विकास में कोई फर्क नही पडा, किन्तु सघन दूरी से पौधों में शाखाओं की संख्या अधिक थी । ताजा तथा शुष्क जड की उपज 30x45 सेमी परस्पर दूरी तथा 40 सेमी की उचाई पर चुटाई वाले परीक्षण में अधिकतम थी ।

जैव उर्वरक (*एजोटोबैक्टर*, पीएसबी या वीएएम) युक्त माध्यम में बोए गए 50 या 100 पीपीएम जीए-3 से उपचारित बीजों में अंकुरण काफी अधिक था । जी.बी.पी.यू.ए.टी., भरसार केन्द्र पर *एस. कॉर्डेटा* तथा *एस. सिलीएटा* दोनों प्रजातियों में पर्ण चित्ती रोग का प्रकोप देखा गया, यह रोग *आल्टर्नेरिया* नामक कवक द्वारा फैलाया गया ।

बाबूना फूल (*मेट्रिकेरीया चमोमीला*)

एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर 10 टन प्रति है० प्रेस मड के प्रयोग से ताजा तथा शुष्क पुष्प उपज सर्वाधिक थी ।

गिलोय (*टीनोस्पोरा कॉर्डीफोलिआ*)

औ.स.प.अनु.नि., आणंद पर मांड कणों के आकार तथा इनके कोशिका द्रव्य में वितरण के आधार पर जननद्रव्यों का वर्गीकरण किया गया । संकलन आईसी-283650 तना उपज की दृष्टि से श्रेष्ठतर था ।

गुग्गल (*कॉमिफोरा व्हाईटी*)

औ.स.प.अनु.नि., आणंद पर राजस्थान से एकत्रित जननद्रव्यों का आरएपीडी तथा आईएसएसआर सूचकों के आधार पर मूल्यांकन किया गया । निदेशालय पर किए गए अध्ययनों से ज्ञात हुआ की परागण द्वारा इस असंगजननिक प्रजाति में फलो का विकास बढ़ा । वृद्धि तथा कार्यिकी प्राचलो पर मृदा आर्द्रता के विभिन्न स्तरों का सार्थक प्रभाव पडा, अधिक मृदा आर्द्रता (30 प्रतिशत) श्रेष्ठतम वृद्धि दर तथा अधिकतम ओलिओ-गम-रेजिन उत्पादन हेतु सहायक थी । नत्रजन की विभिन्न खुराको का गोंद उपज पर कोई प्रभाव नही था । आणंद परिस्थितियों में सर्वाधिक गोंद उपज वर्षा पश्चात (मध्य सिंतबर) की गई टेपिंग से प्राप्त हुई ।

ईसबगोल (*प्लेंटेगो ओवेटा*)

औ.स.प.अनु.नि., आणंद पर रासायनिक उत्परिवर्तजन से उपचारित बीज संतति से जल्दी पिरपक्व (70-85 दिनो में) होने वाले उत्परिवर्ती तथा एक चतुर्गुणित की पहचान की गई । निदेशालय पर हल्के हरे पत्तों तथा दूर-दूर व्यवस्थित फलोरेट वाली डीपीओ-4 पंक्ति द्वारा स्थानीय जाँच जीआई-2 की तुलना से 34 प्रतिशत अधिक उपज प्राप्त हुई । निदेशालय पर आर्द्रता प्रतिबल के प्रभाव में जाँची गई 60 स्थायी एम-3 पीढ़ी की पंक्तिओं में विभिन्न कार्यिकी प्राचलो, जैसे संध्या पूर्व तथा मध्य दिवस जल विभव, गैस विनियम तथा क्लोरोफिल-अ प्रतिदीप्ति गतिज इत्यादि में काफी विविधता देखी गई । निदेशालय पर एक अन्य परीक्षण में फसल में एफिड का प्रकोप जनवरी के अंतिम सप्ताह से शुरू हुआ तथा फरवरी के द्वितीय सप्ताह में यह प्रकोप सर्वाधिक था । उच्च नत्रजन की खुराक वाले परीक्षणों में एफिड की जनसंख्या अधिक थी, इसी प्रकार मृदुरोमिल मिल्डयू का प्रकोप भी उच्च खुराक वाले परीक्षणो में सर्वाधिक था । कीटनाशकों द्वारा सुरक्षित फसल में उच्च नत्रजन की खुराक वाले परीक्षणों में (60N तथा 45N) बीज उपज अधिक थी, तथा असुरक्षित फसल में नत्रजन की विभिन्न खुराको के मध्य बीज उपज में कोई अंतर नही था ।

जीवन्ति (*लेप्टेडेनीया रेटिक्यूलेटा*)

ए.ए.यू., आणंद केन्द्र पर 10 टन प्रति है० गोबर खाद या 2 टन प्रति है० अरण्डी की खली या 5 टन प्रति है० पोल्ट्री खाद के प्रयोग से सर्वाधिक शाकीय उपज प्राप्त हुई ।

कालमेघ (*एन्ड्रोग्राफिस पेनीकुलेटा*)

एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर किए गये परीक्षण में संकलन आईसी-471918 द्वारा सर्वाधिक शाकीय उपज (9333 किग्रा प्रति है०) प्राप्त हुई, तत्पश्चात आईसी-111291 (8107 किग्रा प्रति है०) का क्रम रहा । पी.डी.के.वी., अकोला केन्द्र पर कालमेघ तथा अरहर की अंतरा सस्यन खेती की गई, लेकिन सर्वाधिक शाकीय उपज उस परीक्षण में थी, जिसमें कालमेघ को एकल फसल के रूप में लगाया गया । एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर 14 टन गोबर खाद व 10 किग्रा नत्रजन प्रति है० तथा 6 टन गोबर खाद व 50 किग्रा नत्रजन प्रति है० के प्रयोग से सर्वाधिक शुष्क शाकीय उपज प्राप्त हुई । एम.पी.यू.ए.टी., उदयपुर केन्द्र पर पूर्ववर्ती ईसबगोल फसल में प्रयुक्त नौ

कार्बनिक पोषक तत्त्वों में से गोबर खाद प्रयुक्त परीक्षण में आगामी कालमेध फसल में शुष्क शाकीय उपज सर्वाधिक थी, जो कि नीम खली, अरण्डी खली तथा पोल्ट्री खाद प्रयुक्त परीक्षणों के बराबर थी ।

कौंचा (*मुकूना प्रूरीटा*)

पी.डी.के.वी., अकोला केन्द्र पर 05 टन प्रति है० गोबर खाद तथा *राइजोबियम* व पीएसबी से उपचारित बीजों के सयुक्त प्रयोग से सर्वाधिक बीज उत्पादन हुआ । इसी परीक्षण में मूल ग्रंथिका का निर्माण तथा सकल लाभ भी सर्वाधिक था ।

लॉग पीपर (*पाईपर लॉगम*)

ए.ए.यू., असम केन्द्र पर दो पूर्वोत्तरराज्यों, असम व मेघालय से *पाईपर* प्रजाति के जननद्रव्य एकत्र किए गये । पी.डी.के.वी., अकोला की परिस्थितिओं में 10 किग्रा प्रति है० नीम खली के साथ अकार्बनिक पोषक तत्त्वों के प्रयोग द्वारा पौधों में उचाई तथा शुष्क फल उपज सर्वाधिक थी । विभिन्न उपचारों में पाइपरीन तत्त्व में कोई सार्थक विविधता नही थी । ए.ए.यू., जोरहाट केन्द्र पर *सर्कोस्पोरा पाईपरेंट* प्रभावित एक नया पर्ण चित्ती रोग दर्ज किया गया ।

मकोय (*सोलेनम नाईग्रम*)

ए.पी.एच.यू., बापटला केन्द्र पर किए गये परीक्षण में विभिन्न कार्बनिक उर्वरको में से नीम खली तथा वर्मीकम्पोस्ट के प्रयोग द्वारा गोबर खाद की तुलना में शाकीय उपज अच्छी थी । 40 किग्रा प्रति है० की दर से नत्रजन के प्रयोग द्वारा सर्वाधिक उपज प्राप्त हुई, लेकिन नत्रजन की इस खुराक से निम्न व उच्च खुराक द्वारा रोग व कीट के प्रकोप की वजह से उपज घटी । कार्बनिक व अकार्बनिक पोषक तत्त्वों व जैव उर्वरको के विभिन्न संयोजनो का प्रयोग किया गया तथा 05 किग्रा प्रति है० *एजोर्स्पिलम* तथा *फॉसफोबेक्टर* से अनुपूरित 50 किग्रा प्रति है० नत्रजन के संयोजन द्वारा सर्वाधिक उपज प्राप्त हुई ।

मामेजो (*एनीकोस्टोमा ऑक्सिलेरीस*)

औ.स.प.अनु.नि., आणंद परिस्थितिओं में प्रथम कटाई रोपण के पाँच माह पश्चात की गई, तत्पश्चात विभिन्न अंतरालो पर कटाई की गई । सर्वाधिक शाकीय उपज 60 दिन के अंतराल पर की गई कटाई द्वारा प्राप्त हुई । शुष्क शाक के मिथेनोल सत्त के डाइक्लोरोमिथेन में घुलनशील भाग से दो यौगिक तथा अघुलनशील भाग से एक यौगिक विशुद्ध किया गया ।

मंडूकपर्णी (*सिन्टेला एसियाटिका*)

टी.एन.ए.यू., कोयम्बटूर केन्द्र पर तमिलनाडु तथा कर्नाटका राज्य के विभिन्न क्षेत्रों से 22 जननद्रव्य एकत्र किए गए तथा इनमे विभिन्न लक्षण के लिए काफी विविधता दर्ज की गई ।

औ.स.प.अनु.नि., आणंद में किए गए परीक्षण में यह पाया की छाया का स्तर घटने के साथ-साथ शाकीय उपज में बढ़ोत्तरी हुई तथा खुली अवस्था में उपज सर्वाधिक थी । छाया के विभिन्न स्तरों का एसियाटिकोसाइड तत्त्व पर सार्थक प्रभाव था ।

अफीम (*पपावर सोम्निफेरम*)

आर.वी.एस.के.वी.वी., मंदसौर केन्द्र पर किए गये संकर मूल्यंकन से ज्ञात हुआ की संकर एनडीएचव्हाई-1 में लेटेक्स उपज, एमओएच-2 में बीज व भूसी उपज तथा एमओएच-1 में मोर्फीन उपज सर्वाधिक थी । उदयपुर के निकट

बहुत से किसानों के खेतों पर एक नये मूल विगलन रोग का प्रकोप देखने को मिला । प्रायोगिक तौर पर इस रोग के वाहक की पहचान *साइलिंड्रोक्लेडीयम* प्रजा. के रूप में की गई ।

पामारोजा (*सिंबोपोगन मार्टिनी*)

सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर किए गये जननद्रव्य मूल्यांकन से ज्ञात हुआ की सबसे अधिक तेल उपज जननद्रव्य पीआरएच-8-8 में थी जो कि जाँच आरएच-49 की तुलना में काफी बेहतर थी । इसी केन्द्र पर 15 पुष्ठ क्लोनों की तुलना जाँच आरएच-9 से की गई । तेल तथा जिरेनिओल तत्त्व की उपज की दृष्टि से कुछ पंक्तियाँ काफी अच्छी थी ।

सफेद मूसली (*क्लारोफाइटम बोरिविलिएनम*)

पी.डी.के.वी., अकोला केन्द्र पर किए गये परीक्षणों में यह पाया की वंशरूप एकेएसएम-07 में मांसल जड़ उपज सर्वाधिक थी, तत्पश्चात एकेएसएम-08 का क्रम रहा जिसमें सेपोनिन तत्त्व भी अधिक था ।

एम.पी.ए.यू.टी., उदयपुर केन्द्र पर किए गए परीक्षण में सर्वाधिक ताजा मांसल जड़ उपज वंशरूप पीसी-30 में थी जो कि जाँच एमसीबी-405 की तुलना में काफी बेहतर थी ।

आर.एम.वी.एस.के.वी.वी., मंदसौर केन्द्र पर किए गये परीक्षण में यह पाया की ताजा मांसला जड़ उपज जाँच जेएसएम-405 (2416 किग्रा प्रति है०) की तुलना में वंशरूप एमसीबी-412 (3399 किग्रा प्रति है०) में अधिक थी ।

औ.स.प.अनु.नि., आणंद में रोपण के 120 तथा 165 दिन पश्चात काटी गई मांसल जड को छिलना आसान था, जबकि इससे पहले (90-105 रोपण पश्चात दिवस) तथा बाद (180-240 रोपण पश्चात दिवस) में काटी गई जड़ो को छिलना कठिन था । पृथक करने योग्य बहुपरतीय फिलोडर्म परतो द्वारा छिलना काफी आसान हो गया । लक डी के बक्से में 05 इंच की मिट्टी की परतो के मध्य 03 इंच मूसली की मांसल जड़ों का संग्रह करने से स्वस्थ जड़ों की पुनः प्राप्ति सर्वाधिक हुई । विभिन्न स्त्रोतों से एकत्र किए गए जड़ के नमूनों में चार कवक प्रजातिओं तथा एक जीवाणु का संक्रमण था । नमूनों में 0.013-0.027 प्रतिशत एफ्लाटॉक्सीन संदूषण था तथा 35-45 पीपीएम कार्बेन्डिजम अविशष्ट था ।

सर्फगंधा (*रॉवुल्फिया सर्पेन्टिना*)

बी.सी.के.वी., कल्याणी तथा एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर पर्ण चित्ती रोग का काफी प्रकोप देखा गया, यह रोग *कोरिनीस्पोरा केसीकोला* नाम कवक द्वारा फैलाया गया ।

शतावर (*एस्पेरेगस रेसीमोसस*)

सी.सी.एस.एच.ए.यू., हिसार केन्द्र पर किए गए परीक्षण में वंशरूप एचएआर-03-18 (7039.50 किग्रा प्रति है०) द्वारा सर्वाधिक शुष्क जड़ उपज प्राप्त हुई ।

एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर प्रफुल्लन काल, वर्तिकाग्र ग्राहीता, पराग की जीवन क्षमता हेतु प्रजनन संबंधी अध्ययन किया गया । इसी केन्द्र पर एक नये स्तंभ मूलसंधि विगलन रोग का प्रकोप देखा गया जो कि *राइजोक्टोनिया सोलेनाई* नामक कवक द्वारा फैलाया गया । प्राथमिक परीक्षण में *ट्राईकोडर्मा हर्जिएनम* नामक कवक इस रोग के प्रबंधन हेतु काफी अच्छी साबित हुई । *फ्यूजेरियम सोलेनाई* द्वारा फैलाया गया एक अन्य रोग, शुष्क मूल विगलन रोग का प्रकोप भी देखा गया ।

सनाय (*केसिया ऑगस्टीफोलिया*)

औ.स.प.अनु.नि., आणंद केन्द्र पर सनाय की फसल में तीन ट्री हौपर्स व दो लटो का प्रकोप देखा गया । आणंद परिस्थितिओं में फसल की अवस्था तथा जलवायु कारकों का *केटोपसिलिया पाइरेंथी* की जनसंख्या पर प्रभाव पडा, तथा अक्टुबर माह में कीट की जनसंख्या सर्वाधिक थी ।

शंखपुष्पी (*कॉवोल्वुलस माईक्रोफाईलस*)

ए.ए.यू., आणंद केन्द्र पर किए गये छ कार्बनिक उर्वरकों के परीक्षण में 10 टन गोबर खाद प्रति है० के प्रयोग द्वारा सर्वाधिक शाकीय उपज प्राप्त हुई ।

स्वीट वुडवर्म (*आर्टिमिसीया एन्यूआ*)

औ.स.प.अनु.नि., आणंद पर किये गये परीक्षण में विभिन्न दूरी पर रोपण का विकास मानकों पर कोई महत्वपूर्ण प्रभाव नही था, लेकिन पूर्ण पुष्पन की अवस्था में 45x45 सेमी की परस्पर दूरी वाले परीक्षण से सर्वाधिक ताजा व शुष्क शाकीय तथा तेल उपज प्राप्त हुई । फसल की उम्र में वृद्धि के साथ-साथ तेल तत्त्व में भी वृद्धि हुई तथा तेल उपज पूर्ण पुष्पन के दौरान सर्वाधिक थी ।

तुलसी (*ऑसिमम सेंक्टम*)

एन.डी.यू.ए.टी., फैजाबाद केन्द्र पर किए गए परीक्षण में 15 टन प्रति है० गोबर खाद या 6 टन प्रति है० नीम खली के प्रयोग से ताजा शाकीय पैदावार सर्वाधिक हुई ।

बच (*एकोरस कलेमस*)

ए.पी.एच.यू., बापटला केन्द्र पर किये गये परीक्षण में विभिन्न पौध से पौध की दूरी तथा गोबर खाद की खुराक का विकास तथा उपज मानकों पर कोई सार्थक प्रभाव नही था ।

सूचना प्रबंध प्रकोष्ठ

निदेशालय पर सूचना प्रबंध प्रकोष्ठ द्वारा पूर्वविकसित डेटाबेसो का अद्यतन किया गया । इंटरनेट सुविधा को और सुचारू बनाने हेतु वाईफाई इंटरनेट कनेक्टिविटि शुरू की गई । आगंतुको के लिए निदेशालय की गतिविधियों के प्रदर्शन हेतु एलसीडी टीवी के माध्यम से एक प्रदर्शन सुविधा विकसित की गई ।

पानलता (*पाईपर बीटल*)

सात केन्द्रों पर पानलता के जननद्रव्यों के रखरखाव एवं मूल्यांकन का कार्य चल रहा है । ए.पी.एच.यू., बापटला केन्द्र पर संकर का स्थानीय जाँच (तिलकु पौनूर) के साथ मूल्यांकन से ज्ञात हुआ की जीएन संकर, पत्ती उपज के मामले में खराब प्रदर्शन के बावजूद, पत्ती गुणवत्ता के मामले में स्थानी जाँच से बेहतर था ।

आई.आई.एच.आर., बैंगलुरू केन्द्र पर प्रजनन तथा लक्षण निर्धारण, पुष्पन एवं परागण व्यवहार के मूल्यांकन, फलन इत्यादि हेतु जननद्रव्य एकत्रण का कार्य किया गया । सजातिय एवं अंतरजातिय संकर (क्रास) के सफलतापूर्वक निष्पादन के परिणामस्वरूप बीज व पौध का उत्पादन हुआ । विकास एवं पत्ती विशेषताओं हेतु संकरो का मूल्यांकन किया जा रहा है ।

ए.पी.एच.यू., बापटला, बी.सी.के.वी., कल्याणी, आर.ए.यू., पूसा तथा टी.एन.ए.यू., कोयम्बटूर इत्यादि केन्द्रो पर उन्नत आईसीएम तकनिक द्वारा उच्च पत्ती उपज व गुणवत्ता हेतु एकीकृत पोषक पदार्थ प्रबंध तथा एकीकृत कीट प्रबंध के संयोजन से एकीकृत फसल प्रबंध का अध्ययन किया गया ।

आर.ए.यू., इस्लामपुर केन्द्र पर घनी जनसंख्या की तुलना में 1.5 लाख प्रति है० दखलताओं की जनसंख्या द्वारा उत्तम आकार वाली पत्तीयों का विकास हुआ जिनमें रोग का प्रकोप भी कम था ।

ए.पी.एच.यू., बापटला तथा बी.सी.के.वी., कल्याणी केन्द्र पर स्थित पानलता के बागानो में किए गयें कार्बनिक कार्बन के मूल्यांकन से ज्ञात हुआ की पत्ती उपज तथा गुणवत्ता के साथ मिट्टी में उपस्थित कार्बनिक कार्बन का सकारात्मक सहसंबंध था ।

ए.पी.एच.यू., बापटला, ए.ए.यू., जोरहट, बी.सी.के.वी., कल्याणी, जे.एन.के.वी.वी., जबलपुर, एम.पी.के.वी., राओरी, आर.ए.यू., पूसा तथा टी.एन.ए.यू., कोयम्बटूर द्वारा विकसित प्रबंधन की तकनीको के निदर्शन से ज्ञात हुआ कि बेहतर उपज तथा रोगों के कम प्रकोप हेतु इन केन्द्रों द्वारा विकसित तकनीके किसानों द्वारा अपनायी जा रही तकनीको से बेहतर थी ।

जे.एन.के.वी.वी., जबलपुर तथा ए.पी.एच.यू. बापटला केन्द्र पर किए गये परीक्षण में *ट्राईकोडर्मा* विगलक ने दाखलता के खेतों से एकत्र *फईटोपथोरा* तथा *पिथियम* विगलक के लिए उच्च विरोध दिखाया ।

अन्य गतिविधियॉ

निदेशालय में शोध व विकास की गतिविधियों के मूल्यांकन एवं निरीक्षण हेत संस्थान अनुसंधान समिति (आई.आर.सी.), अनुसंधान सलाहकार समिति (आर.ए.सी.), संस्थान प्रबंध समिति (आई.एम.सी.) तथा मासिक बैठके नियमित रूप से आयोजित की गई । औ.स.प.अनु.नि. परिवार ने हिन्दी सप्ताह, निदेशालय का वार्षिक दिवस, स्वतंत्रता दिवस, गणतंत्र दिवस, सतर्कता दिवस, सदभावना दिवस इत्यादि तथा अन्य महत्वपूर्ण समारोह पूर्ण सोहर्द और उत्साह से मानाये । इसके अतिरिक्त निदेशालय द्वारा विकसित प्रौद्योगिकी के प्रसार हेतु कई विस्तार गतिविधियो का आयोजन किया गया । निदेशालय द्वारा कई छात्रों को शोध कार्य के लिए प्रशिक्षण भी दिया 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
DAP	Days after planting
DAS	Days after sowing
DES	Diethyl sulfate
DMAPR	Directorate of Medicinal and Aromatic Plants Research
EMS	Ethylmethane Sulphonate
ETL	Economic threshold level
GA	Gibberelic acid
GAP	Good agricultural practices
GBPUAT	G.B. Pant University of Agriculture and Technology
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/ Months after planting
MPKV	Mahatma Phule Krishi Vidyapeeth
MS medium	Murashige and Skoog medium
NDUAT	Narendra Dev University of Agriculture and Technology
NPK	Nitrogen-phosphorous-potash
OUAT	Orissa University of Agriculture and Technology
PDI	Percent disease index
PDKV	Dr. Punjabrao Deshmukh Krishi Vishwavidyalaya
PSB	Phosphate solubilising bacteria
RAPD	Random amplified polymorphic DNA
RAU	Rajendra Agricultural University
RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
TNAU	Tamil Nadu Agricultural University
UBKV	Uttar Banga Krishi Vishwa Vidyalaya
YSPUH&F	Dr. Y.S. Parmar University of Horticulture and Forestry

SUMMARY

Directorate of Medicinal and Aromatic Plants Research (DMAPR) and its outreach programme All India Coordinate Research Project on Medicinal, Aromatic Plants and Betelvine (AICRPMAP&B) are engaged in research on medicinal and aromatic plants including betelvine. Salient findings of 2009-10 are presented below:

ALOE (*Aloe barbadensis*)

At PDKV, Akola, AKAV-09-01 and at CCSHAU, Hisar, IC-112526 were identified as superior lines based on leaf yield. Under DMAPR, Anand conditions, planting during July (rainy season) resulted in highest fresh weight, gel content and leaf exudates content. Similarly, at CCSHAU, Hisar, frequent irrigation (3 months interval) resulted in maximum growth and yield. Raised bed planting was found the best with maximum growth and yield. Application of 60 Kg N ha^{-1} and 30 Kg ha^{-1} P_2O_5 produced highest leaf yield at CCSHAU, Hisar conditions. A leaf spot disease was noticed at Jabalpur. The causal organism was identified as *Fusarium solani*.

ARJUN (*Terminalia arjuna*)

At PDKV, Akola, higher tannin content (20.58-22.60 %) was estimated in the bark of 20-25 years old trees during October harvesting.

