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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

We have now stepped into 12th Five Year Plan with a big bang. Now it is the time for steering up the preparation of the 12th Plan. Financial allocation has already been communicated such as Rs.25.00 crore for DMAPR and Rs. 30.00 crore for AICRP-MAPB subjected to final clearance by the EFC. Two new initiatives have been suggested in the EFC which are for agricultural growth in North Eastern Region and also in Tribal area.

The DMAPR has planned and prepared its EFC with various new initiatives within the domain agricultural research for quality raw drug production which is the first input of the quality herbal drugs preparation. We are also targeting the requirements of the Farmers, keeping the call of our Honourable Director General in mind "Farmers' First". The first input requirement of the farmers' is quality seed and planting material. We are making a special effort to ensure quality planting material supply of Medicinal and Aromatic Plants (MAP). In addition to these, our efforts will continue to improve the quality by breeding new high yielding varieties of MAP; developing location specific Good Agricultural Practices; developing standard operating procedure (SOP) for quality analysis and monitoring; post harvest processing, etc. We would also support establishment of certification (GACP & Organic) and labelling; providing training, information and research; promoting conservation and helping to shape government policies.

MAP sector is becoming more and more challenging with the advancement of new technologies. Opening of new market opportunities and competitive pricing from the neighbouring countries made the MAP sector to be more creative and competitive. In this changing scenario, the DMAPR would participate in shaping the sector by playing an effective role in transformation of rural economy by incorporating MAP crops in agriculture for income generation as well as job creation.

I take advantage of this opportunity to place on record my gratitude to Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR and Dr. N.K. Krishna Kumar, Deputy Director General (Horticulture) for their keen interest and kind support for the over all development of the Directorate and its activities. I am also thankful to formerly Assistant Director General (Hort. II), Dr. Umesh C. Srivastava, Dr. S. K. Malhotra, Assistant Director General (Hort. II) and Ms. Shashi Prabha Razdan, Director (Horticulture) for their personal care in dealing the matters of our directorate at the headquarters. Thanks are also due to all the scientists of the DMAPR and AICRP on MAP and Betelvine for their valuable contributions those have

found place in this annual report. Timely support received from my colleagues, Dr. Satyanshu Kumar; Dr. Geetha, K. A.; Dr. R. S. Jat and Dr. Thania S. Varghese in compilation and section editing of this volume is gratefully acknowledged. My thanks are due to Dr. Satyanshu Kumar and Dr. A. P. Trivedi in getting this volume printed within the deadline set by the Honb'le Director General, ICAR.

Jai Hind!

Anand **Satyabrata Maiti**

July 3, 2013

ABBREVIATIONS USED

AAU	Anand Agricultural University/ Assam Agricultural University
AICRP	All India Coordinated Research Project
BAU	Bihar Agricultural University/ Birsa Agricultural University
BCKV	Bidhan Chandra Krishi Vishwa Vidyalaya
B:C ratio	Benefit cost ratio
CCSHAU	Chaudhary Charan Singh Haryana Agricultural University
DAP	Days after planting
DAS	Days after sowing
DUS	Distinctiveness uniformity and stability
DMAPR	Directorate of Medicinal and Aromatic Plants Research
FYM	Farm yard manure
GAP	Good agricultural practices
GC-MS	Gas chromatography and mass spectrometry
ha	Hectare
HPLC	High performance liquid chromatography
IBA	Indole butyric acid
ICM	Integrated crop management
IGKV	Indira Gandhi Krishi Vishwavidyalaya
IIHR	Indian Institute of Horticultural Research
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
KAU	Kerala Agricultural University
MAP	Medicinal and Aromatic Plants
MPKV	Mahatma Phule Krishi Vidyapeeth
N ha^{-1}	Nitrogen per hectare
NDUAT	Narendra Dev University of Agriculture and Technology
NPK	Nitrogen-phosphorous-potash
OUAT	Orissa University of Agriculture and Technology
Plant ha^{-1}	Plant per hectare
PDI	Percent disease index
PDKV	Dr. Punjabrao Deshmukh Krishi Vishwavidyalaya
PSB	Phosphate solubilising bacteria
q	Quintal (100kg)
RAPD	Random amplified polymorphic DNA
RAU	Rajendra Agricultural University
RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
TLC	Thin layer chromatography
TNAU	Tamil Nadu Agricultural University
UBKV	Uttar Banga Krishi Vishwa Vidyalaya
UUHF	Uttarakhand University of Horticulture and Forestry
YSPUHF	Dr. Y.S. Parmar University of Horticulture and Forestry
YSRHU	Dr. Y. S. Reddy Horticulture University

SUMMARY

Directorate of Medicinal and Aromatic Plants Research (DMAPR) and its outreach program All India Coordinated Research Project on Medicinal & Aromatic Plants and Beletvine (AICRP-MAPB) are engaged in research on medicinal and aromatic plants and betelvine. Salient findings of 2012-13 are presented below:

ALOE (*Aloe barbadensis*)

Nine genotypes were evaluated at PDKV, Akola of which IC 112532 recorded significantly highest leaf weight (291.50 g leaf^{-1}).

Planting at a spacing of 60 x 60 cm and application of vermicompost 5 t ha^{-1} recorded highest number of suckers at PDKV, Akola. However, planting at same spacing and application of vermicompost 2.5 t ha^{-1} resulted in significantly more leaf weight, peel weight and latex. Application of vermicompost 5 t ha^{-1} and planting by ridge and furrow method recorded highest total leaf yield at IGKV, Raipur.

ARJUN (*Terminalia arjuna*)

Nine out of 209 plants were selected as superior plant type based on plant height, stem girth and bark thickness at PDKV, Akola. It was also found that total phenol and tannin contents were higher in trees of higher age group and similar was the trend in antioxidant activity.

ASALIO (*Lepidium sativum*)

MLS-1007 and MLS-1016 exhibited highest seed yield (2166 kg ha^{-1}) out of 40 selected germplasm lines at RVSKVV, Mandsaur. MLS-1007 also produced highest seed yield at AAU, Anand (1741 kg ha^{-1}) and MPUAT, Udaipur (2365 kg ha^{-1}).

Application of three irrigations (each at 25, 50 and 75 DAS) and 80 kg ha^{-1} nitrogen recorded highest seed yield at IGKV, Raipur. At MPUAT, Udaipur, application of 10 t FYM along with 40 kg N ha^{-1} in three equal doses (1/3rd each at sowing, 25 DAS and 45 DAS) recorded superior growth characters, yield and net return. Sowing at 30 x 10 cm spacing during 43rd meteorological week (Oct. 22-28) recorded maximum seed yield. Similarly, application of four irrigations at 25, 45, 65 and 85 DAS along with two sprays of 0.6 ppm brassinosteroids at 50 and 70 DAS recorded higher productivity and net returns. At RVSKVV, Mandsaur, seed rate of 8 kg ha^{-1} resulted into highest number of branches, stem diameter and seed yield. Similarly, N application through inorganic fertilizers recorded highest plant height, stem diameter, number of branches and seeds.

At RVSKVV, Mandsaur, a total of 24 genotypes was screened against *Alternaria* leaf blight out of which MLS-1, MLS-5, MLS-7, MLS-8, and MLS-13 were found to have field resistance.

At NDAUT, Faizabad spraying of Propiconazole 0.2% were found effective for *Alternaria* blight control whereas Trifloxystrbin 25+Tebuconazole 50% (Nativo at 0.15%) was found to be most effective at RVSKVV, Mandsaur.

Among the six fungicide tested at RVSKVV, Mandsaur, Trifloxystrbin 25+Tebuconazole (50%) (Nativo at 0.15%) was found to be most effective against *Alternaria* leaf blight which recorded a per cent disease incidence of 17.52% and a maximum seed yield of 1775.78 kg ha^{-1} .

ASHOKA (*Saraca asoca*)

At DMAPR, Anand, studies on reproductive biology of the species including flowering pattern, flower and fruit maturity, stigma receptivity, pollen viability, pollen count, floral visitors and pollination methods were conducted. The study indicated the cross pollinating nature of the species. It was also found that polyembryony was genotype specific and extent of polyembryony was observed up to 5.07%.

A simple rapid and validated HPLC method was developed at DMAPR, Anand for the identification and quantification of catechin and epicatechin in the bark extracts.

ASHWAGANDHA (*Withania somnifera*)

Out of 68 lines tested, MWS-90-130 recorded highest dry root yield (422 kg ha^{-1}) at RVSKVV, Mandsaur. Different distinct and stable characters were also identified. At MPUAT, Udaipur, AWS-2B showed significantly higher dry root yield (810 kg ha^{-1}) over all the entries and the checks.

At JNKVV, Jabalpur, maximum control of *Alternaria* leaf blight was in Mancozeb treatment which recorded maximum dry root yield (5.0 q ha^{-1}) and seed yield (75.0 kg ha^{-1}).

At DMAPR, Anand, higher withanolide A (mg g^{-1}) and 12-deoxy-withastramanolide (mg g^{-1}) content were recorded in two purified lines DWS-130 B7 (1.486 and 0.611), DWS-145 B7 (1.483 and 0.686). Extract yield, chemical composition of the extracts (total phenol and withanolide content) and antioxidant activity varied with the extraction method used as well as solvent composition used for extraction.

At DMAPR, Anand, azadirachtin 1% and Flavanoids 6% were found effective for the control of hadda beetle. It was also found that the beetle completes its life cycle in 20.08±0.24 days after passing through four larval instars.

BACH (*Acorus calamus*)

At YSRHU, Venkataramannagudem, 24 accessions were evaluated for their morphological and agronomical traits and ploidy status. Highest rhizome yield was found in APAc-9.

At YSRHU, Venkataramannagudem, sowing at 60 x 45 cm spacing and application of FYM 15 t ha^{-1} recorded maximum growth parameters, rhizome weight and rhizome yield (34.48 q ha^{-1}).

At BCKV, Kalyani an integrated management against leaf spot showed that spraying of *Pseudomonas* sp at the rate of 10^9 cfu ml^{-1} followed by Salicylic acid at the rate of 12 mM and *Clerodendron* leaf powder at the rate of 14% resulted in lowest per cent disease incidence (7.33%) and highest inhibition of disease incidence (81.73%).

BAEL (*Aegle marmelos*)

A rapid LC-ESI-MS/MS method was developed for simultaneous determination of five bioactive molecules i.e. umbeliferone, psoralene, marmin, imperatorin and skimmianine in root and stem bark extracts at DMAPR, Anand. These compounds were found in higher quantity in root extracts.

BALA (*Sida cordifolia*)

TLC profiling of methanolic extracts *Sida cordifolia*, *S. cordata*, *S. acuta*, *S. rhombifolia* subsp. *S. rhombifolia* and *S. rhombifolia* sub sp. *retusa* showed that ephedrine content was higher in aerial parts as compared to roots and its content was maximum in the seed at KAU, Trichur.

BASIL (*Ocimum basilicum*)

At AAU, Anand, ten accessions of basil were evaluated for green leaf yield and oil yield. Significantly highest green leaf yield (684.84 q ha^{-1}) and oil yield (198.36 kg ha^{-1}) were obtained in accession Ob 3. Twenty one germplasm lines were evaluated at RVSKVV, Mandsaur and the highest seed yield was found in MOB-14 (2222 kg ha^{-1}).

BANKAKDI (*Podophyllum hexandrum*)

At UUHF, Bharsar, seed germination studies revealed maximum germination at 20°C constant temperature.

BACHHNAG (*Aconitum deinorrhizum*)

At YSPUHF, Solan, application of IBA 100 mg l^{-1} at top portion of rhizome initiated sprouting in minimum days, recorded maximum sprouting and survival ability in the field.

CHIRAYITA (*Swertia chirayita*)

At UBKV, Kalimpong, distinct plant types were identified based on plant height, leaf characters and flower characters. The seed germination under different temperature regimes were studied at UUHF, Bharsar and maximum seed germination was found at 25° C constant temperature.

CHITRAK (*Plumbago zeylanica*)

Forty five accessions were characterized based on plant height, plant spread, number of branches, leaf length and leaf breadth at TNAU, Coimbatore.

DODI (*Leptadenia reticulata*)

Application of FYM 10 t ha^{-1} recorded significantly highest dry biomass yield, net return and B:C ratio and remained on par with castor cake 2 t ha^{-1} and poultry manure 5 t ha^{-1} at AAU, Anand.

GILOE (*Tinospora cordifolia*)

At DMAPR, Anand, genetic similarity and interrelationship among 53 accessions were studied using RAPD markers.

HPTLC method was also standardized for identification and quantification of two alkaloids palmatine and berberine in methanol extract. 34 germplasms were also screened for palmatine, 20β-hydroxyecdysone (TBH) and cordioside-1 concentration in the extract.

GUGGUL (*Commiphora wightii*)

At DMAPR, Anand, 73 accessions were assessed for genetic relationship by RAPD and ISSR markers.

HIMALAYAN RHUBARB (*Rheum australe*)

At YSPUHF, Solan, application of NPK 120:60:30 kg ha^{-1} recorded maximum plant height, root length, above and underground biomass at 12 and 24 months after planting followed by Vermicompost + *Azotobacter* + PSB (10 t:5 kg:5 kg ha^{-1}).

INDIAN VALERIAN (*Valeriana jatamansi*)

At UBKV, Kalimpong, germplasm were characterized based on plant height, leaf characters and flower initiation. It was also found that crop raised through seeds and transplanted in June at a spacing of 30 x 45 cm recorded significantly higher fresh aerial, underground, rhizome and root biomass. Whereas the crop raised through rhizome cuttings and transplanted in June recorded maximum underground biomass. Transplanting of rhizome cuttings at spacing of 30 x 45 cm produced maximum aerial, rhizome and root biomass.

Fixed plot survey result revealed that the percent disease incidence (PDI) of stem rot disease was maximum during the month of August (39.32%) and minimum during the month of January (6.17%), whereas PDI of leaf mosaic disease was maximum during February (25.29%) and minimum during the month of July (14.29%).

ISABGOL (*Plantago ovata*)

At RVSKVV, Mandsaur, eighty lines were evaluated and highest seed yield was observed in MIB-5.

At MPUAT, Udaipur, 32 lines were evaluated along with checks RI-89, GI-2 and Niharika for higher seed yield and swelling factor. Twelve lines exhibited higher seed yield over the best check Niharika (1320 kg ha^{-1}). At this centre two varietal evaluation trials were conducted and in the first trial, entry DPO-4 exhibited significantly higher seed yield (1375 kg ha^{-1}) over the best check Niharika and in the second trial, the entry MIB-123, MIB-124 and AMB-2 exhibited significantly higher seed yield over the best check Niharika.

At DMAPR, Anand, application of 15 kg $ZnSO_4$, 7.5 kg $CuSO_4$, 12.5 kg $FeSO_4$ and 12.5 kg $MnSO_4$ ha^{-1} recorded highest dry matter and seed yield. Biochemical changes during seed development were studied and was found that soluble sugar content decreased whereas, starch and cellulose content increased from 0 to 28 days after anthesis.

Screening of 15 genotypes at MPUAT, Udaipur against downy mildew, leaf spot and blight revealed two genotypes (PB-3-1 and Gumary) of moderate field resistance and six genotypes (MIB-123, MIB-124, AMB-2, P-6, P-80 and DM-2) of resistance against downy mildew as well as leaf spots.

At DMAPR, Anand, application of Frapioned triterpenoids 4% + Neem oil 0.22% was found most effective for the control of aphids.

Feeding potential of coccinellid predators (*Scymnus quadrellum*, *Menochilus sexmaculatus* and *Coccinella transversalis*) were evaluated at DMAPR, Anand against cotton aphid (*Aphis*

gossypii). The larvae of *Scymnus quadrellum*, *Menochilus sexmaculatus* and *Coccinella transversalis* were having a mean predation of 39.90, 69.18 and 72.85 percentage whereas the adults of these three insects recorded a predation percentage of 27.87, 85.24 and 85.69, respectively.

At DMAPR, Anand augmentation of coccinellid predators suppressed the population of Isabgol aphids significantly after 15 days of second release and a significant yield difference was observed between control (without predatory coccinellids) (485.04 kg ha^{-1}) and treatment (augmented with predatory coccinellids) (618.96 kg ha^{-1}), but it was at par with natural condition (587.26 kg ha^{-1}) where the predatory coccinellids in the nature was left undisturbed.

JALA NIRGUNDI (*Vitex trifolia*)

A validated rapid and simple HPLC method was developed at DMAPR, Anand for identification and quantification of p-hydroxy benzoic acid and two bioactive iridoids negundoside, agnuside in extracts.

JATAMANSI (*Nardostachys grandiflorum*)

At YSPUHF, Solan, a new chromosome count of 2n=78, *i.e.*, genomic hexaploid was reported for the first time. Details of reproductive biology of the species were also studied at this centre.

KALIHARI (*Gloriosa superba*)

At TNAU, Coimbatore yield loss due to defoliators (*Plusia signata* and *Spodoptera litura*) and the major sucking pest, *Thrips tabaci* was found to be 38.87% and 28.89%, respectively. Among the different biopesticides evaluated against Thrips tabaci and defoliators at TNAU, Coimbatore, natural lactones 2 ml l^{-1} were found effective against thrips whereas flavanoids 1 ml^{-1} were effective against defoliators.

KALIJIRI (*Vernonia anthelmintica*)

At AAU, Anand, sowing on 1st October at 45 cm spacing recorded significantly higher seed yield, return and B:C ratio.

KALMEGH (*Andrographis paniculata*)

Eleven accessions were evaluated at NDUAT, Faizabad and IC 342135 had the best performance based on two years' data. In another trial, twenty accessions were evaluated and maximum fresh and dry herbage yields were observed in IC 210635 (101.96 q ha^{-1}) and IC 210635 (42.55 q ha^{-1}), respectively.

At DMAPR, Anand, DUS descriptors were identified for in ten morphological characters and accordingly distinct lines were developed. Forty five distinct reference varieties were developed and highest herbage yield was found in DMAPR AP 2 (112.13 q ha^{-1}).

At PDKV, Akola, kalmegh + pigeon pea intercropping at 3:1 row proportion recorded highest kalmegh and pigeon pea equivalent yield, LER and gross monetary return and it was concluded that kalmegh + pigeon pea intercropping at this row proportion was most suitable and economical.

Application of 60 kg N ha^{-1} and planting at 30x30 cm spacing recorded significantly highest dry herbage yield at RVSKVV, Mandsaur.

At DMAPR, Anand, a rapid and validated HPLC method was developed for the simultaneous determination of andrographolide, neoandrographolide and andrograpanin in the extracts. Extracts were prepared using cold percolation, refluxing, ultrasound and microwave assisted solvent extraction as well as super critical fluid extraction methods.

KUTKI (*Picrorhiza kurroa*)

TLC and HPLC analysis at YSPUHF, Solan showed that out of fifty eight market samples, five per cent samples were spurious samples.

LAL CHITRAK (*Plumbago rosea*)

At KAU, Trichur, pruning at 15 months after planting at a height of 30 cm gave the highest root yield, however, the highest plumbagin content was found in pruning at 9 months after planting and at a height of 30 cm.

LONG PEPPER (*Piper longum*)

Eight accessions were evaluated for various morphological characters at AAU, Jorhat and highest fresh spike weight was observed in JPL-32.

At PDKV, Akola, application of NPK 150:75:75 kg + neem cake 20 q ha^{-1} recorded highest berries per vine, yield of berries and gross monetary return.

Sun, shade, solar drier and hot air oven drying methods were compared for drying of fresh fruits. Loss recorded was lowest in solar drier drying (77.32%) and highest in sun drying (79.67%). Piperine content was higher in solar drier dried samples (5.17%) followed by oven dried sample (5.12%) and lowest in sun dried samples (4.43%).

MADHUNASHINI (*Gymnema sylvestre*)

At JNKVV, Jabalpur, seven accessions were evaluated for the selection of a superior cultivar and maximum dry leaf yield was found in JBPGS8-9-104 (51.83 g plant^{-1}).

MAKOI (*Solanum nigrum*)

At YSRHU, Venkataramannagudem, 44 accessions were evaluated for their morphological and agronomical traits.

At TNAU, Coimbatore, 52 accessions were characterized for morphological characters, solasodine content and ploidy status. Three species *viz.*, *S. nigrum*, *S. americanum* and *S. villosum* were identified in the collection.

At YSRHU, Venkataramannagudem, application of vermicompost 6 t with Azophosmet 2 kg + Methylobacterium 500 ml ha^{-1}; line sowing at 30x30 cm and harvesting at 45 days intervals significantly increased the growth parameters and herbage yield. Similarly, transplanting of 45 days old seedlings produced maximum plant height and branches. At TNAU, Coimbatore, application of vermicompost (6 t ha^{-1}) along with Azophosmet (2 kg ha^{-1}) and foliar spray of methylbacterium (1%); 12.5 kg seeds rate for broadcasting, sowing at 20x10 cm spacing

and harvesting at 30 days interval recorded maximum growth parameters and herbage yield.

At TNAU, Coimbatore yield loss due to the major pests (*Aphis craccivora*, *Thrips tabaci* and defoliators) was found to be 36.36%. Foliar application of azadirachtin 10,000 ppm at 500 ml ha^{-1}, twice at 15 days interval was recommended for the management of insect pests. Studies on efficiency of various shades of yellow sticky traps in attracting major sucking pests complex revealed that maximum numbers of thrips were attracted to golden yellow shade whereas, maximum numbers of aphids were attracted to butter scotch yellow shade. In case of whiteflies, maximum attraction was recorded in golden yellow shade.

MAMEJO (*Enicostemma axillare*)

A new CPC method for separation of swertiamarin was developed at DMAPR, Anand. Methyl benzoate (8.5%), 2,4,6-octatrienal (24.7%), and 4-ethylphenol (8.5%) were identified as the main constituents of the volatile oil from the aerial parts.

MANDUKAPARNI (*Centella asiatica*)

Five accessions at AAU, Jorhat, seven accessions at UBKV, Kalimpong and eleven accessions at RAU, Pusa were evaluated.

At DMAPR, Anand, application of 15 t FYM ha^{-1} along with 60:50:60 kg ha^{-1} N:P:K as basal and top dressing of 20 kg N ha^{-1} at each harvest recorded highest dry herbage yield. Balance sheet of NPK showed different trends with levels of nutrient application. It showed negative balance for N and K with the lower doses of application and positive with the higher levels of application. Whereas, phosphorus showed a positive balance with increasing levels of application and P build up was very high over the initial values. Planting at 20 x 20 cm spacing recorded highest total fresh herbage yield, whereas, length and breadth of the leaves were maximum at 40 x 20 cm at AAU, Jorhat.

Planting on 15th February recorded maximum plant height, leaf area, petiole length, fresh and dry herbage yield followed by 1st February and 1st March at NDUAT, Faizabad.

Field experiments conducted at RAU, Pusa for the management of stem rot of mandukaparni indicated that soil drenching with carbendazim was highly effective in checking the stem rot with least disease severity of 0.5 on 0-4 scale.

MUCUNA (*Mucuna pruriens var. utilis*)

At DMAPR, Anand, ultrasound and microwave assisted solvent extractions were found to be viable alternatives to conventional methods in terms of extract yield and L-DOPA concentration of the extract.

NEEL (*Indigofera tinctoria*)

Nineteen accessions were evaluated for herbage yield and quality at KAU, Trichur. Significantly higher herbage yield was obtained in TCRIT 4 (232.35 g $plant^{-1}$). Indican content was highest in TCRIT 12 (0.555%).

At KAU, Trichur, planting during 2nd week of September under fully open condition with spacing at 45x30 cm and cutting at 90 days interval recorded the highest plant height. In an another experiment, highest plant height was recorded at the time of first cutting

(2 month after planting) with the application of vermicompost 3 t ha^{-1}, however, herbage yield was maximum with the application FYM 10 t + *Azospirillum* 2 kg +VAM 2 kg ha^{-1}.

OPIUM POPPY (*Papaver somniferum*)

Thirty five lines at NDUAT, Faizabad, 36 plant types at RVSKVV, Mandsaur and 85 lines were evaluated at MPUAT, Udaipur for various morphological and yield characters.

At RVSKVV, Mandsaur, application of three irrigations produced significantly highest plant height and seed yield, however, latex yield and number of capsules were maximum with one irrigation. Similarly, application of 30 kg N ha^{-1} produced highest plant height, however, number of capsules, seed yield and latex yield were maximum with 15 kg N ha^{-1}.

At RVSKVV, Mandsaur, three sprays of Sectin (Fenamidone 10% +Mancozeb 50%) either at 0.15% or 0.2% at 35, 55 and 75 days after sowing were found to be effective in managing downy mildew. Two sprays of Trifloxystrbin 25+Tebuconazole 50% (Nativo) at 300 g ha^{-1} or 400 g ha^{-1} at flowering and capsule maturity stage were found effective in reducing the powdery mildew incidence. At MPUAT, Udaipur an integrated disease management strategy for root rot of opium poppy consisting of soil application of Neem cake manure at 500 g m^{-2} as organic amendment + seed treatment with *Trichoderma* talc based formulation (10^8 cfu g^{-1}) at 10 g kg^{-1} + drenching with Hexaconazole (0.1%) at 35 and 60 DAS resulted in minimum plant mortality (9.17%), maximum percent disease control (90.29%), yielded maximum dry latex powder (35.34 kg ha^{-1}), seed (15.1 q ha^{-1}), capsule husk (13.9 q ha^{-1}) and increased per cent of morphine content (12.88%). Twelve genotypes screened at the centre against downy mildew, root rot, leaf spots, bacterial blight, and powdery mildew revealed that six genotypes (UOP-20, UOP-44, UOP-53, UOP-69, UOP-79, and UOP-80) were resistant (R) and the remaining five genotypes UOP-30, UOP-35, UOP-60, MPO-04 and UO-1185 were ranked as moderately resistant (MR) genotypes.

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

At DMAPR, Anand, under modified mass selection, fifteen palmarosa clones selected by two years screening and composite developed were evaluated along with variety Trishna as check. Non-significant differences were observed for yield parameters and highest essential oil content was observed in DCM-14 and highest geraniol content in DCM-3 clone.

Among different varieties, the variety Jamarosa produced the highest herbage yield with the application of 125 kg N ha^{-1} at IGKV, Raipur.

PUNARNAVA (*Boerhavia diffusa*)

Integrated management of leaf spot disease conducted at BCKV Kalyani showed that treatment combination of spraying Trichoderma sp. at the rate of 3.7×108 spores ml^{-1} followed by Salicylic acid at the rate of 3mM and Trichoderma sp at the rate of 3.7×10^8 spores ml^{-1} recorded lowest per cent disease incidence (12.41) and per cent disease index (13.29).

SAFED MUSLI (*Chlorophytum borivilianum*)

Thirteen clones along with a check, MCB 405 were evaluated for different morphological characters and yield at PDKV, Akola. AKSM-13 produced highest fleshy root yield, however,

saponin content was highest (7.43%) in AKSM 08.

Twenty-four clones were evaluated at RVSKVV, Mandsaur and fresh fleshy root weight was highest in MCB-412 (3888 kg ha-1).

At PDKV, Akola, intercropping of safed musli + pigeon pea at 3:1 row proportion recorded highest fresh (35.47 q ha^{-1}) and dry root (5.91 q ha^{-1}) yield of safed musli.

At RVSKVV, Mandsaur seed treatment with carbendzim 1.5g kg^{-1}+ soil drenching with carbendazim at 0.15% recorded the minimum root rot incidence (17.85%) and higher yield (3116 kg ha^{-1}).

Under integrated disease management package against root rot at MPUAT Udaipur, showed that soil application of Neem cake manure at 500 g m^{-2} as organic amendment + seed treatment with SAAF 75 WP (Mancozeb 63% + Carbendazim 12%) at 0.2% + application of Trichoderma (10^8 cfu g^{-1}) at 20% recorded minimum plant mortality (8.87%), maximum percent disease control (86.48) and higher yield of fasciculated root (45.10 q ha^{-1}).

At RVSKVV Mandsaur, twenty three genotypes were screened against fasiculated root rot and MCB-412, JSM-405, RVSM-414, MCB-416, MCB-423 were found as field resistant.

SARPAGANDHA (*Rauvolfia serpentina*)

At JNKVV, Jabalpur spraying of 0.1% carbendazim was found to be effective for the management of *Cercopspora* leaf spot of sarpagandha.

Studies on the integrated management of target leaf spot (*Cornyspora cassicola*) done at BCKV, Kalyani revealed that spraying of *Pseudomonas* sp. at the rate of 10^9 cfu ml^{-1} followed by Salicylic acid at 1mM and *Clerodendron* leaf powder at 14% recorded lowest per cent disease incidence (7.64) and per cent disease index (9.7)

SENNA (*Cassia angustifolia*)

At DMAPR, Anand, it was found that the plants are dependent on insects for pollination. A total of 10 insect pollinators were collected and identified.

In the field experiments conducted at DMAPR, Anand it was found that azadirachtin 1% was very effective for the management of *Catopsilia pyranthe*.

At DMAPR, Anand an yield loss of 15.74% was recorded due to the damage of *Catopsilia pyranthe*. It was found that azadirachtin 1% was very effective for the management of *Catopsilia pyranthe*. A larval endoparasitoid *Cotesia glomerate* was identified as the major parasitoid of *Catopsilia pyranthe* and its parasitisation ranges from 20-60%.

SHANKHPUSHPI (*Convolvulus microphyllus*)

At AAU, Anand, the four years result showed that application of bio-fertilizer (*Azotobactor* + phosphate culture at 1 liter ha^{-1} each recorded maximum dry biomass yield, net return and B:C ratio.

SHATAVARI (*Asparagus racemosus*)

Thirteen accessions were evaluated along with a local check JBPAR8-9-127 at JNKVV, Jabalpur and highest fresh fleshy root yield per plant was recorded in JBPAR8-9-117.

At YSPUHF, Solan, application of FYM 5 t + vermicompost 2 t + PSB 10 kg ha^{-1} recorded maximum plant height, number of branches per plant, number of roots per plant and fresh root yield after 12 and 18 months of planting followed by vermicompost 2 t + PSB10 kg ha^{-1}.

Application of vermicompost 2 t + mustard cake 1 t ha^{-1} and inoculated with PSB 5 kg + *Azospirillum* 2 kg ha^{-1} recorded highest root yield followed by vermicompost inoculated with mixture of *Azospirillum* and PSB at RAU, Pusa.

TULSI (*Ocimum sanctum*)

At NDUAT, Faizabad, application of 30:20:10 kg NPK along with 10 t FYM ha^{-1} recorded highest plant height, number of branches and fresh and dry herbage yield and essential oil yield. Application of 60 kg N ha^{-1} and sowing at wider spacing of 60 x 40 cm recorded highest plant height, number of branches, dry herbage yield and seed yield at RVSKVV, Mandsaur.

An yield loss of 27.84% was recorded at RAU, Pusa due to the damage of tingid bug.

BETELVINE (*Piper betle*)

At IIHR, Bangalore,106 germplasm are being maintained including three *Piper* species.

Eight high yielding clones along with local check (Hirehalli Local) were evaluated and higher leaf yield was found in Mysore Local (17.56 lakh ha^{-1})

The hybridization work was continued using fourteen female clones, eight male clones and four hybrids. Twelve inter-varietal crosses, six crosses between varieties and hybrids and two interhybrid crosses were also carried out. Inter-specific hybridization between *P. betle* and *Phytophthora* resistant *P. colubrinum* was continued.

Highest hybrid seed germination was recorded in cross Maghai/Swarna Kapoori (74.33%).

Performance of hybrids in terms of morphology including flowering, vigour and yield was studied. Under field conditions, Hy 06-4 produced maximum number of leaves (237.94 leaves vine^{-1}) and under shade net condition, Hy 07-32 had maximum number of leaves (66.8 leaves vine^{-1}).

At BAU, Islampur, application of vermicompost 10 t ha^{-1} recorded significantly higher number of branches vine^{-1}, vine elongation month^{-1}, marketable leaves, weight of 100 leaves and with lesser disease incidence during three consecutive years from 2010-2013. Similarly population density of 1.50 lakh plant ha^{-1} recorded ideal number of marketable leaves, leaf size and fresh weight which fetched higher market price and recorded significantly lower incidence of disease during all the three years.

