ISSN 0975-394X

Annual Report 2014-15

भाकृअनुप
ICAR

ICAR – Directorate of Medicinal and Aromatic Plants Research
(ISO 9001:2008 Certified)
Boriavi, Anand – 387 310, Gujarat, India

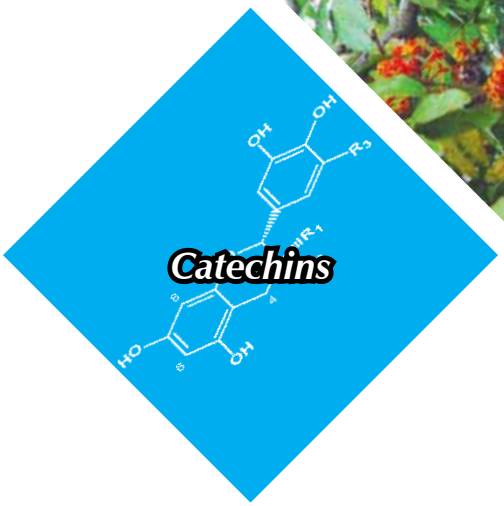

Andrographis paniculata


Cassia angustifolia


Tinospora cordifolia


Cymbopogon martinii


Saraca asoca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ANNUAL REPORT
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Correct Citation:

Annual Report 2014-15
ICAR - Directorate of Medicinal and Aromatic Plants Research

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Printed at:
Anand Press, Anand - 388 001, Gujarat
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PREFACE

In recent times, considerable attention has been paid to utilize eco and bio friendly cultivation practices. Also, there has been an exponential growth in the market for organic produce all over the world. The European countries hold the major share in import of organic produce. Under the Flagship programme of the Directorate, standardisation of organic cultivation practices of some of medicinal plants have been under taken. Processing is another area of major concern, as for effectiveness of herbal medicines adequate quantities of bioactive principles are very important. In this direction, a new paradigm was initiated for standardization of post harvest technologies and value addition for medicinal and aromatic plants to improve the yield, quality and economic return. Multi-disciplinary team research projects with broader visions were formulated by merging the on-going projects. In addition to mandate crops of the Directorate, research work on other four important crops namely Kalmegh (Andrographis paniculata), Mamejo (Enicostemma axillarae, Gudmar (Gymnema sylvestre) and Asalio (Lepidium sativum) were prioritized in the newly formulated research projects. Dissemination of the technology generated at the Directorate was carried out by bringing the publication of extension and technical bulletins for the maximum benefits of the farmers, growers and other stakeholders of medicinal and aromatic plants. The Directorate has also been participating in exhibitions so that direct interfacing with the stakeholders could deliver its best possible role to them.

The visits of dignitaries, to name a few, Padam Bhusan Dr. R. S. Paroda, Chairman TAAS and Formerly, Secretary, DARE and Director General, ICAR; Dr. N. K. Krishna Kumar, DDG (Horticultural Science), ICAR; Dr. Arvind Kumar, DDG (Education); Dr. C. Devakumar, Formerly, ADG (EPD), ICAR; Dr. A. Bandopadhayay, Formerly, National Co-ordinator, NBFSARA, ICAR and Dr. P.K. Bansal, ADG (NASF), ICAR during last one year, immensely benefitted the ICAR-DMAPR family in terms of their valuable comments as well as critical appraisal of the on-going research activities at the Directorate.

I am extremely grateful to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR and Dr. N. K. Krishna Kumar, Deputy Director General (Horticultural Science) for their keen interest in the activities of the Directorate and I am thankful to Dr. T. Jankiram, Assistant Director General (Hort. II) for their personal care in dealing with the matters of our Directorate at the ICAR Headquarters. I take pleasure to acknowledge the valuable contribution of all scientists of DMAPR and AICRP - MAPB centres for providing inputs to this annual report. Timely support received from Dr. Satyanshu Kumar, 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. I place a special thanks to Dr. Satyanshu Kumar in getting this annual report printed within the deadline set by the Honourable Director General, ICAR.

Jai Hind!

Anand **Jitendra Kumar**
24.06.2015

ABBREVIATIONS USED

AAU	Anand Agricultural University/ Assam Agricultural University
AICRP - MAPB	All India Coordinated Research Project on Medicinal and Aromatic Plants & Betelvine
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	Cetyl trimethyl-ammonium bromide
DAP	Days after planting
DAS	Days after sowing
DAT	Days after transplanting
DST	Department of Science and Technology
DUS	Distinctiveness uniformity and stability
ICAR - 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
ICT	Information and Communication Technology
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
NPK	Nitrogen-phosphorous-potash
OUAT	Orissa University of Agriculture and Technology
PDA	Photo diode array
Plant ha^{-1}	Plant per hectare
PDI	Percent Disease Index
PDKV	Dr. Punjabrao Deshmukh Krishi Vishwavidyalaya
PPV & FRA	Protection of Plant Varieties & Farmers' Rights Authority
PSB	Phosphate Solubilising Bacteria
q	Quintal (100 kg)
RAPD	Random Amplified Polymorphic DNA
RAU	Rajendra Agricultural University
RDF	Recommended Dose of Fertilizer
RIL	Recombinant Inbreed Line
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

ALOE (*Aloe barbadensis*)

At PDKV, Akola, seventeen accessions including nine local collections were evaluated, the accession, IC 112532 recorded significantly higher leaf thickness (16.96 mm), leaf weight (367.60 g plant^{-1}) as well as mucilage (66.15 %). At NDUAT, Faizabad, twenty four accessions were evaluated, the accessions, IC-112531 (905 q ha^{-1}), IC- 112279 (794 q ha^{-1}) and IC-310618 (708 q ha^{-1}) recorded maximum leaf yield.

At IGKV, Raipur raised bed planting and application of vermicompost 5 t ha^{-1} recorded maximum leaf and gel yield.

ARJUN *(Terminalia arjuna)*

At PDKV, Akola a TLC method developed for quick detection of adulteration bark samples. Out of 77 samples, 18.18 % samples were found to be spurious.

ASALIO (*Lepidium sativum*)

At ICAR - DMAPR, Anand, Initial evaluation trial with seven high yielding lines were evaluated. At Anand, Udaipur, RVSKVV, Mandsaur, Hisar and Solan, the entries, MLS-1007 (1968.13 Kg ha^{-1}) and MLS1016 (1931.94 Kg ha^{-1}) recorded maximum seed yield.

At RVSKVV, Mandsaur, forty lines were evaluated, the accession MLS-1007 recorded highest seed yield (2717 kg ha^{-1}).

At Udaipur, seven entries ULS-1, ULS-2, ULS-6, ULS-8, ULS-9, ULS-20 and ULS-15 exhibited higher seed yield over the check GA-1.

At Hisar, fifty progenies were evaluated, the progeny, PRT-74 recorded highest yield (833 kg ha^{-1}). The genotype, HLS-50 recorded highest yield (817 kg ha^{-1}) in a small scale trial.

At IGKV, Raipur irrigations at 25, 50 and 75 days after sowing and application of 80 kg N ha^{-1} recorded highest grain yield. At MPUAT, Udaipur, irrigations at 25, 45, 65 and 85 DAS and two sprays of brassinosteroids (0.6 ppm) at 50 and 70 DAS recorded maximum seed yield, net return and B:C ratio. Hand weeding at 25 and 50 days after sowing gave highest seed yield and net return at MPUAT, Udaipur. At RVSKVV, Mandsaur, application of 100% N through RDF followed by 100% N through vermicompost recorded maximum plant height, girth number of branch and seed yield. The maximum plant height with one hoeing at 25 DAS and seed yield with three hand weeding at 25, 35 and 45 DAS along with one hand hoeing at 30 DAS recorded at RVSKVV, Mandsaur. At PDKV, Akola, sowing on 44th meteorological weeks with seed rate of 6 kg ha^{-1} recorded significantly higher grain yield. Application of 10 t FYM ha^{-1} + 60 kg N ha^{-1} at 1/3 as basal + 1/3 at 25 DAS + 1/3 at 45 DAS recorded maximum grain yield and net returns, however, B:C ratio was found maximum with 5 t FYM ha^{-1} + 60 kg N ha^{-1} applied at 1/3 at sowing + 1/3 at 25 DAS + 1/3 at 45 DAS at YSPUHF, Solan. At JNKVV, Jabalpur, application of NPK 50:50:30 kg ha^{-1} + PSB + *Azotobacter* recorded maximum seed yield, however, the maximum net return and B:C ratio was obtained with NPK 25:25:15 kg ha^{-1} + PSB. The treatment involving application of

Trichoderma fortified FYM + application of *Azotobacter* + 2 sprays of Nimbecidine (0.15% Azadirachtin) recorded minimum disease incidence (33.3) against *Alternaria* leaf blight. Twenty four germplasms were also screened against *Alternaria* incidence at the centre.

At RSKVV, Mandsaur spraying Metalaxyl (72 % MZ @ 0.2%) recorded minimum Downy mildew incidence (15.59%).

ICAR-DMAPR, Anand, variation of total phenolic content was estimated at different three growth stages.

ASHWAGANDHA (*Withania somnifera*)

At ICAR - DMAPR, Anand multilocation trial was conducted with three test entries (AWS-2B, DWS 132, and DWS 135) and with three check varieties (JA 20, JA 134 and RVA 100). DWS 132, DWS 135 and AWS 1 had significantly higher yield than the check JA 20. Two (DWS 132 and DWS 135) high yielding pure lines were entered in to MLT. Three twenty eight breeding lines were advanced and characterized for morphological traits. Sixty six lines were screened for total phenol content. Seventy nine accessions were evaluated for root yield and quality, AWS-38 (79 g plant^{-1}) and AWS-48 (78 g plant^{-1}) recorded highest dry root yield. At RVSKVV, Mandsaur, thirty seven accessions were characterized and grouped into twenty one categories on the basis of berry colour, berry size, plant type, branching pattern, leaf type, leaf surface. At IGKV, Raipur, twenty nine genotypes were evaluated for yield and quality related traits. Maximum fresh root yield was observed in genotype MSW-310 (6.54 q ha^{-1}).

At MPUAT, Udaipur, thirteen genotypes were evaluated for root yield and quality, UWS-10, UWS-11, UWS-23, and UWS-93 exhibited significantly higher dry root yield over the best check RAV-100.

At CCSHAU, Hisar, eleven crosses were attempted between high root yield and wilt resistant genotypes and F_1 seeds were collected. Fifteen genotypes were evaluated for root yield and quality. Highest dry root yield was recorded for genotype HWS-132 (1246 kg ha^{-1}) against the check JA 20 (708 kg ha^{-1}).

The interaction effect of application of nimbecidine (0.15% Azadirachtin) followed by *T. asperellum* @ 10^{6-9} cfu/ml and P. *fluorescens*. @ 10^{6-9}cfu/ml reduced the *Alternaria* leaf blight incidence to 28.4% at JNKVV, Jabalpur.

At MPUAT, Udaipur, an integrated disease management module under organic farming was evaluated against root rot and foliar diseases. Screening of 16 genotypes at the centre against root/collar rot, leaf spot/ blight under natural infection and chemical protected conditions revealed that, six genotypes (RAS-10, RAS-37, RAS-23, RAS-11, RAS-92 and RAS-22) were resistant. 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 at RVSKVV, Mandsaur.

ASOKA *(Saraca asoca)*

At KAU, Thrissur, the total phenol content in the stem bark increased 3 to 5 times within a period of 6 years of growth.

At ICAR - DMAPR, Anand : extraction optimization and HPLC method was developed for quantification of bioactive molecules in different parts.

BACH (*Acorus calamus*)

At YSRHU, Venkataramannagudem, twenty eight accessions including three new collections from Kodaikanal, Bengaluru and Pandirimamidi were evaluated. At AAU, Jorhat, four accessions were collected and twenty two accessions were evaluated for morphological and yield traits.

BASIL (*Ocimum basilicum*)

At RVSKVV, Mandsaur, twenty one accessions collected from farmers' field were evaluated, the accession, MOB-14 (479 kg ha^{-1}) recorded maximum seed yield.

CHIRAYITA (*Swertia chirayita*)

At UBKV, Kalimpong, the survey of fungal diseases showed that highest leaf spot incidence was recorded during May and lowest during December whereas highest leaf blight incidence was recorded during August and it was lowest during January.

At YSPUHF, Solan: Based on the TLC and HPLC analysis data, 51.92% of market samples were found to be true samples.

CHITRAK (*Plumbago zeylanica)*

At TNAU, Coimbatore, forty two accessions were harvested after two years of planting. The accession TN*PZ* 10 recorded maximum root weight of 2723.67 g plant^{-1}.

At ICAR - DMAPR, Anand: plumbagin content varied from 0.05 to 0.48%.

COLEUS (*Coleus forskohlii*)

At TNAU, Coimbatore lowest root rot incidence was recorded when cuttings were dipped in P. *fluorescens* (0.2%) followed by drenching with P. *fluorescens* (0.2%) on 30 DAP.

DODI *(Leptadenia reticulata)*

At ICAR - DMAPR, Anand yield loss due to sucking pests, aphids (*Aphis nerii),* psyllids *(Diaphorina dakariensis)* and Red spider mite *(Tetranychus* spp.) was estimated to be 60 per cent.

GUDMAR (*Gymnena sylvestre*)

At ICAR - DMAPR, Anand, the accessions, DGS 31 with orange flowers and DGS 1-20 with early flowering (10 months after sowing, usually flowering starts 15-20 months after sowing) were identified. Evaluation of the lines for morphological parameters revealed highly significant differences for leaf related parameters. Also a HPLC method was developed for identification and quantification of bioactive principle gymnemagenin.

At JNKVV, Jabalpur, seven accessions were evaluated, the accession JBPGS8-9-104 recorded maximum number of fresh leaves per plant (2135.67), fresh leaf yield per plant (199.7 g) and

dry leaf yield (95.10 g). The cuttings planted in the month of September needed less time for sprouting as compared to July and August. Survivability of cuttings was observed highest in August month with 750 ppm IBA.

GUGGAL (*Commiphora wightii*)

At ICAR - DMAPR, Anand, segregating population was developed by crossing obligate sexual *vs* apomictic genotypes and *In vitro* regeneration protocols were developed.

INDIAN VALERIANA *(Valeriana jatamansi)*

At UBKV, Kalimpong, crop raised either through seeds or rhizome cuttings and transplanted in 1st week of June at a spacing of 30 × 45 cm recorded significantly higher fresh aerial and underground biomass, rhizome and root biomass.

ISABGOL (*Plantago ovata*)

At ICAR - DMAPR, Anand, advanced varietal evaluation trials of early maturing group and medium maturing group were conducted. A high yielding variety "Vallabh Isabgol -1" was identified for release. Ploidy of ninety seven tetraploid lines were confirmed through cytology. Seven mutants showed resistance to downy mildew. Many morphologically distinct mutants were identified. RIL progenies of cross DPO-185 x DPO-40 were advanced from F_4 to F_5 and evaluated for various morphological and agronomic characters. Seventy two SSR markers were developed. Genetic linkage map was constructed using RAPD markers. Value added compost was prepared by using isabgol crop residue and cowdung as substrate, and different sources of rock phosphate. Among the different biopesticides against aphids azadirachtin (10000ppm @ 3ml l^{-1}) was found to be effective. In another field trial to know the dissipation pattern of imidacloprid 17.8 SL, it was found that the chemical persisted in spikes for 10 days and the half life was calculated as 3 days.

At NDUAT, Faizabad, thirty accessions were evaluated, maximum seed yield was recorded for MPI-1 (3.86 q ha^{-1}) followed by PB-6-1 (3.44 q ha^{-1}) and JI- 16 (3.18 q ha^{-1}).

At RVSKVV, Mandsaur, eighty accessions were evaluated, the accession MIB-1004 recorded highest seed yield (1022 kg ha^{-1}).

At AAU, Anand, five mutants (wheat type mutant, ball mutant, PCM, tetraploid and branched spike) were evaluated.

At RVSKVV, RVSKVV, Mandsaur, seeds of JI-4 variety were treated with six doses (0.1%, 0.2%, 0.4%, 0.6%, 0.8% and 1.0% EMS) and mutagenic variability for various agronomic traits were observed in M_1 generation.

Screening of 10 promising genotypes against Downy mildew, bacterial blight, leaf spot blight and root rot revealed that five genotypes (P-80, P6, PB-3-1, AMB-2, and MIB-124) showed resistance against the diseases at MPUAT, Udaipur.

At YSRHU, Venkataramannagudem, the application of chlorothalonil in combination with two sprays of potassium salt of phosphorus acid was found to be effective in reducing Downy mildew incidence.

KALIHARI (*Gloriosa superba*)

At TNAU, Coimbatore, yield losses due to defoliators (*Plusia signata and polytelia gloriosae*) and the major sucking pest, *Thrips tabaci* were found to be 27.05 and 11.49 per cent respectively.

Natural lactones (2 ml l^{-1}) was found to be effective against sucking pests and defoliators. Spraying chlorothalonil (0.1%) twice or *Bacillus subtilis* (0.2%) on 30 and 60 days after planting was effective in managing the leaf blight disease. Root rot disease was effectively managed by dipping tubers in *B. subtilis* (0.2%) followed by drenching with *B. subtilis* (0.2%) at 30 days after planting.

KALMEGH *(Andrographis paniculata)*

At ICAR - DMAPR, Anand, descriptors for DUS testing were identified, finalized and submitted to the PPV& FR Authority. Four (ICAR - DMAPR AP 13, ICAR - DMAPR AP 18, ICAR - DMAPR AP 35 and ICAR - DMAPR AP 02) lines of high herbage yield and andrgrapholide content were identified. Integrated use of vermicompost 7.5 t ha-1 and NPK 80 : 30 :50 (50 % N applied at planting and 50 % at 25 and 40 DAP) recorded highest dry herbage yield, whereas andrographolide content was highest with castor cake 2.5 t ha-1 and NPK 80 : 30: 50 (50 % N applied at planting and 50 % at 25 and 40 DAP). Under organic nutrient management application of castor cake 2.5 t with Jivamrut at 25, 50 and 75 DAP recorded highest yield and andrographolide content. HPLC combined with electrospray ionization triple quadrupole tandem mass spectrometry (LC-ESI-MS/MS) under the multiple reaction monitoring (MRM) mode was standardized for the determination of seven major diterpenoid lactones.

At RVSKVV, Mandsaur, twelve accessions collected from farmers' field of Mandsaur district were evaluated. Highest dry herbage yield were recorded for MAP-1 (1741 kg ha^{-1}).

At NDUAT, Faizabad, eleven accessions with Faizabad local as a check were evaluated for three years. The accession, IC- 342135 recorded highest dry herbage yield (48.65 q ha^{-1}).

At IGKV, Raipur, two hundred and ninety five accessions and two checks, Simmegha and Anand Kalmegh-1 were evaluated for various qualitative and quantitative traits.

At PDKV, Akola intercropping of kalmegh + pigeon pea at row proportion 3:1 recorded highest dry foliage and andrographolide yield, kalmegh equivalent yield, land equivalent ratio, gross return, net return and B:C ratio. At BCKV, Kalyani, when planted at 30 × 30 cm spacing recorded three fold higher dry matter production over planting at 60 × 60 cm. Kalmegh planted on 1st June recorded highest canopy spread and plant height. At RVSKVV, Mandsaur, application of 150 kg N ha^{-1} recorded highest fresh herbage yield, whereas, 40 kg N ha^{-1} recorded highest dry herbage yield.

KUTKI (*Picrorhiza kurroa*)

At YSPUHF, Solan, on the basis of TLC profile and HPLC analysis and after comparing with genuine samples it was concluded that out of the 36 samples, 34 samples were true samples.

LAL CHITRAK (*Plumbago rosea*)

At KAU, Thrissur, the accession, TCRPR 521 registered superiority with respect to root characters at three different locations. Coppicing of plants at 15 months after planting at plant height of 30 cm recorded maximum root length and fresh weight of roots. However, coppicing at 9 months after planting at 30 cm height recorded highest plumbagin content.

LEMON GRASS (*Cymbopogon flexuosus*)

At ICAR - DMAPR, Anand, the waste biomass material distillation was used for removal of Cu(II) and Zn(II) from water.

LONG PEPPER (*Piper longum*)

At AAU, Jorhat, thirty five accessions collected from different states of North East India were evaluated and characterized. The accession, JPL-1 recorded maximum number of spikes/ plant (78.67). The spacing of 90 × 60 cm and planting without support recorded highest number of spike per plant and fresh and dry weight per spike. Application of 25% RDF through fertilizers + 75% RDF through vermicompost recorded maximum fresh and dry weight of spikes. At ICAR - DMAPR, Anand sixteen accessions received from AAU, Jorhat were screened for piperine content using HPLC method. Piperine content of six accessions was higher than the piperine content of "Viswam"(5.15%).

At RAU, Pusa, soil incorporation of 10g of *Trichoderma viride* formulation with 100 g of FYM per pit at the time of planting effectively reduced the leaf spot disease.

MAKOI (*Solanum nigrum*)

At TNAU, Coimbatore, thirty five descriptors were identified and tested for DUS.

At YSRHU, Venkataramannagudem, forty five accessions were evaluated, the accession, TNSn-19 recorded highest herbage yield (15.80 t/ha). The seed rate of 12.5 kg ha^{-1} for broadcasting produced maximum seed yield which was at par with 2.5 kg ha^{-1} seed rate and transplanting at 30 x 30 cm. Similarly, transplanting of 25 days old seedlings produced highest number of branches and herbage yield which was at par with 15 and 20 days old seedlings.

Yield loss due to the major insect pests was found to be 31.63 % whereas yield loss due to the major mite pest, *Polyphagotarsonemus latus*, was recorded to be 66.92 % at TNAU, Coimbatore. In another field trial it was found that foliar application of spiromesifen 240 SC @ 500 ml/ha caused 98 per cent mortality of mites and recorded higher marketable leaf yield (18.8kg/12m^2/harvest).

At YSRHU, Venkataramannagudam, maximum reduction of mite population was recorded in propargite (5.89 $plant^{-1}$) treated plants followed by wettable sulphur (6.21 $plant^{-1}$) and spiromesifen (8.22 $plant^{-1}$) treated plants.

MANDUKAPARNI (*Centella asiatica*)

At UBKV, Kalimpong, ten accessions were characterized for various morphological traits, the

accession KCA-1 had reddish stem color, crenate leaf margins, deep green leaf colour and deep pink petals.

At NDUAT, Faizabad application of FYM 15 t ha^{-1} recorded 175% higher dry herb yield over control. Similary, sowing at closer spacing of 30 × 60 cm and harvested on 15th May recorded maximum fresh and dry herbage yield.

At RAU, Pusa, FYM soil incorporation and inoculated with *Trichoderma harzianum* combined with sapling treatment with the same bio agent was most effective in suppression of stolon rot.

NEEL (*Indigofera tinctoria*)

At KAU, Thrissur, multiocational trial with selected accessions (TCRIT 2, TCRIT 4, TCRIT 14 and TCRIT 15) along with local check was laid out at three locations (Ollukkara, Madakkathara and Irinjalakkuda). Crop planted in September under 25% shade gave the highest herbage yield consecutively for three years. However, planting in the month of August under fully open condition was ideal for getting maximum indican content. Similarly, application of FYM 5 t ha^{-1} along with NPK 45:60:45 kg ha^{-1} recorded higher herbage yield followed by FYM 10 t ha^{-1} along with NPK 45:60:45 kg ha^{-1}, however, indican content was not affected with the application of manures or fertilizers.

OPIUM POPPY (*Papaver somniferum*)

At RVSKVV, Mandsaur, 255 accessions were evaluated. Out of them 33 recorded higher latex yield (above 40 kg ha^{-1}).

At MPUAT, Udaipur, thirteen entries were evaluated for latex, seed, husk yield and other yield contributing traits. Three genotypes (UOP-132, UOP-145 and UOP-150) had significant higher husk 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.

PALMAROSA (*Cymbopogon martinii* var. motia)

At CCSHAU, Hisar, forty nine clones from modified mass selection were evaluated, the clone, C-22 yielded highest oil yield per plant (5.86 ml).

At IGKV, Raipur, the maximum oil yield was found with variety Jamarosa with application of nitrogen 150 kg ha^{-1}.

SAFED MUSLI (*Chlorophytum borivilianum*)

At PDKV, Akola, thirteen genotypes were evaluated, the accession AKSM-07 recorded significantly higher root weight per plant (16.87g). The accession AKSM-07 had higher root yield (q ha^{-1}) recorded for AKSM-07 (38.19) followed by AKSM-08 (37.65) in the preliminary yield trial.

At RVSKVV, Mandsaur, twenty four accessions were evaluated for yield and quality, the accession MCB-412 recorded maximum fresh fasciculate root yield (3704 kg ha^{-1}).

At PDKV, Akola, intercropping of safed musli + pigeon pea at row proportion 3:1 produced highest number of roots, length, girth, saponin content, fresh and dry root yield, safed musli equivalent yield, land equivalent ratio, net return and B:C ratio followed by sole safed musli.

Spraying of carbendzim + mancozeb @ 0.25 % was effective in reducing anthracnose disease at RVSKVV, Mandsaur and twenty three germplasms at the centre were also screened for fasciculated root rot disease.

At MPUAT, Udaipur an integrated disease management strategy for root rot under organic farming was evaluated.

SARPAGANDHA (*Rauwolfiana serpentina*)

At NDUAT, Faizabad spraying of neem leaf extract @ 5.0 % was found to be effective in reducing *Cercospora* leaf spot. In another field trial at JNKVV, Jabalpur soil application of FYM @ 10 t ha^{-1} + 3 sprays of mancozeb 75% WP at 15 days interval was found effective in reducing *Cercospora* leaf spot incidence.

SATAVARI (*Asparagus racemosus*)

At ICAR - DMAPR, Anand, the *Asparagus adscendens* was acclimatized in plains, flowering and seeds were observed in DAA1 accession. Twenty five accessions of A. adscendense were screened for saponin content using HPLC-ELSD method.

At NDUAT, Faizabad, twenty four accessions were evaluated for three years, the genotypes NDAS- 24 recorded maximum fresh roots yield (484.62 q ha^{-1}).

At MPKV, Rahuri, eleven accessions were evaluated for yield and quality, the accession, RSLG-11 recorded maximum fresh root yield (2.35 kg plant-1) and dry root yield (1.927 kg plant-1).

At JNKVV, Jabalpur, thirteen accessions were evaluated, fresh root weight per plant ranged from 1391 to 4629 g and dry root weight ranged from 145.5 to 642.50g.

Application of 50% RDF though inorganic fertilizers + 50% RDF through FYM recorded maximum number of roots per plant, root length, root diameter, fresh and dry root yield.

At RAU, Pusa, combined application of vermicompost 2 t + mustard cake 1 t ha^{-1} and inoculated with mixture of PSB 5 kg + *Azospirillum* 2 kg ha^{-1} produced significantly higher number of roots per plant, root length and root yield both on fresh and dry weight basis. It was followed by vermicompost 2 t ha^{-1} inoculated with mixture of *Azospirillum* 2 kg + PSB 5 kg ha^{-1}.

