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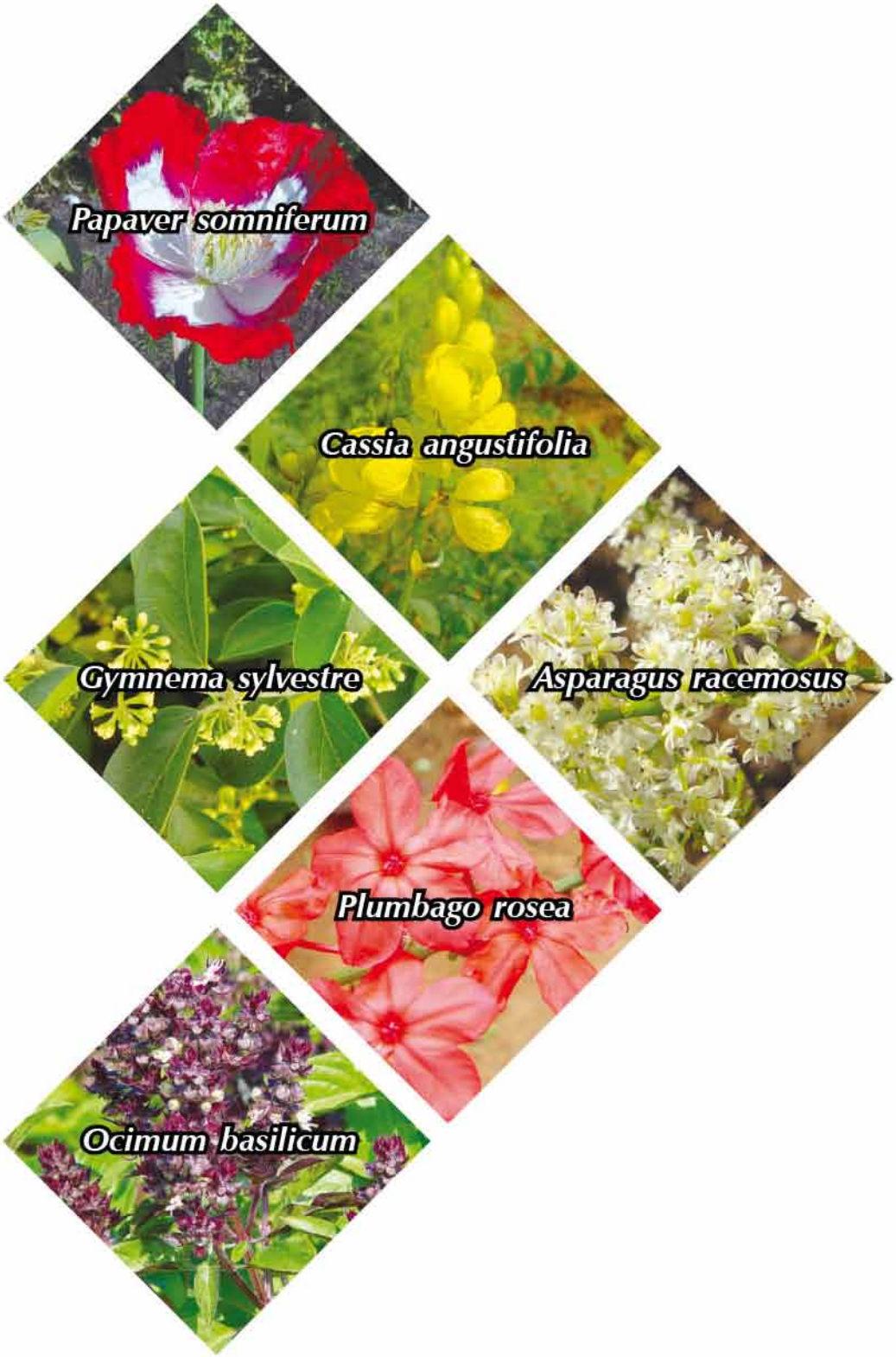
Annual Report 2013-14

भाकृअनुप
ICAR

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


Papaver somniferum
Cassia angustifolia
Gymnema sylvestre
Asparagus racemosus
Plumbago rosea
Ocimum basilicum

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Directorate of Medicinal and Aromatic Plants Research

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PREFACE

We have already entered into the 12th Five Year Plan with revised plan of work after reviewing the achievements, failures and experiences of the previous plan. The 11th Five Year Plan was the successful period for DMAPR. Some of the major achievements during the 11th Five Year Plan period included 1) Filing of two patents, 2) Release of the first variety of DMAPR (Vallabh Medha in *Centella asiatica*), 3) Registration of eight valuable genetic stocks at NBPGR, New Delhi; 4) Development of Good Agricultural Practices (GAP) for six MAP species, 5) Development of Standard Operating Protocol (SOP) for qualitative and quantitative up scaling of ten medicinal crops, 6) Formation of a professional society, the Medicinal and Aromatic Plants Association of India (MAPAI) and organization of three National Seminars, 7) Publication of an Open Access Journal of OAJMAP through MAPAI, 8) Extensive Human Resource Development (HRD) of scientists through training at international and national level, 9) Good number of publications in high ranking journals 10) Development of infrastructure facilities such as Super Critical Fluid Extraction (SFE) and many more.

Considering the above mentioned achievements and the future needs, I am confident that we shall accomplish much more in the 12th plan. DMAPR has already prepared a road map and is marching ahead to achieve its goals. The Quinquenial Review Team (QRT) reviewed the progress of the Directorate and gave the recommendations for its improvement. During this year the Directorate was gifted by the visits of many respectful personalities like the Hon'ble Shri Sharad Pawar, Union Minister of Agriculture and Food processing Industries; Shri Jayantbhai Ramanbhai Patel, MLA, Sarsa, Anand; Dr. S. Ayyappan, Secretary, DARE; Dr. N. K. Krishna Kumar, DDG (Hort.); Dr. K. L. Chadha, Formerly DDG (Hort.); Dr. R N. Pal, Formerly DDG (Hort.); Dr. C. Devakumar, Formerly ADG (EPD) and Dr. R. R. Hanchinal, Chairperson, PPVFRA, New Delhi. They all appreciated the progress of the Directorate and gave their advices for its future improvement. Considering all the facts, figures, advices, suggestions and criticism from all the sources, DMAPR is putting its strength into its two flagship programmes "Development of GAP and Development of SOPs". Besides, its mandate crops, DMAPR is also giving importance to strengthen the genetic resources of more MAPs and development of high yielding varieties of commercially important MAPs in the coming years.

To integrate MAP sector with other horticultural crops, the Directorate is initiating a collaborative research with its sister Institutes under Horticulture Division for effective utilization of land and getting more benefit to the horticulture farmers.

We have a long way to go! I am hopeful that DMAPR will coordinate with farmers, scientists, administrators, NGOs, pharmaceutical companies and other functionaries in the best possible way to uplift the MAP sector in our country.

I am extremely grateful to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR and Dr. N. K. Krishna Kumar, Deputy Director General (Horticulture Science) for their keen interest in the activities of the Directorate and I am thankful to Dr. S. K. Malhotra, Assistant Director General (Hort. II) and Mrs. Shashi Prabha Razdan, Director (Horticulture) for their personal care in dealing with the matters of our Directorate at the ICAR Headquater. I take pleasure to acknowledge the valuable contribution of all the scientists of DMAPR and twenty two centres of AICRP on MAP&B for providing inputs to this annual report. Timely support received from Dr. Satyanshu Kumar, Dr. K. A. Geetha, Dr. R. S. Jat, Dr. R. Nagaraja Reddy, Dr. Raghuraj Singh and Dr. Thania Sara Varghese in compilation and section editing of this volume is gratefully acknowledged. My thanks are due to Mr. Suresh Patelia, PS to the Director; Mr. Vijay Kumar, Administrative Officer; Mr. Mangal Singh, Assistant Finance & Accounts Officer; Mr. Raghunadhan K., Assistant Administrative Officer and all staff from administrative and finance section for their valuable help to bring this annual report printed. I place a special thanks to Dr. Satyanshu Kumar and Dr. Raghuraj Singh in getting this annual report printed within the deadline set by the Hon'able Director General, ICAR.

Jai Hind!

Anand **P. Manivel**

14.6.2014

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
cfu	Colony-forming units
CTAB	Hexadecyl trimethyl-ammonium bromide
DAP	Days after planting
DAS	Days after sowing
DST	Department of Science and Technology
DUS	Distinctiveness uniformity and stability
DMAPR	Directorate of Medicinal and Aromatic Plants Research
ETL	Economic Threshold Limit
FWB	Fresh Weight Basis
FYM	Farm Yard Manure
GAP	Good Agricultural Practices
GC-MS	Gas Chromatography and Mass Spectrometry
ha	Hectare
HPLC	High Performance Liquid Chromatography
HPTLC	High Performance Thin Layer Chromatography
IBA	Indole Butyric Acid
ICM	Integrated Crop Management
IDM	Integrated Disease Management
IGKV	Indira Gandhi Krishi Vishwavidyalaya
IIHR	Indian Institute of Horticultural Research
ISSR	Inter Simple Sequence Repeat
IW/CPE	Irrigation Water/Cumulative Pan Evaporation
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
KAU	Kerala Agricultural University
LC-MS/MS	Liquid Chromatography–Mass Spectrometry
LER	Land Equivalent Ratio
MAP	Medicinal and Aromatic Plants
MPKV	Mahatma Phule Krishi Vidyapeeth

N ha^{-1}	Nitrogen per hectare
NAIP	National Agricultural Innovation Project
NDUAT	Narendra Dev University of Agriculture and Technology
NET	National Eligibility Test
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
RDF	Recommended Dose of Fertilizer
RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
SSR	Simple Sequence Repeats
t	Tonne (1000 kg)
TLC	Thin Layer Chromatography
TNAU	Tamil Nadu Agricultural University
TSP	Tribal Sub Plan
UBKV	Uttar Banga Krishi Vishwa Vidyalaya
UUHF	Uttarakhand University of Horticulture and Forestry
VAM	Vesicular Arbuscular Mycorrhiza
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 2013-14 are presented below:

ALOE (*Aloe barbadensis*)

Nine genotypes were evaluated at PDKV, Akola and IC 112532 recorded significantly highest leaf weight (325.70 g plant^{-1}) and IC 285630 had significantly highest gel content (71.07%).

Planting at 60 x 60 cm spacing and application of vermicompost at 2.5 t ha^{-1} was found optimum for obtaining higher leaf yield and monetary returns at PDKV, Akola. Highest herbage yield was obtained by the application of vermicompost at 5 t ha^{-1} and planting on raised beds at IGKV, Raipur.

ARJUN (*Terminalia arjuna*)

Two hundred and nine plants were screened to identify superior plant types at PDKV, Akola and elite lines were selected based on better plant height, stem girth and bark thickness.

The antioxidant potential was assayed for bark samples from tree of three age groups at PDKV, Akola. A validated rapid HPLC-PDA method was developed for identification and quantification of five tannin related constituents gallic acid, corilagin, chebulagic acid, ellagic acid and chebulinic acid in the extracts prepared from the bark and fruits of four *Teminalia* species at DMAPR, Anand.

ASALIO (*Lepidium sativum*)

Seed standards were developed at DMAPR, Anand. Fifteen promising lines were evaluated at AAU, Anand and the highest seed yield was recorded in ALS 6 (1481.41 kg ha^{-1}). Out of eighten promising lines evaluated, Sel-10 gave the highest seed yield (1570.0 kg ha^{-1}) at CCSHAU, Hisar. Fifteen entries were evaluated and ULS-9 exhibited significantly higher seed yield (3148 kg ha^{-1}) at MPUAT, Udaipur. At YSPUHF, Solan, three promising lines were evaluated and none of the entries could out yield the check, however at CCSHAU, Hisar, seed yield was significantly higher in HLS-4 (1044.64 kg ha^{-1}). The entry MLS-1007 exhibited significantly higher seed yield (2465 kg ha^{-1}) at MPUAT, Udaipur.

Maximum seed yield, mucilage yield, net returns and B:C ratio were recorded for sowing at 30 x 10 cm spacing during 43rd meteorological week at MPUAT, Udaipur. Similarly, application of four irrigations at 25, 45, 65 and 85 DAS along with two sprays of brassinosteroids (0.6 ppm) at 50 and 70 DAS were recorded higher productivity and net returns.

Seed rate of 8 kg ha^{-1} and sowing by broadcasting method gave maximum seed yield at RVSKVV, Mandsaur. Similarly, application of nitrogen (100%) as inorganic fertilizer gave highest plant height, plant girth, number of branches and seed yield.

Spraying of propiconazole (0.2%) during the appearance of *Alternaria* leaf blight disease followed by same two sprays at 10 - 15 days interval recorded lower percent disease severity at NDAUT, Faizabad.

ASHWAGANDHA (*Withania somnifera*)

Fourty eight accessions alongwith two check varieties JA-134 and JA-20 were characterized using RAPD and ISSR markers at DMAPR, Anand.

The seventy four lines of annual types were evaluated at MPUAT, Udaipur and thirty lines showed higher dry root yield than the best check JA-20. The alkaloid content in the germplasm varied from 0.16 to 0.66%.

Out of sixty eight lines evaluated for thirteen characters at RVSKVV, Mandsaur, MWS-90-142 recorded the highest dry root yield (620 kg ha^{-1}).

Three promising lines were tested at AAU, Anand and AWS 1 outperformed over the three check varieties in terms of dry root yield.

Five promising entries of early maturing annual types were tested at MPUAT, Udaipur and UWS 10 outperformed over all the check varieties. In another trial, 11 promising annual types were tested and five lines had significantly higher dry root yield than the best check RAV-100 (1005 kg ha^{-1})

At DMAPR, Anand, seeds of 140 accessions were stored for 36 months at room temperature. It was found that seed viability ranged from 0 to 23%. Inheritance pattern of procumbent & erect growth habits and yellow *versus* red berry colour were worked out.

Lowest *Alternaria* leaf blight disease incidence was recorded in soil application of FYM @ 10 t ha^{-1} + *Trichoderma* sp. @ 10^6 – 10^9 cfu ml at JNKVV, Jabalpur. An integrated disease management module under organic farming was evaluated against root rot and foliar diseases at MPUAT, Udaipur. At RVSKVV, Mandsaur, seed treatment with carbendazim + mancozeb @ 2.5 g followed by soil drenching with carbendazim + mancozeb @ 0.2% recorded the lowest seedling mortality due to damping off disease.

ASOKA (*Saraca asoca*)

Tissue culture protocol for callus development was standardized at DMAPR, Anand. Frequency of callus induction was higher in young leaves and nodal explants as compared to the immature inflorescence.

BACH (*Acorus calamus*)

Twenty four accessions were evaluated and highest rhizome yield was obtained from APAc-5 at YSRHU, Venkataramannagudem.

BASIL (*Ocimum basilicum*)

Nine accessions were evaluated at AAU, Anand and Ob 3 was found superior and yielded 89.59 % higher green leaf yield than the local check Ob 1 and 95.21% higher green leaf yield than national check cv. Saumya.

BRAHMI (*Bacopa monnieri*)

Fourteen accessions were characterized at RAU, Pusa and highest dry herbage yield was observed in RAU BM-11 (44.25 q ha^{-1}).

CHIRAYITA (*Swertia chirayita)*

Application of VAM with PSB recorded significantly higher plant height, per plant fresh and dry weight of aerial and root biomass at UBKV, Klimpong.

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.

The coppicing of 15 MAP at a height of 30 cm gave the highest root yield at KAU, Thrissur however, plumbagin content was highest when coppiced at 9 MAP at 30 cm height.

COLEUS (*Coleus forskohlii*)

Sanitation and dipping stem cuttings in carbendazim (0.1%) followed by drenching with carbendazim (0.1%) at 30 DAP recorded the lowest root rot disease incidence 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 at AAU, Anand. Similarly, irrigation at 1.0 IW/CPE ratio produced significantly higher dry biomass yield.

GILOE (*Tinospora cordifolia*)

Dry stem yield was significantly higher in IC 310602 (125.51 q ha^{-1}) at DMAPR, Anand. HPTLC profile of stem methanolic extract of 34 accessions also showed that IC 310608 had maximum number of major bands (10).

GUDMAR (*Gymnema Sylvestre*)

Seven accessions were evaluated at JNKVV, Jabalpur for the selection of a superior cultivar and maximum dry leaf yield was recorded in JBPGS8-9-104.

Time for sprouting was minimum in treatment of cuttings with IBA (750 ppm) and planted in the month of July. Its maximum sprouting as well as maximum survivability was recorded with 500 ppm IBA treated cuttings and planted in August month at JNKVV, Jabalpur.

HIMALAYAN RHUBARB (*Rheum australe)*

At YSPUHF, Solan, application of NPK at 120:60:30 kg ha^{-1} recorded maximum plant height, root length, underground biomass, gross returns and B:C ratio at 12, 24 and 36 months after planting followed by vermicompost + *Azotobacter* + PSB (10 t:5 kg:5 kg ha^{-1}).

ISABGOL *(Plantago ovata)*

The method for induction of somatic embryogenesis was standardized at DMAPR. Among the 247 lines screened for Downy mildew resistance, three lines, DPO 144, DPO 145 and DPO 333-2 showed resistance.

Among 32 lines of genetic stocks were evaluated at MPUAT, Udaipur and 17 lines exhibited higher seed yield over the best check Niharika (1111 kg ha^{-1}).

Four entries *viz.,* DPO-1, DPO-4, Selection-10 and HI-2009 were evaluated against HI-5 and Niharika at CCSHAU, Hisar. The entry HI-2009 recorded significantly higher seed yield (1123.81 kg ha^{-1}). The entry DPO 4 produced significantly higher seed yield (1200 kg ha^{-1}) at MPUAT, Udaipur.

Five early maturing lines were evaluated at AAU, Anand along with check GI 2 and maximum seed yield was recorded for DPO-14 (1018.05 kg ha^{-1}). At DMAPR, Anand and CCSHAU, Hisar, DPO 174 had higher seed yield than the check variety. At MPUAT, Udaipur, DPO-385 exhibited significantly higher seed yield (695 kg ha^{-1}).

The genotypes, MIB-123, MIB-124, AMB-2, P-6, P-80 and DM-2 showed resistance against downy mildew and leaf blight at MPUAT, Udaipur.

JATAMANSI *(Valeriana jatamansi)*

Sowing/transplanting in June at a spacing of 30 x 45 cm recorded significantly higher fresh aerial, underground, rhizome and root biomass when this crop was raised either through seeds or rhizome cuttings at UBKV, Kalimpong,.

KALIHARI (*Gloriosa superba*)

At TNAU, Coimbatore, yield loss due to defoliators and the major sucking pests (*Thrips tabaci*) was found to be 26.17 and 10.98 percent, respectively.

Natural lactones (2ml l^{-1}) and azadirachtin (1%) were found effective against sucking pests and defoliators at TNAU, Coimbatore. Spraying of tebuconazole (0.1%) twice on 30 and 60 DAP recorded the lowest leaf blight intensity at TNAU, Coimbatore.

Soil application of *Trichoderma viride* (2.5 kg ha^{-1}) along with Mahua cake (150 kg ha^{-1}) + dipping the tubers in *P. fluorescens* (0.2%) followed by spraying (tebuconazole + trifloxystrobin) 0.2% twice at 30 and 60 DAP recorded the lowest root rot intensity at TNAU, Coimbatore.

KALMEGH (*Andrographis paniculata*)

Eleven accessions were evaluated at NDUAT, Faizabad and maximum dry herbage yield was obtained in IC 342135 (48.65 q ha^{-1}). In another trial, twenty accessions were evaluated and IC 265622 produced better dry herbage yield (64.06 q ha^{-1}).

DUS descriptors were confirmed at DMAPR, Anand for ten morphological characters and accordingly distinct lines were developed.

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 N (80 kg ha^{-1}) and plantation on 30th June recorded significantly higher dry herbage yield at RVSKVV, Mandsaur.

At DMAPR, Anand, application of castor cake (2.5 t ha^{-1}) and N80:P30:K50 (half N with full P and K as basal and remaining half N in three equal splits at 25, 40 and 60 DAS) recorded significantly higher dry herbage yield. Similarly, seed standards were developed.

The efficiency of supercritical fluid extraction (SFE) using carbon dioxide was compared with the solid–liquid extraction techniques such as solvent extraction, ultrasound assisted solvent extraction and microwave assisted solvent extraction with methanol, water and methanol–water as solvents.

A rapid and validated reverse-phase high-performance liquid chromatography-diode array detection method was also developed for the simultaneous determination of the three biologically active compounds, andrographolide, neoandrographolide, and andrograpanin, in the extracts.

LONG PEPPER (*Piper longum*)

At PDKV, Akola, application of NPK at 100:50:50 kg ha^{-1} along with FYM (20 t ha^{-1}) was found optimum to harvest good yield with higher net monetary returns and B:C ratio and sustained/improved soil fertility.

MAKOI (*Solanum nigrum*)

Fourty four accessions were evaluated at YSRHU, Venkataramannagudem for their morphological and agronomical traits. The significantly highest herbage was recorded in APSn-19.)

At TNAU, Coimbatore, evaluation of 52 accessions for herbage yield and quality traits resulted in the identification of two promising accessions *viz*., TNSn 19 and TNSn 10.

At YSRHU, Venkataramannagudem, application of vermicompost 6 t ha^{-1} along with azophosmet 2 kg + methylobacterium, broadcasting sowing and planting of 20 days old seedlings produced maximum herbage yield.

At TNAU, Coimbatore, application of vermicompost 6 t ha^{-1} along with azophosmet 2 kg ha^{-1} and foliar spray of methylobacterium 500 ml ha^{-1}, sowing at 20 x 10 cm spacing and harvesting at 30 days interval; sowing of 12.5 kg seeds through broadcasting recorded maximum growth parameters and herbage yield.

Yield loss due to the major insect pests was found to be 35.60%, whereas yield loss due to the major mite pest, *Polyphagotarsonemus latus* was 63.59% at TNAU, Coimbatore.

Foliar application of azadirachtin 1% or *Andrographis paniculata* leaf extract 2% was recommended for the management of pests of *S. nigrum* at TNAU, Coimbatore.

At TNAU, Coimbatore, golden yellow shaded sticky trap kept below the crop canopy, butter scotch yellow shaded trap kept below the crop canopy and golden yellow shaded trap placed above the crop canopy were effective in trapping thrips, aphids and whiteflies respectively.

Foliar application of spiromesifen 240 SC @ 500 ml/ha was found to be effective in reducing mite, *Polyphagotarsonemus latus* population at TNAU, Coimbatore.

MANDUKAPARNI (*Centella asiatica*)

Seven accessions were evaluated at UBKV, Kalimpong along with Vallabh Medha as check and the highest fresh herbage yield was observed in KCA 7 (192.5 q ha^{-1}).

Eleven accessions were evaluated at RAU, Pusa and the check Vallabh Medha was found superior performer in terms of dry herbage weight (36.75 q ha^{-1}) over them.

Application of FYM (15 t) along with N60:P50:K60 kg ha^{-1} as basal and 20 kg N ha^{-1} as top dressing at each harvest during first year and N60:K60 kg ha^{-1} as basal and 20 kg N ha^{-1} as top dressing at each harvest during second year recorded significantly higher herbage yield, net returns and B:C ratio at DMAPR, Anand. Similarly, first harvesting at 5 months after planting and subsequent harvesting at 3 months interval; and irrigation at 0.4 IW/CPE ratio recorded maximum dry herbage yield. Triterpenes content were also influenced with nutrient management, harvesting stages and irrigation.

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.

NEEL (*Indigofera tinctoria*)

At KAU, Thrissur, application of FYM 10 t and *Azospirillum* 2 kg ha^{-1} gave significantly higher herbage yield and B:C ratio and recorded higher indican content. Similarly, planting at 45

x 30 cm spacing and harvesting at 60 days interval and planting during September under shade (25%) recorded higher herbage yield, however, indican content was higher under open conditions.

OPIUM POPPY (*Papaver somniferum*)

Eighty five lines were evaluated at MPUAT, Udaipur and 46 lines of them exhibited higher dry latex yield over the best check, Chetak Aphim (31.83 kg ha^{-1}). In another trial, 13 entries were evaluated and two entries *viz.,* UOP-1185 and UOP-80 showed their significant superiority for latex yield over the best check (Chetak Aphim).

Spraying of Copper hydroxide + streptocycline (0.3%+140 ppm) at rosette stage recorded lowest stem rot intensity at RVSKVV, Mandsaur.

Two sprays of trifloxystrbin 25 + tebuconazole 50% (Nativo) @ of 300 g ha^{-1} or 400 g ha^{-1} at flowering and capsule maturity stage effectively reduced the powdery mildew incidence at RVSKVV, Mandsaur.

An integrated disease management strategy for root rot under organic farming was studied at MPUAT, Udaipur.

PALMAROSA (*Cymbopogon martinii*)

Two hundred selected plants of the variety RH 49 were bulked to develop composite seed propagated population and 49 clones were evaluated at CCSHAU, Hisar. C-42 yielded highest oil yield per plant (4.9 ml) against check Trishna (1.95 ml). C-3 and C-10 yielded 0.58% oil content against the check Trishna (0.30%).

SAFED MUSLI (*Chlorophytum borivilianum*)

Thirteen clones were evaluated at PDKV, Akola and two clones, AKSM -08 and AKSM- 07 recorded significantly higher root yield (44.05 and 40.86 q ha^{-1}) over the check MCB - 405 (37.22 q ha^{-1}).

At PDKV, Akola, intercropping of Safed musli + pigeon pea at 3:1 row proportion recorded remarkably maximum growth parameters, fresh and dry root yield, Safed musli equivalent yield, land equivalent ratio and gross monetary returns followed by the sole Safed musli. Seed standards were developed at DMAPR, Anand.

Seed treatment with carbendazim 1.5 g kg^{-1} + soil drenching with carbendazim (0.15%) recorded the minimum root rot incidence at RVSKVV Mandsaur.

An integrated disease management strategy for root rot under organic farming was studied at MPUAT, Udaipur.

SARPAGANDHA (*Rauvolfia serpentina)*

At IGKV, Raipur, Sarpagandha + urd intercropping recorded maximum sarpagandha equivalent yield and net returns followed by sarpagandha + kalmegh intercropping system

SATAVARY (*Asparagus racemosus)*

Twenty four accessions were evaluated and maximum dry roots were harvested from NDAS-24 (54.54 q ha^{-1}) at NDUAT, Faizabad.

At YSPUHF, Solan, application of FYM (5 t) + vermicompost (2 t) + PSB (10 kg ha^{-1}) recorded highest plant height, number of branches per plant, number of roots per plant, dry root weight per plant, fresh and dry root yield and gross returns at 12, 18 and 24 months after planting, however, B:C ratio was maximum at FYM 5 t + PSB 10 kg ha^{-1}.

Field experiments were conducted to estimate the ETL of red bug (*Brachytes bicolour*) and beetles (*Lema downesi*) at MPKV, Rahuri. An ETL of 30 red bug nymphs per plant was worked out and the ETL of beetles recorded in Satavari was 8 grubs per plant

SENNA (*Cassia angustifolia*)

One hundred sixty seven accessions were evaluated and characterised at DMAPR, Anand. Wide variations were noticed in various qualitative and quantitative characters. Ploidy manipulations for increasing herbage yield and leaf transcriptome analysis for studying the sennosides metabolism were also initiated. Seed standards were also developed.

Field experiments were carried out at DMAPR, Anand to find out the economic threshold level (ETL) of *C. pyranthe* larvae in Senna at 45 DAS) and at 75 DAS. At 45 DAS and 75 DAS the ETL was found to be 3.3 and 7.9 larvae per plant, respectively.

The efficiency in terms of extraction yield and composition of the extract for both the conventional (cold percolation at room temperature and refluxing) and non conventional extraction techniques (ultrasound assisted solvent extraction, microwave assisted solvent extraction and super critical fluid extraction) were compared.

A rapid and validated reverse phase high performance liquid chromatography-diode array detection method was also developed for the simultaneous determination of the two biologically active compounds sennoside A and sennoside B in the different extracts.

TULSI (*Ocimum sanctum*)

At NDUAT, Faizabad, application of NPK at 30:20:10 kg along with FYM (10 t ha^{-1}) recorded highest plant height, number of branches and fresh and dry herbage yield.

Application of vermicompost (2 t ha^{-1}) inoculated with mixture of PSB (5 kg) and *Azospirillum* (2 kg ha^{-1}) and planting on 1st July at 40 x 30 cm spacing recorded significantly higher herbage yield both on fresh and dry weight basis at RAU, Pusa.

At RJSKVV, Mandsaur, application of nitrogen (125 kg ha^{-1}) and sowing on 15th July recorded highest herbage and seed yield.

A yield loss of 28.35 % was recorded at RAU, Pusa due the damage of tingid bug in tulsi.

BETELVINE (*Piper betle*)

Eight high yielding clones of betelvine were evaluated at IIHR, Bangalore and higher leaf yield was recorded in IIHR BV 67 (115.7 lakh leaves ha^{-1})

The hybridization work was continued at the centre and fourteen female clones, five male clones and five hybrids (female and male each) were used in the crossing programme. Twelve inter-varietal crosses, six crosses between varieties and hybrids and two interhybrid crosses were carried out. Interspecific hybridization between *P. betle* and *Phytophthora* resistant P. *colubrinum* was also continued.

Highest hybrid seed germination was recorded in cross Khasipan/Hy 06-4 (79.56%).

Hybrid performance evaluation under field condition showed that Hy 06-4 and Hy 07-37 recorded higher leaf yield and under shade net condition, Hy 07-13 and Hy 08-58 performed superior.

At RAU, Islampur, soil application of 30 kg $ZnSO_4$ ha^{-1} recorded highest marketable leaves per vine, number of lateral branches per vine and length of vine, however, fresh weight of 100 leaves was maximum in control.

Soil drenching with Bordeaux mixture (1%) at 3 months interval followed by treatment of planting material (30 minutes before planting) with a combination of Bordeaux mixture (1%) + streptocycline sulphate (1000 ppm) significantly controlled fungal diseases like foot-rot (60%), leaf rot (55%), sclerotium wilt (20%) and bacterial disease - bacterial leaf spot (50%) as compared to control at Islampur.

The demonstration trials of the integrated disease management (IDM) technology conducted by MPKV Rahuri on farmers' fields of Maharashtra reported that the wilt incidence varied from 0.75 - 3.5% on plots that adopted the disease management technology, whereas the incidence was up to 11.13% in farmers' practice. The demonstration trials conducted by BCKV, Kalyani showed the maximum yield in IDM technology adopted field (46.12 lakh leaves ha^{-1} per year) where as in farmer's practice it was around 38.12 lakh leaves ha^{-1} per year

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 updated and maintained. Online Examination Facility was commissioned.

Intelactual Property Rights

One elite germplasm was identified and registered with NBPGR, New Delhi.

General Information

The DMAPR hold meetings of IRC and IMC to monitor the research and development activities. A training on promotion of medicinal plants cultivation in tribal areas in Gujarat for livelihood and health security was organised.

A Field Day was also organised under TSP. A three-day training programme on "Good Agricultural and Collection Practices of Medicinal and Aromatic Plants" was organized by the Directorate at the ICAR Research Complex for North-Eastern Hill (NEH) regions, Umiam, Meghalaya. One-day training-cum-awareness programme on "Protection of plant varieties and farmer rights act" was also organized at Anand.