At YSRHU, Venkataramannagudem, four hybrids (Hy-06-1, Hy-06-4, Hy-06-11 and GN) were evaluated. Hybrid 'Hy-06-4' performed well and also recorded significantly higher growth and yield parameters compared to other hybrids and local checks.

At BAU, Islampur, field sanitation + application of 1% Bordeaux mixture (BM) at pre-monsoon period + one month later application of biological agents (*Trichoderma viridi*) + application of 1% BM two months after first BM application resulted in lower incidence of foot rot disease and significantly higher marketable leaves.

The integrated crop management practices developed at RAU, Pusa tested at 22 farmers' field at five different locations produced superior and maximum marketable leaf yield (32 lakhs leaves ha-1) with longer shelf life of leaves (15-16 days) as compared to local farmers' practice.

Intellectual Property Rights

Six elite gemplasm were identified and registered with NBPGR, New Delhi.

Agricultural Knowledge Management

The information related to herbal gardens, availability of species in each garden were up dated. The Directorate website (www.dmapr.org.in) was also redesigned. Intranet website was also created.

General Information

The DMAPR hold metings of IRC, RAC and IMC to monitor the research and development activities. QRT team visited the Directorate. Two trainers' training on "Good Agricultural and Collection Proctices (GACP) for Medicinal and Aromatic Plants" of five days duration was organised. A training cum awareness programme on "Protection of Plant Varieties and Farmers Right Act" and training on "Production of Aromatic Crops" was also organised. The group meeting of All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine was organised to review the work of various centres. The technology developed by the Directorate and AICRPMAP&B were displayed in exhibitions at Ahmedabad, Roorkee and Bhubaneswar. A Kishan Mela was also organised at CHES, Godhra.

Honourable Director General, ICAR inagurated the newly constructed guest house at DMAPR. The Director, DMAPR delivered a lecture on "Advances in Medicinal Plant Research in India." in Natural Product Conference on "Natural Products for Better Health, Beauty and Wealth" at Kathmandu. DMAPR spots team participated in ICAR Inter-Zonal Sport Meet and ICAR Zonal Sports Tournament for Western Zone. The Directorate also organised a two-day national conference on "Intergration of Medicinal and Aromatic Plants for Rural Development and Prosperity."

International Women's Day, Hindi Divas,Vigilance awareness week and Foundation day were also celebrated at the Directorate.

Introduction

Introduction

The Earth is the only planet presently known to support life in different forms and human is the only intelligent race that explores various natural, physical and biological processes for their survival and health and it is often argued that the 'well-being' of nature is inseparable from the physical and psychological 'well-being' of the human condition. Forest has played a key role by supplying fresh water and oxygen as well as providing a diversity of valuable forest products for food and medicine. The age-old traditional knowledge attached with the various forest types and the varieties of forest products (i.e., medicinal plants) have gained remarkable significance in the present century specially for drugs discovery. Furthermore, the cosmetic industries are also using more and more natural ingredients in their products, and these natural ingredients include extracts of several medicinal and aromatic plants. India and China are two of the largest countries in Asia, which have the richest traditional system of medicines such as Ayurveda, Siddha, traditional Chinese medicines, etc that uses a large number of medicinal and aromatic plants (MAPs). Since the Indian subcontinent is well known for its diversity of forest products and the age-old healthcare traditions, there is an urgent need to establish these traditional know-how in both the national and international perspectives realizing the ongoing developmental trends in traditional knowledge. In addition, MAPs are also essentially important as alternate income-generating source to the underprivileged communities living in forests. Therefore, strengthening this sector may benefit and improve the living standard of farmers as well as forest dwellers.

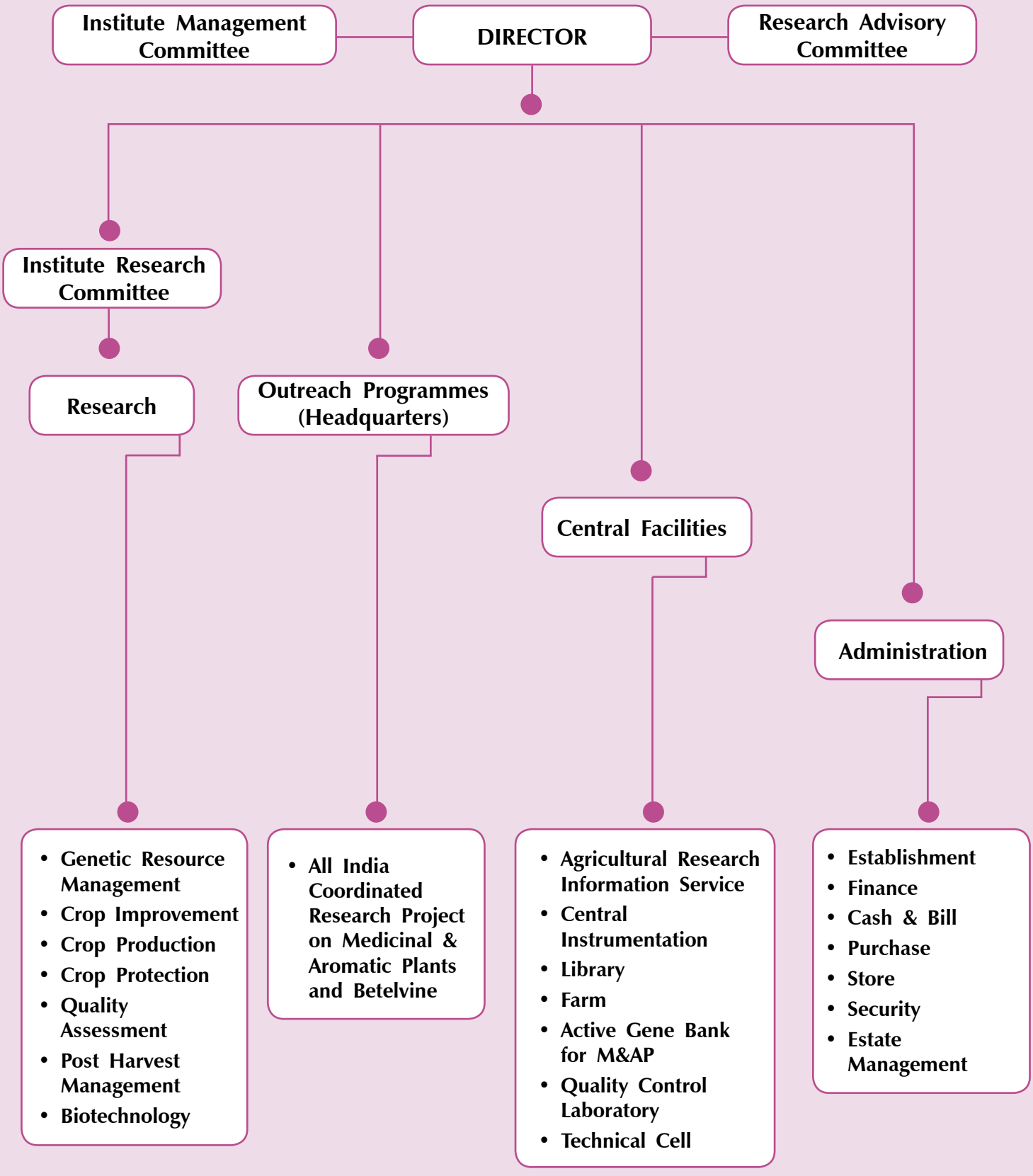
The current rising demand of herbal drugs is unfortunately creating heavy pressure on some selected high-value medicinal plant populations in the wild due to over-harvesting. Several of these medicinal plant species have slow growth rates, low population densities, and narrow geographic ranges, therefore they are more prone to extinction. Apart from the human usages, animal husbandry and veterinary also use a large number medicinal plant species for animal healthcare. Farming of the medicinal plants thus, is an alternative option to save these species as well assuring quality raw drug to the industry.

There are many challenges before the farmers of MAPs. Information on the propagation of MAPs is available only for less than 10% and agro-technology is available only for 1% of the total known plants globally. This trend illustrates the need for developing good agricultural practices (GAP) in compliance with WHO as the principal thrust area for research. Furthermore, in order to meet the escalating demand of MAPs, farming of these plant species is imperative. Farming of MAPs will help to conserve the wild genetic diversity of MAPs in nature when pressure is withdrawn from the forest. Farming would also benefit the industry in getting uniform raw material, from which products of consistent quality can be manufactured. Cultivation also permits genetic improvements for improved variety and improved quality control through GAP. Notwithstanding, it is now fairly understood that the cultivation of MAPs is not an easy task as our past experiences of MAPs farming show.

The Indian Council of Agricultural Research (ICAR) wisely recognized the growth potential of this newly emerging herbal sector way back in 1992 by creating a National Research Centre for Medicinal and Aromatic Plants at Anand, Gujarat which has been rechristened to Directorate of Medicinal and Aromatic Plants Research (DMAPR) by backward linking of its outreach programme, the All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRP-MAPB).

The Directorate of Medicinal and Aromatic Plants Research (DMAPR), has been in the forefront for sustainable production and utilization of major agriculturally important MAPs through its research and development to meet the immediate demands and also to address future national and international challenges.

Organisational Structure



The DMAPR continues to contribute in this sector in the very basic link of quality raw drug supply by research using its core competent area of agriculture which is as important as drug discovery. Research, thus in quality raw drug supply sector demands for varietal improvement, development of good agricultural practices for assuring end quality, quality assessment, quality supply of planting material, fixing of standards, certification, etc. The emerging challenges and opportunities demand for an innovation driven research system using modern tools of ICT, biotechnology, molecular biology, biochemistry, etc to link with all the stakeholders in the entire MAP supply chain.

Mandate

- Development of appropriate production, protection and processing technologies for important medicinal and aromatic plants through basic, strategic and applied research.
- Germplasm enhancement of various medicinal and aromatic plants.
- To act as a National Repository of the genetic resources of selected important medicinal and aromatic plants.
- To coordinate research under the All India Coordinated Research Project on Medicinal, Aromatic Plants and Betelvine (AICRP-MAPB).
- To act as information data bank on medicinal and aromatic plants.
- Transfer of technologies developed by the DMAPR to the farmers through cooperation with the developmental agencies.

Mandate crops

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

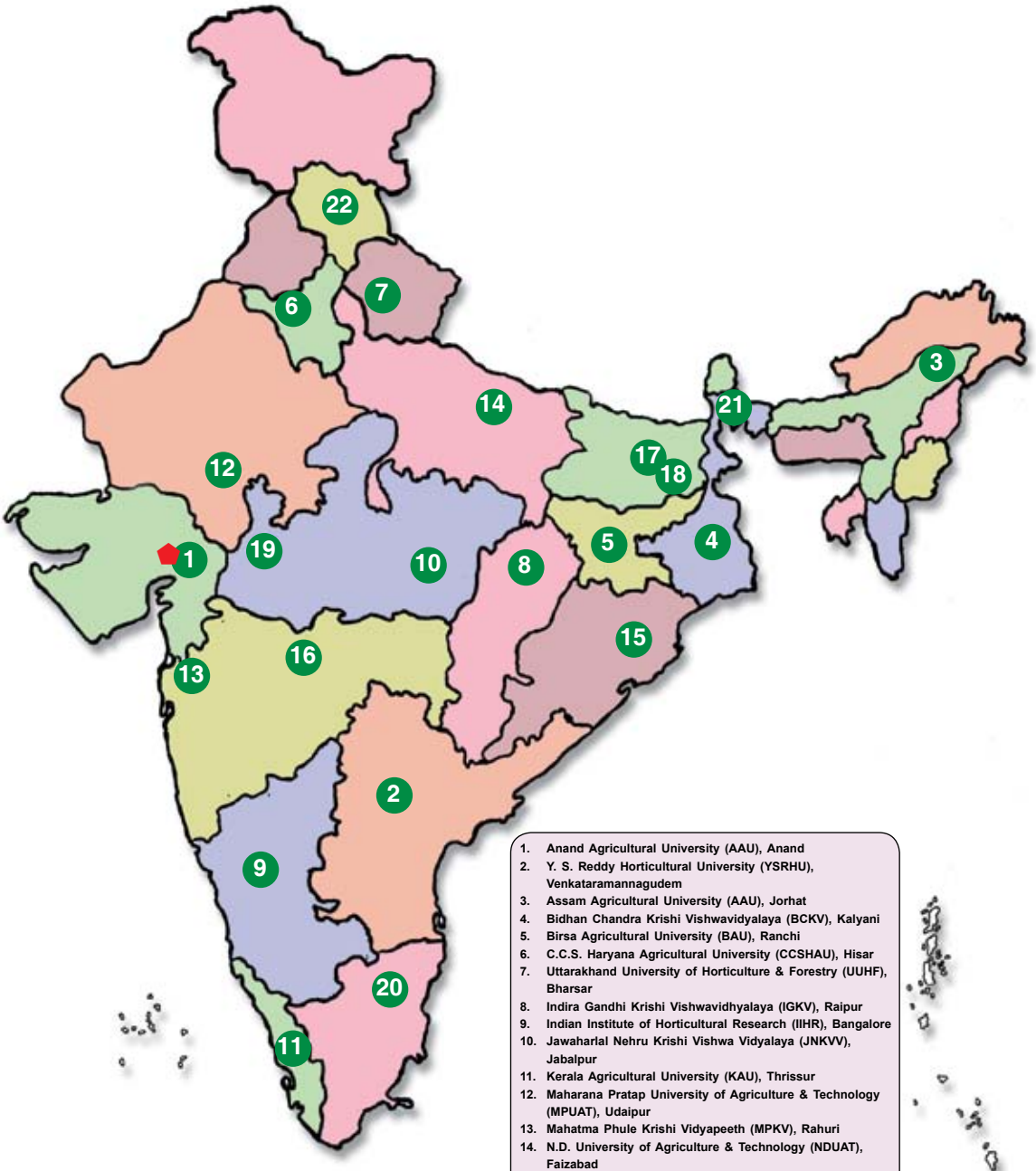
Objectives

- To identify plants which need attention of agricultural scientists and to collect, maintain and evaluate the identified plants.
- To carry out those basic researches on the mandate crops for developing their Good Agricultural Practices (GAP).
- To coordinate the research activities of the centres of AICRP on Medicinal & Aromatic Plants and Betelvine located at various agro-climatic zones of India.
- To provide quality planting material and technology developed,testing and refinement by the centres of the co-ordinated project and DMAPR.
- To develop partnership between the directorate and private sectors, NGOs and farmers' associations/progressive farmers interested in promoting the herbal culture.

Outreach programmes

All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRP-MAPB) is located at DMAPR and the Director, DMAPR is also responsible for coordination and monitoring of research work of the project as Project Co-ordinator. There are 21 centres

Centres of AICRP on Medicinal & Aromatic Plants and Betelvine



1. Anand Agricultural University (AAU), Anand
2. Y. S. Reddy Horticultural University (YSRHU), Venkataramannagudem
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. Uttarakhand University of Horticulture & Forestry (UUHF), Bharsar
8. Indira Gandhi Krishi Vishwavidhyalaya (IGKV), Raipur
9. Indian Institute of Horticultural Research (IIHR), Bangalore
10. Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur
11. Kerala Agricultural University (KAU), Thrissur
12. Maharana Pratap University of Agriculture & Technology (MPUAT), Udaipur
13. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri
14. N.D. University of Agriculture & Technology (NDUAT), Faizabad
15. Orissa University of Agriculture & Technology (OUAT), Bhubaneswar
16. P.D. Krishi Vishwavidyalaya (PDKV), Akola
17. Bihar Agricultural University (BAU), Islampur
18. Rajendra Agricultural University (RAU), Pusa
19. Rajmata Vijayraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Mandsaur
20. Tamil Nadu Agricultural University (TNAU), Coimbatore
21. Uttar Banga Krishi Vishwavidyalaya (UBKV), Kalimpong
22. Y.S. Parmar University of Horticulture & Forestry (YSPUH&F), Solan

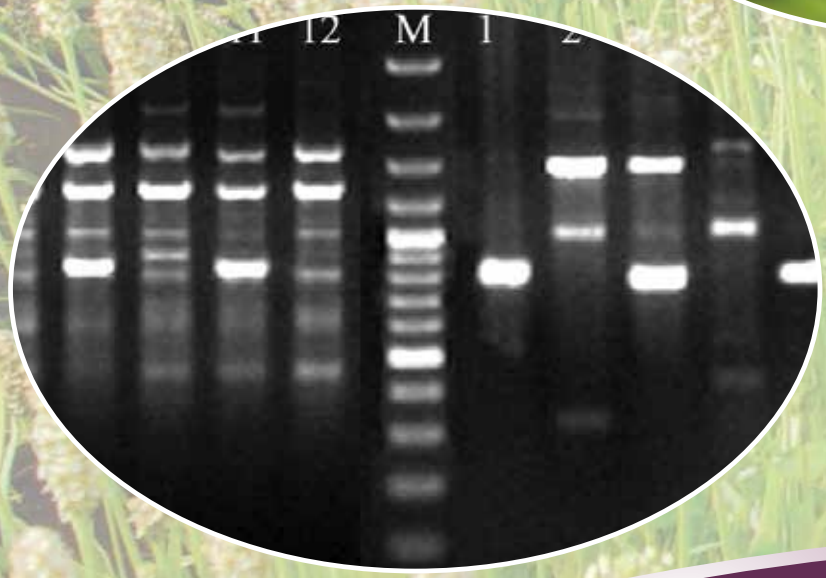
⬟ DMAPR, Anand (Headquarters)

in State Agricultural Universities and one ICAR centre at IIHR, Bangalore under ICAR. The centres of AICRP-MAPB are as follows:

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

Budget profile

Head	Expenditure (₹ in lakh)
Non-Plan Expenditure	309.33
Pension Fund	02.22
Plan Expenditure	125.00
AICRP on MAP & Betelvine	700.00
IPR Scheme	03.61
Externally Funded Projects	
DUS (PPV&FRA)	05.62
Central Sector Scheme	0.23
Web based herbal garden	04.15
Guggle Project	06.81
Revolving Fund Scheme	02.15
NAIP Projects	
NAIP on Unmolecular process	05.54
NAIP on Ecogeography	04.37
NAIP on Mass Media	08.48
NAIP on ARS/Net Online Examination	0.21



Research Achievements

Medicinal and Aromatic Plants

ALOE *(Aloe barbadensis)*

It belongs to family, *Liliaceae*. The species is introduced from African countries which was later naturalized in India. The plant is perennial in habit with fleshy leaves and condensed stem. Flowering occurs in winter. Leaves contain mucilage (polysaccharides) and leaf exudates contain aloin and aloe emodine which are commercially useful. The mucilage has a cooling and moisturizing action and hence used in cosmetic industries. Aloin and aloe emodine are used as pain killer and purgative. The species flowers during November to February. Flowers are having saffron to orange yellow colour which attracts birds for pollination. Fruit set starts from December to March. Seeds have very low germination percentage.The crop is under cultivation in Gujarat, Rajasthan, Madhya Pradesh and Uttar Pradesh. Raw material is collected both from wild and cultivation for the industry. Suckers are mainly used for propagation.

Evaluation of promising genotypes

PDKV, Akola: Nine genotypes collected from Maharashtra and eight genotypes from DMAPR were evaluated. The genotypes were characterized based on morphological and yield characters. Different morphological marker characters identified are spine color (AKAv 09-01), heavy blotches on young leaves (AKAv 09-03) and light blotches on young leaves (IC 112532). IC 112532 recorded significantly highest leaf weight (291.50 g leaf^{-1}), followed by IC 285630 (264.50 g leaf^{-1}). Amongst the collections of Maharashtra, genotype AKAv 09-01 recorded significantly highest plant height, number of leaves plant^{-1}, length and breadth of leaf as well as leaf weight (254.50 g leaf^{-1}), however its mucilage recovery was significantly low.

Effect of spacing and organic manures on growth and yield

PDKV, Akola: The experiment was conducted with three spacings (60x30, 60x45 and 60x60 cm) and four levels of organic manures (control; vermicompost 2.5 and 5 t ha^{-1}; and FYM 5 and 10 t ha^{-1}) to find out their effects on growth and yield. The results revealed that spacing 60x60 cm with vermicompost 5 t ha^{-1} recorded significantly highest number of suckers (7.13 plant^{-1}). However, spacing at 60x60 cm with vermicompost 2.5 t ha^{-1} had significantly more leaf weight (445 g leaf^{-1}), peel weight (186.67 g leaf^{-1}) and exudate (2.23 g leaf^{-1}). Planting at 60x30 cm spacing and application of vermicompost at 2.5 t ha^{-1} recorded highest mucilage recovery (286.67 g leaf^{-1}) and mucilage:peel ratio (2.19) compared to the other treatment combinations.

Effect of planting method and organic manures on growth and yield

IGKV, Raipur: The experiment comprising of different methods of sowing (flat, ridge and furrow and raised bed) and levels of organic manures (vermicompost 2.5 and 5 t ha^{-1}; and FYM 5 and 10 t ha^{-1}) were conducted. Results revealed that sowing methods as well as organic manures significantly influenced the total number of leaves per plant, and leaf and gel yields. The interaction effects showed that application of vermicompost at 5 t ha^{-1} and planting by ridge and furrow method recorded highest herbage yield (24.40 t ha^{-1}).

ARJUN *(Terminalia arjuna)*

It is a tree species belongs to family *Combretaceae* and widely 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. Leaves are compound in nature. A pair of glands is present on the leaf blade close to the tip of the petioles. The bark of the tree is considered as a cardio-tonic and is prescribed in the form of powder along with milk and sugar or in the form of decoction. The astringent property of the bark is also utilized for the treatment of diarrhea. The bark is used for the treatment of coronary disorders and used in many ayurvedic tonics. It is also applied as paste for curing pimples and other minor skin eruptions. The common adulterants of the raw drug are the barks of other *Terminalia* spp., *Sterculia urens* and *Lagerstroemia flos-regina*.

Screening of germplasm

PDKV, Akola: Two hundred and nine plants were screened for morphological and chemical characters to identify a superior plant type. The plant height (m), stem girth (cm) and bark thickness (mm) were measured. Nine plants (*viz.*, AKAr 1-5, AKAr 1-11, AKAr 4-2, AKAr 4-7, AKAr 5-2, AKAr 5-8, AKAr 6-11, AKAr 6-13 and AKAr 10-11) recorded higher plant height, stem girth and bark thickness.

Similarly, barks were collected (10 x 15 cm area) from randomly selected 25 plants and fresh and dry weights of bark and tannin content were estimated. The fresh and dry bark weight were in the range of 103- 263 g and 40-112 g, respectively, and the tannin content was in the range of 13.26- 17.80%.

Evaluation of bark quality of different age groups

PDKV, Akola: Bark was harvested in second week of October 2012 from the selected trees with specific age. Samples were shade dried and powdered for further analysis of phenols and tannin content and antioxidant activity. Mean value of phenol content was 12.19% in 9-11 years old trees, whereas it was 14.49% in 21-26 year old trees.Tannin content also showed similar trend as phenol. Mean value of total tannins content was 13.94% in 9-11 years old trees, whereas it was 15.53% in 21-26 year old trees. The trend for antioxidant activity was almost similar to that of total phenol and tannins content.

ASALIO *(Lepidium sativum)*

The plant belongs to family *Brassicaceae*. The species is a native of Ethiopia and introduced to Europe and Asia. Plants are of about 45-60 cm tall. Leaves are entire or variously lobbed or pinnatisect. Flowers are small and white, arranged in racemes. It is cultivated as winter crop in selected parts of Rajasthan, Gujarat, M.P. and Tamil Nadu for seeds. The seeds are galactagogue, laxative and diuretic. The mucilage obtained from the seeds is used against intestinal irritations. The leaves are also used as diuretic and to treat liver diseases. It is also used as salad for treating anemia. Seeds are used for propagation.

Evaluation of germplasm

RVSKVV, Mandsaur: Forty selected germplasm lines were evaluated on the basis of different morphological characters along with yield and yield contributing characters. Days to 50% flowering ranged from 42 days (MLS-1018) to 79 days (MLS-1011). Number of branches plant^{-1} ranged from 8 (MLS-10) to 18 (MLS-1003). The plant height ranged from 87 cm (MLS-1019) to 115 cm (MLS-10). Maximum test seed weight was recorded in MLS-1005 (1.92 g) and minimum was in MLS-1015 (1.5 g). The highest mean seed yield (kg ha^{-1}) was in MLS-1007 and MLS-1016 (2166 kg ha^{-1}) followed by MLS-1 (2124 kg ha^{-1}) and MLS-1021 (2083 kg ha^{-1}). The lowest yield seed yield was in MLS-15 (1208 kg ha^{-1}).

Evaluation of promising lines

AAU, Anand: Seven promising lines were evaluated along with check variety, GA1 based on seed yield and various morphological characters *viz.*, plant height, number of branches per plant and test seed weight. Highest seed yield was recorded in MLS-1007 (1741 kg ha^{-1}), however it was at par with the check GA-1(1549 kg ha^{-1}) and MLS-1001 (1694 kg ha^{-1}). Significant differences were also found in plant height, however, differences in the number of branches plant^{-1} and test seed weight were found non-significant. Highest plant height was in MLS 1007 (100.88 cm) which was at par with HLS-5, ALS-1, GA-1 and MLS-1001.

MPUAT, Udaipur: Five promising entries from different locations (MLS-1001, 1007, 1016 from Mandsaur and HLS-4 and HLS-5 from CCSHAU CCS, Hisar) along with one check (Local Asalio LSU-15) were evaluated for seed yield. The observations on plant height, number of branches, days to flowering and crop maturity and 1000 seed weight was also recorded. The study showed that the entries MLS-1007 and MLS1016 exhibited significantly higher seed yield over the local check (2365 kg ha^{-1}). The entry HLS-4 was found to be at par with local check and entries MLS10-01 and HLS-5 were significantly poor yielder than the local check.

Effect of irrigation and nitrogen on growth and yield

IGKV, Raipur: The experiment comprised of three levels of irrigation (one irrigation at 25 DAS; two irrigation at 25 and 50 DAS and three irrigation at 25, 50, 75 DAS) and four

levels of nitrogen (20, 40, 60 and 80 kg ha^{-1}). Application of irrigation and nitrogen levels significantly influenced number of branches, pods per plant and seed yield. The interaction effects of irrigation and nitrogen levels showed significant influence on grain yield. Highest yield (16.40 q ha^{-1}) was recorded with the application of three irrigation at 25, 50 and 75 DAS and 80 kg ha^{-1} nitrogen.

Effect of FYM and nitrogen on growth and yield

MPUAT, Udaipur: Two levels of FYM (5 and 10 t ha^{-1}), three levels of nitrogen (20, 40 and 60 kg ha^{-1}) and three schedules of nitrogen application (1/2 at sowing + 1/2 at 25 DAS; 1/2 at sowing + 1/4 at 25 DAS + 1/4 at 45 DAS; and 1/2 at sowing +1/3 at 25 DAS + 1/3 at 45 DAS) were tested to find out their effects on growth and yield. Results revealed that application of 10 t FYM ha^{-1} along with 40 kg N ha^{-1} and splitting of nitrogen application as 1/3 each at sowing, 25 DAS and 45 DAS were found most productive when compared in terms of various growth characters, yields and net returns.

Effect of sowing date and plant spacings on yield and quality

MPUAT, Udaipur: An experiment was conducted comprising four sowing dates (41, 43, 45 and 47 meteorological weeks) and four plant spacings (30x10, 30x15, 40x10 and 40x15 cm). Results revealed that seed yield was (25.34 q ha^{-1}) significantly highest when sowing was done at 43rd meteorological week (Oct. 22-28) and at the spacing of 30x10 cm (3.33 lakh plants ha^{-1}).

Effect of irrigation and brassinosteroids on yield and quality

MPUAT, Udaipur: Effect of six irrigation schedules (4 irrigations at 25, 45, 65 and 85 DAS; 3 irrigations at 25, 45 and 65 DAS; 3 irrigations at 25, 45 and 85 DAS; 3 irrigations at 25, 55 and 85 DAS; 3 irrigations at 25, 65 and 85 DAS and 2 irrigations at 25 and 65 DAS) and three brassinostreroids levels (control, 0.3 and 0.6 ppm) were investigated. Results revealed that application of four irrigations at 25, 45, 65 and 85 DAS along with two sprays of 0.6 ppm brassinosteroids at 50 and 70 DAS were found best and recorded higher productivity and net monetary returns. However, under limited irrigation availability, three irrigations at 25, 55 and 85 DAS may also be recommended.

Effect of sowing methods and seed rates on growth and yield

RVSKVV, Mandsaur: The experiment comprising of two sowing methods (line sowing and broadcasting) and five seed rates (6, 8, 10, 12 and 15 kg ha^{-1}) were conducted to find out their effects on growth and yield. The results revealed that sowing with 15 kg seeds ha^{-1} recorded significantly highest plant height (112.5 cm), however, number of branches (18.0), stem diameter (8.6 cm) and seed yield (20.0 q ha^{-1}) were highest with the seed rate of 8 kg ha^{-1}. The results were also found significant with the methods of sowing and the highest plant height (93.2 cm) was recorded with line sowing whereas, number of branches (14.6), stem diameter (6.74 cm) and seed yield (16.3 q ha^{-1}) were highest with broadcasting of seeds.

Effect of integrated nitrogen management on growth and yield

RVSKVV, Mandsaur: The experiment was conducted to find out the effect of different nitrogen sources (FYM, vermicompost and fertilizers) in different combination (25, 50 and

100%). The results showed that the highest plant height (95 cm), stem diameter (7.5 cm), number of branches plant^{-1} (20) and seed yield (17.0 q ha^{-1}) were recorded with the application of 100% N supplied through inorganic fertilizers.

Screening of germplasm against *Alternaria* blight

RVSKVV, Mandsaur: Twenty four genotypes were screened under field condition for resistance to *Alternaria* leaf blight. Disease severity was recoded in 0-9 scale and the mean of the 3 years data (2010-2013) showed that MLS-1, MLS-5, MLS-7, MLS-8, and MLS-13 had field resistance.

Management of *Alternaria* leaf blight

NDUAT, Faizabad: A field trial was conducted to find out the effective fungicide along with optimum dose and frequency of spray to control the disease. Results showed that spraying of propiconazole (0.2%) during the appearance of leaf blight disease followed by two sprays of the same chemical at 10- 15 days interval recorded lower per cent disease severity (15.25), higher per cent (63.64) disease control and higher seed yield (10.79 q ha^{-1}).

RVSKVV, Mandsaur: Six fungicides *viz*; zineb(0.25%), mancozeb (0.3%), propiconozole (0.2%), COC (0.25%), cuman-L (0.3%) and nativo (0.15%) were tested against the disease. The spraying of fungicides started at the first appearance of the disease symptom and was repeated twice at 10 days interval. Disease severity was recorded on 0-9 scale. Results of the three years data (2010-2013) revealed that *trifloxystrbin* 25 + *tebuconazole* 50% (Nativo at 0.15%) was most effective against the disease which recorded a per cent disease incidence of 17.52% followed by propiconazol at 0.2% (20.56%) and cuman L 0.30% (21.59%). Maximum seed yield was recorded in Nativo at (1775.78 kg ha^{-1}) followed by propiconozol (1689.00 kg ha^{-1}).

ASHOKA *(Saraca asoca)*

It is also an endangered tree. The plant is a medium sized, evergreen tree belonging to family *Caesalpiniaceae*. Flowers are orange-yellow and tender shoots are bronze coloured. It is distributed throughout India particularly in humid areas. The plant is considered as sacred tree of Hindus and Budhists. Asoka bark is widely used in Indian medicines for the treatment of female disorders. The species flowers during December to March. Flowers are also used for the treatment of bleeding piles and skin diseases. The activity of the drug is due to the presence of steroidal compound, tannins and calcium salt. It can be propogated by seeds as well as by layering. Due to over exploitation the species status in nature is vulnerable.

Study of reproductive biology

DMAPR, Anand: Study on flowering pattern revealed that inception of flowering primordial

occurred during December. The flowers started opening from December end to May. Peak flowering time during the year was in February to March. The trees remain in bloom for 2-3 months. Fruiting started from March end to July and peak fruiting was during May to June. The fruits reached maturity by the end of May to July.