ASALIO (*Lepidium sativum*)

Evaluation of germplasm at CCSHAU, Hisar, showed that the highest seed yield was obtained in genotype, HLS-5 (2048.21 kg ha^{-1}). At RVSKVV, Mandsuar, MLS-7 was the highest seed yielder (1941 kg ha^{-1}). Varying sowing dates and seed rates had significant effect on growth, *Alternaria* leaf blight severity and seed yield at Mandsaur. Delay in sowing and higher seed rates resulted in increased disease severity. However, highest yield was obtained from October 20 sowing with 6–8 kg ha^{-1} seed rate. The crop was found less responsive towards inorganic nitrogen as 20 kg ha^{-1} N was optimum for seed yield under Mandsaur conditions. Optimum thinning time was 20 DAS. Application of three foliar sprays (40, 55 and 70 DAS) of contact fungicide (mancozeb) resulted in maximum disease suppression and consequently increaseed seed yield. Systemic fungicide (propiconazole) was less effective.

ASHOKA (*Saraca asoca*)

At KAU, Thrissur, germplasm evaluation showed that tannin content ranged from 1.8 to 4.0%. IC 566467 and IC 566468 showed maximum tannin content (4.0%). Germpalsm were also grouped into different clusters based on molecular characterization using RAPD markers.

Study of flowering behaviour in the species showed that maximum number of inflorescence per tree was 90 in February. The correlation study indicated that higher temperature had a positive influence on flowering behaviour in the species.

At DMAPR, Anand, sequence characterized amplified region (SCAR) markers were developed for rapid raw drug identification and authentication of *S. asoca* from its adulterant species, *Polyalthia longifolia*.

ASHWAGANDHA (*Withania somnifera*)

At DMAPR, Anand, two accessions, *viz.,* RAS 137 and RAS 10 showed significantly higher root yield than the best control variety JA -20. A male sterile plant was identified at the

centre. Protocol for the molecular characterization of the germplasm using RAPD markers was also standardized.

At CCSHAU, Hisar, the highest root yield was observed in Acc. 29 (1250 kg ha^{-1}). At MPUAT, Udaipur, highest dry root yield was in RAs-93 (1111 kg ha^{-1}) which was significantly superior to the checks, JA-20 and JA-134.

Residue of nutrient applied to preceding crop (opium poppy) through FYM, castor cake and inorganic fertilizer influenced growth and yield of *ashwagandha* grown in succession and highest dry root yield was obtained from 15 t ha^{-1} FYM (applied to previous crop). Though different organic manures (FYM, vermicompost and press-mud) and biofertilizer (PSB) produced significant differences in growth parameters, fresh and dry root yields did not differ among the treatments. Close spacing (20x5 cm) yielded maximum dry root yield under MPUAT, Udaipur conditions. However, growing the crop at 25x5, 30x5 and 20x10 cm also produced similar root yields. Insect pest resulted in significant yield reduction in this crop. *Hada beetle* (*Epilachna vigintioctopunctata*) population was maximum during 3rd and 4th week of October under DMAPR, Anand conditions. Infestation became negligible during winter (December–January) and started again from 2nd week of February. Chemical profiling of 14 lines at RVSKVV, Mandsaur showed that wide variability was present in terms of withanolides content. Some of the compounds could be detected to be associated with specific morphological traits. Aflatoxin contamination of the samples collected from different places varied between 0.035 and 0.063%.

BALA (*Sida cordifolia*)

At KAU, Thrissur, planting the crop at close spacing (50x25 cm) produced the highest fresh and dry root yields. Among the planting times, May and June plantings were the highest yielder.

BHUI AMLAKI (*Phyllanthus amarus*)

Under AAU, Anand conditions, maximum herbage yield was obtained from 15x5 cm spacing and on 1 July sowing.

BRAHMI (*Bacopa monnieri*)

Though wide spacing (40x20 cm) promoted best vegetative growth at AAU, Anand, herbage yield was highest at 10x10 cm spacing.

CHIRAYITA (*Swertia chirayita*)

At YSPUHF, Solan, pinching the plant did not promote more growth but, close spacing resulted in more branching. However, fresh and dry herbage yields were maximized from 30x45 cm spacing and pinching at 40 cm height. Significantly highest seed germination was observed when seeds were treated with 50 or 100 ppm GA_3 and sown in media containing any of the biofertilizers (Azotobacter, PSB or VAM). Mean germination time was minimum with GA treatments. A leaf spot disease was found to affect both the species, *S. cordata* and *S. ciliata* at GBPUAT, Bharsar. The pathogen was identified as *Alternaria alternata*.

GERMAN CHAMOMILE (*Matricaria chamomilla*)

Application of 10 t ha^{-1} press-mud resulted in the highest fresh and dry flower yields at NDUAT, Faizabad.

GILOE (*Tinospora cordifolia*)

At DMAPR, germplasm was classified based on starch granular size and its distribution in the germplasm. IC 283650 was identified as superior yielder based on stem yield.

GUGGAL (*Commiphora wightii*)

Germplasm collected from Rajasthan was characterized based on RAPD and ISSR markers at DMAPR, Anand. Study conducted at the centre showed that pollination enhanced fruit development in this apomictic species. Soil moisture levels (30–10%, at 5% intervals) resulted in significant differences in growth and physiological parameters. Higher soil moisture (30%) supported best growth rate and oleo-gum-resin production. However, nitrogen doses did not influence gum yield. Tapping during post-rain (mid September) resulted in the highest gum yield under Anand conditions.

ISABGOL (*Plantago ovata*)

At DMAPR, Anand, an early maturing (80-85 days) mutant and a tetraploid were identified from the chemical mutagen treated seed progenies. Screening of sixty stable M_3 generation lines at DMAPR, Anand under moisture stress, showed wide variability in different physiological parameters like pre-dawn and mid day water potential, gas exchange and chlorophyll-a fluorescence kinetics. Under DMAPR, Anand conditions, aphid infestation initiated during last week of January and reached to maximum population during 2nd week of February. Higher N doses (45 and 60 kg ha^{-1}) caused high insect population. Downy mildew disease severity also showed similar trend. Maximum seed yield was recorded at N60 which was at par with those of N45 when it was protected by appropriate pesticides. However, in the unprotected block no difference between the N doses could be found.

JIVANTI (*Leptadenia reticulata*)

Application of either 10 t ha^{-1}FYM, 2 t ha^{-1} castor cake or, 5 t ha^{-1} poultry manure resulted in maximum dry herbage yield at AAU, Anand.

KALMEGH (*Andrographis paniculata*)

At NDUAT, Faizabad, accession IC- 471918 had highest herb yield (9333 kg ha^{-1}) followed by IC-111291 (8107 kg ha^{-1}). At Akola, *kalmegh* was grown as intercrop in pigeon pea. Better vegetative growth of *kalmegh* resulted in maximum fresh herbage when grown as sole crop. However, main and intercrop combination of 2:1, 2:2 and 4:2 showed significantly higher land equivalent ratio. Maximum dry herbage yield was obtained with 14 t FYM + 10 kg Nha^{-1} and 6 t FYM + 50 kg N ha^{-1} at NDUAT, Faizabad. Among nine different organic nutrients applied to preceding *isabgol* crop at MPUAT, Udaipur, dry herbage yield of succeeding kalmegh was significantly highest due to FYM and at par with neem cake, castor cake and poultry manure.

KAUCHA (*Mucuna prurita*)

Application of 5 t ha^{-1} FYM in combination with seed treatment of *Rhizobium* and PSB produced highest seed yield at PDKV, Akola. Highest root nodule formation was observed

in this treatment. Highest gross monetary return was also recorded from highest yielding treatment.

LONGPEPPER (*Piper longum*)

At AAU, Jorhat, germplasm of *Piper* species were collected from two states of North East India such as Assam and Meghalaya. Application of inorganic nutrients (100:50:50 kg ha^{-1} NPK) along with 10 q ha^{-1} neem cake resulted in maximum plant height and dry fruit yields under PDKV, Akola conditions. Active ingredient, piperin content did not vary significantly among different treatments. A new leaf spot disease due to *Cercospora piperanta* was recorded at AAU, Jorhat.

MAKOI (*Solanum nigrum*)

Among different organic manures, neem cake and vermicompost produced better herbage yields than FYM under APHU, Bapatla conditions. Inorganic nitrogen of 40 kg ha^{-1} resulted in highest yield. However, higher and lower nitrogen applications than this dose caused yield reduction, due to higher disease and insect attacks. Different combinations of organic/ inorganic nutrients and biofertilizers were also tried. Maximum yield was obtained from the combination of 50 kg N ha^{-1} and supplement of 5 kg ha^{-1} each of *Azospirillum* and *Phosphobacter*.

MAMEJO (*Enicostemma axillaris*)

Under DMAPR, Anand conditions, first harvest was done five months after transplanting and subsequent harvesting was done at variable intervals. The maximum fresh herbage yield was recorded when harvested at 60 days interval. Two compounds were purified from dichloromethane soluble portion of methanol extract of dry herbage while one was got from dichloromethane insoluble portion.

MANDUKAPARNI (*Centella asiatica*)

Twenty germplasm were collected from various parts of Tamil Nadu and Karnataka at TNAU, Coimbatore and variability was recorded for various characters.

At DMAPR, Anand, it was found that dry herbage yield of the plant was more in decreasing shade levels and the yield was highest in the open condition. Asiaticoside content was also significantly influenced by the different shade levels.

OPIUM POPPY (*Papaver somnifrum*)

At RVSKVV, Mandsaur, evaluation of hybrids showed that highest latex yield was in NDHY-1, highest seed and husk yields were in MOH-2 and morphine yield was highest in MOH-1. A new root rot disease was found prevalent at several farmers' field near Udaipur. The disease causing agent was tentatively identified as *Cylindrocladium* sp.

PALMAROSA (*Cymbopogon martinii*)

At CCSHAU, Hisar, germplasm evaluation showed that the highest oil yield was in PRH 8-8 which was significantly superior than the check RH-49. Fifteen promising clones were compared with the check, RH-49 at Hisar. Some of the lines were found promising in terms of oil and geraniol contents.

SAFEDMUSLI (*Chlorophytum borivilianum*)

At PDKV, Akola, highest fasciculated root yield was recorded in AKSM-07 followed by AKSM-08 which was higher in saponin content also.

At MPUAT, Udaipur, genotype PC-30 produced highest fleshy root yield which was significantly superior to the check MCB-405.

At RVSKVV, Mandsaur, maximum fresh fasciculated root yield was in MCB-412 (3399 kg ha^{-1}) as compared to the check JSM- 405 (2416 kg ha^{-1}).

At DMAPR, Anand conditions, harvesting of fleshy roots between 120 and 165 DAP made peeling easy. However, roots harvested at earlier (90–105 DAP) or later (180–240 DAP) turned difficult for peeling. Detachable multilayer phelloderm layers made the peeling easy. Storing the fleshy roots in wooden boxes with 7.6 cm musli sandwiched between 12.7 cm soil resulted in maximum recovery of healthy roots at Udaipur. At least four fungal genera and one bacterium were associated with the root samples collected from different sources. Samples contained 0.013–0.027% of aflatoxin contamination and 35–45 ppm carbendazim residue.

SARPAGANDHA (*Rauvolfia serpentina*)

A leaf spot disease was prevalent at BCKV, Kalyani and NDUAT, Faizabd. It was caused by *Corynespora cassicola* (Berk & Curt) Wei.

SATAVARI (*Asparagus racemosus*)

At CCSHAU, Hisar, the highest dry fasciculated root yield was in genotype HAR-03-18 (7039.50 kg ha^{-1}).

Studies on reproductive biology including antheis time, stigma receptivity and pollen viability were conducted at NDUAT, Faizabad. A new collar rot disease was observed at Faizabad. It was caused by *Rhizoctonia solani* Kuhn. In a preliminary trial *Trichoderma harzianum* was found promising in management of the disease. Another dry root rot disease caused by *Fusarium solani* (Mart) Sacc. was also reported.

SENNA (*Cassia angustifolia*)

Three Homopteran and two Lepidopteran pests were observed at DMAPR, Anand. *Catopsilia pyranthe* population was influenced by host plant growth stage and weather conditions at Anand. Highest pest incidence was observed during October.

SHANKHPUSHPI (*Convovulus microphyllus*)

Among six different organic manures tested at AAU, Anand, 10 t FYM ha^{-1} produced maximum dry herbage yield.

SWEET WORMWOOD (*Artemisia annua*)

Under DMAPR, Anand conditions, planting at different spacing had no significant effect on growth parameters. However, at full bloom, maximum fresh and dry herbage and essential oil yields were obtained from 45x45 cm spacing. Essential oil content showed increasing trend with the increase in crop age. Oil content and oil yield were the highest during full bloom (October).

TULSI (*Ocimum sanctum*)

Application of 15 t FYM ha^{-1} or 6 t ha^{-1} neem cake resulted in maximum fresh herbage yields at NDUAT, Faizabad.

VACH (*Acorus calamus*)

Different spacing and FYM doses had nonsignificant effect on the growth and yield parameters tested under APHU, Bapatla conditions.

ARIS cell

ARIS cell of DMAPR updated the different databases developed earlier. It has supported Wi-Fi internet connectivity. A display facility for the visitors was developed for showcasing institute activities through LCD TV.

BETELVINE (*Piper betle*)

Betelvine germplasm are maintained and evaluated in seven centres. Evaluation of hybrids at APHU (Bapatla) with local check showed that GN hybrid performed poorly in terms of leaf yield eventhough the leaf quality was superior to local check (Tellaku Ponnur)

Collection of germplasm for breeding and characterization and evaluation for flowering, pollination behaviours and fruit setting were carried out in full swing at IIHR, Hirehalli. Both intraspecific and interspecific crossings were carried out successfully, resulting in seed setting and seedling production. The hybrids were evaluated for their growth and leaf characteristics.

Integrated crop management (ICM) combining INM and IPM was studied at APHU, Bapatla; BCKV, Kalyani; RAU, Pusa and TNAU, Coimbatore centres for higher leaf yield and leaf quality by following improved ICM technologies.

Plant population of 1.5 lakh vines ha^{-1} at RAU, Islampur produced optimum leaf size with lower disease incidence compared to higher population densities.

Assessment of organic carbon content in betelvine gardens at APHU, Bapatla and BCKV, Kalyani showed positive correlation of organic carbon in soils resulted in leaf yield and quality.

Demonstration of disease management technologies developed at APHU, Bapatla; AAU, Jorhat; BCKV, Kalyani; JNKVV, Jabalpur; MPKV, Rahuri; RAU, Pusa and TNAU, Coimbatore showed that technologies developed by the centres were superior to farmers' practises for obtaining better yield and low disease incidence.

Isolates of *Trichoderma* from JNKVV (Jabalpur) and APHU (Bapatla) showed high antagonism to *Phytophthora* and *Pythium* isolates collected from betelvine fields.

General information

DMAPR hold meetings of RAC, IRC and IMC to monitor the research and developmental activities. It also took part in several extension activities to disseminate the technology developed. The Centre also observed the Hindi week, Annual day and other important occasions with the full co-ordination and spirit. The institute took important role in imparting training to many students for their research work.

Introduction

In the developing world, a large proportion of the rural population depends on biodiversity for their livelihood, nutrition and health. Indian subcontinent is one of the world's 12 leading Biodiversity Centres, encompassing 16 different agro-climatic zones, 10 vegetation zones, 25 biotic provinces and about 426 habitats of specific species. It has been estimated that about 45,000 plant species (nearly 20% of the global species) occurs in the Indian Sub-continent. In Indian Traditional Systems of medicine, about 7000 species are reported to have medicinal properties. More than 80% of medicinal and aromatic plants (MAP) are collected from 17 million hectares of Indian forest land, which play significant role in the economic subsistence of the people, especially those living in the rugged and impoverished hills, mountains and rural interiors. Collection, simple processing and trading of medicinal plants contribute significantly to their livelihood.

Interest in collection, production and marketing of MAP as phytochemicals, pharmaceuticals, neutraceuticals, herbal remedies, food supplements, perfumes and cosmetics, food flavouring agents etc., has increased many folds in recent years. However, global demand for herbal medicines is facing dwindling supply of medicinal plants due to over-harvesting and habitat loss. The international market of medicinal plants is over 60 billion US$ per year, which is growing at the rate of 7% per annum. The present export of herbal raw materials and medicines from India is about US$ 100-114 million per year. India is one of the major exporters of crude drugs mainly to six developed countries *viz*. USA, Germany, France, Switzerland, U.K. and Japan, who share between them 75–80% of the total export market. To cater the demand of such a huge market and for their role in rural livelihoods, concerted efforts for conservation of MAPs is the need of time.

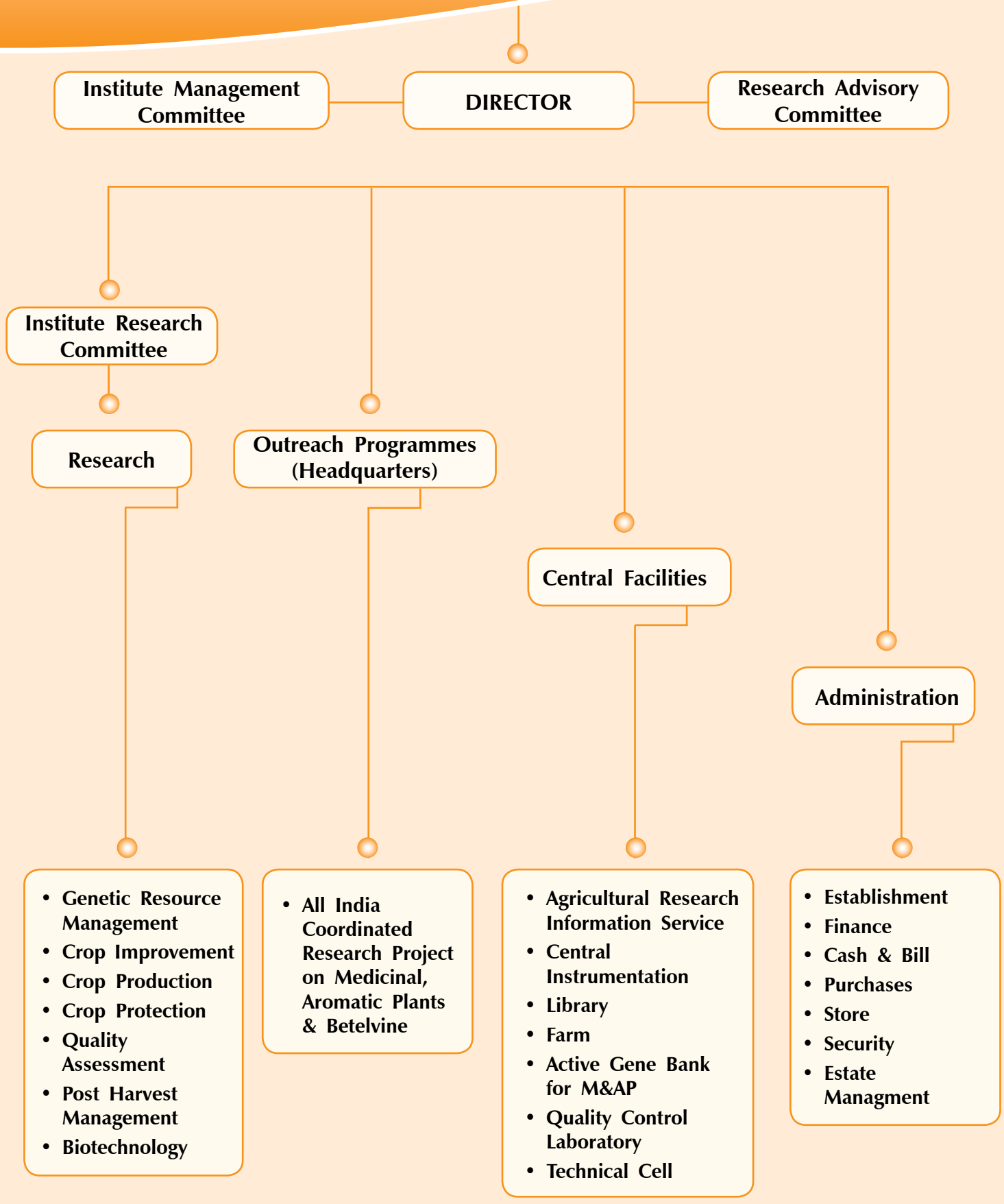
Cultivation offers an excellent prospect for conserving many medicinal plants currently found in the wild as well as to meet the growing demand in the herbal raw drugs worldwide. In India, organized cultivation is practised only in about 70 medicinal plants and superior performing varieties are lacking in majority of the cultivated medicinal plants. A well-planned and organized countrywide planning is required for the commercialization of medicinal plants.

To bring more and more MAPs under cultivation so as to assure quality supply of raw drug, Directorate of Medicinal and Aromatic Plants Research is persuading research in various facets of cultivation such as variety development through plant breeding and biotechnology, crop management through physiology, horticultural and soil science programmes, plant protection for managing pests as well as supply of residue free material, quality assessment and control by its phyto-chemistry programme and supply of quality planting material and finally to develope Good Agricultural Practices module by integrating all the knowledge of various fields. It has its well defined mandates and mandate crops. Its out reach programme, All India Coordinated Research Project on Medicinal, Aromatic Plants and Betelvine located in 22 centres is persuading research on location specific problems and contributing in down stream research activities.

Mandate

- Develop appropriate production, protection and processing technologies for important medicinal and aromatic plants through basic, strategic and applied research.

Organisational Structure



- Germplasm enhancement of various medicinal and aromatic plants.
- Production of parental lines and breeders' stock.
- Act as a National Repository for the genetic resources of some important medicinal and aromatic plants.
- Coordinate research under the All India Coordinated Research Project on Medicinal, Aromatic Plants and Betelvine (AICRPMAP&B).
- Act as an Information Data Bank on medicinal and aromatic plants.
- Transfer of technologies developed by the DMAPR to the farmers through cooperation with the developmental agencies.