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 technologies developed by the Directorate and AICRPMAP&B were displayed in exhibitions at Nagpur in Krishi Vasant-2014. Honourable Shri Sharad Pawar, Union Minister of Agriculture and Food Processing Industries, visited the Directorate. International Women's Day, Hindi Divas,Vigilance awareness week and Foundation day were also celebrated at the Directorate.

Introduction.....

Introduction

The Indian Council of Agricultural Research (ICAR) established a National Research Centre for Medicinal and Aromatic Plants at Anand, Gujarat in 1992 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 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.

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 equally important as drug discovery. Thus, quality raw drug supply sector demands research 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.

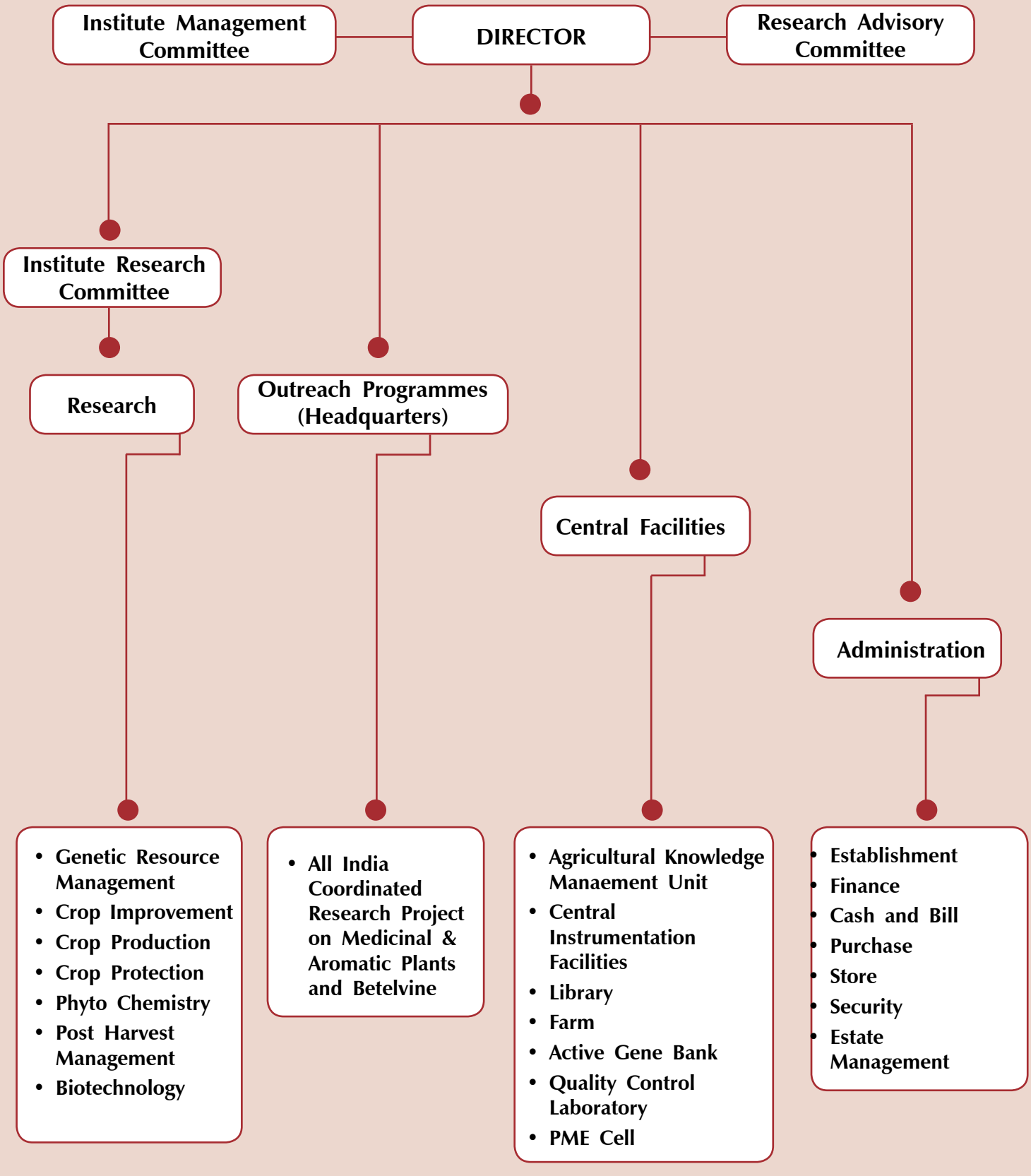
Mandate

- 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.)
- Giloe (*Tinospora cordifolia* (Willd.) Hook f. & Thoms.)
- Guggal (*Commiphora wightii* (Arn.) Bhandari)
- Isabgol (*Plantago ovata* Forsk.)

Organisational Structure



- Lemongrass (*Cymbopogon flexuosus* Nees ex. Steud Wats.)
- Palmarosa (Cymbopogon martinii Stapf. Var. motia)
- Safed musli (*Chlorophytum borivilianum* Santapau & Fernades)
- Senna (*Cassia angustifolia* Vahl.)

Objectives

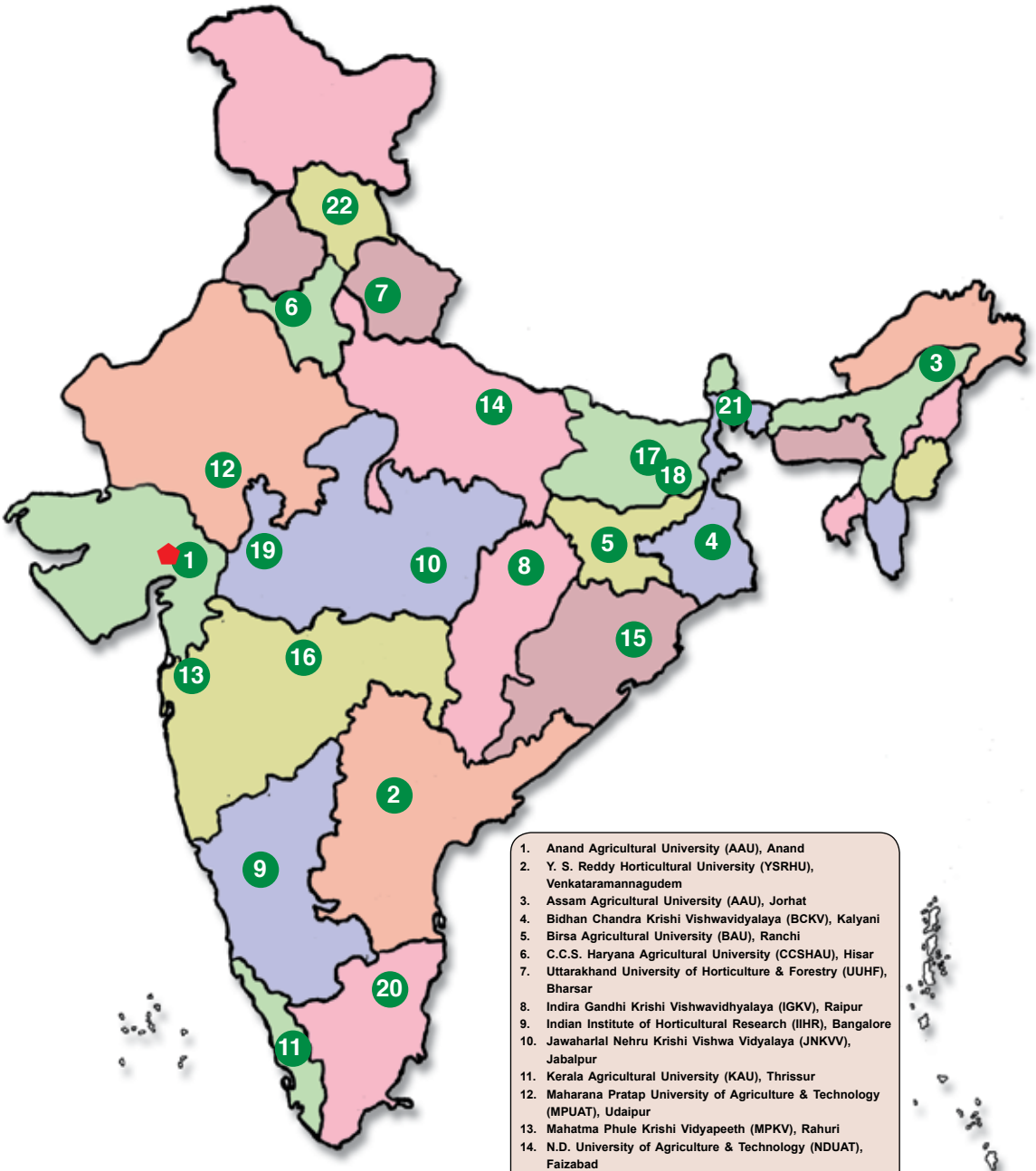
- To identify plants which need attention of agricultural scientists, to collect, maintain and evaluate the identified plants.
- To carry out basic researches on the mandate crops for developing their Good Agricultural Practices (GAP).
- To coordinate the research activities of the centres of AICRP on 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 AICRP-MAPB 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 in State Agricultural Universities and one ICAR centre at IIHR, Bangalore. 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

Centres of AICRP on Medicinal & Aromatic Plants and Betelvine



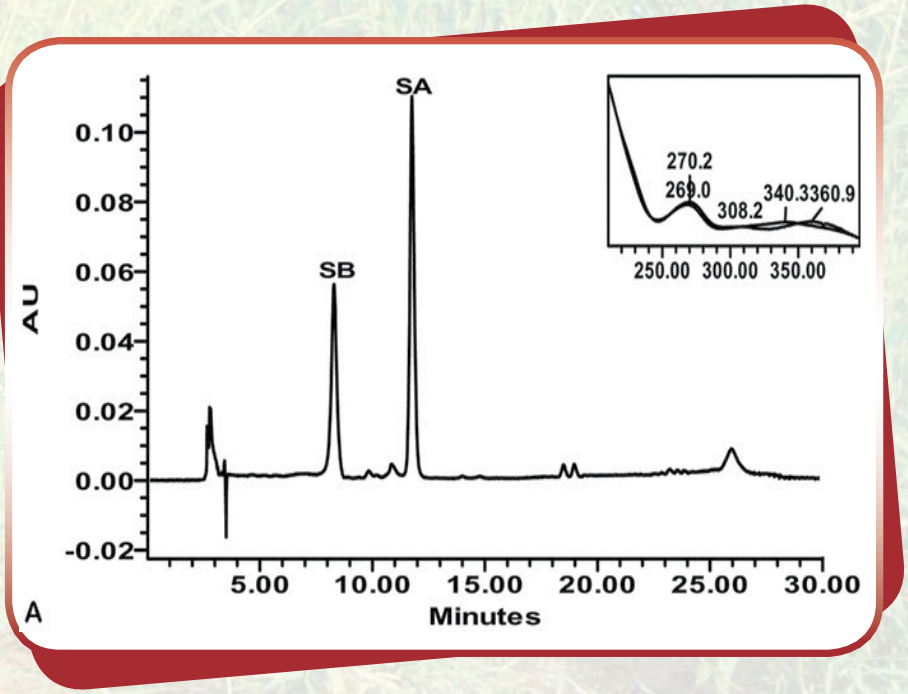
1. Anand Agricultural University (AAU), Anand
2. Y. S. Reddy Horticultural University (YSRHU), Venkataramannagudem
3. Assam Agricultural University (AAU), Jorhat
4. Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Kalyani
5. Birsa Agricultural University (BAU), Ranchi
6. C.C.S. Haryana Agricultural University (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)

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	320.45
Plan Expenditure (including TSP & NEH)	125.43
AICRP on MAP & Betelvine	573.00
IPR Scheme	2.66
NFBSFARA-Scheme	23.52
Externally Funded Projects	
DUS (PPV&FRA)	6.98
Central Sector Scheme	2.02
Web based herbal garden	4.29
Revolving Fund Scheme	2.48
DST Funded Projects	12.81
NAIP Projects	
NAIP on ARS/NET Online Examination	22.56
NAIP on Mass Media	6.07
NAIP on Learning and Capacity Building	15.46



Research Achievementrs.....

Medicinal and Aromatic Plants

ALOE (*Aloe vera*)

It is a member of the family *Liliaceae* and indigenous to African countries and later naturalized in India. The plant is perennial in habit with fleshy leaves and condensed stem. Flowering occurs in winter and the inflorescence stack is about 90-150 cm long with orange coloured flowers. Leaves contain gel (polysaccharides) and also it exudates contain aloins which are commercially useful. Gel has a cooling and moisturizing action and hence used in cosmetic industries. The crop is under cultivation in Gujarat, Rajasthan, Madhya Pradesh and Uttar Pradesh. Raw material is collected from both wild and cultivation for the industry. Suckers are used for propagation.

Evaluation of germplasm

PDKV, Akola: Seventeen genotypes i.e. nine genotypes collected from Maharashtra and eight genotypes from DMAPR were evaluated. The study revealed significantly higher plant height, number of leaves per plant, leaf length and leaf width in AKAv 09-01. Plant height was 60.85 cm, number of leaves was 15 per plant, leaf length was 55.45 cm and leaf width was 7.03 cm in AKAv 09-01. However, leaf yield was significantly superior in IC 112532 (325.70 g plant^{-1}) which was statistically at par with IC 285630 (290.70 g plant^{-1}) and AKAv 09-01 (277.40 g plant^{-1}). Significantly superior gel yield was in IC 285630 (71.07%), which was at par with IC 112532 (70.63%).

Effect of spacing and organic manures on growth and yield

PDKV, Akola: The experiment was conducted during 2011-12 to 2013-14 with three spacings (60 x 30, 60 x 45 and 60 x 60 cm) and four levels of organic manures (control; vermicompost 2.5 and 5 t ha^{-1}; FYM 5 and 10 t ha^{-1}). Results on pooled data basis revealed that plant spacing at 60 x 30 cm recorded significantly higher leaf yield (91.82 t ha^{-1}), gross returns (₹161019 ha^{-1}), net returns (₹ 81673 ha^{-1}) and B:C ratio (1.98). Application of vermicompost at 2.5 t ha^{-1} recorded significantly highest leaf yield (67.82 t ha^{-1}) and gross returns (₹ 118949 ha^{-1}), however, net returns (₹55515 ha^{-1}) and B:C ratio (1.81) was highest with vermicompost at 5 t ha^{-1}. Thus, it was recommended that planting at 60 x 30 cm spacing and application of vermicompost at 2.5 t ha^{-1} found optimum in Aloe vera for obtaining higher leaf yield and monetary returns.

Effect of planting method and organic manures on growth and yield

IGKV, Raipur: The experiment comprising different method of sowing (flat, ridge, 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. Planting methods did not have any significant improvement in

number of leaves per plant, herbage and gel yield, however, maximum herbage yield (20.62 t ha–1) was recorded under raised bed planting followed by ridge and furrow planting. Application of vermicompost @ 5 t ha-1 recorded significantly higher number of leaves per plant, herbage (22.27 t ha-1) and gel yield and remained at par with application of vermicompost @ 2.5 t ha–1.

ARJUN (*Terminalia arjuna*)

It belongs to family *Combretaceae* and mainly distributed in Central India. It has a buttressed trunk and light brown peeling bark. Its leaves are 10-25 cm long and 4-9 cm broad. A pair of glands is present on the leaf blade close to the tip of the petioles. The bark of this tree is considered a cardiotonic and is prescribed in the form of powder along with milk and sugar or in the form of decoction. The astringent property of the bark is utilized for the treatment of diarrhea. 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, Lagerstroemia flos-regina*.

Screening of germplasm for morphological and chemical variability

PDKV, Akola : Two hundred and nine plants were screened for various morphological characters viz., plant height (m), stem girth (cm) and bark thickness (mm) and chemical characters. Bark from unit area (10 x 15 cm) was removed from all the plants and fresh and dry weight of bark were recorded. Genotypes AKAr 3-12, AKAr 4-4, AKAr 10-11, AKAr 1-5, AKAr 1-9 and AKAr 11-15 had significant higher plant height. Similarly, seven genotypes i.e., AKAr 1-11, AKAr 13-11, AKAr 7-1, AKAr 6-1, AKAr 10-11, AKAr 6-11 and AKAr 9-15 recorded significantly higher stem girth. Bark thickness was higher in AKAr 9-15, AKAr 11-13, AKAr 1-9, AKAr 1-11, AKAr 7-1, AKAr 11-8 and AKAr 11-15. Fresh bark weight was higher in AKAr 12-14, AKAr 14-8, AKAr 11-3, AKAr 1-5, AKAr 8-6, AKAr 9-16 and AKAr 3-8. Dry bark weight was higher in AKAr 12-14, AKAr 14-8, AKAr 9-6, AKAr 11-13, AKAr 10-6, AKAr 13-11 and AKAr 11-15. However, tannin content was recorded significantly higher only in seven plants viz., AKAr 3-11, AKAr 1-9, AKAr 4-12, AKAr 7-4, AKAr 6-9, AKAr 3-9 and AKAr 5-9.

Standardization of vegetative propagation methods

PDKV, Akola: Vegetative propagation by grafting was standardized. One year old root stocks were used for different grafting experiments. The study revealed that the days for grafting success was lesser in early December month (18.20 days), which was followed by January month grafting (21.20 days), while November and February required more days for grafting success i.e., 23.00 days and 23.20 days, respectively. The success was also maximum in January month (89.80 %), which was at par with December (88.40 %), minimum grafting

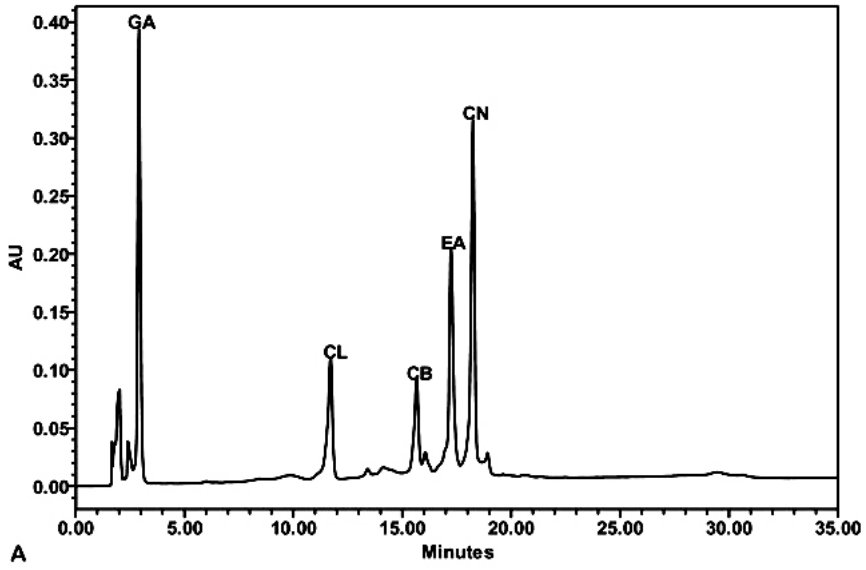
success was observed in November (77.60 %). Number of leaves per graft was more in December (15.00) followed by January (9.20). The height of the graft after 90 days was more in December (22.40 cm) followed by November grafted plants (17.00 cm). Survival of grafted plant (%) was significantly highest in the month December (76.60).

Evaluation of bark quality of *Terminalia arjuna* of different age groups

PDKV, Akola: The bark was collected in the first week of November 2013 from the selected Arjuna trees with specific ages. The bark samples were shade dried and powdered for further analysis of phenols, tannin content and antioxidant potential. The higher antioxidant potential was observed in bark samples of tree of age group III with mean 23.12 μg ml^{-1} as compared to samples from trees of age groups I and II.

Validated HPLC method for determination of tannin related marker constituents in *Teminalia* species

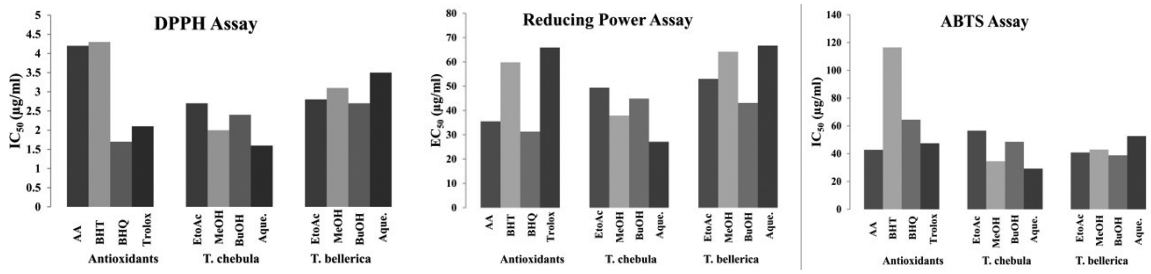
DMAPR, Anand: A validated rapid HPLC-PDA method was developed for identification and quantification of five tannin related constituents gallic acid, corilagin, chebulagic acid, ellagic acid and chebulinic acid in the extracts prepared from the bark and fruits of four *Teminalia* species available in India. The separation of the five analytes was achieved on a RP-18 column (4 × 250 mm, 5µm) at 25°C using a solvent mixture comprising of acetonitrile and (0.05%) trifluoroacetic acid-water in a gradient elution mode. Limit of detection (LOD) were 1.0, 0.5, 1.0, 0.5 and 1.0 μg ml^{-1} for gallic acid (GA), corilagin (CL), chebulagic acid (CB), ellagic acid (EA) and chebulinic acid (CN) respectively. Similarly, limit of quantification (LOQ) were 2.5, 1.0, 2.5, 1.0 and 2.5 μg ml^{-1} for GA, CL, CB, EA and CN respectively. Good linearity ($r^2 > 0.992$) was observed for all the five compounds in wide concentration range. The five analytes were identified and quantified in bark and fruit extracts of *T. chebula, T. belerica, T. arjuna and T. catappa* using the developed HPLC method.



RP-HPLC chromatograms of standard mixtures of GA, CL, CB, EA and CN

Antioxidant potential of extracts of *Terminalia bellerica* and *Terminalia chebula*

DMAPR, Anand: Extracts prepared using solvents of varying polarity were screened for their free radical scavenging and reducing capacity by *in vitro* antioxidant assays. Total phenolic content was also determined in order to assess its effect on the antioxidant activity of the extract. The properties of extracting solvents affected the measured total phenolic content and antioxidant activity. From the high antioxidant activity of the extracts comparable to the synthetic antioxidants such as ascorbic acid, butylated hydroxyl toluene (BHT), tertiary butylhydroquinone (TBHQ), 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (trolox), it could be inferred that these plants have the potential to be an alternate source of natural antioxidants. However, further *In vivo* studies are needed for successful commercialization of the extracts for food and pharmaceutical industries.



In vitro antioxidant assays

ASALIO (*Lepidium sativum*)

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

Development of seed standards

DMAPR, Anand: Seed standards for asalio, physical purity, seed weight, germination percentage (minimum) and seed viability were studied. In asalio, physical purity, 100 seed weight, germination percentage and seed viability were 99.2%, 1.6-1.8 g, 96.0% and 99.9%, respectively.

Evaluation of elite lines

AAU, Anand: Fifteen entries were tested along with GA 1 as check. Significant differences were found for plant height, number of branches per plant, test seed weight and seed yield.

However, differences in plant height were nonsignificant among the entries. Maximum plant height was recorded for ALS 1 (111.14 cm). GA 1 exhibited maximum number of branches per plant (13.60) followed by ALS 1, ALS 28 and MLS 1007. ALS 1 showed maximum test weight (2.03 g per thousand seed), which was at par with ALS 6 and MLS 1007. Maximum seed yield was recorded for ALS 6 (1481.41kg ha^{-1}) which was 26.89 percent higher than the check. For oil content, among all the entries tested, ALS 1 exhibited maximum oil content (25.14%) followed by ALS 7, ALS 16 and ALS 30, whereas, ALS 28 had the lowest oil content. Oil yield ranged from 357.32 to 222.10 l ha^{-1}. Highest oil yield was recorded by ALS 1 followed by ALS 6, MLS 1016, ALS 8 and SLS 1. The entry ALS 1 had 41.56 percent higher oil yield than check GA-1.

CCSHAU, Hisar: Eighteen elite lines including GA-2 as check were evaluated for yield and yield contributing characters. Days to maturity ranged from 115-135.5, plant height ranged from 90 – 128.75 cm, number of branches per plant ranged from 4.0 to 14.0, seed yield per plant ranged from 2.70 – 9.68g, seed yield per hectare ranged from 777.77 – 1875.00 kg ha^{-1}. Sel-10 gave the highest seed yield (1570.0 kg ha^{-1}) followed by Sel 12-1 and HLS-42 (1490.22 kg ha^{-1}), HLS-35 (1220.50 kg ha^{-1}) and HLS-34 (1190.00 kg ha^{-1}) which had significantly higher yield than the check GA-2 (1075.33 kg ha^{-1}).

MPUAT, Udaipur: Fifteen entries were identified as promising along with one check (Local Asalio LSU-15) were evaluated. The observations for plant height, number of branches per plant, seed yield (kg ha^{-1}) were recorded for all the entries. The observations on days to 50 percent flowering and days to maturity were also recorded. Entries ULS-9, ULS-8, ULS-2 and ULS-3 exhibited higher seed yield, while ULS-9 exhibited significantly higher seed yield (3148 kg ha^{-1}) over the local check ULS-15 (2870 kg ha^{-1}). These entries also showed better plant stand ability among the tested entries. The days to 75 percent maturity ranged from 82 to 91 days in the trial.

Evaluation of promising lines

YSPUHF, Solan: Three promising lines were evaluated along with check GA 1 for seed yield and morphological characters viz., plant height, days to 50 percent flowering, number of branches per plant, days to maturity, seed yield and test seed weight. Morphological marker characters were also noted for individual entries. Cauline leaf shape was imparipinnate, unipinnate, leaflet mostly entire, lanceolate, crinate at upper part in MLS 1007, imparipinnate, twice pinnate, leaflets pinnatifid in HLS 4 and GA 1 and imparipinnate, unipinnate, pinnatifid in Anand Local at the lower portion; imparipinnate, unipinnate, mostly entire, lanceolate in MLS 1007, imparipinnate, mostly entire in HLS 4, imparipinnate, mostly entire, lanceolate in GA 1 and imparipinnate, pinnatifid in Anand local at the middle. Leaf shape at the upper part was simple entire, lanceolate to linear in all the entries. None of the entries could out yield the check. The seed yield was significantly higher in MLS 1007 (1294 kg ha^{-1}), however it was at par with line Anand local and check GA 1. Differences in plant height, number of branches per plant and test seed weight observed among the lines were found statistically nonsignificant. Days to 50 percent flowering was lowest in MLS 1007 (119 days) and highest in HLS 4 (125 days).

CCSHAU, Hisar: Two lines i.e., MLS 1007 from Mandsaur and HLS-4 from Hisar were evaluated against the checks GA-2 and Gujarat Local. It was found that days to 50 percent

flowering ranged from 70.00 – 2.95, days to maturity ranged from 125.75 – 137.5, plant height ranged from 98.0 – 127.85 cm, branches per plant ranged from 4.27 – 6.07, seed yield per plant 8.04 – 14.00 g and seed yield per hectare ranged from 745.83 – 1044.64 kg ha^{-1}. The seed yield was significantly higher in HLS-4 (1044.64 kg ha^{-1}) followed by MLS-1007 (872.02 kg ha^{-1}) whereas it was 745.83 kg ha-1 in the check GA-2 and 861.67 kg ha^{-1} in the check Gujarat Local.

MPUAT, Udaipur: Two entries i.e., MLS 1007 and HL S4 along with GA-1 as check were evaluated. Observations were recorded from all the entries for plant height, number of branches per plant, seed yield (kg ha^{-1}) and test weight (g). Observations on days to 50% flowering and days to maturity along with morphological marker traits as reported by the contributing centers were also recorded. Cauline leaf shape was imparipinnate, unipinnate in MLS 1007, imparipinnate, twice pinnate HLS 4 and GA 1 at basal portion; imparipinnate with lateral as well as terminal pinna incompletely divided in MLS 1007 and imparipinnate with lateral as well as terminal pinna incompletely divided in HLS 4 and GA 1 at middle portion; and mostly simple entire, lanceolate to linear at terminal portion in all the entries. Entry MLS-1007 exhibited significantly higher seed yield (2465 kg ha^{-1}) than the check GA 1 and the other entry (HLS-4). HSL-4 was also at par (2336 kg ha^{-1}) with the check (2341 kg ha^{-1}). As far as maturity is concerned, both the test entries had earlier maturity than check GA-1. It was also noted that MLS-1007 had better plant stand ability compared to both HLS-4 and GA-1.

Effect of sowing dates and plant geometries on yield and quality

MPUAT, Udaipur: The experiment was conducted during 2011-12 and 2013-14 comprising of four sowing dates (41, 43, 45 and 47 meteorological weeks) and four planting geometries (30 x 10, 30 x 15, 40 x 10 and 40 x 15 cm). Three years results revealed that sowing at 43rd meteorological week along with plant geometry at 30 x 10 cm recorded maximum seed yield (24.38 q ha^{-1}), mucilage yield, net returns and B:C ratio.

Effect of irrigation and brassinosteroids on yield and quality

MPUAT, Udaipur: Effect of 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 four irrigations at 25, 45, 65 and 85 DAS along with two sprays of brassinosteroids 0.6 ppm at 50 and 70 DAS were found appropriate to achieve higher productivity, net monetary returns and B:C ratio. However, under irrigation water constraints, 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: Five seed rates (6, 8, 10, 12 and 15 kg ha^{-1}) and two sowing methods (broadcasting and line sowing) were investigated. The highest plant height (105 cm) was recorded with seed rate 15 kg ha^{-1}. However, seed yield (19.5 q ha^{-1}) was highest with seed rate 8 kg ha^{-1}. Methods of sowing did not influence significantly, however, highest seed yield (15.58 q ha^{-1}) was recorded in broadcasting method.

Effect of integrated nitrogen management on growth and yield

RVSKVV, Mandsaur: The experiment comprising N application in different combination of organic and inorganic sources (25% through FYM/vermicompost + 75% through RDF, 50% through FYM/vermicompost + 50% through RDF, 75% through FYM/vermicompost + 25% through RDF, 100% through FYM/vermicompost/RDF and control) were investigated. Results revealed that application of 100% N through RDF recorded highest plant height (90 cm), plant girth (7.6 mm), number of branches per plant (21) and seed yield (17.8 q ha^{-1}).

Management of *Alternaria* leaf blight

NDUAT, Faizabad: Field trials were conducted to find out a suitable fungicide along with optimum dose and frequency of spray to control the Alternaria leaf blight. 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 percent disease severity (14.56), higher percent (60.72) disease control and higher seed yield (11.3 q ha^{-1}).

Screening germplasm against *Alternaria* blight

RVSKVV Mandsaur: Twenty four genotypes were screened against *Alternaria* leaf blight. Severity was recorded in 0-9 scale. MLS-1, MLS-5, MLS-7, MLS-8, and MLS-13 were identified as resistant lines, whereas, MLS –2, MLS –3, MLS –4, MLS –6, MLS –9, MLS –10, MLS –11, MLS –12, MLS –14, MLS –15, MLS –16, MLS –17, MLS –18, MLS –19, MLS –20, MLS –21, MLS –22, MLS –23 and MLS –24 were susceptible lines.

ASOKA (*Saraca asoca*)

It is 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.