The tree flowers heavy in, lush bunches. They are yellow/light orange when young; became orange/ scarlet, then crimson with age, turning red before withering/shedding. The flower colour at different stage of anthesis was compared with the Colour chart of Royal Horticultural Society (RHS) - Kew, London.

Time of flower opening in a day was recorded at different time intervals (3 am, 8 am, 3 pm and 8 pm). It was observed that in April, the flower started opening at 3 am and completed by 5.30 am. Maximum flowers in an inflorescence (6.28) opened during 3.00 -5.30 am which accounted 98.9% of the total flowers opened per inflorescence in a day.

Based on the curvature of the style in different growth phases, the flowers were divided into 11 stages. Stigma receptivity was also observed in corresponding stages by hydrogen peroxide test. The study showed that the stigma showed receptivity for about 24 hours after anthesis.

Stigma receptivity was also studied by controlled pollination experiments. For the study, the buds which were about to open the next day were emasculated using forceps and bagged. Then the pollination was done at different intervals and pistils were collected after 24 hours of pollination. The pistils were stained in decolourised aniline blue and observed under fluorescence microscope. In majority of the pistils, pollen tube growth could not be observed. Only in pistils where pollination was done at 24 hours after anthesis, pollen tube growth was observed, indicating the stigma receptivity at this time.

Pollen quantification was done using improved *Neubauer* haemocytometer. Number of pollens per flower was ranged from 60,000 to 1,50,000 with an average of 84,000 pollens per flower. Pollen viability was studied by Fluorescence diacteate (FDA) staining. Fresh pollens were collected at the time of anthesis and stained. Average percentage of viable pollens was 35.12%.

Freshly opened flowers attracted large number of floral visitors, majority of them were from bee family. Maximum insect visitation was occurred between 9 am to 12 noon. Giant Asian Honey bee (*Apis dorsata*) was the most common visitors. It visited many flowers in different inflorescence at a time. Other small bee activity was also noticed.

Different pollination methods were also studied in the species. Selfing was conducted by bagging the whole inflorescence with butter paper bag and the fruit set was recorded. In open cross pollination, a known number of buds were emasculated prior to anthesis and allowed for open pollination. The results showed that the fruit set percentage was higher (2.28) compared to self pollination (0.46%). For controlled cross pollination, the mature buds which were about to open in the next day were emasculated and bagged. The next day, the stigmas were pollinated with fresh pollens collected from a different tree. The fruit set per cent in case of cross pollination was 1.11% which was more than selfing (0.46%) and less than open cross pollination (2.28%). Minimum number of fruits were set (0.46%) in selfing. The study indicated the predominance of cross pollination in the species.

Study of polyembryony

DMAPR, Anand: Asoka seeds were poly-embryonic with 2- 4 seedlings developing per seed. To record the percentage of polyembryony, the seeds were collected from 37 trees from two different populations and kept for germination. Among 454 seeds germinated, 23 were polyembryonic which accounted to 5.07% of the total seed germination. Further, it was also observed that the polyembryony was specific to particular trees *i.e.* genotype specific.

Rapid and validated HPLC method for identification and quantification of catechin and epicatechin in extracts

DMAPR, Anand: A simple, rapid and validated reverse phase high performance liquid chromatography method was developed for determination of two bioactive compounds catechin and epicatechin in bark extracts . Limit of detection (LOD) was 1.5 and 0.5 μg ml-1 for catechin and epicatechin respectively. Similarly, limit of quantification (LOQ) was 2.5 and 1.0 μg/ml for catechin and epicatechin respectively. The developed method was used for identification and quantification of the two compounds in different extracts.

ASHWAGANDHA *(Withania somnifera)*

The plant belongs to family *Solanaceae* and is considered as wonder herb with multiple medicinal properties. It is cultivated in North-western and Central India. The species is an annual to perennial, branched, undershrub to herb of about 30 cm to 120 cm height. Root is the major medicinally important part in addition to leaves and seeds. Roots are used in preparation of vital tonics. It is a stress reliever and is used in treating senile dysfunctions. Its effect on controlling anxiety, depression, phobias, alcoholic paranoia, schizophrenia, *etc* is clinically established by different tests. The active ingredient that attributed to the medicinal property is the alkaloids and steroidal lactones.

Evaluation of germplasm

RVSKVV, Mandsaur: Sixty eight lines were evaluated for thirteen different characters. Wide range of variability was observed in the studied characters. Plant height ranged 20 cm (MWS-101) to 43 cm (MWS-130). The plants were classified on the basis of branching pattern *viz*. biparous (RVA-100, MWS-101, MWS-206, RAS-10) and triparous (MWS- 111, MWS-135, MWS-209). Plants were either bushy or erect. Berry colour also varied from yellow (MWS 101, MWS- 132, MWS- 206, RAS-7) orange (MWS-125, MWS- 124, MWS-139) and red (RAS-16, RAS-21). Duration plant maturity was classified into three groups *i.e.* early 150-165 days (RVA-100, MWS-108, MWS-35), medium-165-180 days (MWS-130, MWS-202, RAS-11, RAS-36) and late 180-195 days (MWS-114, MWS-206, RAS-18, RAS-20). Most of the lines fall either in mid or in late maturing groups. Length and diameter of roots ranged from 13.0 cm to 37.0 cm and 3.6 mm to 12.5 mm, respectively. Quality of roots

were superior (quality grade-2.5) in RVA –100, MWS- 101, MWS-207, RAS-20, RAS-21.

Mean dry root yield ranged from 111 kg ha^{-1} (MWS-227) to 422 kg ha^{-1} (MWS-90-130). MWS-90-130 recorded highest dry root yield (422 kg ha^{-1}) followed by MWS-119 and MWS -90-137 (411 kg ha^{-1}) MWS-130, MWS-106 (399 kg ha^{-1}), MWS-90-121, MWS-90-142 MWS 90-207, JA-134 (388 kg ha^{-1}). Mean seed yield ranged from 111 kg ha^{-1} MWS-90-139) to 466 kg ha^{-1} (MWS-106 and RAS-36). MWS-106 and RAS-36 recroded highest seed yield (466 kg ha-1) followed by RAS-7 (455 kg ha^{-1}), MWS-130 (433 kg ha^{-1}), RAS-20, MWS-206 and MWS-301 (422 kg ha^{-1}) as compared to RVA-100 and JA-134 check (411 kg ha^{-1}).

Purification, identification and characterization of selected working germplam lines

RVSKVV, Mandsaur: On the basis of plant type, leaf pattern, berry colour and other morphological characters, different types of plants were collected and catalogued accordingly. The plant may be erect or bushy; branching pattern was biparous or triparous; leaf type was ovate oblong; leaf surface was hairy or non hairy; berry colour was yellow, orange or red; berry size was small, medium or large and persistent calyx was short or long.

Out of 120 lines, 37 single plant selection were made. Observations were recorded on selected plants on the basis of different morphological characters like berry colour (red, yellow, orange), berry size (small, medium, large,), plant type (erect or bushy) branching pattern, leaf type (oblong or ovate) and leaf surface (hairy, non hairy).

Testing of promising entries

MPUAT, Udaipur: Three entries which were identified as promising at different locations (AWS-2B from AAU, Anand HWS-08-14 and HWs-08-18 from CCSHAU, Hisar) along with three checks (JA20, JA134 and RAV 100) were evaluated. The observations for plant height, number of primary branches, flowering, maturity, root length, root diameter, dry root yield and alkaloid content were taken. The study showed that entry AWS-2B (810 kg ha^{-1}) had significantly higher dry root yield over the other test entries and the best check RAV100 (697 kg ha^{-1}) and grand mean of the experiment (600.80 kg ha^{-1}). None of the entries exhibited significantly higher alkaloid content over the best check *i.e.*, JA-134 (0.50%).

Effect of spraying of fungicides on *Alternaria* leaf blight

JNKVV, Jabalpur: Field experiments were conducted to evaluate the effect of six fungicides, *i.e.* Mancozeb (0.25%), propiconazole (0.25%), rovral (0.25%), copper oxychloride (0.25%), zineb (0.25%) and cumin (0.25%)) on the disease incidence. Results showed that the disease intensity was minimum in mancozeb treatment (12.3%). Among the different fungicides evaluated, the performance of cumin at 0.025% was inferior and recorded maximum disease severity (23.6%). Dry root yield (5.0 q ha^{-1}) and seed yield (75.0 kg ha^{-1}) was maximum in mancozeb treatment.

Efficacy of biopesticides against hadda beetle

DMAPR, Anand: Field experiments were continued this year to assess the efficacy of botanicals and biopesticides *viz.*, azadirachtin at 0.03%, azadirachtin at 0.3%, azadirachtin at 1% neem seed kernel extract, beauveria bassiana at 10%, and flavanoids at 6%, against hadda beetle. Azadirachtin at 1% and flavanoids at 6% were found effective for the control of hadda beetle (*Epilachna viginitioctopunctuata)* and recorded an yield of 237.78 and 227.44 kg ha^{-1} respectively.

Life history and feeding potential of hadda beetle

DMAPR Anand: Biological studies on hadda beetle, revealed that the beetle completes its life cycle (egg to adult stage) in 20.08±0.24 days on cultivated Ashwagandha after passing through four larval instars. The total larval, pre pupal and pupal periods were 10.08±0.13, 1.04± 0.04, 3.41±0.10 days, respectively. The longevity of male and female adults of the pest was 67.79±3.96 and 67.20±3.85 days, respectively. The gravid females laid 562.54±76.16 eggs in several batches in an ovipositional period of 45.67±5.19 days. The amount of food consumed increased from first instar to final instar and the total food consumed in 1st, 2nd, 3rd, 4th instars were 1.55±0.09, 3.90±0.24, 6.58±0.35 and 11.55±0.83 mg respectively. There was maximum food consumption in 4th instar. The values of growth rate (GR) increased from first instar to fourth instar and the values varied between 0.17 and 2.18 mg day^{-1} mg^{-1}, whereas, consumption index (C.I.) progressively decreased from instar to instar and the values varied between 4.08 to 0.95 mg day^{-1} mg^{-1}.

Screening for withanolide A and 12-deoxy-withastramanolide

DMAPR, Anand: Ashwagandha germplasms were screened for two major chemical constituents such as withanolide-A and 12-deoxy-withastramanolide. Withanolide-A content ranged from 0.04 to 1.98 mg g^{-1} and 12-deoxy-withastramanolide varied from 0.16 to 1.068 mg g^{-1}. Highest withanolide-A was recorded in line number L-94 (1.985 mg g^{-1}) and lowest value was recorded in L-118 (0.41 mg g^{-1}). Similarly, highest 12-deoxy-withastramanolide content was recorded in line number L-22 (1.068 mg g^{-1}). Lowest value was recorded in L-94 (0.162 mg g^{-1}).

In the third year of study, sixteen purified lines were screened for withanolide A and 12-deoxy-withastramanolide in root samples. Withanolide A content in the some of the promising lines were as follows : DWS-130 B7 (1.48 mg g^{-1}), DWS-145 B7 (1.48 mg g^{-1}) and DWS-114 B5 (1.28 mg g^{-1}). Similarly, 12-deoxy-withastramanolide content in the some of the promising lines were as follows: DWS-145 B7 (0.68 mg g^{-1}), DWS-130 B7 (0.61 mg g^{-1}) and JA-20 (0.54 mg g^{-1}).

Effect of extraction methods, on phytochemical constituents and antioxidant activity

DMAPR, Anand: Extract yield, phytochemical constituents such as total phenol and withanolide content of water and water-alcohol extracts prepared using two most commonly used extraction techniques also known as ''Green Extraction'' techniques, ultrasound and microwave assisted solvent extraction were compared with the conventional extraction method. Antioxidant activity of the extracts was also determined using DPPH and ABTS methods of antioxidant assay. Extract yield, chemical composition of the extracts (total phenol

and withanolide content) and antioxidant activity of the extracts varied with the extraction process as well as solvent composition. Extraction yield (mass of extract/mass of dry matter) was used as an indicator of the effects of the extraction conditions. In reflux, water extract yield (9.51%) was maximum followed by water–ethanol and ethanol. For UASE and MASE, three time periods 5, 10 and 20 min were used. For UASE also, the trend was similar as observed in the case of refluxing. But extract yield with ethanol (3.17%, 20 min) was about 3.74 times lower than the maximum extract yield (11.85%) obtained with water at 15 min. Total phenol content was maximum in the extract prepared with ethanol (35.93 GAE mg g^{-1}) followed by water–ethanol (21.15 GAE mg g^{-1}) and water (17.63 GAE mg g^{-1}). Total withanolide content (sum of withanolide A and 12-deoxy withastramonolide) of the extract prepared using refluxing varied in the following order: ethanol>water–ethanol > water. For UASE and MASE also, total withanolide content was higher in the ethanol extract as compared to water–ethanol and water extracts. Antioxidant capacities of the extracts were expressed in terms of IC_{50} value of the extracts and low IC_{50} value corresponds to a high antioxidant capacity. In both DPPH and ABTS assays, ethanol extracts had lowest IC_{50} values and they varied in the following order: ethanol< water–ethanol< water. Further, antiradical power of the extracts ($1/IC_{50}$) was found to be highly correlated in DPPH (r^2 = 0.73) and ABTS assays (r^2 =0.86).

BACH *(Acorus calamus)*

It is a member of family *Araceae* and is a small perennial aromatic herb grown naturally in marshy fields. It is a native of Europe and now found distributed throughout India specially in foot hills. The species is cultivated in some parts of India mainly in Andhra Pradesh. The rhizomes are used for medicinal purposes. The dried rhizomes constitute the commercial raw drug 'Calamus'. It is believed to improve memory power and intellect. In southern parts of India the rhizome is given to the newborn children alongwith honey to improve brain development. It is also useful in the treatment of diarrhoea, dysentery, abdominal obstructions and colic. Recently, anti-carcinogenic property of the species has also been reported.

Characterization, evaluation and maintenance of germplasm

YSRHU, Venkataramannagudem: Twenty four accessions were evaluated for morphological and agronomical traits. Among the accessions, plant height ranged from 35.66 to 60 cm, number of leaves $plant^{-1}$ ranged from 16 to 82, internode length ranged from 1.7 to 3.3 cm, leaf length ranged from 32 to 57.66 cm, leaf breadth ranged from 1.70 to 2.36 cm, rhizome lets ranged from 1 to 20, rhizome scales ranged from 6 to 24, rhizome length ranged from 7 to 34 cm, rhizome width ranged from 3.6 to 7 cm, rhizome weight per plant ranged from 10 to 70 g, rhizome yield $plot^{-1}$ ($12m^2$ size) ranged from 0.67 to 4.69 kg. Highest rhizome yield was in APAc-9. Ploidy analysis was done using flow cytometry. The report revealed that the accessions were diploid except one accession, Damaramadugu, AP.

Effect of spacing and organic manures on growth and yield

YSRHU, Venkataramannagudem: An experiment was conducted with three spacings (60x30, 60x45 and 60x60 cm) and three FYM levels (5, 10 and 15 t ha^{-1}). Sowing at 60x45 cm spacing and application of FYM at 15 t ha^{-1} recorded significantly increased growth parameters, rhizome weight (75.33 g $plant^{-1}$) and rhizome yield (34.48 q ha^{-1}).

Integrated management of leaf spot disease

BCKV Kalyani: A field trial was conducted to evaluate the integrated management strategies consisting of botanicals, non conventional chemicals and biocontrol agents against leaf spot disease caused by *Nigrospora oryzae*. The treatment combinations consisted of three sprays. Each spray was done at fifteen days interval. Data of the disease incidence and severity recorded at fifteen days after last spray showed that the lowest per cent disease incidence (7.33) and highest inhibition of disease incidence (81.73%) was obtained in the combination treatment of *Pseudomonas* sp at 10^9 cfu ml^{-1} + Salicylic acid at 12 mM (milliMolar) + *Clerodendron* leaf powder at 14%. In case of per cent disease index or severity, lowest severity (7.22) and highest inhibition (79.69%) of severity was recorded when the treatment combination of Salicylic acid at 12 mM + *Clerodendron* leaf powder at 14% + Salicylic acid at 12 mM was sprayed. Highest fresh and dry weights of bach root (258.33 g $plant^{-1}$ and 79.00 g $plant^{-1}$ respectively) was recorded from the treatment combination (*Pseudomonas* sp. at 10^9 cfu ml^{-1} + Salicylic acid at 12mM + *Pseudomonas* sp. at 10^9 cfu ml^{-1}).

BACHHNAG *(Aconitum deinorrhizum)*

It is a perennial herb of family *Ranunculaceae* with fleshy roots commonly distributed in Himalayan ranges. Roots are used for medicinal purposes. It is used in diarrhoea, dysentery and gastric pain. It is used as a bitter tonic to combat debility after malaria and other fevers. It is also used against hysteria, dyspepsia, vomiting and cough. Wild habitats are the sole source of the raw drug since the plant is not in cultivation. Price of the raw drug is also very high (about Rs 2000 per kg) since the collection from the wild is also very difficult due to the inaccessibility of the wild habitats. Alkaloids (heterophyllisine, atidine and atisine) present in the rhizome are the active ingredient. The crop requires cool climate and organic rich soil for cultivation. It can be propagated by seeds, tubers or stem cuttings. Planting is done in the monsoon. In dry periods, irrigation is given at one month interval. The crop is ready for harvest after about 5-6 years.

Effect of growth regulators on sprouting of rhizomes

YSPUHF, Solan: The experiment comprising of fourteen treatments of different growth regulators (GA3, IBA and Kinetin) including two controls (at top and middle portion) were conducted to find out their effect on sprouting of rhizomes. All the treatments performed better than control both in top portion and middle portion. Application of IBA 100 mg l^{-1} at top portion initiated sprouting in minimum days (39.91 days), recorded maximum sprouting (56.28%) and survival ability (76.14%) in the field. Results also revealed that both

the top and middle portion of rhizomes can be utilized for vegetative propagation, however, the performance of top portion was better.

BAEL *(Aegle marmelos)*

It is a member of family *Rutaceae* and it is a moderate sized, armed tree, 6 to 7.5 m tall. It is commonly found in deciduous forests all over India. It can be propagated by seeds and through vegetative means. Natural regeneration by seed is not adequate. The seed does not retain viability for long and regenration by root-suckers appears to be the cheif mode of propagation in nature. The fruit is used in chronic diarrhoea, dysentry, stomach ache and diabetics. It also act as a tonic for heart and brain. Root is one of the constituent of the popular ayurvedic drug combination of 'dasmoola'. The roots are astringent, bitter and febrifuge. They are useful in diarrhea, dysentery, dyspepsia, stomachalgia, cardiopalmus, seminal weakness, vomiting, intermittent fever and swellings.

LC-MS/MS method development for simultaneous determination of bioactive molecules

DMAPR, Anand: A rapid LC-ESI-MS/MS method was developed for identification and simultaneous determination of five bioactive molecules like coumarins (umbeliferone, psoralene, marmin and imperatorin) and alkaloid (skimmianine) in *Aegle* marmelos. The chromatographic separation of analytes was performed on an RP18 column using mobile phase consisting of methanol and 0.1% acetic acid in water. The method was validated in terms of linearity, accuracy and precision for three days. The method developed was found to be very useful for identification and quantification of marmin, umbeliferone, skimmianine, psoralene and imperatorin in the extracts of the root and stem bark of *Aegle* marmelos. All five bioactive molecule content was found to be higher in root bark as compared to stem bark. The marmin content recorded was highest among all the five bioactive molecules in root bark and umbeliferone content was highest in stem bark.

BALA *(Sida cordifolia)*

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

Ephedrine estimation and TLC profiling of different *Sida* species

KAU, Trichur: TLC fingerprinting of methanolic extract of *S. cordifolia, S. cordata, S. acuta, S. rhombifolia subsp rhomhifolia* and *S. rhombifolia* subsps retusa was carried. From the TLC profile following observations were made : all parts of four Sida species contained ephedrine.However, its content was higher in aerial parts as compared to roots and it was maximum in the seed.

BANKAKDI (*Podophyllum hexandrum*)

It is a member of family *Berberidaceae* and it is an erect, succulent herb up to 30 cm tall.

In india it is found in alpine Himalayas in Jammu and Kashmir, Himachal pradesh, Sikkim, Arunachal pradesh. It is flourished well as undergrowth in fir forests. The plant is poisonous, but when processed has medicinal properties. The rhizome contain podophyllotoxin (a lignan) an anticancer lead compound. Whole plant is used as hepatic stimulant, purgative and in skin diseases. The species is propagated from seed as well as from sections of rizomes in well drained sandy loam soil. It is very tolerant of cold temperatures, as would be expected of a Himalayan plant, but it is not tolerant to dry conditions. Cultivation has yet to be popularised in the species and raw material is mainly collected from the wild.

Study of seed germination

UUHF, Bharsar: Seeds were collected from high altitude areas of Laddakh region of Jammu and Kashmir and studied the germination behavior under different temperature regimes (at room temperature, 15°C, 20°C, 25°C and 30°C, in open nursery and poly house). The results revealed that 28.0±6.93% of seeds germinated at 20°C constant temperature. It was also recorded that 42 days were required to initiate germination and 78 days to complete the germination.

BASIL (*Ocimum basilicum*)

It belongs to family *Lamiacea* and is widely distributed throughout India. The species is

believed to be originated in India, Pakistan and Thailand. Basil prolifically produces large green or purple leaves, measuring around 2 inches in length, throughout the summer. Basil has the ability to synthesize and convert phenylpropenes. The flavor and smell of basil varieties is largely determined by their chemical components. Basil varieties contain cinnamate, citronellol, geraniol, linalool, methyl chavicol, myrcene, pinene, ocimene and terpineol. Basil has been used as a folk remedy for an enormous number of ailments, including, cancer and convulsion.

Evaluation of germplasm

AAU, Anand: Ten accessions were evaluated for green leaf yield, oil yield, oil content in addition to plant height and plant canopy spread. Accession Ob 11 was used as check variety. Significantly highest green leaf yield (68484 kg ha^{-1}) and oil yield (198.36 kg ha^{-1}) were recorded in accession Ob 3. Oil yield in Ob 3 was 16.86% higher than the check variety. Plant height was highest in Ob 10 (81.97 cm) which was at par with Ob 5 (75.70 cm) and Ob 3 (74.53 cm). Plant canopy spread was significantly highest in Ob 2 (76.57 cm) which was at par with Ob 3 (72.50 cm). Oil content varied from 0.14 to 0.56% among the tested entries. Oil content was highest in the check (0.56%), however, it was not reflected in the oil yield since leaf yield was very low in the check (30839 kg ha^{-1}). Oil content in Ob 3 was 0.29%.

RVSKVV, Mandsaur: Twenty one germplasm lines were collected from farmers' field of Mandsaur, Ratlam and Neemuch district and were tested for seed yield and its yield contributing characters. The mean plant height ranged from 42 cm (MOB-20) to 67 cm (MOB-1) and inflorescence length ranged from 15.6 cm (MOB-7) to 27 cm (MOB-12), similarly number of inflorescence per plant ranged from 58 (MOB-3) to 413 (MOB-6). The highest seed yield was in MOB-14 (2222 kg ha^{-1}) followed by MOB-13 (1944 kg ha^{-1}), MOB-8, MOB-9 (1857 kg ha^{-1}) and MOB-16 (1759 kg ha^{-1}) as compared to lowest seed yield in entry MOB-20 and MOB-21 (833 kg ha^{-1}).

Effect of nitrogen levels and spacing on growth and yield

RVSKVV, Mandsaur: The experiment comprising of five levels of nitrogen (0, 20, 40, 50 and 60 kg ha^{-1}) and two spacings (45x25 and 60x40 cm) was conducted to find out their effects on growth and yield. Application of nitrogen significantly affected the plant height, number of branches and herbage and seed yields. However, different spacings could not bring any significant improvement in these parameters. The results showed that highest plant height (69.5 cm), number of branches (17.5 plant^{-1}), dry herbage yield (41.0 q ha^{-1}) and seed yield (18.7 q ha^{-1}) were recorded with the application of 60 kg N ha^{-1}. Whereas, maximum plant height (58.8 cm), number of branches (14.4 plant^{-1}), dry herbage yield (28.4 q ha^{-1}) and seed yield (13.4 q ha^{-1}) were recorded when sown at wider spacing of 60x40 cm.

BRAHMI *(Bacopa monnieri)*

The plant belongs to family *Scrophulariacea*. It is a creeping, succulent highly branched herb and is commonly found in marshy places throughout India up to an elevation of 130 m. The whole herbage is the source of Ayurvedic drug 'brahmi' which is an important ingredient of several preparations such as 'Brahmigritam', 'Brahmirasayanm', 'Brahmitailam' and 'Misrakasneham'. It is considered as astringent, diuretic, laxative and tonic for the heart and nerves and is used in Ayurveda to improve memory. Bacoposide is considered as the major active ingredient in this plant. Raw drug is mainly collected from the wild. It can be cultivated as a perennial crop. Plant cuttings are used for propagation. Total herbage including stem and leaves are harvested, shade dried and used for medicine preparations.

Collection and characterization of germplasm

RAU, Pusa: Twelve collections from various places of Bihar were characterized. RAUBM-11, obtained from Desua (Samastipur), had the most promising performance in terms of herbage, leaf size and highest yield (46.15 q ha^{-1} dry weight). Among the other collections, RAUBM-12 and RAU BM-10 showed better performance based on yield (on dry weight basis) *i.e.*, 41.20 and 39.32 q ha^{-1}, respectively as compared to other collections.

CHIRAYITA *(Swertia chirayita)*

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

Identification of distinct morphological traits

UBKV, Kalimpong: Five plant types were identified based on plant height and the different morphotypes were extra dwarf (Ksc 1 - < 24 cm), dwarf (Ksc 2–25-64 cm), medium (Ksc 3-65-104 cm), long (Ksc 4–105-144 cm), an extra long (Ksc 5->144). Plants were also grouped as early flowering type (1st week of September to 1st week of October), medium flowering type (2nd week of October to 2nd week of November) and late flowering type (3rd week of November to last week of December). Plants were also classified as broad long leaf (leaf length > 8 cm and leaf breadth > 5 cm), medium sized leaf (leaf length 5-8 cm and leaf breadth 3-5 cm) and narrow small leaf (leaf length <5 cm and leaf breadth <3 cm). Narrow small leaf was found in morphotype-1 (KSC-1), small and medium leaf were found in morphotype-2 (KSC-2), medium leaf was found in morphotype-3 (KSC-3) and medium and large leaf were found in Morphotype- 4 (KSC-4).

Effect of temperature on seed germination

UUHF, Bharsar: The seed germination behavior under different temperature regimes (room temperature, 15°C, 20°C, 25°C and in open nursery condition) were evaluated. The results revealed that 86.67% of seeds germinated at 25°C constant temperature. It took 13 days to initiate germination and 28 days to complete the germination.

Analysis of market samples

YSPUHF, Solan: Seventy samples under the market name "chirayita" received from different

AICRP MAP&B centers during 2011-12 were characterized using TLC and HPLC analysis . Results were compared the with genuine samples of Swertia chirayita. Only thirty samples (43%) were of *Swertia chirayita*, thirty four samples (49%) corresponded to *Andrographis paniculata* and five samples were of unknown species.

CHITRAK *(Plumbago zeylanica)*

Chitrak belonging to family *Plumbaginaceae* is perennial and sub acandent shrub, well distributed in Peninsular India. Leaves are ovate, glabrous; flowers are coloured in elongated spike white. Leaves are simple alternate, oblong-lanceolate and acute. Roots are used as one of the ten ingredients of "Dashamoola" which is an ayurvedic drug combination. Plant pacifies vitiated vata, kapha, diarrhea, inflammation, fever, haemorrhoids, skin diseases, irritable bowel disease, amenorrhea and anaemia. Plants are propagated by stem cuttings. Roots are used as Ayurvedic drug which contain plumbagin.

Collection, characterization, evaluation and maintenance of germplasm

TNAU, Coimbatore: Forty five accessions collected from different parts of Tamil Nadu, Kerala, Maharashtra and Himachal Pradesh were characterized. Wide variability was observed for various growth characters. Growth parameters, *viz.*, plant height, plant spread, number of branches, leaf length and leaf breadth were recorded. Plant height was maximum in TNPZ – 34 (104.30 cm); plant spread was maximum in TNPZ–41 (184.00 cm E-W and 127.30 cm N-S); number of branches was maximum in TNPZ-6 (6.70); maximum leaf length (7.30 cm) and leaf breadth (6.20 cm) were in TNPZ 38. Inflorescence developed at the early node in accession TNPZ-3 (Node -1). TNPZ-30 produced maximum number of inflorescence (18.50).

Distinct variations were observed for calyx colour, calyx length, petal shape and flower size. Based on flower size, flowers were classified into four classes namely, small (1– 1.25 cm); medium (1.25– 1.50 cm), large (1.5–1.75 cm) and very large (1.75 -2.00 cm).

DODI *(Leptadenia reticulata)*

The plant belonging to family *Asclepiadaceae,* is a perennial climber. 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 is used as eye tonic. It is also used to cure seminal debility, general weakness, cough, dyspnoea, fever, asthma, constipation, sore throat and gonorrhea. Root and leaf extracts of the plant act as antibacterial and anti-fungal agents. It promotes health and vigour, improves voice and alleviates the three 'doshas', *vata, pitta* and *kapha*.

Effect of organic manures on yield

AAU, Anand: The experiment comprising of five levels of organic manures and one biofertilizer (FYM 10 t, poultry manure 5 t, vermicompost 2 t, caster cake 2 t and neem cake 2 t ha^{-1}, and Azotobactor + phosphate culture 1 litre ha^{-1} each) was carried out. Significantly highest dry biomass yield (6780 kg ha^{-1}) was recorded when crop was supplied with FYM 10 t ha^{-1} and remained at par with castor cake 2 t ha^{-1} and poultry manure 5 t ha^{-1}. Economics of pooled data showed that application of FYM 10 t ha^{-1} gave the maximum net return of Rs.1,03,350/- ha^{-1} with B:C ratio of 1.36.

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 number of aerial roots. The stem and leaves are medicinally used as raw drug. *Tinospora* stem is a common constituent of a number of ayurvedic vital tonics for the treatment of general debility, dyspepsia, fevers and urinary diseases. Starch present in the stem along with alkaloids 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. It is propagated usually by stem cuttings as well as by seeds. The plant is not under regular cultivation and it is grown as a climber on trees in the wild.

Molecular characterization of germplasm

DMAPR, Anand: Randomly amplified polymorphic DNA (RAPD) markers were used to evaluate genetic similarity and interrelationship among 53 accessions. Out of the 120 decamer primers screened, 28 were selected, which amplified 204 amplicons; 170 of which were polymorphic (83.33%). The amplified products of the RAPD profiles ranged from 150 to more than 3000 bp. UPGMA -SHAN clustering and Jaccard's coefficient similarity depicted that all the accessions were grouped in different clusters and sub clusters and the genetic similarity was distributed between 44 and 95%. From the SHAN clustering and Jaccard's coefficient similarity, Hyd-1 and Hyd-5 were found to be closely related (95% similarity), whereas NMRM 16 (Gujarat) and Kalyani (West Bengal) distantly placed (44% similarity).

HPTLC method standardization for identification and quantification of alkaloids

DMAPR, Anand: HPTLC method was standardized for the determination of two alkaloids palmatine and berberine in *T. cordifolia*. Analysis was performed by using pre-coated silica gel 60 F 254 aluminum plates (20 × 10 cm) with mobile phase ethyl acetate, acetic acid, formic acid and water in ratio of 10:1.1:1.1:3.2. The Rf value for berberine and palmatine were 0.50±0.01 and 0.37±0.01, respectively. The dried and fresh samples of leaves and stem of *Tinospora* were extracted in three different solvents like petroleum ether, ethyl acetate and methanol The optimum extraction yield of alkaloid was obtained by extraction

of sample in methanol by reflux for 30 min. Palmatine band was observed in stem and fruit samples. The beberine band was observed in UV mode at same Rf but its spectra not match with reference standard of berberine. This was tested in several accessions of *Tinospora*.

