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Annual Report 2011-12

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


Papaver somniferum
Gymnema sylvestre
Asparagus racemosus
Ocimum basilicum
Tinospora cordifolia
Aloe barbadensis

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Directorate of Medicinal and Aromatic Plants Research
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Directorate of Medicinal and Aromatic Plants Research

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PREFACE

We have crossed the finish line of the 11th Five Year Plan with the closing of 2011-12 fiscal year and now standing at the dawn of 12th Five Year Plan which is the time for gearing up for the 12th Plan preparation. We have to now open our doors for welcoming one more five year plan for leading the nation in the path of prosperity. Thanks to our first Hon'ble Prime Minister, Jawaharlal Nehru and equally talented Dr. Mahalanobis who proposed the concept of five yearly plan coinciding with the terms of the Governments in the Parliament, which takes charge of governance with 5 year planning of activities commensurate with developmental plan and targets of the nation.

Planning Commission is the custodian of fixing the five yearly plan targets and activities for which it constitutes various working groups and their sub committies to look into various sectors to fix the priorities of the plan with various activity milestones. One such Working Group on Horticulture and Plantation Crops for XIIth Five-Year Plan was constituted by the Planning Commission under the Chairmanship of Prof. D. P. Ray, Vice Chancellor, OUAT with a large number of learned members. And by now, they have submitted their reports.

The DMAPR is planning to target in the 12th Five Year Plan in a very aggressive manner in assuring the "quality seed and planting material" supply to ensure quality raw drug production and supply leading to quality drug manufacturing. In addition to these, we shall work to multiply the value of Medicinal and Aromatic Plants by higher quality and new markets and common-ground goals of MAP sector stakeholders would be addressed in (a) establishing certification (GACP & Organic) and labelling; (b) providing training, information, and research; (c) promoting commercialization and investment; (d) fostering preservation of natural resources; and (e) helping to shape government policies.

Since farming is becoming more and more competitive, to maintain income levels, farm families across the country would have to become more creative, diversified, and competitive. The DMAPR would play a virtual role in transformation of the Country's agriculture and rural economy shifting towards higher value-added production by adding high value MAP crops and the creation of new businesses and job opportunities.

I take this opportunity to place on record my thankfulness to Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR and Dr. H. P. Singh, Deputy Director General (Horticulture)

for their keen interest and generous support for the overall development of the Directorate and its activities. I am also thankful to Dr. Umesh C. Srivastava, Assistant Director General (Hort. II) and Ms. Shashi Prabha Razdan, Deputy Secretary for the personal consideration they are giving in dealing the matters of our issues at the headquarters. Thanks are also due to all the scientists of DMAPR and AICRP on MAP and Betelvine for their valuable contributions for this annual report. Timely support received from my colleagues, Dr. Satyanshu Kumar; Dr. Geetha, K. A.; Dr. Vipin Choudhary and Dr. Smitha, G. R. in compilation of this volume and Dr. Satyanshu Kumar in getting this volume printed within the deadline set by the Honb'le Director General, ICAR, are also appreciatively acknowledged.

Jai Hind!

Anand ***Satyabrata Maiti***

July 13, 2012

Abbreviations used

AAU	Anand Agricultural University/ Assam Agricultural University
AICRP	All India Coordinated Research Project
BAU	Bihar Agricultural University
BAU	Birsa Agricultural University
BCKV	Bidhan Chandra Krishi Vishwa Vidyalaya
CCSHAU	Chaudhary Charan Singh Haryana Agricultural University
Chl	Chlorophyll
CPC	Coir pith compost
DAP	Days after planting
DAS	Days after sowing
DES	Diethyl sulfate
DMAPR	Directorate of Medicinal and Aromatic Plants Research
EMS	Ethylmethane Sulphonate
ETL	Economic threshold level
FYM	Farm yard manure
GAP	Good agricultural practices
GBPUAT	G.B. Pant University of Agriculture and Technology
ICM	Integrated crop management
IGKVV	Indira Gandhi Krishi Vishwa Vidyalaya
IIHR	Indian Institute of Horticultural Research
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
KAU	Kerala Agricultural University
LAI	Leaf area index
MAP	Medicinal and Aromatic Plants
MPKV	Mahatma Phule Krishi Vidyapeeth
NDUAT	Narendra Dev University of Agriculture and Technology
NPK	Nitrogen-phosphorous-potash
OUAT	Orissa University of Agriculture and Technology
PDI	Percent disease index
PDKV	Dr. Punjabrao Deshmukh Krishi Vishwavidyalaya
PSB	Phosphate solubilising bacteria
q	Quintal (100kg)
RAPD	Random amplified polymorphic DNA
RAU	Rajendra Agricultural University
RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
SMW	Standard meterological week
TNAU	Tamil Nadu Agricultural University
UBKV	Uttar Banga Krishi Vishwa Vidyalaya
VAM	Vesicular aurbuscular mycorhiza
YSPUHF	Dr. Y.S. Parmar University of Horticulture and Forestry
YSRHU	Dr. Y. S. Reddy Horticulture University

SUMMARY

Directorate of Medicinal and Aromatic Plants Research (DMAPR) and its outreach program All India Coordinated Research Project on Medicinal & Aromatic Plants and Beletvine (AICRP-MAPB) are engaged in research on medicinal and aromatic plants and betelvine. Salient findings of 2011-12 are presented below:

ALOE (*Aloe barbadensis*)

Fifteen genotypes were evaluated at PDKV, Akola and IC 112532 recorded significantly highest leaf weight (393.60 g leaf^{-1}). Application of vermicompost 5 t ha^{-1} produced maximum number of suckers, leaves, leaf length and leaf width, however, it was at par with FYM (10 t ha^{-1}) and vermicompost (2.5 t ha^{-1}).

ARJUN (*Terminalia arjuna*)

At PDKV, Akola, extract yield, total phenol content, antioxidant activity of bark samples collected in July and December from plants of three age groups were compared. Total phenol content in all the three groups of samples was higher in sample collected in July. Antioxidant activity increased with the age

ASALIO (*Lepidium sativum*)

Twenty four germplasm lines of Asalio were tested at RVSKVV, Mandsaur and MLS-1001 and MLS-1013 from narrow leaf group, MLS-1009 and MLS-1016 from mid broad leaves groups, and MLS-1005, MLS-1007 and MLS-1008 from broad leaf were identified as superior genotypes.

At IGKV, Raipur, maximum seed yield was produced when the crop was irrigated thrice at 25, 50 and 75 days and applied with nitrogen 80 kg ha^{-1}.

At RVSKKV, Mandsaur, the application of seed 8 kg ha^{-1} resulted in the highest number of branches, plant girth and seed yield. Among different methods of sowing, seed broadcasting method was the best compared to line sowing.

At MPUAT, Udaipur application of FYM 10 t ha^{-1}, N 60 kg ha^{-1} and application of N in three split doses (1/3rd each at sowing, 25 DAS and 45 DAS) recorded significant increase in number of branches plant^{-1}, 1000 seed weight, seed and straw yield during both the year of experimentation and in pooled analysis. Further, significant improvement in seed yield was recorded when seeds were sown during 43rd meteorological week (Oct. 22-28) and at a spacing 30 x 10 cm (3.33 lakh plants ha^{-1}).

At RVSKVV, Mandsaur, seed yield loss due to Alternaria blight disease was estimated to be 22.97 % , 31.38% and 30.89 % in year 2009-10, 10-11and 2011-12, respectively in Malwa (M.P.). Management trial with six fungicides showed maximum seed yield 1883.16 kg ha^{-1} in trifloxystrbin 25 + tebuconazole 50% (Nativo) treatment.

ASHWAGANDHA (*Withania somnifera*)

Four selected lines were evaluated along with two checks at AAU, Anand and in pooled analysis over years, entry 2B yielded significantly highest root yield and it was 37.78% and 35.15% higher than JA 20 and RVA 100, respectively.

Eleven entries along with 3 checks were evaluated at MPUAT, Udaipur and 6 entries were found to exhibit their superiority over all the three checks as well as over the mean of the experiment for dry root yield.

Three promising entries along with 3 checks were evaluated at MPUAT, Udaipur and entry AWS-2B was significantly higher for dry root yield over best check and overall mean.

At RVSKVV, Mandsaur, maintenance breeding of all released verieties of ashwagandha *viz,* Jawhar Ashwagandha -20, Jawahar Ashwagandha -134 and Raj vijay Ashwagandha- 100 was done.

Single plant progenies of 40 crosses were made in line × tester and were advanced from F_2 to F_3 generations at DMAPR, Anand. A total of 140 germplasm accessions were characterized using the newly developed DUS descriptor at DMAPR, Anand. Distinct characters identified were plant height, plant habit, leaf margin, leaf colour, leaf shape, berry colour, calyx type, branching pattern, leaf size, maturity, hairiness on leaf, laef orientation, etc.

At DMAPR, Anand, yield trial was conducted in 14 selected pure lines and DWS 132 and DWS 135 performed significantly higher in dry root yield than the check varieties JA 20 and JA 134.

At DMAPR, Anand, sixty seven germplasm were screened for *Alternaria* leaf blight under field conditions using disease incidence, severity and percent infection index. Disease incidence ranged from 43.48 - 100%. Disease severity varied from 2.18- 42.02. The percent infection index ranged from 1.33- 45.33.

Efficacy of commercial formulation of botanicals was evaluated against hadda beetle (*Epilachna vigintioctopunctata*) and azadrictin was found most effective.

At TNAU, Coimbatore activity of sucking pest population (*Bemisia tabaci and Ferrisia virgata*) increased to its peak during September 2011.

At YSRHU, Venkataramanagudem, three Eulophid parasitoids of hadda beetles were recorvded.

Screening of germplasm at DMAPR showed that highest withanolide-A and 12-deoxy-withastramanolide contents were in MWS-135. Among the twenty two pure lines, highest withanolide-A and 12-deoxy-withastramanolide contents were in L-22 and L-13, respectively. LC-MS/MS method for the identification and quantification of withanolides was standardized in the extracts of the root, stem, fruit and leaves of Ashwagandha at DMAPR.

ATIS (*Aconitum heterophyllum*)

At YSUHF, Solan, closer spacing of 20X20 cm resulted in the maximum plant height, number of leaves, root length and root yield followed by 30X30 cm spacing during first and third years of cropping.

BACH (*Acorus calamus*)

Sixteen clones were collected and fourteen clones were evaluated for morphological and agronomical traits at YSRHU, Venkataramannagudem. Clone collected from Nagireddigudem recorded higher growth and yield. Spacing with 60x60 cm and application of FYM 15 t ha^{-1} significantly increased the growth parameters like plant height, leaf length and width, whereas, yield parameters viz., rhizome length, width and weight was highest in the plants spaced at 60x45 cm and supplied with 15 t ha^{-1} of FYM.

BASIL (*Ocimum basilicum*)

Ten accessions of basil were evaluated at AAU, Anand and green leaf yield was significantly higher in T_3 and highest oil content was also in the same accession.

BRAHMI (*Bacopa monnieri*)

At RAU, Pusa, planting the crop during earlier months (May-June) resulted in significantly low yield and planting of crop with only 2 or 3 saplings was found to reduce the total herbage yield compared to crop planted with 4 saplings.

CHIRAYITA (*Swertia chirayita*)

At YSPUHF, Solan, seedling population were raised and observed for distinct phenotype and chemical parameters. Different plant types identified studied for distinctness. No correlation can be drawn between morphotype and bitter content.

Populations of *Swertia chirayita* both in the wild and cultivated population were studied at UBKV, Kalimpong for different phenotypic characters.

At UPKV, Kalimpong**,** three disease namely, *Alternaria* blight, *Cladosporium* leaf spot and *Rhizoctonia* seedling blight were reported.

TLC profile of five Swertia species viz., S. chirayita, S. cordata, S. alata, S. purpurascens and S. angustifolia were studied at at YSPUHF, Solan. Amarogentin and Amaroswerin were present only in methanol fraction of *Swertia chirayita* whereas these spots were absent in remaining four species.Methanol was found to be the best solvent for storage of amarogentin. Out of the fourteen market amples analysed, only four samples showed the presence of marker compound of the *Swertia chirayita*, amarogentin

DODI (*Leptadenia reticulata*)

At AAU, Anand, higher dry biomass yield was produced when the plants were supplied with FYM 10 t ha-1.

GILOE (*Tinospora cordifolia*)

Comparative studies of starch granules conducted in *Tinospora cordifolia*, *T. crispa* and *T. sinensis* at DMAPR, Anand showed that starch granular shapes of the three species were of

similar types. HPTLC comparison of methanolic extract of stem of the three species showed higher number of chemical constituents in *T. cordifolia*.

Starch granules of *T. cordifolia* compared with starch granules of rice, wheat, maize and potato showed that the shape was similar to that of wheat and potato, however, the size was similar to that of wheat.

Seven pure compounds were isolated from *T. cordifolia* with retention factor on TLC of 0.16, 0.21, 0.25, 0.34, 0.48, 0.56 and 0.74 at DMAPR, Anand

GUGGUL (*Commiphora wightii*)

At DMAPR, Anand*, in vitro* study of pollen germination in the pistils in 29 female accessions and three hermaphrodite accessions revealed pollen germination and pollen tube growth in all the accessions, however with varying pollination success.

Pollen viability varied from 2.2 to 82.8% among 18 accessions. Pollen of hermaphrodite plants showed low viability. Study showed parthenocarpy in 27 accessions and in one accession, no fruit set was found in un-pollinated flowers. Controlled pollination studies of three females and with two hermaphrodites showed that pollination increased the ability of parthenocarpy invariably and increased the seed set percentage generally in guggul.

Embryo developments were compared in apomict and obligate sexual plants at DMAPR, Anand. Apomictic embryo initials were visible as deeply staining meristematic cells mainly in the nucellar region, as early as 3 DAA to 20 DAA. In obligate sexual type, no embryo initials were found in the nucellar area. Instead, embryo development whenever observed was found in the embryo sac at micropylar end only.

Flow cytometry by fluorescence assorted cell sorting (FACS) at DMAPR, Anand showed cellular ploidy peaks of 2x: 3x as expected of a sexual plant with double fertilization in ovules of open pollinated DMAPR CW33. On the other hand, cell preparations from the other females and hermaphrodites gave mainly 2x:4x or 2x:4x and higher level ploidy peaks revealing autonomous endosperm development.

RAPD marker analysis at DMAPR, Anand showed extent of polymorphism was 0 to 5.8% among the progenies in the apomictic mothers. In contrast, high frequency of polymorphic banding pattern observed among progenies of the DMAPR CW33 further confirmed the obligate sexual nature of this plant.

The screening of Rajasthan accessions at DMAPR, Anand based on Guggulsterone-Z content showed highest content in CW-52 (2.19 mg/g).