Standardization of protocol for *in vitro* induction of callus

DMAPR, Anand: Tissue culture technique offers a viable alternative for production of a large number of plantlets within a short period of time. Different plant parts such as shoot tip, internodal segments, mature and immature leaves and immature floral buds/inflorescence were cut into appropriate sizes and used as explants and inoculated onto Murashige and Skoog (MS) medium supplemented with varying concentrations and combinations of growth

regulators BA, 2, 4-D, and Kn to study the direct or indirect organogenesis. Swelling and initiation of callus from the cut ends of the inoculated explants was observed after one week in MS medium containing 6-benzyladenine (BA) (0.1 and 1.0 mg l^{-1}) and 2, 4-D (0.5 - 2.5 mg l^{-1}). However, explant cultured on growth regulator free MS medium become necrotic and no sign of active growth. Callus proliferation occurred after 2 weeks and the entire segment was covered with callus within 4 weeks. Profuse white, soft and globular calli was obtained and subculturing was performed after four weeks. In the callus induction media all explants showed variable response. However, frequency of callus induction was higher in young leaves and nodal explants as compared to the immature inflorescence**.**

ASHWAGANDHA (*Withania somnifera*)

The plant belongs to the family *Solanaceae* and is a wonder herb with multiple medicinal properties. It is cultivated in northern-western and central India. The species is an annual to perennial branched under-shrub to herb of about 30 – 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 the effects of 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 present in the roots. Among the various alkaloids, withanine is the main constituent. The leaves contain steroidal lactones, which are commonly called withanolides. It is a late kharif crop and grown in sandy loam soil of pH 7.5 – 8.0.

Molecular characterization using RAPD and ISSR markers

DMAPR, Anand: Forty eight accessions (Mandsaur collections) and two cultivars (JA-134 and JA-20) were characterized using molecular markers for developing genetic fingerprints and assessment of the genetic diversity using random amplified polymorphic DNA (RAPD) and ISSR markers. Total genomic DNA from 48 accessions was isolated using modified CTAB method and its qualitative and quantitative analysis was performed by running of genomic DNA sample on 0.8% of agarose gel. A total of 80 RAPD primers (20 each of OPP, OPN, OPQ, OPF series) were used for preliminary screening for their amplification and reproducibility in *Withania* genome of which 20 primers were selected and used for molecular characterization of 48 accessions of Ashwagandha. RAPD profiling produced about 2 to13 bands among the accessions with an average number of seven. DNA fragments (bands) amplified by each random primers ranged from 150-250 bp to 2000 – 2500 bp in size.

Microsatellite repeat based 3′ anchored Inter simple sequence repeat (ISSR) primers, ranged

from di to tri- nucleotide repeat were designed. Dinucleotide microsatellite repeat motifs included (AG, CT, CA, CT and AG) and trinucleotide repeat included (AGC, CAC). The frequency of repetition of dinucleotide and trinucleotide repeats varied from 8-9 and 6-7 times, respectively were used for the analysis. The ISSR primers were screened for their amplification pattern and 20 primers were used for characterization of 48 accessions of Withania. Result revealed that among the di-nucleotide repeats, (AG) followed by (CA) and (TG) produced good amplification. However, the trinucleotide repeat primer was found less effective than the dinucleotide repeat based markers for characterization of *W. somnifera* accessions.

Screening for seed viability

DMAPR, Anand: One hundred and forty accessions were screened for seed viability. The seeds of these accessions harvested during March 2010 were stored at room temperature for three years and tested for its viability through germination test. The seed viability ranged from 0 – 23 percent Among the 140 accessions 110 accessions did not germinate which indicated that they lost viability and from the remaining 30 accessions, 22 had less than 5 percent germination, four had 5-10 percent and another four accessions viz., MWS 204 (16%), IC 286632 (19%), IC 283942 (19%), and IC 310620A (23%) had more than 10 percent germination. It was concluded that there exist a genetic variability among the accessions for duration of seed viability.

Hybridization, advancement of generations and selection of breeding lines

DMAPR, Anand: During 2013-14, artificial hybridization was done in 28 cross combinations and F_1 hybrids were obtained along with their pure parent seeds. The F_1 generation of five crosses viz., RAS 11 × IC 310620, IC 310620 × RAS 11, DWS 16 × IC 310620, IC 310620 × DWS 16, and DWS 10 × DWS 70 of previous years were evaluated along with their parents. The self pollinated seeds from hybrid F_1 plants were harvested and advanced to F_2 generation. Single plant progenies of 40 crosses that were made in line × tester (4 females × 10 males i.e., the females: MWS 302, C-55, MWS 313 and RAS 33 and males: MWS 10, MWS 131, MWS 132, MWS 205, MWS 324, MWS 328, Red berries, RAS 23, RAS 27 and RAS 34) were advanced from F_4 to F_5 generations. Three hundred and twenty eight pure lines were selected during last year (DWS 1 – DWS 228) and advanced to next year for its further testing, evaluation and use in breeding. Out of these, nineteen lines with distinct morphological characters were tested for one more year and the stability of the characters were confirmed. The pure line DWS 23 had compact plant type and less fibrous root. Similarly, another pure line DWS 37 had distinct leaf character i.e. downward curling of leaves as against the normal upward curling of leaves. Based on root traits, 10 pure lines were selected for preliminary yield evaluation trial.

Genetics of growth habit and fruit colour

DMAPR, Anand: Inheritance of growth habit and fruit colour in F_2 population of the cross DWS 6 (procumbent type plant with yellow colour berry) × DWS 323 (erect plant with red colour berry) was studied. The procumbent (spreading type) growth habit was controlled by

single dominant gene and the erect growth habit was controlled by recessive gene. Inheritance studies of yellow versus red berry colour in the DWS-326 (red) × DWS-6 (yellow) indicated that the trait was in control of classical duplicate recessive epistasis. The berry colour of ashwagandha was controlled by two genes with complementary/duplicative recessive epitasis.

Evaluation and maintenance of germplasm

RVSKVV, Mandsaur: Sixty eight lines were evaluated for thirteen different characters. Among the lines wide range of variability was observed for these characters. Plant height ranged between 32 cm (MWS-104) to 65 cm (RAS-20). 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). On the basis of duration of plant maturity, plants were 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 15.0 – 32.0 cm and 4.88 – 10.24 mm, respectively. Quality of roots of RVA-100, MWS- 101, MWS-207, RAS-20 and RAS-21 were superior (quality grade-2.5). Mean dry root yield ranged from 312 kg ha^{-1} (RAS-40) to 620 kg ha^{-1} (MWS-90-142). MWS-90-142 recorded highest dry root yield (620 kg ha-1) followed by JA-134 and RAS-7 (562 kg ha^{-1}), MWS 301 and MWS 317 (541 kg ha-1). MWS-303, MWS -305, MWS -221, MWS -327, RAS-37 and RVA-100 recorded more than 500 kg ha^{-1} dry root yield. Mean seed yield ranged from 333 (RAS-40) – 599 kg ha^{-1} (MWS-319).

MPUAT, Udaipur: A total of 74 lines which belonged to annual types (early maturity) were evaluated for higher root yield and high root quality. Observations were recorded for berry color (yellow/red), plant type (erect/spreading), plant height, number of primary branches, root type (woody/starchy), root length, root diameter, root yield and alkaloid content. Observations on days to 50 percent flowering, days to 75 percent maturity and total alkaloid content were also recorded. JA-20 was found to be the best check (1250 kg ha^{-1}) compared to JA-134 and RAV-100. Thirty one lines exhibited higher dry root yield over the best check JA-20. The alkaloid content in the germplasm varied from 0.16 to 0.66 percent. UWS 28, UWS 38, UWS 47, UWS 58, UWS 66, UWS 122, UWS 135 and UWS 148 had 0.66 percent alkaloid content.

Multi location trial

AAU, Anand: Three promising lines were tested for root yield and quality along with three checks i.e., JA 20, JA 134 and RVA 100. Significant differences were observed only for root length and dry root yield among the lines. Maximum root length was recorded for AWS 1 which was closely followed by DWS 135. Maximum root yield was recorded by AWS 1 (698.74 kg ha^{-1}) which was at par with DWS 132 (628.33 kg ha^{-1}). AWS 1 outperformed all the three checks in terms of dry root yield, however, DWS 132 showed significantly superior root yield only over two checks i.e., JA 20 (501.24 kg ha^{-1}) and JA 134 (590.83 kg ha^{-1}). AWS 1 had 39.40 %, 18.26 % and 15.50 % higher dry root yield than the checks JA 20, JA 134 and RVA 100, respectively. No significant differences were observed among the entries

in terms of withanoloids content (%). However maximum withanoloids yield was recorded by AWS 1 (2.45 kg ha^{-1}).

MPUAT, Udaipur: Five promising entries of early maturing annual types of Ashwagandha lines viz., AWS 2B (AAU, Anand), DWS 132, DWS 135 (DMAPR), UWS 10, UWS 37 (Udaipur) were evaluated for higher root yield, high alkaloid content and other yield contributing traits. The checks used were JA 20, JA 134 and RAV 100. All the test entries including entries from Udaipur centre were early maturing annual type and at par with the maturity periods of the checks (JA 20, JA 134, RAV 100). UWS-10 produced significantly higher dry root yield (509 kg ha^{-1}) which was at par with UWS-37 and AWS-2B. UWS 10 outperformed all the check varieties also.

Varietal evaluation trial

MPUAT, Udaipur: Eleven promising annual types of Ashwagandha lines viz., UWS11, UWS 22, UWS 23, UWS 28, UWS 56, UWS 59, UWS 60, UWS 92, UWS 93, UWS 98, and UWS 111 were evaluated along with three checks i.e., JA 20, JA 134 and RAV 100 for higher root yield, high alkaloid content and other yield contributing traits. All the test entries confirmed the early maturing annual type growth habit. UWS 93, UWS 23, UWS 11, UWS 56 and UWS 92 had significantly higher dry root yield over the best check RAV-100 (1005 kg ha^{-1}) and over grand mean of the experiment (945.92 kg ha^{-1}).

RVSKVV, MANDSAUR: Twenty one lines collected from farmers' fields of Mandsaur, Ratlam and Neemuch district of Madhya Pradesh were tested for seed yield and yield contributing characters. The mean plant height ranged from 102 cm (MOB-1) – 121 cm (MOB-8) and spike length ranged from 19.66 cm (MOB-6) – 29 cm (MOB-2), similarly number of spikes per plant ranged from 102 (MOB-5) – 396 cm (MOB-14). The highest seed yield was recorded by MOB-14 (2161 kg ha^{-1}) followed by MOB-13 (2083 kg ha^{-1}), MOB-19 (1979 kg ha^{-1}), MOB-16 (1875 kg ha^{-1}), MOB-8 and MOB-11(1667 kg ha^{-1}).

Management of *Alternaria* leaf blight

JNKVV, Jabalpur: A field trial was conducted for the management of *Alternaria* leaf blight. The results showed that the lowest disease incidence (11.6 %) was recorded in soil application of FYM @10 t ha^{-1} + *Trichoderma* sp. @ 10^6 - 10^9 cfu ml^{-1} followed by soil application of *Trichoderma* sp. @ 10^6 - 10^9 cfu ml^{-1} + *Pseudomonas* sp. @ 10^6 - 10^9 cfu ml^{-1} (12.27%). The dry root yield was higher in the above two treatments and recorded 66.13 q ha^{-1} and 67.27 q ha^{-1}, respectievely.

Assessment of yield loss due to pest infestation

YSRHU, Venkataramannagudem: Field experiments were conducted to record infestation by major insect pests and its yield loss under protected and unprotected conditions. In the protected plots, spraying of neem oil (0.03%) @ 5 ml l^{-1} was taken up at regular intervals. Yield losses due to sucking pests (red bug and cow bug) were found to be 27.46 percent.

Integrated disease management against root rot and foliar diseases

MPUAT, Udaipur: An integrated disease management module against root rots and foliar diseases under organic farming of Ashwagandha were evaluated under sick plot and

inoculation condition during Rabi 2013-14. Among the six treatments; soil application of Neem cake manure (500 g m^{-2}) supplemented with Trichoderma talc based formulation (10^8 cfu g^{-1}) + seed treatment with neem oil (3.0%) followed by three sprays of Cow urine: Neem leaves: Garlic clove fermented product @ (1%) resulted in lowest plant mortality (28.33 %), highest percent root rot control (69.55%), lowest leaf blight incidence (22.50%) and maximum control (72.30%). This management practice also yielded maximum dry roots (6.50 q ha^{-1}), seed (5.32 q ha^{-1}) and higher alkaloid content (0.55%). The population count of *T. Viridae* (10.65×10^5 cfu g^{-1} soil) was also highest in this treatment

Screening of genotypes against multiple diseases

MPUAT, Udaipur: Sixteen genotypes were screened against diseases like root/collar rot and leaf spot/ blight. Results revealed that, six genotypes (RAS-10, RAS-37, RAS-23, RAS-11, RAS-92 and RAS-22) were found resistant (R) against root/collar rot and leaf blight (6-20% infection), while six genotypes (RAS-56, RAS-59, RAS-7, JA-20, RAS-93 & RAS-28) showed moderate resistance to root/collar rot (21-30% infection) and moderate susceptibility to leaf spots/ blight (31-40%). However, four genotypes (RAS-98, RAS-111, JA-134 & RVA-100) were found moderate susceptible against collar/root rot (31-40%) and susceptible against leaf blight (41-50%).

Management of Damping off

RVSKVV Mandsaur: Field experiments were laid out to manage the damping off disease. Results showed that the treatment involving seed treatment with carbendazim+ mancozeb @ 2.5 g followed by soil drenching with carbendazim + mancozeb @ 0.2% recorded the lowest seedling mortality 17.35% and the maximum seed and root yield of 723.83 and 1561.50 kg ha^{-1}, respectively. Seed treatment with carbendazim + Mancozeb @ 2.5 g alone recorded a disease intensity of 23.15%. In control the highest seedling mortality per cent (41.23%) was recorded. The treatment using the biocontrol agent (Seed treatment and soil drenching using *T. viride*) also recorded lower seedling mortality (24.18%), higher seed yield (715.51 kg ha^{-1}) and root yield (1467.51 kg ha^{-1}).

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. 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 of 'Calamus'. It is believed to improve memory power and intellect. It is also useful in the treatment of diarrhoea, dysentery, abdominal obstructions and colic. Anticarcinogenic property of the species was also reported recently.

Characterization, evaluation and maintenance of germplasm

AAU, Assam: 16 germplasm were collected from different parts of Assam. Observations were recorded on various morphological parameters viz., leaf length, leaf breadth, length x breadth ratio, number of leaves per plant and colour of leaves. Longest leaf (89.33 cm) was found in JAC-10 and shortest in JAC-1(39.93cm). Accession JAC-2 recorded minimum leaf breadth (0.80 cm) and JAC-8 recorded maximum leaf breadth (2.40 cm). Leaf length and breadth ratio ranged from 28.47 (JAC-8) to 72.62 (JAC-10). Number of leaves per plant varied from 4 to 8 and colour of the leaf was either green or light green.

YSRHU, Venkataramannagudem: Twenty seven accessions were maintained, of these, one accession from kodaikanal and one accession from pandirimamidi were collected during this year. The accessions were evaluated for morphological and agronomical traits. Among the accessions, plant height ranged from 30.00 – 72.00 cm, number of leaves per plant ranged from 15 to 87, leaf length ranged from 24.00 – 62.70 cm, leaf breadth ranged from 0.90 – 1.40, rhizome lets ranged from 0.70 – 6.70, rhizome scales ranged from 10.7 – 41.0, rhizome length ranged from 18.50 – 67.30 cm, rhizome width ranged from 5.1 – 7.6 cm, rhizome weight per plant ranged from 25.00 – 148.30 g and rhizome yield ranged from 10.00 – 59.33 kg ha^{-1}. Highest rhizome yield was found in APAc-5.

Effect of spacing and organic manures on growth and yield

YSRHU, Venkataramannagudem: The experiment was conducted for three years (2010-11 to 2012-13) with three spacings (60 x 30, 60 x 45 and 60 x 60 cm) and three levels of FYM (5, 10 and 15 t ha^{-1}). Results on pooled data basis revealed that sowing at 60 x 30 cm spacing and application of FYM 15 t ha^{-1} recorded maximum rhizome yield (26.57 q ha^{-1}), net returns (₹ 1.25 lakh ha^{-1}) and B:C ratio (3.08).

BASIL *(Ocimum basilicum)*

It is an aromatic herb of about 0.6 to 0.9 m tall belonging to family *Lamiacea* and is widely distributed throughout India. The species is believed to be originated in India, Pakistan and Thailand. Basil prolifically produce large green 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, terpineol. Basil grows as a perennial in tropical climates, and is planted as an annual in temperate regions, where it may be sown directly from seed or transplanted. Basil has been used as a folk remedy for an enormous number of ailments, including boredom, cancer, convulsion, deafness, diarrhea, epilepsy, gout, hiccup, impotency. Basil has been reported in herbal publications as an insect repellent.

AAU, Anand: Nine accessions were evaluated for better leaf yield and quality along with local check Ob 10 and cv. Saumya for four years. Among the four years of experimentation and in pooled results, Ob 3 and Ob 4 were found superior performers in terms of green leaf yield, however, Ob 5 and Ob 8 recorded significantly higher green leaf yield for the last three years and in pooled analysis. Among all the four years and in pooled analysis, Ob 3 was found superior and yielded 89.59% higher green leaf yield than local check (Ob 1) and 95.21% higher green leaf yield than cv. Saumya, national check, respectively. Ob-3 recorded 148.70 % higher oil yield than Ob - 10 (check 1) (four years mean) and 96.85 % higher oil yield than Ob 11(check 2) (two years mean).

RVSKVV, MANDSAUR: Twenty one lines collected from farmers' fields of Mandsaur, Ratlam and Neemuch district were tested for seed yield and yield contributing characters. The mean plant height ranged from 102 (MOB-1) – 121 cm (MOB-8) and spike length ranged from 19.66 (MOB-6) – 29 cm (MOB-2), similarly number of spikes per plant ranged from 102 (MOB-5) – 396 (MOB-14). The highest seed yield was recorded by MOB-14 (2167 kg ha^{-1}) followed by MOB-13 (2083 kg ha^{-1}), MOB-19 (1979 kg ha^{-1}), MOB-16 (1875 kg ha^{-1}), MOB-8, MOB-11 (1667 kg ha^{-1}) as compared to the lowest seed yield recorded by entry MOB-5 (917 kg ha^{-1}).

BRAHMI (*Bacopa monnieri*)

The plant belonging to *Scrophulariacea* is a creeping,succulent highly branched herb and is commonly found in marshy places throughout India up to an elevation of 1300 m. The whole herbage is the source of Ayurvedic drug 'brahmi' which is an important ingredient of several Ayurvedic preparations such as 'Brahmigritam', 'brahmirasayanm', 'brahmitailam' and 'misrakasneham'. It is considered as astringent, diuretic, laxative, tonic for the heart and nerves and is used in Ayurveda to improve memory. It is propagated by stem cuttings. Bacoposide is considered 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. The herbage portion including stem and leaves are harvested and shade dried and used for drug preparations

Collection and characterization of germplasm

RAU, Pusa: Fourteen collections obtained from various places of Bihar were characterized based on leaf size, internode length, stem and flower colour and fresh and dry weights of herbage. RAU BM-11 collected from Desua (Samastipur) showed highest leaf size (1.5 x 0.5 cm) and dry herbage yield (44.25 q ha^{-1}) followed by RAUBM-12 and RAU BM-10 i.e., 40.62 and 37.82 q ha^{-1}, respectively as compared to the 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. Chiraita 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 improve 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 practises are not yet fully stanadrdized

Effect of biofertilizers on growth and yield

UBKV, Klimpong: Seven levels of biofertilizers (Azotobactor, PSB, VAM, Azotobactor + PSB, Azotobactor + VAM, VAM + PSB and Azotobactor + VAM + PSB) were investigated and compared with control. Results revealed that significantly higher plant height (177 cm), fresh (189.4 g) and dry (56.4 g) aerial biomass, fresh (14.6 g) and dry (4.4 g) root biomass and whole fresh (202 g) and dry (60.8 g) biomass per plant were recorded with the application of VAM + PSB at transplanting time

Study of disease incidence and severity of fungal diseases

UBKV Kalimpong: The survey of fungal diseases, Alternaria leaf spot disease, Cladosporium leaf blight and seedling blight were conducted at Kalimpong, Algarah and Lava. The results showed that highest leaf spot incidence was recorded during May and lowest during December, whereas highest leaf blight incidence was recorded during August and lowest during January. Results also showed that highest seedling blight was recorded during July and lowest during January.

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 andanaemia. Plants are propagated by stem cuttings. Rootsare used as Ayurvedic drug which contain plumbagin.

Collection, characterization, evaluation and maintenance of germplasm

TNAU, Coimbatore: Forty five accessions were collected from different parts of Tamil Nadu, Kerala, Maharashtra and Himachal Pradesh for the study. Variability was observed among the accessions for various growth characters. Distinct variations were observed for calyx colour, calyx length, petal shape and flower size. Based on the morphological characters viz., flower size, the flowers were classified into four namely, small size (1 - 1.25 cm), medium (1.25 - 1.50 cm), large (1.5 – 1.75 cm) and very large (1.75 -2.00 cm). The accessions TNPZ -7, TNPZ 21, TNPZ 22 ,TNPZ 24, TNPZ 28 ,TNPZ 31 and TNPZ 43 had small size flowers, the accessions TNPZ -2, TNPZ 4, TNPZ 8, TNPZ 9,TNPZ 10, TNPZ 11, TNPZ 12, TNPZ 13, TNPZ 14, TNPZ 15, TNPZ 16, TNPZ 17,TNPZ 18, TNPZ 19, TNPZ 20, TNPZ 26, TNPZ 29, TNPZ 30, TNPZ 32,TNPZ 37 and TNPZ 38 had medium size flowers. The accession TNPZ 1, TNPZ 3, TNPZ 5, TNPZ 6, TNPZ 25, TNPZ 27, TNPZ 33, TNPZ 34, TNPZ 35 TNPZ 40 and TNPZ 42 had large size flowers. Whereas the accessions TNPZ 25, TNPZ 39, TNPZ 41 had very large size flowers. The accessions were also differentiated according to tubular calyx length. Accessions were categorized into three groups as small (1.50-2.00cm), medium (2.00-2.50cm) and large (2.50-3.00cm). Ten accessions exhibited small calyx tube (TNPZ -3, TNPZ 10, TNPZ 12, TNPZ 14, TNPZ 21, TNPZ 22, TNPZ 25, TNPZ 28, TNPZ 37, TNPZ 40), twenty nine accessions showed medium length calyx tube (TNPZ -1, TNPZ 4, TNPZ 5, TNPZ 6, TNPZ 7, TNPZ 8, TNPZ 9, TNPZ 11, TNPZ 13, TNPZ 15, TNPZ 16, TNPZ 17,TNPZ 18, TNPZ 19,TNPZ 20, TNPZ 23,TNPZ 26, TNPZ 27, TNPZ 29,TNPZ 30, TNPZ 32, TNPZ 33,TNPZ 34, TNPZ 35, TNPZ 38, TNPZ 39, TNPZ 41, TNPZ 42 and TNPZ 43) and three accessions were with large calyx tube (TNPZ 2, TNPZ 24 and TNPZ 31). The accessions were characterized into four groups based on expression of colour at open and unopened flower stages viz., Group 1: Green colour at both open and unopened stage (TNPZ 3 , TNPZ 5 , TNPZ 6 , TNPZ 7, TNPZ 17, TNPZ 27, TNPZ 28) : Group-2 : Purple colour at both open and unopened stage (TNPZ 1, TNPZ 4 , TNPZ 11 , TNPZ 14 , TNPZ 16, TNPZ 21, TNPZ 26, TNPZ 30 , TNPZ 37, TNPZ 43): Group-3: At unopened stage, purple colour was observed whereas at open stage only dots were observed. (TNPZ 2 , TNPZ 9 , TNPZ 10 , TNPZ 13 , TNPZ 15, TNPZ 18, TNPZ 20, TNPZ 22, TNPZ 25, TNPZ 33, TNPZ 38 , TNPZ 39 , TNPZ 44.) Group-4: At unopened stage, purple colour was observed whereas at open stage green colour was observed (TNPZ 8, TNPZ 12, TNPZ 19, TNPZ 34, TNPZ 40, TNPZ 41). Accessions TNPZ 1, TNPZ 2, TNPZ 3, TNPZ 5, TNPZ 11, TNPZ 13, TNPZ 14, TNPZ 15, TNPZ 22, TNPZ 26, TNPZ 30, TNPZ 39 and TNPZ 43 had distinct petal shape.

Effect of coppicing on yield and quality

KAU, Thrissur: Three coppicing intervals (9, 12, 15 MAP) and three coppicing heights (15, 30 cm and no pruning) were investigated. Results revealed that coppicing interval and height were significantly influenced root yield and plumbagin content. Coppicing at 15 MAP at a height of 30 cm gave highest root yield (5633 kg ha^{-1}), however, highest plumbagin content (0.90%) was recorded when coppiced at 9 MAP at 30 cm height.

COLEUS *(Coleus forskohlii)*

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

Management of root rot disease

TNAU, Coimbatore: A field experiment was conducted at farmers' field at Thuraiyur, Trichy district, Tamil Nadu to manage the root rot disease in Coleus. The results showed that the treatment involving sanitation, dipping stem cuttings in carbendazim (0.1%) followed by drenching with carbendazim (0.1%) at 30 DAP recorded the lowest root rot disease incidence (12 - 14.7 %) and the highest tuber yield (2008.6 kg ha^{-1}). Soil application of zinc sulphate, neem cake and *Trichoderma viridae* mixture at the rate of 50 g per plant and the other treatment involving sanitation + dipping stem cuttings in *Pseudomonas fluorescens* (0.2%) also recorded significantly less disease incidence and was on par with the above treatment. The growth and yield parameters were also high in these treatments

Dodi (*Leptadenia reticulata*)

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

Effect of organic manures on yield

AAU, Anand: The experiment was conducted for four years (2009-10 to 2013-14) comprising five levels of organic manures and one biofertilizers (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 l ha-1 each). Results on pooled data basis revealed that application of FYM at 10 t ha-1 recorded highest yield (8294 kg ha-1) with maximum net returns (₹312965 ha-1) and B:C ratio (1.89).

Effect of irrigation schedule on yield

AAU, Anand: The experiments comprising of four irrigation schedules at 0.4, 0.6, 0.8 and 1.0 IW/CPE ratio were conducted. Results showed significantly higher dry biomass yield (9168 kg ha-1) with total water requirement of 1785 cm at 1.0 IW/CPE ratio.

GILOE (*Tinospora cordifolia*)

Tinospora 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. It is propagated by stem cuttings as well as by seeds. 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.The plant is not under regular cultivation and it grows as a climber on trees in the wild.

Evaluation of selected lines

DMAPR, Anand: Based on the initial evaluation of 43 accessions, 11 accessions were selected based on high dry stem yield and starch content for the evaluation trial. The accessions selected were IC 283650, IC 283950, IC 283954, IC 283959, IC 283958, Kalyani, IC 310601, K 88, K 87, GUJ 4 and NMRM 16. Significant differences were observed among the accessions. Fresh stem yield varied from 73.56 – 403.50 q ha-1. Fresh stem yield was significantly highest in IC 310602, however it was at par with accessions Kalyani (356.67 q ha-1), GUJ 4 (341.66 q ha-1), K87 (339.83 q ha-1), IC 283950 (331.11 q ha-1), and K 88 (304.00 q ha-1). The lowest fresh stem yield was in IC 283958. Dry matter content was significantly higher in IC 283959 and was at par with IC 283650. Dry stem yield was also significantly higher in IC 310602 (125.51 q ha-1), however, it was at par with IC

283950 (111.47 q ha-1) Kalyani (108.98 q ha-1) and K87 (108.09 q ha-1). Diameter of stem (maximum diameter) recorded also varied significantly among the accessions. It ranged from 5.28 mm to 8.65 mm. Significantly higher diameter was recorded in NMRM 16, which was at par with IC 283650 (8.10 mm), IC 310602 (7.83 mm) and IC 283950 (7.62 mm). The study thus showed that even though, highest stem diameter was observed in NMRM 16, it was not reflected in the yield. However, IC 310602 and IC 283950 had thicker stem as well as superior yield. Accession Kalyani had thinner stem diameter (5.39 mm), however it recorded superior yield.

Phytochemical screening of germplasm by HPTLC profile

DMAPR, Anand: HPTLC profile of methanolic extract of stem of 34 accessions showed that IC 310608 had maximum number of major bands (10). No relation was found between the geographical location of the accessions and HPTLC profile. Accessions were distributed under two major clusters. First cluster consisted of 24 accessions where as in the 2nd cluster there were 11 accessions. K 87 & GUJ 7 and Kalyani & IC 283950 were identical to each other. HPTLC profile of stem chloroform extract of 34 accessions showed that NMRM 15 had maximum number of chemical constituents (13). No relation was found between the geographical location of the accessions and HPTLC profile in this case also. Accessions were distributed under two major clusters. First cluster consisted of 22 accessions whereas in the 2nd cluster there were 13 accessions. K 87 & GUJ 1; GUJ 4 & HYD 2 and GUJ 7 & IC 283958 were identical to each other**.**

Identification of isolated compounds

DMAPR, Anand: NMR and mass spectrometry were used for the identification of isolated compounds (code names: TC-1, TC-2A, TC-3A, TC-6, TC-4B, TC-5A1, TC-5A2 and TC-N2). These seven compounds were identified as: cordioside-1(sitosterol β-glycoside), 5,7, 3′,5′ tetrahydroxy flavanone, 20-β hydroxydecanone, epoxy clerodane diterpenes, sitosterol, stigmasterol and inositol.

LC-MS/MS method development for the determination of major constituents

DMAPR, Anand: LC-ESI-MS/MS with multiple reactions monitoring method was developed for identification and determination of viz., cordioside-1 (Sitosterol –β-O- glycoside), 5, 7, 3′,5′ tetrahydydoxyflavone, 20β hydroxycdysterone, β-sitosterol, palmatine and berberine in *Tinospora cordifolia*. Chromatographic separation of analytes was performed on an C_{18} column by using mobile phase consisting of acetonitrile and formic acid (0.1%) in water. The LC-MS/MS parameters were optimized by using ESI source in positive mode of ionization. Identification and quantification were performed using MRM. 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 the specified compounds from the stem.

GUDMAR (*Gymnema sylvestre*)

It is a more or less pubescent woody climber belongs 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 when tasted are saltish and acidic and they suppress the activity of taste of tounge for sweet taste and the species is believed to destroy the sugar and hence the name 'madhunasini' or gudmar' and 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 on the basis of number of leaves per plant, fresh leaf yield per plant and dry leaf yield for selection of a superior cultivar. 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 was recorded in JBPGS8-9-104 (2076.3) followed by JBPGS8-9-101 (1754) while minimum number of fresh leaves per plant was in JBPGS8-9-106 (1135.6). Maximum fresh leaf yield per plant was in JBPGS8-9-104 (115.3 g) while minimum fresh leaf yield per plant was in JBPGS8-9-106 (67.6 g plant^{-1}). Maximum dry leaf yield was recorded in JBPGS8-9-104 (56.3 g plant^{-1}) followed by JBPGS8-9-101 (54.3 g plant^{-1}) while minimum dry leaf yield was in JBPGS8-9-105 (33.3 g plant^{-1}).