Germplasm evaluation based on major chemical constituents

DMAPR, Anand: Thirty four germplasm were evaluated on the basis of three major constituents like palmatine, 20 β-hydroxyecdysone (TBH) and cordioside-1. Palmatine content in dry stem sample ranged from 5.38 to 66.81 $\mu g\ g^{-1}$ and highest value was in accession IC-310610. TBH content ranged from 0.26–5.98 mg g^{-1} and was found highest in accessions Guj-6 (5.98 mg g^{-1}). Cordioside-1 ranged from 0.10-1.56 mg g^{-1} and was highest in accession IC-310621 (1.56 mg g^{-1}) .

GUGGUL *(Commiphora wightii)*

It is a shrub belonging to *Burseraceae* family. It is distributed in the tropical regions of Africa, Madagascar, Asia, Australia, Pacific Islands, India, Bangladesh and Pakistan. The species is endemic to arid region and found in wild form in the drier parts of Rajasthan and Gujarat. *C.wightii* is a small tree or shrub up to 3–5 m height, the branches are crooked, knotty, aromatic and end in sharp spines. Oleo-gum resin, is the economic product obtained by incision of the bark. The gum resin is mainly used as a fixative in perfumery and in Indian System of Medicine (ISM). The gum is highly effective in the treatment of obesity, arthritis and other diseases. The gum-resin is used in the form of a lotion for indolent ulcers. It is propagated by either seeds or stem cuttings.

Molecular characterization of germplasm

DMAPR, Anand: Seventy three accessions out of which 23 from Rajasthan and 50 from Gujarat were assessed for genetic relationship by using randomly amplified polymorphic DNA (RAPD) and inter simple sequence repeats (ISSR) markers. Initially 140 RAPD primers and 27 ISSR primers were screened, out of which 24 RAPD and 14 ISSR primers were selected. In RAPD screening, a total of 185 amplicons were amplified out of which, 148 (80%) were polymorphic whereas in ISSR screening, 116 loci amplified, out of which, 81 (69.82%) were polymorphic. The amplified fragments for both the analysis ranged from 250 to >3000 base pairs. Jacquard's coefficient similarity showed that all the accessions were distributed between 48% and 98% of similarity in case of RAPD analysis, whereas in ISSR analysis, it was 48% to 99%. The dendrogram developed by RAPD and ISSR primers based analysis grouped the accessions into several clusters. In RAPD analysis, the SHAN clustering depicted that DMAPR CW 61 & DMAPR CW 62 and DMPR CW 66 & DMAPR CW 67 were closely related (98% similarity) whereas DMAPR CW 35 was distantly related to DMAPR CW 61, DMAPR CW 62 and DMAPR 63 (48% similarity). But in ISSR analysis,

DMAPR CW 3 and DMAPR CW 5 were closely related (similarity 99%) whereas DMAPR CW 27 was distantly related to the accessions DMAPR CW 29 and DMAPR CW 32 (48% similarity).

HIMALAYAN RHUBARB *(Rheum australe)*

It is a robust, perennial glabrous plant belonging to family *Polygonaceae*. It is endemic to the Himalayan region. In India it is distributed mainly in Kashmir and Sikkim. It grows in grassy or rocky slopes at higher altitudes and in forest margins at an altitude of 3200–5200 m. The plant grows more than 2 m in height, with stout rhizomes. It is commonly used in traditional medicine for a wide range of ailments related to the circulatory, digestive, endocrine, respiratory and skeletal systems as well as to infectious diseases. The phytochemical studies have shown the presence of many secondary metabolites belonging to anthraquinones, stilbenes, anthrones, sterols, etc. The species flowers from June to August and fruits from July to September. Plant propagates either by rootstocks or seeds. The species status in the wild is 'vulnerable' due to the threat of overharvesting for trade.

Effect of organic manures and bio-fertilizers on growth and yield

YSPUHF, Solan: The experiment comprised of eight treatments of different combinations of organic manures and biofertilizers (control, FYM 20 t, vermicompost 20 t, Azotobacter 10 kg, PSB 10 kg, FYM 10 t + Azotobacter 5 kg + PSB 5 kg, vermicompost 10 t + Azotobacter 5 kg + PSB 5 kg and NPK at 120:60:30 kg ha^{-1}). The data on growth and yield parameters were recorded after 12 and 24 months of planting during October month. Two years data showed that maximum plant height (15.21 and 30.86 cm), root length (21.75 and 46.18 cm), above ground biomass (38.37 and 44.26 g $plant^{-1}$) and underground biomass (28.52 and 54.94 g $plant^{-1}$) at 12 and 24 months after planting was with the application of NPK (120:60:30 kg ha^{-1}), respectively followed by vermicompost + Azotobacter + PSB (10 t : 5 kg : 5 kg ha^{-1}).

INDIAN VALERIAN (*Valeriana jatamansi*)

It is a perennial herb, 15 -60 cm tall, velvet-hairy to hairy. Rhizome are elongate, with fibrous roots. Stems are 3-6 in number. Leaves at the base are heart-shaped or ovate, toothed or wavy-toothed. Flowers are white which are borne in flat-topped clusters on top of the stems. Upper bracts are linear-lanceshaped, about 3 mm long. Stigma is 3-fid. Seed-pods are velvety, shorter than the upper bracts. The species is found throughout the Himalayas, from Afghanistan to SW China, at altitudes of 1500-3600 m. Flowering occurs during March to May. Roots of the species are useful in diseases related to eye, blood, liver and spleen.

Leaves are used for the treatment of headache. Roots are also used in aromatic industry. Raw drug is collected mainly from the wild since cultivation is not yet popularized. Since it is a temperate plant, it requires cold weather for proper growth. The plant is propagated by seeds as well as by root stocks.

Study of morphological variability

UBKV, Kalimpong: Characterization of germplasm showed that plant height ranged between 10.50 cm and 16 cm under open condition. However in poly house condition, it showed maximum growth up to 42 cm. Leaf margin is entire, wavy or sometimes sinuate.

Based on flowering time, there were early flowering type (1st week of January to 2nd week of February), medium flowering type (3rd week of February to 3rd week of March) or late flowering type (4th week of March to 4th week of April). Nine morphotypes were identified *i.e.*, plant with entire leaf margin and early flowering type (KVJ-1-1), plant with entire leaf margin and medium flowering type (KVJ-1-2), plant with entire leaf margin and late flowering type (KVJ-1-3), plant with sinuate leaf margin and early flowering type (KVJ-2-1), plant with sinuate leaf margin and medium flowering type (KVJ-2-2), plant with sinuate leaf margin and late flowering type (KVJ-2-3), plant with wavy leaf margin and early flowering type (KVJ -3-1), plant with wavy leaf margin and medium flowering type (KVJ- 3-2) and plant with wavy leaf margin and late flowering type (KVJ- 3-3). The species was found to be cross pollinated and gynodioecy (co-existence of hermaphrodite plants along with females) was observed.

Effect of time of sowing and spacings on growth and yield

UBKV, Kalimpong: The crop was raised through seeds and transplanted during the first week of June and July at three spacings (30x20, 30x30 and 30x45 cm). Transplanting during June and July failed to produce any significant response on fresh aerial biomass yield at 6 and 9 months stage of observation. However, recorded significantly higher fresh aerial biomass, underground biomass, rhizome biomass and root biomass with June transplanting at later growth phase of 12, 15 and 18 months. Further, plant spacing gave significant response at all the stages of observation, and recorded maximum aerial biomass, underground biomass, rhizome biomass and root growth with spacing of 30x45 cm which was at par with 30x30 cm at 6, 15 and 18 months stage of observation.

In an another experiment the crop was raised through rhizome cutting and planted during the first week of June and July at three spacings (30x20, 30x30 and 30x45 cm). Time of rhizome planting failed to produce any significant response on aerial biomass, however, recorded significantly higher underground biomass with June planting and root biomass with July planting. Plant spacing played significant role on growth of fresh aerial biomass during both the stages of observation. Maximum aerial biomass, rhizome biomass and root biomass were recorded with spacing of 30x45 cm, however, underground biomass was recorded higher with 30x30 cm spacing.

Study of disease incidence

UBKV Kalimpong: Fixed plot survey was conducted to know the incidence of stem rot (*Sclerotinia sclerotiarum*) and leaf mosaic disease from April, 2012 to March, 2013. Per cent

disease incidence (PDI) of stem rot disease was maximum during the month of August (39.32%) and minimum during the month of January (6.17%), whereas PDI of leaf mosaic disease was maximum during February (25.29%) and minimum during the month of July (14.29%).

ISABGOL *(Plantago ovata)*

The species belongs to the family *Plantaginaceae*. It is an annual herb grown during the rabi season. Seed coat is known as isabgol husk under trade. The swelling property of the seed coat or husk after absorption of water is acts as medicine against constipation and gastrointestinal disorders. In addition, it used in food industries for the preparation of ice creams, candy *etc*. India is the only Isabgol production country in the international trade. Country earns on an average Rs. 400 crores annually from its export. It is a widely 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.

Evaluation of germplasm

RVSKVV, Mandsaur: Eighty germplasm lines were evaluated for five characters *viz.*, plant height, days to 50% flowering, number of spikes per plant, length of spikes and seed yield. Plant height ranged from 22.0 cm (SPS-18) to 32.0 cm (SPS-23). Days to 50% flowering ranged from 58 days (SPS-5) to 77 days (SLS-66). Number of spikes per plant varied from 17 (MIB-9) to 44 (SLS-62). Length of spike varied from 3 cm (JI-4) to 6 cm (MIB-1). The highest seed yield (kg ha^{-1}) was in MIB-5 (917 kg ha^{-1}) followed by RI-1 (850 kg ha^{-1}).

MPUAT, Udaipur: Thirty two lines were evaluated with 3 checks (RI-89, GI-2 and Niharika) for higher seed yield and high swelling factor. Data were recorded for plant height, number of branches per plant, days to 75% flowering, days to 75% maturity, spike length, number of effective spikes per plant, seed yield and swelling factor. Twelve lines exhibited higher seed yield over the best check Niharika (1320 kg ha^{-1}) and grand mean of the experiment (1245 kg ha^{-1}). Seed yield ranged from 1600 kg ha^{-1} to 850 kg ha^{-1} among the entries.

Varietal evaluation trial

MPUAT, Udaipur: Three entries (DPO-1 and DPO-4 from DMAPR, Anand; and Selection-10 from AAU, Anand) along with Niharika as national check and RI-89 as local check, were evaluated for seed yield and its attributing characters. The test entries DPO-4 exhibited significantly higher seed yield (1375 kg ha^{-1}) over the best check Niharika (1312 kg ha^{-1}). The other two test entries were at par with Niharika. However, all the three test entries and check Niharika were found to be superior over the local check RI-89 (1218 kg ha^{-1}).

In another trial, three entries (MIB-123, AMB-2 and MIB-124) along with Niharika as National check and RI-89 as local check were evaluated for seed yield and its attributing characters. The test entries MIB-123, MIB124 and AMB-2 exhibited significantly higher seed yield over the best check Niharika (1288 kg ha^{-1}) and over the experimental mean (1397 kg ha^{-1}).

Evaluation of entries

AAU, Anand: Pooled analysis for second and third year of seed yield showed significant results only for the first year *i*.e. 2010-11. Whereas, (2011-12, 2012-13) pooled analysis showed that the results were non- significant for seed yield.

Effect of micronutrient application on growth and yield

DMAPR, Anand: Micronutrient applications significantly improved dry matter as well as seed yield of isabgol. Among the different micronutrient treatments, 15 kg ZnSO4, 7.5 kg CuSO4, 12.5 kg FeSO4 and 12.5 kg MnSO4 per hectare recorded highest dry matter and seed yield. Micronutrient application also improved their content in the seeds except manganese. Soil micronutrients contents were also influenced significantly by their application under pot culture experiment. There was significant increase in micronutrient content in soil with the application of higher doses of Zn and Cu while there was no significant change found in case of Fe and Mn. Best treatment and critical micronutrient content were worked out after considering yield and quality of crop as well as micronutrient content in soil after harvesting. Response curve of yield *vs* micronutrient application, and micronutrient content in soil after harvest *vs* micronutrient application were worked out. In case of yield *vs* micronutrient application curve, there was sharp increase in yield to certain doses of micronutrient and then recorded a decreasing trend in the seed yield. But, in case of second response curve the trend was found only in case of Zn application. In case of Cu, there was still scope to built up soil Cu by the application of higher dose but Fe did not show any sharp trend. Soil Mn content was found to decrease with the application and response was not found as the soil contain sufficient amount of Mn.

Biochemical changes during seed development

DMAPR, Anand: Biochemical studies were carried out during different seed developmental stages at 0, 7, 14, 21 and 28 days after anthesis (DAA) in the variety GI 2. Samples were collected and studied for soluble sugar, starch and cellulose content at these stages. Results revealed that soluble sugar content was reduced from 0.96±0.03 mg g^{-1} of fresh weight at 0 DAA to 0.31±0.05 mg g^{-1} of fresh weight at 28 DAA. Whereas, starch content increased from 0.05±0.01 mg g^{-1} of fresh weight at 0 DAA to 0.62±0.03 mg g-1 of fresh weight at 28 DAA, and cellulose content from 0.53± 0.04 mg g^{-1} of fresh weight at 0 DAA to 0.76±0.03 mg g^{-1} of fresh weight at 28 DAA.

Screening of germplasm for multiple diseases resistance

MPUAT, Udaipur: Screening of 15 isabgol genotypes against downy mildew (*Pseudoperonospora plantaginis* and *Peronospora plantaginis*) and leaf blight revealed that, two genotypes (PB-3-1 and Gumary) were moderately resistant and six genotypes (MIB-123, MIB-124, AMB-2, P-6, P-80 and DM-2) were resistant against the diseases. It was also noticed that yield and swelling factor were significantly higher in resistant and moderate resistant genotypes.

Efficacy of biopesticides against aphid

DMAPR, Anand: Field experiments were continued this year to assess the efficacy of

biopesticides against aphids, *Aphis gossypii*. Frapioned triterpenoids 4% + Neem oil 0.22% was found to be the most effective for the control of aphids and recorded an yield difference of 225.57 kg ha^{-1} over control.

Predatory potential of coccinellids against *Aphis gossypii*

DMAPR, Anand: Feeding potential of coccinellid predators (*Scymnus quadrellum , Menochilus sexmaculatus and Coccinella transversalis*) were evaluated in laboratory condition against cotton aphid (*Aphis gossypii*). Results indicated that the predatory efficiency of adults coccinellids were more than the larvae. The larvae of *Scymnus quadrellum*, *Menochilus sexmaculatus* and *Coccinella transversalis* were having a mean predation percentage of 39.90, 69.18 and 72.85, respectively. The adults of these three insects recorded a predation percentage of 27.87, 85.24 and 85.69, respectively. Though the predatory potential of *Menochilus sexmaculatus* and *Coccinella transversalis* was at par, the longer duration of life cycle of *Coccinella transversalis* ensured the availability of larvae and adults for longer period and qualified it as the more efficient biological control agent for augmentative release in field condition for the management of *Aphis gossypii*.

Evaluation of natural enemies against *Aphis gossypii*

DMAPR, Anand: Field experiments were conducted to evaluate the effect of augmentation of predatory coccinellids in the management of aphids. Results revealed that augmentation of predators suppresses the population of aphids significantly after 15 days of second release and a significant yield difference was observed between control (without predatory coccinellids) (485.04 kg ha^{-1}) and treatment (augmented with predatory coccinellids) (618.96 kg ha^{-1}), however it was at par with natural condition (587.26 kg ha^{-1}) where the predatory coccinellids in the nature was left undisturbed.

JALA NIRGUNDI *(Vitex trifolia)*

It is a member of family Verbenaceae and it is a slender bushy shrub or small tree. It is occasionaly found along the streams of India. Leaves are compound in nature. Flowers are lilac/purple in colour and arranged in a terminal inflourescences. All the plant parts are having aroma.It can be propagated through layering. Stem older than one year or partialy hardened shoots are used for layering. It grows well in sandy loam soil. The leaves are used in female ailments, fever, arthritis, inflammations, lumbago, headache, abdominal pain, dysentery, wounds, ulcers, bronchitis, cough, general debility and also as mosquito repellant.

HPLC method for identification and quantification of bio active molecules

DMAPR, Anand: A rapid and simple isocratic HPLC-PDA method was developed for identification and quantification of p- hydroxy benzoic acid and two bioactive iridoids negundoside, agnuside in extracts of *Vitex negundo* and *Vitex trifolia*. The separation of the three compounds was achieved on a RP-18 (4 X 250 mm, 52 μm) column. Limit of detection was 1, 2.5 and 2.5 μg ml^{-1} and limit of quantification 2.5, 5 and 5 μg ml^{-1} for

p- hydroxy benzoic acid, negundoside and agnuside, respectively. Good linearity (r^2>0.999) was observed for all the three compounds in wide concentration range. p- hydroxy benzoic acid, negundoside and agnuside were identified and quantified in the extracts of leaves and bark of *Vitex negundo* and *Vitex trifolia* using the developed HPLC method.

JATAMANSI *(Nardostachys grandiflorum)*

The plant belongs to family Valerianaceae and is native to the Alpine Himalayas. It is a critically endangered, rhizome-bearing medicinal plant that prefers high altitudes i.e. 3,000 to 5,000 m. The flower has 4 to 5 stamens. The plant has a rich history of medicinal use and has been valued for centuries in Ayurvedic and Unani systems of medicine. The rhizomes of the plant are used in the Ayurvedic system of medicine as a bitter tonic, stimulant, antispasmodic, and to treat hysteria, convulsions, and epilepsy. The root has been used to treat insomnia and blood, circulatory, and mental disorders. The plant also has aromatic value and is used in perfumes and dyes. The plant parts contain a variety of sesquiterpenes and coumarins. The sedative sesquiterpene, valeranone is a major component of the root essential oil.

Studies on species morphology and reproductive biology

YSPUHF, Solan: On the basis of variations in leaf shape, a new morphotype was identified. The new morphotype had entire leaf lamina with dentate margin in contrast to the entire lamina with smooth and wavy margin in normal leaves.

Peak flowering period was during mid July to first week of August, fruit formation was from August onwards. Seeds matured during September to October and the plants were under perennation during mid October to April. Time taken from inflorecence bud appearance to opening of first flower was 20 -25 days; inflorescence bud appearance to fruit set was 25- 30 days; fruit set to seed ripening was 25 -30 days; inflorescence bud appearance to seed ripening was 50- 60 days and flower longevity (from full developed bud to flower senescence) was 20 -25 days.

Anther dehiscence started after 20-25 days of floral bud initiation, when anther lobes reached full length, exerted out of corolla tube and become dark violet colored. Pollen dehiscence occured through longitudinal slits in extrose manner and continued for 2-3 days. Flower was protandrous and stigma became visibly receptive after anther dehiscence. Before anther dehiscence stigma remained much below the anthers. After anther dehiscence, stylar growth increased that pushed stigma out of corolla tube.

Pollen grains were spherical to oval in shape, bicolpate, tricolpate, tetracolpate or pentacolpate, angulaperturate with a size of 0.062 to 0.093 mm long, 0.0549 to 0.09 mm broad. Acetocarmine stain showed approximately 86 to 99% pollen stainability. Ovule was anatropous with a size of 0.47 ± 0.04 x 0.36± 0.031 mm. Pollen ovule ratio was 6135 ± 327.86 per flower.

Meiotic study showed 2n = 78, *i.e.* genomic hexaploid, with normal anaphase I segregation.

Three different types of tetrad arrangements *viz.*, isobilateral type, decussate type and tetrahedral type were present. In literature there is only a single report of x=13 and 2n= 26 in this species. Hence the present count of 2n=78 chromosomes in this species is a new count.

Pollination studies showed that 18.93 fruit set and 8.08 seed set per pod in open pollination in comparison to 11.25 fruit set and no seed set in self pollination which indicated the cross pollinating nature of the species. Seed germination percentage was 52.5 to 72.46.

KALIJEERA *(Vernonia anthelmintica)*

It is a member of family *Asteraceae* and it is an erect, branched, hispid-pubscent herb to undershrub. It is naturally found throughtout India along the roadsides. An annual herb grows up to 70 cm in height. Leaves are ovoid or lanceolate, acute, serrate, pubescent on both sides. Flowers are purplish in corymbose head. Plant pacifies vitiated vata, kapha and used to cure cough, urinary retention, inflammation, fever and leucoderma. The seeds are used as anthelmintic, in curing fever, skin diseases, asthma and in kidney troubles. The seeds and leaves are used for trearting lecoderma, abdominal and urinary disorders. The crop is propagated by seeds and grows during winter.

Effect of dates of sowing and spacings on yield

AAU, Anand: The experiment comprised of four dates of sowing (1st October, 15th October, 1st November and 15th November) and three spacings (broad casting, and line sowing at 30 and 45 cm) was conducted. Significantly higher seed yield (1,193 kg ha^{-1}) was obtained when crop was sown on 1st October at 45 cm spacing between rows. Similarly, sowing on 1st October at 45 cm spacing also gave maximum return of Rs. 50,970/- ha^{-1} with B:C ratio of 2.57.

KALIHARI (*Gloriosa superba*)

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

Economic yield loss assessment

TNAU, Coimbatore: Field experiments were conducted to record infestation by major insect pests of *Gloriosa superba*, and yield under protected and unprotected conditions. In the protected plots, azadirachtin (10,000 ppm) at 1 ml lit-1(1%) was sprayed twice at 15 days interval. Yield loss due to defoliators (*Plusia signata* and *spodoptera litura*) and the major sucking pest (*Thrips tabaci*) was found to be 38.87% and 28.89% respectively.

Efficacy of bio- pesticides for management of sucking pests and defoliators

TNAU, Coimbatore: Different botanicals and biopesticides *viz*. NSKE (5%), azadirachtin (1%), pungam oil at 3ml l-1, natural lactones at (2ml l-1), and *Beauveria bassiana* (2%) were evaluated against the thrips. Fipronil at (1.5ml l-1) and spinosad at (0.4ml l-1) were given as chemical checks. Two sprays were given and after spraying, the mean number of thrips per plant was observed to be the lowest in fipronil (0.08 thrips per plant) followed by spinosad (0.26 thrips per plant) treated plots. Among the biopesticides, natural lactones recorded the lowest mean population of 1.72 thrips per plant, where as the untreated plots recorded an average of 7.82 thrips per plant.

In another experiment, the botanicals and biopesticides like NSKE (5%), azadirachtin (1%), pungam oil (3ml l-1), *Bacillus thuriengenesis* (2g l-1)and flavanoids (1ml l-1) were evaluated against defoliators like *Plusia signata* and *Spodoptera litura*.. Two sprayings were given and quinalphos (2ml l-1) was given as the chemical check. At seven days after spraying, cent per cent reduction in larval population of both the defoliators was observed in flavonoids and quinalphos treatments.

KALMEGH *(Andrographis paniculata)*

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

Evaluation of germplasm

NDUAT, Faizabad: Eleven accessions namely, IC 111287, IC 111290, IC 210635, IC 210699, IC 265622, IC 260035, IC 342135, IC 342136, IC 342139, IC 342141 and Faizabad local were evaluated successively for two years (2011-12 and 2012-13) to find out a suitable

cultivar for eastern Uttar Pradesh conditions. The data were recorded on plant height, number of primary branches per plant and fresh as well as dry herbage yields.

Based on two years' observation, it was found that the average plant height varied from 51.86 to 65.08 cm. Highest plant height was recorded in IC 342135 followed by IC 111287 (59.66 cm) and IC 342141(57.86 cm). Number of primary branches per plant ranged from 12.96 to 19.96. Maximum number of primary branches was in IC 342135 followed by IC 111287 (18.33) and IC 342141 (16.78). Fresh herbage yield ranged from 62.03 to 103.79 q ha-1. Maximum fresh herbage yield was obtained in IC 342135 (103.79 q ha^{-1}) followed by IC 111287 (91.42 q ha^{-1}) and IC 111290 (85.83 q ha^{-1}). IC 342135 gave better dry herbage yield (38.43 q ha^{-1}) as compared to IC 111287 (34.43 q ha^{-1}) and IC 111290 (31.43 q ha^{-1}). From overall results, it was found that among the eleven accessions, IC 342135 had best performance in all respects, on the basis of two years' data.

Development of DUS descriptors and evaluation of reference varieties

DMAPR, Anand: DUS descriptors were identified in respect to ten morphological characters and accordingly distinct lines were developed. The major characteristics considered were plant habit (erect or trailing); leaf type: narrow (long narrow or short narrow); broad (short broad or long broad); leaf colour (light green or dark green); leaf lamina (inwardly closed or outwardly curved); branching pattern (open or close); plant canopy shape (conical, round); flowering pattern (early, normal and late); inflorescence type (flower buds closely arranged or distantly arranged); plant height (tall, normal, dwarf), stem internode length (normal or compact), etc. DMAPR AP 11, 16, 19 and 35 were erect types and DMAPR 21 was trailing type. Plant canopy was conical in DMAPR AP 39, 40 and round in DMAPR AP 35 and 6. DMAPR AP 6 had short narrow leaves and DMAPR AP3 had long narrow leaves. DMAPR AP 18, 19 and 25 were long broad leafed type and DMAPR AP 24 was short broad leaf type. DMAPR AP 6 and 19 had light green coloured leaves and DMAPR AP 3 and 42 had dark green leaves. Leaf laminae were inwardly curved in DMAPR AP 15 and outwardly curved in DMAPR AP 16. DMAPR AP 36 was early flowering type and DMAPR AP 1 and 2 were late flowering types. Flower buds were arranged in DMAPR 3, 33 and 34 and distantly arranged in DMAPR AP 37. DMAPR AP 21 and 22 were tall type and DMAPR AP 42 was dwarf.

Accordingly 45 reference varieties were identified. An experiment was also carried out to evaluate the selected lines based on herbage yield and andrographolide content. Plants were harvested at 105 days after transplanting (DAT). Plant height varied from 65.33±3.05 cm (DMAPR AP 22) to 30.00±3.45 cm. Number of branches varied from 33. 33± 2.31 (DMAPR AP 22) to 24.67±1.15 (DMAPR AP 33). Canopy spread varied from 66.33± 11.93 (DMAPR AP 13) to 38.33± 4.04 (DMAPR AP 19).

Dry herbage yield and andrographolide content varied widely among the lines. Dry leaf yield varied from 4.87 to 87.46 q ha^{-1}, stem yield varied from 21.89 to 87.46 q ha^{-1} and herbage yield varied from 29.99 to 112.13 q ha^{-1} among the lines. Highest dry herbage yield was in DMAPR AP 2.

Intercropping with pigeon pea

PDKV, Akola: The experiment was conducted to evaluate the intercropping of kalmegh+pigeon pea at four row proportions (2:1, 3:1, 2:2 and 1:2), and compared with sole kalmegh and

sole pigeon pea. The results revealed the significantly highest plant height of kalmegh at 1:2 row proportion of kalmegh:pigeon pea. However, pigeon pea height was significantly highest in sole pigeon pea and kalmegh:pigeon pea row proportion at 3:1. The number of branches per plant of kalmegh and pigeon pea, both were significantly highest with the row proportion of 3:1 which was at par with sole crops. Dry foliage yield of kalmegh was recorded significantly higher with the row proportion of 3:1, which was at par with sole kalmegh. However, significantly highest seed yield of pigeon pea was recorded in the sole crop. Kalmegh equivalent yield (26.07 q ha^{-1}), pigeon pea equivalent yield (11.45 q ha^{-1}), LER (1.67) and gross monetary return (Rs. 46934 ha^{-1}) were found significantly highest under kalmegh:pigeon pea row proportion at 3:1. Thus, it was concluded that kalmegh:pigeon pea intercropping at 3:1 row proportion was most suitable and economical.

Effect of nitrogen and spacings on growth and yield

RVSKVV, Mandsaur: The experiment comprising of five levels of nitrogen (0, 15, 30, 45 and 60 kg ha^{-1}) and three spacings (30x10, 30x20 and 30x30 cm) were conducted to find out their effects on growth and yield. Application of 60 kg N ha^{-1} recorded significantly highest plant height (50.3 cm), number of branches (13.3 $plant^{-1}$) and dry herbage yield (24.6 q ha^{-1}). Whereas, planting at 30x30 cm recorded highest number of branches (11.2 $plant^{-1}$) and dry herbage yield (16.4 q ha^{-1}). However, plant height (43.8 cm) was maximum at 30x10 cm spacing.

HPLC method for quantification of andrographolides

DMAPR, Anand: A rapid and validated reverse phase high performance liquid chromatography method was developed for the simultaneous determination of the three biologically active compounds, andrographolide, neoandrographolide and andrograpanin in the extracts. The developed HPLC method was validated as per ICH guidelines for limit of detection, limit of quantification, linearity, accuracy, specificity and repeatability. The results met the acceptance criteria for three analytes and was also applied for identification and quantification of andrographolide, neoandrographolide and andrograpanin in the extracts prepared using cold percolation, refluxing, ultrasound and microwave assisted solvent extraction as well as super critical fluid extraction methods.

KUTKI *(Picrorhiza kurroa)*

It is a small perennial herb of family *Scrophulariaceae*. It grows well in the hilly parts of the North-Western Himalayan region of India and Nepal. Plants are elongated, stout with creeping rootstock and mainly found at an altitude of 2700-4500 m. Leaves are radical, spathulate, sharply serrated; flowers are white to pale blue purpale in a dense in a terminal spicate raceme; fruits are capsule. Dried rhizome and roots are used as drug. The leaf, bark and the underground parts of the plant, mainly rhizomes are widely used in Ayurveda since ancient times. It is used either as adulterants or substitute of Indian

Gentian (*Gentiana kurroa*). It shows anti-oxidant, anti-inflammatory and immunomodulatory activities and also valued for its hepatoprotective effect. The bitter rhizomes have been used for thousands of years in India to treat people with indigestion and constipation due to insufficient digestive secretion. It is considered as a trophorestorative herb for the liver, as well as a potent immune stimulant. Its constituent, picroliv is also reported to possess choleretic effect and prevent hepatic injury caused by ethanol, chemicals and microorganism. The plant and its formulations are widely used in therapy of epidemic jaundice.

Quality analysis of market samples

YSPUHF, Solan: Fifty eight samples received from different AICRP MAP&B centers during the year 2011-12 were characterized using TLC and HPLC analysis. Results were compared the with genuine samples of *Picrorhiza kurroa*. Five percent samples were found to be spurious samples. In the rest of genuine samples, seven percent samples had trace amount of marker compounds Picroside-I and Picroside-II.

LAL CHITRAK (*Plumbago rosea*)

The plant belongs to family *Plumbaginaceae* and is a perennial shrub of about 1.5 m tall.

Flowers are red coloured, borne in elongated spikes. The plant flowers throughtout the year. It is distributed in the peninsulaur India, West Bengal and Orissa. Leaves are simple alternate, oblong-lanceolate and acute. Roots are cylindrical irregularly bent having transverse shallow fissures at bents. Plant pacifies vitiated *vata*, *kapha*, diarrhea, inflammation, fever, nervous palsy, haemorrhoids, skin diseases, irritable bowel disease, amenorrhea and anaemia. The two *Plumbago* species *i.e., P. rosea* and *P. zeylanica* are commonly used for the same purposes in different traditional medicines.In Ayurveda and Unani medicine, the root is used to promote appetite and stimulate digestive process. The freshly harvested roots are used for the drug preparation. Recently, the species is brought to regular cultivation in selected parts of South India and hence work on developing cultivation practices has been initiated in the species.

Effect of pruning intervals on yield and quality

KAU, Trichur: The experiment was conducted with three pruning intervals (9, 12 and 15 months after planting) and three pruning heights (control, 15 and 30 cm). Data revealed that pruning at various heights and intervals significantly influenced the root yield and plumbagin content. Pruning at 15 months after planting at a height of 30 cm gave the highest root yield (284.67 g plant^{-1}), however, the highest plumbagin content (0.90%) was found in pruning at 9 months after planting and at a height of 30 cm.