HIMALAYA RHUBARB (*Rheum australe*)

At, YSPUHF, Solan, it was observed that the sowing of the seeds during November in shade net conditions initiated early germination of the seeds (9.43 days) with maximum germination (83.56%), root (32.5 cm) and shoot length (29.7cm).

ISABGOL (*Plantago ovata)*

Multilocation trial conducted at six different centers *viz*., AAU, Anand; DMAPR, Anand; MPAUT, Udaipur; SD, Jaguden, RVSKVV, Mandasur and CCSHAU, Hisar, showed that among the three test entries DPO 1 had the highest yield in all the locations, except Udaipur. At Anand, the differences in the yield among the varieties were found non-significant.

Variability for morphological characters were created in GI-2, using three chemical mutagens such as diethyl sulphonate (DES), ethyl methyl sulphonate (EMS) and colchicine and some of the stable and distinct mutant lines were identified at DMAPR, Anand. DPO- 14, an early maturing mutant (was registered with NPBGR, INGR 11035).

At DMAPR, Anand, frapioned tripherhroids 4% + neem oil (0.22%) was found as most effective for the control of aphids on Isabgol. Nineteen arthropods were recorded on the crop and their sequential occurrence also was recorded. Species composition and abundance of natural enemies associated with *A. gossypii* infesting isabgol was also studied at DMAPR, Anand. The main predatory complex reported were Coccinellids, chrysopids and syrphids. The population of lady bird beetles (Coccinellids) was more and their predatory potential was also more. Assessment of economic loss caused by aphids in showed that conservation of natural enemies can play important role in containment of aphid population.

KALMEGH (*Andrographis paniculata*)

At NDUAT, Faizabad, eleven Kalmegh accessions were evaluated. The fresh herbage yield was highest in IC-342135 and IC-471918 produced better dry herbage yield.

At PDKV, Akola, experiment on intercropping of Kalmegh with Pigeon Pea showed sole Pigeon pea produced highest seed yield and sole Kalmegh produced highest herbage yield among all the treatments. However, intercropping Pigeon pea with Kalmegh in the row proportion of 2:4 produced maximum pigeon pea seed yield and herbage yield of kalmegh compared to other row proportions.

KUTKI (*Picrorhiza kurroa*)

At YSPUHF, Solan, eleven market samples were analyzed . Only seven samples showed the presence of marker compounds of picroside I and picroside II.

LONG PEPPER (*Piper longum*)

The application of 150:75:75 NPK kg ha^{-1} along with neem cake 20 q ha^{-1} produced significantly highest number of spikes per plant, dry spike yield and total piperin yield at PDKV, Akola. Up to storage period of 135 days after harvesting, piperine content was maximum (5.09-5.01 %), thereafter, it started decreasing with time.

MADHUNASHINI (*Gymnema sylvestre*)

Among the 16 aaccessions evaluated for dry leaf yield at DMAPR, Anand, DGS-22 and DGS-6 had maximum dry leaf yield per plant. An accession with orange flower colour was also identified.

MAKOI (*Solanum nigrum*)

At YSRHU, Venkataramannagudem, twenty seven accessions were evaluated. The accession collected from Chinthapalli recorded higher yield. Germplasm were characterized based on pistil length, berry colour, size of flowers, pollen size, pollen stainability, leaf margin, stem colour and branching types.

At TNAU, Coimbathore, thirty four accessions were characterized based on morphologically distinct characters *viz*., branching pattern, leaf colour, leaf margin, leaf trichome, stem ridges, stem trichome, stem colour, flower size, corolla arrangement and fruit colour. The accessions were also screened for pest and disease incidences. Fourteen new accessions have been added to the existing germaplsm also during the year.

At YSRHU, Venkataramannagudem application of vermicompost 6 t ha^{-1} along with Azophosmet 4 kg ha^{-1} (Soil application) + Methylobacterium at 500 ml ha^{-1} produced highest plant height, branches and herbage yield. Besides, spacing at a distance of 30 x 30 cm and harvesting at an interval of 30 days were found best which recorded higher growth and yield parameters.

At TNAU, Coimbatore, management of *Alternaria* leaf blight disease showed maximum yield (22.9 t ha^{-1}) with spraying of *Pseudomonas fluorescens* (0.2%) on 30 DAS + Dithane M-45 (0.2%) on 45 DAS which was 31.8% increase over control.

At TNAU, Coimbatore management of pests of Makoi with botanicals and Profenofos as check that treated check was the best in containing all the pests of makoi although reduction in population of aphids was maximum with azadirachtin 1% and thrips with *Andrographis paniculata*.

MAMEJO (*Enicostemma axillare*)

At DMAPR, Anand three compounds were identified. *E. axillare* has been identified as a rich source of swertiamarin (18.56±0.79 %) ever known in nature on dry weight basis

MANDUKAPARNI (*Centella asiatica*)

At NDUAT, Faizabad the maximum plant height, leaf area, petiole length, fresh and dry herbage yield was observed when planted at 5th February, while all these parameters were lowest at 30th March planting.

At RAU, Pusa, the results of the 3rd year (2011-12) experiment revealed that the crop planted in the middle of July with 4- sapling recorded maximum herbage yield compared to earlier planting (May-June) with lesser number of saplings.

At DMAPR, Anand, maximum dry herbage yield (3,585 kg ha^{-1}/three harvests) and nutrient uptake of N, P and K nutrients were recorded with the application of 15 t ha^{-1} FYM and $N_{60}P_{50}K_{60}$ as basal and supplemented with 20 kg N ha^{-1} as top dressing at each harvest.

MUCUNA (*Mucuna pruriens*)

At IIHR, Bangalore, two varieties, Arka Dhanvantari and Arka Aswini identified from IIHR, Bangalore were tested along with local check, Sel 3. Arka Dhanvantari recorded significantly higher seed yield and L-dopa yield with higher L-Dopa content.

NEEL (*Indigofera tinctoria*)

The experiment conducted at KAU, Trichur showed plants spaced at 45 cm X 30 cm and harvested at 60 days interval produced the highest herbage yield. Besides, combined application of farmyard manure 10 t ha^{-1} with Azospirillum 2 kg ha^{-1} recorded the highest plant height and herbage yield. Indican percentage at four months after planting was observed in plots supplied with FYM alone or with Azospirillum and VAM.

OPIUM POPPY (*Papaver somniferum*)

At RVSKVV, Mandasur**,** DUS characters were identified for the species. The characters identified were colour of the petal, petal serration peduncle hairiness, leaf serration, capsule shape, plant height and date of flowering. Accordingly 36 lines were identified and purified. Application of higher dose of sulphur 60 kg ha^{-1} recorded maximum plant height, whereas, maximum number of capsules and latex yield was obtained with the application of medium dose of sulphur 40 kg ha^{-1}. However, all growth and yield parameters were highest when zinc was applied in higher dose i.e. 50 kg ha^{-1}.

At NDUAT, Faizabad, 35 working germplasm were maintained and inbred lines were developed by selfing and inbred are in the S4 generation. The performances of various inbred lines for various morphological characters were also recorded.

Under station trial, at MPUAT, Udaipur, ten entries along with 3 checks were evaluated. Five entries showed their superiority for latex yield over the best check (IC42). At RVSKVV, Mandasuar, seven promising entries along with three checks were evaluated. UOP53 and UOP20 performed superior over the best check IC 42 for latex yield.

Maintenance breeding of the three varieties of opium poppy *viz*; Jawahar Aphim -16, Jawahar Opium Poppy -539 and Jawahar Opium Poppy -540 at RSKV, Mandsaur and Chetek Aphim at MPUAT, Udaipur was carried out. INM in Opium poppy- Ashwagandha crop rotation showed application of FYM 15 t ha^{-1} castor cake equivalent to 50 kg N ha^{-1} and 50 kg N ha^{-1} through urea and their interaction significantly increased plant height, number of leaves per plant, number of capsules per plant, gum, seed, capsule husk yield, morphine and thebaine content of gum, net returns and B:C ratio of the main crop Opium Poppy and the succeeding Ashwagandha crop significantly

PALMAROSA (*Cymbopogon martinii*)

At DMAPR, Anand, under modified mass selection for high yield and quality **b**ased on the individual plants performance fifteen clones were identified based on traits which have positive correlation to oil yield. These clones were in the polycross nursery for further evaluation and seed collection.

Among different varieties of palmarosa evaluated at IGKVV, Raipur maximum herbage yield and oil yield were found in the variety Jamarosa which was at par with Tawi rosa. Similarly, herbage yield and oil yield was found maximum when nitrogen was applied to the plants at 150 kg ha^{-1}.

SAFED MUSLI (*Chlorophytum borivilianum)*

At RVSKVV, Mandsaur, twenty-four lines of safed musli were tested and maximum fresh fasciculated root yield per hectare was found in MCB-412.

Evaluation of 11 genotypes and one check *viz* MCB 405 was conducted at PDKV, Akola and AKSM-08 and AKSM-07 were selected as superior yielders.

Maintenance breeding of two verieties *viz*, Jawahar Safed Musli -405 and Raj Vijay Safed Musli -414 was carried out at RVSKVV, Mandsaur.

At MPKV, Rahuri, application of FYM 5 t ha^{-1} + Vermicompost 2 t ha^{-1} + PSB 5 kg ha^{-1} produced maximum plant height, maximum number of branches/plant, root girth and root yield.

One pure compound was isolated from aqueos extract, at DMAPR, Anand.

SALAPARNI (*Desmodium **gangeticum***)

At DMAPR, Anand**,** DUS descriptors were identified. The genetic study of flower colour indicated that the pink flower was dominant over the white flower colour. The evaluation of thirty accessions collected from different parts of India indicated that root fresh weight, plant height, number of secondary branches, number of inflorescences, length of inflorescence, stem fresh weight and leaf fresh weight had direct effect on root dry weight.

SATAVARI (*Asparagus racemosus*)

Accessions evaluated at JNKVV, Jabalpur showed highest fresh root yield in JBPAR8-9-121.

Seven genotypes and HAR-1 as a check were evaluated at CCSHAU, Hissar and higher fresh fasciculated root yield was found in HAR-03-18.

At MPKV, Rahuri heavy infestation of two bugs viz., red coloured bug *Brachytes bicolor* and eurybracid bug, *Eurybrachys tomentosus* on Satavari (*Asparagus rocemosus* Wild) was observed from 25th to 42th SMW, which was maximum during 35th SMW.

Biology of *Brachytes bicolor* revealed that nymphs moults four times before being transformed into adult stage. Nymphal period lasts for 36-55 days. Eggs are laid singly on leaves and a female lay 16 to 53 eggss with an average of 31.8.

In a trial for management of red coloured bug (*Brachytes bicolor*) two sprays of profenofos at 2 ml/litre were most effective and significantly superior over other treatments in reducing the infestation of red coloured bug population and increasing the root yield.

At DMAPR, Anand, a high root yielding line of *A. adscendens* DAA-2 and profuse flowering, DAA 12 were identified. HPLC-ELSD method for identification and quantification of saponins was developed.

SENNA (*Cassia angustifolia*)

At MPKV, Rahuri, application of FYM 5 t ha^{-1} + Vermicompost 2 t^{-1} + PSB 5 kg ha^{-1} resulted in highest plant height, fresh and dry weight of leaves, LAI and leaf yield. However, sennoside content was highest when FYM (5 t ha^{-1}) was applied alone. Similarly, plant height, leaf and seed yield were maximum when the crop was sown on 10th July. Plant spacing of 30 x 15 cm also produced maximum fresh and dry weight of leaves. Whereas, significantly maximum LAI, leaf and seed yield was recorded at a broader spacing of 30 x 45 cm.

At MPKV, Rahuri infestation of *Catopsilia pyranthae* and *Euproctis fracternal* was observed during 36th to 49th and 36th to 47th SMW, respectively which was maximum, during 41th SMW (2011).

Fifty accessions were collected and evaluated at DMAPR, Anand. Accessions differed in plant height, number of primary branches, hundred seed weight and total sennoside content in leaves.

Fifty single plant selections including twenty from cultivars Sona and thirty ALFT-2 were made at DMAPR, Anand. A small pod size selection (A2-24) has been identified and renamed as DCA-121.

Flower structure, *in vitro* pollen germination, pollen viability, stigma receptivity and breeding behaviour were also studied at DMAPR, Anand. *In vitro* pollen germination study showed 53% pollen germination in fresh and fully opened flowers.The effective pollination period was closely linked with the duration of stigmatic receptivity and maximum stigma receptivity was at 10.00 and 10.30 AM in the month of February. Study of breeding system showed that the species is not wind pollinated and insect has predominant role in pollination

TULSI (*Ocimum sanctum*)

Plants supplied with 10 t ha^{-1} FYM along with NPK at 30:20:10 kg ha^{-1} revealed maximum herbage and essential oil yield followed by NPK at 30:20:10 + 5 t FYM and NPK at 50:40:30 + 10 t FYM at NDUAT, Faizabad.

At RVSKVV, Mandsur, the highest dry herbage yield was recorded when N was applied at 43.5 kg ha^{-1} whereas, highest seed yield was recorded in N was applied at 19.7 kg ha^{-1} and planted at a spacing 60 x 40 cm.

BETELVINE (*Piper betle*)

At IIHR, Bangalore a total of ninety-eight germplasm have been maintained. Germplasm evaluation conducted at the centre showed that Godi Bangla had highest yield. Hybridization was continued among the selected parents and new crosses were also attempted along with interspecific hybridization between *P. betle* and *Phytophthora* resistant P. *colubrinum* at IIHR, Bangalore. Most of the male hybrids expressed poor vigour and majority of the female hybrids exhibited high vigour as reported earlier. Testing of eight hybrids along with four parental lines at IIHR, Bangalore showed that among the hybrids, only Hy 06-4 recorded

significantly higher leaf yield/vine over other other hybrids and parents. Among another set of thirty hybrids, ten hybrids expressed desirable plant vigor and leaf traits. Selected hybrids were also planted under shade net house and evaluated for growth and yield. All the hybrids recorded good growth under shade net conditions.

At BCKV, Kalyani, 58 germplasm and hybrids of betelvine are being maintained.

At BAU, Islampur, application of vermicompost 10 t ha^{-1} produced better crop growth and leaf yield along with lesser incidence of foot rot disease compared to inorganic nutrients applied alone. Similarly, planting density of 1.50 lakh plants ha^{-1} recorded better growth parameters, whereas, number of marketable leaves per plant and weight of 100 leaves were highest in higher plant populations of 1.75 and 2.0 lakh plant ha^{-1}. However, plant population of 1.50 lakh ha^{-1} recorded the least foot rot disease incidence.