The yield loss due to fruit borer was recorded to be 57.38% at MPKV, Rahuri and the biology of the pest was also studied at the centre.

SENNA (*Cassia angustifolia*)

At ICAR - DMAPR, Anand, 34 accessions were collected and two hundred accessions were characterized. Anthraquinones biosynthesis genes were mined from the leaf transcriptome. Microsatellite markers were also developed. Leaf transcriptome data was deposited at NCBI.

The economic threshold level of *Catopsila pyranthe* at 60 days after sowing was found to be 5 larvae per plant and azadirachtin 10000 ppm @3 ml l^{-1} was found to be effective against the caterpillar and its efficacy was found to be at par with the chemical check., chlorpyriphos 20 EC. The critical level of soil micronutrient was determined by statistical and graphical approaches. A simple multi residue was established for the determination of 17 organochlorine (OC), 16 organophosphorous (OP) and 7 synthetic pyrethroid pesticides.

At MPKV, Rahuri combined application of FYM 5 t + vermicompost 2 t + PSB 5 kg ha^{-1} recorded highest plant height and dry leaf yield. However, maximum sennoside content was recorded with FYM 5 t + vermicompost 2 t ha^{-1}. Similarly, planting at spacing 30 × 45 cm on 10th June recorded highest leaf yield and B:C ratio at MPKV, Rahuri. At MPUAT, Udaipur sowing at 26th meteorological week and at spacing of 40 × 15 cm recorded maximum dry leaf yield.

At MPKV, Rahuri seed treatment with *Bacillus subtilis* (5 g kg^{-1} of seed) followed by soil application of *Trichoderma viride* + Bacillus *subtilis* enriched FYM (5 g kg^{-1}) recorded lowest wilt incidence. A leaf yield loss of 47 % was calculated due to the infestation of the defoliator.

TULSI (*Ocimum sanctum*)

At RVSKVV, Mandsaur, application of N 125 kg ha^{-1} and planting on 15th July produced highest seed and herbage yield. At RAU, Pusa, application of vermicompost 2 t ha^{-1} and inoculated with mixture of PSB 5 kg and *Azospirillum* 2 kg ha^{-1} produced significantly higher herbage yield both on fresh and dry weight basis and seed yield. Similary, planting on the first July at spacing of 40 × 30 cm recorded maximum fresh and dry herbage yield.

BETELVINE (*Piper betle*)

At ICAR - IIHR, Bengaluru, five land races were collected and 109 accessions including three *Piper* species were maintained. Flowering was recorded in four hybrids and all produced female inflorescence. Eight high yielding clones along with local check (Hirehalli Local) were evaluated, maximum leaf yield was recorded in IIHR BV 67 (93.87 lakh leaves ha^{-1}) followed by Sirugamani 1 and Mysore Local (64.22 and 59.45 lakh leaves ha^{-1}). Ten inter varietal crosses, five crosses between varieties and hybrids and five interhybrid crosses were made and fruit setting was observed. Hybrid seed germination per cent varied from 6.90 to 87.5% among the crosses. Eight hybrids and four parental lines were evaluated under areca nut garden, Hy 06-4 hybrid consistently recorded higher leaf. Twenty three hybrids were evaluated under shade net house (simulating bareja conditions), the hybrids Hy 08-52 (145.50), Hy 06-4 (107.08), Hy 06-1 (105.17) and Hy 06-11 (100.67) recorded higher leaf $vine^{-1}$.

At AAU, Jorhat, four accessions were collected from different locations of Assam. Twenty six accessions were evaluated.

At BAU, Islampur application of zinc sulphate (30 kg ha^{-1}) produced maximum yield of marketable leaves $vine^{-1}$, number of lateral branches $vine^{-1}$ and length of vine as compared to control. The treatment involving field sanitation + soil drenching with Bordeaux mixture - (1%) before planting and 60 days after planting significantly reduced the disease incidence

of *Phytophthora* foot rot (76.1%), sclerotium wilt (83.3%) and bacterial leaf spot (74.9%), respectively.

A survey was conducted for identification of most severe diseases in Magahi paan. It was found that *Phytophthora* foot-rot and *Phytophthora* leaf rot were most severe with 38.5 % and 33.3 % disease incidence.

Demonstration of IDM technology, 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 of NPK ha^{-1} was conducted on farmer's field at MPKV, Rahuri, RAU Pusa and BCKV, Kalyani. The results showed that the IDM technologies of the centres were significantly superior over farmers practice in lowering disease incidence and also higher leaf yield was recorded.

At BCKV, Kalyani, Betelvine hybrid lines were screened for their resistance against leaf spot and blight diseases and their differential susceptibility to *Aleyrorid* flies.

General Information

The Directorate was accredited with ISO 9001: 2008 certification by Bureau Veritas, Lodon. Research advisory committee and Institute Research Committee meetings were held to monitor the research activities of the Directorate. Training programmes on promotion of medicinal plants in tribal areas for livelihood security were organised. Also, training programme on "Good Agricultural and Collection Practices of Medicinal and Aromatic Plants" was organised at Nagaland University Campus, Medziphema, Dimapur, Nagaland. The Group Meeting of AICRP-MAPB was organised to review the research works being carried out at different AICRP-MAPB centres. Technologies developed by the Directorate and its outreach programme AICRP-MAP were exhibited at Gandhinagar, Anand, Patna, Allahabad and New Delhi. The Directorate exhibition stall was selected as best Exhibition stall at Patna and New Delhi exhibitions.

Plantation Day, Hindi Week, Foundation Day and Vigilance Awareness Week were celebrated at the Directorate. Swachchh Bharat Mission campaign was also launched. A workshop on Hindi was organised at the Directorate to promote Hindi language in day to day official works.

Professional Scientific Attachment training was provided to three ICAR-ARS scientists.

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 was rechristened to Directorate of Medicinal and Aromatic Plants Research (ICAR - 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 MAP through its research and development to meet the immediate demands and also to address future national and international challenges.

The ICAR - 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, supply of quality 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.

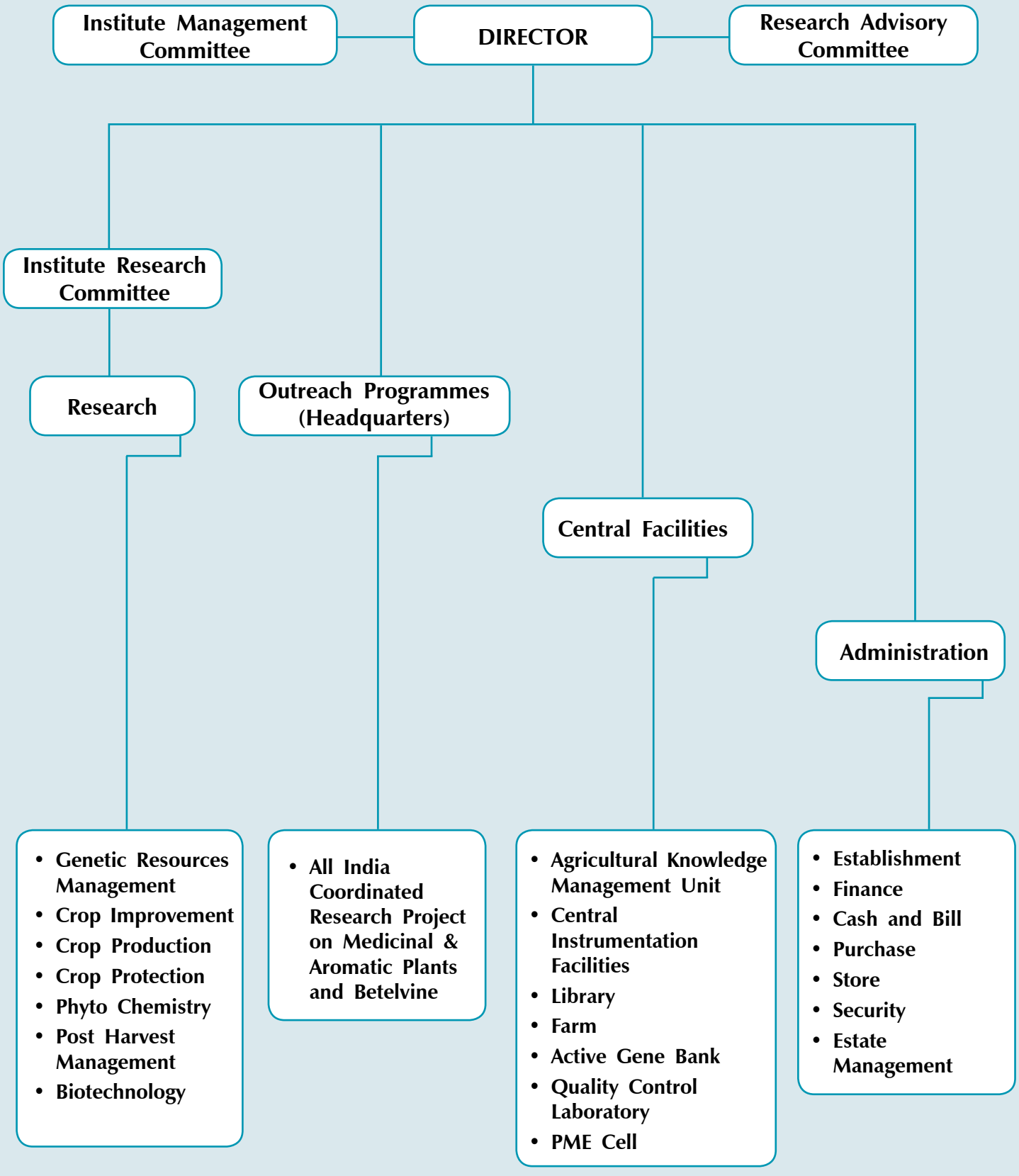
Mandate

- Development of appropriate production, protection and processing technologies for important MAP through basic, strategic and applied research.
- Germplasm enhancement of various MAP.
- To act as a National Repository of the genetic resources of selected important MAP.
- To coordinate research under AICRP-MAPB.
- To act as information data bank on MAP.
- Transfer of technologies developed by the ICAR - DMAPR to the farmers through cooperation with the developmental agencies.

Mandate crops

- Aloe (*Aloe barbadensis*)
- Ashwagandha (*Withania somnifera*)
- Giloe (*Tinospora cordifolia*)
- Guggal (*Commiphora wightii*)
- Isabgol (*Plantago ovata*)
- Lemongrass (*Cymbopogon flexuosus*)

Organisational Structure



- Palmarosa (Cymbopogon martinii)
- Safed musli (*Chlorophytum borivilianum*)
- Senna (*Cassia angustifolia*)

Objectives

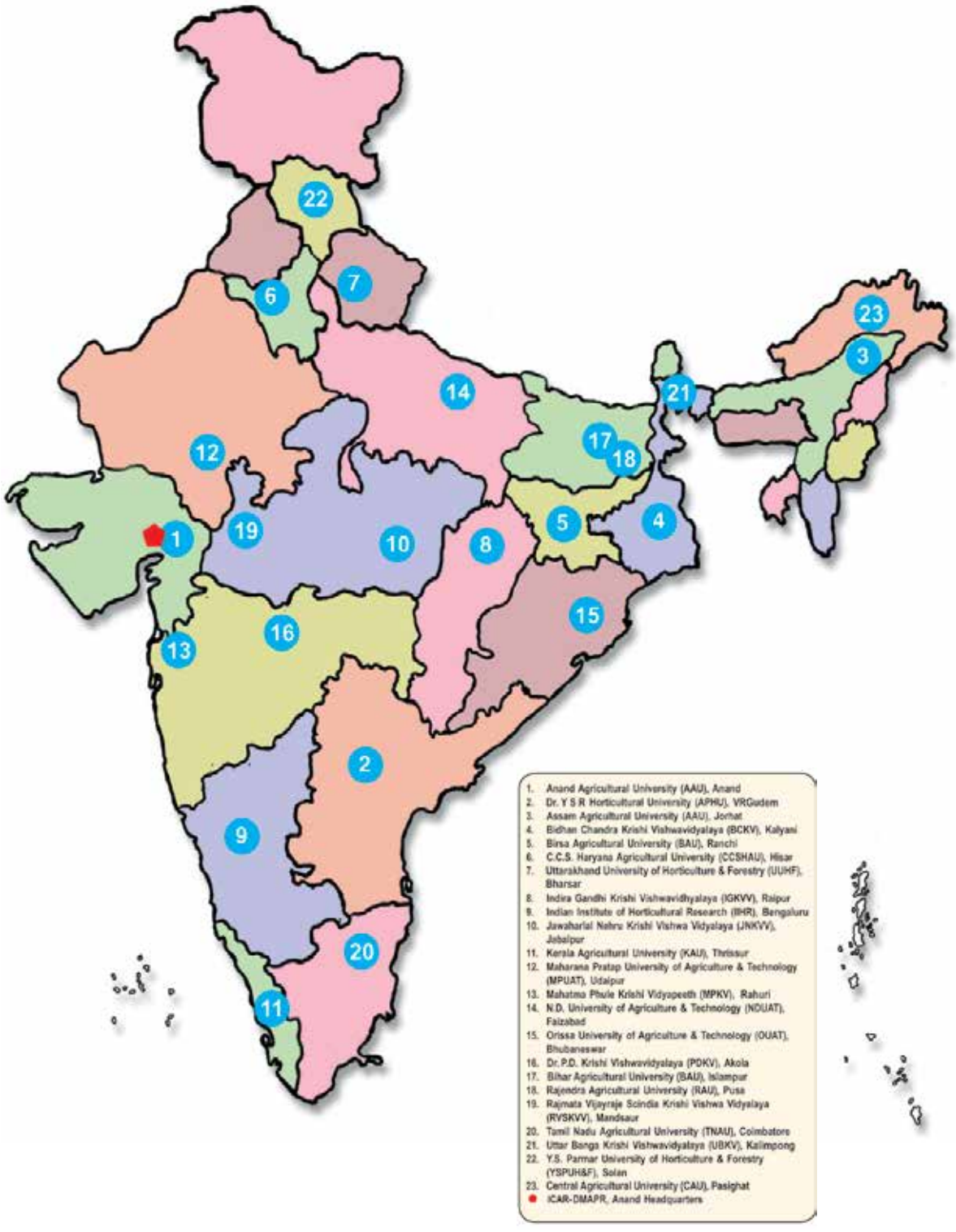
- To identify plants which need attention of agricultural scientists, to collect, maintain and evaluate the identified plants.
- To carry out basic research on the mandate MAP crops for developing their Good Agricultural Practices (GAP).
- To coordinate the research activities of the centres of AICRP - MAPB 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 ICAR - DMAPR.
- To develop partnership between the Directorate and private sector, NGOs and farmers' associations/progressive farmers interested in promoting the MAP cultivation.

Outreach programmes

AICRP-MAPB is located at ICAR - DMAPR and the Director, ICAR - DMAPR is also responsible for coordination and monitoring of research work of the project as Project Co-ordinator. 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. ICAR - Indian Institute of Horticultural Research (IIHR), Bangalore
9. Jawaharlal Nehru Krishi Viswa Vidyalaya (JNKVV), Jabalpur

Centres of AICRP on Medicinal & Aromatic Plants and Betelvine



10. Kerala Agricultural University (KAU), Thrissur
11. Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur
12. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri
13. N. D. University of Agriculture and Technology (NDUAT), Faizabad
14. Orissa University of Agriculture and Technology (OUAT), Bhubaneshwar
15. Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola
16. Rajendra Agricultural University(RAU), Pusa
17. Rajmata Vijayraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Mandsaur
18. Tamil Nadu Agricultural University (TNAU), Coimbatore
19. Uttar Banga Krishi Viswavidylaya (UBKV), Kalimpong
20. Uttarakhand University of Horticulture & Forestry (UUHF), Bharsar
21. Dr. Y. S. Parmar University of Horticulture and Forestry (YSPUHF), Solan
22. Dr. Y. S. Reddy Horticulture University (YSRHU), Venkataramannagudem
23. Central Agricultural University (CAU), Pasighat

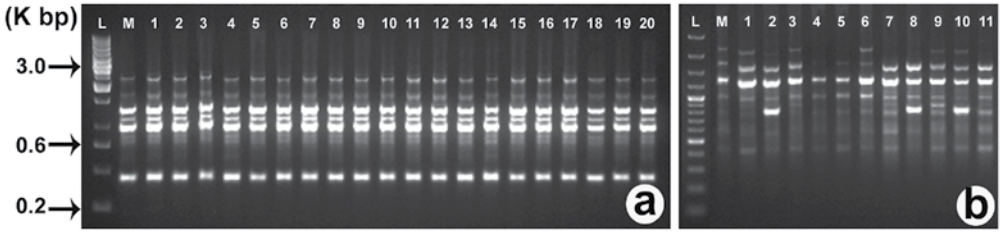
Budget Profile For Financial Year 2014-15

Head	Expenditure (₹. in Lakhs)
Non-Plan Expenditure (including pension)	408.71
Plan Expenditure (including TSP & NEH)	160.83
AICRP on MAP & Betelvine	600.00
Intellectual Property Management and Transfer/ Commercialization of Agricultural Technology Scheme (Up-scaling of existing component i.e. Intellectual Property Right (IPR)	3.03
NFBSFARA-Scheme	11.21
ICAR - Network Research Project on High Value Compounds and Phytochemicals	9.74

Budget Profile For Financial Year 2014-15

Externally Funded Projects	
Head	**Expenditure (₹. in Lakhs)**
PPV&FRA Project- "Protection of Plant Varieties and Farmers' Rights Authority"	5.39
Centrally Sponsored Scheme under National Horticulture Mission for Development of Spices and Aromatic Plants	2.15
DST Project-"Transcriptome analysis of Seena (*Cassia angustifolia*) to identify potential genes involved in the biosynthesis of sennosides"	5.41
DST Project-"Genetic mapping of Isabgol (*Plantago ovata*) genome and identification of quantitative trait loci (QTLs) for yield and resistance to Downy mildew"	2.08
NMPB Project-"Strengthening, up-gradation and maintenance of web based herbal gardens for quality planting material supply in India"	2.37
Developing, commissioning, operating and managing an online system for NET/ARS-Prelim examination by ASRB, ICAR"	0.09

Research Achievements



RAPD profile of apomictic (a) and sexual (b) population of Guggul (*Commiphora wightii*)

Medicinal and Aromatic Plants

ALOE (*Aloe barbadensis*)

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 colour flowers. Leaves contain gel (polysaccharides) and also its 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 accessions including nine local collections were evaluated, the accession, IC112532 recorded significantly higher leaf thickness (16.96 mm), leaf weight (367.60 g plant^{-1}) as well as mucilage (66.15%) followed by IC285630. Accessions showed variation in the morphological traits such as blotches on young leaves (heavy/light) and spine color (light red/pale).

NDUAT, Faizabad: Twenty four accessions were evaluated for leaf yield and quality, leaf yield ranged from 102.46 to 905.00 q ha^{-1}. The accessions, IC 112531 (905 q ha^{-1}), IC 112279(794 q ha^{-1}) and IC 310618 (708 q ha^{-1}) recorded maximum leaf yield.

Effect of planting method and organic manures on growth and yield

IGKV, Raipur: The experiment comprising of different method of sowing (flat, ridge-furrow and raised bed) and levels of organic manures (vermicompost 2.5 and 5 t; and FYM 5 and 10 t ha^{-1}) were conducted. The different method of planting did not influence herbage and gel yield significantly. However, organic manures significantly influenced herbage and gel yield. The maximum gel yield (11.04 t ha^{-1}) was found under raised bed planting and application of vermicompost 5 t ha^{-1} (11.88 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*.

TLC method developed for quick detection of adulteration

PDKV, Akola: Samples (77) were collected from 19 different locations of India. A TLC method was developed for quick detection of adulteration in the samples of *T. arjuna*. Out of 77 samples, 14 (18.18 %) samples were found to be spurious. *T. arjuna* bark samples from PDKV Akola was used for reference profile.

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.

Multilocation evaluation

ICAR - DMAPR, Anand: Initial evaluation trial with seven high yielding (MLS-1007, HLS-4, HLS-27(Sel.10), ULS-15, ALS-1, MLS-1001 and MLS-1016) lines with GA-1(check) were evaluated at Anand, Udaipur, RVSKVV, Mandsaur, Hisar and Solan centers. The entries, MLS-1007 (1968.13 Kg ha^{-1}) and MLS1016 (1931.94 Kg ha^{-1}) recorded maximum seed yield.

Germplasm evaluation

RVSKVV, Mandsaur: Forty lines were evaluated for yield and quality related traits. Days to 50 per cent flowering varied from 51 (MLS-1004) to 69 (MLS-1002). Number of branches per plant varied from 10 (MLS-7) to 17 (MLS-1002), whereas plant height varied from 98 cm (MLS-1002) to 131cm (MLS-1007). Seed yield ranged from 1558 to 2717 (kg ha^{-1}). The accession, MLS-1007 recorded highest seed yield (2717 kg ha^{-1}), followed by MLS-1001 (2658 kg ha^{-1}), MLS-1014 (2642 kg ha^{-1}), MLS-1016 (2550 kg ha^{-1}), MLS-1013 (2500 kg ha^{-1}) and MLS-16 and MLS 1019 (2442 kg ha^{-1}).

MPUAT, Udaipur: Eight promising entries were evaluated along with one check (GA-1) for yield and quality characters. Seven entries ULS-1, ULS-2, ULS-6, ULS-8, ULS-9, ULS-20 and ULS-15 had higher seed yield over the check GA-1. Distinct and stable morphological characters were also recorded.

Progeny row trial

CCSHAU, Hisar: Fifty progenies were evaluated against the check GA-2 for seed yield and quality characters. The progenies, PRT 29 and PRT 33 were maturing early (120 days). PRT 23 was found tall (123.3 cm) while PRT 27 was dwarf (75 cm). PRT-74 recorded highest yield (833 kg ha^{-1}) followed by PRT-5 (729 kg ha^{-1}) and PRT-21 (708 kg ha^{-1}).

Small scale trial

CCSHAU, Hisar: Twenty genotypes and GA-2 were evaluated for seed yield and quality, the genotype HLS-63 was earliest to flower (44 days) and also was earliest to mature (116 days). The genotype HLS-50 recorded highest seed yield (817 kg ha^{-1}) followed by HLS-63 (754 kg ha^{-1}) and HLS-61 (747 kg ha^{-1}).

Effect of irrigation and nitrogen on growth and yield

IGKV, Raipur: The experiment was conducted for three years during 2011-12 to 2013-14 with three levels of irrigation (one irrigation at 25 DAS; two irrigation at 25 and 50 DAS; and three irrigation at 25, 50, 75 DAS) and four levels of nitrogen (20, 40, 60 and 80 kg ha^{-1}). The results on pooled data basis revealed that highest grain yield (14.26 q ha^{-1}) was found under three irrigations at 25, 50 and 75 DAS and application of 80 kg N ha^{-1} (14.38 q ha^{-1}).

Effect of irrigation and brassinosteroids on yield and quality

MPUAT, Udaipur: The effect of six irrigation schedules (4 irrigations at 25, 45, 65 and 85 DAS; 3 irrigations at 25, 45 and 65 DAS; 3 irrigations at 25, 45 and 85 DAS; 3 irrigations at 25, 55 and 85 DAS; 3 irrigations at 25, 65 and 85 DAS; and 2 irrigations at 25 and 65 DAS) and three brassinostreroids levels (control, 0.3 and 0.6 ppm) were investigated during 2012-13, 2013-14 and 2014-15. The results on pooled data basis revealed that four irrigations at 25, 45, 65 and 85 DAS recorded maximum seed yield (26.57 q ha^{-1}), net return (₹ 92076 ha^{-1}) and B:C ratio (4:10). Whereas, two sprays of brassinosteroids at 0.6 ppm at 50 and 70 DAS recorded maximum seed yield (28.28 q ha^{-1}), net return (₹ 103979 ha^{-1}) and B:C ratio (4:11). However, under limited water availability, three irrigations at 25, 55 and 85 DAS was recommended.

Integrated weed management

MPUAT, Udaipur: An experiment was conducted to find out the appropriate weed management strategy with 10 weed management practices. The results showed that two hand weeding at 25 and 50 days after sowing gave significantly higher seed yield (24.43 q ha^{-1}) and net returns (₹ 83364 ha^{-1}), though it remained at par with one hand weeding and hoeing at 35 days after sowing.

Effect of integrated nitrogen management on growth and yield

RVSKVV, Mandsaur: The experiment was conducted to find out the effect of different nitrogen sources (FYM, vermicompost and fertilizers) in different combination (25, 50 and 100%). The results showed maximum plant height (110 cm), girth (8.5 mm), number of

branch (22.0) and seed yield (19.5 q ha-1) with 100% N through RDF followed by 100% N through vermicompost.

Effect of integrated weed control

RVSKVV, Mandsaur: The experiment comprising of integrated weed management with nine practices. The results showed the maximum plant height (132.0 cm) with one hoeing at 25 DAS whereas maximum seed yield (19.0 q ha-1) was recorded in three hand weeding at 25, 35 and 45 DAS along with one hand hoeing at 30 DAS.

Effect of sowing dates and seed rates on growth and yield

PDKV, Akola: The experiment was conducted to assess the effect of date of sowing (38th, 40th, 42nd, 44th and 46th meteorological weeks) and seed rates (6, 8 and 10 kg ha-1). Sowing on 44th meteorological weeks with seed rate of 6 kg ha-1 recorded significantly higher seed yield 898 and 728 kg ha-1, respectively.

Effect of FYM and nitrogen on productivity

YSPUHF, Solan: The experiment comprised of two levels of FYM (5 and 10 t ha-1), three levels of nitrogen (20, 40 and 60 kg ha-1) and three schedules of nitrogen application (1/2 as basal + 1/2 at 25 DAS; 1/2 as basal + 1/4 at 25 DAS + 1/4 at 45 DAS; and 1/3 as basal + 1/3 at 25 DAS + 1/3 at 45 DAS). Application of FYM 10 t ha-1 + N 60 kg ha-1 at 1/3 as basal + 1/3 at 25 DAS + 1/3 at 45 DAS recorded maximum seed yield (17.93 q ha-1) and net returns (₹ 58150 ha-1), however, B:C ratio (2.91) was found maximum with FYM 5 t ha-1 + N 60 kg ha-1 applied at 1/3 at sowing + 1/3 at 25 DAS + 1/3 at 45 DAS.

Effect of inorganic fertilizers and biofertilizers on growth and yield

JNKVV, Jabalpur: The experiment was conducted to find out the effect of RDF and biofertilizers in different combinations on growth and yield. Results revealed that application of NPK 50:50:30 kg ha-1 + PSB + *Azotobacter* recorded maximum seed yield (20.4 q ha-1). However, the maximum net return (₹ 43953 ha-1) and B:C ratio (3.59) was obtained with NPK 25:25:15 kg ha-1 + PSB.