LONG PEPPER (*Piper longum*)

It is a member of family *Piperaceae* and is a slender aromatic perennial herb distributed in Central Himalayas, Assam, Khasi hills, Bengal, Western Ghats and Andaman and Nicobar Islands. Matured 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 8th months onwards, fruits are ready for harvesting and in the third or fourth year, the 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: Eight accessions were evaluated for various morphological characters *viz.*, leaf length, leaf breadth, length/breadth ratio and leaf size. Significant variations were observed for the studied characters except for leaf length/breadth ratio. The leaf tips of all the germplasm were invariably acute and the leaf margins were entire. Leaf base of the JPL-29, JPL-30, JPL-31 and JPL-33 were non pulvinous and others were of pulvinous in nature. Colour of the leaf ranged from green to light green.

Highest leaf length was in JPL-31(6.93 cm) whereas minimum length was in JPL-34 (4.20 cm). Breadth of leaf varied from 4.0 cm (JPL-34) to 5.03 cm (JPL-32). Size of leaves ranged from 26.09 cm^2 (JPL-30) to 41.64 cm^2 (JPL-35). Maximum internode length (5.00 cm) was in JPL-31 while it was minimum in JPL-34 (2.73cm). Stem diameter at the base of the collected germplasm varied from 1.00 cm (JPL-33) to 2.00 cm (JPL-31).

Out of the eight germplasm, JPL-31, JPL-33 and JPL-34 were late flowering type. Individual weight of the fresh spike ranged from 0.72 g to 1.85 g and the differences were found to be statistically significant. Highest fresh weight was in JPL-32 (1.85 g) which was collected from Arunachal Pradesh while the minimum weight was in JPL-30 (0.72 g). Moisture loss during drying was about 60-70% by weight of the spike. Highest loss (70%) was observed in JPL-30. Longest spike (2.87cm) was in JPL-32 while shortest was observed in JPL-30 (1.97 cm). JPL-32 recorded highest diameter (3.00 cm). Minimum was in JPL-30 (1.33 cm). The peduncle length varied from 0.57 cm to 1.57 cm. JPL-32 had the highest peduncle length (1.57 cm), while JPL-30 showed shortest peduncle length (0.57 cm).

Integrated nutrient management

PDKV, Akola: The experiment was conducted comprising of twelve combinations of organic and inorganic nutrient levels. The data revealed that significantly highest vine length (98.20

cm) was recorded with the application of NPK at 200:100:100 kg ha-1. Whereas, number of berries per vine (97.73) was significantly more with the application of NPK at 100:50:50 kg + neem cake 20 q ha-1 followed by NPK 150:75:75 kg + neem cake 20 q ha-1. However, the dry weight of berries per vine (16.20 g vine-1), yield of berries (550.800 kg ha-1) and gross monetary returns (Rs.170748/- ha-1) were significantly highest with the application of NPK at 150:75:75 kg + neem cake 20 q ha-1.

Post harvest loss study

PDKV, Akola

To study the post harvest deterioration, moisture and piperine content were determined periodically at an interval of two months. Fresh fruits collected from farmer were dried using various methods such as sun, shade, solar and hot air oven drying. The dried fruits from farmer were also collected. Dried fruits were analyzed for its piperine content spectrophotometrically and moisture content by method of Indian Pharmacopoeia. Dried fruits were stored in transparent PET bottle at room temperature. The samples were taken out from the container every two month for the analysis. The loss on drying was found to be lowest in case of solar drying (77.32%) and highest in sun drying (79.67%). Piperine content was found to be higher in solar dried sample (5.17%) followed by oven dried sample (5.12%). The lowest content was observed in case of sun dried sample (4.43%).

MADHUNASHINI *(Gymnema sylvestre)*

It is a pubescent woody climber belonging to family *Asclepiadaceae*. Leaves are 2-5 cm long and 1.2-3.0 cm broad, usually elliptic ovate or ovate lanceolate, upper surface dark green, shining, under surface pale green, shortly pubescent at venation. It grows naturally in Western ghats, Konkan, Tamil Nadu and in some parts of Bihar. The leaves are saltish and acidic and they suppress the activity of taste buds of tongue for sweet taste hence the name 'madhunasini' or gurmar'. It is prescribed as antidiabetic. The sugar suppressing constituent of the species is found as mixtures of triterpine saponins which are designated as gymnemic acids. The plant is propagated mainly by stem cuttings and also by seeds.

Evaluation of germplasm

JNKVV, Jabalpur: Seven accessions were evaluated for the selection of a superior cultivar. The study showed that there were significant variations in number of leaves per plant, fresh leaf yield per plant and dry leaf yield among the tested accessions. Maximum number of fresh leaves per plant (1779.33) was in JBPGS8-9-104 followed by JBPGS8-9-101(1615.66) while minimum number of fresh leaves per plant (886.33) was in JBPGS8-9-106. Maximum fresh leaf yield per plant (166.6 g) was in JBPGS8-9-103 while minimum (55.66 g plant-1)

fresh leaf yield per plant was in JBPGS8-9-107. Maximum dry leaf yield was recorded in JBPGS8-9-104 (51.83 g plant^{-1}) followed by JBPGS8-9-101 (49.0 g plant^{-1}) while minimum dry leaf yield was in JBPGS8-9-107 (29.06 g plant^{-1}).

MAKOI *(Solanum nigrum)*

It belongs to family *Solanaceae* and is commonly known as black night shade, makoi or deadly nightshade. It possesses medicinal properties like antimicrobial, anti-oxidant, cytotoxic, antiulcerogenic, and hepatoprotective activities. The juice of the fresh herb is sometimes used for fever and to allay pain. In large doses, black nightshade can cause serious, but usually not fatal, poisoning. Externally, the juice or an ointment prepared from the leaves can be used for skin problems and tumors. The fruit has been used for diabetes. An infusion of the plant is used as an enema in infants having abdominal upsets. 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. It is a potential herbal alternative as anti-cancer agent and one of the active principles reported to be responsible for this action is diosgenin. It is in cultivation in Tamil Nadu and seeds are used for propagation.

Characterization, evaluation and maintenance of germplasm

YSRHU, Venkataramannagudem: Out of forty four accessions maintained, eleven were from TNAU, Tamil Nadu, one accession was from Hisar, Haryana, one from Delhi, two from Anand, Gujarat and the rest collected from Andhra Padesh. These accessions were evaluated for their morphological and agronomical traits. The accessions under evaluation exhibited wide range of variations with respect to the characters like plant height (17.33-83.33cm), total number of branches (12.33- 60.00), stem diameter (1.17- 5.17), leaf length (2.17- 8.17 cm), leaf breadth (1.10- 4.50 cm), leaf area (2.5- 7.9 cm^2) and herbage yield (1.24- 10.38 kg per plot size of 12m^2). Significantly highest herbage yield was recorded in APSn-3. A new distinct plant type (APSn-25) bearing red berries with erect growing habit and flower with streak in petal was identified. Streak in flower petal as reported by TNAU in TNSn-50 was found stable. The samples were also tested for ploidy analysis using flow cytometer. The report revealed wide ploidy variations among the collected accessions.

TNAU, Coimbatore: Fifty two collections were made from different parts of the country. The germplasm was characterized and accessions were scored for thirteen characters and grouped into four categories based on distinct characters. Morphologically distinct accessions (TNSn 8, 10, 12, 19, 23, 30, 32, 38, 44, 47, 51, 52 and 53) were selected from each group and DNA bar coding was carried out for the distinct types. The results revealed that three different species *viz.*, *S. nigrum*, *S. americanum* and *S. villosum* were present in the

germplasm collection. Accessions TNSn 10, 19 and 51 belong to *S. nigrum* , the accessions 8, 12, 23, 38, 52 and 53 belong to *S. americanum* and the accessions TNSn 30, 32, 44 and 47 belong to *S. villosum*.

Total alkaloid and solasodine content were estimated at mature green berry stage. Among the accessions, maximum total alkaloid and solasodine contents present in TNSn 10 and TNSn 12.

Effect of organic manures and biofertilizers on growth and yield

YSRHU, Venkataramannagudem: The experiment conducted was comprising of three levels of organic manures (FYM 8 t, vermicompost 6 t and poultry manure 4 t ha^{-1}) and three bifertilizers (azophos 2 kg, azophosmet 2 kg and azophosmet 2 kg + methylobacterium 500 ml ha^{-1}). The results showed that application of vermicompost 6 t with azophosmet 2 kg + methylobacterium 500 ml ha^{-1} significantly increased the growth *viz.,* plant height (73.60 cm), branches (38.06 $plant^{-1}$), stem diameter (3.26 cm), leaf length (6.82 cm), leaf width (3.54 cm) and herbage yield (18.09 t h^{-1}).

TNAU, Coimbatore: The experiment was comprising of three organic manures (FYM 8t, vermicompost 6 t and poultry Manure 4 t ha^{-1}) and three bio-fertilizers (azophos 2 kg, azophosmet 2 kg and azophosmet 2 kg + methylobacterium 500 ml ha^{-1}). Among the different treatments, application of vermicompost 6 t ha^{-1} along with azophosmet at 2 kg ha^{-1} and foliar spray of methyl bacterium 1% recorded maximum growth parameters such as plant height (82.58 cm), plant stem diameter (2.25 cm), number of branches (10.85 $plant^{-1}$), number of leaves (200.42 $plant^{-1}$), plant weight (147.08 g $plant^{-1}$), and leaf weight 88.24 (g). The same treatment has also recorded maximum total leaf area (987.41 cm^2), total chlorophyll content (2.884 mg g^{-1}) and herbage yield (12.95 t ha^{-1}).

Effect of spacing and harvesting intervals on growth and yield

YSRHU, Venkataramannagudem: Experiment consisting of five spacings (30x30, 45x30, 45x45, 60x45 cm and farmers practice) and three harvesting intervals (30, 45 and 60 days) was conducted to find out the effect on growth and yield. The results revealed that sowing at 30x30 cm spacing and harvesting at 45 days interval recorded significantly higher herbage yield (28.18 t ha^{-1}).

TNAU, Coimbatore: The experiment was conducted comprising of three row spacings (10, 15 and 20 cm) and three harvesting intervals (20, 25 and 30 days). Significant variations were observed for various growth parameters. Among the different treatments, maximum yield (10.90 t ha^{-1}) was obtained with sowing at 20x10 cm spacing and harvesting at 30 days interval, which was at par with broadcasting of seeds and harvesting at 30 days interval.

Effect of seed rate on growth and yield

YSRHU, Venkataramannagudem: Experiment comprising of five seed rates (2.5, 5.0, 7.5, 10.0 and 12.5 kg ha^{-1}) was conducted for broadcasting and compared with transplanting in lines at 30x30 cm spacing. The initial data showed the superior growth parameters with the line transplanting at 30x30 cm than broadcasting method.

TNAU, Coimbatore: The experiment was conducted with five seed rates (2.5, 5.0, 7.5,

10.0 and 12.5 kg ha^{-1}) to standardize the seed rate for broadcasting. Among the different treatments, highest herbage yield (11.20 t ha^{-1}) was recorded with 12.5 kg seeds per ha^{-1}, which was at par with 5.0, 7.5 and 10.0 kg ha^{-1}.

Effect of days of transplantating on growth and yield

YSRHU, Venkataramannagudem: The experiment was conducted with seven different ages of seedlings (45, 40, 35, 30, 25, 20 and 15 days). Significantly highest plant height (20.91 cm) and branches (2.82 cm plant^{-1}) were recorded with the transplanting of 45 days old seedlings while significantly highest leaf length (3.19 cm) and width (1.91 cm) were recorded with the transplanting of 25 days old seedlings.

Economic yield loss assessment

TNAU, Coimbatore: Field experiments were conducted to record infestation by major insect pests of *Solanum nigrum* and its yield under protected and unprotected conditions. In the protected plots, azadirachtin (10,000 ppm) at 1 ml lit^{-1} (1%) was sprayed twice at 15 days interval. Yield loss due to the major pests, *Aphis craccivora*, *Thrips tabaci* and defoliators was found to be 36.36%.

Efficacy of biopesticides against sucking pests and defoliators

TNAU, Coimbatore: Field trial was laid out to assess the efficacy of selected botanical insecticides against aphids, thrips, leaf miners and defoliators and its effect on the predatory coccinellids. The different botanicals and biopesticides selected for the study includes NSKE at 5%, *Andrographis paniculata* (2%) (aqueous extract), *Vitex negundo* (2%) (aqueous extract), Azadirachtin 1%, mineral oil at 3ml l^{-1} and pungam oil at 3ml l^{-1}. The sucking pests population, aphids and thrips were found to be minimum in the standard chemical check, profenophos followed by azadirachtin (1%) and extracts of *A. paniculata* (2%). The leaf damage due to leaf miner was lowest in standard chemical check followed by *A. paniculata* (2%) (aqueous extract) and azadirachtin1% and mean defoliation percentage was observed to be lowest in profenophos followed by *A. paniculata* (2%) and azadirachtin (1%). Maximum leaf yield was obtained in profenophos treated plots (22.40 kg m^{-2} plot harvest^{-1}) followed by azadirachtin (1%) and *A. paniculata* (2%) (aqueous extract) sprayed plots which recorded the leaf yield of 17.85 and 17.70 kg 12m^{-2} plot harvest^{-1}, respectively. The mean predatory coccinellid population was maximum in untreated control (1.32 plant^{-1}) followed by *V. negundo* (1.28 plant^{-1}) as against 0.02 plant^{-1} in profenophos treated plots. Though, foliar application of profenophos at 1000 ml ha^{-1} is found to be the best in managing the pests of solanum nigrum, considering the importance of *Solanum nigrum* as medicinal green leafy vegetable, foliar application of azadirachtin 10,000 ppm at 500 ml ha^{-1}, twice at 15 days interval is recommended for the management of insect pests of *S. nigrum*.

Effect of various shades of yellow sticky traps in management of sucking pests

TNAU, Coimbatore: Studies were carried out to assess the efficiency of different yellow shades in sticky traps in attracting major sucking pests viz., thrips, whiteflies and aphids. Acrylic sheets were cut into square pieces of 18 x 18 cm^2 and coated with four different shades of yellow colour viz., golden yellow, lemon yellow, royal ivory and butter scotch.

These sheets were uniformly coated with a thin layer of castor oil on both sides. These sheets were suspended on a wooden rod at three different height *viz.*, below crop canopy, at canopy level and above crop canopy vertically. Observations were made on number of whiteflies, thrips and aphids on the sticky trap in 10 cm^2 area at weekly intervals during the month of July, August and September 2012. The results revealed that maximum numbers of thrips were attracted to golden yellow sticky trap kept below the crop canopy, which trapped 53.4, 183.6 and 156.6 thrips per 10 cm^2 area respectively during July, August and September, 2012 which was followed by golden yellow sticky trap kept at the canopy level which trapped 45.6, 128.6 and 66.6 thrips 10 cm^2. Minimum numbers of thrips were attracted to royal ivory shaded trap placed above the crop canopy (3.4, 6.8 and 4.4 adults 10 cm^{-2}). In case of whiteflies, maximum attraction was recorded in golden yellow trap placed above the crop canopy which trapped 13.2, 23.6 and 11.8 adults 10 cm^{-2}, respectively during July, August and September, 2012, followed by lemon yellow kept above the crop canopy which trapped 12.8, 20.8 and 9.2 adults 10 cm^{-2}. Maximum number of aphids were attracted to butter scotch yellow trap kept below the crop canopy (14.6, 28.8 and 36.0 adults per 10 cm^2 during July, August and September 2012, respectively followed by butter scotch yellow trap kept at canopy level with population of 11.6, 18.4 and 21.6 aphids 10 cm^{-2}. Results of the field study indicated that yellow sticky traps could be used as an early detection tool in the management of sucking pests of *Solanum nigrum*.

MAMEJO *(Enicostemma axillare)*

It is a tropical traditional medicinal herb, perennial in nature and belongs to family *Gentianaceae*. The leaves are sessile, lanceolate; flowers arranged in clusters, fruit is a capsule. It is a 2-5 inches tall herb, growing throughout India. It is more common in the plains and near the sea. The plant is locally used for its medicinal properties such as antiinflammatory, antiulcer, hypoglycaemic and antimalarial activities. Mainly it is used along with other herbs for the treatment of diabetes type 2. The whole plant is useful as Ayurvedic herbal medicine. The plant contains a number of antioxidative phytochemicals, which include alkaloids, catechins, saponins, sterols, triterpenoids, phenolic acids, flavonoids and xanthones. The species is recently found as one of the major sources of Swertiamarin.

Isolation, identification and structure elucidation of the chemical compounds

DMAPR, Anand: In continuation to earlier work, lup-5,20(29)-dien-3yl acetate, lup-5,20(29)-dien-3-ol, acetate, lupeol acetate, stigmasterol, ginkwanin, ginkwanin-4′-O-(6′′-glucopyranosyl)-beta-glucopyranoside, stigmasterol glucoside, swertiajaponin, swertisin, and gentiopicroside were identified using NMR and MS data from *E. axillare*. The root of the plant was also found to contain beta-sitosterol, swertiamarin, sweroside and disaccharide. Swertiamarin, a major compound of the aerial parts was found to possess new cytotoxic activity against human cervical adenocarcinoma cell line (HeLa). Stigmasterol, lup-5, 20(29)-dien-3yl acetate, lup-5,20(29)-dien-3-ol, sitosterol acetate, lupeol acetate, sitosterol, stigmasterol glucoside,

swertiajaponin, ginkwanin-4′-O-(6′′-glucopyranosyl)-glucopyranoside and gentiopicroside have been isolated and identified for the first time in the *E. axillare*. A gelling agent was also separated. Its aerial parts were found to contain about 0.01% volatile oil, forty three compounds were identified by GC/MS together. The main compounds in the volatile oil was 2,4,6-octatrienal (24.7%), methyl benzoate (8.5%) and 4-ethylphenol (8.5%). This, is the first report on the presence of volatile oil and its chemical composition in *E. axillare*. A new CPC method for separation of swertiamarin was developed. Procedure for preparation of bioactive compounds rich extract has also been developed.

MANDUKAPARNI *(Centella asiatica)*

It is a member of family *Apiaceae*. It is prostrate, slightly aromatic, perennial herb commonly found as a weed in crop fields. The species is widely distributed in India. The species is commonly known as 'brahmi" in Northern parts of India. The flowers are pinkish to red in color, born in small umbels. Leaves are used as vegetable in western and southern parts of India. It is used for the treatment of leprosy, skin diseases and to improve memory. It is also used against cholera, ulcers, bronchitis, leucorrhoea and kidney troubles. Asiaticoside, indocentelloside and thankuniside are the major glycosides responsible for the medicinal properties. It is propagated both by runners as well as by seeds. Humus rich soil and partial shade are suitable for cultivation.

Collection, characterization, evaluation and maintenance of germplasm

AAU, Jorhat: Five accessions were evaluated. Leaf length of the accessions ranged from 1.48 to 2.70 cm, highest being in JCA-18 and lowest in JCA-17. Similarly, the highest leaf breadth (3.30 cm) was in JCA-18 and the lowest (2.05 cm) was in JCA-20. Highest leaf length/breadth ratio (0.91) was in JCA-20 which was followed by JCA-18 (0.82). Leaf size of the collected germplasm ranged from 15.40 cm^2 (JCA-20) to 20.65 cm^2 (JCA-18). Significant variations of petiole length and internode length were recorded among the accessions. Highest petiole length was in JCA-18 (5.35 cm) while the shortest petiole was in JCA-20 (2,65 cm). Longest internode (8.35 cm) was in JCA-19 which was closely followed by JCA-17 (8.25 cm) and they were found to be at par. Leaf colour of the germplasm varied from green to light green. Leaf shapes were invariably reniform with serrated margin.

UBKV, Kalimpong: Seven accessions collected from different regions of West Bengal were evaluated along with variety Vallabh medha. Each accession was characterized based on morphological characters *viz.*, leaf shape, leaf margin, leaf apex, petiole length and colour of the internode.

RAU, Pusa: Eleven accessions collected from different parts of Bihar and other states were characterized. The data indicated that among the accessions, most promising was Vallabh medha obtained from DMAPR, Anand, Gujarat, which produced the largest size of leaves with highest yield on dry weight basis (35.86 q ha^{-1}). This was followed by RAU CA-10, obtained from Jamshedpur, Jharkhand and RAU CA-1 from Pusa, Samastipur, which gave an yield of 30.15 q ha^{-1} and 28.35 q ha^{-1}, respectively on dry weight basis.

Nutrient management

DMAPR, Anand: The experiment was conducted to find out the effect of organic and inorganic nutrient management on herbage yield and quality. The analysis of results of four harvests revealed that application of organic and inorganic nutrient sources significantly affected the herbage yield, and plant NPK content and their uptake. Highest yield (5374 kg ha-1) was recorded with the application of 15 t FYM ha^{-1} along with 60:50:60 kg ha^{-1} N:P:K as basal and top dressing of 20 kg N ha^{-1} at each harvest. Application of different nutrients also affected the soil NPK content and their balance after four harvests. N content in soil after 4 harvests decreased and showed a negative balance with the lower doses of application but positive with the application of higher level of 120 kg N ha^{-1}. Soil phosphorus content increased with the increasing application levels and showed a positive balance and built up very high over the initial values. It is also found that soil potassium balance was negative at lower application levels but positive at higher applications and showed closeness to the initial K values.

Effect of spacings on morphology and yield

AAU, Jorhat: The experiment comprised of three spacings (40x20, 20x20 and 20x10 cm). The internode length of the selected germplasm were recorded at base, mid and tip portions of the runners and found that the variation was significant at base and tip portion while there was no significant difference at the mid portion with the different spacings. Internode length at all the three positions were found maximum under 20x20 cm spacing. Whereas, length (2.43 cm) and breadth (4.23 cm) of the leaves were maximum at 40x20 cm followed by 20x20 cm spacing. Highest fresh yield (81.83 q ha^{-1}) was recorded at the spacing of 20x20 cm while minimum (66.05 q ha^{-1}) was found at 40x20 cm spacing. Pooled analysis of three years data revealed that planting at 20x20 cm spacing recorded highest total fresh herbage yield (140 q ha^{-1}).

Effect of planting time on yield

NDUAT, Faizabad: The experiment was conducted with five dates of planting (1st Feb., 15th Feb., 1st March, 15th March and 30th March). Pooled results revealed that maximum plant height (29.40 cm), leaf area (31.07 cm^2), petiole length (23.83 cm), fresh herbage yield (140.48 q ha^{-1}) and dry herbage yield (29.75 q ha^{-1}) were recorded when planted on 15th February followed by 1st February and 1st March. However, 1st March planting showed maximum internode length (12.71 cm) followed by 15th February planting (11.43 cm).

Management of stem rot

RAU, Pusa: Field experiments conducted for the management of stem rot indicated that soil drenching with carbendazim (0.1%) was highly effective in checking the stolon rot with least disease severity of 0.5 on 0-4 scale.The treatment with biocontrol agents like *Trichoderma viride*, *Pseudomonas fluorescens* recorded a disease severity of 1.2 when used individually and in combination, they produced a lesser severity of 1 in the disease scale. The yield data indicated that the soil treatment with carbendazim (0.1%) produced highest herbage yield (18.6 q ha^{-1}). Both the bio control agents gave significantly higher yield over control.

MUCUNA *(Mucuna pruriens)*

The species is a pubescent annual climber belonging to family *Fabaceae*. 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 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. Land preparation is made with the addition of FYM. Since it is a climber, support is required and irrigation is given during the dry season. Flowering starts after 40 days of growth and pods picking is done 3-4 times per season. The crop is cultivated by seeds.

Effect of extraction methods on extract yield, L-DOPA concentration and antioxidant activity

DMAPR, Anand: Seed of Mucuna pruriens is considered as a rich source of L-DOPA, a non protein phenolic amino acid. An attempt was made to establish the effect of three different extraction methods on extract yield, concentration of bioactive compounds such as total phenol, L-DOPA and antioxidant capacity. Extracts were prepared using water acidified with hydrochloric acid (pH = 2.61) using conventional method of refluxing as well as two green methods ultrasound and microwave assisted extraction. Yield and quality of the extracts were compared. A rapid and validated HPLC method was also developed for quantification of L-DOPA. Ultrasound and microwave assisted extractions were observed as viable alternative to conventional method in terms of yield and quality of extract. Use of these suitable extraction methods will increase versatile utilization of M. pruriens seed with high levels of bioactive compounds.

NEEL *(Indigofera tinctoria)*

It is a shrub belonging to family *Fabaceae* and grows to a height of about one to two meters. It is annual, biennial, or perennial, depending on the climate in which it is grown. The leaves are pinnate and flowers are pink or violet. The species was one of the original sources of indigo dye. It has been naturalized to tropical and temperate Asia, as well as parts of Africa, but its native habitat is unknown. The plant is also widely grown as a soil-improving groundcover and to improve the soil in the same way that the other legume crops. The dye is obtained from processing of the plants' leaves. The species also has medicinal value. The leaves are dried and used for the treatment of any type of toxicity, fever, jaundice, arthritis and indigestion. Root is used in abdominal disorders, leucorrhoea, hair loss and all types of toxicities, *etc*.

Collection, evaluation and maintenance

KAU, Trichur: Nineteen accessions were evaluated for herbage yield and quality. Plant height varied from 15.2 cm (TCRIT 19) to 67.2 cm (TCRIT 1). Plant height was significantly highest in TCRIT 1 which was at par with TCRIT 8 (66.5 cm). Number of branches per plant was significantly highest in TCRIT 1 (14.7 plant^{-1}) which was at par with TCRIT 3 (13.8) and TCRIT 6 (13.5). Significantly higher herbage yield was obtained in TCRIT 4 (232.35 g plant^{-1}) which was followed by TCRIT 2 (168.13 g plant^{-1}). Indican content varied from 0.55% (TCRIT 12) to 1.16% (TCRIT 14).

Effect of organic manures and biofertilisers on yield and quality

KAU, Trichur: The experiment consisted of nine treatment combinations *i.e.*, FYM (10 t ha^{-1}), vermicompost (3 t ha^{-1}) and coirpith compost (4 t ha^{-1}) and biofertilisers (*Azospirillum* 2 kg ha^{-1}, and *Azospirillum* 2 kg + VAM 2 kg ha^{-1}). Highest plant height of 64.4 cm was recorded at the time of first cutting (2 month after planting) with the application of vermicompost 3 t ha^{-1} followed by vermicompost 3 t + *Azospirillum* 2 kg + VAM 2 kg ha^{-1}. The highest herbage yield of 1513 kg ha^{-1} was obtained with the application FYM 10 t + *Azospirillum* 2 kg +VAM 2 kg ha^{-1}.

OPIUM POPPY *(Papaver somniferum)*

It belongs to family *Papaveraceae*. Opium and poppy seeds are obtained from this species. The latex collected from the capsule is otherwise known as opium and is medicinally important. 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 is restricted by the Narcotics Department under licensing system. Seeds of opium poppy are the source of poppy seed oil, a healthy edible oil that has many uses. It is widely grown as an ornamental flower throughout Europe, North America, South America and Asia.

Maintenance of working germplasm

NDUAT, Faizabad: Thirty five working germplasm were evaluated based on morphological and yield characters *viz.*, plant height, number of branches plant^{-1}, days to first flowering, number of capsules plant^{-1}, days to first flowering, peduncle type, petal shape, petal colour, number of leaves plant^{-1}, capsule length, capsule width, seed yield and husk yield.

Plant height ranged from 102.30 to 146.30 cm. Maximum plant height was in N.D.- 40 followed by N.D.-11 (137.70 cm) and N.D. -10 (132.20 cm). Minimum plant height was in N.D.- 7. Maximum number of branches was in N.D.-31 (4.8 plant^{-1}) followed by N.D.-45 and N.D.-48 (4.4 plant^{-1}) and N.D.-35 (4.0 plant^{-1}) while N.D.-16 produced least number of branches per plant (2.2). Number of leaves per plant showed wide variation ranging from 13.8 to 20.8. N.D.-

9, N.D.-31and N.D.-43 showed the highest number of leaves (20.8 plant^{-1}) followed by N.D.-42 (20.0 plant^{-1}) and N.D.-8 (19.8 plant^{-1}). Minimum number of leaves plant^{-1} was in N.D.-7.

Initiation of first flowering varied from 91 days to 108 days. N.D.-4-1 and N.D.-4-2 had earliest first flowering initiation (91 and 92 days) followed by N.D.-17 and N.D.-28 (93 days) and N.D.-12, N.D.-20, N.D.-21 & N.D.-35 (94 days). Late flowering initiation was in N.D.-44 (108 days). Number of capsule plant^{-1} varied significantly from 1.4 to 4.0. N.D.-31 produced maximum number of branches as compared to other accessions resulting the highest number of capsules (4.0 plant^{-1}) while N.D.-16 and N.D.-24 having the lowest number of branches and produced the least number of capsules (1.4 plant^{-1}) and capsule length ranged from 2.27 to 3.66 cm. N.D.-36 had the longest capsules followed by N.D.-89 (3.56 cm) and N.D.-37 (3.53 cm). However, the shortest capsules were in N.D.-8. Width of capsules varied from 3.23 to 4.56 cm. Maximum capsule width was in N.D.-16 followed by N.D.-24 (4.23 cm) and N.D.-37 (4.12 cm) while, the minimum width of capsule was in N.D.-9 (3.23 cm).

Seed yield ranged from 5.20 to 14.58 q ha^{-1}. Maximum seed yield was in N.D.-31 followed by N.D.-45 (12.50 q ha^{-1}) while it was minimum in N.D.-44 (5.20 q ha^{-1}). Maximum husk yield was in N.D.-45 (10.41 q ha^{-1}) followed by N.D.-31 (8.54 q ha^{-1}) and N.D.-40 & N.D.-208 (8.33 q ha^{-1}). However, minimum husk yield was in N.D.-44 (3.33 q ha^{-1}).

RVSKVV, Mandsaur: Different distinct and stable characters were identified in the crop. Leaf type, serration of the leaves, petal type and colour, hairy nature of peduncle, capsule shape, *etc.*, were the major distinct and stable characters in the species. Colour of petal ranged from white, pink, red and violet. Petals were of serrated or non-serrated in each colour types. Similarly peduncle was hairy or non-hairy. Plants can be identified well on the basis of leaf serration and serration was graded into non- serrated (S1) serrated (S2) and deeply serrated (S3). The capsule shape was round (spherical), egg like (ovate) or cylindrical. Date of flowering (early and late) can be a distinguishing character for the species.

On the basis of these characters, thirty six plant types were selected and evaluated and it was found that plant height ranged from 87 cm (ND-42) to 116 cm (MOP-570), leaf length ranged from 12.0 (MOP-108) to 19.0 cm (MOP-539), breadth of leaf 7.7 cm (MOP-278) to 14.0 cm (MOP-570) whereas number of leaves per plant ranged from 10 (MOP-1081) to 19 (MOP-539). Days to 50% flowering ranged from 75 days (MOP-1081) to 97 days (MOP-533), length and width of capsule varied from 34.43 mm to 45.5 mm and 32.4 mm to 47.0 mm, respectively. Mean latex yield (kg ha^{-1}) ranged from 79.3 to 37.54 and mean seed yield (kg ha^{-1}) ranged from 540 to 1200.

MPUAT, Udaipur: Eighty five germplasm lines were evaluated for plant height, peduncle length, number of effective capsules per plant, stem diameter, days to 50% flowering, dry latex yield, seed yield, husk yield and morphine content. A total of 33 germplasm exhibited higher dry latex yield over the best check, chetak aphim (29.17 kg ha^{-1}) and over the trial mean (27.92 kg ha^{-1}). Latex yield ranged from as low as 10.00 kg ha^{-1} (MPO-121) to as high as 53.58 kg ha^{-1} (MPO-129).

Effect of moisture and nitrogen levels on yield

RVSKVV, Mandsaur: The experiment comprising of four irrigation levels (control, one, two and three irrigations) and three nitrogen levels (control, 15 and 30 kg N ha^{-1}) were

conducted. The results revealed that irrigation and nitrogen levels affected plant height and latex yield significantly and number of capsules and seed yield non-significantly. Application of three irrigations produced significantly highest plant height (109.3 cm) and seed yield (9.6 q ha^{-1}), however, latex yield (28.9 kg ha^{-1}) and number of capsules (3 $plant^{-1}$) were maximum with one irrigation. Application of 30 kg N ha^{-1} produced highest plant height (110.2 cm), however, number of capsules (3 $plant^{-1}$), seed yield (9.8 q ha^{-1}) and latex yield (29.2 kg ha^{-1}) were maximum with 15 kg N ha^{-1}.