Demonstration of Integrated Crop Management (ICM) carried out at seven centres (MPKV, Rahuri; BAU, Islampur; BCKV, Kalyani; RAU, Pusa; OUAT, Bhubaneswar; JNKVV, Jabalpur; and YSRHU, Venkataramannagudem) showed the usefulness of the ICM module in increasing the crop yield (upto 40%) as well as the economic return to the farmers.

Agricultural Knowledge Management

The information related to herbal gardens, availability of species in each garden were up dated. Twenty five new herbal gardens were registered under the project "Strengthing ,Up-gradation and Maintenance of Web based Herbal Gardens Network for Quality Planting Material Supply in India".

General Information

The DMAPR hold meetings of IRC, RAC and IMC to monitor the research and development activities. A two day training cum workshop on "Growing Importance of Medicinal and Aromatic Plants" was organized. A unique toolkit comprising of Good Agricultural and Collection Practices (GAPC) illustrated booklet, training manual, training video and illustrated cause and effect of training tool was released Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR. A brain-storming discussion was organised by the directorate to discuss and prioritize researchable issues in the area of MAPs for the 12th five year plan. The group meeting of the All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine was organised to review the work of various centres. International year of forest and chemistry were celebrated.Training on commercial production of medicinal and aromatic plants and also training cum awareness programme on protection of plant varieties and farmers right (PPV&FR) Act for farmers, researchers and students were organized. The Director, DMAPR delivered a keynote speech in the launching ceremony of the EMAP Project workshop on "Establishing an Egyptian Quality Scheme for Medicinal and Aromatic Plants" under upgrading the medicinal and aromatic Plants (MAP) value chain-access to export market organized jointly by United Nations Industrial Development organization (UNIDO), State Secretariat of the Economic Affairs SECO, Switzerland, Ministry of Industry and Foreign Trade, Egypt at Cairo. Zonal seminar on physiological and molecular interventions

on sustainable crop productivity under changing climatic conditions was and state level seminar on sustainable collection and profitable cultivation of aromatic and medicinal Plants in Gujarat were organized.Several farmers, students and MAP growers visited the directorate for technical know-how. Exhibitions on MAP were also organized to disseminate the technology developed. The directorate family also celebrated Independence day, Hindi week, Annual day, Republic day and International Women's day.

Introduction

Introduction

The Vedic chant ॥ सर्वे सन्तु निरामयः ॥ meaning "Let all be free from diseases" has been the part of prayers for ages. Not only Hinduism, every major religion has focussed and worked for freedom from disease and pain. Taking the cue from our Vedic wisdom, we set our vision on "Health for all" and wish to continue our research for achieving this goal by assuring quality raw drug production and supply for ever increasing population of the world.

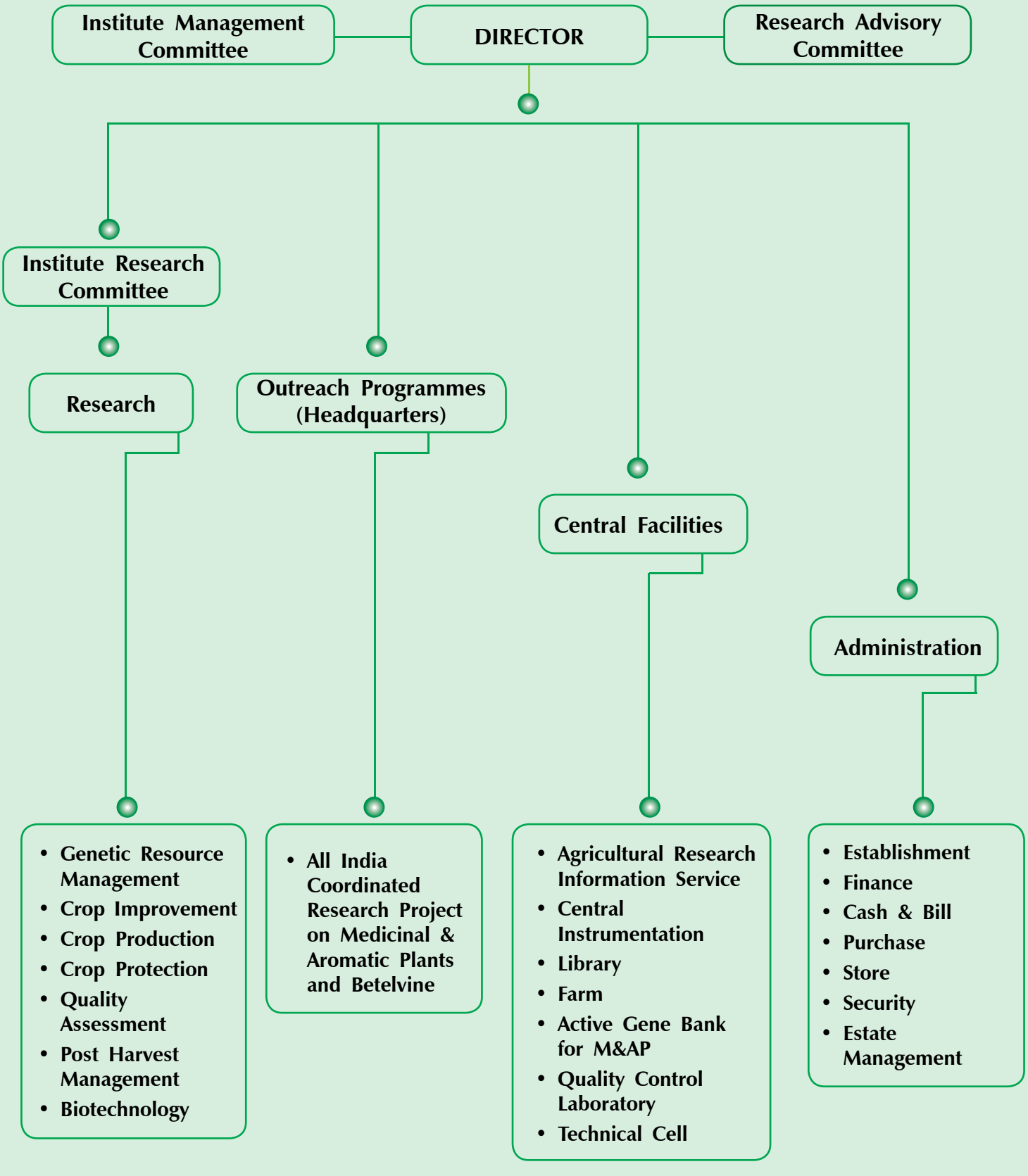
Medicinal plant sector is having a long supply chain starting from either cultivation or collection to marketing, raw drug distribution, primary and advanced processing, drug development, drug validation, drug introduction in the market, etc. those are handled by several stakeholder players. Success of the sector thus depends on the efficient functioning like symphony in an orchestra.

Indian Council of Agricultural Research (ICAR) rightly recognized the growth potential of this newly emerging herbal sector because of revitalization of our traditional knowledge and created a National Research Centre for Medicinal and Aromatic Plants at Anand, Gujarat in 1992 which has been now elevated to the status of Directorate of Medicinal and Aromatic Plants Research (DMAPR) by backward linking of outreach programme to make the research reaching to the ultimate user. In addition, the All India Coordinated Research Project on Medicinal and Aromatic Plants is also contributing as outreach programme of the DMAPR in State Agricultural Universities. A Vision 2030 document is in place for the MAP research sector blending the perspective of Indian agriculture.

Directorate of Medicinal and Aromatic Plants Research (DMAPR), has been working for sustainable production and utilization of major agriculturally important medicinal and aromatic plants through research and development to meet the present day demands and to address future national and international challenges. Basic health care in most of the developing countries is unfortunately either absent or not sufficient at the most elementary level. Medicinal plants provide an opportunity to millions to have access to low cost primary health care that is needed. Many traditionally known plants are having astonishing medicinal value and these can be successfully used to prevent and cure several human illness.

Recently, renewed interest has been created for remedies of many devastating diseases such as cancer, AIDS, etc. from traditional plant based medicinal plants. There is a new surge of demand for medicinal and aromatic plants (MAPs) as raw drug which is steadily and constantly increasing world wide. Commercial cultivation of MAPs is slowly but steadily expanding and gradually becoming popular among farmers. Supply of MAP from natural forest is also gradually restricted. Consumers of traditional drugs are increasingly becoming quality conscious. Under these conditions cultivation is left as the only solution of MAPs for steady and quality raw drug supply. This fact is slowly realized by the industries and phenomenon of contract growing is surfacing in the national scenario. The population of India is predicted to cross 150 crores by 2025 when the main challenge before the country would be not only food but nutritional security also. Hence, the programmes of agriculture sector in general needs a clear vision to meet the challenges ahead, while addressing the present day demand. The present situation on future challenges call for a systematic and

Organisational Structure



continued accelerative efforts in research of medicinal and aromatic plants directed towards sustainable quality production for maintaining the socio-economic and ecological balance.

ICAR contributes in this sector in the very basic link of quality raw drug supply by research in its core competent area of agriculture such as varietal improvement, development of good agricultural practices for assuring quality raw drug supply, quality assessment, quality supply of planting material, etc. The emerging challenges and opportunities demand for an innovation driven research system using modern tools of ICT, biotechnology, molecular biology, biochemistry, etc to link with all the stakeholders in the entire MAP supply chain.

Mandate

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

Mandate crops

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

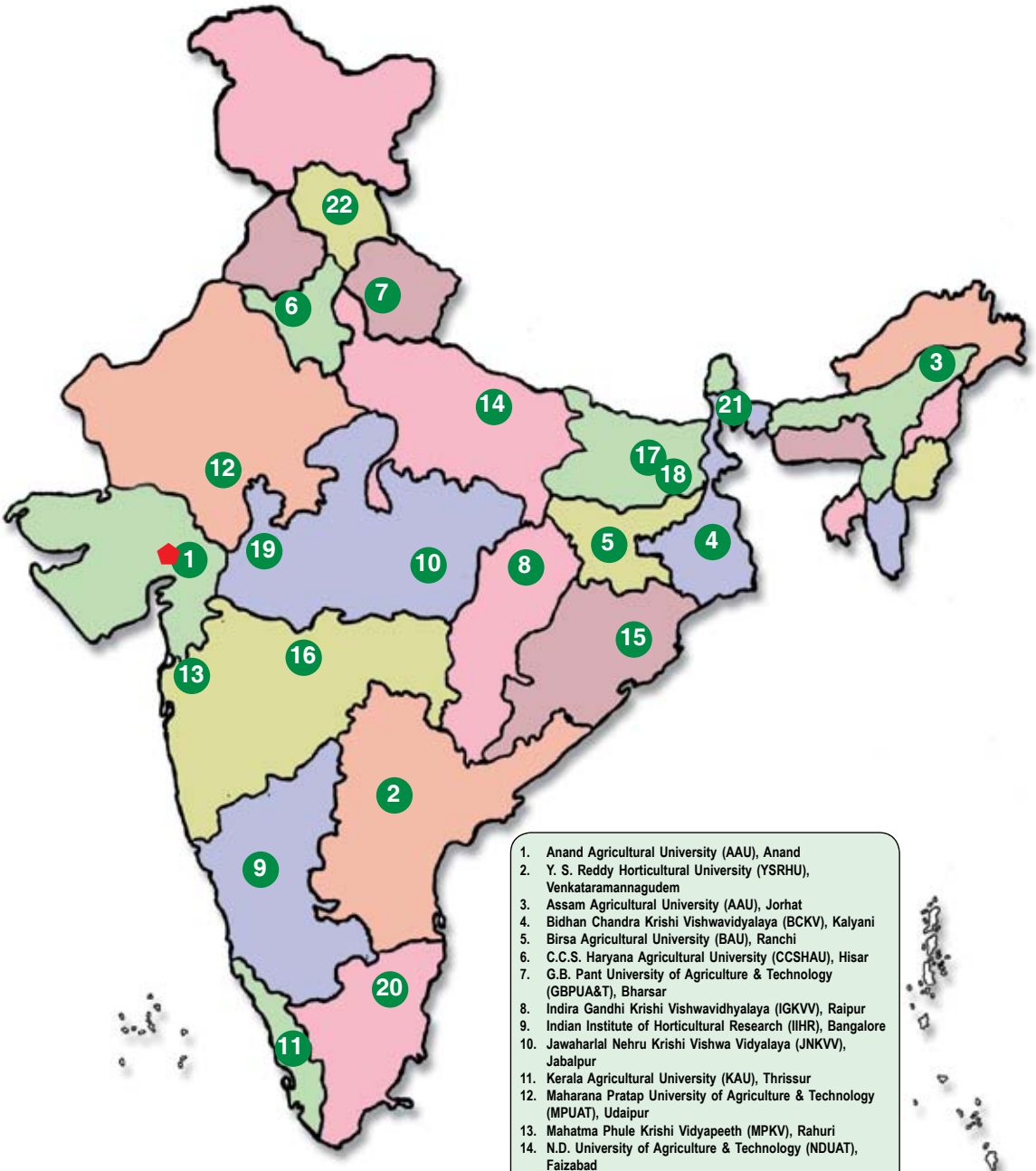
Objectives

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

Outreach programmes

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

Centres of AICRP on Medicinal & Aromatic Plants and Betelvine



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

⬟ DMAPR, Anand (Headquarters)

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

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

Budget profile

Head	Expenditure (₹ in lakh)
Non-Plan Expenditure	253.50
Pension Fund	24.49
Plan Expenditure	296.00
AICRP on MAP & Betelvine	1100.00
IPR Scheme	3.35
Externally Funded Projects	
DUS (PPV&FRA)	4.59
Central Sector Scheme	1.13
Networking of herbal garden	1.45
Guggle Project	7.06
Seed Standard & Seed Sterlization	4.02
Revolving Fund Scheme	1.40
NAIP Projects	
NAIP on Unmolecular process	3.79
NAIP on Ecogeography	14.31
NAIP on Mass Media	1.73

Research Achievements

Medicinal and Aromatic Plants

ALOE *(Aloe barbadensis)*

It is a member of the family Liliaceae and is 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. Leaves contain gel (polysaccharides) and leaf exudates contain aloin which are commercially useful. Gel has a cooling and moisturizing action and hence used in cosmetic industries and the leaf exudates contains aloin and aloe emodine which are used as pain killer and purgative. The crop is under cultivation in Gujarat, Rajasthan, Madhya Pradesh and Uttar Pradesh. Raw material is collected both from wild and cultivation for the industry. Suckers are used for propagation.