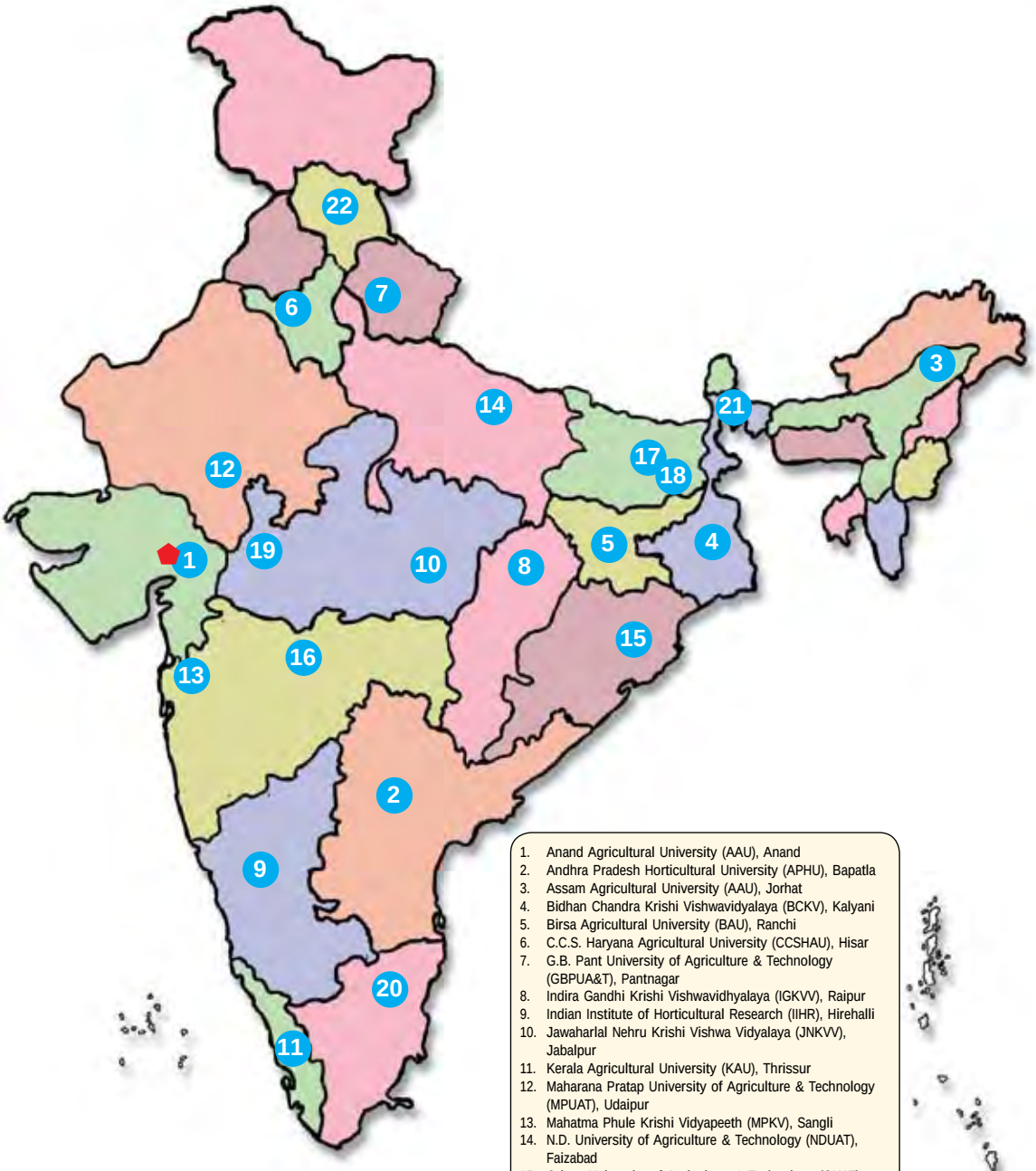
Mandate Crops

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

Objectives

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

Centres of AICRP on Medicinal, Aromatic Plants & 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), Pantnagar
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), Sangli
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), Cooch Bihar
22. Y.S. Parmar University of Horticulture & Forestry (YSPUH&F), Solan

⬟ DMAPR, Anand Headquarters

Outreach Programmes

Two All India Coordinated Research Projects *viz*. All India Coordinated Research Project on Medicinal and Aromatic Plants and All India Coordinated Research Project on Betelvine has been merged and renamed as All India Coordinated Research Project on Medicinal, Aromatic Plants and Betelvine (AICRPMAP&B). Its headquarters is housed in the DMAPR and Director DMAPR is also responsible for coordination and monitoring of research work of the project as Project Co-ordinator. There are now 21 centres in State Agricultural Universities including two new centres at IGKVV, Raipur and BAU, Ranchi and one ICAR centre at IIHR, Hirehalli. The Centres of AICRP are as follows:

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

BUDGET PROFILE

Head	Expenditure (Rs. In million)
Non Plan Expenditure	21.17
Plan Expenditure	
• DMAPR	24.00
• AICRP on MAP & Betelvine	30.50
ICAR Schemes	
• NAIP Project	4.38
• IPR Management	0.07
• Revolving Fund Scheme	0.17
Externally Funded Projects	
• DUS (PPV & FRA)	0.37
• Central Sector Scheme	0.20
• NMPB	2.42

Research Achievements

ALOE (*Aloe barbadensis*)

Aloe – a member of the 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 and the inflorescence stack is about 90-150 cm long with orange coloured flowers. Leaves contain gel (polysaccharides) and leaf exudates contain aloins which are commercially useful. Gel has a cooling and moisturizing action and hence used in cosmetic industries and the leaf exudates contains aloins and aloe emodine which are used as pain killer and purgative. The crop is under cultivation in Gujarat, Rajasthan, Tamil Nadu, Madhya Pradesh and Uttar Pradesh. Raw material is collected both from wild and cultivation for the industry. Suckers are used for propagation. About 15- month old plants are harvested.

Evaluation of germplasm

PDKV, Akola: Sixteen genotypes of Aloe accessions were evaluated for various qualitative attributes. Genotype AKAV-09-01 recorded the highest plant height (57.20cm) followed by genotype, AKAV-09-03 (53.13 cm). Highest number of suckers per plant was produced in AKAV -09-03 and IC-285629 (6.50 plant^{-1}). Genotype AKAV-09-01 produced highest number of leaves plant^{-1} (13.50), leaf length (48.48 cm) and leaf width (6.30 cm), whereas genotype, AKAV-09-03 recorded highest leaf thickness (18.00 cm).

CCSHAU, Hisar: Thirty three genotypes including HAV-1 as check were evaluated. Plant height ranged from 40.5 cm (HAV-04-2) to 70.50 cm (KC/OP-687); leaf length varied from 39.0 cm (HAV-04-2) to 55.5 cm (IC-112526); leaf width varied from 5.55 cm (IC-112567) to 11.12 cm (IC-112526); leaves plant^{-1} varied from 4.35(HAV-07-9) to 10.25(KC/OP-36); fresh leaf weight plant^{-1} varied from 415.00 g (HAV-04-5) to 1950.0 g (IC-112526) and leaf yield ranged from 17250 kg ha^{-1} (HAV-04-5) to 52750 kg ha^{-1} (IC-112526) and the gel content (%) ranged from 41.5 (KC/OP-40) to 72.5 (IC-112273). The highest fresh leaf yield was in genotype, IC-112526 (52750 kg ha^{-1}) followed by IC-112518 (43750 kg ha^{-1}) and HAV-1 (39250 kg ha^{-1}).

Seasonal variations of growth and exudates yield

DMAPR, Anand: Seasonal variations of plant growth and leaf exudates yield were studied by planting at monthly interval in field conditions. Planting season had significant influence on establishment of plants, leaf weight and exudates yield. Planting in the month of July resulted in the highest fresh weight (3.90 kg plant^{-1}), gel content (2.8 kg plant^{-1}) and exudates yield (13.83 g plant^{-1}).

Effect of irrigation and planting methods on yield

CCSHAU, Hisar: Three irrigation schedules and three planting methods were tested in a field experiment. Observations from 17-month old crop showed that both the factors significantly influenced various growth and yield parameters. Irrigating the crop at

3-months interval produced maximum plant height (65.9 cm) and leaf length (58.9 cm). Consequently, leaf weight (419.0 g) and leaf yield (11638 kg ha-1) were also maximum in the treatment. In terms of planting methods, raised bed planting was the best which produced maximum plant height (65.3 cm), leaf length (58.4 cm), leaf weight (410.6 g) and leaf yield (11405 kg ha-1).

Effect of nitrogen and phosphorous fertilizers on yield

CCSHAU, Hisar: Growth and yield were significantly influenced by nitrogen and phosphatic fertilizers. Among different growth parameters tested, plant height, leaf length, leaves plant-1, leaf yield and gel yield varied among the treatments. However, leaf width was not affected by nitrogen and phosphorous treatments. Highest leaf yield was recorded with 60 Kg N ha-1 (12272 Kg ha-1), followed by 40 Kg N ha-1 (10522 Kg ha-1). Similarly, increasing P_2O_5 doses had positive influence on leaf yield, maximum (7292 Kg ha-1) being at 30 Kg ha-1 P_2O_5.

A new leaf spot disease

JNKVV, Jabalpur: A leaf spot disease was noticed during November to April. Symptoms appeared as water soaked, brownish small spots on upper leaves of 2–3 months old crop. Older spots became dark brown and sunken. Several such spots coalesced to cover large area of affected leaves. The fungus isolated from such spots was identified as *Fusarium solani*. Leaves inoculated by pin prick method and the identical symptoms were reproduced.

ARJUN (*Terminalia arjuna*)

It is a tree belongs to family Combretaceae and mainly distributed in central India. 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 cardiotonic 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 utilized for treatment of 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 for bark quality

PDKV, Akola: Barks of *Arjuna* trees of different age groups were collected during September–October (*Sharad ruthu*) and November-December (*Hemant ruthu*) for the assessment of tannin and total ash content. The data indicated that the bark of old trees of 20–25 years age group was having higher tannin content (20.58–22.60 %) during October harvesting. Comparatively lower tannin content (15.74–16-36 %) was recorded in the trees of 10-15 years of age group followed by trees of 7–8 years of age group (12.78–13.06 %). On the contrary total ash content in the bark of various age groups was comparatively higher during December harvesting.

ASALIO (*Lepidium sativum*)

It is a fast-growing, edible annual herb belongs to family Brassicaceae which is botanically related to mustard, sharing their peppery, 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 *Lepidium 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: Fifteen germplasm lines were evaluated based on six characters *viz*., plant height (cm), branches plant^{-1}, seed yield plant $^{-1}$ (g), seed yield (kg ha^{-1}), 1000-seed weight (g) and days to 50% flower initiation. The plant height ranged from 118.97–154.77 cm; branches plant^{-1} varied from 6.10–14.50; seed yield plant^{-1} ranged from 3.88–9.21g; seed yield (kg ha^{-1}) ranged from 862.81 to 2048.21 kg; days to 50% flowering ranged from 44.67-73.00; days to maturity ranged from 44.67–73.00 and 1000-seed weight ranged from 0.88 to 1.80 g. The highest seed yield was recorded in genotype HLS-5 (2048.21 kg ha^{-1}) followed by HLS-7 (1938.36 kg ha^{-1}), HLS-2 (1513.69 kg ha^{-1}), HLS-4 (1389.17 kg ha^{-1}) and HLS-8 (1341.70 kg ha^{-1}). Genotype, HLS-13 was earliest in maturity *i*.e. 117 days followed by HLS-14 (120.67 days), HLS-6 (123.00 days), HLS-5 (124 days), HLS-4 (124.67days) and HLS-3 (133.33 days).

RVSKVV, Mandsaur: Thirteen germplasm lines were evaluated for seed yield and yield contributing characters. The highest mean seed yield was recorded in MLS-7 (1941 kg ha^{-1}) followed by MLS-5 (1917 kg ha^{-1}), MLS-1(1883 kg ha^{-1}), MLS-6 (1700 kg ha^{-1}) and MLS-3 (1625 kg ha^{-1}). The lowest yield was in MLS-10 and MLS-12 (1462 kg ha^{-1}). Mean plant height ranged from 73 cm (MLS-4) to 92 cm (MLS-12) and number of branches ranged from 13 (MLS-2) to 22 cm (MLS-13). Test seed weight (1000 seeds) was highest in MLS-4 and MLS-7 (1.84 g) followed by MLS-6, MLS-8 (1.83 g) and MLS-10 (1.82g). Lowest seed weight was in MLS-12 (1.67g).

Effect of sowing dates and seed rates on disease and yield

RVSKVV, Mandsaur: The crop was grown at 10 days interval between October 10 and November 20 with variable seed rates of 6, 8 and 10 kg ha^{-1}. Growth and seed yield were significantly influenced by both these treatments. Among the sowing dates, maximum plant height (103 cm) was observed in October 20 sowing, whereas number of braches were maximum in crop sown up to October 30 (18.0–18.6 plant^{-1}). However, grain yield was maximum (1760–1850 kg ha^{-1}) in October 20–30 sowing. Increasing seed rate had positive influence on plant height but number of branches followed decreasing trend. Maximum seed

yield (1770 kg ha^{-1}) was recorded from lowest seed rate. Both the sowing time and seed rates had significant effects on *Alternaria* leaf blight disease development. Delay in sowing increased the disease severity till November 10 and it reduced thereafter. Increasing seed rate resulted in increase in blight severity. Hence, 6–8 kg ha^{-1} seed sown on October 10 had minimum disease severity (10.8–13.2 PDI), while maximum (38.9 PDI) was recorded at November 10 sowing with highest seed rate.

Effect of nitrogen levels and crop age at thinning on yield

RVSKVV, Mandsaur: Application of inorganic nitrogen (20, 40 and 60 kg ha^{-1}) and crop age (10, 20 and 30 DAS) for thinning were studied. Nitrogen application significantly increased plant growth and yield. Maximum plant height was obtained with 60 kg ha^{-1} N (82.6 cm), which was at par (77.0 cm) with next lower N dose. Number of branches (16.3–18.3 plant^{-1}) and seed yield (1560 – 1660 kg ha^{-1}) were at par in all the nitrogen treated plots. Thinning at 20 DAS was optimum as plant height (70.0 cm), number of branches (16.0 plant^{-1}) and seed yield (1520 kg ha^{-1}) were maximum in this treatment.

Management of *Alternaria* leaf blight

NDUAT, Faizabad: One contact (mancozeb) and one systemic (propiconazole) fungicides were applied as foliar sprays at different intervals in a field trial. The spray was initiated at 40 DAS and Percent Disease Index (PDI) was calculated. Both the fungicides produced similar results. Minimum disease severity was observed with spray of either of the fungicide thrice (40, 55 and 70 DAS). Disease suppression resulted in higher seed yield compared to unsprayed plots. Three sprays of mancozeb resulted in highest seed yield (1880 kg ha^{-1}), however it was at par with two sprays (1467 kg ha^{-1}). Propiconazole sprays at later dates (55 and 70 DAS) were not effective and produced significantly lower yield (984 kg ha^{-1}) compared to mancozeb application.

ASHOKA (*Saraca asoca*)

It is a medium sized, evergreen tree belonging to family Caesalpiniaceae. Flowers are orange- yellow with bronze coloured tender shoots. 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 uterine 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 component and calcium salt. Bark contains tannins also.

Survey, collection and evaluation of germplasm

KAU, Thrissur: Forty two accessions maintained at the centre were characterized based on tannin content. The analysis of the mean data of various morphological traits and tannin content of the selected accessions after six years of planting indicated that IC-566461 performed better in terms of its growth exhibited by higher height, more number of leaves,

higher girth and better tannin content. Tannin content ranged from 1.8 to 4.0%. IC 566467 and IC 566468 showed maximum tannin content (4.0%). The association of morphological traits and tannin content in *Ashoka* indicated that height of the plant, girth of the stem, and number of leaves have significant association among themselves, while all these traits have no significant relationship with tannin content.

Study of reproductive biology

KAU, Thrissur: Study of flowering behaviour in the species showed that among the different months of the year, maximum number of inflorescence per tree was in February (90), while it was minimum in September (2). Number of flowers per inflorescence followed a similar trend producing more flowers in February and March while least flowers in September and October. Maximum number of pods per tree was observed in May followed by June. Seeds per pod were found maximum in March and April. Number of days required for bud to develop into inflorescence was found highest in the month June and December. During the months September and October, flowers developed to pod within 32 days, while pods matured in 66 days in March. Total reproductive period was 132 days in September while 136 days in December.

Study of flowering behaviour and inflorescence and pod formation in relation to weather parameters like rainfall, relative humidity, maximum temperature, minimum temperature and sunshine hours was also conducted. The correlation study indicated that higher temperature had a positive influence on number of inflorescence produced per tree, number of flowers per inflorescence, number of pods per plant and seeds per pod. Low temperature had a positive influence on number of seeds per pod, seed length, seed volume number of pod per tree. Flower size, pod length and seed volume showed a positive association with sunshine hours. Rainfall and relative humidity showed a negative influence on flower size, pod strength and seed volume. Relative humidity showed a negative influence on number of pods per tree. The duration of inflorescence development, days required for flower to pod formation, pod initiation to pod maturity and total reproductive period did not have any significant relationship with weather parameter.

Study of genetic relationship using RAPD markers

KAU, Thrissur: Ten accessions of Ashoka representing six districts of Kerala were used for molecular characterization. Genomic DNA was isolated from these accessions using modified CTAB method and RAPD analysis was carried out. The dendrogram constructed from pooled RAPD data pointed out that the ten Ashoka accessions were grouped into two clusters *i.e.*, one large cluster with nine accessions and the other small cluster with IC566488 alone (Fig. 1) which was collected from Thiruvananthapuram having distinct variability from the other accessions at its genomic level.

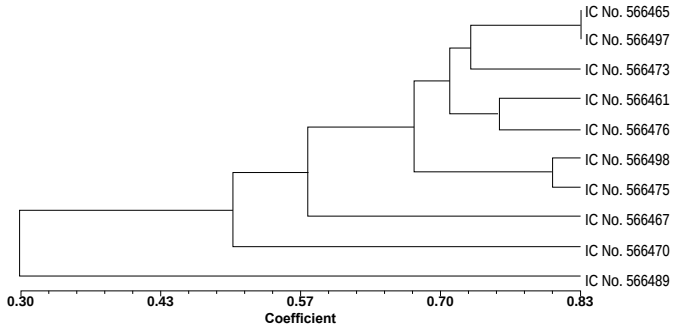


Fig. 1 Dendogram showing genetic relationship among the accessions

Development of PCR based detection tools for *S. asoca* and its adulterant *Polyalthia longifolia*.

DMAPR, Anand: The *Ashoka* raw drug is widely adulterated with the bark of morphologically similar and abundantly available plants of *Polyalthia longifolia* Benth. which belongs to family *Annonaceae*. Therefore, study was carried out to develop molecular tool for rapid identification and authentication of *S. asoca* from *P. longifolia*. A protocol for total genomic DNA isolation from fresh leaves and dry bark powder of both the species was standardized. Species specific RAPD bands of both the species were cloned and sequenced. Sequence characterized amplified region (SCAR) markers were designed from the sequences of corresponding species-specific RAPD amplicons. SCAR primer designed from *S. asoca*, produced the expected amplified product, having a size of 193 bp from *S. asoca* only. Meanwhile, no amplicon was generated in *P. longifolia*. SCAR marker designed from *P. longifolia* developed the expected amplified product, having a size of 395 bp from *Polyalthia* whereas no amplicon was found in *S. asoca* (Fig. 2).

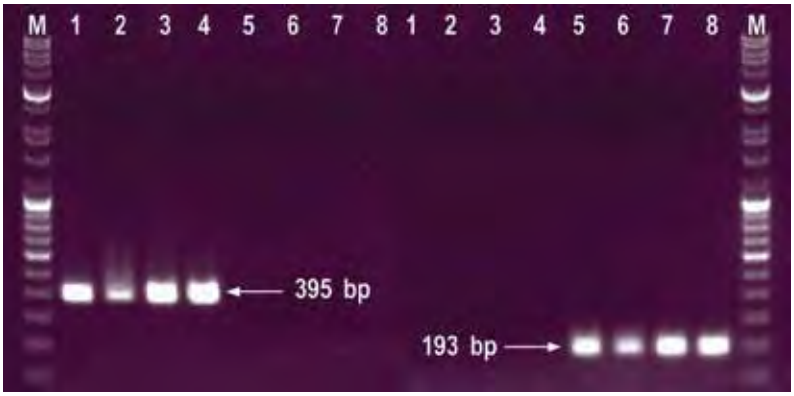


Fig. 2 Amplification of specific SCAR markers. M=100 bp ladder, 1-4=*P. longifolia*, 5-8=*S. asoca*

ASHWAGANDHA (*Withania somnifera*)

The plant belongs to family Solanaceae and is a wonder herb with multiple medicinal properties. Roots are used in preparation of vital tonics. It is a stress reliever and is used in treating senile dysfunctions. Its effect on controlling the effects of anxiety, depression, phobias, alcoholic paranoia, schizophrenia, etc is clinically established by different tests. 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. It is a late kharif crop and grown in marginal and submarginal lands having 7.5 to 8.0 soil pH.

Maintenance and evaluation of germplasm

DMAPR, Anand: A total of 140 ashwagandha accessions maintained were evaluated for yield and its related characters in augmented design. Significant variability was observed for majority of the traits including dry root yield among the accessions. Two accessions, *viz.*, RAS 137 and RAS 10 had significantly higher root yield than the best control variety JA -20.

CCSHAU, Hisar: Thirty wild type accessions were characterized at the centre and it was found that plant height varied from 54.78 cm (Acc. 2) to 83.39 cm (Acc. 5); root length from 22.0 cm (Acc. 27) to 44 cm (Acc. 24); root diameter varied from 1.19 cm (Acc. 27) to 2.12 cm (Acc. 24); branches per plant varied from 2.78 (Acc. 2) to 5.78 (Acc. 10); number of berries per plant varied from 34.11 (Acc. 4) to 141.44 (Acc. 15) and dry root yield varied from 255 kg ha^{-1} (Acc. 27) to 1250 kg ha^{-1} (Acc. 29) among the accessions. The highest root yields were observed in Acc. 29 (1250 kg ha^{-1}), followed by Acc. 30 (988 kg ha^{-1}), Acc. 20 (895 kg ha^{-1}), Acc. 24 & Acc. 24 (881 kg ha^{-1}) and Acc. 19 (858 kg ha^{-1}).

MPUAT, Udaipur: One hundred and thirty nine accessions along with two checks *viz*., JA-20 and JA-134 were evaluated for dry root yield and yield attributing characters as well as other quantitative and qualitative traits. Dry root yield ranged from 444 kg ha^{-1} (RAs-138) to 1111 kg ha^{-1} (RAs-93). Thirty two genotypes exhibited higher root yield over the check JA-20 and JA-134. Higher dry root yields were in genotype RAs-93 (1111 kg ha^{-1}), RAs-48 (1056 kg ha^{-1}), RAs-41 (1000 kg ha^{-1}), RAs-104 (972 kg ha^{-1}), RAs-92 and RAs-10 (945 kg ha^{-1}), RAs-148 (917 kg ha^{-1}), RAs-127 (944 kg ha^{-1}), RAs-23, RAs-46, RAs-76, RAs-84 and RAs-125 (889 kg ha^{-1}), RAs-131 (861 kg ha^{-1}), RAs-7, RAs-18, RAs-38, RAs-95, RAs-98 and RAs-160 (834 kg ha^{-1}), RAs-74, RAs-89, RAs-110, RAs-111, RAs-120 and RAs-122 (833 kg ha^{-1}), RAs-37 and RAs-129 (811 kg ha^{-1}), RAs-57, RAs-77, RAs-135 and RAs-151 (806 kg ha^{-1}). Fifty seven genotypes recorded higher alkaloid content over the best check (0.43%). The alkaloid content ranged from 0.16 to 0.62%. The highest alkaloid content was in RAs-21 (0.62%) followed by RAs-11, RAs-32, RAs-56, RAs-75, RAs-76 and RAs-148 (0.58%), while the lowest was in RAs-135 (0.16%).

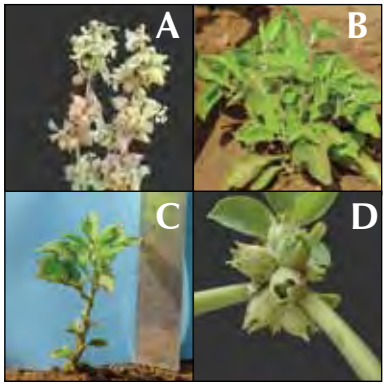


Fig. 3 *Ashwagandha* plants with clustered flowering (A), compact morphology (B), extra dwarf morphology (C) and open type calyx (D).

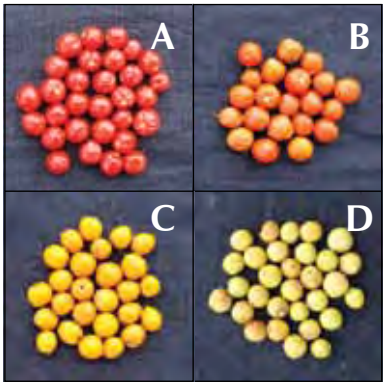


Fig. 4 Different berry colours of *ashwagandha*. Red (A), orange (B), yellow (C) and creamy white (D) berries.

Plant to-row progeny evaluation and selection

DMAPR, ANAND: Progeny rows of single plant selections made from open pollinated population of variety JA-134 during 2007 were advanced through repeated selfing for two years (2008 and 2009) and 214 lines have been selected. The lines obtained from them includes an extra dwarf plant (15-20 cm), plant with open type calyx, clustered flowering type, compact plant type with less fibrous roots and procumbent plant type (Fig. 3). Plant types with four different berry colours *viz*., red, yellow, orange and creamy white were also identified (Fig. 4). First time a male sterile plant in this species was identified.

Evaluation of selections

CCSHAU, Hisar: Eighteen selected accessions were evaluated at the centre along with the check JA- 134. Plant height varied from 34.67 cm (WS-105) to 53.89 cm (WS-202); root length varied from 15.89 cm (HWS-04-2) to 24.00 cm (JA-134); root diameter varied from 0.97 cm (WS-202-1) to

1.42 cm (WS-90-205); berry diameter varied from 0.44 mm (WS-90-126) to 0.54 mm (WS-125 & WS-220); number of branches varied from 2.44 (WS-124-1) to 4.56 (WS-90-205); number of berries plant^{-1} varied from 27.11 (WS-124-1) to 72.33 (WS-90.201); dry root yield plant^{-1} varied from 4.67 g (HWS-04-2-220) to 10.56 g (WS-124-1) and dry root yield ranged from 311 kg ha^{-1} (HWS-04-2) to 703 kg ha^{-1} (HWS-124-1). The highest dry root yield was recorded in WS-124-1 (703 kg ha^{-1}) followed by WS-124 (673 kg ha^{-1}), JA-134 (644 kg ha^{-1}), WS-202-1 (622 kg ha^{-1}) and WS-202 (607 kg ha^{-1}).