Management of downy mildew

RVSKVV, Mandsaur: Four concentrations of sectin *viz*, 0.1%, 0.125%, 0.15% and 0.2% were tested against downy mildew from 2010-2013. The sectin was sprayed three times at 35, 55 and 75 days after sowing; the disease incidence was recorded before lancing period. Diseases incidence recorded before lancing indicated that sectin at 0.15% and 0.2% were more effective and recorded a disease incidence of 21.33% and 18.98%, respectively (Mean of three years). The maximum mean yields of latex, seed and husk (68.99, 1257.79 and 1021.51 kg ha^{-1}) were recorded from sectin at 0.15% concentration followed by sectin 0.2% (68.94, 1233.16 and 1017.03 kg ha $plant^{-1}$).

Management of powdery mildew

RVSKVV, Mandsaur: Four concentrations of Trifloxystrbin 25 + Tebuconazole 50% (Nativo) *viz.*, 250g, 300g, 350 g and 400 g ha^{-1} were tested against powdery mildew. Spraying was done two times at flowering stage and capsule maturity stage and the disease incidence was recorded before lancing. The results showed that Nativo at 400 g ha^{-1} and 300 g ha^{-1} recorded the minimum diseases incidence of 12.17% and 15.12% respectively. The latex , seed and husks yield were maximum (58.92, 1042.70 and 976.42 kg ha^{-1}) in plots sprayed with Nativo at 300 g ha^{-1} concentration followed by Nativo at 400 g ha^{-1} (58.71, 1015.93 and 958.58 kg ha^{-1}).

Integrated disease management practices against root rot

MPUAT, Udaipur: An integrated disease management strategy for root rot was evaluated in sick plots from 2010-2013. Among the thirteen treatments, soil application of neem cake manure at 500 g m^{-2} as organic amendment + seed treatment with *Trichoderma* talc based formulation (10^8 cfu g^{-1}) at 10 g kg^{-1} + drenching with Hexaconazole (0.1%) at 35 and 60 DAS resulted in minimum plant mortality (9.17%), maximum percent disease control (90.29%), maximum dry latex powder yield (35.34 kg ha^{-1}), seed yield (15.1 q ha^{-1}) , capsule husk yield (13.9 q ha^{-1}) and increased per cent of morphine content (12.88%).

Screening of genotypes for multiple disease resistance

MPUAT, Udaipur: Twelve genotypes were screened (severity rating scale used was 0-9 scale) against downy mildew, root rot, leaf spots, bacterial blight, powdery mildew incidence. Six genotypes (UOP-20, UOP-44, UOP-53, UOP-69, UOP-79, UOP-80) were resistant (R) with lowest diseases intensity (11-20%), higher seed yield (10.45-13.60 q ha^{-1}); dry latex powder (34.86-38.27 kg ha^{-1}) and higher morphine content (12.36 and 12.78%).

PALMAROSA *(Cymbopogon martinii)*

It is an important aromatic grass belonging to family *Poaceae*. It attains a height of about 1.75 m under favourable growing condition in the forest and up to 2.5 m under cultivation. Essential oil from this species is used in perfumery, cosmetics, pharmaceutical and flavouring industries. Oil is extracted from the floral shoots and aerial parts of 'motia' variety of *Cymbopogon martinii*. The oil has good demand for export and is very rich in geraniol (75-90%). 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.

Modified mass selection for high yield and quality

DMAPR, Anand: Fifteen palmarosa clones were selected by two years' screening from 1200 plants of seven germplasm based on growth, yield and quality parameters. These fifteen clones were planted in the polycross nursery. The composite hybrid seeds were collected from the polycross nursery and evaluated. The evaluation experiment comprised of the fifteen parental clones DCM-1 to DCM-15 and the composite seed (DCM-16) along with variety Trishna as a check.

Various growth parameters such as plant height and number of tillers were recorded. Plant height showed significant differences among the clones. The highest plant height (176.3 cm) was in clone DCM-12 which was at par with the clones DCM-1, DCM-6, DCM-7, DCM-8, DCM-9, DCM-10, DCM-11 and DCM-16 and Trishna, whereas, the lowest plant height was in DCM-3 (136.7 cm). However, the number of tillers and yield (fresh and dry) did not show significant differences.

Geraniol and geranyl acetate contents in the essential oil were analysed by GC-MS. The essential oil content (on dry weight basis) showed significant differences among different clones. Significantly highest essential oil content of 2.85% was in the clone DCM-14 and least was in DCM-3 (1.67%). Whereas, essential oil yield plant^{-1} differences were found to be statistically non-significant. In contrast, significantly highest geraniol content (73.86%) was in clone DCM-3 and least was in DCM-9 (64.94%). However, data related to geranyl acetate was found to be non-significant.

PUNARNAVA *(Boerhavia diffusa)*

It is a member of family *Nyctaginaceae*. It is a diffusely branched, prostrate medicinal herb. The plant is a common weed found in grassland, cultivated field and orchads throughout India upto an altitude of 2000 m in the Himalayas. It is occassionly cultivated in West Bengal. It can be propagated by seeds. The roots are the source of the ayurvedic drug 'Punarnava' which is laxative, diurect and cardiotonic. Root is also used to cure biliousness, blood impurities, anaemia, inflammations. The whole plant is used for treating cancer, liver and renal diseases.

Roots of *B. erecta* are used to adulterate *B. diffusa*.

Integrated management of leaf spot disease

BCKV, Kalyani: A field trial was conducted to evaluate the integrated management strategies consisting botanicals, non conventional chemicals and biocontrol agents against leaf spot caused by *colletotrichum capscisi*. The treatment combinations consisted of three sprays. Each spray was done at fifteen days interval. Data of disease incidence and severity recorded at fifteen days after last spray showed that lowest percent disease incidence (12.41) and highest inhibition (57.53%) was recorded in the treatment combination of spraying *trichoderma* sp. at 3.7×10^8 spores ml^{-1} + Salicylic acid at 3mM + *Trichoderma* sp at 3.7×10^8 spores ml^{-1}. The lowest disease index (13.29), highest inhibition (63.35%) and maximum yield in fresh weight (883.33 g $plant^{-1}$) were also recorded in the above mentioned treatment. Lowest fresh weight of whole plant (200 g $plant^{-1}$) was obtained from control treatment.

SAFED MUSLI *(Chlorophytum borivilianum)*

It 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 exploited 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 vulnerable species status.The plant is propagated by the stem disc with the attached fleshy roots as well as by seeds.

Evaluation of promising clones

PDKV, Akola: Evaluation trial was carried out during the kharif season of year 2012-13. Thirteen clones along with one check *viz.*, MCB 405 were evaluated for different morphological characters and yield. Number of fleshy root per plant was highest in AKSM-04 (12.40), followed by AKSM–13 and AKSM-12. Root length was highest in AKSM-01(9.95 cm) followed by AKSM-12 (9.27 cm). However, the root diameter was maximum in AKSM-07 (7.53 mm) followed by AKSM-08 (7.49 cm). AKSM- 13 produced highest fleshy root yield (26.60 g $plant^{-1}$) followed by AKSM- 12 as compared to the other clones. Saponin content was highest in AKSM 08 (7.43%), followed by AKSM 07 (7.26%).

RVSKVV, Mandsaur: Twenty-four clones were evaluated and wide range of variability was noticed among the clones. Length of leaves varied from 12 cm (MCB-403) to 31 cm (MCB-417). Breadth of leaves ranged from 14 mm (MCB-409) to 28 mm (MCB-422). Anther colour ranged from yellow, light yellow to light green. Length of fleshy root ranged from 6.3 cm (MCB-417) to 11.5 cm (MCB-412). Root diameter ranged from 4.5 mm (MCB-418) to 12.5 mm (MCB-421). Fresh weight of fleshy roots ranged from 2111 kg ha^{-1} (MCB-421) to 3888 kg ha^{-1} (MCB-412).

Intercropping with pigeon pea

PDKV, Akola: The experiment was conducted on intercropping of safed musli+pigeon pea at four row proportions (2:1, 3:1, 2:2 and 1:2) and compared with sole safed musli and sole pigeon pea. The data revealed that significantly highest leaves number (13.4), length (20.8 cm) and width (1.6 cm) were observed in the intercropping of safed musli:pigeon pea at row proportion of 3:1. The roots per plant (12.9), root length (7.04 cm), root diameter (6.9 mm), fresh root yield (19.16 g plant^{-1} and 35.47 q ha^{-1}), dry root yield (5.91 q ha^{-1}), safed musli equivalent yield (6.10 q ha^{-1}), pigeon pea equivalent yield (119.10 q ha^{-1}), land equivalent ratio (1.61) and gross monetary returns (Rs. 488254/- ha^{-1}) were recorded significantly highest under the row proportion of 3:1 followed by the sole safed musli. However, pigeon pea produced significantly highest seed yield under sole crop.

Management of fasciculated root rot

RVSKVV, Mandsaur: The results of the field experiment conducted for the management of root rot showed that seed treatment with carbendazim 1.5g kg^{-1}+soil drenching with carbendazim at 0.15% recorded the minimum diseases incidence (17.85%) and higher yield of 3116 kg ha^{-1} whereas the control plot recorded the highest fasiculated root rot disease incidence (37.46%) and lowest yield of 1543 kg ha^{-1}.

MPUAT, Udaipur: An integrated disease management package against root rot was evaluated against the disease. Among the different treatments, soil application of neem cake manure at 500 g^{-2} as organic amendment + seed treatment with SAAF 75 WP (Mancozeb 63% + Carbendazim 12%) at (0.2%) + *Trichoderma* talc based formulation (10^{8} cfu g^{-1}) at 20% resulted in minimum plant mortality (8.87%), maximum percent disease control (86.48), higher yields of fasciculated root (45.1q ha^{-1}), higher root parameters (length 15.16cm with 30.33 mm diameter), roots number (751 5 m^{-2} plot) and a maximum plant population of 1.67 lakhs ha^{-1}. The inoculated untreated control treatments recorded 65.45% plant mortality, zero per cent disease control, fasciculated root yield of 17.8q ha^{-1}, root length of 4.08 cm with 7.73 mm diameter, roots number of 296 (5 m^{-2} plot) and a plant stand of 0.66 lakhs ha^{-1}. Twenty three genotypes were screened at the centre against fasiculated root rot and MCB-412, JSM-405, RVSM-414, MCB-416, MCB-423 were screened as resistant lines.

SARPAGANDHA *(Rauvolfia serpentina)*

It 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.

Management of *Cercospora* leaf spot

JNKVV, Jabalpur: Field experiments were conducted to evaluate the effect of fungicides, mancozeb, (0.25%); carbendazim,(0.1%); copper oxychloride,(0.25%); and botanicals, neem leaf extract, 5%; ashoka leaf extract, 5%; garlic leaf extract, 5% for disease control. Per cent disease index was recorded lowest (6.0) in carbendazim treatment whereas, highest (60.3) in control. Mancozeb recorded a per cent disease index of 13.3 followed by ashoka leaf extract (14.0) and neem leaf extract (15.0) Carbendazim treatment recorded maximum yield(11.25 q ha^{-1}) followed by mancozeb (8.5 q ha^{-1}) neem leaf extract (8.0 q ha^{-1}) and ashoka leaf extract (8.25 q ha^{-1}).

Integrated management of target leaf spot

BCKV, Kalyani: A field trial was conducted to evaluate the integrated management strategies consisting of botanicals, non conventional chemicals and biocontrol agents against target leaf spot caused by *Corynespora cassicola*. The treatment combination was consisting of three sprays. Each spray was done at fifteen days interval. Data of disease incidence and severity recorded at fifteen days after last spray showed that the lowest disease incidence and highest inhibition (7.64 & 75.47%) was recorded in the treatment combination of *Pseudomonas* sp. at 1×10^9 cfu ml^{-1} + Salicylic acid at 1mM + *Clerodendron* leaf powder at 4%. Lowest fresh weight and dry weight of sarpagandha root (91.67 g $plant^{-1}$ and 35.00 g $plant^{-1}$ respectively) were obtained from control treatment.

SENNA *(Cassia angustifolia)*

It 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. It is cultivated mainly in India and Pakistan. 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. It is propagated by seeds and normally cultivated as post kharif crop.

Germplasm collection and maintenance

DMAPR, Anand: Seventy collections were made from Tamil Nadu (Madurai, Virudanagar, Tiruneliveli, Toticorin and Kanyakumari districts) and Rajasthan (Bikaner, Jodhpur and Jaiselmer districts) during the year. These accessions differed widely for plant height (30-130 cm),

number of primary branches (8-25) and 100 seed weight (1.82- 3.72 g). A broad pod type (DCA-124) was collected from Rajasthan. These collections were multiplied and maintained in field gene bank.

Study of insect pollinators

DMAPR, Anand: The species is dependent on insects for pollination in nature. A total of 10 insect pollinators were collected and identified as *Xylocopa verticalis* (Lapaletier), *Xylocopa amethystine* (Fabricius), *Xylocopa aestuans* (Linnaeus), *Amegilla violacea* (Lepeletier), *Anthophora sp., Amegilla sp., Trigona iridipennis* (Smith), *Apis dorsata, Apis millifera* and *Nomia sp*. These insects have role in release of pollen from anthers, carrying the pollen and its placement on the stigma.

Efficacy of biopesticides against *Catopsilia pyranthe*

DMAPR, Anand: Field experiments were continued this year to assess the efficacy of biopesticides (Azadirachtin 0.03%, Azadirachtin 0.3%, Azadirachtin 1%, Beauveria bassiana 10%, Flavanoids 6%, and Neem extract) against *Catopsilia pyranthe*. Similar to previous year results, azadirachtin 1% was found most effective for the control of tropical pierid butterfly and it gave an yield difference of 513.89 kg ha^{-1} of dry leaves over control.

Study on the natural enemies of *Catopsilia pyranthe*

DMAPR, Anand: A field study was conducted to record the natural enemies of *C. pyranthe*. Two larval endoparasitoids belonging to *Braconidae* and *Ichneumonidae* were recorded on *Catopsilia larvae*. Among these parasitoids, the braconid parasitoid *Cotesia* sp was predominant. Per cent parasitisation of *C. pyranthe* by *Cotesia* sp in the field ranged from 20–62.5%. The adult female parasitoid lay eggs on the 1st and 2nd instar of the host larvae by inserting its ovipositor. The parasitized host larvae stops feeding and are yellowish in colour. The parasitoid larvae eats the internal contents of the host larvae and emerged out by making a hole between 5th and 6th abdominal segment of the larvae. The emerged out parasitoid larvae spins a silky cocoon and gets pupate outside.

Economic yield loss assessment

DMAPR, Anand: An experiment was conducted to assess the yield loss due to *Catopsila pyranthe* using paired plot technique. Chlorpyriphos 2ml l^{-1} was sprayed at fortnightly intervals as a preventive measure in the treated plots. An yield loss of 15.74% was recorded due to the damage *Catopsilia pyranthe*.

HPLC method development for sennosides determination

DMAPR, Anand: HPLC method was developed for the determination of sennoside-A and B in Senna extracts. The separation of the two analytes was achieved on a RP-18 column (100 mm X 4.6 mm, 3μm) at max 270 nm using a solvent system consisting of methanol and 1.25% acetic acid in water at a flow rate of 1.0 ml min^{-1}. The sennoside-B and sennoside–A eluted at retention time 14.246 min and 15.414 min, respectively.

SHANKHPUSHPI (*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 System of Medicine (ISM) *i.e.* "Ayurveda", "Unani" and "Siddha", Shankhpushpi is reported to be an important memory vitalizing drug plant. The herbage including leaves and stems is the source of raw drug.

Effect of organic manures on yield

AAU, Anand: The experiment was conducted with six levels of organic nutrients (FYM 10 t, poultry maure 5 t, vermicompost 2 t, caster cake 2 t, neem cake 2 t ha^{-1}, and azotobactor + phosphate culture 1 liter ha^{-1} each). Pooled analysis of four years data revealed that application of different organic sources did not significantly influence dry biomass yield, however, maximum dry biomass yield (11,990 kg ha^{-1}) was recorded with the application of azotobactor + phosphate culture (1 liter ha^{-1} each). Economic analysis of pooled data revealed that application of bio-fertilizer (azotobactor + phosphate culture at 1 liter ha^{-1} each) gave maximum net return of Rs. 1,66,820/- ha^{-1} with B:C ratio of 3.29.

SHATAVARI (*Asparagus racemosus*)

It is a creeper, belongs to family *Liliaceae* and is common throughout India. It has an adventitious root system with tuberous roots. 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 saponins content. Cultivation of the species is very limited and under cultivation, it is propagated through seeds. Fleshy roots are harvested, peeled and shade dried and used for the drug preparations.

Evaluation of germplasm

JNKVV, Jabalpur: Thirteen accessions were evaluated along with local check JBPAR8-9-127 on the basis of different parameters *viz.*, length of cladodes, fleshy root diameter, fleshy root length, fresh fleshy root yield, dry fleshy root yield and saponine content. Significant differences were observed for the studied parameters except in number of cladode per node among the accessions.

Maximum length of cladode (9.15 cm) was found in JBPAR8-9-121. Maximum number of fleshy root per plant was in JBPAR8-9-120 (342.5) followed by JBPAR8-9-117 (272.5). Maximum fleshy root length (29.0 cm) was in JBPAR8-9-118 followed by JBPAR8-9-120 (28.0 cm). Maximum fleshy root diameter (1.18 cm) was in JBPAR8-9-118 followed by JBPAR8-9-124 and JBPAR8-9-127 which were statistically at par.Highest fresh fleshy root yield per plant (1870.0 g) was in JBPAR8-9-117 followed by accession JBPAR8-9-118 (1585.0 g).

Effect of organics manures and biofertilizers on growth and yield

YSPUHF, Solan: The experiment was comprised of seven treatments of different combinations of organic manures and biofertilizers (control, FYM 5 t ha^{-1}, vermicompost 2 t ha^{-1}, FYM 5 t + PSB 10 kg ha^{-1}, vermicompost 2 t + PSB 10 kg ha^{-1} and FYM 5 t + vermicompost 2 t + PSB 10 kg ha^{-1}). Maximum plant height (38.29 and 68.53 cm), number of branches $plant^{-1}$ (5.1 and 5.2), number of roots $plant^{-1}$ (22.16 and 23.33) and fresh root yield (42.75 and 56.62 g $plant^{-1}$) were recorded with FYM 5 t + vermicompost 2 t + PSB 10 kg ha^{-1} after 12 and 18 months of planting, respectively followed by vermicompost 2 t + PSB10 kg ha^{-1}.

RAU, Pusa: The experiment was conducted with three levels of organic manures (vermi compost 2 t, mustard cake 1 t and vermi compost 2 t + mustard cake 1 t ha^{-1}), and three levels of biofertilizers (Azospirillum 2 kg, PSB 5 kg and Azospirillum 2 kg + PSB 5 kg ha^{-1}) to find out the suitable combination of organic manures and biofertilizers for higher yield and quality. The results revealed that combined application of vermicompost 2 t + mustard cake 1 t ha^{-1} and inoculated with PSB 5 kg + Azospirillum 2 kg ha^{-1} recorded highest root yield on both fresh (141.62 q ha^{-1}) and dry weight (16.90 q ha^{-1}) basis followed by vermicompost inoculated with mixture of Azospirillum and PSB.

Evaluation of antioxidant potential of water extract

DMAPR, Anand: The antioxidant potential of water extract of A. racemosus was compared with extracts of five other medicinal plants *V. negundo, V. trifolia, T. bellerica, T. chebula*, and *E. officinalis*. Although, extracts of all the six medicinal plants exhibited antioxidant potential, however, A. racemosus extract showed very low antioxidant capacity as established from high IC_{50} value in DPPH and ABTS assay.

TULSI *(Ocimum sanctum)*

It is an erect highly branched aromatic perennial herb belonging to 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. Seedlings are raised in nursery and transplanted at 4-5 leaf stage seedling at the onset of monsoon. Freshly

harvested material is distilled for oil extraction.

Nutrient management studies

NDUAT, Faizabad: The experiment was conducted during 2011-12 and 2012-13 comprising eleven levels of organic and inorganic nutrients to find out their optimum dose in tulsi. Application of 30N: 20P: 10K + 10 t FYM ha^{-1} recorded highest plant height (119.88 cm) followed by 40N: 30P: 20K + 10 t FYM (114.86 cm) and 50N: 40P: 30K kg ha^{-1} (113.76 cm). Maximum number of branches (21.96 $plant^{-1}$) was recorded with 30N: 20P: 10K + 10 t FYM ha^{-1} followed by 50N: 40P: 30K + 5 t FYM ha^{-1} (20.83 $plant^{-1}$). Application of 30N: 20P: 10K kg ha^{-1} along with 10 t FYM ha^{-1} recorded highest fresh herbage (189.33 q ha^{-1}) as well as dry herbage yield (58.65 q ha^{-1}) and essential oil yield (40.61 l ha^{-1}).

Economic yield loss assessment of tingid bug

RAU, Pusa: Experiments were conducted to assess the yield loss due to a tinged bug *Cochlochila bullita*. Dimethoate 1ml l^{-1} was sprayed at fortnightly intervals from last October to mid January as a preventive measure in the treated plot for checking tingid bug. An yield loss of 27.84% was recorded due the damage of tingid bug in tulsi.

Survey of arthropod pest of medicinal and aromatic plants

DMAPR, Anand

Plant/crop	Local name	Scientific name	Family	Order
Commiphora wightii	Termite	*Microtermis mycophagus*	Termitidae	Isoptera
	Mealy bug	*Ferrisia vergata*	Pseudococcidae	Hemiptera
	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera
Tinospora cordifolia	Cotton Mealy bug	*Phenacoccus solenopsis*	Pseudococcidae	Hemiptera
	Looper (fruit sucking moth)	*Elygea materna*	Noctuidae	Lepidoptera
	Red Spider mite	*Tetranychus urticae*	Tetranychidae	Acrai
	Termite	*Odontotermes bellahunisensis*	Termitidae	Isoptera
Cymbopogon martini	Snout beetle	*Mylloceru discolor*	Curculionidae	Coleoptera
		Mylloceru dentifer		
		Mylloceru tenuicornis		
	Termites	*Microtermes obesi*	Termitidae	Isoptera
Cymbopogon flexuosus	Snout beetle	*Mylloceru discolor*	Curculionidae	Coleoptera
		Mylloceru dentifer		
	Termites	*Microtermes obesi*	Termitidae	Isoptera
	Mealy bug	*Phenacoccus solenopsis*	Pseudococcidae	Homoptera
Lepidium sativum	Mustard saw fly	*Athalia lugens proxima*	Tenthredinidae	Hymenoptera
	Mustard aphid	*Lipaphis erysimi*	Aphididae	Homopera
	Diamond back moth	*Plutella xylostella*	Plutellidae	Lepidoptera
	Flea beetle	*Phyllotreta cruciferae*	Chrysomelidae	Coleoptera
	Leaf Webber	*Crocidolomia binotalis*	Pyralidae	Lepidoptera
	Painted bug	*Bagrada hilaris*	Pentatomidae	Hemiptera
	Leaf eating caterpillar	*Trichoplusia ni*	Noctuidae	Lepidoptera
		Thysanoplusia orichalcea		
	Gram pod borer	*Helicoverpa armigera*	Noctuidae	Lepidoptera
Plantago indica	Cotton mealy bug	*Phenococcus solenopsis*	Pseudococcidae	Hemiptera
	Leaf eating caterpillar	*Helicoverpa armigera*	Noctuidae	Lepidoptera
	Leaf eating caterpillar	*Thysanoplusia orichalcea*	Noctuidae	Lepidoptera
	Leaf eating caterpillar	*Trichoplusia ni*	Noctuidae	Lepidoptera
	Green bug	*Nizara viridula*	Pentatomidae	Hemiptera
	Red cotton bug	*Dysdercus cingulatus*	Pyrrhocoridae	Hemiptera
	Sesbania Looper	*Hyposidra successaria*	Geometridae	Lepidoptera
	Cut worm	*Agrotis ipsilon*	Noctuidae	Lepidoptera
	Tussock caterpillar	*Olene mendosa*	Lymantridae	Lepidoptera
		Somena scintillans		
	Surface grasshopper	*Crotogonus trachypterus*	Acrididae	Orthoptera

Grewia asiatica	Shield-backed bug	*Scutellera nobilis*	Scutelleridae	Hemiptera
	Stink bug	*Plautia fimbriata*	Pentatomidae	Hemiptera
	Treehopper	*Otinotus oneratus*	Membracidae	Homoptera
	Tussock caterpillar	*Somena scintnillans*	Lymantridae	Lepidoptera
	Tussock caterpillar	*Olene mendosa*	Lymantridae	Lepidoptera
	Snout beetle	*Myllocerus tenuicornis*	Curculionidae	Coleoptera
Psoralea corylifolia	Groundnut leaf miner_	*Aproarema modicella*	Gelechidae	Lepidoptera
	Citrus caterpillar	*Papilio demoleus*	Papilionidae	Lepidoptera
	Leaf weevil	*Cryptozemia dispar*	Curcullinoidae	Coleoptera
Gymnema sylvestre	Milkweed Aphid	*Aphis nerii*	Aphididae	Homoptera
	Cotton aphid	*Aphis gosypii*	Aphididae	Homoptera
	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera
	Tinged bug	*Compseuta lefroyi*	Tingidae	Hemiptera
	Leaf beetle	*Clytra succinta*	Chrysomelidae	Coleoptera
	Crusader bug	*Graptostethus servus*	Lygaeidae	Hemiptera
	Leaf beetle	*Corynodes peregrinus*	Chrysomelidae	Coleoptera
Adathoda vasica	Termite	*Microtermes mycophagus*	Termitidae	Isoptera
	Cotton mealybug	*Phenacoccus solenopsis*	Pseudococcidae	Homoptera
	Pink mealybug	*Maconellicoccus hirsutus*	Pseudococcidae	Homoptera
Jatropa gossypifolia	Termite	*Odentotermis obesus*	Termitidae	Isoptera
	Fruit borer	*Pempelia morosalis*	Pyralidae	Lepidoptera
Crataeva nurvala	Jassids	*Lectotypella rawa*	Cicadellidae	Homoptera
	Beetle	*Phyllotreta downesi*	Chrysomelidae	Coleoptera
	Leaf eating caterpillar	*Belenois aurota*	Pieriidae	Lepidoptera
	Mealy bug	*Ratrococcus iceryoides*	Pseudococcidae	Homoptera
	Mealy Bug	*Phenacoccus solenopsis*	Pseudococcidae	Hemiptera
Artemesia annua	Gram pod borer	*Helicoverpa armigera*	Noctuidae	Lepidoptera
	Webber	*Etiella zinckenella*	Pyralidae	Lepidoptera
	Looper	*Hyposidra successaria*	Noctudiae	Lepidoptera
	Termites	*Odontotermes bellahunisensis*	Termitidae	Isoptera
	Mealy bug	*Phenacoccus solenopsis*	Pseudococcidae	Homoptera
	Green bug	*Nizara viridula*	Pentatomidae	Hemiptera
Citrus medica	Citrus caterpillar	*Papilio demoleus*	Papilionidae	Lepidoptera
	Citrus Leaf minor	*Phyllocnistis citrella*	Gracillariidae	Lepidoptera
	Gram pod borer	*Helicoverpa armigera*	Noctuidae	Lepidoptera
Carrisa carandas	Caterpillar (Common crow)	*Euploea core*	Nymphalidae	Lepidoptera
	Castor semilooper	*Achaea janata*	Noctuidae	Lepidoptera
	Tussock caterpillar	*Olene mendosa*	Lymantridae	Lepidoptera
	Tussock caterpillar	*Euproctis* Sp	Lymantridae	Lepidoptera
	Fruit borer	*Bactrocera dorsalis*	Tephritidae	Diptera
	Fruit borer	*Bactrocera correcta*	Tephritidae	Diptera
	Ants	*Oecophylla smaragdina*	Formicidae	Hymenoptera

Abelmoschus moschatus	Spotted bollworm	*Earias vittella*	Nolidae	Lepidoptera
	Cabbage-head caterpillar	*Crocidolomia binotalis*	Pyralidae	Lepidoptera
	Gram pod borer	*Helicoverpa armigera*	Noctuidae	Lepidoptera
	Leaf weevil	*Crytozima despar*	Curculionidae	Coleoptera
	Cotton mealy bugs	*Phenacoccus solenopsis*	Pseudococcidae	Hemiptera
	Green bug	*Nazara viridula*	Pentatomidae	Hemiptera
	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera
	Cotton aphids	*Aphis gossypii*	Aphididae	Homoptera
	Cotton looper	*Anomis flava*	Noctuidae	Lepidoptera
	Cotton jassids	*Amrasca biguttula_*	Cicadillidae	Homoptera
Datura metel	Hairy caterpillar	*Pericallia ricini*	Arctiidae	Lepidoptera
	Short horned Grasshopper	*Acrida exultata*	Acrididae	Orthoptera
	Red cotton bug	*Dysdercus cingulatus*	Pyrrhocoridae	Hemiptera
	Hadda beetle	*Epilachna vigintiocopuntata*	Coccinellidae	Coleoptera
	Green bug	*Nizara viridula*	Pentatomidae	Hemiptera
Andrographis paniculata	Gram pod borer	*Helicoverpa armigera*	Noctuidae	Lepidoptera
	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera
	Leaf weevil	*Crytozemia dispar*	Curcullinoidae	Coleoptera
	Green bug	*Nizara viridula*	Pentatomidae	Hemiptera
Centella asiatica	Jassid	*Empoascanara plamka*	Cicadellidae	Homoptera
	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera
	Grasshopper	*Acrida exultata*	Acrididae	Orthoptera
Cassia fistula	Snout beetle	*Myllocerus discolor*	Curcullinoidae	Coleoptera
	Snout beetle	*Myllocerus tenuicornis*	Curcullinoidae	Coleoptera
	Tree hopper	*Leptocentrus taurus*	Membracidae	Homoptera
	Tree hopper	*Otinotus onetatus*	Membracidae	Homoptera
	Tropical pierid butterfly	*Catopsilia pyranthe*	Pieridae	Lepidoptera
	Shoot borer/ leaf Weber	*Etiella zinckenella*	Pyralidae	Lepidoptera
Desmodium gangeticum	Tussock caterpillar	*Olene mendosa*	Lymantridae	Lepidoptera
	Grasshopper	*Acrida exultata*	Acrididae	Orthoptera
	Snout beetle	*Myllocerus* sp	Curcullinoidae	Coleoptera
	Negro bug	*Coptosoma indicum*	Plataspidae	Hemipera
Convolvulus microphyllus	Beetles	*Oocassida pudibunda*	Chrysomelidae	Coleoptera
	Snout beetles	*Myllocerus* sp.	Curculionidae	Coleoptera
		Crytozemia dispar	Curculionidae	Coleoptera
	Spiny caterpillar	*Junonia orithya*	Nymphalidae	Lepidoptera
Enicostemma axillare	Shoot Borer	*Pterophorus* sp.	Pterophoridae	Lepidoptera
Holarrhena antidysenterica	Tussok caterpillar	*Somena scintillans*	Lymantridae	Lepidoptera
	Spiny caterpillar	*Cydalima laticostalis*	Crambidae	Lepidoptera