Evaluation of elite lines

CCSHAU, Hisar: Twelve genotypes including HAV-1 as check were evaluated. The plant height ranged from 45.00 cm (KC/OP-33) to 62.00 cm (IC-112526); leaf length from 39.00 cm (KC/OP-33) to 52.33 cm (IC-112526); leaf breadth from 7.07 cm (KC/OP-33) to 10 cm (IC-112526); suckers/plant ranged from 1.33 (IC-1-112518,526) to 5.67 (KC/OP-33); leaves/plant from 7.33 (TC-1) to 8.67 (KC/OP-33, HAV-04-4, HAV-05-8); spine distance ranged from 1.93 cm (KC/OP-23) to 3.13 cm (IC-112526); fresh leaf yield/plant (g) from 1003.33 (KC/OP-33) to 1486.67 (IC-112526); fresh leaf yield (kg ha^{-1}) ranged from 27873 (KC/OP-33) to 41300 (IC-112526). Significantly highest fresh leaf yield (kg ha^{-1}) was recorded in genotype IC-112526 (41300) which was at par with HAV-04-04 (40883) and HAV-05-8 (40698). Fresh leaf yield was 34355 kg ha^{-1} in the check HAV-1.

PDKV, Akola: Seven genotypes collected from Maharashtra region and eight genotypes from DMAPR, Anand were evaluated. No variation in terms of qualitative attributes was observed. However, IC 112532 recorded significantly highest leaf weight (393.60 g $leaf^{-1}$).

Effect of plant spacing and organic manures

PDKV, Akola: The experiment was conducted to find out the effect of spacing (60x30, 60x45 and 60x60 cm), organic manures (vermicompost 2.5, 5 and FYM 5, 10 t ha^{-1}) and their interactions on growth and yield. Data revealed that the growth parameters such as plant height, number of suckers and number of leaves per plant, leaf length and leaf width and leaf thickness were not influenced significantly with the plant spacing and also with the interactions of spacing and manures. However, the application of organic manures significantly influenced different growth and yield contributing parameters except plant height and leaf thickness. Further, it was observed that the application of vermicompost (5 t ha^{-1}) recorded significantly higher number of suckers (5.11 $plant^{-1}$), leaves (7.2 $plant^{-1}$), leaf length (24.69 cm) and leaf width (3.46 cm). These parameters, however, were at par with FYM (10 t ha^{-1}) and vermicompost (2.5 t ha^{-1}).

ARJUN *(Terminalia arjuna)*

It is a tree belongs to family *Combretaceae* and mainly distributed in Central India. It has a buttressed trunk and light brown peeling bark. Leaves are 10-25 cm long, 4-9 cm broad. A pair of glands is present on the leaf blade close to the tip of the petioles. The bark of the tree is considered as a 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*.

Evaluation of bark quality of different age group

PDKV, Akola: The bark was harvested in the second week of July, 2011 and also in the fifth week of December, 2011 from the selected Arjun trees with specific age and bark color. The bark samples were shade dried and powdered for further analysis of phenols, antioxidant potential and tannin content. Extract was prepared by soaking dried powder (1.00 g) of the bark in methanol (20 ml), shaking overnight, filtering and evaporating the methanol to get methanol extract. In all the age groups, extract yield was lower in samples collected in July (4.2–9.6 %) as compared to samples collected in December (7.6–15.5%). Total Phenol content (TPC) in all the three groups of samples was found to be higher for samples collected in July. Further, the antioxidant activity increased with the age.

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. The species is a native of Ethiopia and introduced to Europe and Asia. It is cultivated in selected parts of Rajasthan, Gujarat, M.P. and Tamil Nadu for seeds. The seeds are galactagogue, laxative and diuretic. The mucilage obtained from the seeds is used against intestinal irritations. The leaves are also used for medicinal purposes as a stimulant and diuretic and liver diseases. It is also used as salad for treating anaemia.

Evaluation of germplasm

CCSHAU, Hisar: Twenty two germplasm lines were evaluated and it was found that days to flowering ranged from 44.67 days (HLS-18) to 75.33 days (HLS-6) and days to maturity from 111.00(HLS-18) to 128.67 (HLS-6). The plant height (cm) ranged from 97.77 (HLS-

18) to 124.63 (HLS-5); branches/plant ranged from 11.00 (HLS-9) to 18.63(HLS-15); seed yield/plant (g) ranged from 11.22 (HLS-2) to 27.78 (HLS-16); seed yield (kg/ha-1) ranged from 921.30 (HLS-22) to 1527.78 (HLS-4) and 1000-seed weight (g) ranged from 1.492 (HLS-19) to 2.345 (HLS-16). Minimum days to flowering was observed in HLS-18 (44.67) where as HLS-18 took minimum days to maturity (111.00). Significantly highest seed yield (kg ha-1) was recorded in HLS-4 (1527.78) which was at par with HLS-1 (1444.45). Plant types were also identified based on distinct morphological characters *viz*., leaf size and shape.

RVSKVV, Mandsaur: Germplasm were characterized and different morphologically distinct characters were identified. Out of 24 lines identified, MLS-1001 and MLS-1013 from narrow leaf group, MLS-1009 and MLS-1016 from mid broad leaves groups, and MLS-1005, MLS-1007 and MLS-1008 from broad leaf were identified as superior genotypes which are morphologically distinct.

Effect of irrigation and nitrogen levels on growth and yield

IGKVV, Raipur: Effect of three different levels of irrigation and four levels of nitrogen were tried for crop growth and yield. Among the three different levels of irrigation, the maximum seed yield (16.18 q ha-1) was obtained when the plants were irrigated at 25, 50 and 75 days after planting, which was at par with irrigation at 25 and 50 days. Similarly among the four different levels of nitrogen application, maximum number of branches per plant (10.88) and seed yield (17.15 q ha-1) were in the treatment 80kg N ha-1 which was at par with the treatment 60kg N ha-1.

Effect of sowing method and seed rate on the growth and seed yield

RVSKVV, Mandsaur: Effect of five different seed rates (6, 8, 10, 12 and 15 kg ha-1) and two sowing methods (broadcasting and line sowing) were investigated. Highest plant height (119.0 cm) was recorded with the 15 kg ha-1 seed rate and it was lowest at 6 kg ha-1 seed rate. However, 8 kg ha-1 seed rate resulted in the highest number of branches (19.5) and seed yield (20.8 q ha-1). Among different sowing methods, seed broadcasting, recorded maximum number of branches (15.2) and seed yield (16.6 q/ha) as compared to line sowing.

Effect of FYM and nitrogen application on productivity

MUPAT, Udaipur: Two levels of FYM (5 and 10 t ha-1), three levels nitrogen (20, 40 and 60 Kg ha-1) and their split application in three combinations were investigated for two years. Significant improvement in number of branches per plant (21.43 and 21.75), thousand seed weight (1.95 and 1.92 g), seed yield (18.3 and 19.6 q ha-1) and straw yield (67.25 and 69.36 q ha-1) were observed with the application of FYM (10 t ha-1) and nitrogen (60 kg ha-1) for both the years. Application of nitrogen in three split doses (1/3 each at sowing, 25 DAS and 45 DAS) recorded significantly higher yield parameters during both the years as well as on pooled basis compared to other schedules (½ at sowing + ½ at 25 DAS and ½ at sowing + 1/4 at 25DAS+1/4 at 45DAS).

Crop loss assessment due to *Alternaria* leaf blight

RVSKVV, Mandsaur: Crop loss assessment due to Alternaria Leaf blight was carried out. The result showed that Seed yieldloss due to Alternaria blight infection was estimated to be 22.97% , 31.38% and 30.89 % in year 2009-10, 10-11and 2011-12, respectively in Malwa (M.P.). Management trial with six fungicides showed that maximum seed yield was recorded in Trifloxystrbin 25 + Tebuconazole 50% (Nativo) treatment which was 1883.16 kg/ha followed by 1801.50 kg/ha inpropiconozol treatment.

ASHWAGANDHA *(Withania somnifera)*

The plant belongs to family *Solanaceae* and is a wonder herb with multiple medicinal properties. It is cultivated in North-western and Central India. The species is an annual to perennial branched under-shrub to herb of about 30 cm to 120 cm height. Root is the major medicinally important part in addition to leaves and seeds. Roots are used in preparation of vital tonics. It is a stress reliever and is used in treating senile dysfunctions. Its effect on controlling the effects of anxiety, depression, phobias, alcoholic paranoia, schizophrenia, etc is clinically established by different tests. The active ingredient that attributed to the medicinal property is the alkaloids and steroidal lactones present in the roots. Among the various alkaloids, withanine is the main constituent. The leaves contain steroidal lactones, which are commonly called withanolides. It is a late kharif crop and grown in sandy loam soil of pH 7.5 to 8.0.

Evaluation of germplasm

AAU, Anand: Five high yielding selections were evaluated alongwith W S 100 and JA 20 as checks. During 2010-11, none of the entries yielded significantly higher root yield over the checks. However in pooled analysis of three year data, entry 2B yielded significantly highest root yield and it was 37.78% and 35.15% higher than W S 100 and JA 2, respectively.

DMAPR, Anand: A total of 140 Ashwagandha germplasm accessions were maintained and characterized using the newly developed DUS descriptor. Three hundred and twenty eight pure lines were harvested and pure lines with distinct characters identified included DWS 327 (dwarf), DWS 6 (procumbent type plant), DWS 12 (straight margin/non-wavy margin), DWS 16 (yellowish colour leaf), DWS 23 (compact plant with less fibrous root), DWS 37 (downward curling leaves), DWS 61 (triangular shape leaves), DWS 65 (creamy colour berry), DWS 69 (non-wavy and elongated leaves), DWS 110 (broad leaves), DWS 112 (big flowers), DWS 114 (more hairs), DWS 117 (open calyx/berries visible), DWS 131 (red berry, non wavy leaves, tall and leaf margin entire), DWS 139 (branches on every node), DWS 195 (more wavy leaves), DWS 207 (profuse branches), DWS 217 (spreading type), DWS 268 (long leaves), etc. DWS 327, dwarf pure line with plant height of less than 30 cm, maturity period of 120-130 days, high withanolide-A content (>1.75 mg g-1 dry weight) compared to its parent JA 134 (0.477 mg g-1 dry weight) has been identified and registered with NBPGR (INGR-11026).

F1 hybrids of five crosses viz. DWS 176 x DWS 163 (red x creamy white), DWS 6 x DWS 323 (procumbent x erect), DWS 323 x DWS 6 (erect x procumbent), DWS 270 x DWS 323 (mono-stem x erect), and DWS 207 x DWS 206 (dark green x light green) were evaluated along with its parents. The selfed seeds obtained will used for advancement of F2 generation.

Single plant progenies of 40 crosses 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 F2 to F3 generations

MPUAT, Udaipur: Eleven lines along with 3 checks (JA20, JA134 and RVA 100) were evaluated. The observations for plant height, number of primary branches, flowering date, and maturity, alkaloid content, root length, root diameter and dry root yield were recorded. It was found that six entries viz., RAs10, RAs23, RAs37, RAs59, RAs60 and RAs93 exhibited superiority over all the three checks as well as over the mean of the experiment for dry root yield. However, entries RAs7 and RAs56 were also found to be at par with the best check RVA 100.

In another trial, three high yielding selections were evaluated along with three checks (JA20, JA134 and RVA 100). The observations for plant height, number of primary branches, root length, root diameter and dry root yield were recorded for all the entries. Entry AWS-2B had significantly higher dry root yield over best check RVA 100(648.23kg ha^{-1}) and overall mean (558.33kg ha^{-1}). The dry root yield for the trial ranged from 344.43kg ha^{-1} (HWS08-18) to 737.88kg ha^{-1} (AWS-2B).

RVSKVV, Mandsaur: Thirty five single plant selection lines were made from the 120 lines of Ashwagandha. Observations were recorded on selected plants on the basis of different morphological characters like berry colour (red, yellow, orange), berry size (small, medium, large,), plant type (erect or bushy) branching pattern (biparous or triparous), leaf type (oblong or ovate), leaf surface (hairy or non hairy).

Breeding for high quality and high yield

DMAPR, Anand: Yield trial was conducted in 14 selected pure lines with two control varieties JA 20 and JA 134. Two lines DWS 132 (792.25 kg ha^{-1}) and DWS 135 (876.16 kg ha^{-1}) were identified with significantly higher dry root yield than the check varieties JA 20 (450.23 kg ha^{-1}) and JA 134 (614.27 kg ha^{-1}).

Management of *Alternaria* leaf blight

DMAPR, Anand: Sixty seven germplasm were screened for *Alternaria* leaf blight resistance under field condition by disease incidence, severity and percent infection index. Disease incidence ranged from 43.48 - 100%. Disease severity varied from 2.18 (RAS 62) - 42.02 (MWS 117). The percent infection index ranged from 1.33 (RAS 27) - 45.33 (MWS 101). Three germplasm lines namely RAS 62, MWS 336 and RAS 36 showed field resistance to *Alternaria* leaf blight as compared to released variety, JA 20 with respect to disease incidence (60.00), disease severity (3.14) and per cent infection index (1.33).

Efficacy of botanicals against hadda beetle

DMAPR, Anand: Efficacy of commercial formulation of botanicals was evaluated against hadda beetle (*Epilachna vigintioctopunctata*) infesting Ashwagandha. Azadrictin (1%) was found the most effective for the control of hadda beetle on Ashwagandha .

Screening of germplasm and purified lines based on alkaloids

DMAPR, Anand: One hundred and forty germplasm were evaluated for withanolide-A and 12-deoxy-withastramanolide content. Withanolide-A content was higher in lines like MWS-135 (1.11 mg/g), MWS-325 (1.03 mg/g), MWS-221 (0.94mg/g) and RAS-55 (0.91 mg/g) whereas, 12-deoxy-withastramanolide was higher in MWS-135 (0.66 mg/g), MWS-323 (0.55 mg/g), MWS-307 (0.44 mg/g) and RAS-47 (0, 40 mg/g). (Fig. 1).

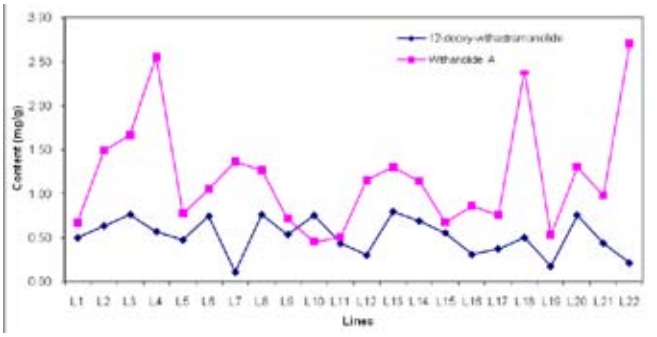


Figure 1 : Screening of pure lines of Ashwagnandha based on withanolide A and 12-deoxy-withastramanolide content

Twenty two pure lines were screened based on two major constituents like withanolide A and 12-deoxy-withastramanolide in the root. Three superior lines were found in terms of withanolide-A content, L-22 (2.71 mg/g), L-4 (2.56 mg/g) and L-18 (2.40 mg/g). 12-deoxy-withastramanolide content was higher in L-13 (0.79 mg/g), L-8 (0.76), L-10 and L-20 (0.75 mg/g). It was lowest in L-7(0.11mg/g).