Assessment of the genetic diversity using molecular markers

DMAPR, Anand: Comparisons were made to find out the best method of DNA isolation from fresh leaves. It was found that modified CTAB method containing 4% CTAB, 0.6% ß mercaptoethanol in extraction buffer and 1% PVP during the grinding of samples produced better quality and quantity of genomic DNA. Sixty decamer RAPD primers of different series were used to screen the amplification pattern, out of which only 28 primers produced good amplifications and were used for characterization of 24 morphologically distinct accessions.

Effect of residual nutrients on yield

MPUAT, Udaipur: Variable nutrient doses were applied to the heavy feeder opium poppy through FYM (5, 10 and 15 t ha^{-1}), castor cake (equivalent to 25 and 50 kg N ha^{-1}) and inorganic fertilizer (25 and 50 kg N ha^{-1}). Residual effect of these nutrients and two levels of inorganic N (0 and 30 kg ha^{-1}) were investigated in *ashwagandha* during next season. Successive increase in FYM levels from 5 to 15 t ha^{-1} to opium poppy has increased significantly length, diameter and yield of root in addition to total alkaloids content and total alkaloids yield in succeeding ashwagandha crop. Highest dry root yield (805 kg ha^{-1}) was obtained from plots receiving 15 t ha^{-1} FYM. Similar trend was also observed with castor cake. Hence, higher dry root yield (747 kg ha^{-1}) was obtained from higher castor cake application. In case of both these organic nutrients, crude fibre contents in root were reduced significantly due to higher doses applied to preceding crop. Application of 50 kg N ha^{-1} through urea to opium poppy significantly increased productivity of dry root yield (755 kg ha^{-1}) compared to lower N dose. In case of nitrogen applied directly to *ashwagandha* through urea significantly increased length, diameter, and yield of roots, in addition to total alkaloids content and total alkaloids yield compared to control. Dry root yield of 744 kg ha^{-1} was obtained from this treatment.

Effect of spacing and nutrient levels on productivity

MPUAT, Udaipur: Six different spacing to accommodate plant populations ranging between 3.33 and 10.0 lakhs ha^{-1} along with three nutrient doses were tested. Maximum root length (19.1 cm) and dry root yield (1166 kg ha^{-1}) were recorded in closest spacing of 20x5 cm. However, it was found at par with few other spacing *viz*. 25x5, 30x5 and 20x10 cm. With successive increase in spacing (decrease in population), a reduction in root length and dry root yield was observed. However, root length and yield increased with increasing nutrient application. Maximum root length (18.4 cm) and dry root yield (1153 kg ha^{-1}) were obtained from highest nutrient dose (50-40-30, N-P-K kg ha^{-1}).

Effect of different organic nutrients on root yield

NDUAT, Faizabad: Three different organic manures (FYM, vermicompost and press-mud) and biofertilizer (PSB) were used in different doses and combinations to find out the best organic nutrient source for optimum yield. Press-mud at 10 t ha^{-1} resulted in the highest plant height (37.5 cm) while 10 t FYM ha^{-1} produced maximum branches (4.2 $plant^{-1}$). However, branches per plant from press-mud applied plots were also statistically at par with the best treatment. Root length varied significantly (11.9–20.4 cm). Maximum root length was recorded in 10 t ha^{-1} press-mud application. Root diameter was also significantly higher with press-mud application. However, fresh and dry root yields did not differ among the treatments.

Effect of insect pest infestation on root yield

DMAPR, Anand: In a paired plot experiment, half of the plots were maintained pests free with repeated spray of insecticides (alternatively, profenophos and monocrotophos) to control *hada* beetle (*Epilachna vigintioctopunctata*). Significant difference in dry root yield was recorded between the treatments, 529.6 and 348.3 kg ha^{-1} from protected and control plots, respectively.

Seasonal incidence of *hada* beetle

DMAPR, Anand: Incidence of *hada* beetle (*E. vigintioctopunctata*) was monitored on cultivar WS-134. The insect activity started from 3rd week of October and reached to the peak during the 4th week of October and thereafter declined till 4th week of December. There was no insect activity after December till harvest of the crop.

To know the hibernation period of adults under the field conditions, 10 adults were released inside a protected area covered with net during 3rd week of December. It was observed that feeding activity started during the 2nd week of February. Eggs and its other developmental stages were also seen during this period. This investigation indicated that the adults undergo hibernation during the winter months and resumed activity as soon as the temperature increased.

Chemical profiling of selected lines

RVSKVV, Mandsaur: Fourteen lines, selected on the basis of morphological traits were screened for variability in steroidal lactones (withanolides) content through preparatory TLC. Chromatogram showed wide variability in the collection with total 13 different compounds. Least number of compounds (3) were found in MWS-10-101 and MWS-10-110 while highest number of spots (8) were seen in MWS-10-002. The compound with RF value 0.97 was common to all lines except MWS-10-110 whereas, compound at RF 0.28 was found only in plants with orange berries (MWS-10-103, MWS-10-104, MWS-10-106, and MWS-10-111). Similarly, specific compounds with RF values 0.68 and 0.24 were present in lines with red berry, except MWS-10-006. The compound with RF value 0.68 varied from 3.81% in MWS-10-004 to 10.88% in MWS-10-001. The other compound (RF = 0.24) varied from 57.68% (in MWS-10-005) to 16.04% (in MWS-10-002).

Post harvest microbial load and aflatoxin contamination

MPUAT, Udaipur: Dried root samples collected from markets, farmers' stock and experimental plots were analyzed. The bacteria were the dominant microbes present in all

samples. However, fungi belonging to genera *Trichoderma*, *Aspergillus*, *Rhizopus* and *Fusarium* were also found to be present. Aflatoxin level varied between 0.035 and 0.063%. Highest contamination was present in samples collected from farmers' stock and lowest in the market samples.

BALA (*Sida cordifolia*)

Bala is an annual herb of family Malvaceae. There are four different varieties *viz*. *bala*, *atibala*, *nagabala* and *mahabala* of which *bala* is most widely used. *Sida cordifolia* is considered as the source of raw drug bala in North India while in South India *Sida rhombifolia* is accepted as the source of the raw drug. All the *Sida* species are widely distributed as a weed in the cultivated fields of tropical and subtropical regions of India. Cultivation in limited scale has been initiated in the 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 planting dates and spacing on yield

KAU, Thrissur: The crop was planted at monthly intervals between May 15 and August 15 following five different spacing (50x25, 50x50, 75x50, 100x25 and 100x 75 cm). At harvesting, either of the planting times and spacing did not influence plant height. However, number of branches plant^{-1} was maximum (48.6) at May planting. Planting time also influenced root growth. Longest root (49.6 cm) with maximum lateral roots (22.9 plant^{-1}) was produced from May planting. Hence, maximum dry root yield (13.2 g plant^{-1}) was obtained from May planting. Spacing also influenced root growth and yield. Widest spacing resulted in highest dry root production (13.5 g plant^{-1}). However, closer spacing produced more root yield per unit area and maximum fresh (786.3 kg ha^{-1}) and dry (603.1 kg ha^{-1}) root yields were obtained from 50x25 cm spacing. Among the planting times, May and June plantings were found producing higher fresh (541.8 and 438.1 kg ha^{-1}) and dry (389.7 and 328.7 kg ha^{-1}) root yields than July planting.

BHUI AMLAKI (*Phyllanthus amarus*)

It 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 lands. The whole herb is used for the medicinal purposes. 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 the 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. Five months old plants are harvested and dried and used as raw drug.

Effect of spacing and date of sowing on yield

AAU, Anand: The crop was grown at varying spacing (15x5 cm, 30x5 cm, broadcasting) with three dates of sowing (1 July, 15 July and 1 August). Plant stand and height were significantly influenced by spacing and interaction effect. Maximum plant stand (122 per 50x45 cm area) was maintained at broadcasted crop sown in August. Plant height was maximum (58.7 cm) at 1 July sowing, but was not influenced by spacing. However, spacing and sowing dates both significantly influenced the dry biomass yield. Maximum yield was obtained from 15x5 cm (2311 kg ha^{-1}) and 1 July sowing (2217 kg ha^{-1}).

BRAHMI (*Bacopa monnieri*)

The plant 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 considered as astringent, diuretic, laxative, tonic for the heart and nerves and is 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 spacing on yield

KAU, Thrissur: Planting was done at four spacing (10x10, 20x10, 20x20 and 40x20 cm) to optimize yield. Widest spacing promoted best vegetative growth of the plant. Hence, runner length (134.8 cm) and number of leaves per runner (491.7) were highest than the other spacing. These values were almost double compared to other closer spacing. Number of branches (35.5 $plant^{-1}$) and inter node length (4.4 cm) were also highest at 40x20 cm spacing. However, herbage yield was lowest with the widest spacing.

CHIRAYITA (*Swertia chirayita*)

The plant belongs to family Gentianaceae. It 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 Himalaya . 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 different spacing and pinching on growth and yield

YSPUHF, Solan: Possibility of increasing the herbage yield through spacing and pinching was tried. Spacing (30x30, 30x45 and 45x45 cm) and pinching (at 10, 20, 30, 40 cm height and no pinching) had significant effect on all the growth and yield parameters recorded. Plants with no pinching attained maximum height (131.9 cm) compared to pinched ones. Close spacing (30x30 and 30x45 cm) produced taller plants (101.9 and 101.3 cm, respectively). Hence, plants with no pinching at closest spacing were tallest (138.0 cm). Pinching also failed to induce more branching. Hence, non pinched plants had maximum branches plant^{-1} (21.8). Among different spacing, closer spacing resulted in more branching (9.7–10.0 plant^{-1}) than 45x45 cm spacing. Hence, plants grown at 30x30 and 30x45 cm spacing without pinching produced highest number of branches (23.7 and 22.7 plant^{-1}, respectively). However, fresh (69.3 g plant^{-1}) and dry (17.0 g plant^{-1}) herbage yields were obtained from plants spaced at 30x45 cm and pinched at 40 cm height.

Effect of biofertilizers and GA_3 on seed germination and seedling vigour

YSPUHF, Solan: Seed treatment with GA_3 (50 or 100 ppm) and soil application of biofertilizers (*Azotobacter*, PSB or VAM) in different combinations were used. Germination percentage significantly increased over control with different treatments. Highest seed germination (78.33%) was observed when seeds were treated with 100 ppm GA_3 and sown in media containing all the biofertilizers. This was at par (73.33–76.67%) with the other treatments where any concentration of GA_3 and any biofertilizer were used in combination. Higher dose of GA_3 induced significantly early germination (23.3–24.3 days). However, germination duration was minimum whenever GA_3 was used (6.0–8.0 days). Accordingly, mean germination time was minimum (26.8–28.9 days) in these treatments. Seedling growth in terms of root length and number of leaves plant^{-1} was best with 100 ppm GA_3 + Azotobacter + VAM (22.3 cm and 14.0, respectively).

Leaf spot disease

GBPUAT, Bharsar: A leaf spot disease was found to affect both the species, *S. cordata* and *S. ciliata*. The disease appeared on mature plants nearing flowering stage. A fungus was isolated from the affected leaves. Healthy plants inoculated with spore suspension of the fungus reproduced identical disease symptoms. On the basis of cultural and morphological characteristics, the pathogen was identified as *Alternaria alternata*.

GERMAN CHAMOMILE *(Matricaria chamomilla)*

It is an annual herb belongs to family Asteraceae and endemic to Europe and temperate Asia. It is widely introduced in temperate North America and Australia. The branched stem is erect and smooth and grows to a height of 15-60 cm. The hollow receptacle of the inflorescence is swollen and lacks scales. This property distinguished German Chamomile from Corn Chamomile (*Anthemis arvensis*), which has a receptacle with scales. The flowers have a strong, aromatic smell, and bloom in early to mid summer.

Flower heads and herbage are medicinally important. It is used as tonic, stomachic, anodyne, and antispasmodic. Chamomile has calming and soothing properties. It is used against nervousness, headaches, anxiety, and hysteria. It is also beneficial for colds and flu. Its antispasmodic properties benefit cramps and spasms, probably due to the easily assimilable form of calcium found in it. Chamomile is frequently used for digestive complaints and taken regularly will gently regulate the bowels.

Effect of various organic nutrients on flower yield

NDUAT, Faizabad: Among the three different organic sources (FYM, vermicompost and press-mud) used, press-mud resulted in best growth. Tallest plant at flowering was recorded with press mud 15 t ha^{-1} (48.3 cm). Minimum plant height of 30.33 cm was measured in control. Number of branches was also maximum (23.3 $plant^{-1}$) in this treatment. However, maximum fresh (4509 kg ha^{-1}) and dry (3884 kg ha^{-1}) flower yields were recorded with lower dose of press-mud (10 t ha^{-1}).

GILOE (*Tinospora cordifolia*)

It is a member of family Menispermaceae. It is a deciduous perennial climber and is distributed throughout tropical India. The species produces a lot of aerial roots. It is propagated by stem cuttings as well as by 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.

Characterization of germplasm

DMAPR, Anand: Forty three accessions maintained were characterized. Based on starch granular size (perimeter) and their frequency distribution in each accession, the germplasm was classified into five classes *i.e.*, very small, small, medium, big and very big. In the class of starch granules of 'very small', perimeter of the starch granules was 15-45 μm; in 'small' class, perimeter was 46 to 75 μm; in 'medium' class, it was 76 to 105 μm; in the 'big' class it was 106 to 135 μm and in 'very big', it was 136 to 165 μm. Based on the frequency distribution of starch granules of different classes, the germplasm was also classified into five classes. The study showed that majority of the accessions were having small starch granules (perimeter 46 to 75 μm, L1 10 to 25 μm and L2 of 10 to 20 μm).

Fresh stem was harvested from 18- month old plants of the accessions. Dry matter content varied from 13.56 to 33.03% within the accessions. Fresh yield varied from 0.09 to 5.44 kg $plant^{-1}$ and dry stem yield varied from 0.03 to 1.43 kg $plant^{-1}$. Highest dry stem yield was

recorded in IC 283650 (1.43 kg plant-1) followed by Kalyani (0.71 kg plant-1), IC 310602 (0.64 kg plant-1) and GUJ 4 (0.60 kg plant-1). Stem starch content varied from 12 to 52% on dry weight basis among the accessions.

GUGGAL (*Commiphora wightii*)

Guggal is a member of family Bursearaceae. It is a perennial shrub or small size tree of about 5 m height. 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 Indian System of Medicine. The species is included in the Red data book (IUCN) since the species is over-exploited 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 61 % resins and 29.3 % gum, 6.1% water, 0.6 % volatile oil and 3.2 % foreign matter. Guggulosterol and guggulsterone are the important active ingredients of the gum resin.

Assessment of genetic relationship in the germplasm using RAPD and ISSR markers

DMAPR, Anand: Twenty four accessions of *C. wightii* collected from diverse locations of Rajasthan were fingerprinted using RAPD markers to study the genetic relationships between and among them. A total of 50 RAPD primers from A, N and P series were used to amplify the DNA and their ability to generate consistently amplified banding patterns and to assess the polymorphisms in the accessions. Of the 50 primers used from OPA, OPN and OPP series, 16 primers revealed polymorphic and unambiguously scorable bands which were used to study the relationships between and among them. Dendrogram constructed by using UPGMA method of pooled RAPD data formed two major groups and each group contained many distinct sub groups and clusters, which signified the wide diversity among the accessions. Moreover, Jaccard's similarity coefficient showed that Raj 13 and Raj 14 were most closely related with a similarity value of 0.98 followed by Raj 09 and Raj 10 (0.94) whereas Raj 03 and Raj 20 were most remotely placed with the similarity coefficient of 0.47.

A total of 27 ISSR markers were screened for temperature optimization out of them 16 were selected based on their banding pattern clarity and polymorphism. The size of the bands amplified using 16 primers were in the range of 230bp to 3000bp. A total of 98 bands were scored from 16 primers out of which 80 bands were polymorphic in nature. The average polymorphism recorded by the ISSR loci was 82%. The Jaccard's coefficient and SHAN clustering showed that Raj 01 and Raj 04 were most closely related with a similarity value of 86% while Raj 03 and Raj 24 were most remotely placed with the similarity value of 43%. The constructed dendrogram formed two groups with 10 sub groups and 17 clusters which showed a wide variability among the accessions.

Effect of pollination on fruit set

DMAPR, Anand: Five lines selected from the germplasm were used for this experiment. In the pollination study, flowers of three female lines (A 12, G 15 and M7) were hand pollinated by using pollen grains from males. Two hermaphrodites (O1 and W7) were allowed for natural self pollination. In A12, 288 flowers were pollinated out of which 50 developed fruits (17.36 %); of which 15 were unfilled (30% of developed fruits), In G15, 229 flowers were pollinated out of which there were 105 developing fruits (45.85 % of pollinated flowers); of which 46 were unfilled (43.81 % of developing fruits), In M7, 267 flowers were pollinated out of which 86 developed into fruits (32.21 % of pollinated flowers); of which 28 were unfilled (32.56 % of developed fruits). In the hermaphrodite O1, 308 flowers were pollinated out of which there were 56 developing fruits (18.18% of pollinated flowers) of which 28 were unfilled (50.00 % of developed fruits , In W7, 302 flowers were pollinated out of which 39 developed fruits (12.91 of pollinated flowers) of which 8 were unfilled (20.51 % of developed fruits). In the second study, cotton was applied over the stigma of three female lines (A 12, G 15 and M7) to avoid pollen. It was found that in line A 12, out of 65 flowers tested, there were 5 developing fruits (*i.e.* 7.69 %) of which all were filled. In line G 15, out of 53 flowers tested 19 developed fruits (35.85 %) of which 2 were unfilled (10.53 % of developed fruits) and in line M7, out of 75 flowers tested there were 10 developing fruits (13.33 %) of which 4 were unfilled (40 % of developed fruits). The study showed that in this apomictic species, pollination enhanced fruit development.

Effect of soil moisture on growth, physiology and yield

DMAPR, Anand: Four month old guggal rooted cuttings were subjected to five different soil moisture (30–10%, in 5% interval) regimes (SM30–SM10). Higher stem water potential (Ψ) and leaf relative water content (RWC) while lower electrolyte leakage (EL) were observed in plants grown at 30–25% soil moisture, indicating better water relations in these plants compared with those grew at low soil moisture. Plants at higher moisture depletion reacted by stomatal closure to reduce transpiration rate (*E*). However, instantaneous water use efficiency (*i*WUE) was greater in plants under SM30–SM20 compared with SM15–SM10. Total leaf chlorophyll (chl) content drastically reduced from 1.5 mg g^{-1} (at SM30) to 0.5 mg g^{-1} (at SM10). Quantum efficiency of open PSII centres (F_v/F_m), photochemical efficiency PSII (F_v'/F_m'), quantum yield of noncyclic electron transport (Φ_{PSII}), quantum yield of CO_2 assimilation (Φ_{CO2}) and electron transport rate (ETR) showed reducing trend with increasing moisture stress. Photo chemical quenching (*q*P) and non–photo chemical quenching (*q*N) had opposite relationship. All these indicated lower soil moisture levels (SM15–SM10) had profound effect on photochemical machinery of guggal plants and resulted in 84.7–96.7% reduction in net photosynthesis rate (P_n). Consequently, plant growth rate hampered significantly with depleting soil moisture. Higher soil moisture (SM30) supported best growth rate (plant height, 98.0 cm; and leaves per plant 155.4) while least was at SM 15 and SM10. Oleo-gum-resin production reduced by 11–20% at SM15–SM10 compared with SM30.

Effect of nitrogen doses on growth and yield

DMAPR, Anand: In a pot experiment, rooted cuttings were applied with 0–0.34 g N kg^{-1} soil through urea. However, after two months of growth, significant differences could not be

observed in plant height and number of branches. Rather leaves plant^{-1} showed a decreasing trend. Highest N applied plants had minimum (44.8) and control plants had highest (87.3) leaves. Gum yield also showed no significant variation among the treatments.

Seasonal variation on gum oozing

DMAPR, Anand: Plants were tapped during four seasons *viz*. post-rain (mid September), winter (December end), post-winter (mid February) and summer (May end). Gum oozing was achieved in all the tapping. However, oozing stopped immediately after initiation when tapped at summer. Also, time taken between tapping and initiation of oozing varied significantly. Maximum time was taken during winter (13.2 days) and minimum during summer (4.4 days). Maximum gum yield was obtained from post-rain tapping (42.3 g branch^{-1}).

ISABGOL (*Plantago ovata*)

The species belongs to family Plantaginaceae. Seed coat is known as 'isabgol husk' or 'psyllium husk' under trade. It is a rabi sown 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.

Creation of variability

DMAPR, ANAND: M3 generation of chemical mutagen treated (DES, EMS and Colchicine) 1736 plant-to-row progenies were raised and 439 lines were selected and named as DPO 1 to DPO 439 (DPO = Directorate *Plantago ovata*). An early flowering (30–35 DAS) and maturing (80–85 DAS) mutant, DPO 14 was identified (Fig. 5A). It had an average plant height of 37.6 cm, 60 leaves plant^{-1}, 37 spikes plant^{-1}, 9.84 g biomass plant^{-1} and seed yield of 2.25 g plant^{-1}. Considerable variation for physiological and biometrical traits was recorded among the 60 selected lines.

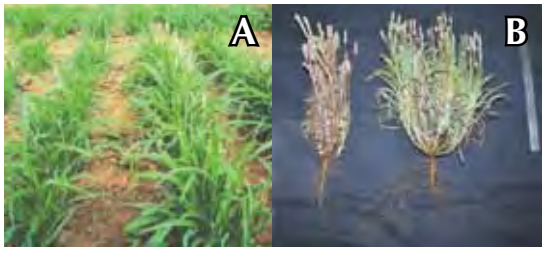


Fig. 5 Variability in *isabgol*. Early flowering type (right) accession (A), tetraploid plant (right) in comparison to diploid (B).

From the colchicines treated plant progenies of GI-2 variety, a tetraploid plant (Fig. 5B) was isolated. Tetraploids plants were more vigorous than the diploids.

Screening for physiological parameters under water stress

DMAPR, Anand: Sixty M_3 generation stable isabgol lines derived from DES, EMS and colchicine were screened for physiological traits like pre-dawn and mid day water potential, gas exchange and chlorophyll-a fluorescence kinetics. Under irrigated conditions, water potential (Ψ) ranged between –1 to –6 bar in the lines. Lowest predawn Ψ was recorded in line-37 (–1.27 bar) and highest in line-11 (–6.40 bar). Mid-day Ψ values ranged between –6 to –17 bar, measuring lowest (–6.47 bar) in line-1 and highest (–16.9 bar) in line-52. Similarly, predawn Ψ ranged between –2 to –13 bars in the lines at 20 days after irrigation, with lowest value of –2.40 bar in line-30 and highest (–12.73 bar) in line-56. Mid-day Ψ ranged between –14 to –25 bars in the lines studied. Lowest Ψ was recorded in line-37 with –13.67 bar and highest with –25.47 bar in line-20. Gas exchange parameters and chlorophyll fluorescence recorded under saturated soil moisture conditions showed significant variations between the lines. Net photosynthetic and respiration rates were highest in line-17 and line-24 (27.1 and 5.95 μmol CO_2 m^{-2} s^{-1}, respectively) while lowest in line-42 and line-7 (8.1 and 0.83 μmol CO_2 m^{-2} s^{-1}, respectively). Similarly, leaf conductance and transpiration rate were found to be highest in line-54 with 218 μmol H_2O m^{-2} s^{-1} and 6.17 mmol H_2O m^{-2} s^{-1}, while lowest in line-42 with 42.3 μmol H_2O m^{-2} s^{-1} and 1.2 mmol H_2O m^{-2} s^{-1}, respectively. Photochemical efficiency of PSII (F_v/F_m) remained above 0.80 for most of the lines tested, while lowest value was recorded in mutant 58 (0.70). Also, quantum yield of noncyclic electron transport (Φ_{PSII}) and photochemical quenching were highest in line-44 with 0.33 and 0.59, but lowest in line-10 (0.158) and line-22 (0.336) respectively. Positive and significant correlation existed between traits related to plant water status and photosynthetic capacity in mutants. Traits for higher plant water status, carbon assimilation and fluorescence may be beneficial for identifying tolerant lines for increased productivity under limited soil moisture.