Management of *Alternaria* leaf blight

JNKVV, Jabalpur: Field trials were conducted to find out suitable fungicide bioagents and biofungicides for the management of *Alternaria* leaf blight. Results showed that the treatment involving application of *Trichoderma* fortified FYM + Azatobacter + 2 spray of nimbecidine (0.15% azadirachtin) recorded minimum disease incidence (33.3) and maximum seed yield (16.25 q ha-1).

Management of Downy mildew

RVSKVV, Mandsaur: The results of the field experiments to manage Downy mildew showed that spraying metalaxyl 72 % MZ @ 0.2% recorded the minimum disease incidence (15.59%), higher seed yield (1641 kg ha-1) maximum yield increased (76.86 %) over the control followed

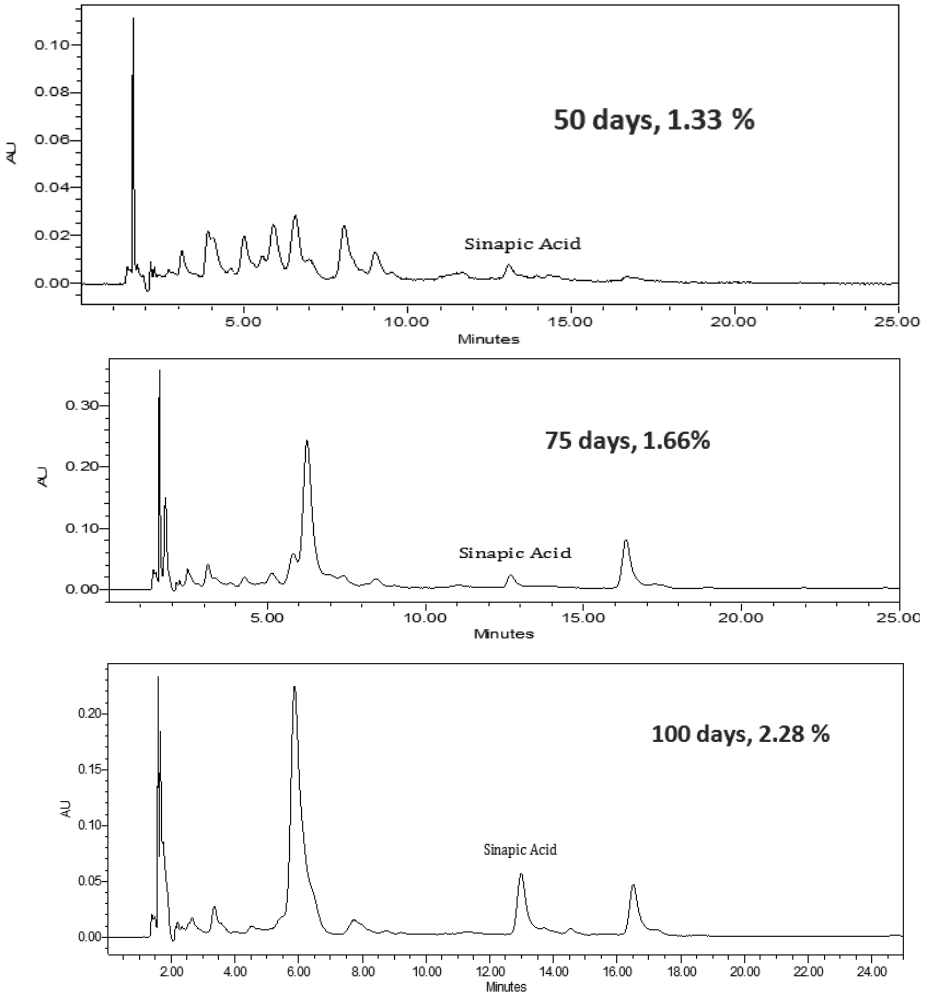
by the treatment of spraying sectin @ 0.15% (21.15 %, 1641.67 kg ha-1 and 56.71 %). The control plot recorded the maximum disease incidence (40.01%) and minimum seed yield (1047.57 kg ha-1).

Screening of 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 screened 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 screened as susceptible lines.

Variation of total phenolic content at different growth stages

ICAR - DMAPR, Anand : Variation of total phenolic content (TPC) was estimated at different three growth stages. TPC in leaves increased with the increase of growth stages. TPC was expressed as sinapic acid content (%).



Sinapic acid content (%) at 50, 75, 100 DAS

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. It 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 attributes to its 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.

Multilocation evaluation

ICAR - DMAPR, Anand: Advanced evaluation trial was conducted with three test entries (AWS-2B, DWS 132, and DWS 135) and with three check varieties (JA 20, JA 134 and RVA 100). The entries, DWS 132, DWS 135 and AWS 1 had significantly higher yield than the check JA 20.

Germplasm evaluation

AAU, Anand: Seventy nine accessions were evaluated for root yield and quality, AWS-38 (79 g plant^{-1}) and AWS-48 (78 g plant^{-1}) recorded highest dry root yield. Variations in plant height, number of branches, root length and root girth were observed.

RVSKVV, Mandsaur: Thirty seven accessions were characterized and grouped into twenty one categories on the basis of berry colour (red, yellow, orange), berry size (small, medium, large) plant type (erect or bushy) branching pattern, leaf type (oblong or ovate) leaf surface (hairy, non hairy). The accessions, MWS-10-001, MWS-10-002, MWS-10-003, MWS-10-007, MWS-10-008, MWS -10-005, MWS -10-006, MWS-10-004, MWS-10-010, MWS-10-011, MWS-10-09 and MWS-10-012 had red berries, MWS-10-105, MWS-10-107, MWS-10-111, MWS-10-106, MWS-10-108, MWS-10-112, MWS-10-113, MWS-10-114, MWS-10-101, MWS-10-102, MWS-10-103, MWS-10-109, MWS-10-104, MWS-10-110 and MWS-10-115 had yellow berries and the accessions MWS-10-205, MWS-10-208, MWS-10-206, MWS-10-209, MWS-10-210, MWS-10-207, MWS-10-204, MWS-10-202, MWS-10-201 and MWS-10-203 had orange berries.

One twenty accessions were evaluated for root yield and other quality traits. The 15 accessions (MWS-130, MWS-90-130, MWS-106, MWS-122, MWS-142, MWS-90-142, MWS-213, MWS-216, MWS-316, MWS-318, MWS-327, MWS-328, RAS-35, RVA-100 and MWS-90-128) recorded higher dry root yield and entries MWS-90-130, MWS-90-142, MWS-216, MWS-318, MWS-213, MWS-122 and RVA-100 recorded highest seed yield.

IGKV, Raipur: Twenty nine genotypes were evaluated for yield and quality related traits. Maximum fresh root yield was observed in genotype MSW-310 (6.54 q ha^{-1}) and MSW-311 (6.50 q ha^{-1}) followed by IGAU-8 (6.44 q ha^{-1}). Variations in other agronomic traits such as plant height, days to flowering, and days to maturity were also observed.

Evaluation of selections

ICAR - DMAPR, Anand: Three hundred twenty eight (DWS 1 to DWS 328) pure lines were evaluated for 14 morphological traits and dry root yield. The DUS characters of all these pure lines were also recorded. DWS 127 with yellow leaves and DWS 37 with downward curling leaves were expressed this year also thus, confirming trait stability. Similarly, male sterility of DWS10 was also confirmed. Male sterile plant produced sterile pollens during cooler months (December-January) and it gets converted into male fertile in warmer days (March onwards) at Anand conditions indicating environmental sensitivity of male sterility system.

DWS 37: downward curly leaves

DWS 127: yellow young leaves

DWS 10 - an environmental sensitive male sterile plant

Station yield trial

ICAR - DMAPR, Anand: Three advanced breeding lines (DWS 420-4, DWS 85 and DWS 62) were evaluated with three check varieties (JA 20, RVA 100 and JA 134). The test entries had significantly higher root yield than the best check. Further, the lines had unique morphological traits. DWS 420-4 had less fibrous root, erect plant type with no secondary roots.

MPUAT, Udaipur: Thirteen genotypes (as identified promising from genetic stock being maintained at the centre) with 3 checks (JA20, JA134 and RAV 100) were evaluated for root yield and quality. Test entries UWS-10, UWS-11, UWS-23, and UWS-93 exhibited significantly higher dry root yield over the best check RAV-100. All the genotype belonged to annual type. The genotype, UMS-93 recorded maximum dry root yield (740 kg ha^{-1}). The genotypes showed variation in morphological traits such as plant type, berry colour, root texture, leaf shape, branching pattern and leaf surface texture.

Generation advancement and selection

ICAR - DMAPR, Anand: The F_2 generation of five crosses (RAS 11 × IC 310620, IC 310620 × RAS 11, DWS 16 × IC 310620, IC 310620 × DWS 16, and DWS 10 × DWS 70) were advanced to F_3 generation by selfing. 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_5 to F_6 generation. Twenty one lines with distinct morphological characters were tested for one more year and the stability of the characters were observed.

Total phenol content estimation

ICAR - DMAPR, Anand: Total phenol content in leaves, stem and root for 64 pure lines was estimated. The phenol content in root ranged from 0.09 (DWS 56) to 0.69 % (DWS 100) with a mean of 0.43%, while in stem it ranged from 0.37 (DWS 89) to 1.02% (DWS 79). In leaves, the phenol content ranged from 0.75 (DWS 71) to 2.42% (DWS 79) with a mean of 1.72%. Sixteen breeding line (DWS 58, DWS 111, DWS 82, DWS 94, DWS 89, DWS 117, DWS 88, DWS 115, DWS 80, DWS 83, DWS 110, DWS 59, DWS 114, DWS 84, DWS 103 and DWS 79) had more than 2% total phenol content in leaves. Total phenol content in plant (leaf+stem+root) ranged from 1.75% to 3.99% with an average of 2.78%. Maximum phenol content per plant was recorded in DWS 79.

Hybridization

CCSHAU, Hisar: Hybridization was attempted between high root yield and wilt resistant genotypes. Eleven crosses (JA-20 x AWS-2-B, JA-20 x HWS 8-18, RVA-100 x AWS-2-B, RVA-100 x HWS 8-18, JA-100 x AWS-2-B, JA-100 x HWS 8-18, JA-134 x AWS-2-B, JA-134 x HWS 8-18, HWS-1405 x AWS-2-B, HWS-1406 x HWS 8-18 and HWS-1407 x HWS 8-18) were effected and F_1 seeds were collected.

Pure lines evaluation

CCSHAU, Hisar: Fifteen pure lines and GA-2 (check) were evaluated for root yield and quality, highest dry root yield was recorded by genotype HWS-132(1246 kg ha^{-1}) followed by HWS-127 (1104 kg ha^{-1}) and HWS-133 (1087 kg ha^{-1}) as against the check JA 20 (708 kg ha^{-1}). Another trial with ten genotypes were evaluated, highest dry root yield was recorded by genotype HWS-08-03 (1244 kg ha^{-1}) followed by HWS-08-10 (1084 kg ha^{-1}) and HWS-08-06 (1042 kg ha^{-1}) against the check JA 20 (736 kg ha^{-1}).

Management of *Alternaria* leaf blight

JNKVV, Jabalpur: A field trial was conducted for the management of leaf blight caused by *Alternaria alternata*. It was observed that the interaction effect of application of nimbecidine (0.15% Azadirachtin) followed by T. *asperellum* @ 10^{6-9} cfu ml^{-1} and P. *fluorescens*. @ 10^{6-9} cfu ml^{-1} reduced the *Alternaria* leaf blight incidence to 28.4% and enhanced the root (5.4 q ha^{-1}) and seed yield (65.0 kg ha^{-1}).

Integrated disease management against root rot and foliar diseases

MPUAT, Udaipur: Integrated disease management modules against root rots and foliar diseases under organic farming were evaluated under sick plot and inoculation condition during 2014-15. Among the five modules tested, the module consisting of soil application of neem cake manure (250 g m^{-2}) supplemented with *Trichoderma* talc based formulation (10^{8}cfu/g) (5%) + seed Treatment with neem oil (3.0%) (For root rot) + three sprays of cow urine: neem leaves: garlic clove fermented product (CNG) @ (5%) and another module of soil application of Neem cake manure (250 g m^{-2}) supplemented with *Trichoderma* talc based formulation (10^{8}cfu/g) (5%) + seed treatment with neem oil (3.0%) (for root rot) + 3 sprays of garlic bulb extracts (10%) resulted in minimum plant mortality (22.95%, 24.72%), maximum percent root rot control (74.25,72.26), minimum leaf blight (19.47%, 20.72%) and maximum control (75.30%,73.77%) as compared to inoculated control. These modules recorded higher dry roots (6.03, 5.80 q ha^{-1}), seed yield (4.58, 4.30 q ha^{-1}) increased alkaloid content (0.58, 0.49 %), and root length (21.88 cm with 6.25 mm diameter; 21.45 cm, 6.33 mm diameter). The above treatments harboured the highest population of T. *viridae* and lowest population of *Rhizotonia solani* and *Fusarium solani* at sowing and flowering stage.

Management of Damping off

RVSKVV, Mandsaur: Field experiments were laid out to manage the damping off disease during 2013-14 and 2014-15. The pooled mean of the two year data 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 (17.84%) and the maximum seed and root yield of 720.58 kg ha^{-1} and 894.13 kg ha^{-1} respectively. Among the biocontrol agents, the lowest seedling mortality (26.09%) and highest seed (714.42 kg ha^{-1}) and root yield (791.14 kg ha^{-1}) was recorded in seed treatment and soil drenching with *Trichoderma viridae*. In control the highest seedling mortality (44.23%) and lowest seed and root yield (536.28 kg ha^{-1} and 581 kg ha^{-1}) were recorded.

Screening of germplasm against diseases

MPUAT, Udaipur: Screening of 16 genotypes of Ashwagandha against root/collar rot, leaf spot/ blight under natural infection and chemical protected conditions revealed that, six genotypes (RAS-10, RAS-37, RAS-23, RAS-11, RAS-92 & RAS-22) were found resistant 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) exhibited moderate resistance against root/collar rot (21-30%) and moderate susceptible against leaf spots/ blight (31-40%). However, four genotypes (RAS-98, RAS-111, JA-134 & RVA-100) exhibited moderate susceptible against collar/root rot (31-40%) and susceptible against leaf blight (41-50%).

ASOCA (*Saraca asoca*)

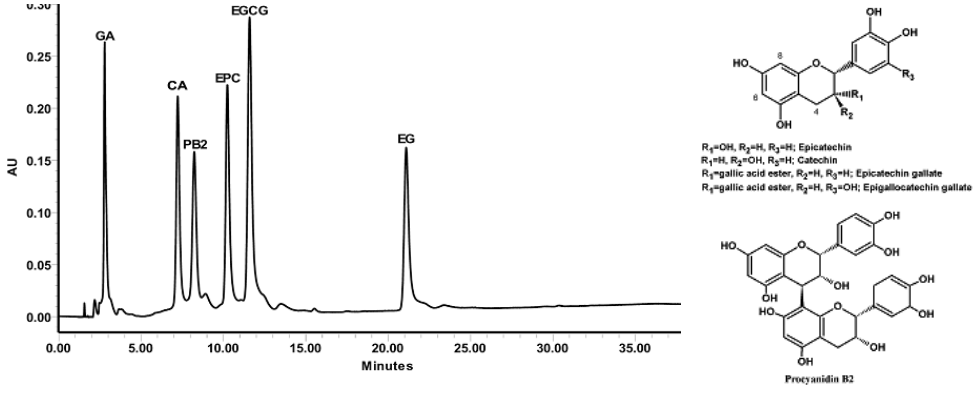
It is an endangered tree. The plant is a medium sized, evergreen tree belonging to family *Caesalpiniaceae*. Flowers are orange-yellow and tender shoots are bronze coloured. It is distributed throughout India particularly in humid areas. The plant is considered as sacred tree of Hindus and Budhists. Asoka bark is widely used in Indian systems of 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. It can be propogated by seeds as well as by layering.

Assessment of age related variation in bark phenol and tannin content in germplasm

KAU, Thrissur: Total phenol content was estimated by Folin-Ciocalteau-spectrophotometric method with catechol as standard. The study revealed that the total phenol content in the stem bark increased 3 to 5 times within a period of 6 years growth (2009-2015).

Extraction optimization and HPLC method development for quantification of bioactive molecules

ICAR - DMAPR, Anand: The extraction conditions for maximum recovery of bioactive phenolics were optimized and also a simple, selective reversed HPLC-PDA method was developed for their identification and quantification. Extraction recovery was optimized using a mixture of methanol and water in different proportions. HPLC separation was achieved on a C_{18} column with acetonitrile and aqueous orthophosphoric acid (0.1 %) as a mobile phase in a gradient elution mode. The total recovery (mg g^{-1}) of six bioactive compounds was maximum with methanol as an extraction medium from all parts except leaves and pods. The developed HPLC method was validated for accuracy, precision, reproducibility, specificity and detection as well as quantification limits in accordance with ICH guidelines. All validation parameters were within the prescribed limit. Extraction was carried out using cold maceration technique. However, best solvent for the extraction of polyphenolics depended on the compound of interest.



HPLC Chromatogram of six bioactive phenolics

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 also distributed throughout India. It 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.

Germplasm collection and evaluation

YSRHU, Venkataramannagudem: Twenty eight accessions including three new collections from Kodaikanal, Bengaluru and Pandirimamidi were evaluated. The accession, APAc-3 recorded highest plant height (97.83cm) followed by APAc-2 (90.3 3cm). Leaf length was highest in APAc-7(66.83 cm) and leaf width was highest in APAc-5(2.67 cm).

AAU, Jorhat: Four accessions (JAC-19, JAC-20, JAC-21 and JAC-22) were collected from different locations of Assam. Twenty two accessions were evaluated for morphological and yield traits. Leaf length ranged from 42.66 to 80.33 cm, highest leaf length was recorded in JAC-10 (80.33 cm) while shortest leaf length was observed in JAC-7 (42.66 cm). JAC-19 had broadest leaf (1.33 cm) and JAC-4 had narrowest leaf (0.83cm). Maximum leaf length to breadth ratio was recorded for JAC-10 (68.89) which was significantly higher than the other accessions. Rhizome length varied from 11.33 cm (JAC-21) to 35.33 cm (JAC-11). Rhizome weight ranged from 10.7 g (JAC-22) to 65.0 g (JAC-11).

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 large number of ailments.

Germplasm evaluation

RVSKVV, Mandsaur: Twenty one accessions collected from farmers' field of Mandsaur, Ratlam and Neemuch district were evaluated for seed yield and yield contributing characters. Plant height ranged from 47cm (MOB-2) to 69 cm (MOB-20) and spike length ranged from 16.3 cm (MOB-6) to 26.0 cm (MOB-16). Husk yield ranged from 1042 (kg ha^{-1}) in (MOB-3) to 4962 (kg ha^{-1}) in (MOB-14). Maximum seed yield was recorded by MOB-14 (479 kg ha^{-1}) followed by MOB-13 (437 kg ha^{-1}), MOB-16 (417 kg ha^{-1}), MOB-19 (396 kg ha^{-1}), MOB-9, MOB-17 and MOB-18 (375 kg ha^{-1}).

CHIRAYITA (*Swertia chirayita*)

The plant belongs to family *Gentianaceae*. It is an erect annual herb which is distributed in temperate Himalayas from Kashmir to Bhutan. The plant is propagated by seeds. It grows well in moist, temperate forests of Himachal Pradesh. Dried herbage portion is used as raw drug. Flowering occurs in July to October and the raw drug is collected when the capsules are fully formed. The drug is extremely bitter in taste. Chirayita is also known as brown or white Chirayita to distinguish it from 'green chirayita' which is the dried herbage of *Andrographis paniculata*. The bitter tonic made from the raw drug improves bile secretion and used for the treatment of bronchial asthma, liver disorders, and anaemia. The active ingredients 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 standardized.

Study of disease incidence and severity of fungal diseases

UBKV, Kalimpong: The survey of fungal diseases of Chirayita, [*Alternaria* leaf spot disease (C.O.- *Alternaria alternata)*, *Cladosporium* leaf blight (C.O.- *Cladosporium tennuissimum*) Seedling blight (C.O.-*Rhizoctonia solani*)] were conducted at Kalimpong, Algarah and Lava from April, 2014 to March, 2015. 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 during July and lowest during January.

Monitoring of adulteration

YSPUHF, Solan: Samples (52) under the market name "Chirayita", received from 10 different AICRP-MAPB centres, were analysed by TLC and HPLC methods. amarogentin and amaroswerin were used as reference compounds for TLC and HPLC analysis. On the basis of TLC profile and HPLC analysis it was concluded that out of the 52 samples, only 27 samples (51.92%) were of *Swertia chirayita*

CHITRAK (*Plumbago zeylanica*)

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

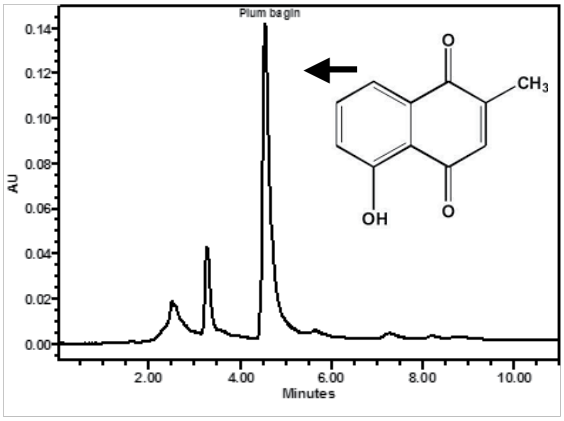
Germplasm evaluation

TNAU, Coimbatore: Forty two accessions were harvested after two years of planting. Total root weight ranged from 56.67 to 2723.67g plant-1. The accession TN*PZ* 10 recorded maximum weight of 2723.67 g plant-1 followed by TN*PZ* 8 (1996.67 g plant-1). The lowest root weight was recorded in TN*PZ* 23 (56.67 g plant-1).

ICAR - DMAPR, Anand: Samples (100) received from TNAU, Coimbatore were analysed from plumbagin content using HPLC method. Plumbagin content varied from 0.05 to 0.48%.

Comparative phytochemical evaluation of the root samples

KAU, Thrissur: The roots of three different species of *Plumbago* namely P. *rosea*., P. *zeylanica* and P. *capensis* were collected at maturity. Phytochemical screening showed the presence of alkaloid, flavanoid, glycoside, phenol, tannin, saponin and sterol in *Plumbago rosea* as well as in P. *zeylanica*. Saponin, sterol and glycoside were found absent in P. *capensis* in preliminary screening. The plumbagin content, antioxidant capacity and potassium content were found higher in case of P. *rosea* roots compared to others. Calcium and sodium content was highest in P. *capensis*. Fibre content was more in P. *zeylanica*. The anti oxidant capacity (expressed in terms of mg ascorbic acid/gram sample) also differed and it was found comparatively higher in P. *rosea*.



HPLC chromatogram of methanol extract of P. *zeylenica*

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 produces a diterpenoid, froskolin. Although synthesis of froskolin was reported, but till now its main source is 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 on farmer's field at Thuraiyur, Trichy district, Tamil Nadu to manage the root rot disease (C.O: *Rhizoctonia bataticola*). The results showed that the root rot disease can be effectively managed by dipping stem cuttings in *Pseudomonas fluorescens* (0.2%) followed by drenching with *P. fluorescens* (0.2%) on 30 DAP which recorded the lowest root rot disease incidence of 12.0% and 17.3% on 45 and 90 DAP, respectively. The highest dry tuber yield of 2012.4 kg ha^{-1} was also recorded in the same treatment. In control, the highest root rot disease incidence (20.0 and 29.3% at 45 and 90 DAP) and lowest tuberous root yield of 1361.3 kg ha^{-1} was recorded.

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.

Estimation of yield loss due to sucking pests

ICAR - DMAPR, Anand: Field experiments were laid out in paired plots to find out the yield loss due to sucking pests aphids (*Aphis nerii),* psyllids *(Diaphorina dakariensis)* and Red spider mite *(Tetranychus* spp.)The two set of plots, protected and unprotected were replicated eight times. The protected plots were given insecticidal spray (spiomesifen 240 SC 0.9 ml l^{-1} and imidacloprid 17.8 SL 0.3 ml l^{-1}) at regular intervals. At, harvest, the fresh weight of leaves recorded from insecticidal sprayed plots was 7.24 kg/7.5 m^2 which was significantly higher than the yield from the unsprayed plots *(*2.84 kg/7.5 $m^{2)}$. The per cent loss of yield caused due to the three sucking pests was found to be 60.77.

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. It destroys the sugar and hence the name 'madhunasini' or gudmar' and is prescribed as antidiabetic. The sugar suppressing constituents are mixtures of triterpine saponins which are designated as gymnemic acids. The plant is propagated mainly by stem cuttings and also by seeds.

Germplasm characterization and evaluation

ICAR - DMAPR, Anand: A total of thirty four accessions collected from different parts of country were maintained in the field gene bank and evaluated for various morphological characters. The accession DGS 31 (collected from Shimoga district in Karnataka) had orange flowers as against the yellow flowers in other accessions while the accession, DGS 1-20 had early flowering (10 months, as compared to 15-20 months after planting).

JNKVV, Jabalpur: Seven accessions were evaluated for various agro morphological traits. The accession, JBPGS8-9-104 recorded maximum number of fresh leaves per plant (2135.67), fresh leaf yield per plant (199.7 g) and dry leaf yield per plant (95.10 g). The maximum Gymnamic acid content (1.21%) was recorded in JBPGS8-9-105 accession which was followed by JBPGS8-9-101(1.02%).