LC-MS/MS method development for identification and quantification of withanolides

DMAPR, Anand: A sensitive liquid chromatography /electrospray ionization tandem mass spectrometry (LC/ESI-MS/MS) method was developed for the identification and quantification of three withanolides namely withaferin A, 12 deoxy withastramonolide and withanolide A in the methanolic extracts of root, stem, fruits and leaves of *W. somnifera*. A multiple reaction monitoring (MRM) method was developed for quantification of withaferin A, 12 deoxy withastramonolide and withanolide A. The method developed was found to be very useful for identification and quantification of withaferin-A, 12 deoxy withastramonolide and withanolide A in the extracts of the root, stem, fruit and leaves of *W. somnifera* (Fig. 2).

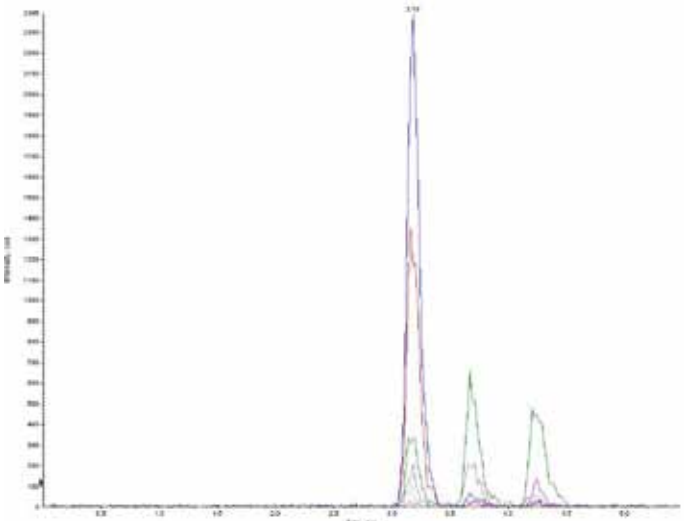


Fig. 2: XIC-MRM chromatogram of three standards with six transactions

Seasonal activity of economically important insect

TNAU, Coimbatore: The sucking pest population *viz.*, *Bemisia tabaci* and *Ferrisia virgata* increased gradually from March 2011. B. tabaci population reached maximum during September 2011 with a population of about 70/plant. Population of *F. virgata* was maximum during April, 2011 (40 per plant). *Dysdercus cingulatus* was noticed for the first time during September, 2011. During November, the crop was harvested. Natural enemies were not observed during the experimentation period.

YSRHU, Venkataramanagudem: Field studies on natural enemies revealed that hadda beetle was parasitized during egg and grub stages by three *Eulophid* parasitoids. Among the parastiods, *Pediobius foveolatus*, a tiny black wasp is found to be dominant grub parasitoid when compared to *Tetrastichus* spp and egg parasitoid *Tamarixia* spp. Yellow coloured eggs and spiny grubs of hadda beetle became brownish and adult parasitoids emerged by making hole. Field collected parasitized grubs or mummies when kept under lab conditions, adult wasps of *P. foveolatus*emerged at 7/grub and survived with honey for eight days.

ATIS *(Aconitum heterophyllum)*

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

Effect of plant spacing on growth and yield

YSPUHF, Solan: The experiment was conducted with five spacings (5x5, 10x10, 15x15, 20x20 and 30x30 cm) for a period of three years (2009-11). During the first year , maximum plant height (14.61 cm), root length (8.09 cm) and root yield (1.41 g/plant) were in 30x30 cm spacing. However, during second and third year of cropping, 20X20cm spacing recorded maximum plant height (48.50, 81.89 cm), number of leaves per plant (15.4, 62.8), root length (13.71, 17.04 cm) and root yield (4.28, 10.17 g/plant) followed by 30X30 cm spacing.

BACH *(Acorus calamus)*

It is a member of family *Araceae* and is a small perennial aromatic herb grown naturally in marshy fields. It is a native of Europe and now found distributed throughout India. The species is cultivated in some parts of India mainly in Andhra Pradesh. The rhizomes are used for medicinal purposes. The dried rhizomes constitute the commercial raw drug of 'Calamus'. It is believed to improve memory power and intellect. It is also useful in the treatment of diarrhoea, dysentery, abdominal obstructions and colic. Anticarcinogenic property of the species is also reported recently

Characterization, evaluation and maintenance of germplasm

YSRHU, Venkataramannagudem: Sixteen clones were collected from various parts of the state and fourteen clones were evaluated for their morphological and agronomical traits. Clone collected from Nagireddigudem recorded higher growth and yield. Stomata studies were also conducted. Clone ACC-13, collected from Rahuri, Maharashtra recorded higher stomata size, while smaller size recorded with ACC-16, collected from Solan, H.P. Number of prominent veins in leaf varied from 4 to 6 among the accessions collected. It was observed that the arrangement of veins and distance between the veins also varied among the accessions.

Effect of spacing and organic manures

YSRHU, Venkataramannagudem: An experiment was conducted to study the effect of spacing (60x30, 60x45 and 60x60 cm), organic manures (FYM 5, 10 and 15 t ha^{-1}) and their interaction on growth and yield. Maximum plant height (50.44 cm), number of leaves (19.81 $plant^{-1}$), leaf length (37.92 cm), leaf width (4.51 cm), rhizome width (8.18 cm) and rhizome weight (21.78 gm $plant^{-1}$) were recorded at planting at a wider spacing (60x60 cm) as compared to the other closer spacings. Similarly, application of higher dose of FYM (15 t ha^{-1}) also recorded maximum plant height (48.37 cm), number of leaves (20.06 $plant^{-1}$), leaf length (37.88 cm), leaf width (4.23 cm), rhizome length (65.55 cm), rhizome width (8.04 cm) and rhizome weight (20.55 gm $plant^{-1}$). Among the interaction effects, spacing of 60x60 cm and FYM @ 15 t ha^{-1} significantly increased the growth parameters such as plant height, leaf length and width. But, the yield parameters like rhizome length and width and rhizome weight was highest in the plants spaced at 60x45 cm and supplied with 15 t ha^{-1} of FYM.

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 and terpineol. Basil grows as a perennial in tropical climates, and is planted as an annual in temperate regions, where it may be sown directly from seed or transplanted. Basil has been used as a folk remedy for an enormous number of ailments, including, cancer, convulsion, deafness, diarrhea, epilepsy, gout, hiccup and impotency. Basil has been reported as an insect repellent also. The seeds are also economically important.

Evaluation of germplasm

AAU, Anand: Ten accessions were evaluated for various yield and yield attributing characters. Significantly, highest green leaf yield (714.72 q ha^{-1}) and dry leaf yield (109.79 q ha^{-1}) were in accession T3. Highest oil yield was exhibited in T2, followed by T9 and T3. Maximum plant height and plant canopy spread was also recorded in T3. However, maximum oil content was in T2 (0.44 %).

RVSKVV, Mandsaur: Twenty one germplasm lines were collected from farmers' field of Mandsaur, Ratlam and Neemuch districts and tested for seed yield and its yield contributing characters. The mean plant height ranged from 63 cm (MOB-8) to 88 cm (MOB-11) and spike length ranged from 17 cm (MOB-12) to 29 cm (MOB-2), similarly number of spikes per plant ranged from 26 (MOB-15) to 72 (MOB-21).The highest seed yield (kg ha^{-1}) was recorded in MOB-2 (1529 kg ha^{-1}).

BRAHMI *(Bacopa monnieri)*

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

Effect of planting time and number of saplings on the Yield

RAU, Pusa : The experiment was conducted for three years and the result of last year experiment (2011-12) indicated that the crop planted in the mid July recorded maximum

herbage yield (285.18 q/ha), whereas, the crop planted in the months of May and June showed significantly lower yield.

CHIRAYITA *(Swertia chirayita)*

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

TLC profiling of some *Swertia species*

YSPUHF, Solan : TLC profile of five Swertia species *viz*., *S. chirayita, S. cordata, S. alata, S. purpurascens and S. angustifolia* was studied. The plant materials of these five *Swertia species* were sequentially extracted with petroleum ether, chloroform and methanol. Comparative TLC profile of petroleum ether, chloroform and methanol soluble fraction of all the five species of *Swertia* was generated. TLC plate of petroleum ether and chloroform soluble fractions of all the five species showed a number of spots. Amarogentin and Amaroswerin were found as distinct spots only in methanol fraction of *S. chirayita* whereas these spots were absent in the remaining four species.

Stability of bitter compounds in different solvent systems

YSPUHF, Solan: Effect of the storage durations (0-6 months) under different solvent systems were recorded for variation in amarogentin content (%). Amarogentin content decreased significantly with increase in storage duration. The initial value of amarogentin content (99.87%) recorded at the time of storage, decreased to 97.21% in pure methanol, 27.81% in methanol: water (75:25), 18.35% in methanol: water (50:50) mixture, 21.46% in methanol: water (25:75) mixture and 45.83% in pure water after six months of storage.The stored samples were also qualitatively monitored on TLC using a solvent system consisting of chloroform: methanol: water (65:25:10) as the mobile phase and fast red B salt solution as the spraying reagent. Additional spots detectable with fast red B salt solution started appearing after four months of storage. Additional spots were also visible in the HPLC chromatograms. Therefore, it may be concluded that methanol is the best solvent for storage of amarogentin.

Analysis of the market samples

YSPUHF, Solan : Fourteen samples received from the AICRP MAP & B centers were analyzed by TLC and HPLC methods and results were compared with genuine *Swertia chirayita* sample. Out of the fourteen samples analysed, only four samples showed the presence of marker compound of the *Swertia chirayita*, Amarogentin, after spraying the TLC plates with Fast Red B salt.

Survey for diseases

UPKV, Kalimpong: Survey for diseases and isolation of pathogen reveled that presence of three disease such as*Alternaria* blight, *Cladosporium* leaf spot and *Rhizoctonia* seedling blight. Cox's postulate has been confirmed of these three pathogens. Morphological characters of these fungal pathogens were also recorded in Uttar Banga Krishi Viswavidyalaya, Kalimpong.

DODI *(Leptadenia reticulata)*

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

Effect of organic manures on dry biomass yield

AAU, Anand : Effect of application of different organic manures was investigated for dry biomass yield. Significantly, higher dry biomass yield (6780 kg ha^{-1}) was recorded in FYM application (10 t ha^{-1}). However, it was at par with the application of caster cake (2 t ha^{-1}) and poultry manure (5 t ha^{-1}).

GILOE *(Tinospora cordifolia)*

Tinospora is a member of family Menispermaceae. It is a deciduous perennial climber and is distributed throughout tropical India. The species produces a number of aerial roots. It is propagated by stem cuttings as well as by seeds. The stem and leaves are medicinally used as raw drug. *Tinospora* stem is a common constituent of a number of ayurvedic vital tonics for the treatment of general debility, dyspepsia, fevers and urinary diseases. Starch present in the stem along with alkaloids is the active principle of the species. Leaf also contains a number of alkaloids. Leaf

is used for the treatment of gout, jaundice and rheumatism. Raw drug is mainly obtained from the wild habitats of the species.The plant is not under regular cultivation and it is grown as a climber on trees in the wild.

Comparative study of *Tinospora* spp.

DMAPR, Anand : Comparative studies of starch granules were conducted in *Tinospora cordifolia*, *T. crispa* and *T. sinensis* (=*T. malabarensis*). The study showed that starch granular shapes of the three species were of similar types. Starch granular sizes of *T. crispa* and *T. sinensis* (=*T. malabarensis*) were also within the size range of *T. cordifolia*. Starch granular size, LI (μm) ranged from 15.31± 3.90 to 29.05± 5.48 and L2 (μm) ranged from 9.57± 2.72 to 23.62± 4.93 among the different accessions of *T. cordifolia*. Average starch granular size, LI (μm) was 15.11 ± 3.96 and L2 (μm) was 11.56 ±3.77 in *T. crispa*, however, average starch granular size, LI (μm) was 13.11 ±3.29 and L2 (μm) was 10.02 ±2.03 in *T. sinensis* (=*T. malabarensis*).

Starch granules of *T. cordifolia* were compared with starch granules of rice, wheat, maize and potato. The study showed that starch granular shape of *T. cordifolia* was similar to that of wheat and potato, however, granular size was similar to that of wheat. Biggest starch granules were in potato and smallest was in rice.

HPTLC comparison of methanolic extract of stem

DMAPR, Anand : Among *T. cordifolia, T. crispa and T. sinensis* higher number of chemical constituents was in *T. cordifolia*.

Isolation, identification and quantification of major chemical constituents

DMAPR, Anand : Total seven pure compounds were isolated. The compounds were tentatively named as TC-3, TC-21, TC-13, TC-1, TC-2, TC-4 and TC-5 and its retention factor on TLC was 0.16, 0.21, 0.25, 0.34, 0.48, 0.56 and 0.74, respectively in silica gel pre-coated plate with mobile phase chloroform, methanol and formic acid (9.3: 0.5: 0.2).

GUGGUL *(Commiphora wightii)*

Guggal or Indian bdellium (*Commiphora wightii*) is a shrub belonging to *Burseraceae* family and is an endangered species in India. 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.

In vitro study of pollen germination in the pistils

DMAPR, Anand : Decolourized aniline blue staining method was used to examine pollen germination on stigmatic surface, growth of pollen tube through the style, and pollen tube entry into the ovules in 29 female accessions and three hermaphrodite accessions of Guggul. The study revealed pollen germination and pollen tube growth in all the accessions, however with varying pollination success. Pollination success varied from 4 to 100% among the accessions. For pistils those showed pollination success, it was also found that pollen germination was not evident during the first two days after pollination (DAP). On the third day, pollen started germinating on the stigmatic surface but pollen tubes did not enter into the style. Genotypic differences were observed in the growth rate of pollen tube in the pistils. Out of the 28 accessions tested, fourteen accessions showed pollen tube entry into the ovule after 4-5 DAP, whereas in another 13 accessions it was recorded at 7 DAP. In one accession (DMAPR CW52), pollen tube entry into ovule occurred after 10 DAP. In all the cases, only single pollen tube was found to traverse deep into the style and reach the ovule, even though a number of pollen grains germinated on the stigma and a few reached in upper half of the style. Thus germination of pollen grains and growth of pollen tube under natural conditions appears to be very slow and the time needed to effect fertilization is variable among the genotypes.