Effect of irrigation schedules and nitrogen on pest attack and yield

DMAPR, Anand: The crop was grown with four different irrigation schedules and supplied with five nitrogen doses. Half of the experimental plots were protected against disease and insect attacks by appropriate pesticide application (0.2% metalaxyl, 0.2% mancozeb and 0.1% propanophos) and the rest half was left untreated. Aphid infestation initiated during last week of January and population reached to its peak during second week of February. Infestation was positively influenced by N doses. Hence, irrespective of irrigation schedules, maximum aphid infestation $plant^{-1}$ (33.78) was observed at highest N (60 kg ha^{-1}). However, this was at par with 45 kg ha^{-1} N (29.68 aphids $plant^{-1}$). Interestingly, aphid population showed a decreasing trend after 4th week of February and became negligible by 1st week of March. Downy mildew disease severity was also significantly influenced by the fertilizer doses but not due to irrigation schedules. Maximum disease (PDI) was recorded at 60 kg N ha^{-1} (14.23) which was at par with 45 kg N ha^{-1} (13.29). Minimum PDI was at 0 N (9.44). Pests attack resulted in drastic yield reduction and no difference between the treatments could be found in terms of seed yield from the untreated block. However, effective pest control helped in higher yield realisation. Maximum seed yield (1253.4 kg ha^{-1}) was recorded at 60 kg ha^{-1} N which was at par with those of 45 kg ha^{-1} N (1193.9 kg ha^{-1}) and 30 kg ha^{-1} N (1249.7 kg ha^{-1}). Control produced minimum seed yield (726.2 kg ha^{-1}). Similarly, straw yield from pesticide treated block also showed significant differences due to N applications. Significantly highest (5518.2 kg ha^{-1}) and lowest (2506.6 kg ha^{-1}) straw yields were obtained from 60 kg ha^{-1} N and control, respectively.

JIVANTI (*Leptadenia reticulate*)

The plant 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 different organic manures on yield

AAU, Anand: Six different organic manures were applied (10 t FYM ha^{-1}, 5 t poultry manure ha^{-1}, 2 t vermicompost ha^{-1}, 2 t castor cake ha^{-1}, 2 t neem cake ha^{-1} and 1 l ha^{-1} Azotobacter + PSB) as nutrient sources. Total herbage was harvested twice at 90-days interval beginning from 90 DAS. FYM application resulted in maximum dry herbage yield (6780 kg ha^{-1}). However, it was at par with castor cake (6038 kg ha^{-1}) and poultry manure (5876 kg ha^{-1}).

KALMEGH (*Andrographis paniculata*)

It is a highly branched annual plant belongs to family Acanthaceae. *Kalmegh* grows erect to a height of 30-110 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 accessions were evaluated for plant height, number of branches per plant and fresh as well as dry weights of herbage. Plant height ranged from 51.65 to 60.66 cm. Accession IC-211295 had maximum plant height (60.66 cm) followed by IC-471894 (58.15 cm) and IC-471917 (57.74 cm). Minimum plant height was in genotype IC-111288 (51.65 cm). Number of branches per plant varied from 24.29 to 32.71. Maximum number of branches was in IC-471919 (32.71) followed by IC-471918 (28.62) and IC-471894 (27.64). Lowest number of branches was noted in genotype IC-111291 (24.29). Fresh herbage yield varied from 5478 to 9333 kg ha^{-1}. Accession IC- 471918 had highest herb yield (9333 kg ha-1) followed by IC-111291 (8107 kg ha^{-1}), IC- 471895 (8084 kg ha^{-1}) and IC-111288 (6964 kg ha^{-1}). Dry herbage yield varied from 2561 to 4410 kg ha^{-1}. IC-471918 had highest dry herbage yield (4410 kg ha^{-1}) followed by IC 111291 (3700 kg ha^{-1}), IC 471895 (3399 kg ha^{-1}) and IC 111288 (3206 kg ha^{-1}).

Effect of intercropping with various proportion of pigeon pea (*Cajanus cajan*)

PDKV, Akola: A field experiment was conducted where kalmegh was grown as intercrop in pigeon pea at different proportions (pigeon pea: kalmegh 1:1, 2:1, 2:2 and 4:2) and as individual sole crops. It was observed that heights of pigeon pea and kalmegh were not influenced either by various row proportions or by sole crops. Branches plant^{-1} of kalmegh was significantly higher (42.1) when it was grown as sole crop. However, pigeon pea growth was not affected due to intercropping. Better vegetative growth of kalmegh as sole crop produced maximum fresh (76.2 g plant^{-1}) and dry (29.1 g plant^{-1}) herbage. Among different intercropping treatments, lowest dry herbage of kalmegh was produced at 2:2 combinations (6.4 g plant^{-1}), others being similar to each other (7.2–8.6 g plant^{-1}). Andrographolide content was found significantly high (1.74%) when kalmegh was grown as sole crop. In terms of pigeon pea seed yield, comparable yield (1342.9–1047.4 kg ha^{-1}) was produced in all treatments including sole crop except 1:1 combination, which was lowest yielder (837.1 kg ha^{-1}). Maximum pigeon pea equivalent yield was obtained from the main and intercrop combination of 2:1 (1496.9 kg ha^{-1}) which was at par with 2:2 and 4:2. Hence, these three intercropping combinations showed significantly higher land equivalent ratio (1.52–1.46) than sole crops or combination.

Selection of nutrient sources for optimum yield

NDUAT, Faizabad: A field trial was conducted with six different combinations of organic (6–16 t FYM ha^{-1}) and inorganic nitrogen (0–50 kg ha^{-1}) application for yield optimization. Half of the inorganic N was applied as basal and rest in two equal splits at 20–30 and 50–60 days after transplanting. Plant height was not significantly influenced by the treatments. Maximum number of branches (26.8 plant^{-1}) was produced when inorganic nitrogen was applied maximum (6 t FYM ha^{-1} + 50 kg N ha). However, highest fresh (273.5 g plant^{-1}) and dry (136.8 g plant^{-1}) leaves were produced with 14 t FYM ha^{-1} + 10 kg N ha^{-1}. Fresh and dry stem yields were highest with 14 t ha^{-1} FYM along with 10 kg N ha^{-1}. However, this treatment was at par with 16 t FYM ha^{-1} and 14 t ha^{-1} FYM + 10 kg N ha^{-1}. Total herbage yield varied significantly due to various doses of FYM and inorganic nitrogen. Dry herbage yield was maximum with 14 t ha^{-1} FYM + 10 kg N ha^{-1} (4505 kg ha^{-1}), which was statistically at par with that from 6 t ha^{-1} FYM + 50 kg N ha^{-1} (4138 kg ha^{-1}).

Effect of residual nutrients on yield

MPUAT, Udaipur: To examine the long term effect of various organic and inorganic manures applied to isabgol, residual effect on succeeding kalmegh crop was investigated. Nine different organic nutrients and urea were applied to provide 30 or 45 kg N ha^{-1} to isabgol. Dry herbage yield of succeeding kalmegh was significantly highest due to FYM (3389 kg ha^{-1}), though it was found at par with neem cake (3186 kg ha^{-1}), castor cake (3180 kg ha^{-1}) and poultry manure (3177 kg ha^{-1}). Interestingly, residual effect of urea on succeeding kalmegh was significantly low compared to all other sources with lowest dry herbage yield (2213 kg ha^{-1}). Neem cake and castor cake resulted in highest andrographolide content, 1.38 and 1.30%, respectively. It was also found that higher nitrogen equivalent (45 kg ha^{-1}) level resulted in better dry herbage yield (2965 kg ha^{-1}) and andrographolide content (1.06%). Absolute control resulted in drastic lower yield (1929 kg ha^{-1}) compared to nitrogen treatment (2899 kg ha^{-1}).

KAUCHA (*Mucuna prurita*)

The species is a pubescent annual climbing shrub with long vines that can reach over 15 m in length belonging to family Fabaceae. The leaves are trifoliolate; the leaflets, broadly ovate, elliptic or rhomboid ovate and unequal at the base; the flowers, purple and in axillary, pendulous racemes. The fruit (pod) is covered densely with stinging hairs. It is distributed almost throughout India and also cultivated in limited areas. The seeds are used to treat, Parkinson's disease, sexual disorders, cholera, urinary troubles and liver and gall bladder diseases. L-dopa present in the seeds is the active principle responsible for therapeutic action. Seeds are used for propagation and sowing is done at the onset of monsoon. Since it is a climber, support is required under cultivation. Flowering starts after 40 days of growth.

Effect of nutrient doses and biofertilizer seed treatments on yield

PDKV, Akola: The crop was grown during kharif season (July–January) with different levels of FYM and seed treatments with biofertilizers. Application of 5 t ha^{-1} FYM in combination with seed treatment of *Rhizobium* and PSB produced highest seed yield (3482 kg ha^{-1}). This was at par with the other treatments where 5 t ha^{-1} FYM were used along with any one biofertilizer. Highest root nodule formation (20.6 $plant^{-1}$) was observed when crop was supplied with 5 t ha^{-1} FYM and both the biofertilizers. Test weight was higher wherever 5 t ha^{-1} FYM was applied. Although the L-DOPA content was not significantly influenced by different treatments, the total L-DOPA yield significantly varied among the treatments. Highest L-DOPA yield (98.08 kg ha^{-1}) coincided with highest physical yield while, 5 t ha^{-1} FYM (84.48 kg ha^{-1}) and 5 t ha^{-1} FYM along with *Rhizobium* seed treatment (86.71 kg ha^{-1}) produced lower L-DOPA yield. Considering cost of cultivation as Rs. 9500 ha^{-1} and selling rate of seed as Rs. 10 kg^{-1}, significantly highest gross monetary return (Rs. 35030 ha^{-1}) was also recorded from highest yielding treatment. It was however, statistically at par with that of 5 t ha^{-1} FYM in combination with either of the biofertilizers application.

LONGPEPPER (*Piper longum*)

Long pepper 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. Ripened 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 for the propagation of the species. From the 8th month of planting onwards 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, evaluation and maintenance of germplasm

AAU, Jorhat: Ten *Piper* species were collected from different locations of North-East region of Assam and Meghalaya during the year 2009 and 2010. These collections are maintained and catalogued. The passport data of the collected specimen were also prepared and accession numbers were also given against each collection. Morphological features of the collected plants were studied.

Effect of nutrient doses on yield

PDKV, Akola: Influence of different nutrient doses – supplied through inorganic, organic or combination of the two was studied in terms of growth, yield and quality. Application of 100:50:50 NPK kg ha^{-1} inorganic nutrients along with 10 q ha^{-1} neem cake resulted in maximum plant height (97.3 cm). This was at par with that observed with similar inorganic nutrients, sole (94.6 cm) or in combination with 10 t ha^{-1} FYM (96.1 cm). These three treatments also produced significantly highest dry fruit yields (371.689–407.94 kg ha^{-1}). Active ingredient, piperin content did not vary significantly among different treatments.

A new leaf spot disease

AAU, Jorhat: A leaf spot disease was recorded in some of the collections. Leaf spots were indistinct to definite, sub circulate to irregular in form, 4–10 mm in diameter, reddish brown on upper surface, some times with pale green to yellowish brown, on lower surface grayish olivacious. A fungus was isolated from such tissues on PDA and Koch's postulate was established. Morphological characters of the fungus were studied in detail. Fruiting body was hypophylous, sub afused, conidiophore solitary or in small fasicules emerging from stomata, subhyaline to pale yellowish brown, mostly non septate, rarely 1–3, geniculate, 2–4 x 10–15 μm; conidia subhyaline to pale olivacious , narrowly obclavate, 1–5 septate, straight to mildly curved, base obconically truncate, tip blunt to conic, 2–3.5 x 15–75 μm. Based on the above morphological characterstics the organism was identified as *Cercospora piperanta*.

MAKOI (*Solnaum nigrum*)

It is a herb or short-lived perennial shrub belongs to family Solanaceae. It has 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

against fever and to 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 for preserves, jams, and pies. The fruit is used as a cosmetic; rubbing the seeds on the cheeks remove freckles. The fruit has been used for diabetes. 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.

Effect of organic manures and inorganic nitrogen levels on yield

APHU, Bapatla: Makoi was grown in a factorial experimental design with different combinations of organic manures (10 t FYM ha^{-1}, 1 t ha^{-1} neem cake or, 1 t ha^{-1} vermicompost) and inorganic nitrogen (80, 60, 40 or, 20 kg ha^{-1}) nutrients. Basal levels of 40 kg P and 50 kg k ha^{-1} were applied through inorganic fertilizers. Among the organic manures, neem cake and vermicompost produced better herbage yields, 10195 and 9466 kg ha^{-1}, respectively than FYM. Inorganic nitrogen of 40 kg ha^{-1} resulted in highest yield (12788 kg ha^{-1}). However, higher and lower nitrogen applications than this dose caused yield reduction, due to higher disease and insect attacks.

Effect of organic manures and biofertilizers on yield

APHU, Bapatla: Different nutrient dose (5–10 t ha^{-1} FYM or 50 kg ha^{-1} inorganic N) in combination with different biofertilizers (5–10 kg ha^{-1} Azospirillum, 10 kg ha^{-1} Phosphobacter and their combinations) were tried to optimize growth and yield. The inorganic N increased the growth and yield parameters. Hence, plant height (46.8 cm) and number of branches (13.1 $plant^{-1}$) were maximum with 50 kg ha^{-1} N. Consequently, herbage yield was also highest (3178 kg ha^{-1}) in this treatment. Among the bio-fertilizers, *Azospirillum* + *Phosphobacter* (each 5kg ha^{-1}) maximized plant height (48.5 cm), branches (12.5 $plant^{-1}$) and herbage yield (2338 kg ha^{-1}). Hence, maximum yield (3445 kg ha^{-1}) was obtained from the combination of 50 kg ha^{-1} and supplement of 5 kg ha^{-1} each *Azospirillum* and *Phosphobacter*.

MAMEJO (*Enicostemma axillaris*)

It is a perennial herb belongs to family Gentianaceae. The species is distributed throughout most of India to an 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 anthemintic 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, swertimarine, alkaloids, ophelic acid and tannins. The species is also used as an adulterant of *Chiraita* (*Swertia chirayita*). The plant is not under regular cultivation and the raw drug is collected from the wild habitats.

Standardization of harvesting frequency

DMAPR, Anand: The root suckers were planted in poly bags with potting mixture of sand: soil: FYM in the ratio of 2:1:1. After 45 days when sufficient rooting was observed, the rooted suckers were transplanted in the main field at a spacing of 30x30 cm. The first harvest was done five months after transplanting when more than 50% of the plants showed lower leaf senescence. All the plots were harvested uniformly and the average fresh herb yield was 500 kg ha^{-1}. Subsequent harvesting was done at variable interval of 30, 45, 60 and 75 days. The maximum fresh herbage yield was recorded when harvested at 60 days interval (6870 kg ha^{-1}, 3 harvests in 180 days) followed by 45 days interval (6302 kg ha^{-1}, 4 harvests in 180 days) and 75 days interval (5450 kg ha^{-1}, 2 harvests in 180 days). The least fresh herb yield was recorded when harvesting was done at 30 days interval (3490 kg ha^{-1}, 6 harvests in 180 days).

Chromatographic separation of chemical compounds

DMAPR, Anand: The aerial part (without fruit) was collected, cut into the small pieces and shade dried. Preliminary chemical analysis of the aerial parts showed that it contained mixture of volatile chemical compounds (~0.006%) and about 29.0% water soluble extract. The water soluble extract was further macerated with methanol. It was found that the sample contained ~20% methanol soluble and ~9.0% methanol insoluble portions. Air dried aerial parts was extracted with methanol and the yield of the extract was found to be 34.5%. Methanol extracts (60 g) was macerated with dichloromethane. Dichloromethane soluble portion of methanol extract was chromatographed over silica gel and two pure compounds, EA-1 (200 mg) and EA-2 (110 mg) were isolated. Dichloromethane insoluble portion was also chromatographed over silica and a pure compound, EA-3 (2.5 g) was isolated and purified.

MANDUKAPARNI (*Centella asiatica*)

Mandookaparni is a member of family Apiaceae and is a prostrate slightly aromatic, perennial herb commonly found as a weed in crop fields. The species is widely distributed in India. It is propagated both by stolons as well as by seeds. It is used for the treatment of leprosy, skin diseases and to improve memory. It is also used against cholera, ulcers, bronchitis, leucorrhoea and kidney troubles. Asiaticoside, indocentelloside, 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. Field is made weed free at the initial stages. Herbage can be harvested from six month onwards. The harvested herbage is shade dried or used afresh for raw drug purposes.

Collection, characterization, evaluation and maintenance of germplasm

TNAU, Coimbatore: Twenty accessions were collected from various parts of Tamil Nadu and Karnataka. Observations on inter-nodal length, leaf length and width and plant height

were recorded in the accessions. Variability was observed for the studied characters among the germplasm. The mean inter-nodal length ranged from 5.50 to 12.16 cm and the mean stem length ranged from 3.76 to 12.00 cm. Poondi collection recorded maximum inter-nodal length of (12.16 cm) followed by Thevaram hills (10.50 cm). Accession collected from Keelkothagiri had maximum leaf length (3.03cm) followed by Poondi (3.00cm). Accession collected from Coimbatore recorded the highest leaf width (4.43 cm) followed by Kolli hills (4.27 cm). The stem length was maximum in accession collected from Thevaram hills (12.00 cm) followed by Thadiyankudisai (8.70 cm).

Influence of different shade levels in the performance of two genotypes

DMAPR, Anand: Performance of two genotypes *viz.,* the elite genotype, INGR 08105 developed at DMAPR and local control (Anand local) of *C. asiatica* were tested under various shade levels such as 75 %, 50 %, 25 % and open condition. The elite line was superior in terms of herbage and asiatocoside yields, irrespective of the shade levels. Shade levels significantly influenced different morphological characters studied. Plant height, leaf area, internodal length and internodal diameter were significantly increased in increased shade levels. However, number of leaves per plant was more in the open condition in both the genotypes. Interaction of the shade levels and the genotypes also significantly influenced all the morphological characters studied. Fresh herbage yield was not significantly influenced by the different shade levels. However, dry matter content was more in decreasing shade levels and it was highest in the open condition in both the genotypes, consequently, dry herbage yield was also higher in the open condition. Genotypic difference was observed in the case of Asiaticoside content under different shade levels. Asiaticoside content showed decreasing trend in increased shade level in the case of the elite genotype, however, in the local type, the trend was in the reverse order and it was highest in 75 % shade level. However, asiaticoside yield was more in the open condition in both the genotypes which was due to the effect of higher herbage yield in the open condition.

OPIUM POPPY (*Papaver somnifrum)*

It 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 restricted by the Narcotics Department under licensing system. Seeds of opium poppy are important food item and the source of poppyseed oil, healthy edible oil that has many uses. The plant is under cultivation in Uttar Pradesh, Rajasthan and Madhya Pradesh.

Evaluation of hybrid

RVSKVV, Mandsaur: Six hybrids (two from M.P., two from Rajasthan and two from U.P.) along with local check (JOP-540) and national check (IC-42) were tested. The analysis of variance for latex, seed and husk yields showed the significant differences among the entries tested. The latex yield ranged from 38.03 kg ha^{-1} (IC-42) to 50.74 kg ha^{-1} (NDHY-1). Maximum latex yield of 50.74 kg ha^{-1} was recorded in NDHY-1, followed by 49.50 kg ha^{-1} in NDH-2 and 49.12 kg ha^{-1} in MOH-2. Mean seed yield ranged from 527 kg ha^{-1} to 875 kg ha^{-1}. Highest seed yield was in MOH-2 followed by MOH-1 (762 kg ha^{-1}) and NDHY-2 (717 kg ha^{-1}). Husk yield ranged from 552 kg ha^{-1} (NDHY-1) to 749 kg ha^{-1} (MOH-2). Morphine content ranged between 11.2 % (ROH-42) and 14.3% (MOH-1), whereas morphine yield ranged between 3.96 kg ha^{-1} (IC-42) to 6.57 kg ha^{-1} (MOH-1).

A new root-rot disease

MPUAT, Udaipur: Root rot of opium poppy has become a serious problem in last 3-4 years and it has caused tremendous loss of the mature crop at the lancing stage. A fungus was consistently isolated from diseased root tissues, purified and identified as *Cylindrocladium* sp., on the basis of its morphological and cultural characteristics. Stem bases and roots of five healthy plants were inoculated with a spore suspension (10^6 conidia ml^{-1}) from a 07-day-old culture grown on PDA. Control plants were inoculated only with sterile distilled water. Plants were incubated at high relative humidity and kept under the field conditions. After 12-15 days, the inoculated plants reproduced the typical root rot symptoms. Koch's postulates were established for the organism. This is the first report of *Cylindrocladium* sp., causing root rot of opium poppy.

PALMAROSA (*Cymbopogon martinii*)

Palmarosa or Rosha grass 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.

Evaluation of superior lines

CCSHAU, Hisar: Ten accessions along with check RH-49 were evaluated. Plant height ranged from 188.567 to 232.100 cm; internodes per plant varied from 15.53 to 21.967 cm; internode length varied from 11.20 to 15.20 cm; culm diameter varied from 4.1 to 5.1 mm; leaf

length ranged from 21.87 to 27.33 cm; leaf breadth ranged from 1.60 to 1.90 cm; tillers per plant varied from 40.67 to 66.43; inflorescence bearing tillers per plant varied from 40.67 to 66.43; inflorescence length varied from 34.93 to 41.667 cm; fresh herb yield per plant varied from 363.33 g to 774.68 g; fresh herb yield varied from 179.97 to 313.92 kg ha^{-1}; oil content varied from 0.20 to 0.36 % and oil yield varied from 35.99 to 106.73 l ha^{-1}. Three accessions yielded significantly higher oil yield than the check RH-49 (65.80 l ha^{-1}). The highest oil yield was in PRH 8-8 (106.73 l ha^{-1}), followed by PRH-8-5 (87.67 l ha^{-1}) and PRH-8-16 (83.80 l ha^{-1}).

Oil quality of promising clones

CCSHAU, Hisar: Fifteen promising clones were compared with the check, RH-49 in terms of oil content and quality. Oil content ranged from 0.32 to 0.48%. Clones RH-03-12, RH-03-13, RH-03-29, RH-03-30, RH-03-31 and Vaishnavi recorded higher oil content (0.46–0.48%) than the check variety (0.42%). Most of the clones were rich in geraniol content. Essential oil of nine clones *viz*., RH-03-31 (85.3%), RH-03-35 (83.1%), RH-03-12 (82.1%), RH-03-57 (82.0%), RH-03-29 (81.9%), RH-03-43 (81.2%), RH-03-11 (81.0%), RH-03-13 (80.3%) and RH-03-30 (80.2%) contained more then 80% geraniol. The check variety had 78.5% geraniol in the essential oil.

SAFEDMUSLI (*Chlorophytum borivilianum*)

Safedmusli 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.

Evaluation of germplasm

PDKV, Akola: Initial evaluation trial of ten germplasm lines along with JSM-405 was conducted for different morphological and yield characters. Fasciculated root yield per plant varied from 23.40 to 44.00 g. Highest fasciculated root yield was in AKSM-07 (44.00 g), followed by AKSM-08 (38.40 g) and in the check, the yield was 37.40 g. Lowest yield was in AKSM-02 (23.40 g). Saponin content was highest in genotype AKSM-08 (7.01%) followed by AKSM-06 (7.00).

MPUAT, Udaipur: Twenty genotypes along with one check MCB-405 were evaluated. Two years mean data indicated that highest fasciculated root yield was in genotype PC-30 (3566

kg ha-1) followed by PC-26 (3300 kg ha-1), PC-17 (2711 kg ha-1), PC-32 (2644 kg ha-1) and PC-19 (2622 kg ha-1). Root yield was 1932 kg ha-1 in MCB-405 (check variety). Number of fasciculated roots per plant (12.0), thickness of main fasciculated root (9.0mm), length of main fasciculated root (10.3 cm), and length and breadth of leaf (23.8 cm, 1.8 cm) were also highest in PC 30.