Murraya koenigii	Citrus caterpillar	*Papilio demoleus*	Papilionidae	Lepidoptera
	Cotton mealy bug	*Phenacoccus solenopsis*	Pseudococcidae	Hemiptera
	Indian sunbeam	*Curetis thetis*	Lycaenidae	Lepidoptera
Mentha spiciata	Tingid bug	*Momantha globulifera*	Tingidae	Hemiptera
	White fly	*Bemisia* sp	Aleyrodidae	Homoptera
Barleria prionitis	Spiny caterpillar	*Junonia hierta*	Nymphalidae	Lepidoptera
	Spiny caterpillar	*Junonia orithya*	Nymphalidae	Lepidoptera
Ampelocissus latifolia	Spotted leaf eating beetle	*Scelodontia strigicollis*	Chrysomelidae	Coleoptera
Ricinus communis	Castor slug	*Latoia lepida*	Limacodidae	Lepidoptera
	Castor semilooper	*Achoea janata*	Noctuidae	Lepidoptera
	Serpentine leaf minor	*Liriomyza trifolii*	Agromyzidae	Diptera
	Castor butterfly	*Ergolis merione*	Nymphalidae	Lepidoptera
	Short horned grass hopper	*Acrida exultata*	Acrididae	Orthoptera
	Tussok caterpillar	*Euproctis subnotata*	Lymntridae	Lepidoptera
	Tobacoo caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera
Cassia sophera	Leaf eating Caterpillar	*Catopsilia pyranthe*	Pieridae	Lepidoptera
Cissus quadrangularis	Leaf eating beetle	*Scelodontia strigicollis*	Chrysomelidae	Coleoptera
	Sphingid larvae	*Hippotion celerio*	Sphingidae	Lepidoptera
	Leaf folder	-	-	Lepidoptera
Hemidesmus indicus	Snout beetle	*Myllocerus tenuicornis*	Curculinodiae	Coleoptera
	Caterpillar (Common crow)	*Euploea core*	Nymphalidae	Lepidoptera
Aristolochia bratoelata	Spiny caterpillars	*Pachliopta aristolochiae*	Papilionidae	Lepidoptera
	Pyralid leaf folder	*Parotis marginata*	Pyralidae	Lepidoptera
	Leaf gall psyllid	*Pseudophacopteron tuberculata*	Phacopteronidae: Psylloidea	Hemiptera
Pongamia pinnata	Ash weevils	*Myllocerus* sp	Curculionidae	Coleoptera
	Leaf minor	Idn pending	Nepticulidae	Lepidoptera
	Cotton strainer	*Dysdercus koenigii*	Pyrrhocoridae	Hemiptera
	Indian sunbeam	*Curetis thetis*	Lycaenidae	Lepidoptera
Terminallia bellerica	Green colour snout beetle	*Myllocerus tenuicornis*	Curcullinoidae	Coleoptera
	Snout beetle	*Myllocerus dentifer*	Curcullinoidae	Coleoptera
	Snout beetle	*Myllocerus discolor*	Curcullinoidae	Coleoptera
	Castor slug	*Latoia lepida*	Limacodidae	Lepidoptera
Gloriosa superba	Spotted caterpillar	*Polytela gloriosae*	Noctuidae	Lepidoptera
	Leaf eating caterpillar	*Trichoplusia ni*	Noctuidae	Lepidoptera
	Leaf eating caterpillar	*Thysanoplusia orichalcea*	Noctuidae	Lepidoptera
	Tobaco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera

Celastrus paniculatus	Scale	*Ceroplastus floridensis*	Coccidae	Hemiptera
Cordia dichotoma	Tinged bug	*Cysteochila delineata*	Tingidae	Hemiptera
Ficus racemosa	Leaf eating caterpillar	*Perina nuda*	lymantridae	Lepidoptera
Leptadenia reticulata	Psyllid	*Diaphornia dakariensis*	Psyllidae	Hemiptera
	Stripped larvae	*Danaus chrysippus*	Danaidae	Lepidoptera
	Milk weed aphid	*Aphis nerii*	Aphididae	Homoptera
Ocimum sanctum	Tingid bug	*Momantha globulifera*	Tingidae	Hemiptera
	Tobaco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera
	Shield bug	*Euscarcoris* sp	Pentatomidae	Hemiptera
	Black fly	*Acaudaleyrodes rachipora*	Aleyrodidae	Hemiptera
Asparagus racemosus	Leaf eating Beetle	*Clytra succincta*	Chrysomelidae	Coleoptera
	Leaf eating Beetle	*Lema downsei*	Chrysomelidae	Coleoptera
	Shorgum bug	*Brachytes bicolar*	Coreidae	hemiptera
	Aphid	*Aphis craccivra*	Aphididae	Homoptera
Boerhavia diffusa	Hairy caterpillar	*Spilarctia obliqua*	Arctiidae	Lepidoptera
	Hippotion spnix moth	*Hippotion boerhaviae*	Sphingidae	Lepidoptera
	Leaf eating caterpillar	*Aegoceropsis brevivitta*	Noctuidae	Lepidoptera
Hibiscus rosasinensis	Cotton mealybug	*Phenacoccus solenopsis*	Pseudococcidae	Homoptera
	Orange band blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera
Sida cordata	Seed bug	*Oxyceranus hyalinipennis*	Lygaeidae	Hemiptera
	Scentless plant bug	*Corizus rubicundus*	Rhopalidae	Hemiptera
	Scentless plant bug	*Corizus sp.*	Rhopalidae	Hemiptera

BCKV Kalyani

Plant/crop	Local name	Scientific name	Family	Order
Abroma augusta	Cotton jassid	*Amrasca kerri*	Cicadellidae	Hemiptera
Barleria lupulina	Lemon Pansy	*Junonia lemonias*	Nymphalidae	Lepidoptera
Cassia fistula		*Euphalerus vittatus*	Psyllidae:	Hemiptera)
Litsea monopetala		*Papilio clytia*	Papilionidae	Lepidoptera
Sida cordifolia	Mealy bug		Pseudococcidae	Hemiptera
	Ash or grey weevil	*Myllocerus* sp	Curculionidae	Coleoptera

Erythrina variegata	Erythrina leaf-roller	*Agathodes ostentalis*	Pyralidae	Lepidoptera
Abelmoschus moschatus	Leaf roller	*Sylepta derogata*	Pyralidae	Lepidoptera
	Cotton semilooper	*Anomis flava*	Noctuidae:	Lepidoptera
	Flea beetle	*Podagrica* sp.	Chrysomelidae	Coleoptera
	Grey weevil	*Myllocerus discolor*	Curculionidae	Coleoptera
	Aphids	*Aphis gossypii*	Aphididae	Hemiptera
	Mite	*Tetranychus urticae*	Tetranychidae:	
	Blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera
	Fruit borer	*Earias vittella*	Noctuidae	Lepidoptera
	Red cotton bug	*Dysdercus koenigii*	Pyrrhocoridae	Hemiptera

TNAU, Coimbatore

Plant/crop	Local name	Scientific name	Family	Order
Solanum nigrum	Fruit borer	*Leucinodes orbonalis*		Lepidoptera
	Blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera
	Stink bug	*Nezara viridula*	Pentatomidae	Hemiptera
	Red cotton bug	*Dysdercus cingulatus*	Pyrocoriedae	Hemiptera
	Red pumpkin beetle	*Aulacophora foveicollis*	Chrysomelidae	Coleoptera
Plumbago zeylanica	Inflorescence caterpillar	*Helicoverpa armigera*	Noctuidae	Lepidoptera
	Blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera
Catharanthus roseus	Blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera
	Stink bug	*Nezara viridula*	Pentatomidae	Hemiptera
Cassia angustifolia	Pod bug	*Clavigralla gibbosa*	Coriedae	Hemiptera
	Ash weevil	*Myllocerus viridanus*	Cruculionidae	Coleoptera
Psoralea corylifolia	Spiralling white fly	*Aleurodicus dispersus*	Aleyroridae	Hemiptera
	Cow bug	*Oxyrachis tarandus*	Memberacidae	Hemiptera
Asparagus racemosus	Beetle	*Lema downesi*	Chrysomelidae	Coleoptera
Solanum trilobatum	Spiralling white fly	*Aleurodicus dispersus*	Aleyroridae	Hemiptera
	Cow bug	*Oxyrachis tarandus*	Memberacidae	Hemiptera
Datura metel	Red cotton bug	*Dysdercus cingulatus*	Coriedae	Hemiptera
	Spiralling white fly	*Aleurodicus dispersus*	Aleyroridae	Hemiptera
	Cow bug	*Oxyrachis tarandus*	Memberacidae	Hemiptera
Cassia auriculata	White butterfly	*Catopsilia pyranthae*	Pieridae	Lepidoptera
	Blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera

Betelvine *(Piper betle)*

It is a perennial evergreen dioecious climber, belonging to family *Piperaceae*. It is a native of Central and Eastern Malaysia and 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 with high humidity. 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 the old traditions of India and it is considered as a holy plant. Fresh leaves are consumed along with betel nuts. It is also medicinal and is used 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. Recent studies also revealed that the leaf improves immune system and inhibits cancer growth.

Germplasm collection, characterization and documentation

IIHR, Bangalore: Four land races namely, Mysore Chiguru, Pavagada Local, Banaras 1 and 2 were added to the existing germplasm. A total of 106 germplasm are being maintained including three Piper species. Ten new germplasm lines were multiplied and planted in the field.

Germplasm evaluation

IIHR, Bangalore: Eight high yielding clones along with local check (Hirehalli Local) were planted during October 2010 and observations on different growth and yield parameters were taken during the period under report. Length of the plagiotropic shoot was maximum in Karapaku (56.26 cm) followed by Godi Bangla (55.03 cm) and lowest in Sirugamani 1 (41.93 cm). The latter recorded maximum number of plagiotropic shoots (24 m^{-1}) followed by IIHR BV 67 (23.88 m^{-1}) and Mysore Local (22.13 m^{-1}). Higher leaf yield was in Mysore Local (17.56 lakh ha^{-1}) and the clones IIHR BV 67 and Sirugamani 1 were at par. Hirehalli Local recorded lowest leaf yield (8.79 lakhs ha^{-1}) and also the lowest number of plagiotropic shoots (8).

During 2012-13 flowering was recorded in 40 female clones and 12 male clones. So far flowering was not observed in Meetha Pan and Kakair.

Hybridization experiments

IIHR, Bangalore: The hybridization work was continued and crosses were made between the selected parents and four new crosses were attempted. Fourteen female clones, eight male clones and four hybrids were used in the crossing programme.

Twelve inter varietal crosses, six crosses between varieties and hybrids and two interhybrid crosses were carried out. Fruit setting was observed in all the crosses. Seeds of the different crosses were germinated and in some crosses seedlings were established in the polyhouse.

Interspecific hybridization between *P. betle* and *Phytophthora* resistant *P. colubrinum* was continued. In total eight betelvine clones were used as female parents. Few interspecific hybrid seedlings could be established in crosses involving Simurali Babna and Bangla Nagaram. These clones as female parents with *P. colubrinum* consistently showed similar results over two years. Though the germination per cent ranged from 65 to 88%, the number of seeds per fruit and the establishment of seedlings was very low resulting in very few interspecific hybrid seedlings. The new crosses attempted also did not show any fruit set.

The interspecific hybrids raised in previous year were multiplied through split bamboo technique. These seedlings showed prop root character which was observed in *P. colubrinum*. Some of the seedlings showed the leaf characters of *P. colubrinum* with the flavor of betelvine leaves confirming the hybridity.

Standardisation of raising *P. colubrinum* seedlings

The plants of *P. colubrinum* grown under open conditions showed profuse flowering and fruiting. The seeds were collected from the fruits and were germinated both in pots and petri-plates under laboratory conditions. The number of seeds per fruit ranged from 200 to 400. The germination per cent ranged from 81 to 92. The seedlings were uniform and showed very good vigour and growth. The seedlings raised were transferred to polybags and were maintained under shade net house. These seedlings are ready for planting or grafting after 3-4 months age. Large scale multiplication of *P. colubrinum* through seeds is viable and useful technology as this species is being exploited for grafting in black pepper to overcome pepper wilt caused by *Phytophthora*. Preliminary studies on grafting betelvine (cv. Meetha Pan) on *P. colubrinum* rootstock have shown encouraging results.

Seed germination and raising hybrid seedlings

Germination per cent varied widely from 11.88 to 74.33 among the crosses. Highest germination was recorded in cross Maghai/Swarna Kapoori (74.33%) followed by Simurali Babna/ Hy 06 -4 (71.58%). The crosses Sirugamani 1/Hy 07-13 and Hirehalli Local/ Swarna Kapoori recorded lower germination of 11.88 and 13.33, respectively. Hirehalli Local was morphologically similar to Sanchi types and hybrids with all Sanchi type clones as parent recorded nodular fruits and very low seed germination. In total more than 800 seedlings were raised from different crosses.

Evaluation of hybrids

IIHR, Bangalore: Flowering was recorded in four more hybrids during the year under report. Field planted hybrids *viz*., Hy 08-23, 08-20, and 08-43, produced female inflorescence where as 08-52 produced male inflorescence. Out of the male hybrids, Hy 06-4 has performed very well recording higher leaf yields both under field and shade net conditions. In the remaining male hybrids, HY 07-13, 07-34 and 08-52 showed better vigor and leaf yield. Majority of the female hybrids recorded good vigor and leaf traits.

Eight hybrids and four parental lines were planted under areca nut garden and were evaluated for different growth and leaf traits. Vine length varied from 167.88 to 276.7 cm. Number of plagiotropic shoots was higher in Swarna Kapoori followed by Vasani Kapoori i.e., 31.63, 25.25, respectively. Maximum plagiotropic shoot length was in HY06-4 (45.88). Among the hybrids plagiotropic leaf length varied from 10.66 to 13.63 cm and leaf breadth varied from 5.66 to 9.11 cm. Hy 06-4 recorded higher leaf yield (195.48 leaves vine-1)

followed by Hy 06-1 (153.07 leaves vine-1). Hy 06-04 showed superior performance and had 39.63 per cent more leaf yield over the better parent (Sirugamani 1).

Another set of thirty hybrids which were planted in the field during the year 2010 and 2011 were also evaluated for their growth and vigor. Eleven hybrids with desirable plant vigor and leaf traits were identified. Maximum leaf yield was in Hy 07-24 (140.95 leaves vine-1) followed by Hy 07-37 (122.50 leaves vine-1).

Selected hybrids were also planted under shade net house (simulating bareja conditions) and evaluated for growth and yield. Data were taken after three years' growth. Length of vine varied from 109 to 194.08 cm and Hy 07-4 recorded maximum vine length. Maximum leaf length was in Hy 06-10 (13.40 cm) followed by Hy 06-4 (13.08cm). Hy 06-4 recorded maximum leaf width (10.92 cm) followed by Hy 06-1 (9.43 cm). Leaf yield among hybrids varied from 20.5 to 57.5 per vine. Higher leaf yield (per vine) was in Hy 08-45, Hy 07-4, Hy 08-59, Hy 07-9 and Hy 06-4 (57.5, 56.17, 54.25, 54, 50.75) and all of them were at par with each other.

In another trial thirty four hybrids planted under shade net house during 2011 were evaluated for growth and yield traits. The vine length varied from 94.5 to 221.25 cm in Hy 06-7 and Hy 07-32, respectively. Leaf length varied from 7.48 (Hy 06-7) to 16.78 cm (Hy 07-36). Leaf yield per vine varied from 11.50 to 89.00. Hy 07-32 recorded high leaf yield (89.00 leaf vine-1) followed by Hy 07-39, Hy 07-41 and Hy 07-35 with a yield of 53, 52.75, 50.68 leaf vine-1, respectively. Some of the hybrids *viz.*, Hy 07-35, 07-32, 07-36, 07-37 and 08-58 produced plagiotropic shoots under shade net conditions.

Selection of promising hybrids

IIHR, Bangalore: Based on two years evaluation, eleven promising hybrids were selected both under field and shade net conditions. Under field condition, Hy 06-4 produced maximum number of leaves (237.94 leaves vine-1) followed by Hy 06-1, Hy 07-24, Hy 08-52 and Hy 06-11. Under shade net condition, Hy 07-32 had maximum number of leaves (66.8 leaves vine-1) followed by Hy 07-4, Hy 07-35, Hy 07-41 and Hy 07-36. Plagiotropic shoot production was observed in all the selected hybrids under field conditions, whereas only eight hybrids produced plagiotropic shoots under shade net conditions.

Efficacy of bio-fertilizers on betelvine production

BAU, Islampur: Effect of application of seven levels of inorganic fertilizers, manures and bio-fertilizers (*Azotobactor* 5 and 10 kg ha-1; *Phosphobactor* 10 kg ha-1; *Azotobactor* 5 kg + *Phosphobactor* 5 kg ha-1; vermicompost 10 t ha-1; urea + oilcake; and control) were investigated for growth, yield and disease incidence (foot rot). Results revealed that application of vermicompost 10 t ha-1 recorded significantly higher crop growth parameters viz. number of branches per vine (21.00, 23.94 and 26.81), vine elongation per month (10.22, 10.97 and 12.17 cm) and marketable leaves (22.90, 24.17 and 26.34 lakh ha-1) as well as weight of 100 leaves (194.00, 204.20 and 207.26 g) during three consecutive years from 2010-11, 2011-12 to 2012-13, respectively. Per cent disease incidence were varied and reduced appreciably with all microbiological treatments in order of vermicompost < *Azatobactor* 10 kg ha-1 < *Phosphobactor* 10 kg ha-1 < *Azatobactor* 5 kg + *Phosphobactor* 5 kg ha-1< *Azatobactor* 5 kg ha-1 < urea + oil cake < control during all the years. However,

application of only inorganic nutrients (urea + oilcake) recorded more disease incidence.

Effect of plant population on yield and quality

BAU, Islampur: Three plant populations (1.50, 1.75 and 2.0 lakh plants ha^{-1}) were compared with the farmer practices (1.25 lakh vine cutting ha^{-1}) during three years (2010-13). Result showed that population density at 1.50 lakh plant ha^{-1} recorded higher number of branches per vine (13.80, 14.30 and 16.01), vine elongation per month (9.0, 10.0 and 11.1 cm) and weight of 100 leaves (195.0, 232.7 and 231.68 g) during 2010-11, 2011-12 and 2012-13, respectively. Marketable leaves per hectare with plant population of 1.75 and 2.0 lakh vine cutting ha^{-1} were higher with reduced leaf size which resulted in to reduced fresh weight. However, population at 1.5 lakh plant ha^{-1} recorded ideal number of marketable leaves, ideal leaf size and fresh weight which fetched higher market price. Population density at 1.5 lakh plant ha^{-1} also recorded significantly lower incidence of disease during all the three consecutive years.

Evaluation of hybrids in local agro climatic conditions

YSRHU, Venkataramannagudem: Four hybrids (Hy-06-1, Hy-06-4, Hy-06-11 and GN) were evaluated with local checks (Karapaku and Tellaku Ponnuru) for growth and yield. Hybrid 'Hy-06-4' performed well and also recorded significantly higher growth and yield parameter compared to other hybrids and local checks. However, these hybrids are to be evaluated for another two years to get the confirmed results and stable data.

Integrated Disease Management

BAU, Islampur: Results of the field experiment conducted for three consecutive years from 2010-2013 showed that field Sanitation + application of 1% Bordeaux mixture (BM) at pre-monsoon period + one month later application of biological agents (*Trichoderma viridi*) + application of 1% BM two months after first BM application resulted in lower incidence of foot rot disease (11.25, 10.00 and 10.62%) and significantly higher marketable leaves 28.57, 30.00 and 33.60 lakh per ha during 2010-11, 2011-12 and 2012-13.

Integrated Crop Management

RAU, Pusa: The integrated crop management (ICM) technology which include integrated nutrient management (INM practice of applying NPK at 200:100:100kg ha^{-1} in the form of organics) and integrated disease management (IDM practice of sanitation + soil drenching with Bordeaux mixture(1%) followed by Incorporation of mustard cake at 500kg ha^{-1} inoculated with *Trichoderma viride* (1kg *Trichoderma*/100kg oilcake) after 30days and again drenching with Bordeaux mixture(1%) 60 days after 1st drenching) of Betel vine cultivation developed by center was tested in 22 farmes, field at 5-different locations in 4- different districts-Samastipur, Vaishali, Darbhanga and Begusarai districts of Bihar. The crop performance under ICM/IDM practice was found superior at all locations with maximum marketable yield (32.5lakh leaves ha^{-1}) and quite less disease incidence in Darbhanga district. The Crop in ICM/IDM practice also recorded longer shelf life (15-16 days). The crop under ill managed condition (Farmers' practice) registered lower yield (maximum-20.5 lakh leaves ha^{-1}) with higher incidence of *Phytophthora* rot (up to 24.3%) and shorter shelf life (10-12 days).

Plant Genetic Resources

Germplasm of medicinal and aromatic plants maintained at DMAPR

Sl. No.	Species	No. of Acessions
1	*Aloe spp.*	55
2	*Andrographis paniculata*	60
3	*Asparagus spp.*	88
4	*Cassia angustifolia*	120
5	*Chlorophytum borivilianum*	54
6	*Commiphora wightii*	175
7	*Cymbopogon martinii*	07
8	*Desmodium gangeticum*	52
9	*Gymnema sylvestre*	43
10	*Plantago ovata*	85
11	*Tinospora cordifolia*	52
12	*Urgenia spp*	12
13	*Withania somnifera*	142
	Total	945

Germplasm of medicinal and aromatic plants maintained at AICRP centres

Sl. No.	Crop	Centre	Accessions
1	*Aloe* spp.	AAU, Anand CCSHAU, Hisar IGKV, Raipur IIHR, Bangalore NDUAT, Faizabad PDKA, Akola RVSKVV, Mandsaur	30 42 07 42 20 18 10
2	*Aconitum heterophyllum*	YSPUHF, Solan	20
3	*Acorus calamus*	YSRHU, Venkataramanagudem	11
4	*Andrographis paniculata*	AAU, Anand CCSHAU, Hisar NDUAT, Faizabad OUAT, Bhubaneshwar	20 13 20 24
5	*Asparagus spp.*	AAU, Anand BAU, Ranchi CCSHAU, Hisar JNKVV, Jabalpur NDUAT,Faizabad	06 08 24 14 24
6	*Bacopa monnieri*	KAU, Trichur RAU, Pusa	43 12

Sl. No.	Crop	Centre	Accessions
7	*Cassia angustifolia*	AAU, Anand	17
8	*Chlorophytum borivilianum*	AAU, Anand CCSHAU, Hisar MPUAT, Udaipur RVSKVV, Mandsaur PDKV, Akola	20 12 10 24 13
9	*Commiphora wightii*	AAU, Anand MPUAT, Udaipur	33 16
10	*Cymbopogon martinii*	CCSHAU, Hisar	65
11	*Cymbopogon spp.*	CCSHAU, Hisar KAU, Trichur NDUAT, Faizabad	46 20 16
12	*Gymnema sylvestre*	CCSHAU, Hisar JNKVV, Jabalpur	08 07
13	*Indigofera tintctorea*	KAU, Trichur	22
14	*Lepidium sativum*	CCSHAU, Hisar MPUAT, Udaipur RVSKVV, Mandsaur YSPUHF, Solan	28 20 24 06
15	*Centella asiatica*	AAU, Jorhat BCKV, Kalyani RAU, Pusa	20 06 11
16	*Mucuna spp.*	AAU, Anand BAU, Ranchi IIHR, Bangalore	20 10 102
17	*Nelumbo nucifera*	KAU, Trichur	24
18	*Ocimum basilicum*	RVSKVV, Mandsaur	21
19	*Ocimum sanctum*	AAU, Anand CCSHAU, Hisar	17 12
20	*Papaver somniferum*	NDUAT, Faizabad MPUAT, Udaipur RVSKVV, Mandsaur	36 85 235
21	*Picrorhiza kurroa*	YSPUHF, Solan	20
22	*Piper longum*	AAU, Jorhat KAU, Trichur OUAT, Bhubneshwar	35 25 16
23	*Podophyllum hexandrum*	YSPUHF, Solan	12
24	*Plantago ovata*	AAU, Anand CCSHAU, Hisar MPUAT, Udaipur NDUAT, Faizabad RVSKVV, Mandsaur	55 83 32 42 80
25	*Plumbago rosea*	KAU, Trichur	25
26	*Plumbago zeylanica*	TNAU, Coimbatore	45
27	*Rauvolfia serpentina*	OUAT, Bhubaneshwar	29
28	*Saraca asoca*	KAU, Trichur	42
29	*Silybum marianum*	AAU, Anand	10

Sl. No.	Crop	Centre	Accessions
30	*Solanum nigrum*	TNAU, Coimbatore YSRHU, Venkataramanagudem	52 34
31	*Tinospora cordifolia*	AAU, Anand YSRHU, Venkataramanagudem CCSHAU, Hisar	06 13 20
32	*Withania somnifera*	AAU, Anand CCSHAU, Hisar IIHR, Bangalore IGKV, Raipur MPUAT, Udaipur NDUAT, Faizabad PDKV, Akola RVSKVV, Mandsaur YSPUHF, Solan	40 58 186 22 76 07 08 119 07
33	*Vetiveria zizaniodes*	CCSHAU, Hisar KAU, Trichur NDUAT, Faizabad	50 37 12

Germplasm of betelvine maintained at AICRP centres

Centres	Total collection	Catalouged
BCKV, Kalyani	42	42
IIHR, Bangalore	103	103
MPKV, Rahuri	28	28
OUAT,Bhubneshwar	21	21
RAU,Pusa	10	10
BAU,Islampur	10	10
YSRHU, Venkataramanagudem	64	64

Intellectual Property Rights

DMAPR Anand:- Six elite germplasm i.e one each in Madhunashini (*Gymnema sylvestre*)-DGS-22,Kalmegh (*Andrographis paniculata*) DMAPR AP3, Aloe (*Aloe barbadensis*) DMAPR AB1, Ashwagandha (*Withania somnifera*) DWS-6 and two in Guggal (*Commiphora wightii*) NRC CW2 & NRC CW1 were identified and registered with NBPGR,New Delhi during the year. The details are as follows.

DGS-22 (INGR 13041): A high fruit producing plant type of Madhunashini

DMAPR AP3 (INGR-13042): Narrow leaf type with high andrographoloide content of Kalmegh

DMAPR AB1 (INGR-13043): A yellow flowered plant type with 22.23% Aloin A content of Aloe

NRC CW2 (INGR-13044): A male plant of erect or divergent branches with 0.125% guggulosterone Z content of Guggal

NRC CW1 (INGR-13045): A female plant of drooping or weeping branches with 0.176% guggulosterone Z content of Guggal

DWS-6 (INGR-13047): A procumbent plant type of Ashwagandha

Agricultural Knowledge Management Unit (AKMU)

Institute website

The institute website (www.dmapr.org.in) has been redesigned and face lifted with newest scripting, coding, flash animation, graphics, compatible CSS for most browsers etc., and redesigned in a very professional appearance. It has been updated on daily basis.

Intranet website

The Directorate intranet website has been created to share out information to employees. It has been maintained and published the information such as office circulars, applications forms, documents and other information related to this office. It has been updated on daily basis.

Strengthening of Herbal Gardens Network

Attempts are continuing for strengthening of herbal gardens network at www.herbalgardenindia.org under the project "Strengthening, Up-gradation and Maintenance of web based Herbal Gardens Network for quality planting material supply in India". A number of 20 herbal gardens were registered newly under this network during this period. Also about 50 species images were appended to this existing database. The information related to herbal gardens, availability of species in each garden has been updated. The species information based on plant habits viz., herb, shrub, tree and climber have been collected, compiled and updated in the database.

Databases

Attempts are also continued for updating the software applications such as Digital Herbarium of Medicinal & Aromatic Plants in India (www.dmapr.org.in:8080/dhmap/Home.jsp), Open Access Journal of Medicinal & Aromatic Plants (www.oajmap.in) and Digital Photo Library of Medicinal and Aromatic Plants *etc*,.

General Information

Committee meetings

Research Advisory Committee (RAC)

Tenth RAC meeting was held on April 24, 2012 at DMAPR under the chairmanship of Dr. B. R. Tyagi, Ex Deputy Director, CIMAP, Lucknow. Other members present in the meeting were Dr. Y.B. Tripathi, Head, Department of Medicinal Chemistry, Institute of Medical Sciences, BHU, Varanasi, Shri Rajneesh Awasthi, C.E.O., Agricons Agropreneurs Limited, Raipur, Dr. Satyabrata Maiti , Director, DMAPR, Anand and Dr. Manish Das, Senior Scientist (Plant Physiology) and Member Secretary, RAC. The meeting started with the presentation of flower bouquet to the Chairman and the members of RAC by Dr. Maiti followed by the welcome note proposed by Dr. Das. The Chairman initiated the proceedings of the meeting and the action taken report on the recommendations made during the last meeting was presented by the member secretary. The Chairman suggested to prioritize the plants for the development of standard operating protocols (SOP), for accreditation of laboratory. He also emphasised that ISSR markers should be given priority over RAPD markers in identification of important traits in medicinal and aromatic plants (MAP). An overview of activities during the last year at the directorate was presented by Dr. Maiti. Thereafter, presentation of research achievements during the year 2011-12 were presented by Dr. P. Manivel, Principal Scientist (Plant Breeding) and Dr. Vipin Chaudhary, Sr. Scientist (Entomology). Thorough discussions were made on the presentations. The meeting ended with the vote of thanks proposed by Dr. P. Manivel.

Eleventh RAC meeting was held on January 24, 2012 at DMAPR under the chairmanship of Dr. B. R. Tyagi, Ex Deputy Director, CIMAP, Lucknow. Other members present in the meeting were Dr. Umesh Srivastava, ADG (Hort. II), ICAR, New Delhi, Dr. Y.B. Tripathi, Head, Department of Medicinal Chemistry, Institute of Medical Sciences, BHU, Varanasi, Dr. R.C. Srivastava, Jt. Director, BSI, Kolkata, Dr. Satyabrata Maiti , Director, DMAPR, Anand and Dr. Geetha, K.A., Senior Scientist (Plant Breeding) and Member Secretary, RAC. The proceedings of the meeting started with the welcome address by Dr. Geetha and presentation of flower bouquet to the Chairman and the members of RAC by Dr. Maiti. The proceedings of the meeting was initiated by the introductory remarks of the Chairman, RAC followed by remarks of the members of the RAC. Dr. Maiti presented a brief description about the mandate, thrust areas of research and significant achievements made by the directorate since its establishment. He also sought the recommendations of RAC for incorporation of more crops for continuous work on development of Good Agricultural Practices (GAP) for individual crops. This was followed by appraisal of the house about the action taken on recommendations made in Tenth RAC meeting. The Chairman emphasised that identification of molecular markers, particularly ISSR markers for important traits in medicinal and aromatic plants (MAP) should continue for their use in marker assisted breeding programme. Core collection also need to be identified in germplasm collection of the targeted MAP species. The Chairman also expressed that germplasm enhancement be carried out through pre-breeding. Thereafter, presentation of research achievements during last year were presented

by Dr. P. Manivel, Principal Scientist (Plant Breeding), Dr. Satyanshu Kumar Principal Scientist (Organic Chemistry) and Dr. Vipin Chaudhary, Sr. Scientist (Entomology). Thorough discussions were made on the presentations of different research projects and qualitative improvement in the research work was suggested. The meeting ended with the vote of thanks proposed by Dr. P. Manivel.

Institute Research Committee (IRC)

The 21st Institute Research Committee meeting was held under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR during April 25-26, 2012. Dr. B.R. Tyagi, Ex. Deputy Director, CIMAP, Lucknow and Chairman, RAC, DMAPR was also present as a special invitee on the first day of the meeting to discuss the new research projects proposals submitted by the newly joined scientists of the directorate . Dr. P. Manivel, Principal Scientist (Plant Breeding) and Secretary, IRC, welcomed, Dr. Tyagi and Dr. Maiti along with the members of IRC. Dr. Maiti, also welcomed, Dr. B. R. Tyagi for this meeting. Thereafter, the action taken report of the last IRC recommendations was presented by the Member Secretary. New research project proposals were presented by Dr. Ruchi Bansal, Scientist (Plant physiology) and Dr. Vanita N.Salunkhe., Scientist (Plant Pathology) . New project proposal "Data Management of Medicinal and Aromatic Plants by IT applications" by Dr. N.S. Rao, Sr. Scientist (Computer Applications) and "Development of good agricultural practices for Mandukaparni (*Centalla asiatica* L.)" by Dr. Ram Swaroop Jat, Sr. Scientist (Agronomy) were also discussed. After thorough discussion on new project proposals, the research achievements of the last year and target for the next year for the ongoing projects in plant breeding, crop production, crop physiology, crop protection, quality management and information technology were presented by the scientists. Modifications in new projects and improvement in ongoing projects were suggested. The meeting ended with the vote of thanks proposed by the Member Secretary, IRC.