Effect of season and PGR on rooting

JNKVV, Jabalpur: The experiment was conducted with three planting seasons (July, August and September) and four levels of PGR (control, 250, 500 and 750 ppm IBA). Results revealed that cuttings treated with 750 ppm IBA for 30 minutes and planting in July month taken minimum time (7.67 days) for sprouting and recorded maximum sprouting (74.67%). Maximum survivability of cutting (41.33%) was recorded with 500 ppm IBA and when planted in August month, whereas, minimum survivability (16.0%) was noticed in September planting without IBA

HIMALAYAN RHUBARB (*Rheum australe*)

It is a robust, perennial glabrous plant and belongs to family *Polygonaceae*. It is endemic to the Himalayan region and 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. The stems are glabrous or pubescent at the nodes. The basal leaves have 30–40 long petioles and thick blades. The flowers are pedicellate and dark purple. 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, oxantrone etc.

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

YSPUHF, Solan: The experiment comprising 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}) were investigated. Observations on growth and yield parameters were recorded after 12, 24 and 36 months of planting. Three year results showed maximum plant height (15.36 cm), root length (38.30 cm), underground biomass (16.47 q ha^{-1}), gross returns (₹233400 ha^{-1}) and B:C ratio (10.15) with the application of NPK at 120:60:30 kg ha^{-1}, however, above ground biomass per plant (38.29 g) was maximum with vermicompost + azotobacter + PSB at 10 t : 5 kg : 5 kg ha^{-1}. Thus, NPK at 120:60:30 kg ha^{-1} was recommended for cultivation with maximum gross return and B:C ratio.

ISABGOL (*Plantago ovata*)

The species belongs to the family *Plantaginaceae*. Seed coat is known as Isabgol husk under trade. The swelling property of the seed coat or husk after absorption of water is the cause of its use as a famous medicine against constipation and gastrointestinal irritations. In addition, it is used in food industries for the preparation of ice creams, candy, etc. India is the leader in Isabgol production and largest exporter of husk. Country earns on an average ₹200 crores annually from its export. It is a cultivated species of North Gujarat, adjoining Rajasthan and Madhya Pradesh over an area of about 1, 00,000 ha. Its number of high yielding varieties are available for cultivation. It is an annual herb grown during the rabi season.

Standardization of protocol for somatic embryogenesis

DMAPR, Anand: Haploids play important role in the breeding programme. *In vitro* anther and ovary culture is often the method of choice for doubled haploid production in plants.

Plant tissue culture-mediated somatic embryogenesis has been suggested as a promising tool for obtaining efficient true-to-type plant propagation. A method for induction of somatic embryogenesis in *P. ovata* was standardized and it was found that devised MS media in the presence of TDZ (1.0- 2.0 mg l^{-1}) and AgNO3 (0.5-2.0 mg l^{-1}) enhanced initiation and higher frequency of somatic embryos. The development of somatic embryos started through the different stages ranged from initiation to globular, heart and torpedo stages. Similarly, physical conditions such as photoperiod (16 h light- 8 h dark), temperature (ranged from 22-25 °C) and period of sub-culturing (21 days) were found better for the induction and development of somatic embryos.

Maintenance and evaluation of germplasm

MPUAT, Udaipur: A total of 32 lines maintained as genetic stock were evaluated for different morphological traits, viz., plant height, number of branches per plant, spike length, number of effective spikes per plant and seed yield. The observations on days to 75 percent flowering, maturity and swelling factor were recorded. Seventeen lines exhibited higher seed yield over the best check Niharika (1111 kg ha^{-1}) and over grand mean of the experiment (1091 kg ha^{-1}). Seed yield for the trial ranged from 556 kg ha^{-1} (HI-9) to 1428 kg ha^{-1} (UI-16).

RVSKVV, Mandsaur: Eighty lines of Isabgol were evaluated for five characters and wide range of variability among the lines were observed. Plant height ranged from 27.0 cm (MIB-1006) to 39.0 cm (MIB-125). Days to 50 percent flowering ranged from 69 (MIB-1008) – 99 days (MIB-103). Number of spikes per plant varied from 25 (MIB-3) – 60 (HI-2). Length of spikes varied from 3 cm (RI-2) – 6 cm (MIB-1008). Seed yield ranged from 233 (SLS-52) – 1183 kg ha^{-1} (SPS-4). The highest seed yield was recorded by SPS-4 (1183 kg ha^{-1}) followed by SPS-19, SPS-25, SPS-50, and HI-2 (900 kg ha^{-1}) as compared to JI-4 (750 kg ha^{-1}).

Study of tetraploids

DMAPR, Anand: The tetraploids developed from GI 2 using colchicine were in advanced generation (C7). A total of 117 lines were screened for its ploidy level (diploid vs tetraploid) using ploidy analyzer and 97 lines were confirmed as tetraploid. These lines were advanced to next generation. The line DTPO 2-1 had significantly higher yield than the variety GI-2.

Data mining and development of SSR markers

DMAPR, Anand: High quality transcriptome data of *P. ovata* were downloaded from NCBI public domain, assembled and used for bioinformatics analysis to develop SSR markers. A total of 23,586 transcript contigs having more than 200bp size were obtained after the assembly. Analysis using MISA software identified 16,393 SSRs having more than 12bp motif length were identified. One thousand SSR markers were developed for application in Isabgol breeding. Out of the 25 markers tested, 16 (68%) markers showed amplification.

Screening of breeding lines for Downy mildew resistance

DMAPR, Anand: Breeding lines of Isabgol were screened for resistance to Downy mildew disease by developing artificial disease pressure in the field. Out of 247 lines screened three mutants DPO 144, DPO 145 and DPO 333-2 showed resistance**.**

Mutation breeding and selections

DMAPR, Anand: In mutation breeding experiment (M7 generation), 439 stable mutants/lines (DPO 1 – DPO 439) were selected and selfed seeds of these lines were harvested. Distinct stable mutants were identified. Some of the stable and distinct mutant lines identified for different morphological characters were, DPO 259 (yellowish green leaf base), DPO 275 (short plant, less than 22 cm with only two branches), DPO 276 (short leaf mutant, less then 12 cm) and DPO 395-3 (decumbent type plant).

Advanced varietal trial evaluation

CCSHAU, Hisar: In this trial, two entries, DPO-1 and DPO-4 from DMAPR, Anand, one entry, Selection-10 from AAU, Anand and HI-2009 from Hisar were evaluated against HI-5 (Local check) and Niharika (National check). Plant height (cm) ranged from 30.83 (DPO-1) – 35.58 (HI-2009), number of branches varied from 3.47 (HI-5) – 4.08 (HI-2009), number of spikes from 33.07 (Sel-10) – 54.18 (DPO-4); length of spikes (cm) 4.37 (DPO-1) – 5.3 (HI-2009); length of peduncle (cm) 20.83 (HI-5) – 24.08 (HI-2009) and seed yield (kg ha^{-1}) 776.19 (Sel-10) – 1123.81 (HI-2009). HI-2009 recorded significantly higher seed yield (1123.81 kg ha^{-1}) followed by DPO-4 (902.38 kg ha^{-1}) over the check HI-5 (840.47 kg ha^{-1}) and Niharika (776.19 kg ha^{-1}).

MPUAT, Udaipur: Three entries along with Niharika as national check and RI-89 as local check were evaluated. Among the entries, DPO 4 produced significantly higher seed yield (1200 kg ha^{-1}) followed by DPO 1 (975 kg ha-1), however, the performance of DPO 1 was at par with Sel 10 (936 kg ha^{-1}). All the three entries outperformed the local check, RI-89 (866 kg ha^{-1}), however, Sel 10 could not outperform the national check, i.e. Niharika (894 kg ha^{-1}). DPO-4 showed earliness in maturity compared to the other entries and checks in the trial.

Initial varietal trial of early maturing lines

AAU, Anand: Five early maturing lines (90-100 days for maturity) were evaluated along with check GI-2. Significant differences were found among the lines in the case of plant height, plant spread, spike length, number of spikes per plant, peduncle length, seed yield, test seed weight and days to crop maturity except number of branches per plant. Maximum plant height was observed in GI-2 (36.70 cm) which was at par with DPO 14, DPO 174 and DPO 385. Similarly, maximum plant spread was recorded by GI-2 (10.05 cm) however; it was at par with all the other lines except APO-1. Spike length was also significantly higher in GI-2 (5.17 cm). Maximum peduncle length was observed in GI-2 (24.80 cm) and it was at par with DPO 14 and DPO 174. Maximum seed yield was recorded by DPO-14 (1018.05 kg ha^{-1}), however it was at par with GI-2 (1003.47 kg ha^{-1}), APO-1 (944.44 kg ha^{-1}) and DPO-

174 (984.03 kg ha-1). Among the lines tested, APO-1 has recorded maximum test weight (1.81g) whereas, DPO 385 recorded minimum test weight (1.51 g). Days to crop maturity for most of the entries were 21 to 26 days, earlier than the check variety GI-2. Maximum per day productivity was recorded by DPO-14 (10.60 kg ha-1) and it was 27.86 percent higher than the check GI-2.

DMAPR, Anand: Three test entries viz., DPO 174, DPO 186, DPO 385 and one check (DPO 14) of early maturing group (90-100 days) were tested and DPO 174 showed 14 percent higher seed yield than check variety.

CCSHAU, Hisar: Three early maturing entries viz., DPO 174, DPO 186 and DPO 385 from DMAPR, Anand were evaluated against INGR 11035 and HI 5 (local check). Plant height ranged from 28.42 cm (DPO 174) – 30.66 cm (HI 5); number of branches ranged from 2.92 (DPO 174) – 3.92 (INGR 11035); number of spikes ranged from 23.75 (DPO 174) – 33.75 (DPO 385); length of spikes ranged from 3.70 cm (DPO 174) – 4.22 cm (HI 5); length of peduncle ranged from 17.83 cm (DPO 186) – 21.33 cm (HI 5) and seed yield ranged from 616.07 kg ha-1 (INGR 11035) – 895.83 kg ha-1 (HI 5). Entry DPO 174 recorded significantly higher seed yield (827.38 kg ha-1) followed by DPO 186 (684.53 kg ha-1) and DPO 385 (666.67 kg ha-1) over the check INGR 11035 (616.07 kg ha-1).

MPUAT, Udaipur: Three early maturing lines (DPO 174, DPO 186, DPO 385) were evaluated along with DPO-14 as check. DPO-385 exhibited significantly higher seed yield (695 kg ha-1) which was at par with DPO-186 (660 kg ha-1). DPO 385 outperformed had better seed yield than check DPO 14 (590 kg ha-1).

Initial varietal evaluation trial of late maturing lines

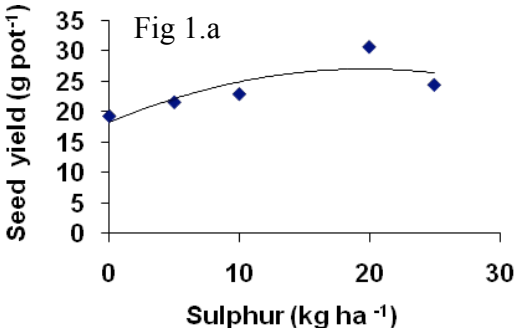
CCSHAU, Hisar: Two entries viz., AMB-2 and MIB-124 from Udaipur and HI-2009 from Hisar were evaluated against the check GI-2, Niharika and HI-5 (local check). Plant height ranged from 26.32 cm (GA-2) – 37.52 cm (Niharika), number of branches per plant ranged from 3.74 (MIB-124) – 4.52 (HI-2009), number of spikes ranged from 33.12 (MIB-124) – 47.40 (Niharika); length of spikes ranged from 4.08 cm (AMB-2) – 5.04 cm (HI-2009); length of peduncle ranged from 21.92 cm (MIB-124) – 23.80 cm (HI-2009) and seed yield ranged from 745.23 kg ha-1 (AMB-2) – 1130.95 kg ha-1 (HI-2009). HI-2009 recorded highest and significantly higher seed yield (1130.95 kg ha-1) than the checks, HI-5 (1014.29 kg ha-1), Niharika (1000.00 kg ha-1) and GI-2 (847.16 kg ha-1). None of the other entries gave higher seed yield than the local check HI-5 (1014.29 kg ha-1).

MPUAT, Udaipur: Two late maturing entries UI-2-1 and UI-124 were evaluated at Udaipur centre along with Niharika and GI-2 as standard checks and UI-89 as local check. UI 124 recorded significantly higher seed yield (1360 kg ha-1) which was at par with UI 2-1 (1285 kg ha-1). Both the entries outperformed over all the three checks i.e. Niharika (1134 kg ha-1), GI 2 (1163 kg ha-1) and UI 124 (1144 kg ha-1) also.

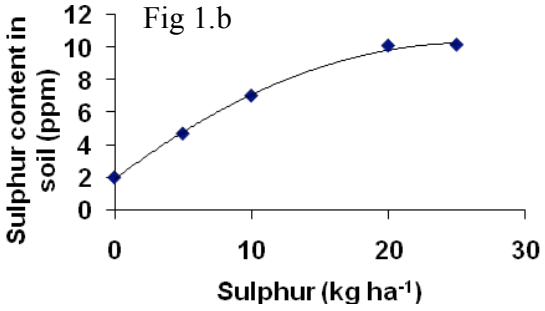
Effect of gypsum on growth and yield

DMAPR, Anand: Pot culture experiment was conducted to study the response of gypsum as source of sulphur on yield and sulphur content. Total dry matter (64.05 g pot-1), seed yield (30.63 g pot-1), seed quality attributes like, swelling factor (16%) were highest with the

application of sulphur 20 kg ha-1. Sulphur content in plant and soil were also influenced significantly with sulphur application. Yield and quality of crop as well as soil sulphur content after harvesting was worked out with with following response curves. After considering yield, quality and sulphur content in plant as well as soil after harvesting, critical dose of sulphur was found 20 kg ha-1.



Seed yield vs sulphur application response curve



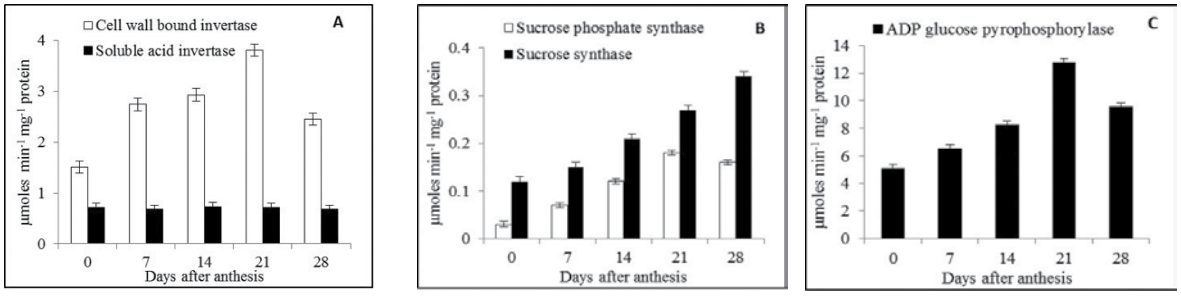
Sulphur content in soil vs sulphur application response curve

Development of seed standards

DMAPR, Anand: To develop the seed standard for Isabgol, physical purity, seed weight, and seed viability were studied. In isabgol, physical purity, thousand seed weight, seed viability were 90.4%,1.3-1.4 g and 99.9%, respectively.

Cabrohydrate metabolism during seed development

DMAPR, Anand: Enzyme activities of cell wall bound invertase, soluble invertase, sucrose synthase, ADP glucose pyrophosphorylase and sucrose phosphate synthase were studied in Isabgol during seed developmental stages at 0, 7, 14, 21 and 28 days after anthesis (DAA). Results revealed that enzyme activity of cell wall bound invertase increased significantly from 1.51 to 3.81 μmoles min-1 mg-1 protein and was maximum at 21 DAA. Soluble invertase activity increased non-significantly at different stages of observation. Sucrose phosphate synthase activity increased from 0.03 to 0.18 μmoles min-1 mg-1 protein and was maximum at 21 DAA, whereas, sucrose synthase activities was recorded maximum at 21 DAA (0.18 μmoles min-1 mg-1 protein) and 28 DAA (0.34 μmoles min-1 mg-1 protein). ADP glucose pyrophosphorylase activity increased and was maximum at 21 DAA (12.78 μmoles min-1 mg-1 protein).



Changes in (A) Cell wall bound invertase; soluble acid invertase (B) Sucrose phosphate; sucrose synthase (C) ADP glucose pyrophosphorylase activities during seed development in Isabgol

Screening of Isabgol germplasms for multiple diseases resistance

MPUAT, Udaipur: Screening of fifteen genotypes of Isabgol against Downy mildew , leaf spot and blight revealed that, six genotypes (PB-6-1, PS-17, Palampur-2, P-1, HI-1, MIB-125, GI-2) were moderately susceptible, while two genotype (PB-3-1 and Gumary) were moderately resistant (MR) and six genotypes (MIB-123, MIB-124, AMB-2, P-6, P-80 and DM-2) showed resistance against Downy mildew and leaf spots of Isabgol. It was also noticed that yield and swelling factor were significantly higher in resistant and moderate resistant genotypes (except P-6, P-80 and DM-2) comparison to susceptible genotypes.

Studies on population biology, ecology and epidemiology of Downy mildew

MPUAT, Udaipur: Studies on population biology and epidemiology of pathogen of Isabgol Downy mildew were carried out in field and laboratory. It was observed that two genus i.e. *Pseudoperonospora* and *Peronospora* existed in Isabgol crop during the cropping season and caused Downy mildew. The pathogen *Pseudoperonospora plantaginis* produced sporangia and released zoospores when temperature varied from 12.1 to 15.3 °C with a relative humidity of 12-23 percent; whereas, *Peronospora plantaginis* produced conidia and germinated through germ tube when temperature varied from 5.5 to 12.0 °C with a relative humidity of 20-38 percent. It showed that lower temperatures favoured infection and occurrences of *Peronospora plantaginis* and higher temperatures favours Pseudoperonospora plantaginis. It was concluded that downy mildew of Isabgol was caused by two pathogens i.e. *Pseudoperonospora plantaginis* and *Peronospora plantaginis*) in Udaipur, Chittorgarh, Pali, Sirohi, Barmer (Rajasthan conditions).

JATAMANSI (*Valeriana jatamansi*)

It belongs to family *Valerianaceae* and is a perennial herb of about 45 cm height and root stock including rhizome is thick, nodular and aromatic. The species is distributed in the Himalayan region. Roots of the species are useful in diseases related to eye, blood, liver and spleen. Leaves are used for the treatment of headache. Roots are also used in aromatic industry. Raw drug is collected mainly from the wild since cultivation is not yet popularized. Since it is a temperate plant, it requires cold weather for proper growth.

Study of morphological variability

UBKV, Kalimpong: Characterization studies revealed that the germplasm included nine morphotypes viz., 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). It was also found that anthesis of the female flowers was earlier than the hermaphrodite flowers and it was 3-4 days earlier in female flowers than hermaphrodite flowers in Northern Eastern Himalayan region. The stamens were found to be located in between the petal spaces of the flower in Northern Eastern Himalayan region in contrast to the epipetalous nature reported in the species. In addition, flowers of female and hermaphrodite plants were found to have both five and four petals within the same individual.

Effect of time of sowing and spacings on growth and yield

UBKV, Kalimpong: The crop was raised through seeds and planted during first week of June and July at three spacings (30 x 20, 30 x 30 and 30 x 45 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, significantly higher fresh aerial, underground, rhizome and root biomass with June transplanting at later growth phase of 12, 15, 18, 21 and 24 months were recorded. Further, plant spacing gave significant response at all the stages of observation and maximum aerial, underground, rhizome and root biomass at 30 x 45 cm which was at par with 30 x 30 cm and it was recorded at 6, 15, 18, 21 and 24 months stage of observation. In an another experiment the crop was raised through rhizome cutting and planted during first week of June and July at three spacings (30 x 20, 30 x 30 and 30 x 45 cm). Rhizome planting recorded significantly higher fresh aerial, underground and root biomass with June planting and rhizome biomass with July planting at later stages. Plant spacing played significant role on growth of fresh aerial, underground, rhizome and root biomass and these were maximum at 30 x 45 cm at later stages.

Study of incidence of stem rot and leaf mosaic disease

UBKV Kalimpong: Fixed plot survey was conducted to know the incidence of stem rot and leaf mosaic disease at Kalimpong during April, 2013 to March, 2014. Percent disease incidence (PDI) of stem rot was maximum during the month of August (31.76%) and minimum during the month of January (12.17%), where as PDI of leaf mosaic was maximum during January (20.61%) and minimum during the month of July (13.87%).

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.

Assessment of economic yield loss due to major insect pests

TNAU, Coimbatore: Field experiments were conducted to record infestation by major insect pests of under protected and unprotected conditions. In the protected plots, azadirachtin (1%) 10,000 ppm @ 1 ml l^{-1} was sprayed twice at interval of 15 days. Yield losses due to defoliators (*Plusia signata* and *spodoptera litura*) and the major sucking pest *Thrips tabaci* were found to be 26.17 and 10.98 percent respectively.

Efficacy of bio-pesticides for the management of thrips

TNAU, Coimbatore: The different biopesticides viz. NSKE (5%), azadirachtin (1%), Pungam oil (3ml l^{-1}), natural lactones (2ml l^{-1}) and *Beauveria bassiana* (2%) were evaluated against the thrips. Fipronil (1.5 ml l^{-1}) and spinosad (0.4 ml 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 (0.06 thrips $plant^{-1}$) followed by spinosad (0.12 thrips $plant^{-1}$) in treated plots. Among the biopesticides and natural lactones recorded the lowest mean population of 0.76 thrips per plant followed by azadirachtin (1%) (0.96 thrips $plant^{-1}$), whereas the untreated plots recorded an average of 8.38 thrips per plant.

Management of leaf blight using fungicides and biocontrol agents

TNAU, Coimbatore: A field experiment was conducted at farmer's field at Vellipalayam, Coimbatore district, Tamil Nadu to manage the leaf blight disease (*Alternaria alternata*). Spraying of fungicides and bio-control agents were done at 30 and 60 DAP. The results revealed that spraying tebuconazole (0.1%) twice on 30 and 60 DAP was effective in managing the leaf blight disease which recorded the lowest disease intensity (16.3%) and highest yield (523 kg ha^{-1}). It was found to be at par with spraying *Pseudomonas fluorescens* (0.2%) on 30 DAP followed by lemongrass oil (0.2%) on 60 DAP which recorded a disease incidence 17.2 percent. In the control, the disease intensity had gone up to 29.4 percent and seed yield was 386 kg ha^{-1}.

Management of root rot

TNAU, Coimbatore: A field experiment was conducted at farmer's field at Vellipalayam, Coimbatore district, Tamil Nadu to manage the root rot disease caused by *Macrophomina phaseolina* in Kalihari. The results revealed that soil application of *Trichoderma viridae* (2.5 kg ha^{-1}) along with Mahua cake (150 kg ha^{-1}) + dipping the tubers in *P. fluorescens* (0.2%) followed by spraying (tebuconazole + trifloxystrobin) (0.2%) twice at 30 and 60 days after planting recorded the lowest disease intensity (11.0%) and recorded highest seed yield (553 kg ha^{-1}). Dipping the tubers in tebuconazole + trifloxystrobin (0.2%) followed by spraying with the same chemical and another treatment involving soil application of Mahua cake (150 kg ha^{-1}) followed by dipping the tubers with *P. fluorescens* (0.2%) were the other best management practices that recorded disease incidence of 14.0 and 14.7 percent, respectively

KALMEGH (*Andrographis paniculata*)

Kalmegh 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. 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 useful. Andrographolide is the active contituents 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.

Evaluation of germplasm

NDUAT, Faizabad: Eleven accessions of Kalmegh 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 three years (2011-12, 2012-13 and 2013-14) 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. Average plant height varied from 55.12 to 65.13 cm. The highest plant height was observed in IC 342135 followed by IC 111287 (60.89 cm) and IC 210699 (58.53 cm) while minimum height was recorded in 210635 (55.12 cm). Number of primary branches per plant ranged from 14.60 – 20.42. Maximum number of primary branches was in IC 342135 followed by IC 111287 (18.64) and IC 342141 (17.67) and minimum was in Faizabad Local. Fresh herbage yield ranged from 76.20 to 121.87 q ha^{-1}. Maximum fresh herbage yield was obtained in IC 342135 followed by IC 111287 (91.42 q ha^{-1}) and IC 111290 (85.83 q ha^{-1}). Minimum fresh herb yield was in Faizabad local (76.20 q ha^{-1}). IC 342135 gave better dry herbage yield (48.65 q ha^{-1}) which was 57.59 percent more than the check i.e. Faizabad Local (30.87 q ha^{-1}) followed by IC 111287 (40.57 q ha^{-1}) and IC 111290 (31.43 q ha^{-1}) which was 31.42 percent more than the check Faizabad local. From pooled analysis for three years 2011-12, 2012-13 and 2013-14, it was found that amongst eleven accessions, IC 342135 performed as the best for plant height, number of primary branches, fresh as well as dry herbage yields. In another trial, twenty accessions of Kalmegh were evaluated to find out a suitable cultivar favorable for Eastern Uttar Pradesh conditions. The data were recorded with respect to plant height, number of primary branches per plant and fresh as well as dry herbage yields. The plant height varied significantly from 52.40 – 59.50 cm. The highest plant height was in IC 211295 followed by IC 342135 (58.60 cm) and IC 111291 (58.00 cm) while, minimum plant height was in IC 342139 (52.40 cm). Number of primary branches per plant ranged significantly from 13.15 – 20.65. Maximum number of primary branches was recorded in IC 210699 followed by IC 260035 and IC 111290 and minimum was in IC 342135. Fresh herbage yield varied significantly among the 20 accessions (64.06 – 127.60 q ha^{-1}). Maximum

fresh herbage yield was in IC 265622 (127.60 q ha-1) followed by IC 210635 (124.99 q ha-1) and IC 111291 (119.79 q ha-1). Minimum fresh herb yield was in IC 471894 (64.60 q ha-1). IC 265622 produced better dry herbage yield (64.06 q ha-1) as compared to IC 210635 (60.41 q ha-1) and IC 111291 (55.73 q ha-1), while minimum dry herbage yield was in IC 471894 (31.77 q ha-1).

Development of DUS guidelines

DMAPR, Anand: DUS descriptors were identified for ten morphological characters and accordingly distinct lines were developed. The major characteristics identified 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, medium and late); inflorescence type (flower buds closely arranged or distantly arranged); plant height (tall, normal, dwarf), stem internode length (normal or compact), flowering pattern (medium and late); and stem internode length (normal or compact). Accordingly, 45 distinct reference varieties were identified.

During 2013-14, the identified distinct lines were transplanted in the field for the confirmation of the identified characters. One set of the identified lines were planted at BCKV, Kalyani, West Bengal for stability testing across location. Among the characters, 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); branching pattern (open or close) and flowering pattern (early), plant canopy shape (conical, round); flowering pattern (medium and late); inflorescence type (flower buds closely arranged or distantly arranged) and plant height (tall, normal, dwarf) were confirmed. One character i.e., stem internode length (normal or compact) was found not stable in plants transplanted in the middle of July. The character was expressed in late transplanted line and hence was kept under observation for one more year. Another character i.e. leaf lamina (inwardly closed or outwardly curved) was kept under rechecking since the character was not expressed properly at BCKV, Kalyani.

One new character was identified for DUS descriptor during the year i.e., broad leaf at the primary nodes. DMAPR AP 1, 2, 19 were long broad leaf type and DMAPR AP 24 was short broad leaf type. DMAPR AP3 had long narrow leaves and DMAPR AP 6 had short narrow leaves. DMAPR AP 6 and 19 had light green colour and DMAPR AP 3 and 42 had dark green leaves. DMAPR AP 46 had broad leaf at the primary nodes. Branching pattern of open type was found in DMAPR AP 13, 22 and close type were found in DMAPR AP 19, 35. DMAPR AP 37 was early flowering type and DMAPR AP 1 and 2 were late flowering types. Leaf data like length and breadth of 100 leaves of nine accessions were taken for grouping of the leaf character. It was found that mean breadth of narrow leaves were not more than mean breadth of 1.5 cm, whereas mean breadth of broad leaved lines were having more than breadth of 2.5 cm. In case of short broad and short narrow leaves, mean length was not more than 7.7 cm and 7.79 cm, respectively, but in case of long broad and long narrow leafed lines, the mean length varied from 9.05 to 10.09 cm, whereas in case of small leafed

line, the mean breadth was 1.65 cm and mean length was 6.29 cm. Among the long broad leafed lines, DMAPR AP 19 was having maximum length of 12.1 cm and maximum breadth of 4.2 cm. Maximum length breadth ratio varied from 3.3-2.4 among broad leafed lines, whereas in narrow leafed line, the ratio was 6.8.

Effect of nutrient management on yield

DMAPR, Anand: The experiment conducted with organic (FYM 0, 10 and 15; vermicompost 5 and 7.5; castor cake 1.5 and 2.5 t ha^{-1}) and inorganic (N0P0K0; N40:P10:K30; N60:P20:K40; N80:P30:K50; N80:P30:K50 (half N with full P and K as basal and remaining half N at 25 DAS); N80:P30:K50 (half N with full P and K as basal and remaining half N in two equal splits at 25 and 40 DAS); N80:P30:K50 (half N with full P and K as basal and remaining half N in three equal splits at 25, 40 and 60 DAS) nutrient sources. Results showed that application of castor cake at 2.5 t ha^{-1} and N80:P30:K50 (half N with full P and K as basal and remaining half N in three equal splits at 25, 40 and 60 DAS) recorded significantly higher dry herbage yield (4265 kg ha^{-1}).

Inter-cropping of Kalmegh with pigeon pea

PDKV, Akola: The experiment was conducted to evaluate the suitable inter-cropping system of Kalmegh+pigeon pea comprising of four row proportions (2:1, 3:1, 2:2 and 1:2), and compared with sole Kalmegh and sole pigeon pea. The two year results showed significantly highest plant height (52.5 cm) at 1:2 row proportion. Whereas, dry foliage yield (15.9 q ha^{-1}), Kalmegh equivalent yield (25.41 q ha^{-1}), LER (1.59) and gross returns (₹48219 ha^{-1}) were significantly higher at 3:1 row proportion. Thus, it was concluded that Kalmegh+pigeon pea intercropping at 3:1 row proportion was the most suitable and economical.

Effect of planting dates and nitrogen levels on the growth and yield

RVSKVV, Mandsaur: The experiment comprising of three dates of planting (15th June, 30th June and 15th July) and four levels of nitrogen (control, 40, 60, 80 kg ha^{-1}) were conducted. Result revealed that application of N 80 kg ha^{-1} recorded highest herbage yield (27.3 q ha^{-1}), whereas, planting at 30th June recorded highest herbage yield (26 q ha^{-1}).