In another trial, eleven germplasm lines along with check MCB-405 were evaluated for fasciculated root yield and other accessory characters. It was found that RC-84 was best in respect to fasciculated root yield (based on two years data). Root yield was 2471 kg ha-1 in RC-84 followed by 2173 kg ha-1 in RC-80 and 2168 kg ha-1 in CBI-7. In RC 84, number of faciculated roots per plant was 10.10, main fasciculated root thickness was 7.57 mm, main fasciculated root length was 8.28 cm, leaf length was 23.7 cm and leaf breadth was 2.3 cm. The lowest fasciculated root yield was in genotype PC-26 (1321 kg ha-1).

RVSKVV, Mandsaur: Twenty-four lines were evaluated for morphological and yield characters. Wide range of variability was noticed among the lines. Length of leaves varied from 14 cm (MCB-411) to 22 cm (MCB-420). Breadth of leaves ranged between 17 mm (MCB-409) and 25 mm (MCB-412). Colour of anther ranged from yellow to light yellow and sometimes light green. Length of fleshy root ranged from 4.6 cm (MCB-417) to 7.5 cm (MCB-419). Root diameter ranged between 5.8 mm (MCB-401) and 8.1 mm (MCB-414). Fresh weight of root ranged from 2183 kg ha-1 to 3399 kg ha-1. Maximum fresh fasciculate root yield was in MCB-412 (3399 kg ha-1) followed by MCB-414 (3260 kg ha-1), MCB-411 (2805 kg ha-1), MCB-421 (2790 kg ha-1), MCB-407 (2735 kg ha-1), MCB-423 (2677 kg ha-1) and MCB-416 (2643 kg ha-1) as compared to the check JSM- 405 (2416 kg ha-1).

Effect of harvesting age on peeling time and yield

DMAPR, Anand: It was observed that harvesting age (90–240 DAP) did not have significant effect on fresh fleshy root yield. However, peeling time significantly varied between the treatments. Peeling was difficult during 90–105 DAP and more time was required for this job. Fleshy roots became amenable to peeling between 120 and 165 DAP. Hence, significantly minimum time (5.14–6.36 h) was required to peel 1 kg fleshy root of this age. However, hereafter (180–240 DAP) roots again turned resistant to peeling, requiring more time for processing. Peeling % (mass of peeled fleshy root from 100 units) was also significantly highest during 135–150 DAP (64.86–72.33%). The value reduced before and beyond this age. Anatomical study of the fleshy roots showed that during initial period (90–105 DAP) root epidermis consisted of single layer of cells which were tightly adhered to the cortex tissues. During 120 DAP, 1–2 layer thick phelloderm layers started developing. It further increased to 2–3 layers. But as the phelloderm increased to 4–7 cell layers, during the period of 135–150 DAP, peeling became very easy. This was possible because epidermal layer then had only loose contact with cortex tissue and epidermal cells became thin walled. The peeled material consisted of epidermis and layers of periderm. Sometime the removal of periderm could be achieved while washing the roots after harvesting. However, epidermal cells became lignified during 180 DAP. Periderm layer turned oblique due to internal pressure created by the parenchymatous cells of the cortex toward the epidermis layer. This led to strong attachment of cortex cells with phelloderm layers. All these resulted in the peeling difficult.

Post harvest storage of fasciculated roots as planting material

MPUAT, Udaipur: Fasciculated roots need proper storage after harvesting (first week of April) till planting in next season (onset of monsoon, usually July) to decrease post harvest losses. Hence, 7.6–15.2 cm layers of fasciculated roots were kept in wooden boxes overlapped by 7.6–12.7 cm layer of soil. Soil used was dried properly under the sun for 7 days before use. Minimum weight loss (29.1%) was recorded from the treatment of 7.6 cm layer of roots overlapped by 12.7 cm layer of soil, though it was found at par with all the other treatments where 10.2–12.7 cm soil overlapping was used. However, minimum dry roots (10.2%) along with maximum number of healthy roots (85.4%) were recovered from 7.6 cm roots sandwiched with 12.7 cm soil.

Post harvest microbial load, aflatoxin contamination and fungicide residue

MPUAT, Udaipur: At least four fungal genera and one bacterium were associated with the root samples collected from different sources (market, farmers' stock and experimental plot). Fungi belonged to the genera *Trichoderma*, *Aspergillus*, *Fusarium* and *Mucor* while bacterium belonged to *Pseudomonas*. Samples contained low level (0.013–0.027%) of aflatoxin contamination. Highest was in the market sample and lowest in lab samples. The samples also contained fungicide (carbendazim) residue. Carbendazim residue in market sample, sample collected from farmers' and experimental field were 35, 45 and 41 ppm, respectively.

SARPAGANDHA (*Rauvolfia serpentina*)

Sarpagandha is a perennial under-shrub belongs to family Apocynaceae, distributed throughout India. The species attain a height of about 75 cm to 1 m with inflorescence arranged in cymes with deep red and white flowers. Roots contain alkaloids (reserpine, desrpidine and reseinamine) which are sedative and used to control high blood pressure. It is also used for the treatment of insomnia, asthma and acute stomach-ache. Ruthless collection of the species from its wild habitats developed stress to the plant stand in its natural habitats and the Government of India has prohibited its collection from the wild. The crop is under cultivation and propagated mainly by seeds. Tropical humid climate is better for a good crop growth. Seedlings are transplanted during the rainy season. The crop is ready for harvesting after about 18 months.

Target leaf spot disease

BCKV, Kalyani: Infection first appeared on lower leaves and proceeded upward. The spots had dark brown centres surrounded by concentric rings. Spots were circular in shape and of different sizes. Each spot was surrounded by yellow diffusing haloes. Spots were isolated or coalesced to cause blighting. Later, lower leaves fell off leaving only a few top tender leaves. The disease was present during May–August but, most serious during March–April. The pathogen was isolated on PDA. Fungal colony was olivaceous to grayish or white with dense, fluffy mycelial growth. Conidiophores were mostly simple, some branched, straight, light brown and septate. Conidia were cylindrical or straight, light brown, wide at the base

and had a hilum with a rim. Conidia were 135–195x30–45 µm in size. It was identified as *Corynespora cassicola* (Berk & Curt) Wei. Pathogenicity established by spraying spore suspensions (1.15x10^5 spores ml^{-1}) on healthy plant and incubating it under high humidity.

NDAUT, Faizabad: Same disease was observed. The disease appeared by the last week of June and became severe during July–August (warm and humid weather). Incidence and severity were greater under net house conditions than the open field.

SATAVARI (*Asparagus racemosus*)

It 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 which promotes general well being of an individual by increasing cellular vitality or resistance. The reputed adaptogenic effect of Satavari is attributed to its concentrations of saponins.

Evaluation of germplasm

CCSHAU, Hisar: Six genotypes *viz*. HAR-4, HAR-5, HAR-6, HAR-03-4, HAR-03-17 and HAR-03-18 were evaluated based on fasciculated root characters *viz.,* root length, root diameter and fresh and dry root yields. Fresh fasciculated root length ranged from 30.00cm (HRR-03-4) to 39.33 cm (HAR-03-18), fresh fasciculated root diameter varied from 1.20 (HAR-4) to 1.50 cm (HAR-03-17 and HAR-03-18); number of fresh fasciculated roots plant^{-1} varied from 192.33(HAR-6) to 303.33(HAR -03-18), fresh fasciculated root yield plant^{-1} varied from 2.80 kg (HAR -6) to 5.57 kg (HAR -03-18), dry root yield varied from 3581.50 kg ha^{-1} to 7039.50 kg ha^{-1}. The highest dry fasciculated root yield was in genotype HAR-03-18 (7039.50 kg ha^{-1}) followed by HAR -03-17 (6483.77 kg ha^{-1}) and HAR-03-04 (6216.17 kg ha^{-1}).

Studies on floral biology

NDUAT, Faizabad: Studies on the floral biology of *A. racemosus* were carried out. Anthesis starts from 5.00 AM and continued up to 11.00 AM. Days required for bud emergence to flower opening were 11-14 days. Stigma receptivity was recorded up to 30-32 hours after anthesis. Pollen fertility was found as 95-98 % by aceto-carmine staining. Self pollination was observed in the species. Time taken for flower to berry setting was 11-13 days and for berry setting to seed maturity was 90-100 days. Seed setting percentage was 65-73 %. Under self pollination there was 65-70% seed setting.

Collar rot disease

NDUAT, Faizabad: During hot and humid conditions of August–September, the disease became serious in the nursery. High soil moisture aggravated the problem. The symptoms first

appeared as water soaked lesions at the collar region. Gradually the lesions became brown in colour and enlarged girdling the stem. Finally the infected seedlings toppled from collar. During early morning, brownish mycelial growth were observed at the necrotic portions of the seedlings. From the infected tissues, a fungus was isolated on PDA and purified which was identified as *Rhizoctonia solani* Kuhn.

Preliminary investigation on management of collar rot

NDUAT, Faizabad: In a pot trial, *R. solani* inoculum (200 g) grown on PDA was thoroughly mixed with steam sterilized garden soil (1 kg). The soil was lightly watered and the pots were covered with brown paper. After 7 days of incubation, seeds were sown. Seeds were treated with *Trichoderma harzianum* formulation (10 g kg^{-1} seeds), *Pseudomonas flurosence* formulation (10 g kg^{-1} seeds) and thiram (3 g kg^{-1} seeds) before sowing and a untreated control was maintained. All the treatments reduced collar rot. The highest seed germination was recorded with *T. harzianum* (96.66%) followed by thiram (91.52%). Control seeds showed 41.66% germination. Similar trend was found for disease free seedling. *T. harzianum* resulted in highest (92.40%) normal seedlings while lowest was in the control (14.52%).

Dry root rot disease

NDUAT, Faizabad: The disease was prevalent mostly in older roots (one year or more). The disease initiated as small brown discolouration on the surface of the roots. The brown spot that appeared at the root tip gradually proceeded upward. The older portion of the infected region turned grey with blackish spots over it. The infected portion of the root shrank, demarcating the healthy region by a blackish ring. Infection proceeded from periphery towards core of the root as brown discolouration. The older portion became black. However, the skin remained intact but became hollow. The disease initiated in field but caused maximum damage in storage. *Fusarium solani* (Mart) Sacc. was isolated from diseased roots and its pathogenicity was established by artificial inoculation.

SENNA (*Cassia angustifolia*)

The plant 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'. *Cassia 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.

New insect pests

DMAPR, Anand: Some new insect pests were found during the year. Three of them were tree hopper (*Oxyrachis tarandus*, *Otinotus oneratus* and *Leptocentrus Taurus*; Family Membracidae, Order Homoptera) and two were tussock caterpillar (*Somena scintnillans* and *Olene mendosa*; Family Lymantridae, Order Lepidoptera).

Catopsilia pyranthe infestation

DMAPR, Anand: Population studies suggested that incidence of *Catopsilia pyranthe* was influenced by growth stage of host plant and weather conditions. Pest infestation was favoured by warm-humid climate and plants of 75-105 DAS age. Crop was sown at 15 days interval between June 15 and August 14. *C. pyranthe* infestation was more during September and October when the temperature was optimum and humidity was high and it was more pronounced in the crop aged between 45 to 105 days. Highest pest incidence was observed in October when 80.86–86.48% infestation was observed in the crop sown between June 15 and July 15 (105-75 DAS). Thereafter incidence showed a decreasing trend. Infestation ranged between 12.14 – 35.38% during November which further reduced to 18.42 – 24.77% during December. With the decline in temperature infestation became zero in January–February. However, with the increase in temperature in March the activity of *C. pyranthe* was again observed and stray incidence of egg laying was also observed.

SHANKHUPUSHPI (*Convolvulus microphyllus*)

It 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. It is used to reduce mental tensions as a psycho-stimulant and tranquilliser. The decoction is used as aphrodisiac and also in diabetics. The plant contains alkaloids such as convolvine, convolamine, phyllabine, convolidine, confoline, convoline, subhirsine, convosine, scopoline and convolvidine along with ß-sitosterol.

Effect of different organic manures on yield

AAU, Anand: Six different organic manures were used (10 t ha^{-1}FYM, 5 t ha^{-1} poultry manure, 2 t ha^{-1} vermicompost, 2 t ha^{-1}castor cake, 2 t ha^{-1} neem cake and 1 l ha^{-1} Azotobacter + PSB). Biofertilizer was applied one month after sowing while others were added before sowing. Above ground growth was harvested twice at 90-days interval. Total dry herbage yield was significantly higher in FYM treatment (10977 kg ha^{-1}) while it was lowest in castor cake (7736 kg ha^{-1}) treatment.

SWEET WORMWOOD (*Artemisia annua*)

It 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 herbage and oil yield

DMAPR, Anand: The crop was transplanted at five different spacing (30x45, 30x60, 45x45, 45x60 and 60x60 cm). There were no significant differences observed in plant height and number of branches under different spacing. However, when harvested during full bloom, the highest fresh and dry herb yields (3033 and 748 kg ha^{-1}, respectively) and fresh and dry leaf yields (1810 and 382 kg ha^{-1}, respectively) were obtained from 45x45 cm. Leaf harvest index (24.64) and leaf to stem ratio (0.27) were also found significantly maximum at this spacing. Essential oil content did not differ among the different spacing and it ranged from 0.71 to 0.78%. But, the oil yield (61.33 kg ha^{-1}) was highest in 45x45 cm due to the maximum herbage and leaf yield.

Influence of harvesting stage on the essential oil content and yield

DMAPR, Anand: In a field trial the crop was harvested at four phenological stages *viz.* vegetative (May), pre-bloom (September), bloom (October) and post bloom (November). Essential oil content was highest during full bloom (0.76%) followed by post bloom (0.59%) and the least was recorded in the vegetative stage (0.24%). The oil yield per hectare was also maximum when the crop was harvested during full bloom (49.84 kg ha^{-1}) followed by post bloom (33.96 kg ha^{-1}) which were directly proportional to the high oil content and the high herbage yield during the above stages.

TULSI (*Ocimum sanctum*)

It 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 it yields essential oils. The essential oils obtained have immense

value in aroma industry. The chemical constituents of the essential oils are monoterpenes, sesquiterpines and phenols with their alcohols, esters, aldehydes, etc. 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 various organic nutrients on yield

NDUAT, Faizabad: Three different organic nutrient sources (FYM, castor cake and neem cake) were applied at various doses along with control. Plant height at harvesting stage varied significantly (79.0–102.7 cm) among the treatments, highest being at 6 t ha^{-1} neem cake. However, plant height from all the FYM doses (5, 10 and 15 t ha^{-1}) and other two neem cake doses (4 and 5 t ha^{-1}) were at par. Similar trend was also obtained for branches per plant. Fresh herbage yield, however were maximum with highest doses of neem cake and FYM, 21209 and 20311 kg ha^{-1} , respectively. Dry herbage yield varied between 50.74 and 53.06 kg ha^{-1}.

VACH (*Acorus calamus*)

It is a member of family Araceae and is a small perennial aromatic herb grown naturally in marshy fields. The species is thought to have originated in Central Asia or India and it is common in areas that surround the Himalayas. The species is cultivated in some parts of India mainly in Andra Pradesh. Both the leaves and rhizome are apparently psychoactive, with the rhizome being more potent. The dried rhizomes constitute the commercial raw drug of 'Calamus'. It is believed to improve memory power and intellect. It is also useful in the treatment of diarrhoea, dysentery, abdominal obstructions and colic. Anticarcinogenic property of the species is also reported recently. The oil of *A. calamus* is used as an ingredient in flavors, particularly in liquors. However, in the USA, the plant is considered unsafe for human consumption by the Food and Drug Administration due to high doses of beta-asarone which is carcinogenic was detected from the species of Indian origin.

Effect of spacing and organic manures on yield

APHU, Bapatla: An experiment was conducted to determine the suitable spacing and organic manures, requirement for optimum yield. Three different spacing (60x30, 60x45 and 60x60 cm) in combination with three FYM doses (5, 10 and 15 t ha^{-1}) were tested. However, none of the treatments or their combinations had significant effect on any of the growth and yield parameters tested.

Relationship between ecogeography of the chemotypic variation of some species

DMAPR, Anand: A total of 83 accessions of *Gymnema sylvestre* (25), *Desmodium gangeticum* (23), *Asparagus adscendens* (30) and *Asparagus racemosus* (5) were collected from different

ecogeographical regions of India. Phytochemical profiling of 25 accessions of *A. adscendens* and 10 accessions of *G. sylvestre* were completed. Comparative anatomical and morphological study was done in accessions of *A. adscendens* (5), *G. sylvestre* (24) and *D. gangeticum* (16). In *D. gangeticum* two types of flower colour *viz*., white and pink flowers were identified (Fig. 6).

Fig. 6 Pink and white flower types of *Desmodium gangeticum*

Germplasm maintained at DMAPR

Sl. No.	Species	No. of Accessions
1	*Aloe* spp.	55
2	*Andrographis paniculata*	60
3	*Asparagus* spp.	44
4	*Chlorophytum borivilianum*	54
5	*Commiphora wightii*	110
6	*Tinospora cordifolia*	35
7	*Urgenia* spp	12
8	*Withania somnifera*	140
9	*Plantago ovata*	83
10	*Gymnema sylvestre*	25
11	*Desmodium gangeticum*	23
Total		**641**

Germplasm maintained at different AICRP Centres

Sl. No.	Crop	Centre	No. of Accessions
1	Aloe (*Aloe barbadensis*)	AAU, Anand IIHR, Bangalore NDUAT, Faizabad PDKA, Akola	21 42 16 16
2	Ashoka (*Saraca asoca*)	KAU, Thrissur	42
3	Ashwagandha (*Withania somnifera*)	CCSHAU, Hisar IIHR, Bangalore RVSKVV, Mandsaur MPUAT, Udaipur	30 190 31 148
4	Brahmi (*Bacopa monnieri*)	KAU, Thrissur	29
5	Chitrak (*Plumbago rosea*)	KAU, Thrissur	25
6	Guggal (*Commiphora wightii*)	AAU, Anand MPUAT, Udaipur	33 16

Sl. No.	Crop	Centre	No. of Accessions
7	Giloe (*Tinospora cordifolia*)	Bapatla CCSHAU, Hisar	13 20
8	Isabgol (*Plantago ovata*)	AAU, Anand CCSHAU, Hisar MPUAT, Udaipur	47 83 70
9	Kalmegh (*Andrographis paniculata)*	CCSHAU, Hisar NDUAT, Faizabad	11 19
10	Kaucha (*Mucuna* spp.)	IIHR, Bangalore	112
11	Lemongrass (*Cymbopogon* spp.)	CCSHAU, Hisar KAU, Thrissur NDUAT, Faizabad	26 20 14
12	Long pepper (*Piper longum*)	KAU, Thrissur	67
13	Lotus (*Nelumbo nucifera*)	KAU, Thrissur	24
14	Madhunashini (*Gymnema sylvestre*)	CCSHAU, Hisar	8
15	Makoi (*Solanum nigrum*)	Bapatla	12
16	Mandukparni (*Centella asiatica*)	TNAU, Coimatore	20
17	Opium poppy (*Papaver somniferum*)	NDUAT, Faizabad MPUAT, Udaipur RVSKVV, Mandsaur	35 197 90
18	Palmarosa (*Cymbopogon martinii*)	CCSHAU, Hisar	64
19	Safedmusli (*Chlorophytum borivilianum*)	AAU, Anand CCSHAU, Hisar MPUAT, Udaipur RVSKVV, Mandsaur PDKV, Akola	20 11 34 21 10
20	Satavari (*Asparagus* spp.)	JNKVV, Jabalpur	15
		NDUAT, Faizabad	23
21	Tulsi (*Ocimum sanctum*)	CCSHAU, Hisar	12
22	Vach (*Acorus calamus*)	Bapatla TNAU, Coimatore	11 13
23	Vetiver (*Vetiveria zizaniodes*)	CCSHAU, Hisar KAU, Thrissur NDUAT, Faizabad	24 37 14

Minimum seed standards

DMAPR, Anand: Minimum seed standards of nine species (Table 1) were determined in terms of germinability and viability. Seeds were manually cleaned to discard inert matter. Seed moisture content determined by oven drying method (103°C for 17–24 h) was recorded immediately after receiving the seeds. Seeds were also surface sterilized by 0.1% $HgCl_2$ for 10 min and then stored in air tight plastic containers until use. Physical parameters like test weight (1000 seeds wt.) and length and breadth of seeds were recorded before germination testing. Seeds were placed either on top of the paper (TP) or between the paper (BP) at three different temperatures *viz*. 20°C, 25°C and 30°C in three replicates of 100 seeds each. Seeds were considered germinated with emergence of radicle. Parameters like onset of germination along with first count (50% germination), final count (after which no further germination takes place), final germination (% of germinated seeds on the day of final count) and mean germination time (MGT) were recorded for all the nine species. Viability testing was done following 2,3,5-Triphenyl tetrazolium chloride test according to ISTA (2005) rules. For some species, specific treatments were given with respect to different substrates and temperatures.

Table 1: Minimum seed standards of nine species

Plant species	Test wt. (g)	Seed size (mm)		Best suited		Final germination (%)		MGT
		Length	Breadth	Temp (oC)	Substrate	Control	Treatment	
Abelmoschus moschatus	15.7-16.9	3.8	2.9	25-30	TP	40	90-95	2.5
Andrographis paniculata	1.30-1.36	1.87	1.30	25	TP	35	60-66	6.7
Bixa orellana	28.4-29.4	4.54	3.55	30	TP	20	81.3	4.2
Cassia angustifolia	24.3-27.8	6.65	4.08	25	BP	60-78	70-84	2.5
Catharanthus roseus	1.2-1.25	2.19	1.07	25	TP	38	76/86	5.8
Lepidium sativum	1.2-1.4	2.31	1.02	20-25	TP	90-95	-	2.6
Plantago indica	1.5-1.6	2.7	1.39	20-25	TP	98	-	2.6
Plantago ovata	1.16-1.20	2.39	1.01	20-25	TP	97	-	2.5
Withania somnifera	1.76-1.82	2.37	1.93	25-30	TP	60	88-92	6.8

Intellectual Property Rights

New improved tapping method for guggal

DMAPR has filed a process patent application in the Indian patent office, Delhi for gum tapping of guggal (*Commiphora* spp.). Guggal gum, commonly known as guggulu, traditionally is used for its fragrance when burnt. It is also used in several ayurvedic preparations. Modern medicine has approved its efficacy in cholesterol lowering capacity. Guggulu is extracted by tapping 5–15 years old plants. Tapping method in vogue requires making an incision

at the stem base and application of a suspension/ slurry of guggulu in water. Several additives such as, copper sulphate, horse or wild ass urine, etc. are often used by local people with the belief to increase guggulu production. Usually, plants are tapped after rainy season (October–November). However, success rate is very erratic. The novel process involves application of a natural bio-initiator at certain concentration to induce guggulu oozing. The claimed method results uniform success rate in tapping. This is found to induce guggulu production from any guggal plant irrespective of its age and season. Any branch can be tapped by this method which ensures full extraction of the guggulu over a prolonged period of time. Hence, this method can be used for organised guggulu farming for assured gum tapping and increased productivity.

Information Management (ARIS)

During the year, web-based application, "Networking of herbal gardens in India" at the URL: www.herbalgardenindia.org.in was updated. The information related to herbal gardens and availability of species in each herbal garden were updated. The information based on plant habits *viz*., herb, shrub, tree and climber were collected from primary and secondary sources, compiled and updated in the database. At present the database holds 466 records of herbs, 206 records of shrubs, 257 records of trees and 94 records of climber species. The login details were created and provided to all the registered members in this network to update information of herbal garden / medicinal garden maintained in their organization. An option to change the garden password was also created in the website.

Other software applications such as Website of DMAPR, Digital Photo Library of Medicinal and Aromatic Plants, Digital Herbarium of Medicinal and Aromatic Plants in India, Institute Management Information System and Institute Research Monitoring System were also modified and updated.

ARIS cell is strengthened by expanding the LAN connectivity by enabling the office with Wi-Fi internet connectivity. A display facility was developed for showcasing institute activities and high quality photographs of MAP through LCD TV for the visitors.