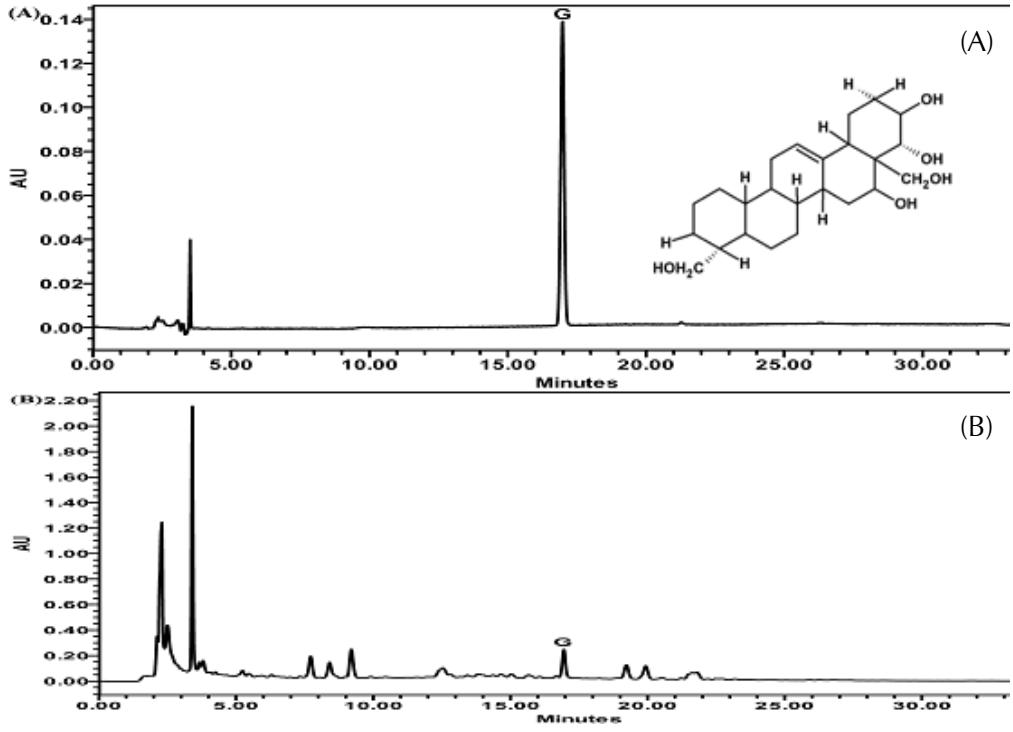
Effect of season and plant growth regulator (PGR) on rooting

JNKVV, Jabalpur: The experiment was conducted in three months (July, August and September) by giving treatment of IBA 250, 500, 750 ppm and without IBA to identify a suitable season and PGR doses for rooting. The results revealed that cuttings planted in the month of September has taken less time (9.67 days) for sprouting as compared to July (10.83 days) and August (11.25 days). The survivability of cutting was observed highest (32.67%.) in August month and minimum in September (30.33%). The maximum survivability of cuttings (38.22%) was recorded with 750 ppm IBA treated cuttings followed by 500 ppm IBA (38.00%). The interaction effects showed the maximum survivability of cuttings (42.00%) under 750 ppm treated cuttings planted in August month, whereas, minimum survivability (18.67%) was recorded in September planted cuttings without IBA.

Screening of gymnemagenin

ICAR - DMAPR, Anand: Evaluation of the lines for morphological parameters revealed highly significant differences for leaf related parameters (length, width, fresh as well as dry weight and petiole length), which directly contribute to the biological yield. Further, HPLC-

PDA method was developed for identification and quantification of bioactive principle *i.e.* gymnemagenin in a gradient elution mode using solvent mixture composing of acetonitrile (solvent A), potassium dihydrogen orthophosphate (10 mM, solvent B) both solvent A and B containing orthophosphoric acid (0.05 %). Results revealed significant differences for gymnemagenin content (0.343-0.533%) amongst the lines evaluated.



HPLC chromatogram of standard gymnemagenin (A) and extract of G. *sylvestre* (B)

GUGGAL (*Commiphora wightii*)

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

Segregating progenies of sexual and apomictic genotypes generated

ICAR - DMAPR, Anand: Segregating population was developed by crossing obligate sexual *vs* apomict genotypes. The pollination experiment was conducted during four months (December 2013 to March 2014). A total of 12,500 crosses were made from which 110 seeds were collected *(*0.88% pollination success0. Out of 110 crossed seeds, 21 hybrids (19% germination) were developed, which can be used for phenotyping for apomixis and sexuality, bulk segregants analysis and genotyping of individuals also for expression analysis of selected differentially expressed genes in individuals.

In vitro regeneration protocols developed

ICAR - DMAPR, Anand: Explants, culture media and culture conditions were standardized for *In vitro* regeneration. Different types of explants (shoot apex, leaves, fruit wall, ovule, roots, stems, etc.) were collected and surface sterilization was made by following appropriate sterilization protocol. The surface sterilized explants were used for inoculation. Full and half basal MS medium supplemented with different concentrations and combinations of growth regulators (auxins, cytokinins, gibberilic acids), vitamins and additives were tested for callusing, somatic embryogenesis and organogenesis. Modified MS medium supplemented with 2,4-D (1.5 and 2.0 mgl^{-1}) and Kinetin (0.1 mgl^{-1}) gave initiation and proliferation of callus in leaves, fruit walls and ovules. Root induction and development were obtained from cotyledonary nodes, shoot auxiliary buds and leaves cultured on modified MS media with IAA (4.0 mgl^{-1}) and Kinetin (0.05 mgl^{-1}). Different combinations of media and growth regulators were tested for somatic embryogenesis. Modified MS medium supplemented with 2,4-D + Kinetin gave initiation and proliferation of callus in leaves, fruit walls and ovules after two to four week of the culture. Ovule calli were cultured in MS media supplemented with BAP + kinetin + NAA gave embryogenic calli after 2-3 months of the culture. The medium was reproducible in other *In vitro* raised seedlings explants also.

INDIAN VALERIANA (*Valeriana jatamansi*)

The plant belongs to family Valerianaceae and is a perennial herb of about 45 cm height and rootstock including fhizome 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.

Date of sowing and biomass yield

UBKV, Kalimpong: The experiment was conducted with two sowing times (1st week of June and July) and three spacings (30 × 20, 30 × 30 and 30 × 45 cm). The crop raised through seeds and transplanted in 1st week of June at a spacing of 30 × 45 cm recorded significantly higher fresh aerial and underground biomass, and rhizome and root biomass. Whereas, the crop raised through rhizome cuttings and transplanted

in 1st week of June recorded maximum underground biomass. Transplanting of rhizome cuttings at spacing of 30 × 45 cm produced maximum aerial, rhizome and root biomass.

Studies of incidence of stem rot disease

UBKV, Kalimpong: Fixed plot survey was conducted to know the incidence of stem rot caused by *Sclerotinia sclerotiarum* during April, 2014 to March, 2015. PDI of stem rot disease was maximum during the month of August (31.98) and minimum during the month of January (13.77).

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. It is cultivated in 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 cultivated during the rabi season.

Multilocation evaluation

ICAR - DMAPR, Anand: Advanced varietal evaluation trial with four entries from the early maturing group (DPO-174, DPO-186, DPO-385, APO-01) and check (INGR 11035) were evaluated for second year to identify high yielding and early maturing (95-100 days) varieties. The trial was conducted at Anand, Udaipur, RVSKVV, Mandsaur, Hisar and ICAR - DMAPR, Anand centers. The test entries, DPO-385 (1440 kg ha^{-1}) and DPO-174 (1359 kg ha^{-1}) recorded maximum seed yield across centres. Advanced varietal evaluation trial with twelve entries from medium maturing group (AMB-2 (UI-2-1), MIB124 (UI-124), UI-89, DPO335, DTPO6-6, DTPO11-1, DPO267-3, DPO253-2, DPO248, MIB5, MIB1004, HI-2009) and check (Niharika, GI-2, HI-5, JI-5) were evaluated for second year to identify high yielding varieties.

Germplasm maintenance and evaluation

ICAR - DMAPR, Anand: Eighty four isabgol germplasm accessions were maintained in field gene bank and were screened for Downey mildew disease resistance under field conditions. The accessions, EC 124345, EC 427062, DM 11, UR 188, JI 9, PB-10-4, PB 80, RI 149, RI 9808, RI 153, RI 156, HI 6, RI 9809, RI 157, HI 34, MIB 2, RI 130 and DM 5 were found resistant.

NDUAT, Faizabad: Thirty accessions were evaluated for seed yield and quality related traits, maximum seed yield was recorded in MPI-1 (3.86 q ha^{-1}) followed by PB-6-1 (3.44 q ha^{-1}) and JI- 16 (3.18 q ha^{-1}).

RVSKVV, Mandsaur: Eighty accessions were evaluated for various agro-morphological traits. Plant height ranged from 25.0 (RI-88) to 35.0 cm (SLS-55), days to 50% flowering ranged from 69 (MIB-1008) days to 99 days (SPS-15). The highest seed yield (kg ha^{-1}) was recorded for 1022 kg ha^{-1} (MIB-1004) followed by 878 kg ha^{-1} (MIB-5, SLS-62), 867 kg ha^{-1} (MIB-1003), 833 kg ha^{-1} (MIB-123, SPS-13), 800 kg ha^{-1} (SLS-59, MIB-1002) as compared to 767 kg ha^{-1} for JI-4 and 644 kg ha^{-1} for GI-2 (check).

Mutation breeding

ICAR - DMAPR, Anand: Five mutants (Wheat type mutant, Ball mutant, PCM, Tetraploid and Branched spike) were evaluated. Seed weight (g plant^{-1}) was highest in Branched spike (5.53) and PCM (4.59) mutants. Four hundred thirty nine (M_8 generation) stable mutants/lines (DPO 1 to DPO 439) were maintained and selfed seeds were harvested. Morphologically distinct mutants like yellowish green leaf base (DPO 259), short plant, (< 22 cm with only two branches, DPO 275), short leaf mutant, (< 12 cm DPO 276), decumbent growth habit (DPO 395-3), DPO 113 (folded leaf mutant), DPO 9 (an extended bract mutant), DPO 401 (short and dark green leaf mutant), and DPO 402 short leaf with light green mutants were stable and observed during this year also.

RVSKVV, Mandsaur: Seeds of variety JI-4 were treated with six doses (0.1%, 0.2%, 0.4%, 0.6%, 0.8% and 1.0%) of EMS and mutagenic variability for various agronomic traits were observed in M_1 generation.

New variety developed

ICAR - DMAPR, Anand: Based on the four years multi-location evaluation, the isabgol mutant line, DPO 1 was found high yielding across locations and recommended for release as "Vallabh Isabgol -1" during last AICRP-MAPB group meeting. Vallabh Isabgol-1 was superior in seed yield compared to check GI 2 (24.6%). The mean seed yield of Vallabh Isabgol-1 was 967 kg ha^{-1} compared to 775 kg ha^{-1} of GI 2. The swelling factor of Vallabh Isabgol-1 was 11.83 as compared to GI 2 (11.72). Mucilage yield was 9.21 g kg^{-1} seed in Vallabh Isabgol-1 which was higher compared to GI 2 (8.96 g kg^{-1}). The breeder seeds of Vallabh Isabgol-1 were also produced.

Cytological confirmation

ICAR - DMAPR: Tetraploids developed from GI 2 using Colchicine treatment were in advanced generation (C_8). Last year, 117 lines were screened for its ploidy level (diploid vs tetraploid) using ploidy analyzer and 97 lines confirmed as tetraploid and these lines were maintained and tetraploidy was confirmed using cytological studies.

Screening for Downy mildew resistance

ICAR - DMAPR, Anand: A total of 247 inbred/mutant lines were screened for resistance to Downy mildew disease under sick plot. Out of these lines, seven mutants (DPO 11, DPO 92, DPO 185, DPO 188, DPO 144, DPO 145 and DPO 333-2) exhibited resistance.

Mapping population developed

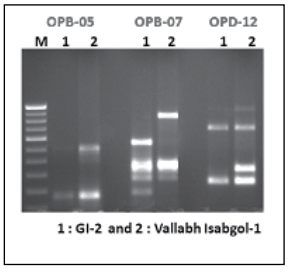
ICAR - DMAPR, Anand: The parent DPO-185 and DPO-14 were crossed and a total of 160 progenies were advanced from F_4 to F_5 by selfing. The population showed segregation for leaf tip drying, leaf curling and other morphological traits. Transgressive segregants were identified among the RIL lines for various traits

Development SSR Markers

ICAR - DMAPR, Anand: SSR marker database was developed using the publically available transcriptome sequence information and database contains one thousand five hundred SSR markers. Amplification of 75 markers were tested, 72 (96%) markers showed amplification. However, only one marker showed polymorphism between the parents of RIL mapping population.

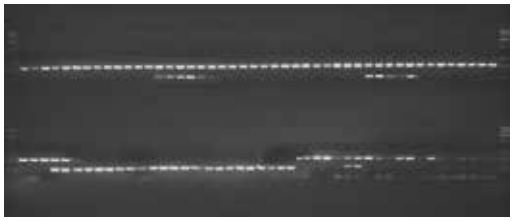
Marker based charectization of Vallabh Isabgol-1

ICAR - DMAPR, Anand: Molecular markers complement to morphological markers for classifying and distinguishing plant genotypes within a species is useful for protection of plant variety. Molecular markers allow precise and rapid identification of variety. One hundred RAPD markers were used to distinguish Vallabh Isabgol-01 from its patent GI-2. Among these the makers OPB-05, OPB-07 and OPD-12 produced clear and repeatable bands, thereby, distinguishing Vallabh Isabgol-1 from its parent GI-02.



Molecular characterization of germplasm

ICAR - DMAPR, Anand: Microsatellite based markers were used to characterize ninety five accessions of Isabgol. A total of 57 SSR markers generated 77 alleles. The size of the amplification varied with each primer and products ranged from 150 to 500 bp. The number of bands produced ranged from 2 to 6 with an average of 1.31 per primer. Out of 77 alleles observed, 58 were observed to be polymorphic.



Genome mapping

ICAR - DMAPR, Anand: One hundred RAPD markers (OPA1-OPA20, OPB1-OPB20, OPC1-OPC20, OPD1-OPD20 and OPE1-OPE19) were tested for parental polymorphism between mapping parents (DPO-185 and DPO-14). Among these, 18 markers were polymorphic, hence subjected to genotyping of 160 F_5 RILs developed from DPO-185 x DPO-14. Linkage map was constructed using JOINMAP®3.0 software with a minimum significant link LOD of 3.0 between the markers. Recombination frequencies were converted into map distances (centi morgans (cM) values) using the Kosambi mapping function. The genetic map comprises of 30 RAPD markers spreading across 11 linkage groups (PO-1 to PO-11) with a total map distance of 75.6 cM. The linkage groups PO-05 and PO-8 had maximum linkage distance.

Management of Downy mildew

YSRHU, Venkataramannagudem: A field experiment was conducted to manage the downy mildew disease in Isabgol using the combination sprays of potassium salt of phosphoric acid and chemical fungicides. Foliar sprays were initiated after the first disease appearance and subsequent sprays at an interval of 15 days. Among the combination of chemicals evaluated for the management of isabgol Downy mildew, chlorothalonil in combination with two sprays of potassium salt of phosphorus acid was effective with 35.62 per cent reduction in disease incidence followed by individual sprays of captan and copper oxychloride at an interval of 15 days (41.96%).

Screening of Isabgol germplasms for Multiple Diseases Resistance

MPUAT, Udaipur: Screening of 10 promising genotypes against Downy mildew, bacterial blight, leaf spot blight and root rot revealed that, five genotypes (P-80, P6, PB-3-1, AMB-2, and MIB-124) showed resistance and two genotype (MIB-125, Gumary) were moderately resistant, while three genotypes (GI-2,DM-2, and MIB-123) were found to be moderately susceptible against Downy mildew and leaf spots, bacterial blight and wilt. It was also noticed that yield and swelling factor were significantly higher in resistant and moderate resistant genotypes (except PB-3-1 & P-80) as compared to susceptible genotypes.

Management of aphids

ICAR - DMAPR, Anand: Seven biopesticides (*Metarhizium anisopliae* 1 $\times 10^9$ gm^{-1}, *Verticillium lecanii*1 $\times 10^9$ gm^{-1}, *Beauveria bassiana* 1$\times 10^9$ gm^{-1}, azadirachtin 10000ppm, azadirachtin 1500ppm, neem soap, pongamia soap) and chemical check imidacloprid 17.8 SL were evaluated against *Aphis gossypii*. The pooled data showed that aphid population was lowest in imidacloprid 17.8 S.L @ 25 g a.i ha^{-1} treated plots (1.89 plant^{-1}). Among the different biopesticides, azadirachtin 10000ppm @3ml/ l (10.01 plant^{-1}) was found to be effective followed by Azadirachtin 1500 ppm (17.20 plant^{-1}), neem soap (19.66 plant^{-1}) and Pongamia soap (19.67 plant^{-1}). The bioagents (*Metarhizium anisopliae* 1 $\times 10^9$ gm^{-1}, *Verticillium lecanii* 1 $\times 10^9$ gm^{-1}, *Beauveria bassiana* 1$\times 10^9$ gm^{-1}) were found less effective but significantly superior over untreated control (51.81/plant).

Dissipation of Imidacloprid

ICAR - DMAPR, Anand: A field trial was conducted to study the dissipation pattern of imidacloprid 17.8 SL and estimation of its half life (T1/2). Two sprays of imidacloprid 17.8 SL were given at two weeks interval @ 25 g a.i. ha^{-1} and 50 g a.i. ha^{-1} after emergence of spikes. The samples of Isabgol spikes were drawn at 0, 1, 3, 5, 10, 14 and 21 Days after Treatment (DAT). Fresh samples were processed by QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) approach. Quantification of the imidacloprid residues was done using on HPLC. The method gave good recovery (80-120 %) and the Limit of quantification was 0.01 μg g^{-1}. At both the dosages, the imidacloprid residues persisted up to 10 days. At harvest, no residues were found in spikes, crop herbage (straw) and soil samples. From the dissipation data the half life for imidacloprid was evaluated as 3 days.

Recycling of waste for preparation of value added compost

ICAR - DMAPR, Anand: Value added compost was prepared by using isabgol crop residue and cowdung as substrate, and different sources of rock phosphate (Udaipur, Jhabua and Purulia). Two different percentage of rock phosphate (2 and 4 % P) were used along with one control (ordinary compost) where no rock phosphate was used. The products were analyzed for total C, N and C:N ratio and also for different fractions of phosphorus to see the phosphorus enrichment during composting. After 150 days of composting C:N ratio came below 20 for all treatments. Enriched compost showed significantly lower C:N ratio as compared to ordinary compost. The compost was analysed for different fractions of phosphorus to study the effect of composting on mobilization of P from rock phosphate. About 4-7 fold enrichment in terms of total P was found in value added compost as compared to ordinary compost. Significant improvement in water soluble P as well as Olsen P was found in enriched compost as compared to ordinary compost. Also it was observed that there was significant amount of P mobilized from rock phosphate during composting period.

Design and development of Dehusker

ICAR - DMAPR, Anand: Tentative design values of experimental set up was determined for components like feeding unit, power transmission pulley, belt, dehusking mechanism and aspirator, etc.

KALIHARI (*Gloriosa superba*)

The plant belonging to *Liliaceae* family is a climbing herb commonly found in the forests throughout India upto 2000 m altitude. 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 a 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 and its yield under protected and unprotected conditions. In the protected plots, azadirachtin 10,000 ppm @ 1 ml l^{-1} (1%) was sprayed twice at 15 days interval. Yield losses due to defoliators (*Plusia signata and polytelia gloriosae*) and the major sucking pest *Thrips tabaci* were found to be 27.05 and 11.49 per cent, 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 (@ 1.5ml l^{-1}) and spinosad (@ 0.4ml l^{-1}) were given as chemical checks. Two sprays were given and after spraying, the mean number of thrips per plant was observed to be the lowest in fipronil (0.04 thrips per plant) followed by spinosad (0.12 thrips per plant) treated plots. Among the biopesticides, natural lactones recorded the lowest mean population of 1.66 thrips per plant. Regarding the seed yield, the maximum seed yield of 47.6 kg ha^{-1} was recorded in fipronil treated plots, which was found to be at par with spinosad treated plots with the seed yield of 465.7 kg ha^{-1}.

Management of leaf blight using fungicides and biocontrol agents

TNAU, Coimbatore: A field experiment was conducted on farmer's field at Vellipalayam, Coimbatore district, Tamil Nadu to manage the leaf blight disease (C.O: *Alternaria alternata*). Spray of chlorothalonil (0.1%) twice or *Bacillus subtilis* (0.2%) at 30 and 60 days after planting was effective in managing the leaf blight disease which recorded the lowest disease intensity of 17.3 per cent and 18.2 per cent respectively. The highest leaf blight disease intensity of 27.4 per cent was observed in the control. The maximum seed yield of 502.4 kg ha^{-1} was recorded in chlorothalonil 0.1% or *Bacillus subtilis* 0.2% spraying whereas the minimum seed yield of 386.1 kg ha^{-1} was recorded in control.

Management of root rot

TNAU, Coimbatore: A field experiment was conducted on farmer's field at Vellipalayam, Coimbatore district, Tamil Nadu to manage the root rot disease caused by Macrophomina phaseolina. The results revealed that the root rot disease of was effectively managed by dipping tubers in B. subtilis (0.2%) followed by drenching with B. subtilis (0.2%) 30 days after planting with the lowest disease incidence of 16.0 per cent against the highest root rot disease incidence of 25.0 per cent in the control. The maximum seed yield of 522.4 kg ha^{-1} was also recorded in the same treatment whereas the minimum seed yield of 346.7 kg ha^{-1} was recorded in control.

KALMEGH (*Andrographis paniculata*)

Kalmegh is a branched annual herb of family *Acanthaceae*. It is about 30-100 cm tall and 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 constituents having the therapeutic properties. 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.

DUS descriptors developed

ICAR - DMAPR, Anand: Descriptors for DUS testing in Kalmegh were finalized and submitted to the PPV&FRA. The trials were conducted at ICAR-DMAPR and AICRP-MAPB, BCKV, Kalyani for two years. DUS descriptors were identified for 14 morphological characters and example varieties (21) were developed for each characteristic. The major characteristics considered were leaf colour (dark green- RBG colour chart Ref: Green Group- 137N A, B or yellowish green- RBG colour chart Ref: Yellow green Group- 146 A, B); leaf lamina (long narrow or short narrow, long broad or short broad); leaf lamina: shape (linear lanceolate, lanceolate, elliptical, ovate and ovate- elliptical / ovate - lanceolate); shoot apex (tender leaves grouped at apex or tender leaves were not grouped at apex); leaf: lamina curvature (inwardly curved or outwardly curved); leaf: lamina surface (wrinkled, smooth); leaf at primary nodes (broad or normal); flowering pattern (early *i.e.,* anthesis initiation at <70 days after transplanting (dat), medium *i.e.* anthesis initiation at 80-110 dat or late *i.e.*, anthesis initiation at > 110 dat); inflorescence type: flower buds distantly arranged *i.e.,* long inflorescence or flower buds closely arranged *i.e.,* short inflorescence; branching pattern (open or close); plant: growth habit (erect, drooping/lodging); stem internode length (long or compact); plant canopy shape (pyramidal1, pyramidal 2, round, vase, broadly columnar/ oval); plant: height (short or tall); leaf andrographolide content (high, medium, low).

Leaf colour was dark green in ICAR - DMAPR AP3 and yellowish green in ICAR - DMAPR AP19; leaf lamina size long narrow in ICAR - DMAPR AP3 and short narrow in ICAR - DMAPR AP6 and ICAR - DMAPR AP27; long broad in ICAR - DMAPR AP1, ICAR - DMAPR AP2, ICAR - DMAPR AP18 and short broad in ICAR - DMAPR AP24; leaf lamina shape was linear lanceolate in ICAR - DMAPR AP3, lanceolate in ICAR - DMAPR AP6, elliptical in ICAR - DMAPR AP48, ovate elliptical to ovate lanceolate in ICAR - DMAPR AP 1, ICAR - DMAPR AP18, ICAR - DMAPR AP19 and ovate in ICAR - DMAPR AP24; tender leaves at the shoot apex were groped in ICAR - DMAPR AP19 and were separate in ICAR - DMAPR AP1and 2; leaf lamina was inwardly curved in ICAR - DMAPR AP15 and outwardly curved in ICAR - DMAPR AP16; leaf lamina surface was wrinkled in ICAR - DMAPR AP2 and ICAR - DMAPR AP13 and smooth in ICAR - DMAPR AP37; leaf at primary nodes was broad in ICAR - DMAPR AP46; branching pattern was open in ICAR - DMAPR AP22 and ICAR - DMAPR AP13 and closed in ICAR - DMAPR AP18 and ICAR - DMAPR AP19; flowering was early in ICAR - DMAPR AP37 and medium in ICAR - DMAPR AP6, ICAR - DMAPR AP13, ICAR - DMAPR AP21 and late in ICAR - DMAPR AP18; flower buds were distantly arranged (long inflorescence) in ICAR - DMAPR AP37 and closely arranged (short inflorescence) in ICAR - DMAPR AP6 and ICAR - DMAPR AP13; plant growth habit was erect in ICAR - DMAPR AP2, ICAR - DMAPR AP19, ICAR - DMAPR AP24 and lodging/drooping in ICAR - DMAPR AP21 and ICAR - DMAPR AP3; stem inter-node was compact in ICAR - DMAPR AP42 and long in ICAR - DMAPR AP2; plant canopy shape was pyramidal 1 in ICAR - DMAPR AP27, pyramidal 2 in ICAR - DMAPR AP39, round in ICAR - DMAPR AP6, vase in ICAR - DMAPR AP10 and broadly columnar/ oval in ICAR - DMAPR AP18, ICAR - DMAPR AP19 and ICAR - DMAPR AP35; plant was short in ICAR - DMAPR AP 6 and tall in ICAR - DMAPR AP22; leaf andrographolide content was high in DMAP AP2, ICAR - DMAPR AP18 and ICAR - DMAPR AP35.

Distinct lines of *Andrographis paniculata*: (A) to (F) leaf types; (G) & (H) branching types; (I) to (K) plant types; (L) & (M) inflorescence types

Superior lines Identified

ICAR - DMAPR, Anand: Based on two years evaluation, four superior lines (ICAR - DMAPR AP13, ICAR - DMAPR AP18, ICAR - DMAPR AP35 and ICAR - DMAPR AP2 INGR 07041) having high herbage yield and andrgrapholide content were selected for multi-location trials. Fresh herbage yield (t ha^{-1}) was 10.94 and 12.54 for ICAR - DMAPR AP13; 9.01 and 13.34 for ICAR - DMAPR AP18; 9.40 and 10.82 in ICAR - DMAPR AP35; 8.71 and 10.29 for ICAR - DMAPR AP2 (INGR 07041); dry herbage yield was 5.03 and 5.89 for ICAR - DMAPR AP13; 3.52 and 3.70 for ICAR - DMAPR AP18; 3.52 and 3.74 for ICAR - DMAPR AP35; 3.57 and 3.86 in ICAR - DMAPR AP2 (INGR 07041), during 2013-2014 respectively.

Germplasm evaluation

RVKSVV, Mandsaur: Twelve accessions collected from different farmers' field of Mandsaur district were evaluated. Highest dry herbage yield were recorded for MAP-1 (1741 kg ha^{-1}), which was followed by MAP-2 (1729 kg ha^{-1}), MAP-6 (1486 kg ha^{-1}), MAP-5 (1278 kg ha^{-1}) MAP-8 (1157 kg ha^{-1}) and MAP-4 (1137 kg ha^{-1}).

NDUAT, Faizabad: Eleven accessions with Fizabad local as a check were evaluated for three years. The accession, IC- 342135 recorded highest dry herbage yield (48.65 q ha^{-1}).