The 22nd IRC meeting was held on January 5, 2013 under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR to review the work done during last six months. He also informed about the implementation of RPF-IV by the Council. The work done reports were presented by the individual scientists on which further modification and improvement were suggested by the house. The meeting came to an end with vote of thanks.

Institute Management Committee (IMC)

24th and 25th IMC meetings were held on July 7 and September 15, 2012, respectively under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. Various developmental issues and activities were discussed in the meeting. In the 25th meeting salient recommendations of the QRT were presented by the QRT Chairman which were further discussed.

QRT meeting

QRT team under the Chairmanship of Padamashree Prof. P. Pushpangadan with members including Dr. C. K. Katiyar, Dr. Bhag Mal, Dr. S. Edison, Prof. S.R. Yadav and Dr. S.K. Pareek visited DMAPR during September 14- 15, 2012 and prepared a draft recommendations which was presented in the 25th IMC meeting held on September 15, 2012.

Extension Activities

Trainers' training on Good Agricultural and Collection Practices (GACP) for Medicinal and Aromatic Plants

Two trainers' training on "Good Agricultural and Collection Practices (GACP) for Medicinal and Aromatic Plants" sponsored by National Medicinal Plant Board (NMPB), New Delhi was organised at the directorate during September 25-29, 2012 and March 4-8, 2013. The themes of this training programme were capacity building and dissemination of the key principles of GACP for medicinal and aromatic plants. Forty participants from NMPB, SAUs, DBT institute and nongovernmental organization attended the two training programmes. In the training programme different aspects such as identification, collection, cultivation, pest and diseases management, post harvest management and value addition were covered. Other relevant aspects on protection of plant varieties, breeders and farmers' right, DUS testing, quality control, certification, marketing and supply chain and biodiversity management were also covered. A video film was shown to the participants on GACP of MAP compiled by NMPB and DMAPR. The participants were also educated through field visit of herbal garden and field gene bank of the directorate was organized. In the valedictory function, Dr. Satyabrata Maiti, Director, DMAPR appreciated the participants for their keen interest on the subject and their involvement during the entire training programme.

Training cum awareness programme on Protection of Plant Varieties and Farmers Right

A training –cum –awareness programme on Protection of Plant Varieties and Farmers Right Act supported by Protection of Plant Varieties and Farmers' Right Authority (PPV&FRA),New Delhi was organised at the Directorate on February 18, 2013. One hundred farmers from the neighbouring districts of Kheda and Panchmahal participated in the training programme. In the training programme, the genesis of PPVFRA, its different acts and importance in the Indian context were explained in the details. Details of the initiatives of the Government of India with reference to legislation for providing an effective system for protection of plant varieties, farmers and breeders's right and encouragement for the development of new varieties of plants were also discussed to the participants. A visit was also organized to DUS testing fields, herbal garden and field gene bank.

Training on production of aromatic crops

One day training on "Production of Aromatic Crops" supported by the Directorate of Arecanut

and Spices was organised on February 19, 2013 at the Directorate. Fifty farmers nearby villages of Anand district attended the training. Training on hands on planting techniques, visit to field and nursery were arranged.

Extension activities for dissemination of technologies and success stories under NAIP Sub-Project - Mobilizing Mass Media Support for Sharing Agro-Information

Communication and awareness at the grass root level and among stakeholders are crucial for awakening and increasing receptivity of farming community to research. A total of 15 web news/success stories were flashed in ICAR (7) and DMAPR (8) websites on ICAR technologies and events from five ICAR institutes located in west zone. A total of 144 news clippings were published in English, Gujarati and Hindi newspapers on ICAR technologies and events thus, increasing the visibility of ICAR as whole and institutes in particular. Four programmes were broadcasted through All India Radio, Vadodara on ICAR technologies. About 104 journalists (English/Gujarati/Hindi newspaper reporters, photographers, radio/TV channels) visited the ICAR institutes during the period and four media meets, one each at the Directorate of Medicinal and Aromatic Plants Research (DMAPR), Anand; Central Horticultural experiment station (CHES), Godhra; Directorate of Groundnut Research (DGR), Junagadh and Regional Research Centre of central Institute for Freshwater Aquaculture (RRC-CIFA), Anand were organized to strengthen the media relations.

Participation in exhibitions

The technology developed by the directorate and its outreach programme All India Co-ordinated Research Project on Medicinal and Aromatic Plants & Betelvine (AICRPMAP&B) were displayed in exhibitions organised by Gujarat Industry Meet of Agro Entrepreneurs of Western India on April 16, 2012 at Ahmedabad, Seminar cum Exhibition on Potential, Prospects and Possibilities of Horticulture Development in Haridwar District , May 12-13, 2012 at Roorkee, Uttrakhand and XI Agricultural Science Congress at OUAT, Bhubaneswar. Agro-techniques of different medicinal plants with special reference to mandate crops of the directorate were explained to the visitors through photographs, live material, semi processed material, literature etc.

Kisan mela

Under the aegis of NAIP Sub-project on Mobilizing Mass Media Support for Sharing Agro-information, a Kisan mela was organised on February16, 2013 at the Central Horticultural Experimental Station (CHES), Godhra under Central Institute for Arid Horticulture (CIAH), Bikaner. The main objective of Kisan Mela was to showcase agricultural technologies available with the ICAR institutes and state agricultural universities before farmers and entrepreneurs. Dr. N. K. Krishna Kumar, Deputy Director General (Horticulture), ICAR was the Chief Guest of the function and Dr. A.R. Pathak, Vice Chancellor, Navsari Agricultural University, Navsari chaired the function. Other dignitaries present in the function were Dr. Satyabrata Maiti, Director, DMAPR, Anand, Dr. S.K. Sharma, Director, CIAH, Bikaner, Dr. G.B. Raturi, Ex.

Director, CIAH, Bikaner and Dr. Sanjay Singh, Head, CHES. Technologies available with ICAR institutes located in Gujarat, SAUs and KVKs were displayed in the exhibition stalls. About seven hundred farmers and scientists were present. A scientist-farmer interaction session and field visits were also arranged.

Farmers, students and other stakeholder's visit

During the year more than one thousand and four hundred visitors including farmers, students and individuals visited the directorate. Farmers were mainly from four states namely Gujarat (454), Madhya Pradesh (19), Maharashtra (35) and Rajasthan (173). Students (452) were mainly from *Ayurvedic* and Pharmacy colleges. Individuals (284) interested in growing medicinal plants also visited the Directorate to know about agro-technology of different MAP, their utilizations and availability/purchase of propagation material. Visitors were briefed about the uses, agro-techniques of different medicinal plants with special reference to mandated crops of the Directorate. Also supply of quality planting material was ensured to the visitors as per their requirements.

Visit of the Director, DMAPR to Nepal

Dr. Satyabrata Maiti, Director DMAPR was invited as a speaker in a three day Natural Product Conference on "Natural Products for Better Health, Beauty and Wealth" jointly organised by Indian Embassay, B.P. Koirala–Nepal Foundation and Ministry of Science and Technology, Government of Nepal during April 18-20, 2012. Dr. Maiti delivered a lecture on advances in medicinal plant research in India in technical session "Policy and Planning" and also Chaired as moderator in the technical session on "Stakeholders".

Resource generation

Through sale of farm produce a revenue of Rs. 8.4 lakh was generated which also included Rs. 3.5 lakh generated through sale of seeds and planting material under Revolving Fund Scheme (RFS) .

Other Activities

Inauguration of guest house

Dr. S. Ayyappan, Secretary, DARE & DG, ICAR, New Delhi formally inaugurated the guest house facility of the Directorate on June 02, 2012 in presence of a galaxy of dignitaries. A function was organised wherein , Dr. Satyabrata Maiti, Director, DMAPR welcomed the Chief Guest and other dignitaries. He also presented a brief report on growth and development of the Directorate. While addressing the function, Dr. Ayyappan, emphasised the need and importance of the research on high value medicinal plants as a functional foods for ensuring the health security of the nation. He called upon the scientists to work in the area of secondary and specialty agriculture. He applauded the Directorate's efforts of sustainable production

technologies development for major medicinal plants for meeting the increasing demands of industry. Honourable Dr. Ayyappan also congratulated the Directorate for adding a guest house facility for the growth and development of science. Prof. Harish Padh, Vice Chancellor, S.P. University, V.V. Nagar, Anand, Guest of the Honour, complemented the Directorate specifically for the research work done in the area of medicinal and aromatic plants for ensuring the supply of quality raw drugs and ICAR in general for research work in the area of agriculture for ensuring the food security of our country. Dr. A.M. Shekh, Vice Chancellor, Anand Agricultural University, Anand, in his presidential address, expressed his happiness over the infrastructure and instrumentation facility created for research at the directorate. The programme ended with the vote of thanks proposed by Dr. Satyanshu Kumar, Principal Scientist and In Charge, PME Cell, DMAPR, Anand.

XXth Group meeting of the All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine

The 20th Group Meeting of the All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRPMAP&B) was organized at Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar during October 3-6, 2012. Dr. K. S. Khokhar, Vice Chancellor, CCS HAU, Hisar, presided over the inaugural function and Dr. Umesh Chandra Srivastava, Assistant Director General (Hort.-II) attended the function as ICAR representative. Other dignitaries present included Dr. Satyabrata Maiti, Director, Directorate of Medicinal and Aromatic Plants Research and Project Coordinator, AICRPMAP&B; Dr. Ramesh Kumar, Director, Directorate of Floriculture Research, New Delhi; Dr. Ram Singh, Dean, College of Agriculture, CCSHAU; Dr. H. P. Yadav, Professor & Head, Department of Genetics and Plant Breeding, CCSHAU and Dr. I.S. Yadav, Head, Department of Medicinal, Aromatic and Underutilized Plants, CCSHAU.

In the inaugural session Dr. Maiti, presented salient achievements by the coordinating centres during last year. Dr. Umesh Chandra Srivastava, ADG (Horti-II) described the growth of AICRPMAP&B and its centres since inception of the project during the Fourth Five Year Plan. Dr. K. S. Khokhar, Vice Chancellor, CCSHAU, Hisar, in his presidential address remarked medicinal and aromatic crops could fit in the diversification process of many important crops. He also mentioned that this type of coordinated research programme with more broad based research planning targeted for utilization of genetic biodiversity, improved varieties, production and protection technology and quality assessment is required.

The group meeting was divided into five technical sessions such as Action taken report, Crop Improvement, Crop Production, Crop Protection and Phytochemistry. Data of experimental trial conducted at the various coordinating centres during the year 2011- 12 were presented and technical programme for 2012-2013 was formulated. The plenary session was Chaired by Dr. N. K. Krishna Kumar, Deputy Director General (Horticulture), ICAR, New Delhi and Co-chaired by Dr. J. S. Dhankar, Director of Research, CCSHAU, Hisar. Dr. Krishna Kumar, in his introductory speech mentioned that India has a rich base of traditional and herbal medicines. He mentioned the need for collection and cryopreservation of pollens of

horticultural crops including MAP as *ex-situ* conservation measure. Dr. Dhankar, suggested that KVK scientists should also be involved in testing of technologies developed for the medicinal and aromatic plants. Finally, recommendations of each session and technical programme were presented in the plenary session. The programme ended with vote of thanks proposed by Dr. Satyabrata Maiti to ICAR, host university, participating centres and delegates.

Sports activities

Three members DMAPR team comprising of Dr. Smitha G.R., Dr. Vanita Salunkhe and Mrs. S.H. Nair participated in ICAR Inter-Zonal Sports Meet held at IARI, New Delhi during January 18-21, 2013. Dr. Smitha G.R. won two gold and one silver medals. Mrs. S.H. Nair also won shuttle badminton doubles with Dr. Smitha G.R. Also a nine member DMAPR sports team participated in the ICAR Zonal Sports Tournament for Western Zone 2013 held at NRCC, Bikaner during February 27 – 2nd March 02, 2013. Sh. Vijay Kumar, Administrative Officer was the *Chief de-misission* and team won 13 medals including Best Athlete – Women medal. Dr. Smitha G.R. won 9 medals including Best Athlete Trophy for Women and Mr. S. H. Nair won 4 medals.

Second National Conference on "Integration of Medicinal and Aromatic Plants for Rural Development and Prosperity"

A two-day national conference on "Integration of Medicinal and Aromatic Plants for Rural Development and Prosperity" was organized jointly by the Medicinal and Aromatic Plants Association of India (MAPAI), Directorate of Medicinal and Aromatic Plants Research and Anand Agricultural University, Anand during January 22-23, 2013 at Anand. There were five themes of the conference namely, biodiversity conservation, sustainable utilization and rural development , quality control (certification) and post harvest management, legal issues and policies and supply chain and marketing of medicinal and aromatic plants (MAPs).

Dr. R.R. Hanchinal, Vice Chancellor, UAS, Dharwad was the Chief Guest and Prof. Harish Padh, Vice Chancellor, Sardar Patel Univeristy, Anand was the Guest of Honour in the inaugural function, Dr. A.M. Shekh , Vice Chancellor, AAU, Anand presided over the function. Dr. Satyabrata Maiti, Director, DMAPR and President, MAPAI welcomed the participants and presented an overview of the conference.

Participants of the conference included academicians, researchers, entrepreneurs, policy makers from different parts of India and overseas. There were five technical sessions on thematic areas. Plenary session was chaired by Dr. C. Devakumar, ADG (EPD), ICAR, New Delhi. At the end, Dr. Smitha G.R., Scientist and Treasurer, MAPAI presented vote of thanks.

Official language implementation

To review the progress of use of Hindi in day to day work at the Directorate four quarterly meetings of official Language Implementation Committee were held. Also, efforts were made to popularize by translation, reply to the letters etc.

औषधीय एवं सगंधीय पादप अनुसंधान निदेशालय, बोरीआवी, आणंद में राजभाषा कार्यान्वयन समिति के तत्वाधन में १४ से २१ सितम्बर २०१२ तक हिन्दी सप्ताह हर्षोउल्लास से मनाया गया, जिसके अन्तर्गत हिन्दी के प्रयोग को बढ़ावा देने हेतु अनेक रूचिकर कार्यक्रमों जैसे निबंध, पत्रलेखन तथा सामान्य हिन्दी ज्ञान प्रतियोगितायें का आयोजन किया गया। २१ सितम्बर को निदेशालय के निदेशक डॉ० सत्यब्रत माईति की अध्यक्षता में समापन समारोह का आयोजन किया गया। समारोह के मुख्य अतिथि श्रीमान अशोक कुमार श्रीवास्तव, उपमंण्डल अभियंता मार्केटिंग, भारत संचार निगम लिमिटेड, आणंद व श्री आनन्द प्रकाश राय, वरिष्ठ अध्यापक, हिन्दी, केन्द्रीय विधालय, वल्लभ विद्यानगर, आणंद विशिष्ठ अतिथि थे। इस समारोह में अन्य कार्यक्रम के अतिरिक्त व्याख्यान व काव्यपाठ प्रतियोगिता का आयोजन किया गया, जिनका संचालन व मूल्यांकन मुख्य अतिथि महोदय व विशिष्ठ अतिथि महोदय ने संयुक्त रुप से किया। विभिन्न प्रतियोगितायों कें विजेता एवं उपविजेता को पुरस्कृत किया गया। कार्यक्रम का समापन डॉ० जी० आर० स्मिथा द्वारा ध न्यवाद प्रस्ताव ज्ञापित कर हुआ।

International women's day celebration

The DMAPR celebrated International Women's Day (IWD) on March, 8. The function was organized by Women's Cell, DMAPR. Dr. Amrapali Merchant, Retried Vice Chancellor, Dr. Babasaheb Ambedkar Open University, Gujarat was the Chief Guest in the function. The inmates of Old Age Home, Rama Krishna Sewa Mandal, Lambhvel were the special invitees in the function. A variety of entertainment programmes viz., Test your tongue, Pass the parcel, etc. were organized, where the senior citizens of Old Age Home, Rama Krishna Seva Mandal and women members of the staff, family and children of DMAPR participated enthusiastically. This year also, the staff members of the DMAPR contributed generously for donation to Old Age Home at Lambhvel.

The formal function was organized in the auditorium of the DMAPR in the afternoon under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. Dr. Geetha K.A., Chairperson, Women's Cell, DMAPR invited the guests. Dr. Amrapali Merchant the Chief Guest in her special lecture, reminded the audience about the empowerment of women for the well being of the society.

Dr. Smitha G.R., Scientist (Horticulture) and Mrs. Subhadra H. Nair (T3 Lab Assistant) were felicitated during the function for their outstanding performance in the ICAR Zonal Sports meet, 2013 by the chief guest. Dr. Satyabrata Maiti and Dr. Amrapali Merchant presented the prizes to the winners of various entertainment games. The

function ended with vote of thanks delivered by Dr. Smitha G.R., Scientist, DMAPR.

Vigilance awareness week

At the Directorate, Vigilance Awareness Week was observed during October 29 - November 03, 2012. A workshop on "Transparency in Public Procurement" was also organised on November 03, 2012. In the valedictory function Shri Vinod Chakravarty, Deputy Commissioner (IncomeTax), Anand, was Chief Guest and Dr. Satyabrata Maiti, Director, DMAPR presided over the function. In his speech, Shri Chakravarty suggested the need for application of information technology (IT) tools in order to bring transparency in public offices. Dr. Maiti also highlighted the utility of Right To Information (RTI) Act and its role in bringing transparency in public administration. At the end of the function, Mr. K. Raghunadhan, Assistant Administrative officer, DMAPR proposed the vote of thanks.

Foundation day celebrated

21st Foundation Day of Directorate was celebrated on November 24, 2012. A voluntary blood donation camp was organized on this occasion. Annual day function was presided by Dr. A.M. Shekh, Vice Chancellor, AAU, Anand. Dr. A.R. Pathak, Vice Chancellor, Navasari Agricultural University, Navasari was the Chief Guest and Dr. K.C. Dalal, Ex. Director DMAPR was the Special Guest in the function. After the annual day function, "Agriculture Education Day" was also celebrated at the Directorate and a special lecture on "Career Prospects in Agriculture" by Dr. A.J. Pandya, Director, Student Welfares, Anand Agriculture University was organized. Fifty four higher secondary students from Kendriya Vidyalaya, Vallabh Vidhyanagar and Anandalaya, Anand also participated in Agriculture Education Day.

Human Resource Development

Name	Subject	Date
Training		
Dr. B.B. Basak	ICAR sponsored summer school on resource conservation practices for soil health security at PDKV, Akola	September 3-23, 2012
Dr. V. S. Rana	4th refresher Course on Agricultural Research Management at NAARM, Hyderabad	January 7-19, 2013
Seminar/symposium/meeting		
Dr. R. S. Jat	Review meeting of the scheme "Spices and Aromatic Plants under Central Sector Scheme" at UAS, Bangalore	July 18-19, 2012
Drs. P. Manivel, Satyanshu Kumar, Vipin Chaudhary, R.S. Jat, N.S. Rao and Vanita Salunkhe	XXth Annual Group Meeting of AICRP on MAP&B at CCSHAU, Hisar	October 3-5, 2012
Dr. P. Manivel	National Seminar on Medicinal Plants: Status and Future at Shivaji University, Kolhapur	November 6-7, 2012
Drs. Satyanshu Kumar, V. S. Rana	Seventh international symposium on recent advances in natural products Amity University U.P, Noida	November 15 -17, 2012
Dr. R. S. Jat	Third international agronomy congress at New Delhi	November 26 -30, 2012
Dr. Vipin Chaudhary	Symposium on managing stress in dry lands under climate change scenarios at Jodhpur Project coordinators meeting for streamlining and consolidating the AICRPs and Network Project for XII Plan at New Delhi	December 1-2, 2012 December 5-6, 2012
Dr. Satyanshu Kumar	Sensitization meeting of Scientist In-Charges for all PME Cells of ICAR at Karnal	December 09, 2012
Mr. Vijay Kumar	Right to Information for PIOs at Institute of Secretariat Training and Management, New Delhi	December 17-18, 2012
Drs. Satyanshu Kumar	XI Agricultural Science Congress at OUAT, Bhubaneswar	February 7-9, 2013

Distinguished Visitors

- Dr. Bali Ram Tyagi, Chairman, RAC, DMAPR and former Deputy Director, CIMAP, Lucknow on April 24, 2012 and January 24, 2013.
- Prof. Y. B. Tripathi, Member, RAC, DMAPR , on April 24, 2012 and January 24, 2013.
- Shri Rajneesh Awasthi, Member, RAC, DMAPR , on April 24, 2012.
- Dr. S. Ayyappan, Secretary, DARE & DG, ICAR, New Delhi on June 2, 2012.
- Dr. A. M. Shekh, Vice Chancellor, AAU, Anand on June 2 and November 24, 2012.
- Prof. Harish Padh, Vice Chancellor, SPU, V. V. Nagar on June 2, 2012.
- Dr. K. C. Dalal, Formerly Director, NRCMAP, Boriavi on June 2, 2012.
- Dr. Jayashankar, Director, CIFA, Bhubaneswar on June 2, 2012.
- Dr. S.K. Garg, Superintendent Engineer, CPWD, Gandhinagar on June 2, 2012.
- Dr. D. J. Patel, Formerly Principal, BACA, AAU, Anand on June 2 and July 27, 2012.
- Dr. M. M. Roy, Director, CAZRI, Jodhpur on June 28, 2012.
- Dr. Srinivasan, Director, NRC on Plant Biotechnology, New Delhi on September 1, 2012.
- Padamashree Prof. P. Pushpangadan, DG, AIHBPD, Trivandrum on September 14, 2012.
- Dr. C.K. Katiyar, Vice President & Head, Health Care Research, Dabur India Ltd., New Delhi on September 14, 2012.
- Dr. Bhag Mal, Former Coordinator, Bio-Diversity International, New Delhi on September 14, 2012.
- Dr. S. Edison, Former Director, CTCRI, Trivandrum on September 14, 2012.
- Prof S.R. Yadav, Deptt. of Botany, Shivaji University Kohlapur on September 14, 2012.
- Dr. S.K. Pareek, Retd. Principal Scientist, NBPGR, New Delhi on September 14, 2012.
- Dr. Shyam Singh, Ex. Director, NRC on Citrus, Nagpur on September 22, 2012.
- Dr. R. N. Pal, Ex. DDG (Horticulture), ICAR, New Delhi on September 14, 2012.
- Dr. Ramana Rao, Ex. ADG (Horticulture II), ICAR, New Delhi on October 10, 2012.
- Dr. V. J. Shivankar, Director, NRC for Citrus, Nagpur on October 11, 2012.
- Dr. N. K. Krishna Kumar, DDG (Horticulture), ICAR, New Delhi on November 21, 2012.
- Dr. S. K. Sharma, Director, CIAH, Bikaner on November 22, 2012.
- Dr.A. R.Pathak, Vice Chancellor, NAU, Navasari on November 24, 2012.
- Dr.A.J.Pandya, Director Student Welfares, AAU, Anand on November 24, 2012.
- Dr. Rameshwar Singh, Project Director, DKMA, New Delhi on November 29, 2012.
- Mr. S. N. Tyagi, Ex. CEO, SMPB, Gandhinagar on December 11, 2012.
- Dr. K. S. Varaprasad, Director, DOR, Hyderabad on December 11, 2012.

- Dr. R. R. Hanchinal Vice Chancellor, UAS, Dharwad on January 22, 2013.
- Dr. R. C. Agrawal Registrar General PPV & FRA on January 22, 2013.
- Dr. S.J.H. Rizvi, Country Director, ICARDA, Afghanistan Programme on January 24, 2013.
- Dr. Umesh C. Srivastava, ADG (Hort. II), ICAR, New Delhi on January 24, 2013.
- Dr. G.S.R. Murti, Member, RAC, DMAPR on January 24, 2013.
- Dr. R.C. Srivastava, Jt. Director, BSI, Kolkata and Member, RAC, DMAPR ,January 24, 2013.
- Dr. P. S. Pandey, National Coordinator, NAIP, New Delhi on February 6, 2013.

Deputations/ meetings attended by the Director

- Attended conference on natural products 2012 at Kathmandu, Nepal during April, 18-20 , 2012.
- Attended 95th meeting of the expert committee on 'S&T for women at Indian National Science Academy (INSA), New Delhi on April 30, 2012.
- Attended the XII Plan meeting at NASC, New Delhi during May 5-7 , 2012.
- Attended a selection committee meeting at ASRB, New Delhi as DG's nominee on June 4, 2012.
- Attended the divisional meeting of horticulture at NASC, New Delhi on July 23.2012.
- Attended the 19th meeting of central sub-committee on crop standards, notification and release of varieties for horticultural crops at KAB II, New Delhi on July 24, 2012.
- Attended the selection committee meeting at ASRB, New Delhi on July 25, 2012.
- Attended the second meeting of reconstituted task force on 'biotechnology based programme for women' at DBT, New Delhi during July 25-26, 2012.
- Attended the knowledge meet under the Chairmanship of the Secretary (DARE) & DG, ICAR, at NASC Complex, New Delhi during August 21-22, 2012.
- Attended the horticulture divisional meeting under the Chairmanship of the DDG (Hort.) at NASC, New Delhi on August 23, 2012.
- Chaired first meeting of *Ayurveda* sectional committee, FAD 26 at Bureau Of Indian Standards, New Delhi on September 7, 2012.
- Attended the selection committee meeting at ASRB, New Delhi on September 27, 2012.
- Attended the ICAR regional committee meeting at CAZRI, Jodhpur during November 16-17, 2012.
- Attended the NMPB awareness programme organized by QCI at Tuticorin on November 20, 2012.
- Attended national research advisory committee (agriculture, veterinary, human health) as member at IIM Ahmedabad on January 3, 2013.

- Attended the RFD meeting under the chairmanship of the DDG (Hort.) at NASC, New Delhi on January 16, 2013.
- Attended XXVI meeting of plant germplasm registration committee at NBPGR, New Delhi on January 31, 2013.
- Attended a meeting of medicinal plants programme for the North East at the National Research Centre for Pigs, Rani, Guwahati on February 10, 2013.
- Attended meetings of the HODs and Directors at NASC, New Delhi on March12- 13, 2013.
- Attended the ICAR directors conference at NASC, New Delhi during March 19-20, 2013.

PUBLICATIONS

Research Papers

DMAPR, Anand

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Chaudhary, V. 2012. Occurrence of cotton mealybug *Phenacoccus solenopsis* Tinsley on medicinal and aromatic Plants in cotton agro-ecosystem of Gujarat, *Insect Environment* (in press).

Chaudhary, V. and Saravanan, L. 2013. Occurrence and biology of *Catopsilia pyranthe* Linn. on Indian senna (*Cassia angustifolia* Vehl) in Gujarat. *Journal of Experimental Zoology India*, **16**: 119-123.

Gajbhiye, N.A., Maksana, J. and Thorat, T. 2012. Simultaneous determination of marmin, skimmamine, umbelliferone, psoralene and imperatorin in the root bark of *Aegle marmelos* by high performance thin layer chromatography. *Journal of Planar Chromatography*, **25**: 306–313.

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YSRHU, Venkataramannagudem

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YSRHU, Venkataramannagudem

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PERSONNEL

DMAPR

Director

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

Scientific

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

Satyanshu Kumar, M.Sc. , Ph.D., Principal Scientist (Organic Chemistry)

Manish Das, M.Sc. ,Ph.D., Senior Scientist (Plant Physiology),upto May 31, 2012

K. A. Geetha, M.Sc. , Ph.D., Senior Scientist (Plant Breeding)

Vipin Chaudhary, M.Sc. , Ph.D., Senior Scientist (Entomology)

V. S. Rana, M.Sc. , D.Phil, Senior Scientist (Organic Chemistry)

N. A. Gajbhiye, M.Sc. ,Ph.D., Senior Scientist (Organic Chemistry)

N. Srinivasa Rao, MCA., Ph.D., Senior Scientist (Computer Application)

R. S. Jat, M.Sc. (Ag),Ph.D. ,Senior Scientist (Agronomy)

Vandana Tripathy, M.Sc. ,Ph.D., Senoir Scientist (Agricultural Chemicals) from July 20, 2013

Smitha G.R., M.Sc. (Ag) , Ph.D., Scientist (Horticulture)

Vinay Kumar, M.Sc. , Scientist (Biotechnology) (on study leave)

Biraj Bandhu Basak , M.Sc. , Ph.D., Scientist (Soil Science)

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R.P.Meena, M.Sc. (Ag), Scientist (Plant Pathology) (on study leave)

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Technical

P. U. Purohit, B.Sc., T-5 (Technical Officer)

A. P. Trivedi,M.Sc., Ph.D., T-5 (Technical Officer)

D. R. Chellani, T-4 (Senior Cartography Assistant) upto January 5, 2013

R. B. Koli, T-4 (Driver)

B. K. Mishra, T-3 (Laboratory Technician)

S. B. Prajapati, T-3 (Field Assistant)

S. R. Patel, T-3 (Field Assistant)

S. H. Nair, T-3 (Laboratory Assistant)

H. A. Khatri, T-3 (Driver)

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

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

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

Administrative

Vijay Kumar, Administrative Officer from June 12, 2012

Mangal Singh, Assistant Finance & Accounts Officer

Suresh Patelia, Private Secretary to the Director

Raghunadhan K., Assistant Administrative Officer

R. J. Vasava, Assistant

N. J. Ganatra, Assistant

S. U. Vyas, Sr.Clerk

V. P. Rohit, LDC

Raghuveer Prasad, LDC

Hayat Ashar Mohammad, LDC

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AAU, Jorhat

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Mrs. B. Tanuja Priya, Assistant Professor (Horticulture)

Mrs. P. Sunitha, Assistant Professor (Entomology)

BAU, Ranchi

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Dr. V. R. Singh, Assistant Professor (Horticulture)

BCKV, Kalyani

Associate Professor (Plant Pathology) -Vacant from 01.08.2011

Dr. B. K. Das, Associate Professor (Entomology)

Assistant Professor (Horticulture) – Vacant from 01.03.2012

CCSHAU, Hisar

Dr. O. P. Yadav, Associate Professor (Plant Breeding)

Dr. V. K. Madan, Associate Professor (Phytochemistry)

Assistant Professor (Agronomy.) Vacant

UUHF, Bharsar

Dr. R. S. Chauhan, Research Scientist (MAP)

Dr. A. Paliwal, Research Scientist (Plant Breeding)

Dr. S. S. Bisht, Research Scientist

IGKV, Raipur

Dr. Alice Tirkey, Scientist

Dr. Rama Mohan Savu, Scientist

IIHR, Bangalore

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Dr. Vijay Agrawal, Assistant Professor

KAU, Trichur

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MPKV, Rahuri

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Dr. A. Joshi, Associate Professor (Phytochemistry)

Dr. Pokhar Rawal, Assistant Professor (Plant Pathology)

Dr. N. S. Dodiya, Assistant Professor (Plant Breeding & Genetics)

NDUAT, Faizabad

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Dr. S.K. Pandey, Assistant Professor (Plant Pathology)

Assistant Professor (Horticulture) Vacant

OUAT, Bhubaneswar

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Assistant Professor (Plant Pathology) Vacant

PDKV, Akola

Associate Professor (Agronomy)-Vacant from 24.11.2011

Shri R. B. Sarode, Assistant Professor (Plant Breeding)

Sh. A.G. Deshmukh, Assistant Professor (Biotechnology)

BAU, Islampur

Dr. S.N. Das, Associate Professor (Agronomy)

Shri Prabhat Kumar, Assistant Professor (Plant Pathology)

RAU, Pusa

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Dr. A. K. Singh, Assistant Professor (Horticulture)

Shri Nagendra Kumar, Assistant Professor (Entomology)

RVSKVV, Mandsaur

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UBKV, Kalimpong

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Dr. Sibdas Baskey, Assistant Professor (Plant Pathology)

YSPUH&F, Solan

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Dr. (Mrs.) Meenu Sood, Assistant Professor (Plant Breeding)

Dr. Yashpal Sharma, Assistant Professor (Agronomy)

Assistant Professor (Phytochemistry)

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