BETELVINE (*Piper betle*)

It is a perennial, evergreen, dioecious climber which is a native of Central and Eastern Malaysia from where it has spread throughout tropical Asia and Malaysia; Madagascar and East Africa at a later date. The plant grows well in shady conditions having moderate temperature (~25°C) with high humidity (~ 80% RH). The major cultivating countries are India, Bangladesh, Srilanka, Pakistan, Malaysia, Thailand, Indonesia, Maldives, Vietnam and Papua New Guinea. In India it is cultivated in an area of

about 50,000 ha. Betelvine or betel leaf is associated closely with cultural traditions of India and is considered as a holy plant. Fresh leaves are generally consumed along with betel nuts (*Areca catechu*). It has many medicinal usages in Indian System of Medicines to cure indigestion, stomach-ache, diarrhoea, flatulence and to heal wounds, bruises, swellings due to sprains, respiratory disorders, constipations, boils and gum disorders Studies also revealed that the leaf improves immune system and inhibits cancer growth.

Germplasm collection, maintenance and evaluation

Germplasm of betelvine maintained, and catalogued at various centres are presented below:

Table 2: Germpalsm collections at various centres

Centres	Total collections	Catalogued
APHU, Bapatla	51	51
AAU, Jorhat	14	14
BCKV, Kalyani	42	42
IIHR, Hirehalli	98	25
MPKV, Rahuri	28	28
RAU, Pusa	20	20
RAU, Islampur	16	16

Hybrid Evaluation Trial

APHU, Bapatla: The evaluation of hybrids with local checks was carried out and it was observed that local variety Tellaku Ponnur performed better than GN hybrid with respect to vine elongation month^{-1} (26.5 cm), number of laterals vine^{-1} (11.81) and leaf yield (38.42lakh ha^{-1} yr^{-1}). However, GN hybrid recorded significantly higher leaf quality *viz.*, petiole length (6.84 cm), leaf size (15 x 11 cm), fresh weight of 100 leaves (280 g) and shelf life (13 days).

Germplasm characterization for breeding purposes

IIHR, Hirehalli: Three germplasm of betelvine were collected and added to the previous collections. Twenty-five Bangla clones were evaluated for leaf yield. Godi Bangla produced maximum yield of 49.68 lakh leaves ha^{-1} followed by Bangla Nagaram and Karapaku with an yield of 41.14 and 40.24 lakh leaves ha^{-1} respectively. Among male clones evaluated, Swarna Kapoori gave highest yield of 35.14 lakh leaves ha^{-1} followed by CARI-6 (32.49 lakh ha^{-1}). Stomata size and density were recorded in sixty-two germplasm accessions consisting of 22 male and 40 female clones. The mean stomatal density was 143.90 for female clones, the cultivars Mysore local and Desi Bangla recorded the maximum stomatal density. Smaller stomata were observed in clones Maghai and Simrali Sanchi. The mean stomatal density was 174.25 in male clones where maximum density is recorded in Kapoori (TN) with smaller stomata. Out of sixty-nine lines including *Piper colubrinum* studied, the accessions Vellaikodi, Kalipathi and Kali Bangla showed 0-5% incidence of phytophthora (West Bengal isolate). In others, the disease incidence ranged from 11 to 80%. The lines IIHR BV 37 (SGM 1), IIHR BV 38 (Awamipan) and IIHR BV 67 (Andaman

1) are relatively free from anthracnose and powdery mildew. All Kapoori (male) clones were free from powdery mildew incidence.

Flowering was recorded in 26 male clones and 44 female clones during 2008-10. IIHRBV 68 (Andamans 2), IIHRBV 36 (Black leaf), IIHRBV 64 (Deshi Bangla), IIHRBV 63 (Deshi Pan) and IIHRBV 65 (Dhoba Bangla) flowered for the first time and all produced female flowers. The line IIHRBV 99 (collection from Andamans from IISR) produced male catkins whereas, IIHRBV 107 (Gujarat collection) and IIHRBV 76 (TBGRI collection) produced female inflorescence.

Table 3: Variations in the flowering behaviour of the betelvine clones at Hirehalli

Flowering throughout the year	Shy flowering type	Not flowering yet
SGM 1 Halisahar Sanchi Swarna Kapoori Simrali Babna (local) Bangla Nagaram Mysore Local	Bangla Mandasur Black leaf Kalipatti Maghai	Kakair (no laterals) Meetha Pan (no laterals)

Pollen fertility is studied in different male clones. Two inflorescences plant^{-1} tagged and two plants line^{-1} were studied. Anthesis started at about 10.30 am and peak anthesis was recorded between 2 to 4 pm. Stigma was receptive up to 8-10 days. Continuous pollination for 8 days resulted in uniform fruit development.

Hybridisation

IIHR, Hirehalli: Female clones like Bangla Nagaram, SGM 1, Simrali Babna, Simrali Babna local and Mysore local were selected as they produced flowers through out the year. The clones Halisahar Sanchi and Karapaku are known resistant sources for different diseases and hence used in the breeding programme. Godi Bangla was also included in the crossing programme, as it was high yielder under arecanut support. The male clones Pachhaikodi and CARI 6, reported to be resistant to different diseases, were also been included in the hybridization programme. New crosses involving the clones, which flowered for the first time, were carried out. More than one hundred different cross combinations were carried out.

Some of the *Piper* species *viz*., *Piper hamiltonii* (Awani Pan), *Piper colubrinum* (Brazilian thippali) were reported to be resistant to Phytophthora disease. The plant material of *P. hamiltonii* was sourced from APHU, Bapatla and *P. colubrinum* from MSSRF, Waynad, Kerala. Female parents were Simarali Babna Local, Simarali Babna, Bangla Nagaram, Halisahar Sanchi and SGM-1 and both the wild species were used as male parents. The pollen fertility of *P. hamiltonii, P. colubrinum* was studied using 1% acetocarmine and it ranged from 85% to 92% in *P. hamiltonii*, and 90% to 95% *P. colubrinum*. No fruit set was observed in the catkins pollinated with *P. hamiltonii*, the catkins dried and dropped off. The female inflorescences of Halisahar Sanchi and SGM 1 hybridized with *Piper colubrinum* did not set fruit. In Simrali Babna local, nodular fruits are formed and they dropped before reaching maturity. The female catkins of Simarali Babna, Bangla Nagaram fertilized with pollen of *P. colubrinum* recorded 80% fruit set. The fruits were nodular and ripened during 97 to 114 days. The fruit length varied from 4.5 to 6.5 cm and fruit weight ranged from 3.3 to 5.7 with a number of

seeds per fruit varying from 17 to 40. Emergence of radical was observed after 15-17 days and the germination percentage varied from 58% to 70%. The putative hybrid seedlings are being established in seedling trays and maintained in polyhouse. The successful crossing, seedling rising in the cross between *P. betle* and *P. colubrinum* indicated that inter-specific hybridisation can be explored in *P. betle* breeding programme. Confirmation of the putative hybrids and investigations of their resistive reaction to Phytophthora disease is essential for further studies in this direction.

Back crossing in flowered hybrids with parents is being carried out. Crossing hybrid 06-1 (with male parent, Swarna Kapoori) and hybrid 06-4 (with female parent, SGM 1) was carried out. Fruit set was observed in all the catkins and the fruits were harvested in the cross Hybrid 06-1/Swarna Kapoori and seedlings were raised.

A total of 2540 hybrid seedlings from different crosses were raised. Wide variability was observed for many morphological traits like plant vigor, leaf size, leaf shape, leaf color, petiole length, internodal length and stem pigmentation. Vigorous hybrid seedlings were selected for further multiplication.

Twenty selected hybrids were multiplied for three identified AICRP centres. BCKV, Kalyani collected 20 hybrids for assessing the performance under bareja conditions. Ten new selections made from the hybrid population were also multiplied for evaluation. Eight selected hybrids were planted under arecanut garden, with a spacing of 100x60 cm during July 2009. The data on plant height, leaf traits recorded on 7 month old hybrid plants showed that hybrid 06-10 recorded longer vines (294 cm) followed by Hybrid 06-1 (273.10cm). Hybrids 06-1, 06-4 and 06-11 are vigorous with suitable leaf traits. Hybrids, 06-1 and Hy 06-4 produced laterals. The leaf size and shape of the laterals varied distinctly between these hybrids. Hybrid 06-1 produced female flowers and lanceolate leaves with oblique leaf base. Hybrid 06-4 produced ovate leaves with cordate base and produced male catkins. Another set of 25 hybrids were also field planted under arecanut garden with a spacing of 100x60 cm during July 2009.

Sex segregation in hybrids

IIHR, Hirehalli: Both female and male inflorescence was observed among the flowering hybrids. Out of the hybrid plants established in the field under *Sesbania* support. Lateral production was observed in sixteen hybrids. The lateral production and flowering was observed after 2-3 years after planting. Among the hybrids, which produced laterals, eight hybrids produced inflorescence and the others are yet to flower. Hybrid 06-1 and 07-33 produced female catkins where as Hybrids 06-4, 07-27 and 07-33 produced male inflorescence. Three hybrids Hybrid 06-13, 06-15 and 07-31 put forth laterals with inflorescences which failed to reach maturity (some dry and drop off or underdeveloped catkins) making the identification of sex of the vines difficult. In these hybrids vine vigor was poor and leaves produced are not of good quality.

Standardization of rooting media

IIHR, Hirehalli: Cocopeat + FYM (1:1) rooting medium produced maximum vine length (1.17m), nodes (19.17 nos), rooted nodes (15-95), root number (8.06) and root length (16.27 cm) which was at par with the cocopeat alone.

Integrated Crop Management (INM+IPM)

APHU, Bapatla: The treatment having optimum plant population + recommended fertilizers applied as Neem cake + Urea (1 : 1) at 200 kg N, 100 kg P_2O_5 and 100 kg K_2O ha^{-1}, irrigation 100% replenishment of CPE and application of Bordeaux mixture (4 drenches and 8 sprays) recorded significantly superior leaf yield (45 lakh leaves ha^{-1}) and lower disease incidence (21%) compared to other treatments. No significant difference in keeping quality among the three treatments. All the treatments showed a soil pH of 8 and EC was ranging from 0.28 to 0.31ds m^{-1}; available N (ranged from 225 - 250 kg ha^{-1}); available P_2O_5 (ranged from 6 - 10 kg ha^{-1}) and available K_2O (ranged from 450 - 537 kg ha^{-1}). The pH of the soil recorded near pH 8 irrespective of the treatments and the EC ranged from 0.28 to 0.31ds m^{-1}. Soil available N ranged from 225 - 250 kg ha^{-1}. Available P_2O_5 ranged from 6 - 10 kg ha^{-1} and K_2O ranged from 450 - 537 kg ha^{-1} in the treatments.

BCKV, Kalyani: The pooled data revealed that vine elongation, fresh weight of 100 leaves and leaf yield were recorded the highest in treatment having 1,50,000 plant population + 200 kg N in splits of organic form +100 kg P_2O_5 + 100 kg K_2O(ha^{-1} y^{-1}) + Irrigation at 100 % replenishment of CPE + Bordeaux mixture application (4 Drenching and + 8 Spraying) + recommended insecticides if required was applied.

RAU, Islampur: Sanitation and soil drenching with *Trichoderma viridi* at 30 DAP as well as soil drenching with Bordeaux mixture (1%) at pre monsoon and 60 DAP resulted in higher marketable leaves per plan (27.22 lakh ha^{-1}) and lower incidences of foot rot disease (10.75) compared to other treatments ie; either sanitation or soil drenching alone.

TNAU, Coimbatore: Integrated disease management with sanitation + one soil drench of Bordeaux mixture + *Trichoderma* application (after one month) + one more soil drench of Bordeaux mixture significantly reduced the wilt disease incidence and increased the leaf yield.

Effect of plant population on yield and quality

RAU, Islampur: Results showed that population density at 1.50 lakh ha^{-1} recorded higher no. of branches per vine (20.50), vine elongation per month (9.90 cm) and weight of 100 leaves (210 g) compared to other population densities. However, marketable leaves per plant with plant population of 1.75 and 2.0 lakh plant ha^{-1} registered higher (23.40 and 25.75 lakh ha^{-1} respectively) but with reduced leaf size reflecting reduced fresh weight and as such the harvested leaves were sold comparatively at low cost which fetched low returns. Therefore population at 1.5 lakh plant ha^{-1} depicted ideal marketable leaves per plant (22.61 lakh ha^{-1}) having ideal leaf size and fresh weight which gets higher market price. Population density at 1.5 lakh plant ha^{-1} recorded appreciably lower incidence of diseases then higher plant population density treatment.

Assessment of organic carbon content in Betelvine gardens

APHU, Bapatla: Soil samples of ten farmers fields from villages Chintalapudi, Machavaram and Mulkuduru were subjected to mechanical analysis and the results obtained showed that the soil type was of clay loam type with clay content (ranging from 67.4 to 79%), sand content (ranging from 13 to 18%) and silt content (ranging from 7 to 15%). The final organic carbon content of soils ranged from 0.55 to 0.89% with an average of 0.72% and leaf yield showed significantly positive correlation with organic carbon content of the soil.

BCKV, Kalyani: Soil samples from ten betelvine fields located in districts of N-24 pgs and Murshidabad were collected and analyzed. Soil samples from Raghunathganj showed that organic carbon (%), available N (kg ha^{-1}), total P (kg ha^{-1}) and total K (kg ha^{-1}) in different borajas were 0.40% – 0.70%, 90.55 – 211.28 (kg ha^{-1}), 119.46 – 541.64 (kg ha^{-1}) and 264.0 – 396.0 (kg ha^{-1}) respectively. The pH of above soil ranged from 7.51 – 8.08.

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

APHU, Bapatla*:* Demonstration of disease management technology developed by the centre in the farmer's fields (15 sites) showed that there were significant differences among farmers' practices and technology developed at the centre with respect to percent disease incidence, percent disease index and leaf yield by the end of 2nd year and the disease management technology was found superior to farmers practice.

AAU, Jorhat: Disease management technology developed by the centre was demonstrated in the farmers fields in Ambagan, Dhekiajuli, Borhola, Bogijan, Lengeri and Chilapathar locations. All the diseases showed significant reduction under AAU techniques over the farmer's practices. Yield, fresh weight and net return also produced significantly higher results in the AAU technology.

BCKV, Kalyani*:* Demonstration of disease management technology developed by the centre was conducted in eight farmers' fields at Simurali, Nadia. Sanitation and application of Bordeaux mixture at pre monsoon + after one month biocontrol agent + one application of Bordeaux mixture 2 month after first Bordeaux mixture application were demonstrated. The results revealed that disease incidence and yield parameters recorded in improved technology were statistically superior to the farmer's management practices at 1% level of significance.

JNKVV, Jabalpur*:* Field demonstration trials were conducted at ten locations of different farmer's field by JNKVV centre. It was observed that the technology generated by the centre found to be superior in terms of marketable leaf yield and quality compared to farmers practice.

MPKV, Rahuri: Results revealed that improved management package had significant impact on control of diseases. Significant increase in fresh weight of leaves by 12.7 %, yield by 28.37 % and cost : benefit ratio of 1:1.73 is obtained with the adoption of improved technology package over farmer's practice.

RAU, Pusa: Disease management technology was demonstrated in 20 farmers' fields in four locations at Bhagwatpur village (Sarayranjan), Lakhua pateli (Ujiyarpur), koithia village in samastipur district and Baligaon village in Vaishali district of Bihar. The comparative study of crop performance under ICM practice and that of farmers practice at all locations showed that ICM practice registered the yield of 29.5-32.6 lakh marketable leaves ha^{-1} as compared to farmers practice (19.6-23.9 lakh ha^{-1}). The crop under ICM practice was healthier having low incidence of phytophthora rot (4.5-8.4% 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 (10.6-14.8% PDI).

TNAU, Coimbatore: Results indicated that integrated disease management with sanitation + one soil drench of Bordeaux mixture + *Trichoderma* application (after one month) +

one more soil drench of Bordeaux mixture significantly reduced the Phytophthora disease incidence in betelvine and increased the leaf yield.

Studies on isolates of *Trichoderma* collected from different AICRP centres

BCKV, Kalyani: Isolates of Trichoderma from JNKVV (Jabalpur), APHU (Bapatla) and OUAT (Bhubaneswar) sent their cultures for testing the properties and antagonism of their cultures at BCKV, Kalyani. The properties and antagonism of above two isolates of JNKVV and APHU were studied. Both isolates showed high antagonism to *Phytophthora* and *Pythium* isolates collected from betelvine fields.

General Information

COMMITTEE MEETINGS

Research Advisory Committee meeting held

The Seventh meeting of the RAC of DMAPR was held on June 11, 2009 under the chairmanship of Dr. B. R. Tyagi, Ex-Deputy Director, CIMAP. The meeting was attended by Dr. A.A. Farooqui, Ex-Prof. & Head, Division of Horticulture, UAS, Bangalore; Dr. P.L. Tondon, Ex Principal Scientist, PDBC, Bangalore ; Dr. Umesh Srivastava, ADG (Hort. II), ICAR, New Delhi; Dr (Mrs) Sushma Chaphalkar, Director, School of Biotechnology, Baramati, Pune; Dr. I.L. Kothari, Ex-Head, Dept. of Bio Sciences, S.P.U., V.V. Nagar; Dr. S. Maiti, Director, DMAPR and all scientists of DMAPR. The meeting started with presentation of bouquet to the Chairman and Members of the RAC. All the members and Chairman shared their experiences and views and appreciated Dr. Satyabrata Maiti, and his team for their untiring efforts in up gradation of NRCMAP to Directorate. Dr. S. Samantaray, Member-Secretary appraised the house about the action taken on suggestions made during the last RAC meeting. Dr. Maiti made an elaborate presentation on the progress of research work since February 2008. He emphasized that with limited scientific and technical staff the institute had tried its level best to achieve the set targets. Chairman and members offered several suggestions for further improvement of research and visibility of the institute. The meeting ended with the vote of thanks proposed by Dr. P. Manivel, Pr. Scientist, DMAPR.

The eighth RAC meeting was held on January 12, 2010. The meeting was chaired by Dr. B. R. Tyagi, Ex-Deputy Director, CIMAP and attended by Dr. A. A. Farooqui, Ex-Prof. & Head, Division of Horticulture, UAS, Bangalore; Dr. P.L. Tondon, Ex Principal Scientist, PDBC, Bangalore ; Dr. Umesh Srivastava, ADG (Hort. II), ICAR, New Delhi; Dr I. L. Kothari, Ex-Prof. & Head, Department of Biosciences, SPU, V.V. Nagar; Dr. S. Maiti, Director, DMAPR and all scientists of DMAPR. At the outset, the Chairman

and Members of the RAC were greeted with presentation of bouquet. Dr. S. Samantaray, Member-Secretary presented the action taken report on the recommendations made during the previous RAC meeting. Dr. Satyabrata Maiti appraised the house about the institute's progress. He informed the merger of the two All India Networking Projects, Medicinal & Aromatic Plants and Betelvine into one All India Coordinated research project on Medicinal, Aromatic Plants and Betelvine. It was followed by elaborate presentations by Dr. P. Manivel, Principal Scientist (Plant Breeding) and Dr. K. Mandal, Senior Scientist (Plant Pathology) on Institute's research achievements during the last year. The presentations covered salient research findings on ten crops *viz*. aloe, *ashwagandha*, *brahmi*, *giloe*, *guggal*, *isabgol*, black *isabgol*, *kalmegh*, *mamejo* and sweet wormwood spanned on aspects like germplasm collection, plant breeding, biotechnology, crop production, crop protection, value addition and computer application. All the scientists interacted with the Chairman and members for refinement of ongoing research projects. The meeting ended with the vote of thanks proposed by Dr. P. Manivel, Pr. Scientist, DMAPR.

Institute Research Committee meeting

The eighth IRC meeting was held during July 23–24, 2009 under the chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. The meeting was attended by all the scientific staff of DMAPR. At the out set, Dr. P. Manivel, Member Secretary, IRC welcomed all. He highlighted filing of second patent from the institute as one of the major achievements. All the project leaders presented their work done report. Discussion was done on 17 projects concerning 9 crops such as aloe, *ashoka*, *ashwagandha*, *giloi*, *guggal*, *harde*, *isabgol*, palmarosa, *safed musli,* senna and sweet wormwood. The projects dealt on crop improvement, production, protection and quality management aspects and computer application. Four new projects were also presented, discussed in detail and two of them were approved by the house. The meeting came to an end with vote thanks proposed by the Member Secretary.

Institute Management Committee meeting

The 20th IMC meeting was held on 30 December, 2009 at DMAPR under the chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. At the out set chairman welcomed all the members – Dr. A.M. Sheikh, Dean, Faculty of Agriculture, AAU, Anand; Dr. D. V. Bharot, Dy. Director Horticulture, Gandhinagar; Dr. Guru Raja Rao, J.D., CSSRI(RS), Bharuch; Dr. R. S. Kurothe, Head, CSWRTI(RC), Vasad; Dr. Vipin Chaudhary, Sr. Sceintist, DMAPR; Sh. Mangal Singh, AFAO, DMAPR and Sh. R. T. Thakar, AAO, DMAPR. He then presented a brief report of the progress made by the institute. Sh. Thakar presented ATR of the last meeting. Committee members discussed about different agenda items of the meeting and reviewed the various research and developmental activities of the institute. The meeting ended with the vote of thanks to the Chair.

EXTENSION ACTIVITIES

During the year more than 500 farmers/growers of medicinal and aromatic plants and about 200 students visited the institute to know about agro-technology of different MAP, their utlisation and availability of propagation material. Besides, the Institute took part

in three Exhibitions at (i) Mahamada, Pusa, Samastipur, Bihar during May 28–31, 2009 (ii) Charotar Education Society, DN High School, Anand duirng November 19–22, 2009 (iii) NASC, New Delhi from March 11–14, 2010 wherein technology developed by the Institute and different AICRP centres was showcased through depiction of photographs, live material, micropropagted material, post harvest material, literature etc.

Training programme on aromatic crop cultivation and value addition held

A training programme for the farmers of Gujarat state on cultivation of aromatic crops and value addition technologies was held on November 30, 2009 at DMAPR in collaboration with Krishi Vigyan Kendra (KVK), Mehsana. The programme was sponsored by the Central Sector Scheme. Training was imparted to 55 farmers and cultivators of Mehsana district and a few from other districts of Gujarat on the cultivation of aromatic crops and their value addition techniques. The chief guest of the inaugural function, Dr. S. N. Tyagi, IFS., CEO, State Medicinal Plants Board, Gujarat addressed the farmers and encouraged the farmers to take up cultivation of the aromatic crops and explained in details the efforts undertaken by State Medicinal Plants Board and other government agencies for the promotion and support available for the cultivators of medicinal and aromatic crops. Dr. Satyabrata Maiti, Director, DMAPR briefed the activities of DMAPR in research and development. He also presented the facilities available in DMAPR for analytical needs of all the stake holders. He specifically highlighted the importance of Good Agricultural Practices and invited the farmers to form SHG for keeping records of their farm activities which will be an integral part for getting GAP certification of the produce.

The technical session comprised of presentations by resource persons which was followed by on-farm demonstration of different activities and visit to analytical laboratories. Dr. K. Mandal, Dr. V. Chaudhary, Sri S. Raju (all from DMAPR) and Dr. Manish Patel (KVK, Mehsana) talked on various aspects related to trade, cultivation of aromatic crops and value addition of essential oil. After the technical session, farmers were briefed about the analysis of essential oils and facilities available at the institute for testing. A practical demonstration

on extraction of essential oil in the pilot plant was also arranged for educating the farmers on all the aspects of essential oil extraction and down stream processing. The programme ended with concluding remarks and feedbacks from farmers.

OTHER ACTIVITIES

Annual Day celebrated

On November 24, 2009 the institute observed Annual Day coinciding with its foundation day. Members of the DMAPR family consisting of staff from all the categories took part in a function arranged to commemorate the occasion. The function was also attended by the members from other ICAR institutes from Baroda, Godhra, Vasad and also from AAU, Anand. Dr. Satyabrata Maiti, Director of the institute presided over the function. He narrated the progress made by the institute in recent years even with its minimum manpower. Sh. R. N. Joshi, Collector and District Magistrate of Anand graced the occasion as chief guest. He congratulated all the staff members and wished that the institute would grow further to meet the expectations of the mass.