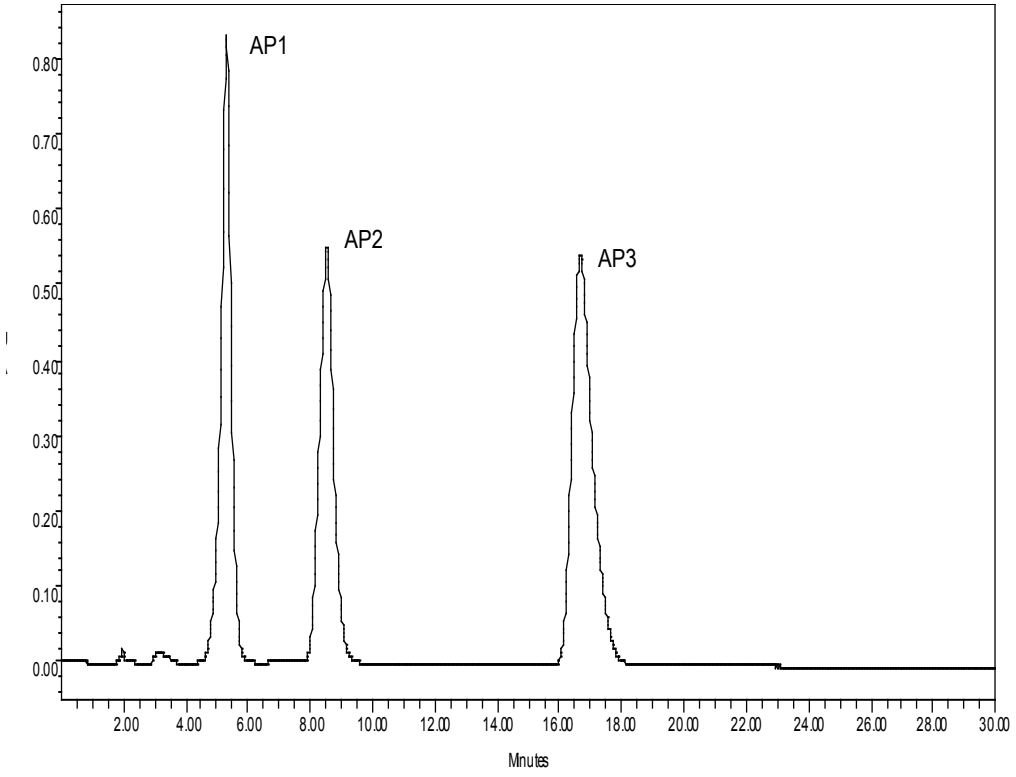
Development of seed standards

DMAPR, Anand: To develop the seed standard in Kalmegh, physical purity, seed weight, germination percentage (minimum) and seed viability were studied. It was reported that physical purity, thousand seed weight, germination percentage and seed viability were 82.9%, 1.7-1.9 g, 84.0% and 98.4%, respectively.

Effect of the extraction techniques on extract composition and quantification of three andrographolides

DMAPR, Anand: Diterpenoid compounds andrographolides (AP) are the main bioactive phytochemicals present in leaves and herbage of *A. paniculata*. The efficiency of supercritical fluid extraction (SFE) using carbon dioxide was compared with the solid–liquid extraction techniques such as solvent extraction, ultrasound assisted solvent extraction and microwave-

assisted solvent extraction with methanol, water and methanol–water as solvents. Also a rapid and validated reverse-phase high-performance liquid chromatography- diode array detection method was developed for the simultaneous determination of the three biologically active compounds, andrographolide (AP1), neoandrographolide (AP2), and andrograpanin (AP3), in the extracts. Under the best SFE conditions tested for diterpenoids, which involved extraction at 60 °C and 100 bar, the extractive efficiencies were 132 and 22 mg g^{-1} for AP1 and AP2, respectively. The modifier percentage significantly affected the extraction efficiency.



HPLC chromatogram of standard mixture of AP1, AP2 and AP 3,

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.

Evaluation of the selected accessions

KAU, Trichur: A multilocational trial was conducted with selected accessions; TCRPR 516 and TCRPR 521 along with two local checks Mrudula and Agni at farmers' field at three locations viz; Ollukkara, Irinjalakuda and Madakkathra of Kerala. Observations were recorded on plant height, number of branches per plant, internodal length, plant type, leaf shape, leaf colour, leaf length and breadth. Pooled analysis of data indicated that location effects were not significant for TCRPR 516, TCRPR 521 and local checks Mrudula and Agni. The treatments showed significant differences for plant height, number of branches and internodal length. The selected accessions had more plant height and number of branches per plant in comparasion to Agni. Internodal length was less for the selected accessions compared to both the local checks Mrudula and Agni. With respect to morphological characters like plant type and leaf characters, no variation was noticed.

Integrated nutrient management

PDKV, Akola: The experiment was conducted during 2011-12 to 2013-14 comprising of twelve combinations of organic and inorganic nutrient sources. Three year results on pooled basis revealed that highest number of fruits per vine (89.24) was recorded with application of NPK at 100:50:50 kg along with neem cake 20 q ha^{-1}. Whereas, application of NPK at 150:75:75 kg along with neem cake 20 q ha^{-1} recorded significantly higher dry fruits yield (464 kg ha^{-1}) and gross monetary returns (₹147837 ha^{-1}), however, net monetary returns (₹88805 ha^{-1}) and B:C ratio were significantly higher with the application of NPK at 100:50:50 kg along with FYM 20 t ha^{-1}. Soil fertility status was improved in respect of organic carbon and available nitrogen with NPK at 100:50:50 kg along with FYM 20 t ha^{-1}. However, the available P and K were maximum with NPK at 200:100:100 kg ha^{-1} alone. The fertility status in respect of available micronutrients was also sustained/improved due to application of organic and inorganic nutrients. Thus, it was concluded that application of NPK at 100:50:50 kg along with FYM 20 t ha^{-1} was optimum to harvest good yield and net monetary returns with higher B:C ratio and sustained or improved soil fertility.

LONG PEPPER (*Piper longum*)

It is a member of family *Piperaceae* and it 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 also contains 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. Its fruits are readdy to harvest from 8th months onwards and in the third or fourth year, the entire plants are uprooted. The harvested products are sun-dried and used.

Collection, characterization, evaluation and maintenance of germplasm

AAU, Jorhat: Thirty five germplasm accession of long pepper were collected from different locations of Northern Eastern States viz., Arunachal Pradesh (03), Tripura (02), Meghalaya (02) and Assam (28) and were studied for various morphological and yield characters. Among the germplasm, one accession (JPL-8) was found to be male type. Leaf tips were invariably found to be acute and the leaf margins were entire among the accessions. Leaf bases were either pulvinous or non-pulvinous whereas the leaf colour ranged from light green to green and dark green. Wide variations in leaf length, leaf breadth, leaf length/ breadth ratio and leaf size were observed among the germplasm. Leaf length (cm) ranged from 3.13 (JPL-9) – 6.23 (JPL- 14). Similarly, the leaf breadth (cm) varied from a 3.33 (JPL-9) – 5.87 (JPL-7). Accordingly leaf length to breadth ratio varied from 0.84 (JPL- 1) – 1.37 (JPL-11). Significant variations in leaf size (cm^2) were also found among the collected accessions which ranged from 19.10 (JPL-10) – 44.42 (JPL-31). Internodal length (cm) of the germplasm varied from 2.27 (JPL-25) – 6.10 (JPL-1). Significant variation was also found among the germplasm with regard to the stem diameter at base. Highest diameter at base was recorded in JPL-7 (1.87 cm) whereas minimum was found in JPL-3 (0.63 cm). Fruit length, fruit diameter, number of fruits per plant, fresh weight and dry weights of the fruits of different accessions were also varied significantly. Longest fruit of 3.7 cm was observed in JPL-32 whereas shortest fruit (1.13 cm) was observed in JPL-1 and followed by JPL-16 (1.47 cm). Diameter of fruit was also maximum in JPL-32 (3.33 cm). JPL-1 recorded minimum diameter of fruit (0.90 cm). Assam collections showed medium length of fruits with smooth and uniform diameter. Number of fruits per plant was maximum in JPL-1 (85) whereas JPL-28 had minimum number of fruits (19). Dry weight of fruits ranged from 60-70 percent among the accessions.

Post harvest deterioration of piperine content

PDKV, Akola: The dry fruits of piper were collected from 20 different farmers and dried fruits were stored in transparent pet bottle at room temperature. The samples were taken from the container at an interval of two months for the analysis of piperine content and moisture content. Significant difference was not found in the piperine content and moisture content.

MAKOI (*Solanum nigrum*)

It belongs to family *Solanaceae* and commonly known as black night shade, makoi or deadly nightshade. It possesses medicinal properties like antimicrobial, anti-oxidant, cytotoxic properties, antiulcerogenic and hepatoprotective activity. 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 berries are poisonous, but boiling apparently destroys the toxic substances and makes them usable for preserves, jams, and pies. The fruit is used as a cosmetic; rubbing the seeds on the cheeks to remove freckles. 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 constituent reported to be responsible for this action is diosgenin.

Characterization, evaluation and maintenance of germplasm

YSRHU, Venkataramannagudem: Forty four accessions were evaluated for morphological and agronomical traits. The accessions under evaluation exhibited wide range of variations with respect to the growth parameters and yield. Distinct characters like plants bearing red berries with erect growing habit and flowers with streak in petal were identified in APSn-25 (collected from Shankarghat, UP). TNSn-50 exhibited streak in flower petal, the character as reported by TNAU was found stable. Similarly, taxonomic identification of the accessions of *Solanum* spp. was carried out with the help of BSI, Coimbatore. Alkaloid analysis was carried out for 11 accessions. Organoleptic studies were carried out for AP accessions. APSn-12, APSn-6 and APSn-20 were found suitable for leafy vegetable purpose. Apsn-1, Apsn-2, Apsn-4, Apsn-6, Apsn-7, Apsn-8, Apsn-9, Apsn-10, Apsn-11, Apsn-12, Apsn-14, Apsn-16, Apsn-18, Apsn-19-, Apsn-20, Apsn, -21, Apsn-22, Apsn-23, Apan-24, Apsn-25, Apsn-26, Apsn-27, MG-14, MG-8, TNSn-8, TNSn-10TNSn-12, TNSn-19, TNSn-23, TNSn-24, TNSn-30, TNSn-31, TNSn-50, TNSn-38, TNSn-44 APSn-30 and APSn-31 were erect and Apsn-3, Apsn-5, Apsn-17, TNsn-30, TNsn31, TNsn-50 were spreading type. Apsn-1, Apsn-2, Apsn-4, Apsn-6, Apsn-7, Apsn-8, Apsn-9, Apsn-10, Apsn-11, Apsn-12, Apsn-14, Apsn-16, Apsn-18, -, Apsn-20, Apsn, -21, Apsn-22, Apsn-23, Apan-24, , Apsn-26, Apsn-27, MG-14, MG-8, TNSn-8, TNSn-12, TNSn-19, TNSn-23, TNSn-24, TNSn-38, TNSn-44, APSn-30, APSn-31, APSn-30 and APSn-31 were having green stem colour and Apsn-3, Apsn-5, Apsn-17, Apsn-19 Apsn-25, TNSn-10TNsn-30, TNsn31 and TNsn-50 were having purple stem colour. Leaf colour was green in Apsn-1, Apsn-2, Apsn-4, Apsn-6, Apsn-7, Apsn-8, Apsn-9 , Apsn-10, Apsn-11, Apsn-12, Apsn-14, Apsn-16, Apsn-18, Apsn-20, Apsn, -21, Apsn-22, Apsn-23, Apan-24, Apsn-26, Apsn-27, MG-14, MG-8, TNSn-8, TNSn-12, , TNSn-23, TNSn-24, TNSn-31, TNSn-

38, TNSn-44 APSn-30 and APSn-31 and dark green in Apsn-3, Apsn-5, Apsn-17, Apsn-25, TNSn-10TNSn-19TNsn-30, TNSn-23 and TNsn-50. Fruit colour was black in Apsn-1, Apsn-2, Apsn-4, Apsn-6, Apsn-7, Apsn-8, Apsn-9, Apsn-10, Apsn-11, Apsn-12, APSn-13, Apsn-14, Apsn-16, Apsn-18, Apsn-20, Apsn, -21, Apsn-22, Apsn-23, Apan-24, , Apsn-26, Apsn-27, MG-14, MG-8, TNSn-8, TNSn-12, TNSn-19, TNSn-23, TNSn-24,TNSn-38, TNSn-44 and red in Apsn-3, Apsn-5, Apsn-17 APSn-25, APSn-28, APSn-29, TNsn-30, TNsn31 and TNsn-50.

Wide range of variations with respect to the characters noticed for plant height (45.33 - 137.66 cm), total number of branches (5.00 - 103.33), stem diameter (1.17 - 5.17 mm), leaf length (2.50 - 8.80 cm), leaf breadth (1.20 - 4.60 cm), leaf area and herbage yield (3.30 - 64.20 kg per plot size of 12 m^2). Herbage yield was significantly highest in APSn-19.

TNAU, Coimbatore: Germplasm collections were made from different parts of the country. Based on the IPGRI descriptor, the germplasm was characterized for morphological characters. Among the accessions, morphologically distinct accessions (TNSn 8, 10, 12, 19, 23, 30, 32, 38, 44, 47, 51, 52 and 53) were identified and DNA barcoding was carried out for the distinct types. The results revealed that three different species viz., *Solanum nigrum*, *S. americanum* and *S. villosum* were present in the germplasm collection. The accessions TNSn 10, 19 and 51 belonged to *S. nigrum*, the accessions TNSn 12, 23, 38, 52 and 53 belonged to *S. americanum* and the accessions TNSn 30, 32, 44 and 47 belonged to *S. villosum*. Root tip mitosis results revealed that chromosome number of *S. nigrum* and *S. americanum* was 2n=2x=24 and the chromosome number of *S. villosum* was 2n=4x=48 and one accession of *S. nigrum* (TNSn 10), was hexaploid (2n = 6x = 72). Total alkaloid content was estimated at matured green berry stage. The alkaloid content was found to be increasing with increasing ploidy level also. Among the accessions, highest total alkaloid content was present in TNSn 10 (0.48 %). Evaluation of accessions for herbage yield and quality traits resulted in the identification of two promising accessions viz., TNSn 19 and TNSn 10.

Effect of organic manures and biofertilizers on growth and yield

YSRHU, Venkataramannagudem: The experiment was conducted for 3 years (2010-11 to 2012-13) comprising of three levels of organic manures (FYM 8 t, vermicompost 6 t and poultry manure 4 t ha^{-1}) and three biofertilizers (azophos 2 kg, azophosmet 2 kg and azophosmet 2 kg + methylobacterium 500 ml ha^{-1}). The results on pooled basis showed that application of vermicompost 6 t with azophosmet 2 kg + methyl bacterium 500 ml ha^{-1} produced maximum plant height (73 cm), branches per plant (22), herbage yield (20.6 t ha^{-1}), net returns (₹ 2.00 lakh ha^{-1}) and B:C ratio (3.76).

TNAU, Coimbatore: The experiment comprising of organic manures (FYM 8 t, vermicompost 6 t and poultry Manure 4 t ha^{-1}) and bio-fertilizers (azophos 2 kg, azophosmet 2 kg and azophosmet 2 kg + methylobacterium 500 ml ha^{-1}) were investigated. Results revealed that application of vermicompost 6 t along with azophosmet 2 kg + methylobacterium 500 ml ha^{-1} resulted in maximum growth parameters such as plant height (75.7 cm), number of branches per plant (6.2), weight per plant (110.2 g) and herbage yield (11.2 t ha^{-1}).

Effect of spacing and harvesting intervals on growth and yield

TNAU, Coimbatore: The experiment was conducted with 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 (12 t ha^{-1}) was obtained with sowing at 20 x 10 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: The experiment was conducted with five seed rates (2.5, 5.0, 7.5, 10.0 and 12.5 kg ha^{-1}) for broadcasting and compared with transplanting in lines at 30 x 30 cm spacing. The study revealed that there was no significant difference in growth parameters in all treatments. Seeds broadcasted at 12.5 kg ha^{-1} recorded significantly higher herbage yield (24.46 t ha^{-1}) followed by seed @ 5 kg ha^{-1} (19.73 t ha^{-1}).

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 of *S. nigrum*. Among the different treatments, highest fresh herbage yield (15.66 t ha^{-1}) was recorded with 12.5 kg seeds ha^{-1} which was on par with 5.0, 7.5 and 10.0 kg ha^{-1}.

Effect of age of seedling for transplantation 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). The results indicated that planting of 20 days old seedlings recorded highest plant height (86.2 cm) and herbage yield (12.12 t ha^{-1}).

Assessment of economic yield loss due to major insect pests

TNAU, Coimbatore: Field experiments were conducted to record infestation by major insect pests and its yield under protected and unprotected conditions. In the protected plots, azadirachtin (1%) 10,000 ppm @ 1 ml l^{-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 35.60 percent where as yield loss due to the major mite pest, *Polyphagotarsonemus latus* alone was recorded to be 63.59 percent.

Efficacy of biopesticides against major insect pests

TNAU, Coimabatore: Field trial was laid out to assess the efficacy of selected botanical insecticides against aphids, thrips, leaf miners and defoliators infesting *S. nigrum*. The different botanicals and biopesticides selected for the study includes NSKE @ 5%, *Andrographis paniculata* (aqueous extract, 2%), *Vitex negundo* (aqueous extract, 2%), azadirachtin (1%), mineral oil @ 3 ml l^{-1} and pungam oil @ 3 ml l^{-1}. The mean population of aphids and thrips were found to be minimum in the standard chemical check, profenophos (0.1 aphids/ three leaves $plant^{-1}$, 0.22 thrips $plant^{-1}$) followed by *A. paniculata* 2%, extract (3.76 aphids/ three leaves $plant^{-1}$, 0.6 thrips/plant) and azadirachtin 1% (3.24 aphids three leaves per plant, 1.14 thrips/plant). The leaf damage due to leaf miner was lowest in standard chemical check

followed by *A. paniculata* 2% (aqueous extract) and azadirachtin 1% and mean defoliation percentage was observed to be lowest in profenophos (2.12%) followed by *A. paniculata* 2% (4.3%) and azadirachtin 1% (4.46%). Maximum leaf yield was obtained in profenophos treated plots (19.86 kg 12 m^{-2} plot per harvest) followed by azadirachtin 1% (15.85 kg 12 m^{-2} plot per harvest) and *A. paniculata* 2% (15.75 kg 12 m^{-2} plot per harvest).

Management of yellow mite (*Polyphagotarsonemus latus*)

TNAU, Coimbatore: Field trial was laid out at the farmer's holdings at Edaiyarpalayam, Papampatti, Coimbatore to assess the field efficacy of selected botanical and acaricides against *Polyphagotarsonemus latus* infesting *S. nigrum*. Foliar application of spiromesifen 240 SC @ 500 ml ha^{-1} was found to be superior with maximum mean percent mortality (98%) of mites and higher marketable leaf yield (18.9 kg 12 m^{-2} plot per harvest) followed by propargite @ 2 ml l^{-1} (93.7 %, 18.3 kg 12 m^{-2} plot per harvest) and triterpenoid @ 1 ml l^{-1} (79.8%, 14.5 kg 12 m^{-2} plot per harvest).

Efficiency of different shades of yellow sticky traps on the 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 pest complex of *S. nigrum*. 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 the number of whiteflies, thrips and aphids on the sticky trap in 10 cm^2 area at weekly intervals. After each count, the traps were cleaned and again smeared with castor oil. The results revealed that maximum numbers of thrips were attracted to golden yellow shaded sticky trap kept below the crop canopy, which trapped 39.0, 44.0 and 86.7 thrips per 10 cm^2 area during July, August and September, 2013 respectively followed by golden yellow shaded sticky trap kept at the canopy level which trapped 43.3, 46.3 and 24.7 thrips per 10 cm^2. Minimum numbers of thrips were attracted to royal ivory shaded trap placed above the crop canopy (2.7thrips per 10 cm^2). In case of whiteflies, maximum attraction was recorded in golden yellow shaded trap placed above the crop canopy which trapped 18.3, 14.7 and 18.7 adults per 10 cm^2 during July, August and September, 2013 respectively, followed by golden yellow shade trap kept at canopy level (11.0, 8.0 and 11.0 adults per 10 cm^2 area). Maximum number of aphids were attracted to the butter scotch yellow shade kept below crop canopy (21.33, 18.00 and 28.33 adults per 10 cm^2 during July, August and September 2013, respectively), followed by butter scotch yellow shade kept at canopy level with population of 18.0, 12.67 and 18.0 aphids/10 cm^2. Minimum number of adults was trapped in golden yellow shade trap kept below crop canopy. 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 *S. nigrum*.

Management of insect pests using biopesticides

YSRHU, Venkataramannagudem: Field experiments were conducted to find out the efficacy of biopesticides against hadda beetle and thrips infestation profenofos @ 2.0 ml l^{-1} was

found significantly superior than other biopesticides. Among the biopesticides evaluated, azadirachtin @ 10000 ppm was found to be significantly effective over other aqueous extracts and oil formulations.

MANDUKAPARNI (*Centella asiatica*)

Mandukaparni is a member of family *Apiaceae* and is a prostrate slightly aromatic, perennial herb commonly found as a weed in crop fields. The species are widely distributed in India. It is propagated both by stolons as well as by seeds. It is used for the treatment of leprosy, skin diseases and to improve memory. It is also used against cholera, ulcers, bronchitis, leucorrhoea and kidney troubles. Asiaticoside, indocentelloside, thankuniside are the major glycosides responsible for the medicinal properties. Humus rich soil and partial shade are suitable for its cultivation.

Collection, characterization, evaluation and maintenance of germplasm

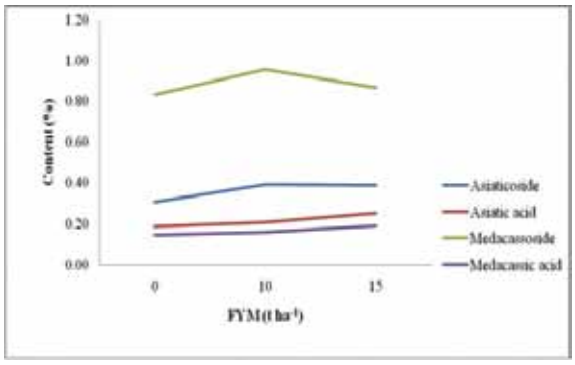
UBKV, Kalimpong: Seven accessions collected from different regions of West Bengal were evaluated along with Vallabh Medha as check. Different morphological characters viz., leaf margin, leaf colour and flower colour were compared for the study. Colour of the stem was light green in KAC 1 and 2; green in KAC 4, 5, 6 and reddish in KAC 7 and Vallabh Medha. Leaf margin type was uniformly crenate with small grooves in KAC 1 to 6, crenate in KAC 7 and uniformly crenate with large grooves in Vallabh Medha. The distinctness in flower colour was found in KAC 7 which is a unique character of the Kalimpong mandukaparni as flower colour is different in other accessions. Internode length varied from 3.1 (KAC 4) – 8.9 cm (KAC 7); leaf length varied from 2.1 cm in KAC 4 – 7.4 cm in Vallabh Medha; leaf breadth varied from 4.1 cm in KAC 1 – 8.7 cm in Vallabh Medha; petiole length varied from 2.9 cm in KAC 5 – 10.2 cm in KAC 7 and fresh herbage weight varied from 95.7 q ha^{-1} in KAC 6 – 192.5 q ha^{-1} in KAC 7. In Vallabh medha, fresh herbage yield was 167.8 q ha^{-1}.

RAU, Pusa: Eleven accessions collected from different parts of Bihar and other states were studied along with Vallabh Medha. The data indicated that among various accessions, the most promising was Vallabh medha obtained from DMAPR, Anand, Gujarat, which produced the largest size of leaves with highest yield on dry weight basis (36.75 q ha^{-1}). This was followed by RAU CA-10, obtained from Jamshedpur, Jharkhand and RAU CA-1 from Pusa, Samastipur, which gave dry weight of 31.50 q ha^{-1} and 29.65 q ha^{-1}, respectively.

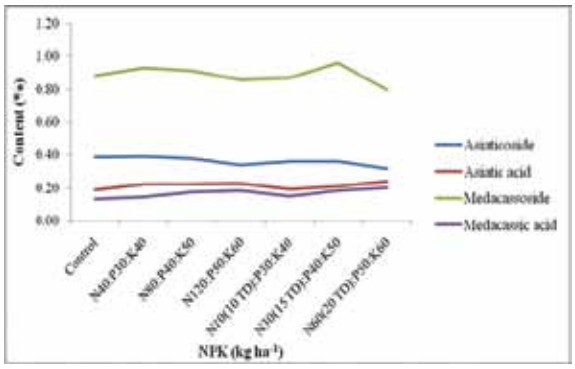
Effect of nutrient management on yield and quality

DMAPR, Anand: The experiment was conducted during 2011-13 to find out the effect of organic (FYM at 0, 10 and 15 t ha^{-1}) and inorganic fertilizers (N0:P0:K0; N40:P30:K40; N80:P40:K50; N120:P50:K60; N10:P30:K40 (N10 as top dressing at each harvest);

N30:P40:K50 (N15 as top dressing at each harvest); and N60:P50:K60 (N20 as top dressing at each harvest) on herbage yield and quality. N was applied as top dressing in split doses as per treatments, whereas, P and K were applied as basal in all the treatments. Pooled results of seven harvests revealed that application of FYM at 15 t along with N60:P50:K60 kg ha^{-1} as basal and 20 kg N ha^{-1} as top dressing at each harvest during first year and N60:K60 kg ha^{-1} as basal and 20 kg N ha^{-1} as top dressing at each harvest during second year (after 4th harvest) recorded significantly higher herbage yield (8.2 t ha^{-1}), NPK uptake, agronomic efficiencies of NPK, net returns (₹1.2 lakh ha^{-1}) and B:C ratio (1.6). Variable response to triterpenes content were obtained with the application of organic and inorganic fertilizers



Effect of organics on triterpens content



Effect of inorganics on triterpens content

Effect of harvesting stages on yield and quality

DMAPR, Anand: The experiment comprising of three stages of first harvesting (4 MAP, 5 MAP and 6 MAP) and 4 stages of subsequent harvestings (control, 2 month after first harvest, 3 months after first harvest and 4 months after first harvest) were investigated. Results showed that first harvesting at 5 months after planting and subsequent harvesting at 3 months interval recorded significantly higher leaf area and dry herbage yield (1.3 t ha^{-1}). Harvesting stages also influenced triterpenes content significantly.

Effect of irrigation on yield and quality

DMAPR, Anand: The experiment was conducted with six irrigation levels (0.4, 0.6, 0.8, 1.0, 1.2 and 1.4 IW/CPE ratio). Results revealed that application of irrigation at 0.4 IW/CPE ratio recorded maximum dry herbage yield (5.5 t ha^{-1}) and number of leaves per node (16), whereas, leaf area (20 cm^2) was recorded maximum with irrigation at 1.2 IW/CPE ratio. Irrigation at 0.4 IW/CPE ratio recorded maximum medacassoside and asiaticoside content, whereas, medacassic acid and asiatic acid were higher at 0.8 IW/CPE and decreased with further increase in IW/CPE ratio and irrigation interval.

Effect of planting time on yield

NDUAT, Faizabad: The experiment was conducted during 2011-12 to 2013-14 with five dates of planting (1st Feb., 15th Feb., 1st March, 15th March and 30th March). Three years results on pooled basis revealed that maximum plant height (29.37 cm), leaf area (38.18

cm^2), petiole length (23.94 cm), fresh (124.7 q ha^{-1}) and dry herbage yield (26.4 q ha^{-1}) were recorded when planted on 15th February followed by 1st February and 1st March. Thus, it was concluded that the best planting time was the first fortnight of February to obtain the maximum fresh as well as dry herb yield.

NEEL (*Indigofera tinctoria*)

It is a shrub which belongs to family *Fabaceae* and grows to a height of about one – two meter. It is an 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 ground cover and to improve the soil in the same way as the other legume crops such as alfalfa and beans are gorwn. Dye is obtained from the processing of the leaves. The species also have medicinal values. The leaves are dried and used for the treatment of any type of toxicity, fever, jaundice, arthritis and indigestion. The root is given for abdominal disorders, leucorrhoea and all types of toxicities etc.

Effect of organic manures and biofertilisers on yield and quality

KAU, Thrissur: The experiment was conducted with nine treatments having combinations of FYM (10 t ha^{-1}), vermicompost (3 t ha^{-1}) and coirpith compost (4 t ha^{-1}) and biofertilisers (azospirillum 2 kg, and azospirillum 2 kg + VAM 2 kg ha^{-1}). Three year results on pooled basis revealed that combined application of FYM 10 t and azospirillum 2 kg ha^{-1} gave significantly higher herbage yield (5928 kg ha^{-1}) and B:C ratio (3.56). Indican content was highest with application of farmyard manure. Application of vermicompost and azospirillum recorded highest uptake of N (405.44 kg ha^{-1}), P (18.95 kg ha^{-1}) and K (188.23 kg ha^{-1}).

Effect of spacing and cutting interval on herbage yield and quality

KAU, Thrissur: The experiment was conducted with four spacings (45 x 30, 60 x 30, 60 x 45 and 90 x 60 cm) and three cutting intervals (30, 60 and 90 days).. Pooled results of three year data revealed that planting at 45 x 30 cm spacing and harvesting at 60 days interval recorded higher herbage yield (4322 kg ha^{-1}), net return (₹63400 ha^{-1}) and B:C ratio (2.42). The herbage yield reduced significantly with increase in spacing and cutting intervals.

Effect of shade and planting dates on yield and quality

KAU, Thrissur: Three shade levels (25 and 50 % and open conditions) and three planting dates (2nd week of August, September and October) were investigated for the effect on yield and quality. Results showed that herbage yield (5555 kg ha^{-1}) was significantly higher under 25 percent shade condition with planting in September month. However, indican

content (1.10%) was higher under open condition followed by 25 percent shade (1.01%). Combination of open condition and planting in September month gave the highest indican content (1.13%).

OPIUM POPPY (*Papaver somniferum*)

The plant belongs to family *Papaveraceae*. Opium and poppy seeds are extracted from this species. The latex collected from the capsule is 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 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 also important food item and 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.

Evaluation and maintenance of working germplasm

MPUAT, Udaipur: A total of 85 germplasm lines were maintained as genetic stock and evaluated along with three checks. The observations were recorded for plant height, peduncle length, number of effective capsule per plant, stem diameter, days to 50 percent flowering, dry latex yield, seed yield, husk yield and morphine content. Latex yield ranged from 48.44 kg ha^{-1} in UOP 88 – 13.11 kg ha^{-1} in UOP 88 and seed yield varied from 1778 kg ha^{-1} in UOP 117 – 444 kg ha^{-1} in UOP 290. A total of 46 lines exhibited higher dry latex yield over the best check, Chetak Aphim (31.83 kg ha^{-1}) while 43 lines exhibited higher dry latex yield than trial mean (33.0 kg ha^{-1}). Latex yield ranged from as low as 13.11 (UOP-290) – 48.44 kg ha^{-1} (UOP-88).

RVSKVV, Mandsaur: Two hundred and thirty four lines were characterized based on DUS descriptors. The colour of the petal ranged from white, pink, red and violet with serrated/ deeply serrated or non-serrated margin. Similarly, peduncle was hairy or non-hairy. The capsule shape was also round (spherical), egg like (ovate) or long (cylindrical). Date of flowering was of early or late. On the basis of these characters, thirty six plant types were selected. Observations were recorded from these lines on morphological and yield parameters. Plant height ranged from 82 (MOP-1077) – 118 cm (MOP-1057); leaf length varied from 14.3 (MOP-572) – 22.7 cm (MOP-579); breadth of leaf varied from 9.3 (MOP-510) – 14.3 cm (MOP-506) where as number of leaves per plant ranged from 9 (MOP-1084) – 19 (ND-40). Days to 50% flowering ranged from 82 (MOP-581) – 97 days (MOP-1057), length and breadth of capsule varied from 15.0 – 24.7 mm and 9.7 – 14.3 mm respectively. Mean latex yield ranged from 7.47 – 57.95 kg ha^{-1} and mean seed yield ranged from 200 – 1044 kg ha^{-1}.