IGKV, Raipur: Two hundred ninety five accessions and two checks (Simmegha and Anand Kalmegh-1) were evaluated for various qualitative and quantitative traits. Plant height ranged from 27.67 to 72.03 cm and chlorophyll content ranged from 79.87 (acc.65) to 31.62 (acc.91). Among this, 166 accessions were semi erect type, 67 were erect type and 64

were spreading type. The colour of the leaf was dark green (148 accessions), light green (72 accessions) and purple (77 accessions).

Intercropping with pigeon pea

PDKV, Akola: The experiment was conducted to evaluate the intercropping of Kalmegh + pigeon pea at four row proportions (2:1, 3:1, 2:2 and 1:2), and compared with sole Kalmegh and sole pigeon pea. Pooled mean over three years (2012-13 to 2014-15) revealed that significantly highest plant height of Kalmegh (50.8 cm) was recorded with the treatment of 1:2 row proportion of Kalmegh + pigeon pea. The number of branches per plant of Kalmegh (28.9) was significantly higher with the row proportion of 3:1 of Kalmegh + pigeon pea. Pooled mean of dry foliage yield of Kalmegh (15.18 q ha^{-1}) and andrographolide yield (33.6 kg ha^{-1}) were noticed significantly higher at row proportion of 3:1 Kalmegh + pigeon pea. Kalmegh equivalent yield (28.07 q ha^{-1}), land equivalent ratio (1.61), gross return (₹ 49222 ha^{-1}), net return (₹ 31983 ha^{-1}) and B:C ratio (2.86) were found significantly higher with Kalmegh + pigeon pea row proportion of 3:1.

Effect of spacing on growth and yield

BCKV, Kalyani: The experiment was conducted to evaluate the performance of the crop growth and yield under five different spacings (30 × 30, 45 × 30, 45 × 40, 45 × 60 and 60 × 60 cm). The results revealed that kalmegh planted at 30 × 30 cm spacing recorded highest dry matter production (49.17 q ha^{-1}), about three fold higher over planting at 60 × 60 cm.

Effect of date of planting

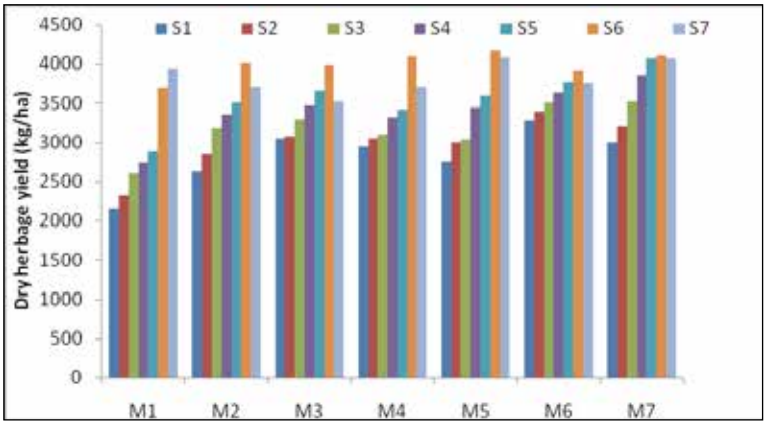
BCKV, Kalyani: The crop was planted at four different dates on fortnightly interval between 1st June and 15th July. The results revealed that kalmegh planted on 1st June recorded highest canopy spread (61.40 cm) and plant height (95.86 cm) which was significantly superior as compare to other dates of planting.

Effect of nitrogen and sulphur

RVSKVV, Mandsaur: Four levels of nitrogen (control, 50, 100, 150 kg ha^{-1}) and three levels of sulphur (control, 20, 40 kg ha^{-1}) were investigated. Results revealed that application of N 150 kg ha^{-1} recorded highest fresh herbage yield (72.7 q ha^{-1}), whereas, 40 kg ha^{-1} recorded highest dry herbage yield (47.9 q ha^{-1}).

Effect of integrated nutrient management on yield and quality

ICAR - DMAPR, Anand: The experiment was conducted during 2014 to find out the effect of integrated nutrient management on herbage yield and quality of kalmegh. Treatments comprised of three organic manures each at two levels (FYM 10 and 15; vermicompost 5 and 7.5; and castor cake 1.5 and 2.5 t ha^{-1}) and three levels of NPK (40:10:30, 60:20:40 and 80:30:50 kg ha^{-1}) and three levels of split application of N (25 DAP; 25 and 40 DAP and 25, 40 and 60 DAP) with control. The results revealed that application of castor cake 1.5 t ha^{-1} along with NPK (80:30:50 kg ha^{-1} where N applied as 50% at planting and 50% at 25, 40 and 60 DAP recorded significantly higher plant height (84.6 cm) and number of branches

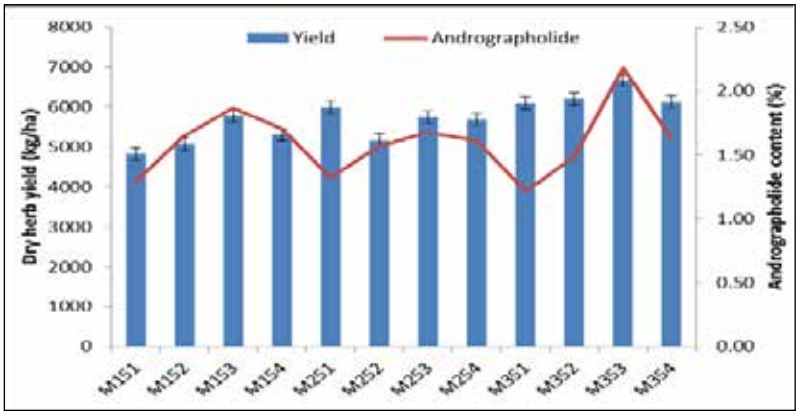


M1: control, M2: FYM 10 t ha-1, M3: FYM 15 t ha-1, M4: vermicompost 5 t ha-1, M5: vermicompost 7.5 t ha-1, M6: castor cake 1.5 t ha-1, M7: castor cake 2.5 t ha-1, S1: Control, S2: NPK 40:10:30kg ha-1, S3: NPK 60:20:40kg ha-1, S4: NPK 80:30:50kg ha-1, S5: NPK 80:30:50 kg ha-1(50% N as basal and 50% at 25 DAP), S6: NPK 80:30:50 kg ha-1(50% N as basal and 50% at 25 and 40 DAP), S7: NPK 80:30:50 kg ha-1(50% N as basal and 50% at 25, 40 and 60 DAP)

(36 plant-1). Dry herbage yield (4169 kg ha-1) was significantly higher with application of vermicompost 7.5 t ha-1 along with NPK 80:30:50 kg ha-1 and split application of N as 50% at planting and 50% at 25 and 40 DAP. Andrographolide content (2.48%) was recorded highest with application of castor cake 2.5 t ha-1 along with NPK 80:30:50 kg ha-1 and split application of N as 50% at planting and 50% at 25 and 40 DAP. Different combination of organic manures and NPK fertilizers also variably influenced plant and soil NPK content.

Standardization of organic nutrient management practices

ICAR - DMAPR, Anand: The experiment was conducted during kharif 2014 with three organic manures FYM (15 t ha-1), vermicompost (7.5 t ha-1) and castor cake (2.5 t ha-1) as main-plot treatments and four levels of biofertilizers and jivamrut (control, *Azotobacter* + PSB, Jivamrut



M1S1: FYM (15 t ha-1), M1S2: FYM (15 t ha-1) + biofertilizers, M1S3: FYM (15 t ha-1) + Jivamrut,M1S4: FYM (15 t ha-1) + biofertilizers + Jivamrut, M2S1: vermicompost (7.5 t ha-1),M2S2: vermicompost (7.5 t ha-1) + biofertilizers,M2S3: vermicompost (7.5 t ha-1) + Jivamrut, M2S4: vermicompost (7.5 t ha-1) + biofertilizers + Jivamrut, M3S1: castor cake (2.5 t ha-1),M1S2: castor cake (2.5 t ha-1)+ biofertilizers, M3S3: castor cake (2.5 t ha-1)+ Jivamrut,M3S4: castor cake (2.5 t ha-1) + biofertilizers + Jivamrut

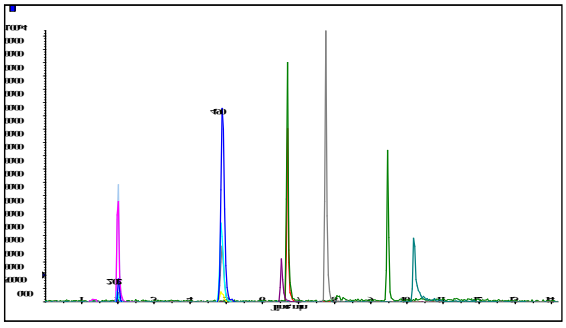
and *Azotobacter* + PSB + Jivamrut) as sub-plot treatments in split plot design. Jivamrut prepared as per procedure defined by National Centre for Organic Farming and applied at 25, 50 and 75 DAP with irrigation water. The results revealed that application of castor cake 2.5 t ha^{-1} along with jivamrut at 25, 50 and 75 DAP produced significantly higher dry herbage yield (6668 kg ha^{-1}) and andrographolide content (2.18%). The andrographolide content was lowest with the application of organic manures alone, however, markedly increased with the combined application of organic manures either with biofertilizers or jivamrut. The plant and soil NPK content were analyzed and found to be influenced variably with organic inputs. The soil health in terms of microbial biomass carbon (mg kg^{-1}), dehydrogenase (μg TPF g^{-1} h^{-1}), alkaline phosphatase (μg PNPg^{-1} h^{-1}), acid phosphatase (μg PNP g^{-1} h^{-1}), fluorescein diacetate (μg fluorescein g^{-1} h^{-1}) were also studied and found highest with vermicompost 7.5 t ha^{-1} and jivamrutapplied at 25, 50 and 75 DAP.

Incidence of different diseases

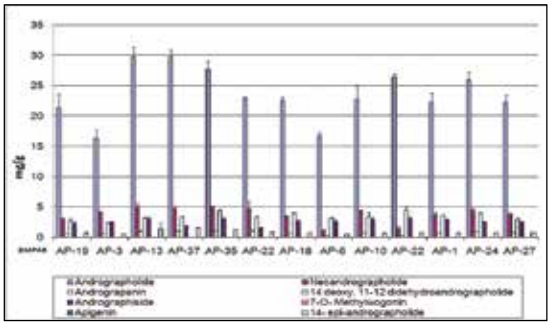
BCKV, Kalyani: A study was conducted to record the diseases in different lines. There were total 11 entries including one local variety (Kalyani Local). The incidence of total 4 diseases was recorded throughout the growth period *viz.,* Kalmegh gall, leaf spot, leaf blight and root rot. The incidence of gall caused by *Synchytrium* sp was recorded for the first time and it was maximum in the month of November. The percentage of incidence was recorded maximum on Kalyani Local (58.52) and DMAPR 35 (59.25). The incidence of other diseases namely, leaf spot, leaf blight and root rot was recorded very low in these lines.

LC-MS/MS method for the determination of major diterpenoid lactones

ICAR - DMAPR, Anand: HPLC combined with electrospray ionization triple quadrupole tandem mass spectrometry (LC-ESI-MS/MS) under the multiple reaction monitoring (MRM) mode was standardized for the determination of seven major diterpenoid lactones (andrographolide, neoandrographolide, andrograpanin, 14-deoxy, 11-12 didehydroandrographolide, andrographiside, 7-o- methylwogonin and apigenin). The LC-MS/MS parameters were optimized by using ESI source in positive mode of ionization. The chromatographic separation of analytes was performed on RP18 column using mobile phase, acetonitrile and 0.1% formic acid in water in gradient condition. The retention time of 4.90 min for andrographolide, 6.75 min for neoandrographolide, 9.38 min for andrographanin, 7.64 min for 14 deoxy,



XIC chromatogram of reference standards of diterpenoid lactones



Accumulation pattern of major diterpenoid lactones in leaves at 70 days after transplantation of selected lines

11-12 didehydroandrographolide, 2.02 min for andrographiside, 10.26 min for 7-O-methylwogonin and 6.56 min for apigenin were observed (Fig 1). The developed method was applied for the determination of major diterpenoid lactones in leaves, stem and root.

Standardization of post harvest practices

ICAR - DMAPR, Anand: Fresh herbage of kalmegh was collected from the field. Standardization of primary processing technologies like removal of dirt, foreign materials, washing etc. was done. The fresh samples were analyzed for various physico-chemical parameters like moisture content, chlorophyll content, microbial load and active principle content. Statistical analysis showed significant differences in moisture content of fresh samples.

The fresh kalmegh samples (A0 & A1) were subjected to four methods of drying *viz*., shade drying, sun drying, solar drying and oven drying. The dried samples were analyzed for various physico-chemical parameters like moisture content, chlorophyll content, microbial load and active principle constituent. Statistical analysis showed that the different methods of drying had significant influence on final moisture content, chlorophyll content, microbial load and active principle contents.

Dried samples were stored in five type of packaging materials (gunny bag, polypropylene bag, HDPE, LDPE and corrugated box/cartons and stored at ambient conditions. The samples were withdrawn after three months after storage and analyzed again for various physico-chemical parameters and microbial load. The moisture content of the stored products was found to increase in all kind of packaging material. Significantly higher moisture absorption was recorded in shade dried samples stored in gunny bag whereas the least moisture content was observed in solar drier and stored in HDPE containers. Both chlorophyll A & B content of the stored samples were found to reduce during storage period. However, less reduction was observed in samples without washing (A0), dried under shade (D1) and packed in HDPE containers (P4) and corrugated boxes (P5).

KUTKI (*Picrorhiza kurroa)*

It is a small perennial herb of family *Scrophulariaceae*. It grows well in the hilly parts of the North-Western Himalayan region of India and Nepal. The leaf, bark and the underground parts of the plant, mainly rhizomes are widely used in Ayurveda since ancient times. It shows anti-oxidant, anti-inflammatory and immunomodulatory activities and also valued for its hepatoprotective effect. The bitter rhizomes have been used for thousands of years in India to treat people with indigestion and constipation due to insufficient digestive secretion. It is considered as a trophorestorative herb for the liver, as well as a potent immune stimulant. Its constituent, picroliv is also reported to possess choleretic effect and prevent hepatic injury caused by ethanol, chemicals and microorganism. The plant and its formulations are widely used in therapy of epidemic jaundice.

Quality analysis of market samples

YSPUHF, Solan: 36 samples under the market name "Kutki", received from 8 different AICRP MAP&B centres, were analysed by TLC and HPLC methods. Picroside-Iand Picroside-II were used as reference compounds for TLC and HPLC analysis. On the basis of TLC profile and HPLC analysis and after comparing with genuine samples it was concluded that out of the 36 samples, 34 samples were of Picrorhiza kurroa (including 2 samples having trace amount of marker compounds).

LAL CHITRAK (*Plumbago rosea*)

The plant belongs to family *Plumbaginaceae*. It is a perennial shrub of about 1.5 m tall. Flowers are red colour, 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* systems of medicine, the root is used to promote appetite and stimulate digestive process. The freshly harvested roots are used for the drug preparation.

Germplasm evaluation

KAU, Thrissur: Selected accessions were evaluated at three different locations (Irinjalakuda, Ollukkara and Madakathara). The accession, TCRPR 521 registered superior with respect to root characters like root length (61.09 cm), root girth (3.94 cm), number of roots (32.58), fresh root weight (165.80g), dry root weight (72.20g) and with moderately high plumbagin content (0.51%).

LEMONGRASS (*cymbopogon flexosus*)

Lemongrass, which is commonly known as Nimbu ghass is an important aromatic grass of Indian origin. The leaves and shoot of the plant is used to extract essential oil which is rich in citral content (75-85%). Lemongrass oil is one of the most important essential oil produced in the world. The oil is mainly used in the manufacture of perfumes for soaps, hair oils, scents and medicines. There are three types of the lemongrass namely, the East Indian or true lemongrass (C. *flexuosus*), West Indian lemongrass (C. *citrates*) and C. *pendulus* (North Indian or Jammu lemongrass). The oil obtained by the distillation of the grass of C. *flexuou-*

sus is the genuine oil of commercial importance. Presently it commercially cultivated in Kerala, Assam, Maharashtra, Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh and Uttar Pradesh.

Use of aromatic plant waste for removal of heavy metals from water

ICAR - DMAPR, Anand: The potential use of the organic acid modified distillation waste biomass for removal and of Cu(II) and Zn(II) from water was evaluated. Normal and modified lemon grass distillation waste was characterized by using FTIR. The influence of solution pH, biosorbent dose, metal ions concentration, and contact time on the biosorption process was also studied. The extent of adsorption increased with contact time, and adsorbent doses but decreased with increasing adsorbate dosage and acidic pH was found to be suitable for adsorption. The optimum parameters were established as follows: solid/liquid ratio: 8 g l^{-1}, equilibrium time 120 and 180 mins for Cu and Zn , respectively; optimum pH: 5.0 and 5.5 for Cu and Zn, respectively. By comparing various kinetic models, the biosorption process was found to follow the pseudo-second-order kinetics. Batch biosorption equilibrium data were fitted to both Langmuir and Freundlich crubs and found to fit well with the Langmuir model, and the maximum adsorption capacity of the of organic acid-modified lemon grass distillation waste was 7.59-8.76 mg g^{-1} and 7.2-9.9 mg g^{-1} for Cu and Zn, respectively. The results indicated that lemon grass distillation waste can be used as a cost-effective biosorbent for the removal of Cu and Zn ions from aqueous solution.

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.

Germplasm characterization and evaluation

AAU, Jorhat: Thirty five accessions collected from different states of north east India with Viswam (check) were evaluated and characterised. While leaf margin was invariably “Entire”. Leaf base was ‘Pulvinus’ type for some accessions while others were “Non pulvinous” type. In variety ‘Viswam’ the leaf base was found to be non pulvinous. Colour of the leaves were either “green” or “light green” in nature. Leaf length ranged from 3.13 cm (JPL-9) to 5.93

cm (JPL-14 and Viswam). JPL-15, though recorded a length of 9.20 cm but it seems that the germplasm may not be a Piper longum species. Significant variations of leaf length was observed in the collected germplasm with that of 'Viswam'. Viswam recorded a leaf breadth of 8.97 cm while in others the breadth varied from 2.87 cm (JPL-33) to 6.07 cm (JPL-7). Leaf length and breadth ratio was highest in Viswam (0.660) while the lowest L/B ratio was found in JPL-17 (0.357). Leaf size of collected germplasm varied from 18.92 cm^2 (JPL-1) to 42.44 cm2 (JPL-7). Leaf size of all the collected germplasm varied significantly with that of Viswam (53.20 cm^2). Spike length and spike diameter ranged from 1.10 cm (JPL-1) to 3.10 cm (JPL-32) and 0.88 cm (JPL-1) to 3.37 cm (JPL-32), respectively. Significant variations in number of spikes/plant was found among the germplasms, highest being recorded in JPL-1 (78.67 nos) and lowest in JPL-6 (20.33 nos). Fresh weight of the spikes varied significantly with that of Viswam (0.68 g). Highest spike weight was recorded in JPL-32 (1.56 g) while lowest was found in JPL-1 (0.61 g). Similarly dry weight of spike of JPL-1 was minimum (0.21 g) and the JPL-32 was maximum (0.51 g).

Standardization of planting methods and spacing

AAU, Jorhat: The experiment consists of planting with and without support and at four spacings (40 × 40, 60 × 40, 60 × 60 and 90 × 60 cm). Planting with support significantly increased leaf size (31.05 cm) and internode length (5.50 cm). However, spike length, spike breadth, fresh weight and dry weight of spike found at par with planting without support. Whereas, number of spikes per plant (43.33) was significantly higher without support planting. Spacing of 90 × 60 cm recorded maximum leaf size (34.67 cm), internode length (5.7 cm), spike length (2.53 cm), number of spikes per plant (43.50) and fresh (1.24 g) and dry (0.38 g) weight per spike.

Integrated nitrogen management

AAU, Jorhat: The experiment comprising of RDF and FYM and vermicompost in different combinations was conducted. The results revealed that length of leaf (6.17 cm) and breadth (6.2 cm) was maximum in 75% RDF through inorganic fertilizers and 25% RDF through FYM, whereas, highest number (75) and length (3.00 cm) of spikes were recorded with 100% RDF through vermicompost. The maximum fresh (1.30 g) and dry (0.43 g) weight of spikes were recorded with the application of 25% RDF through fertilizers + 75% RDF through vermicompost and 100% RDF through FYM, respectively.

Management of leaf spot

RAU, Pusa: Field experiments on the management of leaf spot caused by *Botryodiplodia theobromae* showed that soil incorporation of 10g of *Trichoderma viride* formulation with 100g of FYM per pit at the time of planting effectively reduced the leaf spot disease (PDI 21.75) as compared to control (PDI 46.10). The application of T. *viridae* enriched with FYM followed by preventive spray of Blitox 50, further reduced the disease intensity to 17.0%. There was further significant reduction in disease intensity (11.25%) when this treatment was followed by one spray of propiconazole @ 0.1% just after appearance of initial symptom.

Screening for high piperin content

ICAR - DMAPR, Anand: Sixteen accessions received from AAU, Jorhat were screened for piperin content using HPLC method. Piperine content of six accessions viz., JPL-12 (7.85%), JPL-06 (7.64%), JPL-04(6.52%), JPL-17 (6.33%), JPL-03 (5.46%) and JPL-19 (5.24%) were higher than variety "Viswam"(5.15%).

MAKOI (*Solanum nigrum*)

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

DUS descriptors developed

TNAU, Coimbatore: Thirty five descriptors based on the morphology of leaf, stem, flower and fruits were identified and tested for their distinctness, uniformity and stability.

Germplasm evaluation

YSRHU, Venkataramannagudem: Forty five accessions were evaluated for yield and quality. The accession, APSn-23 recorded highest herbage yield per plant (9.62 kg) followed by APSn-6 (9.05 kg). Highest plant height was recorded in APSn-11(99.50 cm) followed by ApSn-20 (97.00 cm). Number of branches was highest in APSn-23 (22.33) followed by APSn-12 (22.00). Highest stem girth was recorded in APSn-18 (4.50 cm) followed by APSn-16 (4.33 cm). Leaf length was highest in APSn-26 (6.25 cm) followed by APSN-25 (6.10 cm) and Leaf breadth was highest in APSn-26 (4.25 cm) followed by APSn-27 (3.70 cm). Six accessions with a check (MG-8) were evaluated for greens and alkaloid purpose at different locations. During the year 2014-15 highest plant height was recorded for TNSn-10 (70.00 cm) which is on par with TNSn-45 (63.67 cm). Number of branches was highest in case of TNSn-19 (49.00) which was at par with TNSn-45 (greens) (45.00). Herbage yield was highest in case of TNSn-19 (15.80 t ha-1) which was at par with TNSn-45 (greens), APSn-4, APSn-7 and MG-8.

Effect of seed rate and spacing on growth and yield

YSRHU, Venkataramannagudem: The experiment was conducted comprising of 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 maximum seed yield (3.03 t ha^{-1}) was recorded with 12.5 kg ha^{-1} seed rate which was on par with 2.5 kg ha^{-1} seed rate (2.86 t ha^{-1}) and transplanting at 30 x 30 cm (2.72 t ha^{-1}).

Effect of days of 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). Highest number of branches (21.33) and herbage yield (11.81 t ha^{-1}) was recorded when 25 days old seedlings were transplanted which was at par with 15 and 20 days old seedlings.

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 10,000 ppm @ 1 ml l^{-1} (1%) was sprayed twice at 15 days interval. Yield loss due to the major pests (*Aphis craccivora, Thrips tabaci* and defoliators) was found to be 31.63 % where as yield loss due to the major mite pest, *Polyphagotarsonemus latus* was recorded to be 66.92 %.

Management of yellow mite

TNAU, Coimbatore: Field trial was laid out on the farmer's holdings at Edaiyarpalayam, Papampatti, Coimbatore to assess the field efficacy of selected botanical acaricides against *Polyphagotarsonemus latus*. 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 (18.8 kg/12m^2/harvest) followed by propargite @ 2 ml l^{-1} (93.7 %, 18.4 kg/12m^2/harvest) and triterpenoid @ 1 ml l^{-1} (79.5%, 14.5kg/12m^2/harvest).

Bio efficacy of pesticides for the management of mite

YSRHU, Venkataramannagudem: A field experiment was laid out to manage the mite infestation using chemical pesticides and botanicals. The results showed that the maximum reduction of mite population was recorded in propargite treated plot (5.89 plant^{-1}) followed by wettable sulphur (6.21 plant^{-1}) and spiromesifen (8.22 plant^{-1}). There was no significant difference in fresh herbage yield in all the treatments including control.

MANDUKAPARNI (*Centella asiatica*)

Mandukaparni is a member of family *Apiaceae*. It 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.

Germplasm characterization

UBKV, Kalimpong: Ten accessions were characterized for various morphological traits. The accession KCA-1 had reddish stem color, crenate leaf margins, deep green leaf colour and deep pink petals.

Effect of organic and inorganic manures on growth and yield

NDUAT, Faizabad: The experiment was carried out with three levels of NPK (25:20:15; 50:20:15; 75:20:15) and FYM (5, 10 and 15 t ha^{-1}) and compared with control. The maximum fresh herb yield (117.6 q ha^{-1}) was obtained with FYM 15 t ha^{-1} followed by 10 t ha^{-1}. The maximum dry herb yield (23.53 q ha^{-1}) was recorded with FYM 15 t ha^{-1} which was 1.75 times higher than control.

Effect of spacing and harvesting time on herb yield

NDUAT, Faizabad: Three spacing (30×60, 45×60, 60×60 cm) and three different harvesting time (15th May, 15th June and 15th July) were investigated. The maximum fresh herbage (101.69 q ha^{-1}) and dry herbage (18.98 q ha^{-1}) yield was recorded when sown at closer spacing (30 × 60 cm) and harvested on 15th May.

Management of stolon rot:

RAU, Pusa: Results of the field experiments showed that FYM incorporated in soil with *Trichoderma harzianum* combined with sapling treatment with the same bio agent was most effective in suppression of stolon rot (6.0 % disease intensity) and also resulted in maximum herbage yield with 50.66 and 10.06 q/ha on fresh and dry weight basis. When *Trichoderma viridae* was used for the above mentioned treatment, the disease intensity became 6.3% and recorded a fresh and dry herbage yield of 38.76 and 7.90 q ha^{-1} respectively.

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.

Germplasm evaluation

KAU, Thrissur: Multiocational trial with selected accessions (TCRIT 2, TCRIT 4, TCRIT 14 and TCRIT 15) along with local check was laid out in three locations (Ollukkara, Madakkathara and Irinjalakkuda). Pooled analysis of the data indicated that location effects were not significant. All accessions registered higher yield and quality characters than local check. The accession, TCRIT 4 recorded highest yield (9589.95 kg ha-1) and indican content (0.99 %).