Celebration of Hindi week

The official language implementation day (September 14) was celebrated in the Institute by organising a Hindi Week during September 14–22, 2009 under the aegis of Official Language Implementation Committee (OLIC) of the Institute. During the entire week several competitions like essay writing, letter writing and general Hindi test were organized as part of our endavour to enhance the use of Hindi in day to day work and to make the officials comfortable in the use of Hindi. On the last day of the week a closing ceremony was organized. Dr. M. M. Sharma, Senior Lecturer, S.P. University, V. V. Nagar, 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. During valedictory session two competitions *viz*., Poem Recitation and Lecture were organized and these competitions were evaluated by Chief Guest himself. Runners and winners of the various competitions were presented the certificate and prizes. The session ended with vote of thanks proposed by Dr. Manish Das.

Women Cell

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

Right to Information

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

Dissertation done by students

Student's Name and Institute/ University	Degree	Title of the thesis	Co-guide/ Guide/
Mr. Amit Gajera B.R.D. School of Biosciences Sardar Patel University Bakrol Road V.V.Nagar	M.Sc	Qualitative and quantitative analysis of agnuside and p-hydroxy benzoic acid in the leaves of *Vitex* species/variety.	Dr. V.S. Rana, Sr. Scientsit (Org. Chemistry)
Ms. Archana Laxminarayan B.R.D. School of Biosciences Sardar Patel University Bakrol Road V.V.Nagar	M.Sc	Molecular characterization of eight medicinally important species of Lamiaceae family based on random amplified polymorphic DNA (RAPD) markers	Dr. S. Samantaray, Sr. Scientist (Bio technology)
Arunkumar Phurailatpam Kalyani University	Ph.D.	Studies on plant-environment interaction in relation to phenotypic expressions and andrographolide production in *Andrographis paniculata* Nees.	Dr. Satyabrata Maiti, Director
Mr. Jigar D. Patel Shri P.M. Patel Institute of Bioscience, Anand	M.Sc	Evaluation of genetic variability in Betelvine (*piper betle* L.) using random amplified polymorphic DNA (RAPD)	Dr. S. Samantaray, Sr. Scientist (Bio technology)
Ms. Pushpa M. Deore Department of Agril. Botany Anand Agricultural University, Anand	M.Sc	Assessment of genetic diversity in *Aloe barbadensis* Mill. using molecular markers	Dr. S. Samantaray, Sr. Scientist (Bio technology)

Training imparted to students

Student's name	Topic of training programme	Guide
Mr. Dhrumit S. Bhatt	Techniques like micropropagation and DNA isolation, purification and quanification some important medicinal plants	Dr. S. Samantaray, Sr. Scientist (Bio technology)
Ms. Nilam I. Patel	Techniques like micropropagation and DNA isolation, purification and quanification some important medicinal plants	
Ms. Jaina B. Parikh	Techniques like micropropagation and DNA isolation, purification and quanification some important medicinal plants	
Ms. Kosha Y. Shelat	Techniques like micropropagation and DNA isolation, purification and quanification some important medicinal plants	

HUMAN RESOURCE DEVELOPMENT

Name	Details	Date
Dr. M. V. Kawale, RA	Hands on training on standardized protocols of pharmacognostic study for the characterization of medicinal plants at NBRI, Lucknow.	29 August – 4 September, 2009
Dr. P. Manivel, Principal Scientist (Plant Breeding)	Data mining and GIS for decision support in agriculture at Indian Institute of Management, Lucknow	31 August – 11 September, 2009
N. S. Rao, Scientist (SS) Computer Application	Decision making in agriculture using data mining at NCAP, New Delhi	27 October – 16 November, 2009

Distinguished Visitors

- Dr. S. N. Shukla, ADG(F&FC), ICAR, New Delhi on April 4. 2009
- Dr. B. R. Tyagi, Chairman, RAC & Retd. Dy. Director, CIMAP, Lucknow on June 11, 2009
- Dr. Umesh Srivastava, ADG (Hort. II), ICAR New Delhi on June 11, 2009
- Dr. J. B. Misra, Director, DGR, Junagadh on June 26, 2009
- Prof. P. Das, Former ICAR National Professor on July 20, 2009
- Dr. K. A. Singh, Director, IGFRI, Jhansi on 3.8.2009
- Sh. Ananth Kumar, Ex. Cabinet Minister, Government of India on August 10, 2009
- Sh. A.M. Diwakar, Chairman, AIIMS Engineering College, Bangalore on August 10, 2009
- Dr. S. N. Tyagi, Member Secretary, SMPB, Gandhinagar on September 5, 2009
- Sh. R. N. Joshi, IAS, Collector and District Magistrate, Anand on November 24, 2009
- Dr. A. K. Srivastava, Director, NDRI, Karnal on December 11, 2009
- Sh. Rajiv Mehrishi, Additional Secretary, DARE & Secretary, ICAR, New Delhi on January 19, 2010
- Dr. S. P. Singh, Former Director, PDBC, Bangalore on February 2, 2010
- Sh. Raj Ganguli, MADP Project Coordinator, FAO, New Delhi on February 9, 2010
- Dr. O. M. Banmbawale, Director, NCIPM, New Delhi on February 19, 2010
- Dr. O. M. Prakash, Chief Consultant (NHM),DAC, New Delhi on February 20, 2010
- Dr. B. C. Viraktamath, Project Coordinator, AICRP on Rice Improvement, DRR, Hyderabad on March 8, 2010

Deputation / Meetings attended by the Director

- Deputation as FAO International Consultant in Kabul, Afghanistan during April 20–May 19, 2009.

- National Debate on DUS test procedure and national test guidelines for tropical and sub-tropical plantation crops organized by the PPV&FRA at CPCRI, Kasaragod on July 10, 2009
- Chaired 1st Technical meeting of NMPB at Quality Council of India, New Delhi on July 15 2009
- Review meeting of the DUS testing project at PPV&FRA, New Delhi on July 22, 2009.
- Scientific Advisory Committee meeting at PPV&FRA, New Delhi on August 7, 2009.
- Selection Committee meeting for short listing nominations for ASPEE L. M. Patel Farmer of the Year Award 2008 at Mumbai during October 9–10, 2009.
- Mid-Term Review (MTR) of the Department of Agricultural Research & Education (DARE/ ICAR) for the 11th Five Year Plan at CIFE, Mumbai on October 26, 2009.
- Monitoring of the DBT funded project of TERI during November 5-7, 2009.
- Review meeting on DUS testing project at PPV&FRA, New Delhi on November 10, 2009.
- Chaired Technical meeting of NMPB on Certification standards of GAP & GFCP at Quality Council of India (QCI), New Delhi on November 26, 2009.
- Co-Chaired Relevance of Plant Protection in Global food security (Session: A) of the National Symposium on 'Climate Change, Plant Protection and Food Security Interface' during December 17–19, 2009.
- Chaired Plenary session of National Symposium on "Climate Change, Plant Protection and Food Security Interface" on December 19, 2009.
- Chaired the committee meeting and visited the coastal areas of Orissa, i.e. Puri, Cuttack and Balasore for examining the possibility for further strengthening of OUAT, Bhubaneswar centre during January 28-30, 2010.
- Chaired the NMPB Technical committee meeting on Certification standards of GAP & GFCP on 12th March at the QCI, New Delhi
- *National Conference on* Production of Quality Seeds and Planting Material – Health Management in Horticultural Crops at New Delhi on March 13, 2010.
- Delivered lecture in the awareness Workshop on India GAP & NMPB Standards at Mumbai organized by the QCI on March 17, 2010.

PUBLICATIONS

Research Papers

DMAPR, Anand

Mandal, K., P. R. Patel, S. Maiti and I. L. Kothari. 2010. Induction of male and female sterility in Isabgol (*Plantago ovata*) due to floral infection of downy mildew (*Pernospora plantaginis)*. *Biologia* **65**: 17-22.

Phurailatpam, A. K., K. A. Geetha, N. A. Gajbbhiye, R. Saravanan and S. Maiti. 2009. Comparative study of *Chlorophytum borivilianum* Sant. & Fernnand. and C. *arundinaceum* Baker – Two

'Safed Musli' species used as vital tonic in Indian System of Medicine. *Phytomorphology* **59**: 77-81.

Ram Chandra, Dinesh Kumar, O. P. Aishwath and B. K. Jha. 2009. Response of Isabgol to macronutrients under hot semi-arid eco-region of Gujarat. *Indian Journal of Horticulture* **66**: 549-550.

Samanta, J. N., B. D. Solanki and K. Mandal. 2009. First report of sweet wormwood leaf blight disease in India. *Australasian Plant Disease Notes* **4**: 78-79.

Samantaray, S. and S. Maiti. 2010. An assessment of genetic fidelity of micropropagated plants of *Chlorophytum borivilianum* using RAPD markers. *Biologia plantarum* **54**: 334-338.

Samantaray, S. and S. Maiti. 2010. *In vitro* organogenesis in *Aloe barbadensis* Mill.: An aloin A rich plant. *Indian Journal of Horticulture*. **67**: 80-84.

Samantaray, S., K. A. Geetha, K. P. Hidayath and S. Mati. 2010. Identification of RAPD markers linked to sex determination in guggal [(*Commiphora wightii* (Arnott.)] Bhandari. *Plant Biotechnology Reporter* **4**: 95-99.

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

Srinivasa Rao, N., K. A. Geetha and S. Maiti. 2009. Networking of Herbal Gardens in India : A New Venture by NMPB & NRCMAP. *ICAR news* **15**: 6.

AAU, Anand

Makwana, P. D., D. H. Patel, J. J. Patel and H. K. Patel. 2009. Effect of different organic manures and spacing on yield and quality attributes of Kalmegh panchang (*Andrographis paniculata* Wall. Ex Nees.) under middle Gujarat conditions. *The International Journal of Plant Sciences* **5**: 30-32.

Makwana, P. D., D. H. Patel, J. J. Patel, J. C. Patel, H. K. Sushilaben and H. K. Patel. 2009. Effect of different organic manures and spacing on quality and soil fertility status on Kalmegh panchang (*Andrographis paniculata* Wall. Ex. Nees.) under middle Gujarat conditions. *The International Journal of Plant Sciences* **5**: 81-86.

Patel, D. H., M. A. Patel, S. Sriram and J. R. Parmar. 2009. Inter cropping in safed musli (*Chlorophytum borivilianum*). *The International Journal of Agricultural Sciences*. **5**: 595-596.

APHU, Bapatla

Sireesha, K., P. Rama Devi and B. Tanuja Priya. 2009. Biodiversity of insect pests and their enemies in betelvine ecosystem in Andhra Pradesh. *Karnataka Journal of Agricultural Sciences* **22**: 727-728.

BCKV, Kalyani

Das, B. K. and S. K. Mallick. 2009. Assessment of yield loss due to Aleyrodid flies [*Singhiella pallida* Singh and *Aleurocanthus rugosa* Singh] and Control of *Singhiella pallida* Singh in betelvine (*Piper betle* L.) ecosystem. *Environment and Ecology* **27**: 1157-1160.

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

CCSHAU, Hisar

Anil Kumar and V. K. Madan. 2009. Effect of sowing time and seed rate on yield and quality of Shatawar (*Asparagus racemosus* Wield). *Journal of Medicinal and Aromatic Plants Sciences,* **31**: 288 -291.

NDUAT, Faizabad

Singh, A. K. and O. P. Singh. 2009. Correlation and path coefficienta nalysis in african marigold. *Advances in Plant Sciences* **22**: 239-241.

Singh, A. K. and O. P. Singh. 2009. Genetic variability in african marigold (*Tagetes erecta* L). *Advances in Plant Sciences* **22**: 261-263.

PDKV, Akola

Wankhade, S. G, A. G. Wagmare, S. V. Gholap, S. S. Wanjari, S. S. Narkhade. 2009. Effect of phosphorous and potassium levels on Seed yield and quality isabgol. *PKV Research Journal* **33**: 199-201.

Wankhade, S. G., P. P. Khode, S. V. Gholap and S. A. Agashe. 2009. Effect of time of harvest on root yield and quality of Ashwagandha. *PKV Research Journal* **33**1: 30-31.

Wankhade, S. G., P. P. Khode, S. V. Gholap and S. A. Bhuyar. 2009. Growth Performance of Shatavar as influenced by spacing and duration. *PKV Research Journal* **33**:70-72.

Wankhade, S. G., P. P. Khode, S. V. Gholap, S. A. Agashe. 2009. Effect of time of harvest on root yield and quality of Safed musli. *PKV Research Journal* **33**: 228-230.

Wankhade, S. G., R. B. Sarode, S. V. Gholap and S. B. Nandanwar. 2009. Saponin content in Safed musli (*Chlorophytum borivilianum)* as influenced by peeling of roots. *The Asian Journal of Experimental Chemistry* **3**: 79-81.

RAU, Pusa

Singh, S. K., P. K. Jha and P. K. Ray. 2010. Papaya Diseases in Bihar: An Overview. *ISHS Acta Horticulturae* **851**: 481- 86.

Singh, S.K. P.K. Jha and P.K. Ray. 2010. Integrated Management of Papaya Ring Spot Virus (PRSV) in Agro Ecological Conditions of Bihar. *ISHS Acta Horticulturae* **851**: 487-494.

KAU, Thrissur

Latha. A., V. V. Radhakrishnan and S. Mini. 2009. Influence of combination of organic manures and biofertilisers on growth, yield and quality of *Plumbago rosea* as an intercrop in coconut gardens. *Journal of Plantation Crop* **37**: 157-159.

YSPUH&F, Solan

Kaur R., N. Panwar, B. Saxena, R. Raina and S. V. Bharadwaj. 2009. Genetic stability in long term micropropagated plants of *Gentiana kurroo* - an endangered medicinal plant. *Journal of New Seeds* **10**: 236-244.

Books/Book Chapters/Seminar Papers presented

DMAPR, Anand

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

Manivel, P. 2010. Breeding medicinal plants in India: Current scenario and future opportunities. *In:* "Proceedings of the 3rd Indo-Korean joint seminar on Medicinal Plant Research" held at Coimbatore on February 23, 2010. pp. 25-44.

Srinivasa Rao, N. 2009. Medicinal and aromatic plants reference information system to server the researchers. *In*: Information Technology Applications in Horticulture Crops, pp. 290-293.

Srinivasa Rao, N., K. A. Geetha and S. Maiti. 2009. A user friendly web based information system on herbal gardens in India – www. Herbalgardenindia.org. *In*: Information Technology Applications in Horticulture Crops, pp. 232-238.

Srinivasa Rao, N., K. A. Geetha and S. Maiti. 2009. Digital photo library of medicinal and aromatic plants. *In*: Information Technology Applications in Horticulture Crops, pp. 287-289.

Srinivasa Rao, N., K. A. Geetha and S. Maiti. 2009. Digitalization of medicinal and aromatic plants herbarium data. *In:* Information Technology Applications in Horticulture Crops, pp. 282-286.

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Datta, P., B. Dasgupta and C. Sengupta. 2009. Standardization of inoculum for mass multiplication of *Trichoderma*. *In*: "National Symposium on Microorganisms and their role in Plant and Human Affairs" held at Kolkata during December 3 - 5, 2009. pp. 39.

Kumar, V. and B. Dasgupta. 2009. Management of major diseases of paddy using Biogem – a biocontrol agent. *In*: "National Symposium on Microorganisms and their role in Plant and Human Affairs" held at Kolkata during December 3 - 5, 2009. pp. 50.

CCSHAU, Hisar

Anil Kumar, V. K. Madan and J. S. Hooda. Production prospect of ashwagandha (*Withania somnifera* Dunal) under haryana situation. *In*: "Proceedings of Stake Holders Meet/ Workshop on Emerging Challenges: Medicinal and Aromatic Plants" held at Hisar during March 26-27, 2010. pp. 30-33.

Hooda, J. S., M. K. Deen, I. S. Yadav and O. P. Yadav. 2010. Geographical indications: Importance & prospects. *In*: "Proceedings of Stake Holders Meet/Workshop on Emerging Challenges: Medicinal and Aromatic Plants" held at Hisar during March 26 - 27, 2010. pp. 100-105.

Hooda, J. S., O.P. Yadav and I. S. Yadav. 2010. Breeding underutilized crops for tolerance to biotic stresses. *In:* Genetic Improvement for Biotic Stresses (Editors: S.K. Sethi, A. K. Chhabra, Kushal Raj, S. S. Siwach, Dhiraj Singh) pp. 61-69.

Khabiruddin, M., J. S. Hooda, O. P. Yadav and I. S. Yadav. 2010. Role of medicinal herbs in human health. *In*: "Proceedings of Stake Holders Meet/Workshop on Emerging Challenges: Medicinal and Aromatic Plants" held at Hisar during March 26-27, 2010. pp. 89-92.

Madan, V. K. 2010. Extraction, Storage and quality of essential oils of aromatic plants. *In*: "Proceedings of Stake Holders Meet/Workshop on Emerging Challenges: Medicinal and Aromatic Plants" held at Hisar during March 26-27, 2010. pp. 84-88.

Sunita Rani, V. K. Madan, Anil Kumar , I. S. Yadav and Savita Rani. 2010. Turmeric (*Curcuma longa*) – Chemistry, uses and future prospects. *In*: "Proceedings of Stake Holders Meet/Workshop on Emerging Challenges: Medicinal and Aromatic Plants" held at Hisar during March 26 - 27, 2010. pp. 93-96.

Yadav, I. S., O. P. Yadav, J. S. Hooda, M. K. Deen and V. K. Madan. 2010. Status Paper on Medicinal and Aromatic Plants in Haryana. *In*: "Proceedings of Stake Holders Meet/Workshop on Emerging Challenges: Medicinal and Aromatic Plants" held at Hisar during March 26-27, 2010. pp. 16-19.

Yadav, O. P., I. S. Yadav and K. R. Bhardwaj. 2010. Recent challenges and opportunities in management of biodiversity in medicinal and aromatic plants. *In*: "Proceedings of Stake Holders Meet/Workshop on Emerging Challenges: Medicinal and Aromatic Plants" held at Hisar during March 26-27, 2010. pp. 23-25.

Yadav, O. P., I. S. Yadav, J. S. Hooda and M. K. Deen. 2010. Challenges & Prospects of Marketing in Medicinal Plants. *In*: "Proceedings of Stake Holders Meet/Workshop on Emerging Challenges: Medicinal and Aromatic Plants" held at Hisar during March 26-27, 2010. pp.

KAU, Thrissur

Beena, C. 2009. A rapid method for detection of Adulteration in the market samples of Saraca asoca bark. *In*: "Proceedings of 19th *Swadeshi Science Congress*" held at Mannuthy during December, 10 - 12, 2009. pp. 64.

Latha, A and V. V. Radhakrishnan. 2010. Effect od organic manures and biofertilisers on nutrient uptake, herbage yield and bacoside content of *Bacopa monnieri*. *In*: "Proccedings of extended abstracts of 22nd Kerala science congress" held at Peechi during January, 28-31, 2010. pp. 65-66.

Nandini, K and Latha, A. 2010. Photosynthesis in relation to the development of stipulate tubers and rhizomes in kacholam. *In*: "Proccedings of extended abstracts of 22nd Kerala science congress" held at Peechi during January, 28-31, 2010. pp. 82-84.

NDUAT, Faizabad

Kumar, M., D. K. Chakrabarti, G. Chand and O.P. Singh. 2009. Morphological, histochemical and biochemical indices of downy mildew resistant cultivar of opium poppy. *In: "5th international conference on plant pathology in the globalized era"* held at IARI, New Delhi, November 10 -13, 2009. pp. 79.

RAU, Pusa

Jha, P. K and Singh, S. K. 2010. Poshan Prabandhan dwara udhyanik Phaslon men Rog Prabandhan. *In*: Rog, Keet, Sutrakrim and Kharpatwar Prabandhan, S. K. Singh (Ed.), RAU, Bihar , Pusa.

Jha, P. K. 2010. Paan men samekit keet-Vyadhi Prabandhan. *In*: Rog, Keet, Sutrakrim and Kharpatwar Prabandhan, S. K. Singh (Ed.), RAU, Bihar , Pusa..

TNAU, Coimbatore

Vanitha, S., M. Suganthy, L. Nalina and K. Rajamani. 2010. Induction of Bio-chemical compounds due to interaction of *Alternaria chlamydospora* with plant products, Biocontrol agent and chemical in *Solanum nigrum*. *In:* National conference on The challenges, chances and perspectives in Biotechnology" held at Erode during January, 22 - 23, 2010. pp. 35.

YSPUH&F, Solan

Sood, M and Kumar, V. 2010. Influence of transplanting time , spacings and fertilizers on herb and oil yield of *Mentha citrata* Ehrh in mid hill condition of Himachal Pradesh. *In*: "National Seminar cum Interactive workshop on Medicinal plants of Himalayan region" held at Solan during March 26-27, 2010. pp. 18.

Vikas Thakur and Meenu Sood. 2010. Effect of different growing medias on seed germination in *Aconitum deinorrhizum* Stapf. *In*: "National Seminar cum Interactive workshop on Medicinal plants of Himalayan region" held at Solan during March 26-27, 2010. pp. 22.

PERSONNEL

DMAPR

Director
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Scientific
Dr. P. Manivel, Principal Scientist (Plant Breeding)
Dr. Sanghamitra Samantaray, Senior Scientist (Biotechnology)
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Dr. Vipin Chaudhary, Senior Scientist (Entomology)
Dr. V. S. Rana, Senior Scientist (Organic Chemistry), from July 28, 2009
Mr. Saravanan Raju, Scientist Senior Scale (Plant Physiology)
Mr. N. A. Gajbhiye, Scentist Senior Scale (Organic Chemistry)
Mr. N. Srinivasa Rao, Scientist Senior Scale (Computer Application)
Dr. Gutam Sridhar, Scientist (Plant Physiology), till November 3, 2009
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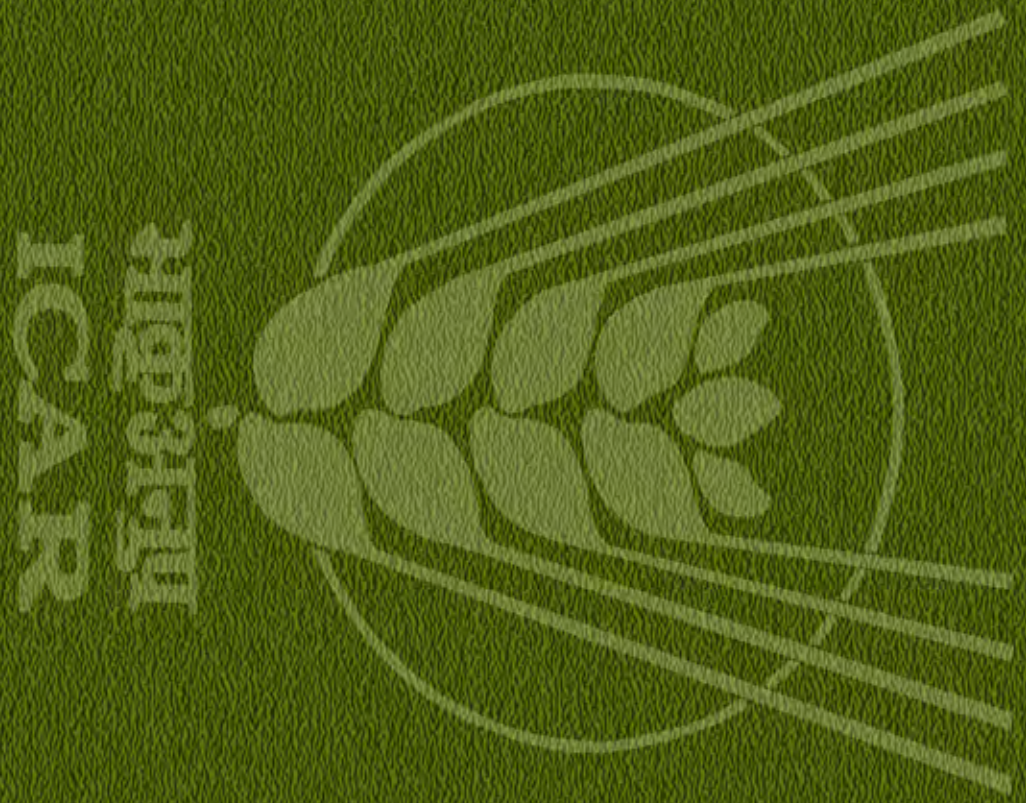

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