Study of variability in pollen viability among the accessions

DMAPR, Anand : Pollen viability was determined among 18 accessions of Guggul (15 males and three hermaphrodites) by fluorescein diacetate (FDA) test. The study showed that pollen viability varied from 2.2 to 82.8% among the accessions. Nearly half of the accessions tested had pollen viability close to or greater than 50% and all of those were males. Highest pollen viability was in DMAPR CW 34M3 (82.8%) and lowest pollen viability was in DMAPR CW32 (2.2%) which is a hermaphrodite. Pollen of hermaphrodite plants showed low viability and the highest pollen viability observed in hermaphrodite was (37.2%) below the average value of male plants. Six male plants had more than 65% pollen viability and can be chosen as pollen donors to cross with female plants for controlled pollination experiments.

Study of parthenocarpy among the accessions

DMAPR, Anand : Twenty eight female plants were used to test for parthenocarpy in the absence of pollination. Bagged but unpollinated flowers of all the 28 female accessions except DMAPR CW33 showed fruit set (0.42 to 40%) which suggested parthenocarpy and apomictic reproduction in these accessions. No fruit set was found in un-pollinated flowers of obligate sexual plant type, DMAPR CW33, even after bagging of about 300 flowers but fruit/seed set was observed under open pollination condition.

Controlled pollination studies

DMAPR, Anand : Three females were selected (DMAPR CW1, DMAPR CW8 and DMAPR CW16) along with two hermaphrodites (DMAPR CW17 and DMAPR CW29) for controlled pollination tests *i.e.* one set of flowers were pollinated and another set was bagged to avoid pollination and studied for fruit set as well as seed set success. The pollen parents

(male or hermaphrodite) were selected based on the result of FDA test for pollen viability. In hermaphrodites, despite low pollen fertility, self pollination gave fruit and seed set, even though it was lower when compared to the other female apomicts. The study showed that pollination increased the ability of parthenocarpy invariably and increased the seed set percentage generally, even though it is not a rule. Thus pollen grain was found to have a stimulatory role in increasing the fruit set in the studied genotypes of guggal.

Study of embryo/seed development in the apomictic and obligate sexual plant types

DMAPR, Anand : The study was conducted in one hermaphrodite (DMAPR CW17) and four female (DMAPR CW1, DMAPR CW8, DMAPR CW16 and DMAPR CW33) genotypes. Ovule/seed samples at various growth stages, *i.e.*, from 1- 40 days-after-anthesis (DAA). Ovule clearing was done with modified Hoyer's medium. Fruits were collected 30-40 DAA and developing ovules/seeds of selected genotypes were dissected out and used for the study. The study revealed that a well-developed embryo-sac in the ovules in flowers at anthesis stage. Apomictic embryo initials were visible as deeply staining meristematic cells mainly in the nucellar region, as early as 3 DAA to 20 DAA. Rarely, some cells of the integument also developed apomictic initials. Multiple apomictic embryo developments were visible at later stages. Well developed apomictic embryos were found at the micropylar half of the ovule in majority of the cases, very rarely apomictic embryo was found at the chalasal half. During the course of the apomictic embryo development, normal sexual embryo sac area remained intact and the central cells were visible even up to 20 DAA.

In DMAPR CW33 (obligate sexual type), no embryo initials were found in the nucellar area. Instead, embryo development whenever observed was found in the embryo sac at micropylar end only. Well developed sexual embryo was visible at 30-40 DAA at the micropylar end. Interestingly, in this genotype only one ovule developed from each flower and the other three ovules degenerated resulting in single-chambered fruit giving it an oblique shape. In contrast, apomictic individuals bore usually two-loculed and rarely three- or four-loculed fruits. No multiple embryo development was recorded in DMAPR CW 33.

Study of cleared ovules of all the apomicts including the hermaphrodites showed development of single or multiple embryos from the micropylar half of the ovules, however DMAPR CW 33 the obligate sexual female invariably developed single embryo that too exactly at the micropylar end.

Study of endosperm by flow cytometry

DMAPR, Anand : Flow cytometry by fluorescence assorted cell sorting (FACS) was employed to identify the occurrence of triple fusion or autonomous endosperm development in developing ovules/seeds of selected four accessions including one obligate sexual plant, DMAPR CW33. Since endosperm is transitory and absorbed during embryo development in guggul, developing ovules (about 30- to 40-day-old) from controlled or open pollination were used for the analysis. Developing ovules of open pollinated DMAPR CW33 showed cellular ploidy peaks of 2x: 3x as expected of a sexual plant with double fertilization. Thus, FACS confirmed the triple fusion occurred in DMAPR CW33. On the other hand, cell preparations from the other females and hermaphrodites gave mainly 2x:4x or 2x:4x and higher level ploidy peaks. In DMAPR CW1 (Female apomict) two-third of the ovules

examined showed peaks at 2x:3x ploidy indicating high frequency of triple fusion. The hermaphrodite plant (DMAPR CW17) with assured pollen supply produced seeds of mostly 2x:4x ploidy composition rather than 2x:3x ploidy series suggesting predominance of autonomous endosperm development in this apomictic individual. The flow cytometric analysis thus provided an indirect assessment of the events of endosperm formation on the basis of their nuclear DNA content.

Assessment of extent of sexual and apomictic reproduction among guggul accessions

DMAPR, Anand : RAPD marker analysis was employed to assess the extent of sexual and apomictic reproduction among six guggul accessions. A total of 69 seedlings from five apomicts (3 females and 2 hermaphrodites) and 11 progenies from DMAPR CW33 obligate sexual female were used in this study. RAPD analysis of majority seedlings of apomictic plants showed monomorphic pattern identical to the mother plant. Only in a few cases, deviant RAPD patterns were detected. Extent of polymorphism was 0 to 5.8% among the progenies of the apomictic mothers. However, RAPD analysis of 11 progenies of DMAPR CW33 using the same series of primers gave highly polymorphic banding pattern. RAPD patterns of all the progenies of DMAPR CW33 deviated from the maternal parent. These results clearly show that among the six tested parents, except in DMAPR CW33, most of the progenies are of asexual origin. Polymorphic banding pattern recorded for individual plants with one or two primers suggests that sexual pathway is also operating to some extent in these genotypes. In contrast, high frequency of polymorphic banding pattern observed among progenies of the DMAPR CW33 further confirmed the obligate sexual nature of this plant.

Evaluation of Rajasthan accessions based on guggulsterone content

DMAPR, Anand : The screening of Rajasthan accessions based on guggulsterone-Z content showed highest content in CW-52 (2.19 mg/g); it was followed by CW-53 (2.07 mg/g), CW-60 (2.0 mg/g) and CW-50 (1.75 mg/g). The same trend in guggulsterone-Z content was observed in evaluation data of the same accessions sampled in year 2009 also.

HIMALAYAN RHUBARB (*Rheum australe*)

It is a robust, perennial glabrous plant belongs to family Polygonaceae. It is endemic to the Himalayan region, and in India it is distributed mainly in Kashmir and Sikkim. It grows in grassy or rocky slopes at higher altitudes and in forest margins at an altitude of 3200–5200 m. The plant grows more than 2 m in height, with stout rhizomes. The stems are glabrous or pubescent at the nodes. The basal leaves have 30–40 long petioles and thick blades. The flowers are pedicellate and dark purple. It is commonly used in traditional medicine for a wide range of ailments related to the circulatory, digestive, endocrine, respiratory and skeletal systems as well as to infectious diseases. The phytochemical studies have shown the presence of many secondary metabolites belonging to anthraquinones, stilbenes, anthrones, oxantrone

ethers and esters, chromones, flavonoids, carbohydrate, lignans, phenols and sterols. The species flowers from June to August and fruits from July to September. Plant propagation is by either rootstocks or seeds. The species status in the wild is 'vulnerable' due to the threat of overharvesting for trade

Effect of different environmental conditions and time of sowing on seed germination

YSPUHF, Solan: The experiment comprised of nine dates of sowing starting from November to July at an interval of one month under the three environmental conditions (open, poly house and shade net). It was observed that the sowing of the seeds during November in shade net conditions initiated early germination of the seeds (9.43 days) with maximum germination (83.56%), root (32.5 cm) and shoot length (29.7cm).

ISABGOL *(Plantago ovata)*

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

Multi-location trial

A multi-location trial of Isabgol was conducted during 2011-12 at six different AICPRP-MAP centers *viz*., AAU,Anand; DMAPR, Anand; MPAUT, Udaipur; SDAU, Jagudan; RVSKVV, Mandasur and CCSHAU, Hisar. Three test entries *viz*., two entries from DMAPR (DPO 1 and DPO 4) and one entry from AAU, Anand (Selection–10) were tested along with three check varieties *viz*. Niharika, GI 2 and a local check (HI-5 for Hisar, RI-89 for Udaipur and GI 3 for Jagudan and AAU Anand)]

Out of six locations, the trial conducted at Mandsaur center was not considered because of very low plant population. The result showed that among the three test entries DPO 1 had the highest yield in all the locations, except at Udaipur. The yield of DPO 1 was significantly higher (1192.78 kg ha^{-1}) than at least one check variety at all the centers except at AAU, Anand. At Anand, the differences in the yield among the varieties were found non-significant. At DMAPR, Anand, DPO 1 out-yielded all the other entries including the checks. Similarly, at Hissar, DPO 1 out-performed (927.41 kg ha^{-1}) all the check varieties and DPO 4, however it was at par with Sel 10 (900.77 kg ha^{-1}); at Jagudan, DPO 1 had superior yield (1073.33 kg ha^{-1}) than all the other entries except the check GI 2 (1052.78

kg ha-1)which was at par and at Udiapur, DPO 4 had the highest yield (1341.66 kg ha-1) and it was at par with DPO 1 (1324.31 kg ha-1), Sel 10 (1304.86 kg ha-1) and the local check RI 89 (1318.75 kg ha-1).

Considering the mean yield over locations, DPO 1 had 42.38% and 16.84% higher yield than the check varieties GI-2 and Niharika, respectively. Sel 10 was 6.51%, 29.79 and 5.17% higher than the checks GI-2, Niharika and GI 3. The yield over locations for DPO 4 (866.77) was 18.74 higher than GI-2.

Induction of variability

DMAPR, Anand : Eighty four accessions were maintained in field gene bank. Variability for morphological characters were induced in GI-2, using three chemical mutagens such as diethyl sulphonate (DES), ethyl methyl sulphonate (EMS) and colchicine. Four hundred and thirty nine stable mutants/lines (DPO 1 - DPO 439) were obtained in M5 generation. Some of the stable and distinct mutant lines identified for different morphological characters were, DPO 9 (an extended bract mutant), DPO 296 (golden yellow leaf mutant), DPI 113 (folded leaf mutant), DPO 219 (whitish green leaf), DPO 220 (dark green leaves), DPO 259 (yellowish green leaf base), DPO 275 (short plant, less than 22 cm with only two branches), DPO 276 (short leaf mutant) and DPO 385A (profuse hairy mutant) .

DPO- 14, an early maturing mutant was registered with NPBGR (INGR 11035). Flowering started at 34 days after sowing (DAS) in DOP 14 and seed matured at 85-90 DAS under Anand conditions and also had high harvest index (22.8%). Its parent variety GI-2 matures in 120 DAS.

Efficacy of botanicals against the major pest

DMAPR, Anand: Efficacy of commercial formulation of botanicals was evaluated against aphid (*Aphis gossypii*) infesting Isabgol. Frapioned tripherhroids 4% + neem oil (0.22%) was most effective for the control of aphids in Isabgol.

Study of pest sequence

DMAPR, Anand: Ninteen arthropods were recorded. Among them, 13 were phytophagous species belonging to order *Lepidopteran* (09), *Hemipteran* (03) and *Homopteran* and six predatory species belonging to order *Coleoptera* (03), *Neuroptera* (01) and *Odanata* (02). The sequential occurrence of arthropods revealed the presence of aphid (*Aphis gossypii*) from second week of January to fourth week of February, whereas, Lepidopteran (*Helicoverpa armigera, Trichoplusia ni, Thysanoplusia oricalchae, Spliarictia* sp. *Hyposidra successari & Olene mendosa* and true bugs (*Graptostethus servus, Spilostethus pandurus*) were seen associated during early crop growth stages (*i*.e. from second week of December). Infestation of aphid was uniform and severe, whereas, that of lepidopterans and true bugs, was sporadic and less severe. However, presence of these pest arthropods caused significant reduction in seed yield.

Species composition and abundance of natural enemies associated with *A. gossypii* infesting isabgol

DMAPR, Anand : The main predatory complex reported was *coccinellids*, *chrysopids* and *syrphids*. The population of lady bird beetles (*Coccinellids*) was maximum and their

predatory potential was also more as both adults and grubs were found feeding on aphids. Therefore, observation on population of lady bird beetle and syrphid maggot *vis-à-vis* aphids was taken. The activity of aphids was first observed in first week of February (*i.e.* 6th SMW) which remained at par up to 2nd week of February 2012 (7th SMW), gradually the population started building up and correspondingly the predators appeared and their population also increased. The population of aphids and lady bird beetles were maximum during the fourth week of February (*i.e.* 9th SMW). Gradually with the decrease in relative humidity, the population of both prey and predator started declining and became zero in the fourth week of March (*i.e.* 13th SMW). The population of prey and predators showed a positive trend, with the increase in population of prey, population of predators were also increased.

Assessment of economic loss caused by aphids in absense of natural enemies

DMAPR, Anand : Paired plot, *i.e.* treatment (aphids without natural enemies) and control (natual *i.e.* aphids and natural enemies) with buffer in between was laid out. Highly significant difference was observed between treatment and control, as in control aphids with natural enemies undisturbed. Yield (640.00 kg ha-1) was realized against 391.11 kg ha-1 in treatment (aphids without natural enemies), revealing that conservation of natural enemies can play important role in containment of aphid population. But when the performance of natural enemies was compared with insecticidal treatment, it was low, as with insecticidal treatment yield of 684.44 kg ha-1 was realized against 640.00 kg ha-1 with natural enemies.

KALMEGH (*Andrographis paniculata*)

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

Intercropping of Kalmegh in pigeon pea

PDKV, Akola: Intercropping of pigeon pea at different row proportions (1:2, 2:1, 3:3, 2:2, 2:4 and 4:2) with Kalmegh was compared with sole crop. The results exhibited that sole pigeon pea produced significantly higher seed yield similarly, sole Kalmegh produced significantly higher herbage yield for all the treatments. Pigeon pea yield was significantly higher when pigeon pea was intercropped with kalmegh at 4:2 row proportions, which was at par with Pigeon pea+ Kalmegh at 2:4 row proportion. Significantly highest land equivalent

ratio (LER) was reported in Pigeon pea+ Kalmegh (4:2) inercropping. Land equivalent co-efficient (LEC) was highest in pigeon pea intercropped with kalmegh in the proportion of 2:4. In particular, Kalmegh intercropped with pigeon pea at 4:2 or 2:4 row proportions had highest ATER values. Compatibility study showed that, for best results kalmegh could be intercropped at 4:2 row proportions in pigeon pea+ kalmegh intercropping system. Gross income from intercropping system was highest (Rs. 42880 ha^{-1}) in Pigeon pea+ Kalmegh in 4:2 row proportion followed by pigeon pea+ kalmegh (2:4) than monocropping and the other row proportions.