Effect of shade and planting dates on yield and quality

KAU, Thrissur: The experiment comprising three levels of shade (25, 50% shade and open) and three planting dates (2nd week of August, September and October) was conducted during 2012-13, 2013-14 and 2014-15. Pooled analysis of three year data revealed that crop planted in September under 25% shade gave the highest herbage yield (5762 kg ha^{-1}) consecutively for three years. Pooled analysis of indican content confirmed that planting under fully open condition during the month of August was most ideal for getting maximum indican content (1.19%) followed by planting in September under fully open condition (1.15%).

Integrated nutrient management for higher yield and quality

KAU, Thrissur: The experiment comprised of nine combination of FYM and NPK was conducted. The higher herbage yield (6413 kg ha^{-1}) was recorded with FYM 5 t ha^{-1} along with NPK 45:60:4 5kg ha^{-1} followed by FYM 10 t ha^{-1} along with NPK 45:60:45 kg ha^{-1} (6128 kg ha^{-1}). The maximum indican content (0.90%) was found in plants without manures or fertilizers as against in plants with manures and fertilizers.

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 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.

Multilocation evaluation at MPUAT, Udaipur, NDUAT, Faizabad, RVSKVV, Mandsaur

Initial evaluation trial with eight entries (UOP20, UOP30, UOP79, UOP80, NOP11, NOP22, MOP278 and MOP511) with two checks (Chetak Aphim and JOP540) was evaluated to identify high yielding varieties. The check, Chetak Aphim (24.87 kg ha^{-1}) recorded maximum latex yield across the centers.

Germplasm evaluation

RVSKVV, Mandsaur: Two hundred and thirty five accessions were evaluated for yield and quality. The accessions (MOP-8, MOP-510, MOP-535, MOP-278, NOP-4 , MOP-511, NOP-11, ND-43 , ND-36, ND-47, ND-40, NC-57955, MOP 1085, MOP 1088, ND-35, ND-45, ND-201, ND-2001, UOP-18, UOP-22, UOP-28, UOP-38, UOP-36, UOP-52, UOP-69, UOP-590, IC-42, IC-15-2, NBPGR-1, NC-57159, UO-1395, JA-16 and JOP-540) recorded higher latex yield (above 40 kg ha^{-1}) while, the accessions, (ND-1146,UOP 590, ND-36 , UOP 80 and ND-1001 MOP 278, MOP 510, MOP 511, MOP 525, MOP 535, MOP-700, MOP-1071, MOP-1085, UOP-37, UOP-40, UOP-52, UOP-60, UO-17682, ND-6, ND-24, ND-43, ND-44, ND-47, ND-2001, P3 x P10, NBPGR-2, NC-57159 and NC-57936) were found superior for seed yield (kg ha^{-1}).

Germplasm regeneration

RVSKVV, Mandsaur: One hundred and seventy one accessions maintained at the long term storage at NBPGR, New Delhi were regenerated and multiplied.

MPUAT, Udaipur: One hundred and thirty eight accessions maintained at the long term storage at NBPGR, New Delhi were regenerated and multiplied.

Evaluation of selections

MPUAT, Udaipur: Thirteen entries along with three checks (Chetak Aphim, IC42 and MOP540) were evaluated for latex, seed, and husk yield & other yield contributing traits. Three genotypes(UOP-132, UOP-145 and UOP-150), showed their significant superiority for husk yield over the best check (Chetak Aphim) while genotype UOP-60 was at par check (Chetak Aphim). Variations in morphological traits were observed for leaf serration, peduncle nature, flower colour, petal serration, capsule shape and capsule colour.

Management of stem rot

RVSKVV, Mandsaur: Field trials were conducted to evaluate the efficacy of antibiotics and fungicides against the stem rot during 2013-2014 and 2014-2015. The mean of the two year data showed that spraying of copper hydroxide + streptocycline (0.3%+140 ppm) at rosette stage recorded lower disease intensity (23.73 %) and highest latex, seed & husk yield (51.94, 782.62 & 658.66 kg ha^{-1}). In the control, the highest disease intensity (44.26%) and the lowest latex, seed & husk (29.41, 497.55 & 439.83 kg ha^{-1}) yield was recorded.

Integrated disease management practices against root rot and Downy mildew

MPUAT, Udaipur: Organic integrated disease management modules against root rot and Downy mildew evaluated under sick plot and inoculation condition during Rabi 2014-15. Among the four modules tested, soil application of neem cake manure + farm yard manure @ (250g m^{-2}) supplemented with *Trichoderma* formulation @ (5%) + Seed treatment with neem oil @ (3%) followed by drenching with cow urine: neem leaves: garlic clove (CNG) fermented product @ 10% at 30 and 60 DAS and 3 sprays of CNG fermented product @ 5% at 30, 45 and 60 days after sowing resulted highest germination (80.11%), lowest plant mortality (11.92%) and Downy mildew incidence (19.54%) with maximum control of root rot and downy mildew diseases (86.49 and 73.18 %, respectively) and yielded higher dry latex powder, seed and capsule husk (1.92, 83, 75 gram plot^{-1}, respectively) with higher morphine content (11.24%). The soil from the different modules were again tested for the population of biocontrol agent and root rot pathogen. It was found that the same treatment harboured maximum T. *viridae* population and minimum root rot pathogen at sowing (4.5×10^5 cfu g soil^{-1} and 2.47×10^5 cfu g soil^{-1}) and flowering (14.80×10^5 cfu g soil^{-1} and 0.55×10^5 cfu g soil^{-1}) .

Screening for multiple disease resistance

MPUAT, Udaipur: Ten promising genotypes were screened against Downy mildew, root rot, leaf spots, bacterial blight and powdery mildew (disease severity rating was done based on 0-9 scale). Six genotypes (UOP-20 ,UOP-79, UOP-69, UOP-44, UOP-53, UOP-80) showed resistance with lowest diseases intensity (11-20%) against all diseases and with higher yields of seed (71-92 g plot^{-1}); husk (67-77 g plot^{-1}); dry latex powder (1.63-1.92 g plot^{-1}) and higher morphine content (9.41-10.91%), However, three genotypes (UOP-35, UOP-60, and UOP-1185) were moderately resistant with disease intensity of 21-40 %. The variety Chetak Aphim was found moderate-susceptible with high disease intensity (41-50%) and low dry latex yield (1.62 g plot^{-1}), seed yield (55 g plot^{-1}), husk yield (60 g plot$^{1)}$ and morphine content (8.06%).

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 it is very rich in geraniol (75-90%). It is used in perfumery, cosmetics, soap and also in flavouring tobacco. The genus Cymbopogon is chiefly distributed in the tropical South Eeast Asia and Africa. 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.

Modified mass selection

CCSHAU, Hisar: The seeds of 200 selected plants of the variety RH 49 were bulked to grow composite seed propagated population. Forty nine clones were selected and evaluvated. Plant height (cm) ranged from 154.53 (C-9) to 303.20 (C-17), fresh herb yield (g plant) ranged from 335.3 (C-39) to 1253.3 (C-42) and Oil yield (ml plant-1) 1.07 (C-39) to 5.86 (C-22). The clone, C-22 (5.86 ml) yielded highest oil yield per plant followed by C-21 (5.76 ml), C-42 (4.69 ml), C-3 (4.18 ml) and C-38 (3.93 ml) the Trishna (3.04 ml).

Effect of nutrient management on herbage and oil yield of different varieties

IGKV, Raipur: The experiment comprising of three varieties of palmarosa (Tawirosa, CN 5 and Jamarosa) and four nitrogen levels (75, 100, 125 and 150 kg ha-1) were conducted during 2011-12 to 2013-14. The results on pooled data basis revealed that maximum oil yield was found from variety Jamrosa and application of nitrogen 150 kg ha-1.

Analysis of samples from modified mass selection

CCS HAU, Hisar: Oil content of 11 promising clones in third cutting ranged from 0.32 to 0.49 per cent. The clone P11 recorded highest oil content (0.49%) on FWB followed by P133 (0.48%), P174 (0.45%), P138 (0.37%), P17, P82 & P171 (all 0.35%), P28 (0.34%), P76 & P168 (both 0.33%) and P43 (0.32%). The oil content data of another 49 promising clones ranged from 0.23 to 0.58 per cent. The clone C22 recorded highest oil content (0.58%) on FWB followed by C21 (0.57%), C3 & C12 (both 0.55%), C10 & C16 (both 0.54%), C49 (0.53%), C23 (0.50%), C24 (0.48%), C18 & C38 (both 0.47%); C14 & Trishna (Check) (both 0.46%), C11, C46 & C48 (all 0.45%), C17 & C28 (both 0.44%), C13 & C25 (both 0.43%), C9 & C47 (both 0.42%) and C7 & C26 (both 0.40%).

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

Germplasm evaluation

PDKV, Akola: Thirteen genotypes with one check (MCB 405) were evaluated for different morphological characters and yield. AKSM-07 recorded significantly higher root weight per

plant (16.87g), followed by AKSM-08 (16.87 g) and saponin content was highest in AKSM-08 (8.14%).

RVSKVV, Mandsaur: Twenty four accessions were evaluated for yield and quality. The fasciculated root yield ranged from 1481 to 3704 kg ha^{-1}. Maximum fresh fasciculated root yield was recorded for MCB-412 (3704 kg ha^{-1}) followed by MCB-404 (3426 kg ha^{-1}), MCB-406 (3185 kg ha^{-1}), RVSM-414 (3148 kg ha^{-1}), MCB-422, MCB 424 (2963 kg ha^{-1}) as compared to check JSM-405 (2778 kg ha^{-1}).

Intercropping with pigeon pea

PDKV, Akola: The experiment was conducted on intercropping of safed musli + pigeon pea at four row proportions (2:1, 3:1, 2:2 and 1:2) and compared with sole safed musli and sole pigeon pea. Pooled mean over three years (2012-13 to 2014-15) revealed the significantly higher number of roots (11.9), length (7 cm), girth (6.52 mm), saponin content (7.71%), fresh root yield (33.24 q ha^{-1}) and dry root yield (5.54 q ha^{-1}) with row proportion of 3:1 followed by the sole safed musli. Safed musli equivalent yield (5.28 q ha^{-1}), land equivalent ratio (1.51), net return (₹ 348653 ha^{-1}) and B:C ratio (3.87) were significantly higher under the intercropping at row proportion 3:1 of safed musli + pigeon pea.

Management of anthracnose disease

RVSKVV, Mandsaur: Field experiments were laid out for the management of anthracnose disease. The results showed that spraying of carbendzim + mancozeb @ 0.25 % recorded minimum diseases incidence (16.34 %) and maximum yield (3118.00 kg ha^{-1}) which was 118 per cent yield increase over control. This was followed by the treatment carbendazim @ 0.15 % which recorded disease incidence of 21.21 % and root yield of 2775.00 kg ha^{-1} where as maximum disease incidence (42.20 %) and minimum root yield (1429.00 kg ha^{-1}) was recorded in control.

Integrated disease management against root rot and leaf blight

MPUAT Udaipur: Integrated disease management module against root rot and leaf blight 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 (500g 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 (CNG) @ 1% resulted in minimum plant mortality (16.94 %), maximum per cent root rot disease control (75.80%), higher yields of fasciculated root (41.9 q ha^{-1}), increased root parameters (length - 13.20 mm, width - 25.30 mm, roots number - 659 5 m^{-2}), and increased saponin content (11.26%) compared to untreated control. The highest population counts of T. *viride* (12.44×10^5 c.f.u. g^{-1} soil cf.u. g^{-1} soil) in the soil rhizosphere were also found in this treatment.

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.

Management of leaf spot

NDUAT Faizabad: A field experiment was laid out to know the efficacy of fungicide and different botanicals against *Cercospora* leaf spot. The minimum percent disease index (14.56) was recorded in the treatment mancozeb @ 0.25% followed by neem leaf extract @ 5.0 % (16.83 %), garlic bulb extract (21.45 %) and tulsi leaf extract (23.25 %) as compared to control plot (65.63 %). The highest yield was obtained in the plot treated with mancozeb (21.57 q ha^{-1}) and lowest in control plot (15.25 q ha^{-1}).

JNKVV, Jabalpur: Field experiments were laid out to evaluate *Trichoderm*a fortified manure and fungicide against *Cercospora* leaf spot. The pooled mean of the result (2013-14 and 2014-15) showed that the disease incidence was lowest (4.36 % and 30.0 %) in application of FYM @ 10t ha^{-1} + 3 sprays of mancozeb 75% WP at 15 days interval. The next best treatment was application of vermicompost @ 2.5t ha^{-1} + T. *asperellum* @ 10^6 cfu/ml + 3 spray of mancozeb 75% WP at 15 days interval (5.4 and 36.33)

SATAVARI (*Asparagus racemosus*)

It is a creeper, 1 to 2 meters tall belonging to family *Liliaceae* and it is distributed throughout

India and in the Himalayas. It has an adventitious root system with tuberous roots that measure about one 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. Its cultivation is very limited and 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 and peeled. Shade dried roots are used for drug preparation.

Germplasm maintaince and evaluation

ICAR - DMAPR, Anand: Forty four *Asparagus adscendense* accession collected from different geographical regions of India were maintained and acclamatised. The accession, DAA1 produced flower and seed set at Anand conditions.

NDUAT, Faizabad: Twenty four accessions were evaluated for three years. Maximum fresh roots were harvested from genotype NDAS-24 (484.62 q ha^{-1}) followed by NDAS-25 (418.70 q ha^{-1}) and NDAS- 14 (406.55 q ha^{-1}).

MPKV, Rahuri: Eleven accessions were evaluated for yield and quality. The accession, RSLG-11 recorded maximum plant height (107.38 cm), root length (23.9 cm), root girth (8.2 cm), fresh root yield (2.35 kg $plant^{-1}$) and dry root yield (1.927 kg $plant^{-1}$) and produced purple colour flowers and black colour seeds.

JNKV, Jabalpur: Thirteen accessions were evaluated for various agro morphological traits. Number of cladode per node varied from 1 to 3, the length of cladode ranged from 5.9 to 15.2 cm. Fresh root weight per plant ranged from 1391 to 4629 g and dry root weight ranged from 145.5 to 642.50g. The accession, JBPAR8-9-118 recorded maximum number of roots per plant (389.5), fresh root yield (4629 g) and dry root yield (653.5g).

Effect of organics manures and biofertilizers on growth and yield

RAU, Pusa: The experiment was conducted with three levels of organic manures (vermi compost 2 t, mustard cake 1 t and vermi compost 2 t + mustard cake 1 t ha^{-1}), and three levels of biofertilizers (*Azospirillum* 2 kg, PSB 5 kg and *Azospirillum* 2 kg + PSB 5 kg ha^{-1}) to find out the suitable combination of organic manures and biofertilizers for higher yield and quality. The combined application of vermicompost 2 t + mustered cake 1 t ha^{-1} and inoculated with mixture of PSB 5 kg + *Azospirillum* 2 kg ha^{-1} produces significantly higher number of roots per plant (167.25), root length (29.8 cm), and root yield both on fresh (135.28 q ha^{-1}) and dry weight (16.25 q ha^{-1}) followed by vermicompost 2 t ha^{-1} inoculated with mixture of *Azospirillum* 2 kg + PSB 5 kg ha^{-1}.

Effect of nutrient management on yield

JNKV, Jabalpur: The experiment was conducted to standardize a suitable nutrient dose for maximizing root yield. The results revealed that application of 50% RDF through inorganic fertilizers + 50% RDF through FYM recorded maximum number of roots per plant (182.25), root length (29.2 cm), root diameter (14.29 mm), fresh root yield (2125.75 g $plant^{-1}$) and dry root yield (559.00 g $plant^{-1}$).

Yield loss assessment due to fruit borers

MPKV, Rahuri: A field experiment was conducted to assess the yield loss due to fruit borer in Satavari. Cypermethrin@5 ml $10l^{-1}$ was sprayed at fortnight interval for control of fruit borer. An yield loss of 57.38% was observed due to fruit borer infestation.

Biology of fruit borer

MPKV, Rahuri: Fruit borer was found as a major pest with infestation of 50-60% in fields during December 2014- March 2015. The larva made small holes inside the fruit and feeds from inside. Early instars of larva were milky white in colour with 2.5-4.5 mm in length and later instars were greenish in colour with 19-23.5 mm in length. The larval period lasted for 16-30.5 days. Pupation was observed inside the white cocoons of size (7.5-11) × (2.25-3.65) mm. Pupae were reddish black in colour with size 7.5-10.5 ×2.5-3.5 mm. A pupal period of 16.5 to 25.5 days was observed in laboratory. Adults had small black spots on the dorsal side of the wings and white lines on anterior side. The mean duration of adults was about 17.5 to 23 days.

Screening for high saponin content

ICAR - DMAPR, Anand: Twenty five accessions of *A. adscendense* were screened for saponin content using HPLC-ELSD method. Three accessions DAA2, DAA4, DAA12-R1 had higher saponin concentration.

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 and maintenance

ICAR - DMAPR, Anand: An exploration trip was undertaken in parts of Rajasthan and Gujarat and 34 accessions were collected. These accessions differ widely for plant height (30-120

cm), number of primary branches (5-20) and 100 seed weight (1.54-3.00g). A total of 222 collections were multiplied and maintained.

Characterization and evaluation

ICAR - DMAPR, Anand: Two hundred accessions were characterized and evaluated for various agro-morphological traits. Accessions showed variation in various morphological traits such as plant habit type, leaf shape, number of leaflets per leaf, pod shape and pod size.

Screening for resistance to *Catopsilia pyranthe*

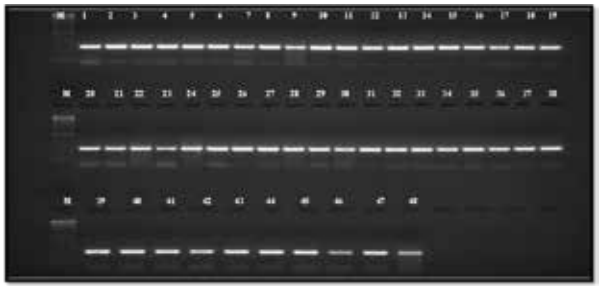
ICAR - DMAPR, Anand: Two hundred accessions were screened for their ovipositional preference to *Catopsilia pyranthe* in Senna. The egg laying in different germplasms ranged from 0 to 1.33 eggs per plant. Ovipositional preference was negatively correlated with abaxial and adaxial trichome density.

Mining of anthraquinones biosynthesis genes

ICAR - DMAPR, Anand: Leaf transcriptome was mined for presence of gene encoding enzymes involved in the biosynthesis of anthraquinones. The biosynthesis of anthraquinone shares isochorismate pathway with phenylpropanoid and shares MVA/MEP with sterol and (or) terpenoids. There were 31 coding DNA sequences (CDS) in young and 29 CDS in mature leaf libraries for six enzymes involved in the Mevalonate pathway leading to production of precursor dimethylallyl diphospahate. Dimethylallyl diphospahate is also produced through non-mevalonate pathway (MEP pathway), there were 38 and 34 CDS respectively, in young and mature leaves for eight enzymes involved in the MEP pathway. Biosynthesis of anthraquinone shares isochorismate pathway or shikimate pathway leading to production of the precursor chrorismate which in turn forms a substrate for the production of 1, 4-dihybroxy-2-napthoyl-Co-A, a precursor for anthraquinone production in the menoquinone pathway. There were 64 and 78 CDS, respectively in young and mature leaf libraries encoding for seven enzymes in the shikimate pathway. For four enzymes in menoquinone pathway, identified 14 CDS in young and 22 CDS mature leaf libraries. Anthraquinone are also known to be produced from acetyl co-A and melonyl co-A in the polyketide pathway in plants. Polyketide synthase III is an important enzyme involved in the polyketide pathway. There were two CDS each in young and mature leaf encoding for enzymes involved in polyketide pathway.

Microsatellite markers developed

ICAR - DMAPR, Anand: A total of 66,610 SSRs were identified in 31,010 transcripts using MISA. Among the SSR motifs, hexamers were more frequent (75.23 %) followed by trimers (11.92 %), dimers (5.75 %), tetramer (5.70 %) and pentamers (1.39%). Primers for thirty five SSRs were designed and the PCR revealed amplification in 22 (62 %) markers. These SSRs are highly useful in genetic analysis and molecular breeding of senna.



Amplification of Genic-SSR marker Xcadas11 with 48 germplasm accessions of Senna. M:100bp marker, 1-48: germplasm accessions

Leaf transcriptome data deposited

ICAR - DMAPR, Anand: The raw paired-end DNA sequence data of leaf transcriptome was deposited at National Center for Biotechnology Information (NCBI) as a Short Read Archive (SRA) with accession numbers SRS654537 and SRS654538

Effect of sowing date and spacings on growth, productivity and quality

MPUAT, Udaipur: An experiment was conducted during *kharif,* 2014 with five sowing date (at 26, 28, 30 and 32 and 34 meteorological weeks) and four spacings (40 × 15, 40 × 20, 50 × 15, 50 × 20 cm). Results showed that overall performance of crop during *kharif* season was poor under Udaipur conditions. However, dry leaf yield (412.10 kg ha^{-1}) was highest, when sowing was done at 26th meteorological week at spacing of 40 × 15 cm.

Influence of organic manures and biofertilizer on growth, yield and quality

MPKV, Rahuri: The experiment comprising of six levels of manures and biofertilizers with control (FYM 5 t, vermicompost 2 t, FYM 5 t + vermicompost 2 t, FYM 5 t + PSB 5 kg, vermicompost 2 t + PSB 5 kg, FYM 5 t + vermicompost 2 t + PSB 5 kg ha^{-1}) were conducted during 2011-12, 2012-13, 2013-14 and 2014-15. The results of pooled data basis showed that application of organic manures alone and in combination with biofertilizers significantly influenced the growth and yield of senna. The combined application of FYM 5 t + vermicompost 2 t + PSB 5 kg ha^{-1} recorded highest plant height (88.72 cm) and dry leaf yield (18.23 q ha^{-1}). However, maximum sennoside content (2.52%) was recorded with FYM 5 t + vermicompost 2 t ha^{-1}.

Effect of spacing on growth and yield

MPKV, Rahuri: The experiment was conducted with six levels of spacings (30 × 30, 30 × 45, 45 × 30, 45 × 45, 45 × 60 and 60 × 60 cm) during 2011-12, 2012-13, 2013-14, 2014-15. The results of pooled data basis showed that sowing at 30 × 30 cm recorded maximum plant height (93.25 cm), however, spacing 30 × 45 cm recorded highest leaf yield (12.76 q ha^{-1}) and B:C ratio of (1.75).

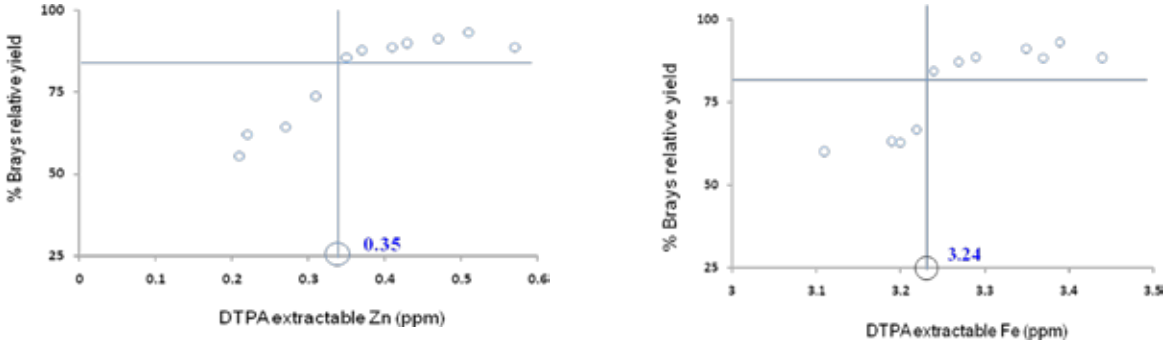
Effect of planting time on growth and yield

MPKV, Rahuri: The experiment was conducted during 2011-12, 2012-13, 2013-14, 2014-15 with five different sowing date (10th June, 20th June, 30th June, 10th July and 20th July). The pooled results of four years revealed that sowing on 10th June recorded maximum plant height (83.85 cm), and leaf yield (14.09 q ha^{-1}) and B:C ratio (1.94) followed by 20th June sowing. It could be concluded that sowing of senna during 10th June to 20th June is recommended for higher marketable yield and maximum B:C ratio.

Critical limit of micronutrients

ICAR - DMAPR, Anand: A pot culture experiment was conducted with soil top collected from different plots of ICAR - DMAPR farm (0-15 cm). Based on the availability of the micronutrients in soil following different micronutrient treatments (Zn: 0 and 5 mg kg^{-1} soil;

Fe: 0 and 5 mg kg-1 soil; Cu: 0 and 2.5 mg kg-1 soil; Mn: 0, and 2.5 mg Kg-1 soil) were applied for pot culture experiment. Herbage yield, sennoside content and leaf micronutrient content were recorded. The critical level of each soil micronutrient was determined by statistical and graphical approaches. Available Zn and Fe content (DTPA extractable Zn and Fe) in soil showed significant and positive correlation with leaf yield as well as Zn and Fe content where as Cu and Mn did not show any specific trend.



Critical level of DTPA extractable Zn and Fe for senna

Management of wilt

MPKV, Rahuri: The bioagents *viz*., *Trichoderma viride*, *Trichoderma harzianum, Pseudomonas fluorescens* and *Bacillus subtilis* alone and their combinations along with FYM were tested against wilt disease caused by *Fusarium oxysporum*. Among the bioagent tested, the seed treatment with *Bacillus subtilis* (5g kg-1 of seed) followed by soil application of *Trichoderma viride* + *Bacillus subtilis* enriched FYM(5g kg-1) recorded lowest wilt incidence (6.02%) against control (17.59%). The above mentioned treatment also reduced the wilt to 65.78% has compared to control.

Estimation of yield loss due to defoliator

MPKV, Rahuri: Field experiments were laid out in paired plot design to find out the yield loss due to defoliator, *catopsilia pyranthe*. The protected plots were given four sprays of chlorpyriphos 20 EC @ 2ml l-1 at 15 days interval. A leaf yield loss of 47 % was calculated due to the infestation of the defoliator.

Estimation of economic threshold level of defoliator

ICAR - DMAPR, Anand: The methods of artificial infestation by different levels of larval densities were followed to establish (ETL) economic threshold levels of defoliator, *Catopsilia pyranthe*. The economic threshold level was worked out at 60 DAS. The different larval densities (0 larvae/ plant, 4 larvae/ plant, 5 larvae/ plant, 6 larvae/ plant, 7 larvae/ plant) were released into caged plants at 60 DAS and were allowed to feed. At harvest (at 120 DAS) the average leaf yield obtained from maximum larval infestation (7 larvae plant-1) is 15.13 g (dry wt) and the control plants (0 larvae /plants) recorded an average dry weight yield of 48.67 g/ plant. The ETL of catopsilia larvae at 60 DAS was found out to be 4.57 larvae per plant.