Varietal evaluation trial

MPUAT, Udaipur: Thirteen entries along with three checks (Chetak Aphim, IC42 and MOP540) were evaluated for latex, seed, and husk yields and yield contributing traits. All the entries flowered between 82-87 days which was at par with the checks. Two entries, UOP-1185 and UOP-80 showed their significant superiority for latex yield than the best check (Chetak Aphim). The entries UOP-20, UOP-79 and UOP-60 were also gave statistically higher yield in terms of latex yield over the best check, Chetak Aphim**.**

Management of stem rot

RVSKVV, Mandsaur: Field trials were conducted to evaluate the efficacy of antibiotics and fungicides against the stem rot of Opium poppy. The results showed that spraying of copper hydroxide + streptocycline (0.3%+140 ppm) at rosette stage recorded lower disease intensity 27.10 percent and highest latex, seed and husk yield (50.68, 617.90 and 580.15 kg ha^{-1}). This treatment was followed by spraying copper oxychloride + strepto cycline (28.20%) and streptocycline alone (33.40%). The highest disease intensity of 44.60 percent was recorded in control. The lowest latex, seed and husk yield (29.44, 408.10 & 395.64 kg ha^{-1}) was recorded in the control plots.

Management of Powdery mildew

RVSKVV, Mandsaur: Four concentrations of trifloxystrbin 25 + tebuconazole 50 percent (Nativo) viz., 250g, 300g, 350 g and 400 g ha-1 were tested against Powdery mildew of opium poppy. Nativo was sprayed two times at flowering stage and capsule maturity stage and the disease incidence was recorded before lancing. The results showed that the treatments involving concentration @ 400 g ha^{-1} and 300 g ha^{-1} recorded the lowest powdery mildew diseases incidence of 10.87 percent and 13.87 percent respectively whereas the control plot recorded the maximum incidence of 23.54 percent. The latex , seed and husk yield were maximum (54.37, 899.12 and 846.42 kg ha^{-1}) in plots sprayed with Nativo @ 300 g ha^{-1} concentration followed by plots sprayed @ 400 g ha^{-1} concentration (52.63, 896.87 and 853.08 kg ha^{-1}). Control plots recorded the lowest latex, seed and husk yield of 38.29, 735.75 and 651.62 kg ha^{-1}, respectively.

Integrated disease management practices against root rot of opium poppy

MPUAT, Udaipur: An integrated disease management strategy for root rot of opium poppy under organic farming was evaluated in sick plot condition. Among the nine treatments, seed treatment with mancozeb (63%) + carbendazim (12%) - 75 WP @ 0.20 percent and with *trichoderma* talc based formulation @ 10 g kg^{-1} followed by drenching with hexaconazole-5EC (0.10%) at 30 and 60 DAS resulted in maximum germination (82.15%), minimum plant mortality (8.85%) and maximum (90.14) percent disease control, and yielded maximum dry latex powder (35.42 kg ha^{-1}), seed (15.3q ha^{-1}), capsule husk (14.0 q ha^{-1}) and (10.20 percent) morphine content, this was statistically at par and closely followed by soil application of Neem cake manure (500 g m^{-2}) and farm yard manure (500 g m^{-2}) supplemented with *Trichoderma* talc based formulation (10^8 cfu g^{-1}) @ 5 percent + seed treatment with neem oil (3%) followed by drenching with cow urine: neem leaves: garlic clove fermented product @ (10%) at 30 and 60 DAS which resulted in 80.24 percent germination, 10.52 percent plant mortality and 88.30 percent disease control as well as yielded maximum dry latex

powder (34.46 kg ha^{-1}), seed (15.0 q ha^{-1}), capsule husk (13.3 q ha^{-1}) and increased percent morphine content (11.46). The highest population counts of *T. viridae* (12.65×10^{5} c.f.u. g^{-1} soil) in Opium rhizosphere were also observed in this treatment.

Screening of genotypes for multiple disease resistance

MPUAT, Udaipur: Twelve genotypes were screened (disease severity rating was done based on 0-9 scale) against Downy mildew, root rot, leaf spots, bacterial blight. Powdery mildew revealed that, 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, 12.78%). Remaining five genotypes (UOP-30, UOP-35, UOP-60, and MPO-04 and UO-1185) were moderately resistant (MR) with a disease intensity of 21-30 percent.

Screening of genotypes against Downy mildew

RVSKVV, Mandsaur: A total of 235 genotypes of opium poppy were screened under the field conditions against Downy mildew. Severity was recorded on 0-5 scale. MOP-187, MOP-217, MOP-404, MOP-507, MOP-508, MOP-513, MOP-514, MOP-518, MOP-517, MOP-536, MOP-559, MOP-571, MOP-1057, MOP-1071, MOP-1072, MOP-1083, MOP-1084, MOP-1089, MOP-1092, Shewta, IC-95, IC-15-2, NOP-11, NC-57159, NC-57295, NC-57915, NC-57928, NBPGR-2, NBRI-6, ND-6, ND-35, ND-40, ND-44, ND-47, ND-1146, UO-7482, UOP-1, UOP-37, UOP-58, UOP-60, UOP-62, UIOP-68, UOP221, UOP-290, UOP-490 were screened as resistant lines whereas MOP-8, MOP-278, MOP-379, MOP-519, MOP-540, MOP-570, MOP-581, MOP-1055, MOP-1069, MOP-1070, MOP-1078, MOP-1081, MOP-1087, Post –91, Brop-1, P3XP10, IC-18, IC-19, IC-42, IC-99, NOP-549, NC-57913, NC-57948, NC-59555, NBPGR-1, NBPGR-4, NBRI-1, NBRI-8, NBRI-9, NBRI-10, ND-9, ND-12, ND-16, ND-17, ND-22, ND-24, ND-48, ND-208, ND-1001, UO-1985, UO-177-185, UOP-6, UOP-18, UOP-32, UOP-34, UOP-36, UOP-39, UOP-41, UOP-63, UOP-64, UOP-65, UOP-66, UOP-67, UOP-70, UOP-72, UOP-73, UOP-75, UOP-77, UOP-78, UOP-79, UOP-80, UOP-84, UOP-85, UOP-87 were screened as the susceptible lines. The lines screened as moderately susceptible were MOP-1056, MOP-1079, MOP-1080, MOP-1082, MOP-1091, Posta –149, P4XP10, IC-1, NC-57923, NC-57950, ND-8, ND-10, ND-11, ND-20, ND-35, ND-37, UOP-82, UOP-86, ND-35, ND-37.

PALMAROSA (*Cymbopogon martinii*)

Cymbopogon is an important genus of aromatic grasses belonging to family *Poaceae* with about 140 species and Palmarosa is one of the important species for essential oil used in perfumery, cosmetics, pharmaceutical and flavouring industry. Oil of Palmarosa is obtained from the floral shoots and aerial parts. The oil has good demand for export and is very rich in geraniol (75-90%). It is used in perfumery, cosmetics, soap and also in flavouring

tobacco and for blending of soaps due to lasting rose note it imparts. The genus cymbopogon is chiefly distributed in the tropical South Eeast Asia and Africa. Out of the total of 102 species, 56 are found in Africa and 21 in India. The palmarosa grass attains a height of about 1.75 m under favourable growing conditions in the forest and up to 2.5 m under cultivation.

Improvement of RH 49 cultivar through modified mass selection

CCSHAU, Hisar: Seeds of 200 selected plants of the variety RH 49 were bulked to grow composite seed. Propagated population and 49 clones were selected and the observations were recorded for these plants. Plant height (cm) ranged from 152.33 (C-9) – 301.00 (C-17), leaf length (cm) 22.66 (C-23) – 43.00 (C-18), leaf width (cm) 1.93 (C-16) – 3.60 (C-33), culm diameter (cm) 2.20 (Trishna) – 7.00 (C-17 &18), number of internodes 8.0 (C-1) – 17.67 (C-16), internode length (cm) 10.00 (C-9 & 19) – 21.00 (C-1), inflorescence length (cm) 45.00 (Trishna) – 165.67 (C-24), panicle bearing tillers 4.67 (C-37) – 52.00 (C-42). Number of tillers per plant 13.67 (C-11) – 66.70 (C-42), fresh herb yield per plant (g) 325 (C-34) – 1225 (C-42) and oil yield per plant (ml) 0.8 (C-19) – 4.9 (C-42). Clone C-42 (4.9) yielded highest oil yield per plant (ml) followed by C-47 (4.8), C-3 (4.35) C-37 (4.29) and C-21 (4.00) against Trishna (1.95). Clones C-3 and C-10 yielded 0.58 percent oil content against the check Trishna (0.30%).

Analysis of samples from modified mass selection

The oil content of 11 promising clones in 2nd cutting ranged from 0.40 to 0.50 percent. The clones P43, P82 and P133 recorded highest oil content (0.50%) on FWB followed by P76 (0.47%); P174 (0.45%); P11, P17, P28 and P171 (all 0.43%) and P138 and P168 (both 0.40%). Most of the clones were rich in geraniol ranging from 83.8 – 89.9 percent. Geraniol content was highest in the essential oil of P174 (89.9%) followed by P76 (88.7%); P168 (88.3%); P171 (87.1%); P17 (86.4%); P43 (86.2%); P133 (85.8%), P138 (85.4%); P11 and P82 (84.9%) and P28 (83.8%).

Oil content in these clones ranged from 0.16 to 0.58 per cent. The clones C3 and C10 recorded highest oil content (0.58%) on FWB followed by C23 and C24 (0.54%), C38 (0.52%), C7, C18, C46 and C48 (0.48%), C11 (0.46%), C16, C17, C43, C49 (0.44%), C12 (0.43%) and C25, C28, C36, C47 (0.42%). Essential oils of these 49 clones showed that most of the clones were rich in geraniol content ranging from 63.0 – 86.4 percent. Essential oil of twenty clones, C31 (86.4%); C46 (86.3%), C44 (85.7%), C42 (83.8%), C21 and C38 (83.6%), C24 (83.3%), C33 (83.2%), C48 (83.0%), C18 (82.7%), C35 (82.2%), C49 (82.2%), C41 (81.5%), C30 & C47 (81.1%), C12 (81.0%), C37 (80.8%), C11 (80.5%), C16 (80.2%) and C43 (80.0%) contained geraniol content more than 80 percent. The geraniol content in the essential oil of fifteen clones C15 (79.5%), CIMAP (79.3%), C27 (79.2%), C22 (79.1%), C3 (79.0%); C10 (78.3%); C2 (78.1%), C13 (77.9%); C34 (77.4%); C4 & C32 (both 77.1%); C17 (76.9%); C23 (76.8%), C25 (75.6%); and C26 (75.5%) was between 75 to 80 percent.

SAFED MUSLI (*Chlorophytum borivilianum*)

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

Evaluation of germplasm

RVSKVV, Mandsaur: Twenty-four lines of Safed musli were tested. Wide variability was noticed among the lines. Length (cm) of leaves varied from 17 (MCB-401) – 32 (MCB-419). Breadth (mm) of leaves ranged from 15 (MCB-409) – 29 (MCB-422). Colour of anther ranged from yellow to light yellow or sometimes light green in few entries. Length (cm) of fleshy root ranged from 6.3 (MCB-402) – 11.6 (MCB-412). Fleshy root diameter (mm) ranged from 4.5 (MCB-406) – 12.5 (MCB-421). Fresh weight (kg ha^{-1}) of fleshy root ranged from 2111 (MCB-409) – 3956 (MCB-412). Maximum fresh fasciculated root yield per hectare was recorded for MCB-412 (3956 kg ha^{-1}) followed by MCB-406, RVSM-414 (3333 kg ha^{-1}) MCB-405 (3222 kg ha^{-1}), MCB-401 (3124 kg ha^{-1}) and JSM-405 (3222 kg ha^{-1}).

Preliminary yield trial

PDKV, Akola: Eleven genotypes including one check, MCB-405 were evaluated for morphological parameters, yield and quality. The study revealed that differences observed in number of leaves, length of leaves and breadth of leaves were statistically nonsignificant.

Number of fleshy roots per plant varied from 21.80 (AKSM 01) – 30.20 (AKSM 08), length (cm) of fleshy roots varied from 2.76 (AKSM 04) – 7.27 (AKSM 01), and diameter (mm) of fleshy root varied from 5.37 (AKSM 01) – 7.00 (AKSM 07). Saponin content (%) ranged from 6.34 in AKSM 05 – 7.33 in AKSM 08**.**

Out of ten genotypes, two genotypes AKSM-08 and AKSM-07 recorded significantly higher root yield (44.05 and 40.86 q ha^{-1}) than the check MCB-405 (37.22 q ha^{-1}). Regarding the other characters, AKSM-07 and AKSM- 08 recorded at par performance with the check MCB-405. However, significantly higher saponin content was observed in AKSM-08 as compared to the other genotypes tested.

Intercropping of safed musli 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 were compared with sole Safed musli

and sole pigeon pea. Two year results showed significantly higher number of leaves (13.18), leaf length (20.35 cm) and width (1.6 cm) with sole Safed musli, however, it was at par with the intercropping at row proportion of 3:1. Significantly, higher number of roots per plant (12.55), root length (6.04 cm), root girth (6.8 mm) and fresh root yield per plant (18.75 g), fresh root (34.65 q ha^{-1}) and dry root (5.78 q ha^{-1}) yield, safed musli equivalent yield (5.98 q ha^{-1}), land equivalent ratio (1.54) and gross monetary returns (₹478662 ha^{-1}) were recorded under intercropping at row proportion of 3:1 followed by sole safed musli. Thus, it was concluded that intercropping of safed musli with pigeon pea at 3:1 row proportion was found most suitable and economical.

Development of seed standards

DMAPR, Anand: The seed standard for Safed mulsi [physical purity, seed weight and germination percentage (minimum)] were studied. In Safed musli, physical purity, hundred seed weight and germination percentage were 99.3 percent, 1.5-1.7 g and 18.4 percent, respectively.

Management of fasciculate root rot disease

RVSKVV, Mandsaur: The results of the field experiment conducted for the management of root rot of Safed musli showed that seed treatment with carbendazim 1.5g kg^{-1} followed by soil drenching with carbendazim @ 0.15 percent recorded the lowest diseases incidence (17.33%) and highest yield of 3216.42 kg ha^{-1} where as the control plot recorded the highest fasciculate root rot disease incidence (37.77%) and lowest yield (1547.55 kg ha^{-1}). Among the biocontrol agents, seed treatment and soil drenching with *Trichoderma viridae* and *Pseudomonas fluorescens* recorded lower disease incidence of 24.59 and 23.99 percent respectively.

Integrated disease management against root rot and leaf blight

MPUAT Udaipur:. Integrated disease management module against root rot and leaf blight of Safed Musli under organic farming was evaluated under sick plot and inoculated condition during Kharif-Rabi (June-April) 2013-2014. Among the six treatments; soil application of neem cake manure (500 g m^{-2}) supplemented with trichoderma talc based formulation (10^8 cfu g^{-1}) (5%) + seed treatment with neem oil (3.0%) followed by three sprays with cow urine: neem leaves: garlic clove fermented product @ (1%) resulted in minimum plant mortality (18.13%) and maximum percent root rot disease control (73.20%), as well as higher yields of fasciculated root (40.1 q ha^{-1}), saponin content (10.74%,) compared to untreated control. The highest population counts of *T. viridae* (11.45×10^5 c.f.u. g^{-1} soil) in the soil rhizosphere were also found in this treatment. The per cent leaf blight incidence (24.11%) was also lower in this treatment.

Screening of safed musili germplasm lines against fasiculated root rot

RVSKVV Mandsaur: Twenty three genotypes of Safed musili were screened against fasiculated root rot during 2010-2013. MCB-412, JSM-405, RVSM-414, MCB-416, MCB-423 were screened as resistant lines.

SARPAGANDHA (*Rauvolfia serpentina*)

It is a perennial under-shrub belonging 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 approximately after 18 months.

Intercropping in sarpagandha

IGKV, Raipur: The experiment comprising eight intercropping systems (sole sarpagandha, sarpagandha + soybean, sarpagandha + urd, sarpagandha + til, sarpagandha + kalmegh, sarpagandha + clusterbean, sarpagandha + moong and sarpagandha + groundnut) were investigated. Intercropping of sarpagandha with different crops significantly influenced root length and dry root yield. Sarpagandha + urd intercropping recorded maximum sarpagandha equivalent yield (21.48 q ha^{-1}) and net returns (₹108866 ha^{-1}) which was at par with sarpagandha + Kalmegh intercropping system.

Management of *Cercospora* leaf spot

JNKVV Jabalpur: Disease management strategy for *Cercospora* leaf spot of Sarpgandha was evaluated with *Trichodema* fortified manure and fungicide. The result showed that percent disease incidence was lowest (3.6) in soil application of FYM@ 10 t ha^{-1} fortified with *Trichoderma* sp @ 10^6 – 10^9 cfu m^{-1} followed by 3 sprays of propiconazole @ 0.25% at 15 days interval and in soil application of FYM @ 10 t ha^{-1} followed by 3 sprays of propiconazole @ 0.25 percent at 15 days interval (4.36) and these treatments were also statistically at par with each other.

SATAVARI (*Asparagus racemosus*)

It is a creeper, 1 to 2 meters tall belonging to family *Liliaceae* and it is distributed throughout India and the Himalayas. It has an adventitious root system with tuberous roots that measure about 1 meter in length, tapering at both ends. Its roots are used in Ayurvedic medicine, as an anodyne, aphrodisiac and galactogogue. Shatavari is considered to be the main Ayurvedic rejuvenating female tonic for overall

health and vitality. In the Ayurveda, *A. racemosus* is commonly mentioned as a rasayana drug which promotes general well being of an individual by increasing cellular vitality or resistance. The reputed adaptogenic effect of Satavari is attributed to its concentrations of saponins. 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. Yield depends on the crop age and an average of about 10-15 t ha^{-1} fresh root is obtained if harvested in the third year.

Evaluation of germplasm

NDUAT, Faizabad: Twenty four accessions including check NDAS-20 were evaluated for yield and yield contributing characters viz., number of fleshy roots per plant, length of fleshy root and diameter of fleshy root. Differences in number of fleshy roots per plant observed among the accessions were statistically nonsignificant. Length of fleshy roots per plant varied from 19.33 – 29.52 cm. Maximum length of fleshy root was in NDAS-17 (29.52 cm) followed by NDAS-9 (29.45 cm) and NDAS-23 (29.40 cm) and the lowest length of fleshy root was in NDAS-12 (19.33 cm). The pooled statistical analysis of three years (2007-08, 2010-11 and 2013-14) data for fresh root yield clearly indicated that maximum fresh fleshy roots were harvested from NDAS-24 (484.62 q ha^{-1}) followed by NDAS-25 (418.70 q ha^{-1}) and NDAS-14 (406.55 q ha^{-1}) which clearly indicated the significant increase over the check i.e. NDAS-20 (208.70 q ha^{-1}) i.e. 132.21, 100.62 and 94.80 percent, respectively. The pooled statistical analysis of three years with respect to dry root yield indicated that maximum dry roots were harvested from NDAS- 24 (54.54 q ha^{-1}) followed by NDAS-25 (42.27 q ha^{-1}) and NDAS-23 (41.37 q ha^{-1}) which had significant increase over check i.e. NDAS-20 (21.11 q ha^{-1}) i.e., 158.36%, 100.24% and 95.97 percent, respectively. Minimum dry roots were obtained from check NDAS-20 (21.11 q ha^{-1}).

Effect of organics manures and biofertilizers on growth and yield

YSPUHF, Solan: The experiment was conducted with seven different combinations of organic manures and biofertilizers (control, FYM 5 t, vermicompost 2 t, FYM 5 t + vermicompost 2 t, FYM 5 t + PSB 10 kg, vermicompost 2 t + PSB 10 kg and FYM 5 t + vermicompost 2 t + PSB 10 kg ha-1). Observations were recorded after 12, 18 and 24 months of the crop growth. Results of three observations revealed that maximum plant height (53.7 cm), number of branches per plant (4.5), number of roots per plant (31.15), dry root weight per plant (13.42 g), fresh (20.58 q ha^{-1}) and dry root (4.97 q ha^{-1}) yield and gross returns (₹136500 ha^{-1}) were recorded at FYM 5 t + vermicompost 2 t + PSB 10 kg ha^{-1} after 12, 18 and 24 months, however, B:C ratio (4.12) was maximum at FYM 5 t + PSB 10 kg ha^{-1}. Soil available nitrogen (437 kg ha^{-1}), available phosphorus (279.76 kg ha^{-1}), available potassium (337.69 kg ha^{-1}) and organic carbon (2.22) were maximum at FYM 5 t + vermicompost 2 t + PSB 10 kg ha^{-1}.

Yield loss assessment due to pest infestation

MPKV, Rahuri: A field experiment was conducted to assess the yield loss due to aphids (*Aphis craccivora*) and beetles (*Lema downesi*) on Satavari. Spraying of dimethioate @ 1.5ml l^{-1}. and chloropyriphos @ 2ml l^{-1} were taken up three times at fort nightly intervals for the control of aphids and beetles, respectively in treated plots. An yield loss of 16.69 percent was observed due to aphids on Satavari, where as the beetles caused an yield loss of 13.36 percent.

Estimation of economic threshold level of red bug and beetles

MPKV, Rahuri: Field experiments were conducted to estimate the economic threshold level (ETL) of red bug (*Brachytes bicolour*) and beetles (*Lema downesi*) in Satavari. An ETL of 30 red bug nymphs per plant was worked out in Satavari where control measures have to be carried out to prevent economic yield loss and the ETL of beetles recorded in Satavari was 8 grubs per plant.

SENNA (*Cassia angustifolia*)

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

Germplasm collection, characterization and evaluation

DMAPR, Anand: A total of 55 collections were made during the year by exploring parts of Rajasthan and Gujarat. These accessions differed widely for plant height (50-170 cm), number of primary branches (5-17) and 100 seed weight (1.84-3.09 g). A total of 222 collections were purified and maintained. One hundred fifty seven collection along with four checks (Sona, ALFT-02, Tinneveli local and KKM-01) were evaluated and characterized. Collections showed variations in various morphological traits such as plant habit type (erect, semi-spreading and spreading), leaf shape (obovate, oblong and ovate), number of leaf lets per leaf (at first flowering node) and pod size. Significant variations in the collections were

observed for various quantitative traits also such as days to flowering (51-113 days), days to maturity (90-140 days), plant height (43-150 cm), number of branches (4-14) and test weight (1.95-4.19 g).

Induction of polyploidy

Ploidy manipulations were utilized as a rapid means to realize enhanced production of phytopharmaceuticals since herbage is the economic part in the species. Seeds of ALFT-2 were treated with colchicine (0.5% and 0.1%) for 6 h to induce polyploidy. A total of 607 C_0 plants were screened for polyploidy based on stomatal number and size. The mean stomatal number and size ranged from 23.8 – 52.1 and 24.3 – 34.5 μm, respectively in the treated plants. While in the untreated control, the number of stomata ranged from 29 – 40 with a mean of 35 and size ranged from 27 – 32 μm with a mean of 30.6 μm.

Leaf transcriptome analysis

Raw DNA reads from young and matured leaf samples were generated using Illumina MiSeq Platform on 2x150 reads chemistry for the study of sennosides metabolism pathway in the species. Transcript contigs of 38,718 and 41,691 were generated for young and matured leaves, respectively. Pathway analysis for both the plant samples, revealed a total of 6,103 (young) and 6,292 (mature) coding DNA sequences (CDS) enriched in 24 different functional pathway categories which were predominantly classified in metabolism. Majority of CDSs were falling into energy metabolism, carbohydrate metabolism, translation, signal transduction, folding-sorting degradation and transport categories of KEGG pathway for both samples.

Management of *Alternaria* leaf blight

YSRHU, Venkataramannagudem: Field experiments were conducted to find the efficacy of different plant extracts against *Alternaria* leaf blight in Senna. *Tinospora cordifolia* stem extract proved to be effective in reducing the disease with 11.55 percent increase in seed yield over control.

Estimation of economic threshold level of *Catopsilia pyranthe*

DMAPR, Anand: The methods of artificial infestation by different levels of larval population were followed to establish economic threshold levels of *Catopsilia pyranthe*. The economic threshold level (ETL) was worked out during early vegetative stage, 45 DAS and at late vegetative stage, 75 DAS. The different larval densities were released at 45 DAS (0, 1, 2, 3, 4, 5, 6 and 7 larvae plant^{-1}) and at 75 DAS (0, 5, 7, 10 and 12 larvae plant^{-1}) in separate experiments. At 45 DAS, the percent leaf damage was maximum (82.12 %) when 7 larvae were released per plant and minimum (23.37%) when a single larva was released. The ETL of *Catopsilia pyranthe* at 45 DAS worked out was 3.3 larvae plant^{-1}. At 75 DAS, the percent leaf damage was maximum (40.15%) when 12 larvae were released per plant and minimum (26.9%) when a single larva was released. The ETL at 75 DAS was worked as 7.4 larvae plant^{-1}.

Biology of the larval endoparasitoid *Cotesia* sp of *Catopsilia pyranthe*

DMAPR, Anand: Laboratory experiments were conducted to study the life cycle of the larval endoparasitoid of *Catopsilia* larvae, *Cotesia* sp. From the experiments it was observed that the parasitoid takes 18-19 days to complete its life cycle. The parasitoid took an average of 8.5 days for its development inside *Catopsilia* larvae, ie from egg laying to pupation. Pupae took about 6.4 days to emerge to adult and the adult longevity lasted for about 3.7 days.

Seasonal incidence of *Catopsilia pyranthe* in Senna

DMAPR, Anand: The occurrence of *Catopsilia pyranthe* in senna was recorded during September 2012 to August 2013. The egg count and larval counts were taken per plant and the pest incidence was correlated with weather factors like maximum temperature, minimum temperature, maximum relative humidity and minimum relative humidity. Positive correlation was obtained between pest incidence and weather factors. *Catopsilia pyranthe* was prevalent all through the year except during the months of December, January and February. During the month of March, the population of *Catopsilia* started building up, and it reached maximum during the months of June, July, September and October

Management of *Catopsilia pyranthe*

DMAPR, Anand: Field experiments were conducted to test the efficacy of biopesticides and insecticides against C. *pyranthe*. The insecticides viz, chloranthrinipole 18.5 SC, Spinosad 45 percent SC, flubendiamide 39.35 SC and chlorpyrifos 20 EC treated plots were devoid of *Catopsilia* larvae upto 2 weeks of spraying. The pooled data showed that the biopesticide, flavanoid (6%) at the rate 1ml l^{-1} was statistically on par with insecticidal treatments in its efficacy against *Catopsilia* larvae. At 21 DAS (days after spraying) all the treatments developed larval population and there was no significant difference between the treatments.

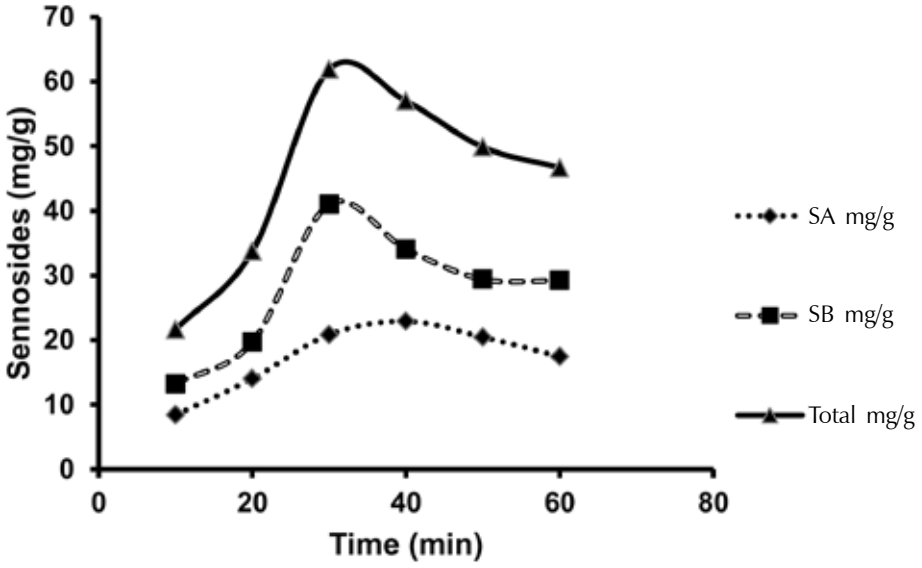
Feeding preference of *Catopsilia pyranthe* to different species of Senna

DMAPR, Anand: Free choice and no choice tests were conducted in laboratory to know the feeding preference of *Catopsilia* larvae to different species of Senna. Ten species of *Cassia* and Senna were used for the study. The results showed that *Cassia occidentalis* and *Senna corymbosa* were the most preferred by *Catopsilia* larvae while Senna ungiculata, Senna uniflora and *Cassia tora* were least preferred. *Cassia italica*, *Cassia ungustifolia* and Senna alata, *Cassia sophera* and *Cassia holoceracia* were found as the medium preferred host in laboratory tests.