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 of *Picrorhiza* 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.

Analysis of market samples

YSPUHF, Solan : Eleven samples received from AICRPMAP&B centers were analyzed using TLC and HPLC and compared with genuine sample. Only seven samples showed the presence of marker compounds of picroside I and picroside II.

LONG PEPPER (*Piper longum*)

Long pepper is a member of family Piperaceae and is a slender aromatic perennial herb distributed in Central Himalayas, Assam, Khasi hills, Bengal, Western Ghats and Andaman and Nicobar Islands. Ripened green fruits and roots are used as the raw drug. India imports a large quantity of raw drug from Malaysia and Singapore. The fruits are used as spice also. It has a pepper like taste. Piperine and piplartine are the two important alkaloids responsible for the therapeutic action. In addition, the raw drug contains a number of essential oils. Raw drug is collected both from the wild and cultivated areas. The crop is under cultivation in parts of Maharashtra, Kerala, Assam and Tamil Nadu. Stem cuttings are used for the propagation of the species.

From 8th months onwards fruits are ready for harvesting and in the third or fourth year, the entire plants are uprooted and thicker stem parts and roots are also harvested. The harvested products are sun-dried and used.

Integrated nutrient management

PDKV, Akola: Application of nutrients on growth, yield and piperine content through organic (FYM and neem cake) and inorganic sources was investigated. NPK (150:75:75 kg ha^{-1}) in combination with neem cake (20 q ha^{-1}) produced significantly higher number of spikes per plant (95.33), dry spike yield (444.69 kg ha^{-1}) and total piperine yield (24.9 kg ha^{-1}). However, it was at par with the application of NPK 150:75:75 kg ha^{-1}+ FYM 20 t ha^{-1} and NPK 150:75:75 kg ha^{-1}+ FYM 10 t ha^{-1}+ Neem cake 10 q ha^{-1}.

Post harvest studies of deterioration of piperine content

PDKV, Akola : Piperine content and moisture content were recorded at an interval of two months. Piperine content decreased with the time, however, moisture content increased. Up to storage period of 135 days after harvesting, piperine content was maximum (5.09-5.01%), thereafter, it started decreasing with time.

MADHUNASHINI *(Gymnema sylvestre)*

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

Collection, characterization, evaluation and maintenance of germplasm

DMAPR, Anand : Three explorations were made and sixteen accessions were collected and augmented with the existing germplasm which made the total germplasm collection to thirty four. Out of 16 lines evaluated for dry leaf yield, DGS-22 and DGS-6 showed maximum dry leaf yield per plant. Usually it had yellow colour flower, however, an accession (DGS 31) with orange colour flower was identified.

JNKVV, Jabalpur: Seven accessions were evaluated and the accessions showed significant differences in leaves per plant and fresh leaf yield per plant while difference in dry leaf yield per plant was non-significant. Maximum number of fresh leaves per plant (271.325)

was found in JBPGS8-9-107 followed by JBPGS8-9-101(216.56), while minimum number of fresh leaves per plant (46.31) was in JBPGS8-9-106. Maximum fresh leaf yield per plant (19.11g) was in JBPGS8-9-107 while minimum fresh yield per plant was in JBPGS8-9-106 (3.66g /plant).

MAKOI *(Solanum nigrum)*

It belongs to family *Solanaceae* and is commonly known as black night shade, makoi or deadly nightshade. It possesses medicinal properties like antimicrobial, anti-oxidant, cytotoxic properties, antiulcerogenic, and hepatoprotective activity. The juice of the fresh herb is sometimes used for fever and to allay pain. In large doses, black nightshade can cause serious, but usually not fatal, poisoning. Externally, the juice or an ointment prepared from the leaves can be used for skin problems and tumors. The berries are poisonous, but boiling apparently destroys the toxic substances and makes them usable for preserves, jams, and pies. The fruit is used as a cosmetic; rubbing the seeds on the cheeks to remove freckles. The fruit has been used for diabetes. An infusion of the plant is used as an enema in infants having abdominal upsets. Freshly prepared extract of the plant is effective in the treatment of cirrhosis of the liver and also serves as an antidote to opium poisoning. It is a potential herbal alternative as anti-cancer agent and one of the active principles reported to be responsible for this action is diosgenin.

Characterization, evaluation and maintenance of germplasm

YSRHU, Venkataramannagudem: Twenty seven accessions were evaluated for their morphological and economical traits. The accession collected from Chinthapalli recorded higher yield. In germplasm lines collected, three types of flowers *i.e.* flower with long pistil, medium pistil and short pistil were observed. APSN-3, collected from Hyderabad bearing red berries had more number of flowers with long pistil having higher pollen size and viability compared to other accessions. The size of the flower was also found bigger in APSN-3, when compared to other accessions. It was found that pollen size ranged from 0.0198 μm (APSN-18) to 0.0318μm (APSN-3) among the accessions. Pollen staining percentage ranged from 50.09– 100 %. Highest pollen viability (100%) was recorded in all the accessions except APSN-20 (50.09%) and APSN-18(88.52%) collected from Guthi, Ananthapur district and VR Gudem, W. Godavari district of Andhra Pradesh, respectively. During evaluation, new plant types like plants of wavy leaf, green stem with trichomes bearing red berries and plants with entire leaf and purple nodes at stem bifurcation were identified. A botanical descriptor of *S. nigrum* was also documented.

TNAU, Coimbatore: Thirty four accessions collected from different places of Tamil Nadu were characterized. Morphologically distinct characters were observed in seventeen accessions. Variations were observed for branching pattern, leaf colour, leaf margin, leaf trichome, stem ridges, stem trichome, stem colour, flower size, corolla arrangement and fruit colour. Spreading of branches was found in twelve accessions. Rhomboid shape of leaves was

observed in TNSn-32. TNSn- 23 and TNSn- 10 had narrowly ovate and broadly ovate leaves, respectively. Leaf trichome was present in eight accessions and cleft margin was observed in seven accessions. The accessions *viz.*, TNSn-B-10, TNSn -30, TNSn 31 and TNSn 33 possessed dark green leaves. Stem ridges was observed in ten accessions. Stem spine was found in nine accessions. Purple colour stem was observed in TNSn 10, TNSn-30, TNSn-31, TNSn-32 and TNSn-33. The accessions viz., TNSn- 10, TN Sn- 30, TNSn 31 and TNSn-32 produced big sized flower with corolla entire. Petal streak was present in TNSn 33.The accessions viz., TNSn -27, TNSn -28, TNSn -29,TNSn -30,TNSn 31, TNSn 32, TNSn 33 and TNSn 34 produced red colour fruits. Significant variation was observed for growth and yield parameters. Among the growth parameters, the height was maximum in TNSn 19 (69.00 cm) and the lowest height was observed in TNSn 31 (51.67 cm). Fresh herbage yield, leaf weight and stem weight were maximum in TNSn 19 (303.60g, 135.63 g and 173.40 g).

Organoleptic evaluation was done for the accessions. Compared to black types, red types had highest bitterness and fiber content. The appeal of the cooked green was good in TnSn -19 .The genotypes viz., TNSn 10, TNSn 19 and TNSn 23 were highly acceptable by the evaluators rather than red types. The red types took extra time for cooking than black type (5 minutes)

The accessions were screened for pest and disease incidences. Among the accessions, leaf blight index was highest in TnSn -19 followed by TnSn -23. Maximum number of thrips was recorded in TnSn -8 followed by TnSn -12 and TnSn -19. Incidence of white flies was found to be maximum in TnSn -19. Maximum incidence of red cotton bug was recorded in TnSn -10 and TnSn 30. TnSn -31 and TnSn -23 registered maximum incidence of hadda beetle grubs. *Leucinodes* (damage %) was maximum in TnSn -10 followed by TnSn -30 and TnSn -31.

Effect of different organic manures and bio-fertilizers

YSRHU, Venkataramanagudem: Results showed that application of vermicompost (6 t ha^{-1}) and azophosmet (4 kg ha^{-1}, soil application)+ methylobacterium (500 ml ha^{-1}) individually and in combination increased significantly the plant height (59.55cm), branches (22.84) and herbage yield (22.40 t ha^{-1}).

Effect of spacing and harvesting interval on growth and yield

YSRHU, Venkataramanagudem: Spacing of 30 x 30 cm and harvesting at 45 days interval significantly increased the plant height (48.32 cm), number of branches (22.60) and herbage yield (43.33 t ha^{-1}) compared to the other treatments.

Management of *Alternaria* leaf blight disease

TNAU, Coimbatore: Management of *Alternaria* leaf blight disease in Tamil Nadu showed that the maximum yield of 22.9 t ha^{-1} was recorded in treatment of spraying of *Pseudomonas fluorescens* (0.2%) at 30 DAS+ Dithane M-45 (0.2%) at 45 DAS which was 31.8% increase over the control.

In addition, centers have also carried out the survey of and surveillance of various diseases in other medicinal plants growing in their herbal gardens.

Management of pests

TNAU, Coimbatore: Against aphids, *Aphis craccivora*, maximum population reduction was observed in the standard check profenophos, where the population of aphids reduced to 0.2 per plant at one day after treatment followed by pungam oil (6.7 plant-1), azadirachtin (7.3 plant-1) and NSKE (7.9 plant-1). Similar trend was observed at three, five and seven days after treatment. At three days after treatment, cent per cent population reduction was observed in profenophos sprayed plot. Among the other treatments, maximum population reduction observed in azadirachtin (2.6 plant-1), followed by NSKE (2.8 plant-1) and *Vitex negundo* (3.1 plant-1).

At 14 DAT, maximum population reduction was observed in standard check (0.3 plant-1) followed by azadirachtin (4.8 plant-1), NSKE (5.1 plant-1) and pungam oil. Mean population reduction of aphids was maximum in the standard check (0.1 plant-1) followed by azadirachtin (3.76 plant-1) and NSKE (4.04 plant-1). Minimum mean population reduction was observed in the mineral oil sprayed plot.

Against thrips, Thrips tabaci, maximum reduction was observed in the standard check profenophos (0.1 no.) followed by azadirachtin (1.9 plant-1), *Andrographis* (2.1 plant-1) and NSKE (2.3 plant-1). Similar trend was observed on three, five and seven days after treatment. At 14 DAT, slight increase in population was observed in all the treatments. Maximum population reduction was observed in standard check (0.3 plant-1) followed by *Andrographis* (0.7 plant-1) and NSKE (0.9 plant-1). Mean reduction in thrips population was maximum in standard check (0.08 plant-1) followed by *Andrographis* (0.92 plant-1), azadirachtin (1.22 plant-1) and NSKE (1.28 plant-1). Minimum mean reduction was observed in *Vitex negundo* (1.60 plant-1).

Leaf yield from the different treatment plots ranged from 12.85 to 21.75 kg/12m2 plot / harvest. Maximum leaf yield was obtained from the profenophos treated plot, which was about 21.75 kg/12m2 plot/harvest, followed by NSKE and azadirachtin treated plots which recorded the leaf yield of about 17.55 and 17.18 kg/12m2 plot/harvest, respectively. Minimum leaf yield was recorded in untreated control 12.85 kg/12m2 plot/harvest, followed by pungam oil treated plot, which recorded the leaf yield of 15.60 kg/12m2 plot/harvest

MAMEJO *(Enicostemma axillare)*

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

saponins, sterols, triterpenoids, phenolic acids, flavonoids and xanthones. The species is recently found as one of the major sources of Swertiamarin.

Isolation, identification and structure elucidation of the chemical compounds

DMAPR, Anand : In continuation to earlier work, three more compounds were isolated from the methanolic extract of the aerial parts of *E. axillare*, constituting a total of six pure compounds from the extract. Three compounds have been identified. *E. axillare* has been identified as a rich source of swertiamarin (18.56±0.79 %) ever known in nature on dry weight basis. Extraction of aerial parts with water and methanol at room temperature (22-25°C) was found to give maximum yield (38.12± 1.74% and 34.0± 1.92%) of swertiamarin followed by hot methanol (30.76± 1.41%) and water (20.13± 0.84%) extracts. TLC and HPLC profiling of different extracts of the plant has been carried out. Standard operating procedure for the detection and quantification of swertiamarin in *E. axillare* raw material was developed and validated. Further, HPLC method was developed for the detection of swertiamarin in its aerial and root parts using minimum of 1 mg and 5mg raw material, respectively.

Analysis of the dried roots was found to contain 10.5, 5.74 and 7.8% petroleum ether, acetone and methanol extracts, respectively. Five compounds were isolated and purified from the petroleum ether extract of the roots by column chromatography and four compounds from methanol extract. Swertiamarin was found to be present in both, aerial and root parts, but roots contain lesser amount.

MANDUKAPARNI *(Centella asiatica)*

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

Standardization of optimum planting time

NDUAT, Faizabad: The experiment was laid out with five planting times (1st Feb, 15th Feb, 1st March, 15th March and 30th March). Result showed that maximum plant height (31.35 cm), leaf area (29.07 cm^2), petiole length (26.32 cm), fresh (139.68 q ha^{-1}) and dry (27.93 q ha^{-1}) herbage yields were obtained for planting date of 15th February planting. All these parameters were lowest in case of 30th March planting.

RAU, Pusa: The experiment was conducted with five dates of planting, starting from mid May to Mid July at an interval of fifteen days with number of nodes per cutting varying from 2-4. The results of the third year experiment showed that the crop planted in the

middle of July with 4 node cuttings recorded maximum herbage yield (105.49 q ha^{-1}). The crop planted at earlier dates (May-June) had lower yield. Planting earlier with 2 or 3 node per cutting was found to reduce the total herbage yield.

Nutrient Management

DMAPR, Anand : A field study was conducted to assess the effect of different levels of organic and inorganic nutrient sources on herbage yield, quality, optimum economic levels and nutrient use and recovery efficiencies. The soil of the experimental plot was low in organic carbon, mineralizable nitrogen, very low in available phosphorus and medium in available potassium. Nutrients were applied as per treatment; FYM was applied at three levels (0, 10 and 15 t ha^{-1}) alone and in combination with inorganic NPK in the main-plots. NPK were applied at different levels as alone or with FYM in the sub-plots. N was applied as split doses also at different harvests where as P and K were applied as basal in all the treatments. Three harvests were taken from the crop. The results showed that application of organic (FYM) and inorganic (NPK) nutrients significantly affected the dry herbage yield. Highest dry herbage yield (3,585 kg ha^{-1}) in total of three harvests was recorded with the application of 15 t ha^{-1} FYM and $N_{60}P_{50}K_{60}$ as basal and supplanted with 20 kg N ha^{-1} as top dressing at each harvest. Application of different levels of nutrients also affected the plant nutrient content ,their uptake and soil nutrient balance. Application of higher doses of organic inputs increased the nitrogen (2.0-2.8%), phosphorus (0.2-0.3%) as well as potassium (1.5-2.5%) content in plants and thereby uptake. However, the total uptake varied with the yield levels and the application of inorganic nutrients. Significantly highest uptake of all the three nutrients were recorded with the application of 15 t ha^{-1} FYM and $N_{60}P_{50}K_{60}$ as basal and supplemented with 20 kg N ha^{-1} at each harvest.