Management of *Catopsilia pyranthe*

ICAR - DMAPR, Anand: Seven biopesticides (*Metarhizium anisopliae* 1 $\times 10^9$/gm, *Verticillium lecanii*1 $\times 10^9$/gm, *Beauveria bassiana* 1×10^9/gm, azadirachtin 10000ppm, azadirachtin 1500ppm, neem soap, pongamia soap) and chemical check chlorpyriphos 20 EC were evaluated against *Catopsilia pyranthe*. Azadirachtin 10000ppm @5ml l^{-1} was found to be effective (0.05 larvae/plant) against the caterpillar and its efficacy was at par with the chemical check (0 larvae/plant). All the other biopesticides tested were found superior over untreated control(1.29larvae/plant).

Determination of pesticide residues

ICAR - DMAPR, Anand: A simple multi residue was established for the determination of 17 organochlorine (OC), 16 organophosphorous (OP) and 7 synthetic pyrethroid pesticides in Senna. The control samples of senna leaves were spiked with the pesticide mixtures at the fortification level of 0.1 and 1.0 mg Kg^{-1}. The extraction and clean up procedure method based on QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) approach was used for the sample preparation. The method gave very good recoveries for most of the pesticides (70-130%). The proposed method was successfully applied to determine pesticide residues in 12 commercial market samples obtained from different areas in Gujarat, Rajasthan and Madhya Pradesh. None of the samples were found to contain any pesticide residue above the Limit of Quantification.

TULSI (*Ocimum sanctum*)

It is an erect highly branched aromatic perennial herb of family *Lamiaceae*. Two plant types

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

Effect of date of planting and nitrogen levels

RVSKVV, Mandsaur: The experiment comprising five levels of nitrogen (control, 50, 75, 100, 125 kg ha^{-1}) and three dates of planting (30^{th} June, 15^{th} July and 30^{th} July) were conducted. The result showed that highest seed yield was recorded with N 125 kg ha^{-1} (17.5 q ha^{-1})

and planted on 15 July (15.4 q ha^{-1}). Highest herbage yield was also recorded with N 125 kg ha^{-1} (37.6 q ha^{-1}) and planted on 15 July (32.8 q ha^{-1}).

Effect of organic nutrient management on growth and yield

RAU, Pusa: The experiment comprising of five levels of organic manures (control, vermicompost 2.5 t, FYM 8 t, neem cake 0.75 t and mustered cake 0.9 t ha^{-1}) and three levels of biofertilizers (*Azospirillum* 2 kg, PSB 5 kg and PSB 5 kg + *Azospirillum* 2 kg ha^{-1}) were conducted. The application of vermicompost 2 t ha^{-1} inoculated with mixture of PSB 5 kg and *Azospirillum* 2 kg ha^{-1} produced significantly higher herbage yield both on fresh (164.30 q ha^{-1}) and dry weight basis (39.45 q ha^{-1}) and seed yield (22.85 q ha^{-1}).

Effect of planting time and spacing on growth and yield

RAU, Pusa: The experiment comprising of five dates of planting (1st June, 15th June, 1st July, 15th July and 1st August) and three spacings (40 × 20, 40 × 30 and 40 × 40 cm) were conducted. The crop planted on the first July at spacing of 40 × 30 cm recorded maximum fresh (159.65 q ha^{-1}) and dry (38.05 q ha^{-1}) herbage yield.

Screening of germplasm against leaf blight

RVKVV, Mandsaur: Field experiments were laid out to screen germplasms against Cercospora leaf blight. A total of 21 genotypes were tested under field conditions and disease severity was recorded in 0-9 scales. There were no resistant lines reported and lines MOB-8, MOB-11, MOB-13, MOB-14, MOB-16 and MOB-19 were reported as moderately resistant. The susceptible lines reported were MOB-1, MOB-2, MOB-3, MOB-4, MOB-5, MOB-6, MOB-7MOB-9, MOB-10, MOB-12, MOB-15, MOB-17, MOB-18, MOB-20and MOB-21

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 shade 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 about 50,000 ha area. 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 Systems of Medicine 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.

Germplasm collection and maintaince

ICAR - IIHR, Bengaluru: Five land races (IIHR BV 158, IIHR BV 159, IIHR BV 160, IIHR BV 161 and IIHR BV 162) were collected. A total of 109 germplasm including three *Piper* species were maintained.

Germplasm evaluation

ICAR - IIHR, Bengaluru: Eight high yielding clones along with local check (Hirehalli local) were planted in Areca nut garden with a spacing of 2.7 x 0.9 m (4115 vines ha^{-1}) during October 2010. Maximum leaf yield was recorded in IIHR BV 67 (93.87 lakh leaves ha^{-1}) followed by Sirugamani 1 and Mysore local (64.22 and 59.45 lakh leaves ha^{-1}). Hirehalli local recorded lowest leaf yield (19.99 lakhs ha^{-1}) and also lowest number of plagiotropic shoots (25.27).

Jorhat: Four accessions (Apb-23, Apb-24, Apb-25 and Apb26) were collected from different locations of Assam. Twenty six accessions were characterized and evaluated for various agro-morphological traits. Leaf shape of all the germplasms except Apb-2 was invariably cordate type. Apb-2 had leaf of oblong type leaf. Petiole length of the germplasm ranged from 5.20 cm (Apb-14) to 9.37 cm (Apb-8). Longest petiole (9.37cm) was recorded for accession Apb-8, whereas shortest for Apb-14 (5.20cm). Lamina of the leaf of all collections was entire and the leaf tip was found acute type. Leaf length was found maximum in Apb-1 (16.33 cm), whereas minimum length was recorded in Apb-2 (8.10 cm). Highest leaf breadth was recorded in Apb-3 (7.20 cm). Apb-3 recorded maximum length/breadth ratio of 1.61. Internodal length of main shoot was found to be highest in Apb-7 (9.97 cm) and shortest internode was recorded in Apb-11 (4.97 cm).

Flowering Behaviour

ICAR - IIHR, Bengaluru: During 2014-15, flowering was recorded in 50 female clones and 8 male clones. Flowering was not observed in Meetha pan and Kakair. Among hybrids developed, flowering was recorded monthly in four hybrids IIHR Hy 8-43, IIHR Hy 08-64, IIHR Hy 07-1 and IIHR Hy 08-62 and all produced female inflorescence.

Hybridization

ICAR - IIHR, Bengaluru: Ten inter varietal crosses, five crosses between varieties and hybrids, and five interhybrid crosses were made. Fruit setting was observed in all the crosses. Fruits of different crosses were harvested and seeds were germinated. In some crosses seedlings are being established. Seed germination per cent varied from 6.90 to 87.5% among the crosses. Among the interspecific crosses, higher germination was recorded in Simurali Babna/ *Piper colubrinum* (80.33%) followed by Bangla Nagram/*Piper colubrinum* (78.20 %). Highest germination was recorded in cross Hy 06-8 /Hy 06-4 (87.5%) followed by Hy 07-1/Hy 06-4 (82%). The cross Calcutta bangla/CARI-6 and Calcutta bangla/Swarna kapoori recorded 71.42 and 66.6% seed germination, respectively whereas the crosses Mysore Local/Swarna kapoori (6.9%) and CARI 2/ *Piper colubrinum* (7.10 %) recorded lower germination.

Hybrid evaluation under areca nut garden

ICAR - IIHR, Bengaluru: Eight hybrids and four parental lines were field planted under areca nut garden, with a spacing of 100 x 60 cm during July 2009 were being evaluated for different growth and leaf traits. Hy 06-4 hybrid consistently recorded higher leaf yield followed by Hy 06-1, Hy 06-8 and Hy 06-9. In an another set of thirty hybrids which were planted in the field during the year 2010 and 2011, the hybrids Hy 07-37, 07-36 followed by Hy 08-20 consistently recorded higher leaf yields.

Hybrid evaluation under shade net

ICAR - IIHR, Bengaluru: Twenty three hybrids were planted during 2010 under shade net house (simulating bareja conditions) were evaluated for growth and yield. Higher leaf per vine was recorded in Hy 08-52 (145.50), Hy 06-4 (107.08), Hy 06-1 (105.17) and Hy 06-11 (100.67). In another trial thirty six hybrids planted during 2011 were evaluated for growth and yield traits under shade net conditions. Leaf yield per vine varied from 26 to 96 leaves vine^{-1}. Hy 07-25 and Hy 07-36 recorded higher leaf yield per vine (96 and 88 leaves vine^{-1} respectively) followed by Hy 08-58 (78.25), Hy 07-37(77.25), Hy 07-24 (63.75) and Hy 07-41 (63.35).

Effect of zinc sulphate on productivity

RAU, Islampur: The experiment was conducted with six levels of $ZnSO_4$ (control, 10, 15, 20, 25 and 30 kg ha^{-1}). The soil application of zinc sulphate 30 kg ha^{-1} produced maximum yield of marketable leaves vine^{-1} (75), number of lateral branches vine^{-1} (5.2) and length of vine (185 cm) as compared to control. Whereas, the maximum fresh weight of 100 leaves were recorded in control and reduced with the application of $ZnSO_4$.

Management of leaf rot and leaf spot

BRS, Islampur: Field experiments were conducted to evaluate different fungicides against *Phytophthora* leaf rot and Anthracnose leaf. For *Phytophthora* leaf spot, two sprays of metalaxyl (8%) + mancozeb (64% WP) at 15 days of interval reduced the disease severity to 74.3 per cent. For anthracnose leaf spot, each fungicide treatment was sprayed at two weeks interval when PDI varied between (13.0 to 22.0%) under natural conditions at the 4th week November. The treatment carbendazim (12%) + mancozeb (63%) at 0.2% concentration significantly reduced the disease severity to 70.6% .

Integrated disease management

BAU, Islampur: Field experiments were conducted to evaluate different integrated management practices for the control of different fungal and bacterial diseases (*Phytophthora* foot rot, sclerotium wilt and bacterial leaf spot) of betel vine. The results showed that sanitation + soil drenching with Bordeaux mixture (1%) before planting and 60 days after planting was significantly superior and reduced the disease incidence by 76.1%, 83.3% and 74.9% respectively.

Survey on diseases of Magahi betel

BAU, Islampur: Survey was conducted for identification of most severe diseases in magahi betel growing regions of Nalanda, Nawada, Gaya and Aurangabad districts in Bihar. During the survey, *Phytophthora* foot-rot and *Phytophthora* leaf rot were found as most severe with 38.5 % and 33.3 % disease incidence and other diseases recorded were Anthracnose leaf spot (27.8%), bacterial leaf spot (21.8%) and *Sclerotium* wilt (6.3%).

Demonstration of IDM technology on farmer's field

MPKV, Rahuri: The demonstration trials on impact of disease management technology developed by the centre (field sanitation + first application of 1 % Bordeaux mixture at pre-monsoon stage + Application of *Trichoderma* plus @ 12.5kg/ha one month after application of 1% Bordeaux mixture+ Second application of 1 % Bordeaux mixture two months after first application + application of RDF 200:100:100 kg NPK/ha (nitrogen in 4 splits through organic form) were conducted at 15 locations on farmer's fields in tahsils of Shrirampur, Shrigonda, Jamkhed and Indapur in Maharashtra. The fresh weight of leaves from the technology adopted fields ranged from 298 to 347 g/100 leaves whereas in farmers practice it ranged from 268 to 318 g/100 leaves. The total yield of betel ranged from 670 to 780 dags/ ha in technology adopted fields as against 506 to 584 dags/ha in farmers practice The wilt disease incidence ranged from 3.10 to 7.53 % in technology adopted fields where as in farmers practice it ranged between 6.58 to 19.39%.

BCKV, Kalyani: The demonstration trials on impact of disease management technology developed by the centre (field sanitation + first application of 1 % Bordeaux mixture at pre-monsoon stage + application of *Trichoderma* plus @ 12.5kg/ha one month after application of 1% Bordeaux mixture+ second application of 1 % Bordeaux mixture two months after first application) were conducted in ten farmer's pan barojs at Simurali, Nadia covering an area of 150 sq M for each baroj consisting of 30 independent rows and with two treatments *i*.e. IDM technology and farmers practice. The per cent vine death varied from 10.75 % to 22.38 % in farmers practice whereas it was only up to 6.52 % in IDM technology adopted fields. The maximum yield recorded in IDM technology adopted field was 45.24 lakh leaves/ha/year where as in farmer's field it was around 39.22 lakh leaves/ha/year.

RAU, Pusa: The ICM/IDM technology of Betel vine cultivation developed by centre was tested on 30 farmers, field at 7-different locations in 4- different districts-Samastipur, Vaishali, Darbhanga and Begusarai districts of Bihar. The crop performance under ICM/IDM practice was found superior at all locations with maximum marketable yield (40.5lakh leaves /ha). The betel leaves in ICM/IDM practice also recorded longer shelf life (15-16 days). The crop under ill managed condition (Farmers practice) registered lower yield (maximum-22.5lakh leaves/ha) with higher incidence of Phytophthora rot (up to 30.5 %) and shorter shelf life (10-12 days).

Screening of hybrid lines against diseases

BCKV, Kalyani: Twenty hybrid lines were screened for their resistance against diseases. Majority of the lines screened were prone to different diseases. Highest (13%) vine mortality

due to foot rot was recorded in PBH- 07-1 and PBH-07-9. The leaf diseases (leaf rot and leaf spot) were recorded maximum during the month of October. The PDI of leaf rot caused by *Phytophthora* ranged from 2.82 (GN-1 Hybrid) to 5.20 (PBH-06-9). The PDI of leaf spot ranged from 4.02 (PBH-08-45) to 7.89 (PBH-06-10).

Survey of the impact assessment of the IDM technology

BCKV, Kalyani: A survey was conducted to assess the impact of disease management technology taking 180 farmers in nearby places where the demonstrations had been conducted. Results of the survey revealed that about 35% farmers had adopted the technology developed by AICRP - MAPB. However, 17.22% and 5.00% of farmers were either used only *Trichoderma* sp. or Bordeaux mixture respectively. Whereas, 26.67% of the populations use only fungicides (other than Bordeaux mixture) available in the local market and 16.11% populations did not use any inputs in betelvine cultivation.

Differential susceptibility of hybrid lines against *Aleyrordid* flies

BCKV, Kalyani: Twenty hybrid lines were evaluated for their susceptibility against aleyrordid flies. Among the lines, PBH-06-1, PBH- 06-4, PBH- 07-4, PBH- 07-10 recorded less than 15 flies vine^{-1}. PBH- 06-3 harboured lowest number of whiteflies (10.6 flies vine^{-1}) where as PBH- 06-8 recorded, the maximum number (23.5 flies vine^{-1}) of *Aleyrordid* flies.

Knowledge Management Unit

Institute website

The institute website (www.dmapr.org.in) was maintained. Tenders, recruitments, publications, news items and photographs were updated on daily basis.

Intranet website

The intranet website was maintained and updated information related to circulars, applications forms, documents and other related information on daily basis for sharing of information from the staff.

Strengthening of Herbal garden Network

A web portal on network of herbal gardens of India has been created at the ICAR-Directorate of Medicinal and Aromatic Plants Research (DMAPR) and it is being maintained and updated regularly. The web portal named "www.herbalgardenindia.org" is useful for researchers to collect and disseminate information on availability of planting material of medicinal plants from various herbal gardens located in India. It also facilitates exchange of planting material among the members of herbal gardens as well as others who desire to have thus ensuring quality planting material supply of these plants. At present a total of 117 herbal gardens across the country registered as members with access to 1500 medicinal plants.

Plant Genetic Resources

Inventory of Registered Germplasm of Medicinal Plants

GILO (*Tinospora cordifolia*)

1 **INGR 06025**

Year : 2006

Trait: High starch containing clone (13.32%)

2 **INGR 04114**

Year : 2006

Trait: Fleshy roots are short (<10 cm) with blunt end and light colour, individual fleshy roots are arranged in wide angles from the axis (diverged type) & with excellent storage quality.

MANDUKAPARNI (*Centella asiatica*)

1 **INGR 08105**

Year: 2009

Trait: Morphtype with high leaf area & high asiaticoside (1.62%).

MADHUNASHINI (*Gymnema sylvestre*)

1 **INGR 13041**

Year : 2013

Trait: A high fruit producing and leaf yielding

SAFED MUSLI (*Chlorophytum borivilianum*)

1 **INGR 04113**

Year : 2005

Trait: Fleshy roots are long (>10 cm) with blunt end and dark colour, individual fleshy roots are arranged compactly in the bunch (converged type)

By

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Dr. R.Nagaraja Reddy, Smt. Subhadra H. Nair

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Germplasm of medicinal and aromatic plants being maintained at ICAR - DMAPR, Anand

Sl. No.	Species	Number of Accessions
1.	*Aloe spp.* (Aloe)	55
2.	*Andrographis paniculata* (Kalmegh)	60
3.	*Asparagus spp.* (Shatavari)	88
4.	*Cassia angustifolia* (Senna)	256
5.	*Chlorophytum borivilianum* (Safed Musli)	54
6.	*Commiphora spp* (Guggal)	225
7.	*Cymbopogon martinii* (Pamarosa)	07
8.	*Desmodium gangeticum* (Salaparni)	52
9.	*Gymnema sylvestre* (Gudmar)	43
10.	*Plantago spp.* (Isabgol)	91
11.	*Tinospora cordifolia* (Giloe)	52
12.	*Withania somnifera* (Ashwagandha)	142
	TOTAL	**1125**

Status of germplasm being maintained at AICRP - MAPB centres

Crop	Centre	No. of accessions
Aloe (*Aloe barbadensis*)	AAU, Anand	30
	CCSHAU, Hisar	42
	IIHR, Bangalore	42
	NDUAT, Faizabad	24
	PDKV, Akola	17
	IGKV, Raipur	14
	RVSKVV, Mandsaur	10
Atis (*Aconitum heterophyllum*)	YSPUHF, Solan	20
Ashoka (*Saraca asoca*)	KAU, Thrissur	42
Asalio (*Lepidium sativum)*	AAU, Anand	20
	CCSHAU, Hisar	38
	RVSKVV, Mandsaur	40
	MPUAT, Udaipur	15
Ashwagandha (*Withania somnifera*)	AAU, Anand	80
	CCSHAU, Hisar	78
	IIHR, Bangalore	186
	RVSKVV, Mandsaur	68
	MPUAT, Udaipur	74
	IGKV, Raipur	44
	BCKV, Kalyani	02
Artemisia (*Artemisia annua*)	AAU, Anand	1
Bach (*Acorus calamus*)	TNAU, Coimbatore	13
	YSRHU, Venkataramanagudem	45
	AAU, Jorhat	22
Ban kakdi (*Podophyllym hexandrum*)	YSPUHF, Solan	12
Bitter snakegourd (*Tricosanthus cucumarina*)	KAU, Thrissur	19
Brahmi (*Bacopa monnieri*)	KAU, Thrissur	43
	RAU, Pusa	14
Chitrak (*Plumbago* spp)	KAU, Thrissur	25
	TNAU, Coimbatore	45
Chirayita (*Swertia chirayita)*	UBKV, Kalimpong	28
Dodi (*Leptadena reticulata*)	AAU, Anand	01
Giloe (*Tinospora cordifolia*)	AAU, Anand	07
	BCKV, Kalyani	05
	YSRHU, Venkataramannagudem	13
	CCSHAU, Hisar	20
Gudmar (*Gymnema Sylvestre*)	JNKVV, Jabalpur	7

Guggal (*Commiphora wightii*)	AAU, Anand	26
	MPUAT, Udaipur	16
Henbane (*Hyoscyamus niger*)	AAU, Anand	5
Indian valeriana (*Valeriana jatamansi*)	UBKV, Kalimpong	09
Isabgol (*Plantago ovata*)	AAU, Anand	55
	CCSHAU, Hisar	93
	MPUAT, Udaipur	31
	NDUAT, Faizabad	42
	RVSKVV, Mandsaur	80
Kalmegh (*Andrographis panicualata)*	AAU, Anand	51
	CCSHAU, Hisar	13
	NDUAT, Faizabad	20
	OUAT, Bhubaneshwar	14
	IGKV, Raipur	257
	BCKV, Kalyani	4
Kasni (*Cichorium intybus*)	HAU, Hisar	20
Kuth (*Picrorhiza kurroa*)	YSPUHF, Solan	20
Lemongrass (*Cymbopogon* spp.*)*	CCSHAU, Hisar	46
	KAU, Thrissur	20
	NDUAT, Faizabad	16
Long pepper (*Piper longum*)	KAU, Thrissur	25
	AAU, Jorhat	35
	OUAT, Bhubaneshwar	9
	BCKV, Kalyani	4
Lotus (*Nelumbo nucifera*)	KAU, Thrissur	24
Liquorice (*Glycyrrhiza glabra*)	AAU, Anand	1
Makoi (*Solanum nigrum*)	YSRHU, Venkataramannagudem	46
	TNAU, Coimbatore	52
	AAU, Anand	6
Mandukaparni (*Centella asiatica*)	AAU, Jorhat	20
	RAU, Pusa	12
	UBKV, Kalimpong	10
	BCKV, Kalyani	5
Mucuna (*Mucuna pruriens*)	AAU, Anand	20
	BAU, Ranchi	10
	IIHR, Bangalore	102
Mentha species	AAU, Anand	5
Pakhanbhed (*Berginia ciliata*)	UBKV, Kalimpong	10
Neel (*Indigofera artinia)*	KAU, Thrissur	22

Opium poppy (*Papaver somniferum*)	NDUAT, Faizabad	41
	MPUAT, Udaipur	85
	RVSKVV, Mandsaur	110
Palmarosa (*Cymbopogon artini*)	CCSHAU, Hisar	65
Periwinkle (*Catharanthus roseus*)	AAU, Anand	6
Salaparni (*Desmodium gangeticum*)	KAU, Thrissur	25
Safedmusli *Chlorophytum borivilianum*)	AAU, Anand	21
	CCSHAU, Hisar	12
	MPUAT, Udaipur	10
	RVSKVV, Mandsaur	24
	PDKV, Akola	13
Sarpgandha (*Rauvolfia serpentina*)	OUAT, Bhubaneshwar	35
	IGKV, Raipur	12
Shatavari (*Asparagus racemosus*)	CCSHAU, Hisar	24
	AAU, Anand	6
	JNKVV, Jabalpur	14
	MPKV, Rahuri	11
	NDUAT, Faizabad	24
Sankpusphi (*Convolvulus microphyllus*)	AAU, Anand	1
Senna (*Cassia angustifolia*)	AAU, Anand	17
Sylibum (*Silybum marianum)*	AAU, Anand	10
Tulsi (*Ocimum sanctum*)	CCSHAU, Hisar	12
	AAU, Anand	3
Tagetes (*Tagetes minuta*)	YSPUHF, Solan	32
Vetiver (*Vetiveria zizaniodes*)	CCSHAU, Hisar	50
	KAU, Thrissur	37
	NDUAT, Faizabad	12
	TOTAL	**3205**

Germplasm of Betelvine being maintained at AICRP MAPB centres

Centres	Total collection
AAU, Jorhat	26
BAU, Islampur	10
BCKV, Kalyani	42
ICAR-IIHR, Bengaluru	118
MPKV, Rahuri	28
OUAT, Bhubaneshwar	21
RAU, Pusa	10
YSRHU, Venkataramannagudem	64
TOTAL	**319**

General Information

ICAR - DMAPR accredited with ISO 9001: 2008 certification

Bureau Veritas, London, awarded ISO 9001: 2008 certificate to the Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand for research and allied services related to medicinal and aromatic crops, with effective from April 30, 2014.

Committee meetings

Research Advisory Committee meeting

The XII Research Advisory Committee (RAC) meeting of the Directorate was held at ICAR - DMAPR, Anand under the chairmanship of Dr. S. B. Dandin, Formerly, Vice Chancellor, University of Horticultural Sciences, Bagalkot, Karnataka during July 10-11, 2014. The members of RAC namely Dr. K. C. Dalal, Former Director, NRCMAP and Head, Medicinal Plant Unit, AAU, Anand, Dr. S. K. Pareek, Former Principal Scientist, ICAR - NBPGR, New Delh, Dr. A.N. Ganeshamurthy, Head, Division of Soil Science and Agricultural Chemistry, ICAR - IIHR, Bangalore and Shri S. N. Tyagi, Joint Managing Director, GFDC Ltd. Vadodara also attended the meeting. The research activities carried out at the Directorate during the year 2013-14 were thoroughly discussed and also future research activities of the Directorate were meticulously planned in the meeting.

XXII Annual Group Meeting AICRP - MAPB

The XXII Annual Group Meeting of AICRP-MAPB was held at ICAR-IIHR, Bengaluru during September 17-20, 2014. The meeting was inagurated by Dr. S. K. Malhotra, Assistant Director General (Hort. Sci.), ICAR, New Delhi. Dr. M. L. Maheshwar, Vice Chancellor, University of Horticultural Sciences (UHS), Bagalkot was the Chief Guest. Dr. Malhotra, in his inaugural address, highlighted the importance of medicinal and aromatic plants for horticulture diversification and primary healthcare. He appreciated the achievements of the project and appraised the need for midterm review of the project.

During the workshop, various research activities under AICRP–MAPB related to plant genetic resource management, crop improvement, crop production, crop protection and phytochemistry were reviewed and technical programmes for the next year were formulated. The plenary session of the workshop was chaired by Dr. N. K. Krishnakumar, Deputy Director General (Hort. Sci.), ICAR. He emphasized the need for prioritization of research on medicinal and aromatic plants in accordance with the emerging issues in this sector.

Institute Research Committee meeting

Institute Research Committee meeting of the Directorate was held under the chaimanship of the Director, ICAR - DMAPR during October 10-11, 2014 and on March 30, 2015.

Extension activities

Training on "Promotion of medicinal plants cultivation in tribal areas of Gujarat for livelihood and health security" under Tribal Sub Plan

A 3-day training programme on "Promotion of medicinal plants cultivation in tribal areas of Gujarat for livelihood and health security" was organized during August 5-7, 2014 at KVK, Dediyapada, Narmada under Tribal Sub Plan (TSP). In the training programme, different aspects of medicinal and aromatic crops cultivation such as agronomic practices, farmers' rights, medicinal plants of Gujarat, ethnomedicinal uses of medicinal plants, IPM in homestead garden were covered in lectures. Seed, planting material and farm implements were also distributed to the beneficiary under TSP.

Successful cultivation of Kalmegh by tribal farmers'- a success story

ICAR - DMAPR, Anand initiated TSP in the areas of Godhra district in the year 2013-14 with the aim of creating awareness and training on MAP cultivation . Seed, planting material and farm implements were also distributed to the beneficiaries. Some of the innovative farmers selected Kalmegh (*Andrographis paniculata*) for large scale cultivation with seedlings and technological support from the Directorate. Six tribal farmers had taken-up the cultivation of Kalmegh.