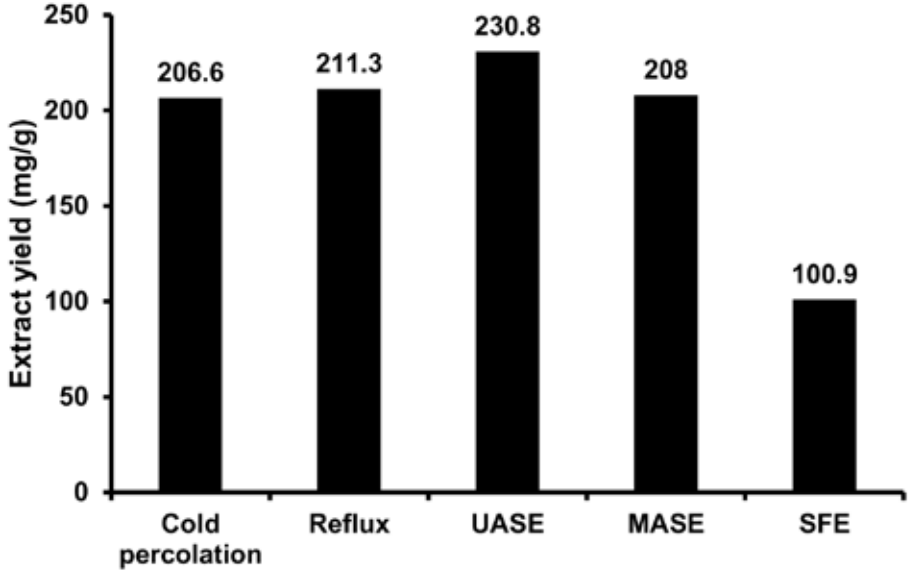
Comparison of extract yield and extract composition by conventional and non conventional extraction techniques

DMAPR, Anand: Dianthraquinone glucosides are the main bioactive phytochemicals present in leaves and pods of *C. angustifolia*. The efficiency in terms of extraction yield and composition of the extract for both the conventional (cold percolation at room temperature and refluxing) and non conventional extraction techniques (ultrasound assisted solvent extraction, microwave

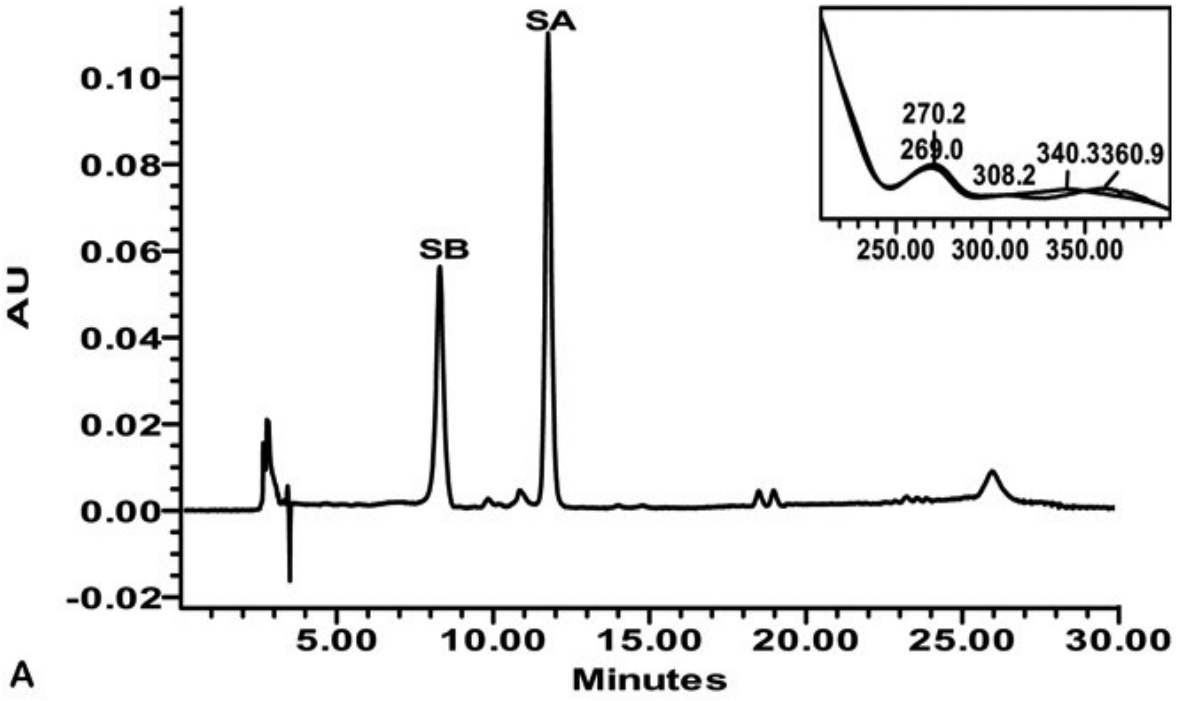
assisted solvent extraction and super critical fluid extraction) were compared. Also a rapid and validated reverse phase high performance liquid chromatography-diode array detection method was developed for the simultaneous determination of the two biologically active compounds sennoside A (SA) and sennoside B (SB) in the different extracts. Ultrasound assisted solvent extraction, microwave assisted solvent extraction were found more effective in terms of yield and composition to cold percolation at room temperature and refluxing method of extraction.



Variation of total sennoside concentration (SA+ SB) with solvent composition in extract prepared using refluxing method.



Extraction yield (mg/g) of extract prepared using cold percolation, refluxing, UASE, MASE and SFE methods



Representative HPLC chromatograms with PDA spectra of standard mixture of SA and SB

TULSI (*Ocimum sanctum*)

It is an erect highly branched aromatic perennial herb of family *Lamiaceae*. Two plant types are commonly available, one is with green leaves and the other one is with purple leaves. It is distributed throughout India and is also under cultivation. Leaves, flowers and occasionally the whole plant are medicinally used to treat heart diseases, leucoderma, asthma, bronchitis and fever. The leaves and tender parts of the shoots are economically important and it yields essential oils. The essential oils obtained have immense value in aroma industry. The chemical constituents of the essential oils are monoterpenes, sesquiterpines and phenols with their alcohols, esters, aldehydes, etc. Propagation is mainly done both by seeds. Seedlings are used for cultivation. Nursery has to be raised in the first week of April and transplantation will be at 4-5 leaf stage of the seedling at the onset of monsoon. Freshly harvested material is distilled for oil extraction.

Nutrient management

NDUAT, Faizabad: The experiment was conducted during 2011-12 and 2013-14 comprising eleven levels of organic and inorganic nutrients (NPK; 30:20:10, 40:30:20, 50:40:30, 30:20:10 + 5 t FYM, 40:30:20 + 5 t FYM, 50:40:30 + 5 t FYM, 30:20:10 + 10 t FYM, 40:30:20 + 10 t FYM, 50:40:30 + 10 t FYM; and FYM 5 t and 10 t ha^{-1} alone). Results

on pooled data basis revealed that application of N30:P20:K10 + 10 t FYM ha^{-1} recorded highest plant height (120.3 cm), number of branches per plant (22.7), fresh and dry herbage yield (183 q ha^{-1} and 59 q ha^{-1}, respectively) .

Effect of organic nutrient management on growth and yield

RAU, Pusa: The experiment comprising of organic manures (control, vermicompost 2.5 t, FYM 8 t, neem cake 0.75 t and mustard cake 0.9 t ha^{-1}) and biofertilizers (azospirillum 2 kg, PSB 5 kg, PSB 5 kg + azospirillum 2 kg ha^{-1}) were investigated. The results revealed that application of vermicompost at 2 t ha^{-1} inoculated with mixture of PSB 5 kg and azospirillum 2 kg ha^{-1} recorded significantly higher herbage yield both on fresh and dry weight basis (162.87 and 40.71 q ha^{-1}, respectively).

Effect of planting time and spacing on growth and yield

RAU, Pusa: The experiment comprising of four dates of planting (1st June, 15th June, 1st July, 15th July and 1st August) and three spacings (40 x 20, 40 x 30 and 40 x 40 cm) were investigated. The results revealed that crop planted on 1st July at 40 x 30 cm spacing recorded maximum fresh and dry herbage yield (158.09 and 39.52 q ha-1, respectively).

Effect of date of planting and nitrogen levels on growth and yield

RVSKVV, Mandsaur: Five nitrogen levels (cotrol, 50, 75, 100 and 125 kg ha^{-1}) and three dates of planting (30th June, 15th July and 30th July) were investigated. Result revealed that application of N 125 kg ha^{-1} recorded highest herbage (38.6 q ha-$^{-1}$) and seed yield (18.6 q ha^{-1}). Date of planting significantly influenced herbage and seed yield and recorded highest value when sown on 15th July (34.4 and 16.6 q ha^{-1}, respectively).

Economic yield loss assessment of tingid bug on Tulsi

RAU, Pusa: Experiments were conducted to assess the yield loss due to *Cochlochila bullita*, a tinged bug. 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 lace bug. An yield loss of 28.35 percent was recorded due the damage of tingid bug in tulsi.

Biology of lace bug (*Cochlochila bullita)*

RAU, Pusa: Laboratory experiments were conducted to study the biology of tulsi tinged bug *Cochlochila bullita*. The female bugs inserted their eggs singly into the leaf tissues of the upper surface of leaves. Eggs were light brown in colour and hatched in 4-6 days. At early instar, the body was relatively smooth without any spine, oval in shaped and without paranotum and wing-buds. But at last instar, the paranotum was clearly noticeable, wing-buds and cephalic spines developed longer and became more prominent. The nymphal duration lasted for 9-15 days while the adult longevity was for 30-35 days. The body length of nymph was 2.0- 2.5 mm where as adult was about 3.0-4.0 mm. The total life cycle of the bug lasted for 43-56 days.

BETELVINE (*Piper betle*)

P. betel is a perennial evergreen dioecious climber, belonging to the family *Piperaceae*. It is believed to be a native of Malaysia. It is a native of Central and Eastern Malaysia and has spread throughout tropical Asia and Malaysia; Madagascar and East Africa later. 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. Betel vine 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 has also medicinal properties and is used in Indian System of Medicines to cure indigestion, stomach ache, diarrhoea, flatulence and to heal wounds, bruises, swellings due to sprains, bruises, respiratory disorders, constipations, boils and gum disorders. Recent studies also revealed that the leaf improves immune system and inhibits cancer growth.

Study of flowering behaviour

IIHR, Bangalore: Sixteen land races (12 from Karnataka, 4 from Tamilnadu) and variety SGM 2 were added to the existing germplasm during the year. Field planting of collected germplasm (Mysore Chiguru, Pavagada Local, Ambadi-Sawanoor) was taken up. A total of 118 germplasm accessions were maintained including three Piper species. Monthly observations on flowering were recorded in the field planted germplasm throughout the year. During 2013-14, flowering was recorded in 52 female clones and 9 male clones. Flowering was not observed in Meetha Pan and Kakair. Among hybrids developed, IIHR 47 put forth female inflorescence and IIHR 13 produced male inflorescence.

First report of flowering in Meetha Pan from farmers' fields

IIHR, Bangalore: Meetha pan is a preferred commercial cultivar of betelvine due to its distinct sweetness in the leaves, traditionally grown in closed (Baroj) cultivation in Midnapur district of West Bengal. Till now, flowering was not reported and sex of this clone was unknown. Meetha pan in farmers' field in Kammardi (Chikmagalur Dt.) and Ripponpet (Shimoga Dt.) put forth luxuriant growth with plagiotropic shoots and flowering was absent. However, flowering was observed in Meetha pan in the Garden of Sri Devaraj of Lakkavalli village, Chikmagalur district. It is grown in areca nut garden as an intercrop and it produced female inflorescence. This is the first report of occurrence of flowering in Meetha pan.

Germplasm evaluation

IIHR, Bangalore: Eight high yielding clones of betelvine along with local check (Hirehalli Local) were planted in areca nut garden with a spacing of 2.7/0.9 m (4115 vines/ha) during

October 2010. The vines were lowered during April, 2012. Growth observations were recorded during 2nd year after lowering. Length of the plagiotropic shoot was maximum in Godi Bangla (57.59 cm) and Karapaku (57 cm) and lowest in Sirugamani 1 and Mysore Local (49.24 and 49.89 cm). Maximum number of plagiotropic shoots was recorded in IIHR BV 67 (94.3 vine-1) followed by Bangla (MP) and Mysore Local (76.62 and 75.58). Higher leaf yield was recorded in IIHR BV 67 (115.7 lakh leaves ha-1) followed by Sirugamani 1 and Mysore Local (100.94 and 82.5 lakh leaves ha-1). Hirehalli Local recorded lowest leaf yield (21.36 lakhs ha-1) and also had lowest number of plagiotropic shoots (36.85). Two years' evaluation of high yielding clones showed that IIHR BV 67, Mysore Local Sirugamani 1 and Godi Bangla had significantly higher yield of leaves than all the other clones due to higher number of laterals and shorter internodal length.

Crosses between cultivars, germplasm and hybrids

IIHR, Bangalore: The hybridization work was continued and fourteen female clones, five male clones and five hybrids (female and male each) 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 collected for germination and in some crosses seedlings were established in the polyhouse.

Interspecific hybridization

IIHR, Bangalore: Interspecific hybridization between *P. betle* and *Phytophthora* resistant *P. colubrinum* was continued. Eight betelvine clones were used as female parents. Successfully established interspecific hybrid seedlings were from crosses involving Mysore Local and Bangla Nagaram. These clones as female parents with *P. colubrinum* consistently showed similar results over two years. Among five new crosses attempted, fruit set was observed in four crosses and there was no fruit set with the crosses using Gujarat Local as female parent. Though the fruit set was observed in the interspecific crosses, the number of seeds per fruit and the establishment of seedlings was very low resulting in very few interspecific hybrid seedlings. The inter specific hybrids raised in previous year were multiplied through split bamboo technique for testing of *Phytophthora* disease reaction under artificial inoculation.

Seed germination and raising of hybrid seedlings

IIHR, Bangalore: Germination per cent varied from 5.55 to 79.56 percent among the crosses. Highest seed germination was recorded in cross Khasipan/Hy 06-4 followed by Hy 06-8/Hy 06-4 and Bangla (MP)/ Swarna Kapoori (79.56, 74.75 and 74.59%), respectively. Seedlings could not be established in crosses involving Khasipan with other germplasm lines. The crosses Hy 06-1/Hy 07-13 and IIHR BV 68/IIHR BV 104 recorded lower germination of 5.5 and 18.34 percent, respectively. More than 2500 seedlings were raised from different crosses.

Performance of hybrids under field conditions

IIHR, Bangalore: Eight hybrids and four parental lines field planted (2009) under areca nut garden were evaluated for different growth and leaf traits. Longer vine length was recorded

in Hy 06-8 followed by Hy 06-1 and Swarna Kapoori (276.6, 261.3, 258.5 cm), respectively. The number of plagiotropic shoots was higher in Swarna Kapoori and HY 06-4 (~ 20). Maximum plagiotropic shoot length was recorded in HY06-4 (49.20 cm). Among the hybrids plagiotropic leaf length varied from 11.90 – 14.04 cm and leaf width varied from 5.49 – 8.27 cm. Hy 06-4 recorded higher leaf yield (241.25 leaves vine-1) followed by Hy 06-9 and HY 06-8 (143 and 142 leaves vine-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. Ten hybrids with desirable plant vigor and leaf traits were evaluated. The maximum leaf yield was recorded by Hy 07-37 (304 leaves vine-1), 07-36 (264 leaves vine-1) followed by Hy 08-20 (237 leaves vine-1).

Performance of hybrids under shade net house

IIHR, Bangalore: Twenty three hybrids were planted during 2010 under shade net house (simulating bareja conditions) were evaluated for growth and yield. Fourth year data on growth and leaf traits of selected 12 promising hybrids showed that Hy 06-11 recorded maximum vine length (278.30 cm), leaf length (14.87 cm) and leaf breadth (12.29 cm). Leaf yield among the selected hybrids varied from 31 – 66.33 leaves vine-1. Hy 07-13, Hy 08-56 and Hy 08-59 produced significantly higher leaf yield per vine i.e., 66.33, 60.00, 59.75 leaves vine-1, respectively.

In another trial thirty six hybrids planted during 2011 were evaluated for growth and yield traits under shade net conditions. The vine length among them varied from 132.42 – 293.00 cm in Hy 06-14 and Hy 08-62, respectively. Leaf length varied from 8.41 (Hy 06-14) – 15.93 cm (Hy 08-62). Leaf yield per vine varied from 21.65 (Hy 07-27) – 75.50 (Hy 08-58). Hy 08-58 produced significantly higher leaf yield per vine followed by Hy 07-37, Hy 07-25, Hy 07-36, Hy 08-62 and Hy 07-41 which recorded 58.5, 52.67, 51.33, 51.00 and 51.00 leaves vine-1, respectively.

Preliminary varietal trial of hybrids

IIHR, Bangalore: Three hybrids were evaluated for higher leaf yield along with two checks i.e., Hirehalli Local and Swarna kapoori. Standard package of practices were being followed to raise the crop. Irrigation was given through drip facility. The data on growth and yield were recorded at five months after planting. Vine length (cm) varied from 210.45 (Hy 06-11) – 260.3 (Hirehalli Local) and vine diameter (cm) varied 1.60 (Hy 06-11) – 2.48 (Hirehalli Local). Hy 06-4, though a male hybrid recorded leaf length/breadth ratio of 1.22 different from check Swarna Kapoori which recorded leaf/breadth ratio of 1.71. Hybrid 06-4 produced leaves resembling Bangla clones (female clones), however produced male inflorescence. Hy 06-4 recorded significantly higher leaves per vine (185.15) followed by check Swarna Kapoori (175.85).

Effect of zinc sulphate on yield

RAU, Islampur: The experiment comprising of six levels of zinc sulphate, ZnSO4 (control, 10, 15, 20 kg, 25 and 30 kg ha-1, ZnSO4) were conducted to find out their effect on yield and quality. Results showed that soil application of zinc sulphate recorded better production

of betle leaves at all levels compared to control. Application of ZnSO4 30 kg ha-1 recorded highest marketable leaves per vine (80), number of lateral branches per vine (5.4) and length of vine (180 cm.), whereas, fresh weight of 100 leaves (131 g) was maximum in control.

Management of *Phytophthora* leaf rot and Anthracnose leaf spot

BRS, Islampur: Field experiments were conducted to evaluate different fungicides against *Phytophthora* leaf rot and anthracnose leaf spot in betel vine. Application of metalaxyl (8%) + mancozeb (64% WP) at 0.4 and 0.2 percent concentration significantly reduced the *Phytophthora* leaf rot incidence to the extent of 79.6 and 78 percent respectively, when compared to other fungicidal treatments. These treatments were followed by Bordeaux mixture at (1%, 0.5%) that controlled the disease incidence to 47.2 and 45.0 percent respectively. The combination of carbendazim (12%) + mancozeb (63% WP) at 0.4 and 0.2 percent significantly reduced the *Anthracnose* leaf spot disease incidence to 86.9 and 79.5 percent respectively followed by tebuconazole 25 EC at 0.4 (84.4%) and 0.2 percent (73.4%).

Integrated disease management in *Betel vine*

BAU, Islampur: Field experiments were conducted to evaluate different integrated management practices for the control of different fungal and bacterial diseases of betel vine. Soil drenching with Bordeaux mixture (1%) at 3 months interval followed by treatment of planting material (30 minutes before planting) with a combination of Bordeaux mixture (1%) + streptocycline sulphate (1000 ppm) significantly controlled fungal diseases like foot-rot (60%), leaf rot (55%), sclerotium wilt (20%) and bacterial disease - bacterial leaf spot (50%) as compared to control. These treatments were followed by soil drenching with *Trichoderma harzianum* + *Pseudomonas fluorescens* + mustard cake in the ratio 1:1:10 at the rate of 1 kg 10 m^2 area at 3 month interval followed by planting material treatment with *Trichoderma harzianum* @10% + *Pseudomonas fluorescens* @ 5 percent for 30 minutes were also most effective in controlling fungal diseases like foot-rot (50%), leaf rot (45%), sclerotium wilt (30%) and bacterial leaf spot (30%) as compared to control.

Cross inoculation of fungal pathogens from Long pepper in to Betelvine

AAU, Jorhat: Laboratory studies were conducted to cross inoculate fungal pathogens like, *Colletotrichum piperis, Cercospora piperis* and *Sclerotium rolfsii* isolated from the leaves and stem of diseased long pepper vines into betelvine. The result showed that *Colletotrichum* and *Cercospora* were non-pathogenic to betelvine whereas *Sclerotium rolfsii* was pathogenic to betelvine.

Demonstration of Integrated disease management (IDM) technology at farmers' field

MPKV, Rahuri: The demonstration trials on impact of disease management technology developed (field sanitation + first application of Bordeaux mixture (1%) at pre monsoon stage + application of *Trichoderma* plus @ 12.5 kg ha-1 one month after application of Bordeaux mixture (1%) + second application of Bordeaux mixture (1%) two months after first application + application of RDF 200:100:100 kg NPK ha-1 (nitrogen in 4 splits through

organic form) were conducted at 15 locations on farmers' fields in Jalgaon, Amalner, Bhusawal, Jamner, Indapur, Shrigonda, Jamkhed tahsils of Maharashtra. The wilt incidence varies from 0.75 - 3.5 percent on plots that adopted the disease management technology, whereas the incidence was up to 11.13 percent in farmers practice.

BCKV, Kalyani: The demonstration trials on impact of disease management technology developed by the centre (field sanitation + first application of Bordeaux mixture (1%) at pre monsoon stage + application of *Trichoderma* plus @ 12.5 kg ha^{-1} one month after application of Bordeaux mixture (1%) + second application of Bordeaux mixture (1%) two months after first application) were conducted in five farmers' pan barojs at Simurali, Nadia covering an area of 150 m^2 for each baroj consisting of 30 independent rows and with two treatments i.e. IDM technology and farmers practice. The percent vine death varies from 11 – 21 percent in farmers practice whereas it was only up to 6 percent in IDM technology adopted fields. The maximum yield recorded in IDM technology adopted field was 46.12 lakh leaves ha^{-1} per year whereas at farmers' field it was around 38.12 lakh leaves ha^{-1} per year.

Screening of hybrid betelvine lines against plant diseases

BCKV, Kalyani: Twenty betelvine hybrid lines were screened for their resistance against diseases. Majority of the lines screened were prone to different diseases. Higher (15-25%) vine mortality due to foot rot was recorded in PBH-07-1, PBH-07-9 and PBH-07-4. Higher incidence of leaf diseases (20-30%) was recorded on PBH-06-9, PBH-08-64, PBH-06-10 and PBH-07-10. The hybrid lines PBH-08-45, PBH-07-16 were free from foot rot and leaf diseases.

Differential susceptibility of hybrid betelvine lines against *Aleyrordid* flies

BCKV, Kalyani: Twenty hybrid betelvine lines were evaluated for their susceptibility against *aleyrordid* flies. Among the lines PBH-08-64, PBH-08-10, PBH-06-2, PBH-06-8, PBH-06-9 and PBH-07-9 harboured less than 05 flies per vine. GN-1 Hybrid, PBH-08-45, PBH-06-3, PBH- 06-4 and PBH-07-10 recorded higher numbers of flies (more than 8 flies per vine).

Standardization of the sample preparation methodology for the determination of multi pesticide residue

For the determination of organochlorine, organophosphorous and synthetic pyrethroid pesticides in four medicinal plants of Senna , Isabgol , Ashwagandha, and Safed-musli, the multi-residue method (MRM) based on QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) aprproach was used for pesticide residue analysis in plants matrices. The method was standardized on the basis of fortification or recovery studies. Fortification and recovery experiments were conducted by spiking the standard pesticide mixtures at various levels such as 0.1 ppm, 0.5 ppm and 1.0 ppm. Qualitative and quantitative analysis of the pesticide residue in the desired samples was performed as per the standardized method on GC-ECD/ GC-FPD. The average recoveries were obtained in the range of 70-130% at fortification levels

of 0.1 and 1.0 ppm for each plant matrix. Limit of Quantification (LOQ) of the different pesticides on the medicinal plant matrices was determined.

Agricultural Knowledge Management Unit (AKMU)

Institute website

The institute website (*www.dmapr.org.in*) were maintained. Tenders, recruitments, market information, publications – Annual reports, Newsletters, Audio Videos and also as special glitter - Thoughts of the day etc. were updated on daily basis.

Intranet website

The Directorate intranet website were created to share out information to employees. It has been maintained and the information such as office circulars, applications forms, documents and other information related to this office were continuously up dated.

Strengthening of Herbal Garden Network

Attempts are continued for strengthening of herbal garden 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". One new herbal garden was registered under this network during this period. Also images of about 150 species were appended to the existing database. The information related to herbal gardens, availability of species in each garden were also updated. The species information based on plant habits viz., herb, shrub, tree and climber were collected and updated in this database.

Databases

Attempts are also continued for updating the software applications such as Digital Herbarium of Medicinal and 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. AKMU responsible for Biometric attendance system monitoring, maintaining and database backing and providing reports as and when requires.

National Online Examination Centre commissioned

Under the NAIP sub project on "Developing, Commissioning, Operating and Managing an Online System for NET/ARS-Prelim Examination" the National Online Examination Centre at the Directorate was commissioned. Centre has 100 client system capacity, two servers (64 GB RAM each) connected with LAN to all the client system, CCTV cameras enabled in all the halls with NVR, high speed internet connectivity, 20 kVA Online UPS and DG set facilities. For first time, at this on -line examination centre 850 candidates appeared in National Eligibility Test (NET)-2014 (I) conducted by ASRB, New Delhi during March 26 - April 04, 2014.

Learning and capacity building strengthened ICT infrastructure

Information and communication technology (ICT) is one of the integral components for excellent research output and this demands a strong ICT infrastructure. Strengthening of ICT infrastructure for learning and capacity building including implementation of Management Information System (MIS)-Financial Management System (FMS) is the need of hour in the ICAR institutes. Under the NAIP sub project entitled "Learning and capacity building" under component-I, ICT Infrastructures such as Desktop computers, printers, online UPS, multimedia projector and extension cum training kits have been strengthen in the Directorate.

Plant Genetic Resources

Germplasm of medicinal and aromatic plants maintained at DMAPR

Sl. No.	Species	Number of Accessions
1.	*Aloe spp.*	55
2.	*Andrographis paniculata*	60
3.	*Asparagus spp.*	88
4.	*Cassia angustifolia*	222
5.	*Chlorophytum borivilianum*	54
6.	*Commiphora spp*	225
7.	*Cymbopogon martinii*	07
8.	*Desmodium gangeticum*	52
9.	*Gymnema sylvestre*	43
10.	*Plantago spp.*	91
11.	*Tinospora cordifolia*	52
12.	*Withania somnifera*	142
TOTAL		**1091**

Germplasm of medicinal and aromatic plants maintained at different AICRP MAPB centres

Crop	Centre	No. of accessions
Aloe *(Aloe barbadensis)*	AAU, Anand	30
	CCSHAU, Hisar	42
	IIHR, Bangalore	42
	NDUAT, Faizabad	20
	PDKV, Akola	17
	IGKV, Raipur	14
	RVSKVV, Mandsaur	10
Atis *(Aconitum heterophyllum)*	YSPUHF, Solan	20
Ashoka *(Saraca asoca)*	KAU, Trichur	42
Asalio *(Lepidium sativum)*	AAU, Anand	16
	CCSHAU, Hisar	28
	RVSKVV, Mandsaur	40
	MPUAT, Udaipur	15
Ashwagandha *(Withania somnifera)*	AAU, Anand	40
	CCSHAU, Hisar	58
	IIHR, Bangalore	186
	RVSKVV, Mandsaur	68
	MPUAT, Udaipur	74
	IGKV, Raipur	44
Bach *(Acorus calamus)*	TNAU, Coimbatore	13
	YSRHU,Venkataramanagudem	27
	AAU, Assam	18
Basil *(Ocimum basilicum)*	AAU, Anand	10
	RVSKVV, Mandsaur	21
Ban kakdi *(Podophyllym hexandrum)*	YSPUHF, Solan	12
Bitter snakegourd *(Tricosanthus cucumarina)*	KAU, Trichur	19
Brahmi *(Bacopa monnieri)*	KAU, Trichur	43
	RAU, Pusa	14
Chitrak *(Plumbago* spp)	KAU, Trichur	25
	TNAU, Coimbatore	45
Chirayita *(Swertia chirayita)*	UBKV, Kalimpong	24
Giloe *(Tinospora cordifolia)*	YSRHU, Venkataramannagudem	13
	CCSHAU, Hisar	20
Guggal *(Commiphora wightii)*	AAU, Anand	33
	MPUAT, Udaipur	16

Crop	Centre	No. of accessions
Indian Valerian *(Valeriana jatamansi)*	UBKV, Kalimpong	09
Isabgol *(Plantago ovata)*	AAU, Anand	55
	CCSHAU, Hisar	83
	MPUAT, Udaipur	31
	NDUAT, Faizabad	42
	RVSKVV, Mandsaur	80
Kalmegh *(Andrographis panicualata)*	AAU, Anand	20
	CCSHAU, Hisar	13
	NDUAT, Faizabad	20
	OUAT, Bhubaneshwar	14
	IGKV, Raipur	257
Kuth *(Picrorhiza kurroa)*	YSPUHF, Solan	20
Lemongrass *(Cymbopogon* spp.)	CCSHAU, Hisar	46
	KAU, Trichur	20
	NDUAT, Faizabad	16
Long pepper *(Piper longum)*	KAU, Trichur	25
	AAU, Assam	35
	OUAT, Bhubaneshwar	9
Lotus *(Nelumbo nucifera)*	KAU, Trichur	24
Makoi *(Solanum nigrum)*	YSRHU, Venkataramannagudem	46
	TNAU, Coimbatore	52
Mandukaparni *(Centella asiatica)*	AAU, Assam	20
	RAU, Pusa	12
Mucuna *(Mucuna pruriens)*	AAU, Anand	20
	BAU, Ranchi	10
	IIHR, Bangalore	102
Neel *(Indigofera tinctorea)*	KAU, Trichur	22
Opium poppy *(Papaver somniferum)*	NDUAT, Faizabad	41
	MPUAT, Udaipur	85
	RVSKVV, Mandsaur	110
Palmarosa *(Cymbopogon martinii)*	CCSHAU, Hisar	65
Safedmusli *(Chlorophytum borivilianum)*	AAU, Anand	20
	CCSHAU, Hisar	12
	MPUAT, Udaipur	10
	RVSKVV, Mandsaur	24
	PDKV, Akola	13

Crop	Centre	No. of accessions
Sarpgandha *(Rauvolfia serpentina)*	OUAT, Bhubaneshwar	35
	IGKV, Raipur	12
Shatavari *(Asparagus racemosus)*	CCSHAU, Hisar	24
	JNKVV, Jabalpur	14
	MPKV, Rahuri	11
	NDUAT, Faizabad	24
Senna *(Cassia angustifolia)*	AAU, Anand	17
Sylibum *(Silybum marianum)*	AAU, Anand	10
Tulsi *(Ocimum sanctum)*	CCSHAU, Hisar	12
Vetiver *(Vetiveria zizaniodes)*	CCSHAU, Hisar	50
	KAU, Trichur	37
	NDUAT, Faizabad	12

Germplasm of Betelvine maintained at different AICRP MAPB centres

Centres	Total collection
BCKV, Kalyani	42
IIHR, Bangalore	118
MPKV, Rahuri	28
OUAT, Bhubaneshwar	21
RAU, Pusa	10
BAU, Islampur	10
YSRHU, Venkataramannagudem	64

Intellectual Property Rights

Elite germplasm registered with NBPGR, New Delhi.

DPO 296-4 (INGR 14010): A Golden yellow leaft colour of Isabgol (Plantago ovata) was registered with NBPGR, New Delhi during this year.

General Information.....

Committee Meetings

Honourable Shri Sharad Pawar, Union Minister of Agriculture and Food Processing Industries visited the Directorate

Honourable Shri Sharad Pawar, Union Minister of Agriculture and Food Processing Industries, visited the Directorate on December 22, 2013. Shri Pawar was felicitated in a function organized at the Directorate. Shri Jayantbhai Ramanbhai Patel, MLA, Sarsa, Anand , Dr S. Ayyappan, Secretary, DARE and Director General, ICAR, New Delhi and Dr. A. M. Sheikh, Vice Chancellor, Anand Agriculture University (AAU), Anand were also present in the function. Dr. Satyabrata Maiti, Director, DMAPR, Anand, welcomed the dignitaries and the guests. Dr. Maiti, also made a brief presentation on "Country Status Report on Medicinal and Aromatic Plants (MAP)". At the end of the function, Dr. Ayyappan expressed his gratitude to the honourable minister for the kind guidance and support in the endeavors of DMAPR. Shri Pawar also visited the Herbal Garden being maintained at the Directorate's Botanical Garden and the Field Gene Bank at Lambhvel Farm, Anand. He also planted a tree at the Lambhvel Farm. In interaction with the farmers, entrepreneurs and scientists, he expressed keen interest in life saving plants being used in various Indian Systems of Medicine (ISM). He also appreciated various activities being undertaken by the Directorate for the promotion of cultivation of medicinal and aromatic plants in India.