Training on "Good Agricultural and Collection Practices (GACP) for Medicinal and Aromatic Plants" under NEH plan

A one day training on "Good Agricultural and Collection Practices (GACP) for Medicinal and Aromatic Plants" was organized on February 27, 2015 at Department of Horticulture, School of Agriculture Sciences and Rural Development, Nagaland University, Medziphema Campus, Nagaland. More than 100 participants including farmers, staff of KVK, forest department and Universities attended the programme. The Director, ICAR-DMAPR addressed the participants and highlighted

the need of cultivation as well as conservation of medicinal plants. He specially stressed the concerns and opportunities of medicinal plants in the North-eastern regions. Dr. R.S. Jat, Senior Scientist (Agronomy), delivered a lecture on "Good agricultural and collection practices for medicinal and aromatic plants cultivation".

Other activities

Plantation Day Celebration

Plantation Day was celebrated by the Directorate on July 24, 2014. Mr. Sunil M. Patel, IAS, District Development Officer, Anand was Chief Guest of the function. On this occasion, staff members of the Directorate participated enthusiastically and planted Neem trees in the residential complex of the Directorate.

Swachchh Bharat Campaign

In consonance with the call of Hon'ble Prime Minister, the "Swachchh Bharat Mission" was launched at the Directorate on October 02, 2014. The mission began with the cleanliness drive in the campus by the Director and the staff members. All the staff members of the Directorate participated in this mission with great enthusisasm.

Vigilance Awareness Week

Vigilance Awareness Week was observed at the Directorate during October 27 - November 01, 2014. The week began with administration of the PLEDGE by Dr. Jitendra Kumar, Director, ICAR - DMAPR, Anand. In order to create awareness posters and banners on anti-corruption aspects were exhibited in the office and all files relating to purchases and procurement at ICAR - DMAPR were made available to public for scrutiny during the entire week. A workshop on "Combating Corruption-Technology as an enabler" was organised on November 01, 2014.

23rd Foundation day

The 23rd Foundation day of the ICAR - DMAPR was celebrated on 24th November, 2014. Dr. Pawan Kumar Agrawal, Assistant Director-General (NASF), ICAR was the Chief Guest. Dr. K.C. Dalal, Formerly, Director, NRCMAP, Anand was the Special Guest and Dr. N. C. Patel, Vice-Chancellor, Anand Agricultural University, Anand presided over the function.

At the outset, Dr. Jitendra Kumar, Director, ICAR - DMAPR, Anand welcomed the chief guest and other dignitaries. He also presented the brief achievements, growth and progress of the Directorate. Dr. K. C. Dalal, in his address appreciated the Directorate's research work and its fast progress. He suggested the need for eco friendly technologies for the MAP cultivation. Dr. P. K. Agrawal, in his address said there is need for enhancing the quality of raw drugs of MAP through appropriate good agricultural practices. He emphasized the need to move from products with precise information regarding nutrients, active ingredients, value addition, storage and delivery system. There is also need to utilize the parts of medicinal plants for different purposes. Dr. Patel in his presidential address emphasized upon the need for developing a linkage between MAP growers, processors and end users. He opined the need for mechanization and entrepreneurship in MAP cultivation for enhancement and productivity. Six progressive medicinal plant growers from the tribal areas of Panchamahal district of Gujarat were also felicitated on this occasion.

Showcasing of Directorate's technology

Date	Venue
January 07-13, 2015	Vibrant Gujarat Summit at Mahatma Mandir, Gandhinagar, Gujarat
February 09, 2015	Shastri Maidan, Anand, Gujarat
February 19-22,, 2015	Eastern Zone Regional Agricultural Fair at ICAR- CPRI, Regional Station, Patna, (Best Exhibition Stall Award)
February 21-22, 2015	17th Agricultural Scientists and Farmers' Congress at Bioved Research Institute of Agriculture and Technology, Allahabad
March 10-12, 2015	Pusa Krishi Vigyan Mela at ICAR- IARI, New Delhi (Best Exhibition Stall Award)

Dr. Sanjeev Kumar Balyan, Minister of State, Agriculture & Food Processing Industries conferring Award at Krishi Vigyan Mela, ICAR - IARI, New Delhi

ICAR - DMAPR Exhibition Stall at Krishi Vigyan Mela, ICAR - IARI, New Delhi

Superannuation

Dr. Satyabrata Maiti, Director, Directorate of Medicinal and Aromatic Plants Research and Project Coordinator, All India Coordinated Research Project on Medicinal and Aromatic Plants & Betelvine got superannuated on April 29, 2014.

Transfer

1. Dr. Vanita Navnath Salunkhe, Scientist (Plant Pathology) was transferred to ICAR-Directorate of Onion & Garlic Research, Pune, on April 19, 2014.
2. Dr. Vinay Kumar, Scientist (Biotechnology) was transferred to ICAR - National BISM, Raipur on July 05, 2014
3. Dr. Ruchi Bansal, Scientist (Plant Physiology) was transferred to ICAR- National Bureau of Plant Genetic Resources, New Delhi on November 01, 2014

भाकृअनुप – औषधीय एवं सगंधीय पादप अनुसंधान निदेशालय, आणंद

हिन्दी चेतना सप्ताह

निदेशालय की राजभाषा कार्यान्वयन समिति के तत्वाधान में १५-२२ सितंबर, २०१४ के दौरान हिन्दी सप्ताह हर्षोल्लास से मनाया गया, जिसके अन्तर्गत हिन्दी के प्रयोग को बढावा देने हेतु अनेक रुचिकर कार्यक्रमों का आयोजन किया गया। इस दौरान हिन्दी निबंध, पत्र लेखन, सामान्य हिन्दी (हिन्दी संबंधित ज्ञान हेतु), सामान्य ज्ञान, व्याख्यान व काव्यपाठ प्रतियोगितायें आयोजित की गई।

कार्यक्रम के प्रारंभ में निदेशक व सत्र के सभापति डॉ. जितेन्द्र कुमार ने मुख्य अतिथि को गुलदस्ता भेंट कर स्वागत किया, तत्पश्चात राजभाषा कार्यान्वयन समिति के सदस्य सचिव एवं हिन्दी अधिकारी, डॉ. वंदना त्रिपाठी ने अपने स्वागतीय भाषण में मुख्य अतिथि महोदय का स्वागत करते हुए उनका लघु जीवन चित्रण सभा के समक्ष प्रस्तुत किया। उन्होंने डॉ. एस. अय्प्पन, सचिव, कृषि अनुसंधान एवं शिक्षा विभाग तथा महानिदेशक, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली की अपील भी सभा के समक्ष प्रस्तुत की, जिसमें महानिदेशक महोदय ने सरकारी कामकाज में हिन्दी का अधिक से अधिक प्रयोग करने का संकल्प लेने को कहा। स्वागतीय भाषण के पश्चात व्याख्यान व काव्यपाठ प्रतियोगिताओं का आयोजन किया गया जिनका संचालन व मूल्यांकन मुख्य अतिथि महोदय ने किया। सभी प्रतियोगिताओं में प्रथम व द्वितीय रहे प्रतिभागियों को प्रशस्ति पत्र एवं प्रोत्साहन पुरस्कार मुख्य अतिथि महोदय के कर कमलों द्वारा प्रदान किये गए। पुरस्कार वितरण समारोह के उपरान्त मुख्य अतिथि महोदय ने हिन्दी के प्रचार-प्रसार के संबंध में अपने विचार प्रकट किए। उन्होंने हिन्दी के प्रति अपने रुझान के बारे में बताया व हिन्दी के सरल शब्दों का प्रयोग को बढावा देने को कहा, जिससे सरकारी कामकाज करने मे आसानी हो। निदेशालय के निदेशक तथा सत्र के सभापति डॉ. जितेन्द्र कुमार ने हिन्दी की महत्ता को बताते हुए निदेशालय के दैनिक कामकाज में हिन्दी को अधिक बढ़ावा देने पर बल दिया।

हिन्दी सप्ताह का समापन समारोह २२ सितंबर, २०१४ को मनाया गया। इस अवसर पर श्री अशोक कुमार श्रीवास्तव, उपमंण्डल अभियंता (मार्केटिंग), भारत संचार निगम लिमिटेड, आणंद को मुख्य अतिथि के रूप में आमंतित्र किया गया। निदेशालय के निदेशक एवं राजभाषा कार्यान्वयन समिति के अध्यक्ष डॉ. जितेन्द्र कुमार ने समापन समारोह सत्र की अध्यक्षता की।

समारोह का संचालन डॉ. जी. आर. स्मिता द्वारा किया गया तथा समारोह का समापन डॉ. तानिया सारा वर्गिस द्वारा धन्यवाद ज्ञापन से हुआ जिसमें उन्होंने आगन्तुक अतिथि, निदेशालय के निदेशक, हिन्दी समिति सदस्यों, विभिन्न प्रतियोगिताओं के प्रतिभागी, कार्यक्रम में सहयोगीजनों, सभी कर्मचारीगण जिन्होंने परोक्ष व अपरोक्ष रुप से अपना सहयोग दे कर इस कार्यक्रम को सफल बनाया, उन सबका आभार व्यक्त किया।

भाकृअनुप – औषधीय एवं सगंधीय पादप अनुसंधान निदेशालय, बोरीआवी – ३८७३१० आणंद (गुजरात)
हिन्दी कार्याशाला

औषधीय एवं सगंधीय पादप अनुसंधान निदेशालय, आणंद में ''सरकारी कामकाज में हिन्दी का व्यवहारिक प्रयोग'' विषय

पर २८ जनवरी, २०१५ को हिन्दी कार्यशाला का आयोजन किया गया। जिसमें हमारे निदेशालय सहित भारतीय कृषि अनुसंधान परिषद के गुज रात स्थित अन्य संस्थानों, क्षेत्रीय अनुसंधान केन्द्र, कार्यशाला के उद्घाटन सत्र में संस्थान की हिन्दी अधिकारी डॉ. वंदना त्रिपाठी ने सभी उपस्थित प्रतिभागियों का स्वागत किया। निदेशालय के निदेशक डॉ. जितेन्द्र कुमार ने मुख्य अतिथि श्री दुर्गा सिंह, प्रधानाचार्य, केन्द्रीय विद्यालय, विद्यानगर, आणंद का फूलों के गुलदस्ता द्वारा स्वागत किया। तत्पश्चात मुख्य अतिथि महोदय ने अपने भाषण में कहा कि हिन्दी भाषा की लोकप्रियता देश में ही नहीं अपितु विदेशों में भी फैल रही है। निदेशालय के निदेशक महोदय ने हिन्दी के प्रयोग पर बल देते हुए कहा कि हिन्दी कार्यशाला या हिन्दी दिवस को केवल उत्सव की तरह ही नहीं लेना चाहिए। बल्कि सरकारी कार्य में हिन्दी का प्रयोग बढाना चाहिये। हमें हिन्दी को दैनिक कार्यों में प्रयोग लाना चाहिए। जिससे कार्यालय के हिन्दी कामकाज में बढ़ोत्तरी हो सके तथा अनुसंधान कार्य हिन्दी तथा स्थानीय भाषाओं के माध्यम द्वारा किसानों तक पहुँच सके। उदघाटन सत्र के अंत में वैज्ञानिक, डॉ. स्मिता जी. आर. ने मुख्य अतिथि महोदय को धन्यवाद ज्ञापित किया।

केन्द्रीय मृदा एवं जल संरक्षण अनुसंधान एवं प्रशिक्षण संस्थान, वासद केन्द्रीय बागवानी परीक्षण केन्द्र, गोधरा क्षेत्रीय अनुसंधान केन्द्र, केन्द्रीय मीठाजल जीव पालन संस्थान, आणंद के लगभग ९० प्रतिनिधियों ने भाग लिया। इस कार्यशाला में डॉ. नवनीत चौहान, अध्यक्ष एवं प्रोफेसर (हिन्दी विभाग) सरदार पटेल विश्वविद्यालय, विद्यानगर, आणंद एवं डॉ. कनकलता, योजना समन्वय, केवीके, वेजलपुर, पंचमहल प्रमुख वक्ता थे।

कार्याशाला के प्रथम सत्र में मुख्य वक्ता डॉ. कनकलता ने हिन्दी के उपयोग में झिझक होने के कारणों पर रौशनी डाली और उनके निवारण भी बताए।

कार्याशाला के द्वितीय सत्र में मुख्य वक्ता डॉ. नवनीत चौहान, अध्यक्ष एवं प्रोफेसर (हिन्दी विभाग) सरदार पटेल विश्वविद्यालय, विद्यानगर, आणंद, गुजरात ने हिन्दी को भारत की संपर्क भाषा के रूप में परिभाषित करते हुए बताया कि भाषा हमेशा समाज के साथ जुड़कर चलती है। उन्होंने यह भी बताया कि भाषा जितनी सरल होती है उसकी लोकप्रियता उतनी ही बढ़ती है, इसलिए हमें हिन्दी को सहज और सरल रूप में स्वीकार करना चाहिए।

भोजन के पश्चात कार्यशाला के तृतीय सत्र में वाद-विवाद प्रतियोगिता ''स्वच्छता अभियान का प्रभाव'' विषय पर अनेक प्रतिभागियों ने भाग लिया एवं पक्ष-विपक्ष दोनों पर अपने विचार व्यक्त किए।

समापन सत्र में निदेशक महोदय एवं दोनों मुख्य वक्ताओं द्वारा प्रतियोगिता में विजेता रहे प्रतिभागियों को पुरस्कृत किया गया। कार्यक्रम के अंत में निदेशालय के वैज्ञानिक डॉ. तानिया सारा वर्गिस ने धन्यवाद ज्ञापन प्रस्तुत किया तथा राष्ट्रीय गान के साथ कार्याशाला का समापन हुआ।

Distinguished Visitors

- Dr. N. K. Krishna Kumar, DDG (Hort. Sci.), ICAR, New Delhi on April 25, 2014 and September13, 2014
- Dr. M. M. Roy, Director, ICAR-CAZRI, Jodhpur on August 13, 2014
- Dr. P. K. Mishra, Director, ICAR-CS&WCR&TI, Dehradun on September 4, 2014
- Dr. Arvind Kumar, DDG (Agril. Education), ICAR, New Delhi on September 13, 2014
- Prof. K. C. Bansal, Director, ICAR-NBPGR, New Delhi on September 13, 2014
- Dr. A. Bandopadhyay, Former National Coordinator, NFBSFARA, ICAR, New Delhi on October 10-11, 2014
- Dr. N. C. Patel, Vice Chancellor, AAU, Anand on November 24, 2014
- Dr. P. K. Agrawal, ADG (NASF), ICAR, New Delhi on November 24, 2014
- Dr. K. C. Dalal, Formerly Director, NRCMAP, Boriavi on May 25, 2014 and November 24, 2014
- Dr. S. Dam Roy, Director, ICAR-CIARI, Port Blair on December 26, 2014
- Dr. R. S. Paroda, Chairman TAAS, New Delhi, Formerly Secretary (DARE) & DG (ICAR) and on January 28, 2015

Deputations/ meetings attended by the Director

Dr. P. Manivel, Acting Director

- Attended a Brain Storming Workshop on work plan of the Centre of Excellence on Medicinal and Aromatic Plants and Non Timber Forest Produce at IGKV, Raipur on May 11, 2014.
- Attended H-PGR meeting with the DDG (Horticultural Science) at IIHR, Bengaluru on May 30, 2014.
- Attended EFC meeting at ICAR, New Delhi during July 09-10, 2014.
- Attended the Directors and Vice Chancellors meet at NASC, New Delhi during July 29-30, 2014
- Participated in TSP programme at KVK, Godhra on August 8, 2014

Dr. Jitendra Kumar, Director

- Participated in interaction meeting with the Director General, FAO at NASC, New Delhi on September 8, 2014.
- Attended the meeting of Board of Management at Junagadh Agricultural University, Junagadh as the ICAR Representative on November 21, 2014.

- Attended the National Research Advisory Committee Meeting of National Innovation Foundation – India at CSIR Science Center, New Delhi on December 3, 2014. Participated in the Silver Jubilee Symposium of National Academy of Agricultural Sciences at NAAS Complex, New Delhi during December 26-27, 2014.
- Attended the third meeting of the Ayurveda Sectional Committee, FAD-26 at Bureau of Indian Standards, New Delhi on December 29, 2014.
- Participated in the 12th Agricultural Science Congress (ASC) at NDRI, Karnal during February 3-6, 2015.
- Attended the National Workshop on "Sustainable Development of Medicinal Plants Sector in North Eastern India" at Imphal during 16-17 February, 2015.
- Attended the Regional Agricultural Fair at CPRS, Patna during 19-21 February, 2015.
- Attended the 17th Indian Agricultural Scientists and Farmers' Congress on"Agri-Innovation for Enhancing Production & Rural Employment'' at Bioved Research Institute of Agriculture and Technology, Allahabad on February 22, 2015.
- Attended the National Seminar on "Sustainable Horticulture vis-à-vis changing Environment" at SASRD: Nagaland University, Medziphema, Dimapur, Nagaland during February 26-28, 2015.
- Attended the Research Advisory Committee meeting at NRCSS, Ajmer during March 2-3, 2015.

Training and Capacity Building

Training and Seminar/Symposium attended

Name	Details	Date
Trainings		
Dr. Jitendra Kumar	Executive Development Programme (EDP on Leadership Development) at ICAR-National Academy of Agricultural Research, Hyderabad	January 19-23, 2015
Dr. V. Thondaiman	Three months Professional Attachment Training at Department of Forest Products, Dr. Yashwant Singh Parmer University of Horticulture and Forestry, Solan	May 12–August 10, 2014
Dr. Vandana Tripathy	Participated in the Department of Science and Technology sponsored training programme on, "Leadership and career Development for Women Scientists" at Indian National Science Academy (INSA), New Delhi	September 1-5, 2014
Dr. Hemlata Bharti	Professional attachment training at CSIR-CIMAP, Lucknow	November 27–February 27, 2015
Mr. Akula Chinapolaiah	Professional attachment training at ICAR-IIHR, Bengaluru	November 28–February 28, 2015
Dr. Raghuraj Singh	ICAR Winter School on 'Application of sensors, nano-sensors, wireless sensor network and instrumentation in Precision/Conservation Agriculture at ICAR- CIAE, Bhopal	December 03-23, 2014
Dr. B. B. Basak	Winter School on "Waste Recycling and Resource Management through Rapid Composting Techniques" at ICAR-Indian Institute of Soil Science, Bhopal	December 03-23, 2014
Dr. A.P. Trivedi	Agricultural knowledge management techniques at ICAR-NAARM, Hyderabad	September 16-26, 2014
Mr. Vijay Kumar	Pay fixation at ISTM, New Delhi	August 11-13, 2014
Mr. Vijay Kumar	Pension and other benefits at ISTM, New Delhi	June 23-26, 2014
Seminar/Symposium		
Dr. P. Manivel Dr. Nagaraja R Reddy	National Seminar on Biodiversity Conservation - Status, Future and Way Forward, at Department of Biotechnology, KS Rangaswamy College of Technology, Tiruchengode, Tamil Nadu.	July 19-20, 2014
Dr. P. Manivel, Dr. Vandana Tripathy, Dr. Smitha G.R. Dr. Nagaraja R Reddy Dr. Raghuraj Singh Dr. Thania Sara Varghese	International Conference on "Current Status, Opportunities and Challenges in Medicinal Plants and Natural Product Research" at C. G. Bhakta Institute of Biotechnology, Uka Tarsadia University, Bardoli, Gujarat, India.	September 24-26, 2014
Dr. B. B. Basak	National Seminar on 'Development in Soil Science 2014' at Acharya N. G. Ranga Agricultural University Hyderabad.	November 24-27, 2014

Dr. R.S. Jat	National Symposium on "Hi-tech Horticulture for Enhancing Productivity, Quality and Rural Prosperity" at NRCSS, Ajmer during 19-20 **5.** National Seminar on "Sustainable Horticulture visa-a-vis Changing Environment" at SASRD, Medziphema, Dimapur, Nagaland	January, 19-20, 2015 February 26-28, 2015

Scientific attachment training provided to ICAR-ARS scientists at ICAR-DMAPR, Anand

Name of the Scientists	Institute	Area of research	Duration
Richa Singh	ICAR- NDRI, Karnal	Advance Analytical techniques and Phytochemistry	May 12 – August 11, 2014
Dr. Ajit Arun Waman	ICAR-CARI, Port Blair-744101, A&N Islands, India	Advance Analytical techniques and Phytochemistry	May 12 – August 11, 2014
Dr. Awadesh Kumar	ICAR-IISR, Kozikode	Phytochemistry	January 01-February 15, 2015

Degree Dissertation Project Work

Name of the student	Title of thesis	Supervisor
Mr. Harsh Parik Five Year Integrated M. Sc. Programme (Chemistry), Department of Applied Chemistry, Sardar Vallabhbhai National Institute of Technology, Surat	Screening of Ashwagandha germplasm (*Withania somnifera*) for total phenolic content	Dr. Satyanshu Kumar Principal Scientist (Organic Chemistry)
Mr. Jayesh Chauhan Five Year Integrated M. Sc. Programme (Chemistry), Department of Applied Chemistry, Sardar Vallabhbhai National Institute of Technology, Surat	Evaluation of natural phenolic antioxidant of the plant *Lepidium sativum* Linn	Dr. Satyanshu Kumar Principal Scientist (Organic Chemistry)

Awards and Recognition

Dr. Jitendra Kumar, Director, ICAR - DMAPR, Anand was conferred Bioved Agriculture Innovation Award 2015

Dr. Jitendra Kumar, Director, ICAR - DMAPR, Anand was elected Fellow of National Academy of Agriculture Sciences 2015

PUBLICATIONS

ICAR-DMAPR, Anand

Bishoyi , A.K. , Pillai , V.V., Geetha, K.A. and Maiti, S. 2014. Assessment of genetic diversity in *Clitoria ternatea* populations from different parts of India by RAPD and ISSR markers. Genetic Resources and Crop Evolution, 61: 1597-1609.

Kawane, A., Geetha, K.A., Reddy, M.N. and Maity, S. 2014 Degree of polyembryony among the accessions of *Commiphora wightii* collected from different natural habitats of India. Current Science, 107: 361-364.

Dhanani, T., Shah, S. and Kumar, S. (2015). A validated high performance liquid chromatography method for determination of three bioactive compounds p-hydroxy benzoic acid, negundoside and agnuside in *Vitex* species. Macedonian Journal of Chemistry and Chemical Engineering, (in press)

Smitha G.R. and Rana, V.S. 2015, Variations in essential oil yield, geraniol and geranyl acetate contents in palmarosa (*Cymbopogon martinii*, Roxb. Wats. var. motia) influenced by inflorescence development. Industrial Crops and Products 66: 150-160.

Smitha G.R. and Rana, V.S. 2014 The effect of viral infection on essential oil content, chemical composition and biomass yield of *Mentha* cultivars. Journal of Essential Oil Bearing Plants. 2014. (in press).

Nagaraja Reddy, R, Mehta, R., Soni and P. Manivel, P. 2014. Collection and characterization germplasm accessions of Senna (Cassia angustifolia Vahl.). In: Souvenir of National Seminar on Biodiversity Conservation - Status, Future and Way Forward, Department of Biotechnology, KS Rangaswamy College of technology, Tiruchengode, Tamil Nadu from July 19-20.

Manivel, P and Nagaraja Reddy, R. 2014. Biodiversity conservation of medicinal plants in India: present status, future and way forward In: Souvenir of National Seminar on Biodiversity Conservation - Status, Future and Way Forward, Department of Biotechnology, KS Rangaswamy College of technology, Tiruchengode, Tamil Nadu from July 19-20.

Jat, R.S., Singh, R.R and Bansal, R. 2014. Isabgol: Mahatav, UpyogAvamUtpadan. *MridaDarpan 26-29*.

Jat, R.S., Singh, R.R and Bansal, R. 2014. Madukaparni: EkBahu-upayogiAushdheeyePaudha. *MridaDarpan, 20-22*.

Jat, R.S., Bansal, R., Jadav, J.K. and Kumar, R.2014 .Income-Health Expenses and Use of Medicinal Plants by Tribal Communities in PanchMahal District of Gujarat. The Indian Forester (Accepted for Publication).

Basak, B. B. 2015. Potassium Bio-fertilizer: Viable Technology for Sustainable Agriculture. Indian Farming. 64 : 2-4.

Smitha, G.R**.,** 2014, Sagandhiy palmarosa ki krishi taknik. Phal Phool, 35 : 22-25.

Tripathy ,V.and Varghese,T.S. 2014. Need for quality testing for raw herbal drugs. Kerala karshakan e-journal. 2 :16-20.

Extension bulletin

Jat, R.S., Reddy, R.N, Bansal, R. and Manivel, P. 2015. Good agricultural practices for cultivation of Ashwagandha. ICAR- Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand, Gujarat, pp. 1-8

Jat, R.S., Reddy, R.N, Bansal, R. and Manivel, P. 2015. Good agricultural practices for cultivation of Aloe. ICAR-Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand, Gujarat, pp. 1-10

Jat, R.S., Reddy, R.N, Bansal, R. and Manivel, P. 2015. Good agricultural practices for cultivation of Safed musli ICAR-Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand, Gujarat , pp. 1-10

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YSRHU, Venkataramannagudem

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PERSONNEL

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Dr. Satyabrata Maiti, upto April 29, 2014

Dr. P. Manivel, Director (In-Charge) upto September 04, 2014

Dr. Jitendra Kumar from September 05, 2014

Scientific

Dr. P. Manivel, Principal Scientist (Plant Breeding)

Dr. Satyanshu Kumar, Principal Scientist (Organic Chemistry)

Dr. K. A. Geetha, Principal Scientist (Plant Breeding)

Dr. N. A. Gajbhiye, Senior Scientist (Organic Chemistry)

Dr. R. S. Jat, Senior Scientist (Agronomy)

Dr. Vandana Tripathy, Senoir Scientist (Agricultural Chemicals)

Dr. Smitha G.R., Scientist (Horticulture)

Dr. Vinay Kumar, Scientist (Biotechnology) upto July 05, 2014

Dr. R. Nagaraja Reddy, Scientist (Plant Breeding)

Dr. Raghuraj Singh, Scientist (Farm Machinery and Power)

Dr. Biraj Bandhu Basak, Scientist (Soil Science)

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Dr. Ruchi Bansal, Scientist (Plant Physiology) up to October 31, 2014

Dr. Vanita Navnath Salunkhe, Scientist (Plant Physiology) up to April 19, 2014

Dr. Thania Sara Varghese, Scientist (Agricultural Entomology)

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Dr. Hemlata Bharti, Scientist (Spice, Plantation & MAP), from October 08, 2014

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Sh. Akula Chinapolaiah, Scientist (Spice, Plantation & MAP), from October 10, 2014

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Mr. S. R. Patel, Technical Assistant (Field Assistant)

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Mr. J. M. Padhiyar, Technical Assistant (Pump House Operator)

Mr. K. R. Patel, Senior Technician (Tractor Driver)

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Mr. Mangal Singh, Assistant Finance & Account Officer

Mr. Raghunadhan K., Assistant Administrative Officer

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Mr. N. J. Ganatra, Assistant

Smt. R. J. Vasava, Assistant

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