XXI Group Meeting of the AII India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine held at TNAU, Coimbatore

The 21st Group Meeting of the AII India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRP on MAP&B) was organized at Tamilnadu Agricultural University (TNAU), Coimbatore during September 23-26, 2013. The inaugural function was presided by Dr. K. Ramasamy, Vice Chancellor, TNAU Coimbatore and Dr. S.K. Malhotra, Assistant Director General (Hort.-II) was the Chief Guest of the function. Other dignitaries present in the function included Dr. Satyabrata Maiti, Director, Directorate of Medicinal and Aromatic Plants Research and Project Coordinator, AICRP on MAP&B, Dr. S. Mariappan, Dean (Horticulture), TNAU, Dr. N. Kumar, Professor (Horticulture), HC&RI, Coimbatore and R.M. Vijay Kumar, Professor and

Head, Department of Medicinal and Aromatic Crops, TNAU, Coimbatore. Dr. Mariappan, welcomed the guests and the delegates of the group meeting. In his welcome address, he expressed thanks to ICAR for opting TNAU as venue and also expressed gratitude to Dr. Satyabrata Maiti for selecting the university to host the group meeting at TNAU, Coimbatore. Dr. Maiti, presented the salient achievements by the coordinating centres and mentioned that he is presenting the amalgated form of research works of forty medicinal and aromatic plants carried out at twenty two centres under AICRP on MAP&B. Further, he highlighted that development of Good Agricultural Practices (GAP) and genetic resource management of medicinal and aromatic plants (MAP) are the important components of research activities being undertaken in AICRP on MAP&B. Further, he mentioned that although numbers of crops are more but number of programmes less under AICRP on MAP&B, however, multi-location testing across the country serves an excellent back up. Dr. S.K. Malhotra described the ride of agriculture during last two decades and mentioned the challenge of producing more. He described MAP as important crops and highlighted that about eighty percent population in Asia and Africa still relies on MAP for health care. For meeting the industrial requirement of MAP, quality and productivity are important, he mentioned. Describing All India Coordinated Research Project as a unique system, he categorically mentioned the need of high quality planting materials, optimization of irrigation scheduling and pesticide residue free produce of MAP. He suggested to the delegates that as the need of fixing of quality standards in changing scenario is very important, therefore, basic aspects of research must be taken care in research programmes of AICRP on MAP&B. Dr. K. Ramasamy, Vice Chancellor, TNAU, Coimbatore in his presidential address remarked that India has not made a mark in the area of plant based drugs and there is a need to analyze the situation "Where are we"? However, he highlighted the practices of herbal therapy in Kerala. He also mentioned the success story of hepatoprotective drug LIV 52 and anti diabetic plant *Costus speciosus* and *Salacid malbarica*. Regarding phytomolecules, he mentioned that these are specific to plant parts and plant based drugs ameliorates the root cause of the disease as these are not based solely on symptoms, therefore, uniformity in plant extract or crude drug shall be invariably maintained. At the end of inaugural function, Dr. Vijaya Kumar proposed the vote of thanks.

The group meeting was divided into six sessions including the presentation of action taken report and four technical sessions namely Crop Improvement, Crop Production, Crop Protection and Phytochemistry. Data of experimental trial conducted at the various coordinating centers during the year 2012-13 were presented. After thorough discussions of the results, the technical programme of the experiments to be conducted during the year 2013-2014 were formulated.

The plenary session on September 25, 2013 was chaired by Dr. N. Krishna Kumar, Deputy Director General (Horticulture), ICAR, New Delhi. Dr. Satyabrata Maiti, Project Co-ordinatior, presented research highlights of AICRP on MAP&B centres during last one year since the DDG (Horticulture) was not present in the inaugural session. Thereafter, proceedings of the four technical sessions namely Crop Improvement, Crop Production, Crop Protection and Phytochemistry and Analytical Methods were presented by the rapporteurs of the respective technical sessions.

Training on promotion of medicinal plants cultivation in tribal areas of Gujarat for livelihood and health security

Two days training on the "Promotion of medicinal plants cultivation in tribal areas of Gujarat for livelihood and health security" was organized during July 30-31, 2013 by the Directorate at KVK, Vejalpur, Godhra. Fifty tribal farmers from five villages namely Richhiya, Dudhwa, Gajapura, Kharsaliya and Bhadroli of Panchmanal district of Gujarat attended the training. Dr. Satyabrata Maiti, Director, DMAPR presided over the inaugural function and highlighted the importance of medicinal plants in daily life emphasizing the age old saying "Health is Wealth". Dr. Sanjay Singh, Head, CHES, Godhra, was also present in the function and in his speech he emphasized the need of medicinal plants and under-utilized fruit crops for good health. Earlier, Dr. R. S. Jat, Senior Scientist, DMAPR, welcomed the participants and presented an overview of the training. Dr. Kanak Lata, Programme Coordinator, KVK, Vejalpur presented vote of thanks at the end of the inaugural function.

During the training, the medicinal properties of various plants were described to the participants. Lectures covering the topics of cultivation practices, preparation of homemade recipes of medicinal plants, ITKs in agriculture, nutritional value of leafy vegetables, medicinal value of underutilized fruits crops and protection of plant varieties and farmers' rights act were delivered to the participants. A social survey of the participants health problems, medicinal plants use for common diseases and economic status were also conducted. At the end of the training programme, two days activities were reviewed and the seedlings of ten medicinal plant species and improved farm implements were distributed to the participants.

Workshop on Promoting Good Governance-Positive Contribution of Vigilance

A Workshop on "Promoting Good Governance-Positive Contribution of Vigilance" was organized at the Directorate on November 01, 2013. Major General (Retd.) Dr. T.S. Handa, Head Zydus Hospital, Anand, was the Chief Guest of the function and Dr. Satyabrata Maiti, Director, DMAPR chaired the function. Dr. P. Manivel, Principal Scientist (Plant Breeding) and Vigilance Officer, DMAPR welcomed the guests. Dr. Handa in his speech highlighted the eight point of governance and categorically mentioned the problem of overlooking prevailing in society. He highlighted the slogan "Love your institution, love your motherland". At the end of the function, Dr. Satyanshu Kumar, Principal Scientist (Organic Chemistry) proposed the vote of thanks.

Field Day under the project Tribal Sub Plan

A Field Day on the subject "promotion of medicinal plants cultivation in tribal areas of Gujarat for livelihood and health security" was organized by the Directorate on November 11, 2013 at the farmer's field in Dudhwa village, Vejalpur, Godhra. Under the TSP about fifty beneficiary tribal farmers participated in the field day. The farmers were taken to the plots

of medicinal plants such as Kalmegh, Tulsi, Ardusi, Aloe, Satavari, Turmeric, Gandhaprasarni, Giloe, Saragva . Participants learned the cultivation practices and also clarified their doubts in the context of the cultivation of these plants.

22nd Foundation Day Celebrated

The 22nd Foundation day of the Directorate was celebrated on November 24, 2013. Dr. A.M. Shekh, Vice Chancellor, AAU, Anand presided the inaugural function and Dr. C. Devakumar, formerly ADG (EPD), ICAR, New Delhi was the Chief Guest of the function. Dr. K.C. Dalal, formerly Director, NRCMAP was the Guest of Honor and other dignitaries in the function were also present. At the outset of the function, Dr. Satyabrata Maiti, Director, DMAPR, Anand welcomed the guests and also presented a report on the growth and achievements of the Directorate. Dr. K.C. Dalal, in his address, appreciated the progress made by the Directorate. Dr. C. Devakumar in his speech emphasized on the need of popularization of cultivation practices of medicinal and aromatic plants among the farmers and targeted research on entire value chain of some of the medicinal plants. Dr. A.M.Shekh in his presidential address suggested the sharing of information available for medicinal and aromatic crops with the end users. He also highlighted problems of marketing, post harvest management and value addition being faced the growers of medicinal and aromatic crops.

Training on "Good Agricultural and Collection Practices of Medicinal and Aromatic plants in NEH"

A three day training programme on "Good Agricultural and Collection Practices of Medicinal and Aromatic Plants" was organized by DMAPR at the ICAR Research Complex for North-Eastern Hill (NEH) regions, Umiam, Meghalaya during 11-13 February, 2014 under NEH Plan. Dr. Satyabrata Maiti, Director, DMAPR, Anand chaired the function and Dr. S.V. Ngachan, Director, ICAR Research Complex for NEH, Umiam was the chief Guest in the inaugural function of the training programme. There were 20 participants from all the Northern Eastern states.Dr. Ngachan, Director, ICAR Research Complex for NEH, Umiam in his inaugural address highlighted the importance of cultivation and collection practices of medicinal and aromatic plants to maintain the quality. He emphasized the scope of medicinal and aromatic plants in NEH region and various tribal traditions in treating many deadly diseases. Dr. Satyabrata Maiti, Director, DMAPR, Anand in his address, highlighted the importance of traditional system of medicines like Ayurveda, Unani and Siddha. He expressed the concerns of the sector which is facing the major challenges of maintaining the quality and

safety. Various aspects of GACP like principles of GACP, biodiversity management, protection of plant varieties, breeders and farmers' right, quality control and certification, quality seed and planting material and the status of marketing and supply chain were covered in the training programme.

Training-cum-awareness programme on "Protection of plant varieties and farmer rights act"

One-day training-cum-awareness programme on "Protection of plant varieties and farmer rights act" was organized at DMAPR, Anand on March 15, 2014 at the Directorate . The training was aimed for creating awareness of provision available in Protection of Plant Varieties and Farmers Right Act among the clientele such as farmers, researchers, students about the Act. Dr. Satyabrata Maiti, Director, DMAPR, addressed the delegates and delivered a lecture on the topic "Farmers and Breeders Rights, and the Provision Available in Protection of Plant Varieties and Farmers Right Act". He also emphasized to recognize and protect the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of the new plant varieties, and breeders' rights to encourage research and development in the breeding new plant varieties by protecting their rights.

Extension Activities

NAIP Sub-Project - Mobilizing Mass Media Support for Sharing Agro-Information

Under the NAIP Sub-project "Mobilizing Mass Media Support for Sharing Agro-information" a total of 18 web news or success stories related to ICAR technologies and events were hoisted on the websites of ICAR (10) and DMAPR (8). Also about 100 news clippings related to ICAR technologies and events appeared in English, Gujarati and Hindi newspapers. Sixteen audio capsules were produced and broadcasted of their contents were carried out through All India Radio Station at Vadodara. Five media meets at Maharana Pratap University of Agricultural & Technology, Udaipur; Navsari Agricultural University, Navsari; Krishi Vigyan Kendra , Dahod and Panchmahal and Regional Research Station of Central Soil Salinity Research Institute (RRS-CSSRI), Bharuch were organised for the dissemination of technologies .

Showcasing of Technology

Innovative technologies developed by the Directorate were showcased in Krishi Vasant-2014 to farmers, researchers and entrepreneurs during February 9-13, 2014 organized at Central Institute for Cotton Research, Nagpur during. More than seven lakhs stakeholders from different parts of the country including farmers, researchers, academician, officials, policy makers, politicians, students, farm women, entrepreneurs, media persons, etc. visited the fair.

Bamboo based technological interventions from Central Soil and Water Conservation Research and Training Institute, Research centre at Vasad were displayed at Kaprupur, village, Kheda district on 19th march, 2014. Bamboo based technological interventions made by the centre in the community land of Kaprupur displayed to the famers. Discussion were held on adoption and value addition of various Bamboo technologies.

A radio talk on "cultivation of Senna" was delivered at AIR, Vadodara. A brochure on NAIP sub project "Mobilizing mass media support for sharing agro-information" was published.

List of Audio capsules produced

S.No.	Technology	Institute
1.	Artificial groundwater recharge helps to overcome water shortage and ensures water quality as well in Gujarat	CSSRI, Bharuch
2.	Value added products from Banana Pseudostem	NAU, Navsari
3.	Bamboo and Anjan grass for enhancing productivity of Mahi ravines	CSWCR&TI, Vasad
4.	Cultivation of Bael	CHES, Godhra
5.	Cultivation of Jamun	CHES, Godhra
6.	Cultivation of Tamarind	CHES, Godhra
7.	Cultivation of Senna Medicinal Plant	DMAPR, Anand
8.	Technology for browning free Custard Apple (Sitafal) pulp extraction	MPUAT, Udaipur
9.	Cultivation of Dill (*Anethum Graveolens*) on moderately saline black soil	CSSRI-RC, Bharuch
10.	Technology for rejuvenation of old mango orchards	NAU, Navsari
11.	Prosperity through intervention of green house cultivation technology	KVK, Panchmahal
12.	Cultivation of Lemon grass	DMAPR, Anand
13.	Cultivation of Palmarosa	DMAPR, Anand
14.	Cultivation of Safed musali	DMAPR, Anand
15.	Glioe cultivation and importance	DMAPR, Anand
16.	Guggal: An important medicinal plant	DMAPR, Anand

Other Activities

International Women's Day celebrated

International Women's Day was celebrated at the Directorate. On this occasion a function was organised in the auditorium of the Directorate under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. Dr. Rama Srivastava, Senior Gynaecologist, Anand was the Chief Guest of the function. The senior citizens from Old Age Home , Rama Krishna Sewa Mandal, Lambhvel, Anand were the special invitees in the function. Dr.Geetha, K.A., Chairperson, Women's Cell welcomed the guests.

हिन्दी चेतना सप्ताह

निदेशालय की राजभाषा कार्यान्वयन समिति के तत्वाधान में दिनाँक १३-१९, सितम्बर २०१३ तक हिन्दी सप्ताह हर्षोल्लास से मनाया गया । इस दौरान हिन्दी के प्रयोग को प्रोत्साहन देने के लिये निबंध लेखन, हिन्दी व्याकरण, सामान्य ज्ञान, व्याख्यान एवं काव्यपाठ प्रतियोगिताओं का आयोजन किया गया । हिन्दी सप्ताह का समापन समारोह १९ सितम्बर को मनाया गया । समारोह का प्रारम्भ राजभाषा कार्यान्वयन समिति की सदस्य सचिव डॉ. वन्दना त्रिपाठी के स्वागत भाषण से हुआ । इस कार्यक्रम की अध्यक्षता निदेशक एवं राजभाषा कार्यान्वयन समिति के अध्यक्ष डॉ. सत्यब्रत माईति ने की ।

कार्यक्रम के मुख्य अतिथि, डॉ. नवनीत चौहान, प्रोफेसर एवं अध्यक्ष, हिन्दी विभाग, सरदार पटेल विश्वविद्यालय, आणंद ने विभिन्न प्रतियोगिताओं मे विजयी रहे प्रतिभागियों को प्रशस्ति पत्र एवं पारितोषिक वितरित किये । मुख्य अतिथि महोदय ने हिन्दी भाषा पर अपने विचार प्रकट करते हुए संपर्क भाषा के रुप में सरल हिन्दी का प्रयोग करने पर जोर दिया । सत्र के सभापति डॉ. सत्यब्रत माईति ने कहा कि हिन्दी का उपयोग केवल हिन्दी दिवस / सप्ताह / पखवाड़ा तक सीमित न होकर दैनिक कार्यों में भी होना चाहिए । समारोह के अन्त में प्रशासनिक अधिकारी एवं राजभाषा कार्यान्वयन समिति के सदस्य, श्री विजय कुमार ने धन्यवाद प्रस्ताव प्रस्तुत किया ।

हिन्दी कार्याशाला

औषधीय एवं सगंधीय पादप अनुसंधान निदेशालय, बोरीआवी, आणंद, गुजरात में ''राजभाषा हिन्दी के प्रचार-प्रसार में राजभाषा नियम/अधिनियम की भूमिका'' विषय पर २७ नवम्बर, २०१३ को हिन्दी कार्यशाळा का आयोजन किया गया था। जिसमें हमारे निदेशालय सहित भारतीय कृषि अनुसंधान परिषद के गुज रात स्थित ५ अन्य संस्थानों, क्षेत्रीय अनुसंधान केन्द्र, केन्द्रीय मृदा एवं जल संरक्षण अनुसंधान एवं प्रशिक्षण संस्थान, वासद (CSWCRTI), क्षेत्रीय अनुसंधान केन्द्र, केन्द्रीय मृदा लवणता अनुसंधान संस्थान, भरुच, (CSSRI) केन्द्रीय बागवानी परीक्षण केन्द्र, गोधरा (CHES), क्षेत्रीय अनुसंधान केन्द्र, केन्द्रीय मीठाजल जीव पालन संस्थान, आणंद, (CIFA) एवं क्षेत्रीय अनुसंधान केन्द्र, केन्द्रीय अंत:स्थलीय मात्स्यिकी अनुसंधान संस्थान, बड़ौदा (CIFRI) के लगभग ७० प्रतिनिधियों ने भाग लिया । इस

कार्यशाला में डॉ. महेन्द्र कुमार साहू, वरिष्ठ तकनीक अधिकारी (राजभाषा), राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो, नागपुर (NBSS&LUP) प्रमुख वक्ता थे। कार्यशाला के शुरुआत में संस्थान की हिन्दी अधिकारी एवं वरिष्ठ वैज्ञानिक डॉ. वंदना त्रिपाठी ने सभी उपस्थित प्रतिभागियों का परिचय देते हुए स्वागत किया। निदेशालय के प्रधान वैज्ञानिक डॉ. पी. मणिवेल, ने डॉ. साहू का स्वागत किया।

कार्यशाला के प्रथम सत्र में डॉ. महेन्द्र कुमार साहू ने राजभाषा हिन्दी के प्रचार-प्रसार में राजभाषा नियम/अधिनियम की भूमिका पर सभी को संबोधित किया। हिंदी की महत्त्वपूर्ण भूमिका बताते हुए उन्होंने कहा कि राजभाषा हिन्दी हमारे संस्कृति एवं देश से जुड़ी है और भारत जैसे बहुसांस्कृतिक देश में विविधता में एकता लाने के लिए हिन्दी संपर्क भाषा का काम करती है। राजभाषा का स्पष्टीकरण करते हुए उन्होंने कहा की राजभाषा वही है जिससे हमारे कार्यालय में दैनिक कार्य चलता है। इसलिए भारतीय संविधान की अनुच्छेद ३४३(१)-३५१ के अंतर्गत २२ राजभाषाएँ शामिल की गयी है। बाकी भाषाओं की तुलना में हिन्दी का क्षेत्र हमेशा से ही अधिक रहा है। हिन्दी ही एकमात्र ऐसी भाषा है जिसको अधिकतर भारतवासियों ने अपनाया है। कार्यशाला के द्वितीय सत्र के आरंभ में भा.कृ.अनु.प. के अंतर्गत गुजरात प्रांत से आए अन्य संस्थान के प्रतिभागियों ने अपने संस्थान में चल रहे हिन्दी उत्प्रेरक कार्यों के बारे में जानकारी दी।

डॉ. साहू ने इस कार्यशाला के सफल आयोजन पर निदेशालय की राजभाषा कार्यान्वयन समिति को बधाई दी। कार्यक्रम के अंत में निदेशालय के वैज्ञनिक डॉ. जी.आर. स्मिता ने धन्यवाद प्रस्ताव प्रस्तुत किया।

Distinguished Visitors

- Dr. K. L. Chadha, Formerly DDG (Hort.),ICAR, New Delhi on September 11, 2013
- Dr. R. N. Pal, Formerly DDG (Hort.) ICAR, New Ddhi on October 19, 2013
- Dr. M. G. Bhat, Formerly Director, DCR, Puttur on October 19, 2013
- Dr. R. R. Hanchinal, Chairperson, PPVFRA, New Delhi on October 22, 2013
- Dr. R. C. Agrawal, Registrar General, PPVFRA, New Ddhi on Oetober 22, 2013
- Dr. C. Devakumar, Formerly ADG (EPD), ICAR, New Delhi on November 24, 2013
- Shri Sharad Pawar, Union Minister of Agriculture, Government of India. New Delhi on Deeember 21, 2013
- Shri Jayatbhai Ramanbhai Patel, MLA, Sarsa, Anand on December 21, 2013
- Dr. S. Ayyappan, Secretary (DARE) & DG (ICAR), New Delhi on December 21, 2013

Deputations/ meetings attended by the Director

- Attended a brain storming discussion on Seed Platform at IARl, New Delhi on April 8, 2013.
- Attended a meeting on formulating the guidelines for open access policy in ICAR, New Delhi on April 12, 2013.
- Altened a meeting of the Sub Expert Committee for the programme on Wornen Technology Parks of DST at Institute of Bio-resources and Sustainable Development (IBSD), Imphal on May 02, 2013.
- Attended a delegation briefing meeting to participate in the 4th Plenary Meeting of ISO/TC 249 to be held at Durban, South Africa during May 20-23, 2013 at Bureau of Indian Standards, New Delhi on May 14, 2013.
- Participated as a Member of Indian Delegation in the 4th Plenary Meeting of ISO/TC 249 held at Durban, South Africa during May 20 -23, 2013.
- Attended administrative works at CARl, Port Blair during during June 13 -17, 2013
- Attended 97th meeting of the Expert Committee on "S & T for Women" at NASC Complex, New Delhi on July 26, 2013.
- Attended the Group Monitoring Workshop (GMW) of projects funded by Department of Science and Technology under its Scheme “Science & Technology for Women” held at JECRC University, Jaipur during November 12-13, 2013.
- Attended the Second meeting of the reconstituted Expert Committee on Medicinal Plants at NBA, Chennai during November 26 -27, 2013.
- Presented country report in the Expert Consultation on Promotion of Medicinal and Aromatic Plants in Asia and the Pacific Region held at Bangkok, Thailand during December 2-3, 2013 .
- Attended a selection committee meeting at ASRB. New Delhi on December 10, 2013.
- Attended the Vice Chancellors and Directors meet at Baramati and Pune during January 19-20, 2014.

Human Resource Development

Name	Details	Date
Training		
Dr. R. Nagaraja Reddy	Training on next generation sequencing : bioinformatics and data analysis at Madras Institute of technology (MIT), Chennai	September17-21, 2013
Dr. Ruchi Bansal	Advanced 'Omics' techniques for improvements in plant and human health at Division of Biochemistry, IARI, New Delhi	November 15- December 5, 2013
Dr. Raghuraj Singh	Training on "Developing, Commissioning, Operating and Managing an Online System for NET/ARS-Prelim Examination in ASRB, ICAR" at ASRB/IARI, New Delhi.	November 21-22, 2013
Shri Vijay Kumar	Training on Administrative Vigilance at ISTM, New Delhi Training on Records Management for Right to Information at ISTM, New Delhi	December 02-06, 2013 January 15-17, 2014
Dr. Vinay Kumar	Winter School on frontier technologies in the area of biotechnology, on gene isolation, characterization and breeding with reference to abiotic stress related genes at National Research Center on Plant Biotechnology, New Delhi.	December 10-30, 2013
Dr. N.A. Gajbhiye	Training on "Biomolecules" under NAIP, at Institute of Organic Chemistry with Centre of Phytochemistry, Bulgarian Academy of Sciences , Sofia, Bulgaria	January 13- March 13,2014
Shri N. J. Ganatra	Training on Noting and Drafting at ISTM, New Delhi	February 10-11 2014
Seminar/symposium/meeting		
Dr. R. Nagaraja Reddy	National Workshop on Conservation of RET Medicinal Plants at IIHR, Bangalore Review Workshop of the NAIP Sub-Project - Mobilizing Mass Media Support for Sharing Agro-Information at CHES, Chettalli, Kodagu Review Workshop of the NAIP Sub-Project - Mobilizing Mass Media Support for Sharing Agro-Information at IIVR, Varanasi Krishi Vasant-2014 Fair at CICR, Nagpur National Seminar on Role of Biotechnology in Developing Climate Resilient and Sustainable Agriculture at AAU, Anand	June 19-20, 2013 July 26-27, 2013 January 24-25, 2014 February 9-14, 2014 March 01, 2014

Name	Details	Date
Dr. R.S.Jat	Annual review meeting of the scheme on Spices and Aromatic Plants under CSS at CRSS, SDAU, Jagudan, Gujarat	June 19-20, 2013
	Annual review meeting of ICAR Seed Project at NBPGR, New Delhi.	August26-27,2013
Drs. P. Manivel, Satyanshu Kumar, N.A. Gajbhiye, R.S. Jat, and Thania Sara Verghese	XXI Annual Group Meeting of AICRP on MAP&B at TNAU, Coimbatore	September 23-26, 2013
Dr. Raghuraj Singh	Workshop-cum-installation training to Nodal Officers for NAIP Consortium on 'Strengthening Statistical Computing for NARS' at CIFE, Mumbai	August 30, 2013
	Second National NKN Annual Workshop at IISc, Bangalore	October 17-19, 2013
Dr. P. Manivel	International Round Table on Biochemical and Genetic Dissection of Control of Plant Mineral Nutrition at Palanpur, Gujarat	October 23-24, 2013
Dr. B.B. Basak	National seminar on development in soil Science 2013 and special symposium on agro-ecozone based land use planning in 78th Annual Convention of Indian Society of Soil Science held at CAZRI Jodhpur	October, 23-26 2013
Dr. P. Manivel and Dr.Satyanshu Kumar	Meeting of RFD to review the midterm achivements at NAAS complex, New Delhi	October 28, 2013
Dr. P. Manivel	NABMGR meeting at NRC Grapes, Pune	November 29, 2013
Dr. R. S. Jat and Dr. Ruchi Bansal	National Conference of Plant Physiology-2013 on Current Trends in Plant Biology Research	December 13-16, 2013.
Dr. Satyanshu Kumar	National Seminar on Medicinal Plants-Bioprospecting, Agro techniques and Enhancement of Secondary Metabolites, University of Pune, Pune	February 13-14, 2014,
Dr. A.P. Trivedi	National Seminar on Medicinal Plants-Bioprospecting, Agro techniques and Enhancement of Secondary Metabolites, University of Pune, Pune	February 13-14, 2014,

PUBLICATIONS

Research Papers

DMAPR, Anand

Varghese, Thania Sara, Bharpoda, T.M. Chaudhary, V. and Borad, P.K. 2013. Record of a parasitoid *Homalotylus hemipterinus* (De Stefani) on aphid predator *Cheilomenes sexmaculatus* (Fabricius). *Insect Environment,* **18:** 53-54.

Varghese, T.S. 2014. Battle against pest, biointensive IPM measures. *Kerala karshakan.* **10** : 22-25.

Kumar, S., Dhanani, T. and Shah, S. 2013. Extraction of three bioactive diterpenoids from *Andrographis paniculata* : effect of the extraction techniques on extract composition and quantification of three andrographolide using high performance liquid chrpmatography *Journal of Chromatographic Science* doi: 10.1093/chromsci/bmt157.

Shah, S., Dhanani, T. and Kumar, S. 2013. Validated HPLC method for identification and quantification of p-hydroxy benzoic acid and agnuside in *Vitex negundo* and *Vitex trifolia*. *Journal of Pharmaceutical Analysis*, **3**: 500-508.

Raju, S., Shah, S. and Gajbhiye, N. A. 2013. Effect of light intensity on photosynthesis and accumulation of sennosides in plant parts of Senna (*Cassia angustifolia* Vahl.). *Indian Journal of Plant Physiology*, **18**: 285-289

Smitha, G.R. 2013. Vegetative propagation of Ashoka (*Saraca asoca* (Roxb.) de Wilde) – An endangered medicinal plant. *Research on Crops*, **14** : 274-283.

Jat, R.S. and Singh, R. R. 2013. Mandukaparni: Ek Bahuupyogi Aushdhiya Paudha. *Mrida darpan*.

Jat, R.S. and Singh, R.R. and Bansal, R. 2013. Isabgol: Mahatav, Upyog Avam Utpadan. *Krishak Doot*.

Smitha, G.R. and Tripathy, V, 2013, Aushadhiy padaponse bane gunakari pey padarth, *Phal Phool*: Sept-Oct, 2013: 23-27.

Srinivasa Rao, N., Geetha, K.A., Maiti, S. 2014. Web-based networking of herbal gardens for exchange of planting material. *Computers and Electronics in Agriculture*. **103** : 26–32.

Deore, H.B. and Manivel, P. 2014. Inheritance of growth habit and berry colour in Ashwagandha (*Withania somnifera* (L.) Dunal) – a medicinal plant. *Electronic Journal of Plant Breeding (Accepted)*.

Nandanwar, H.R. and Manivel, P. 2014. Inheritance of flower colour in *Desmodium gangeticum* L. *Electronic Journal of Plant Breeding* (Accepted for publication).

Dhanani, T., Shah, S and Kumar, S. 2014. A validated high performance liquid chromatography method for determination of tannin related marker constituents gallic acid, corilagin, chebulagic acid, ellagic acid and chebulinic acid in four *Teminalia* species from India. *Journal of Chromatographic Science* (accepted for publication)

AAU, Anand

Gangopadhyay,S., Patel, M. A., Mistry, J. G. and Kumar, S. 2014. RAPD based genetic variability assessment in *Andrographis paniculata* (Burm. f) Wall. ex Nees (Kalmegh) : an important hepatoprotective herb. *Medicinal Plants - International Journal of Phytomedicines and Related Industries*, **6** : 47-52.

CCSHAU, Hisar

Goel, V., Duhan, B. S. Devraj and Madan, V. K. 2013. Effect of FYM and N on yield and quality of Kalmegh (*Andrographis paniculata* Nees). *Anals of Biology,* **29** : 167-170**.**

IGKV, Raipur

Kumari, A., Jha, P.K., Vibha**.** 2013. Effect of Rhizosphere and Phylloplane fungi on crop health of *Piper longum*. *Journal of Mycology and Plant Pathology*, **43**: 117

MPUA&T, Udaipur

Kaswan,V., Joshi, A. and Maloo, S.R. 2013 Assessment of genetic diversity in Isabgol (*Plantago ovata* Forks.) using random amplified polymorphic DNA (RAPD) and inter-simple sequence repeat (ISSR) markers for developing crop improvement strategies, *African Journal of Biotechnology*, **12**: 3622-3635.

Kaswan,V., Joshi, A. and Maloo, S. R. 2013. Genetic studies on divergence and quantitative characterization of Isabgol (*Plantago ovata* Forsk.) genotypes. *Research on Crops*, **14**: 585-591.

Kumar, R., Dodiya , N. S. and Khatik, C. L. 2013. Assessment of genetic variability and magnitude of correlation coefficient among different traits in Isabgol (*Plantago ovata* Forsk). *International Journal of Plant Science*, **8**: 193-196.

Rawal, P., Sharma, P., Dodiya, N.S. and Joshi, A. 2013. Evaluation of fungicides, neem bioformulations and biocontrol agent for the management of root rot of Safed Musli caused by *Rhizoctonia solani*. *Journal of Mycology and Plant Pathology* **43**, 297-305.

OUAT, Bhubaneswar

Gawai, D., Das, G. and .Rout, G.R 2013. Phytochemical screening and comparative analysis of antimicrobial activity of root, leaf extracts of *Tinospora cordifolia*, *Phyllanthus niruri* and *Abrus precatorious*, important medicinal plants. *Journal of Medicinal Plants Research*, **7**: 2208-2213.

PDKV, Akola

Koche,M., Gade, R.M. and Deshmukh, A.G. 2013. Antifungal activity of secondary metabolites produced by *Pseudomonas fluorescens*. *The Bioscan* **8** :723-726.

YSPHUF, Solan

Kamini and Raina, R. 2013. Review of *Nardostachys grandiflora* : an important endangered medicinal and aromatic plant of western Himalaya. *Forest Products Journal*, **63**, 67-71.

Raina, R., Patil, P., Sharma, Y. and Rana, R C. 2013. Reproductive biology of *Swertia chirayita* - a temperate critically endangered medicinal plant. *Caryologia*, **66** : 12-20.

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