MUCUNA *(Mucuna pruriens)*

The species is a pubescent annual climber belonging to family Fabaceae. The fruit (pod) is covered densely with stinging hairs. It is distributed almost throughout India and also cultivated in limited areas. The seeds are used to treat, Parkinson disease, sexual disorders, cholera, urinary troubles and liver and gall bladder diseases. L-dopa present in the seeds is the active principle responsible for therapeutic action. Seeds are used for propagation and sowing is done at the onset of monsoon. Land preparation is made with the addition of FYM. Since it is a climber, support is required and irrigation is given during the dry season. Flowering starts after 40 days of growth and pods picking is done 3-4 times per season.

Evaluation of superior lines

IIHR, Bangalore: Evaluation was carried out with two varieties, Arka Dhanvantari and Arka Aswini identified from IIHR, Bangalore along with one selection i.e., Sel 3 as local check. The entries significantly differed for days to flowering, length of inflorescence, number of flowers/inflorescence and pod traits. Arka Dhanvantari recorded significantly higher seed

yield (2.4 t ha-1) and L-dopa yield (104 kg) with higher L-Dopa content (4.3%). Arka Aswini recorded high L-Dopa (4.01%) and gave L-Dopa yield of 56.6 kg ha-1. The entries significantly differed with each other in bearing habit and seed traits. Arka Dhanvantari bears pods from the top nodes and in other two entries bearing starts from the basal nodes. Arka Aswini produces pods with black dense trichomes and the immature pods are black in colour. Arka Aswini bears bold seeds with black mottled seed coat. Arka Dhanvantari produces medium size seeds with shiny black seed coat. The yield data showed that Arka Dhanvantari was promising with high seed and L-dopa yield followed by Arka Aswini.

NEEL *(Indigofera tinctoria)*

The species is a shrub which belongs to family *Fabaceae* and grows to a height of about one to two meters. 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 groundcover and to improve the soil in the same way that the other legume crops such as alfalfa and beans are Dye is obtained from the processing of the plants' leaves. The species also has medicinal value. The leaves are dried and used for the treatment of any type of toxicity, fever, jaundice, arthritis and indigestion. The root is given for abdominal disorders, leucorrhoea, hair loss and all types of toxicities, *etc*.

Effect of spacing and harvesting interval on herbage yield and quality

KAU, Trichur: The experiment was conducted with four spacings (45x30, 60x30, 60x45 and 90x60 cm) and three harvesting intervals (30, 60 and 90 days). Results showed that the plant height, number of branches per plant and canopy spread were higher in plots of wider spacing (90x60 cm) and harvested at 90 day interval. Combination of 60 days harvesting interval with a spacing of 45X30 cm recorded the highest herbage yield (4297 kg ha-1).

Effect of combination of organic manures and bio-fertilizers on yield and quality

KAU, Trichur: Organic manures (FYM, vermicompost and coir-pith compost) and bio-fertilizers (*Azospirillum* and VAM) were applied in single and in combination to know the effects on growth and yield. The highest herbage (5450 kg ha-1) was obtained in application of FYM with *Azospirillum*, followed by the combination of vermicompost and *Azospirillum*. After four months of planting, Chlorophyll a and total chlorophyll content were maximum in plants supplied with the basal application of vermicompost (3 t ha-1). However, chlorophyll b content was highest in plots supplied with FYM and *Azospirillum*. Indican percentage after two months of planting was highest in vermicompost applied plots (0.46%), whereas, at four months after planting it was highest (1.11%) in plots where farmyard manure was applied either alone or in combination with *Azospirillum* and VAM.

OPIUM POPPY *(Papaver somniferum)*

The plant belongs to family Papaveraceae. Opium and poppy seeds are obtained from this species. The latex collected from the capsule is otherwise known as opium and is medicinally important. Seeds are also used for culinary purposes. Opium is the source of many opiates, including morphine, thebaine, codeine, papaverine, and noscapine. The Latin botanical name means, the "sleep-bringing poppy", referring to the sedative properties of the species.Opium poppy is the only species of Papaveraceae that is an agricultural crop grown on a large scale. It is a rabi sown crop and its cultivation is restricted by the Narcotics Department under licensing system. Seeds of opium poppy are 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.

Development and maintenance of inbred lines

NDUAT, Faizabad: Thirty five working germplasm were maintained and to develop the inbred lines they were selfed in S4 generation. The performances of various inbred lines for morphological characters were recorded. The various morphological characters, namely, plant height (cm); number of branches/plant, number of leaves per plant; peduncle type hairy (H), smooth (S), semi hairy (SH); petal type smooth (SM), fringed (F); petal colour white (W), pink (P), purple (PR), red (R); number of effective capsule per plant; capsule length (cm); capsule width (cm); capsule weight per plant (g); seed weight per plant (g) and husk weight per plant (g); were recorded among the inbreds.

Varietal evaluation

MPUAT, Udaipur: Ten entries along with 3 checks (Chetak Aphim, IC 42 and MOP540) were evaluated for latex, seed and husk yield & other yield contributing traits. Among the checks, IC42 was identified as the best check for latex yield (29.15kg ha^{-1}), seed yield (1294.25 kg ha^{-1}) and husk yield (1185.39 kg ha^{-1}). All the entries flowered between 88-95 days. Five entries UOP44, UOP60, UOP69, UOP80, and UOP1185 showed their superiority for latex yield over the best check (IC42). UOP60 and UOP69 were also found superior in terms of seed yield over best check.

RVSKVV, Mandsaur: Seven promising entries along with three checks (Chetak Aphim, IC42 and MOP540) were evaluated for yield and quality traits. UOP53 and UOP20 had significantly higher latex yield over the best check IC 42 (33.27 kg ha^{-1}). Seed yield was significantly higher in UOP35 than the best check Chetak Aphim (1152.75 kg ha^{-1}). However, UOP30 and UOP35 out yielded the best check Chetak Aphim for husk yield. The morphine content (%) ranged from 10.92 (UOP 20) to 12.70(MPO 4). UOP34, UOP-53, MPO9, UOP30 and MPO4 exhibited higher morphine content over the best check (11.85%).

Effect of sulphur and zinc levels on the growth and latex yield

RVSKVV, Mandsaur: The experiment was conducted with four levels of sulphur (0, 20, 40 and 60 kg ha^{-1}) and two levels of zinc (25 and 50 kg ha^{-1}) on growth and latex yield. Highest dose of sulphur (60 kg ha^{-1}) recorded maximum plant height (119.5 cm). At medium sulphur level (40 kg ha^{-1}) number of capsules (4.5 plant^{-1}) and latex yield (77.5 kg ha^{-1}) were maximum. Zinc application(50 kg ha^{-1}) yielded maximum plant height (106.5 cm), number of capsules (3.83 plant^{-1}) and latex yield (73.5 kg ha^{-1}).

Integrated nutrient management in Opium poppy- Ashwagandha crop rotation

MPUAT, Udaipur: In order to find out the integrated nutrient management practices for Opium poppy- Ashwagandha crop rotation, an experiment was conducted during 2006-2011. From the three years pooled data, it was concluded that the successive increase in FYM levels from 5- 15 t ha^{-1}, castor cake equivalent to 50 kg N ha^{-1} and urea 50 kg N ha^{-1} alone and with interaction significantly increased plant height, leaves per plant, capsules per plant, latex yield, seed yield, husk yield, morphine and thebaine content of latex, net returns as well as benefit-cost ratio. Further, results showed that the residual effect of application of FYM (15 t ha^{-1}), castor cake equivalent to 50 kg N ha^{-1} and urea (50 kg N ha^{-1}) increased root length, root diameter, root yield, seed yield, total withanoloid content, net returns of Ashwagandha.

Use of micronutrients for optimization of latex yield and morphine content

RVSKVV, Mandsaur: A trial was conducted to evaluate the effect of micronutrients on yield and quality of opium poppy. Significant increase in seed yield of opium poppy was recorded due to the application of micronutrients. Highest seed yield (1096 kg ha^{-1}) and latex yield (62.94 kg ha^{-1}) was recorded in treatment T-3 of Zn_{25}, Fe_{25}, Mn_{25}, Cu_{15} and B_{10} kg ha^{-1}). However, micronutrient treatment had non-significant effect on morphine content of opium poppy.

PALMAROSA *(Cymbopogon martinii)*

Cymbopogon is an important genus of aromatic grasses belonging to family Poaceae with about 140 species and Palmarosa (*cymbopogon martinii*) 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 of 'motia' variety of *Cymbopogon martinii*. The oil has good demand for export and is very rich in geraniol (75-90%). It is used in perfumery, cosmetics and soap and also in flavouring tobacco and for blending of soaps due to the lasting rose note it imparts. The genus *Cymbopogon* is chiefly distributed in the tropical south- east asia and africa. of the total 102 species, 56 are found in Africa and 21 in India. Palmarosa grass attains a height of about 1.75 m under favourable growing condition in the forest and up to 2.5 m under cultivation.

Modified mass selection for high yield and quality

DMAPR, Anand: Total of one thousand and two hundred clones of seven germplasm accessions were screened for different parameters such as growth, yield and quality over a period of two years. The statistical analysis and Pearson's correlation tests showed that the oil yield was positively correlated with different parameters such as plant height, number of tillers, dry weight and oil content. Different groups were made based on selected traits such as plant height (>140 cm), number of tillers (>190/plant), dry weight (> 300g/ plant) and oil content (>1.7% / plant on dry weight basis). Based on the individual plants performance fifteen clones were identified based on the traits selected. These fifteen clones were raised in a polycross nursery.

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

IGKV, Raipur: Effect of four levels of nitrogen (75, 100, 125 and 150 kg ha^{-1}) on three varieties namely, Tawirosa, CN-5 and Jamarosa were investigated for plant height, herbage and oil yields. Maximum herbage and oil yields were recorded in Jamarosa at highest nitrogen level (150 kg ha^{-1}).

Analysis of samples from modified mass selection

CCSHAU, Hisar : The data of oil content and geraniol content of 36 promising clones including RH-49 (Check) were tested. Oil content on fresh weight basis in first harvest ranged from 0.14 to 0.40 per cent. Clones PRH-03-43 (P2) recorded highest oil content (0.40%). Five other clones *viz*., PRH-03-31-1 (P2), selection-41 (P1 and P2), selection-42 (P1) and selection-45 (P1) recorded 0.33% oil content. These clones were rich in geraniol. Essential oil of five clones *viz*., selection-49 (P1) (93.4%), PRH-03-30 (P1) (92.4%), PRH-03-62-I (P1) (91.0%), PRH-03-62 (P2) (90.3%) and selection-49 (P2) (90.0%) had geraniol content more than 90 per cent. The geraniol content in the essential oil of nine clones was as follows: PRH-03-62-1 (P2) (89.7%), Sel-40 (P2) (89.7%), RH-49 (P2) (89.5%), PRH-03-57 (P2) (88.9%), PRH-03-62 (P1) (88.5%), Sel-47 (P2) (88.4%), Sel-47 (P1) (88.3%), PRH-03-57 (P1) (88.2%) and PRH-03-43 (P2) (88.1%). Geraniol content in the other ten clones were as follows: Sel-46 (P1) (87.8%), Vaishnavi (P2) (87.5%), Sel-45 (P1) (87.4%), Sel-46 (P2) (87.4%), RH-49 (P1) (87.0%), Vaishnavi (P1) (86.5%), Sel-42 (P2) (86.3%), Sel-40 (P1) (86.1%), Sel-45 (P2) (85.6%), Sel-42 (P1) (85.4%).

SAFED MUSLI *(Chlorophytum borivilianum)*

Safed musli belongs to family Liliaceae. There are a number of *Chlorophytum* species, which are known under the trade name 'safed musli' of which *C. borivilianum* is the commercially utilized species. The plant is a perennial herb with condensed stem disc and a whirl of sessile leaves. Fasciculated roots contain saponins and are medicinally important. It is used as a general tonic and is a well-known aphrodisiac. The species is naturally distributed in the forest areas of Maharashtra, MP, Rajasthan and Gujarat. Raw drug is

collected both from wild as well as from cultivation. Unorganized collection of the species from the natural habitat has caused endangered species status.The plant is propagated by the stem disc with the attached fleshy roots as well as by seeds

Preliminary yield trial

PDKV, Akola: Ten genotypes including one check MCB-405 were evaluated. Genotype AKSM- 04 recorded significantly highest number of fleshy roots (12.27). However it was at par with genotype AKSM-08, AKSM-07, AKSM-05 and AKSM-03. The root girth was noticed significantly higher in AKSM-06 and AKSM-08 which was at par with AKSM-04. Significantly highest root yield per plant was in AKSM-08; however it was at par with AKSM-6 and AKSM-07. Fleshy root yield (q ha-1) was significantly highest in AKSM-08 and it was at par with AKSM-06 and AKSM-07.

Isolation of marker compounds

DMAPR, Anand : Aqueous extract prepared from the root powder was used for the column chromatography. One pure compound and five concentrated fractions were collected. The pure compound is being characterized and the concentrated fractions were subjected for further column chromatography to isolate pure compounds.

SALAPARNI *(Desmodium gangeticum)*

It is a perennial shrub belongs to family Fabaceae and is an important member of of *laghupanchamula* groups of plants coming under *dasamula* group. The plant is erect, branched shrub grows up to 1 meter in height. Flowers white, purple or lilac found in elongated terminal or axillary recemes. Fruits are moniliform 6-8 joined pods. Joints separate when ripe into one seeded segments. The useful part is the root and it is an important ingredient in more than 50 ayurvedic formulations. The drug is reported to be a good cardio tonic. It is hot, sweet, diuretc, laxative and nervine tonic. It cures burning sensation, fever, cough, difficult breathing, dysentery, thirst and vomiting. The plant is rich in flavonoids, alkaloids and pterocarpanoids which are responsible for its therapeutic activities.

DMAPR, Anand : DUS descriptors were identified. Three distinct accessions, prostrate type (DDG 6), tall and erect (DDG 15) and narrow and long leaves (DDG 29) were identified besides the pink and white flower plants. The genetic study of flower colour indicated that the pink flower was dominant over the white flower colour. The evaluation of thirty accessions collected from different parts of India indicated that root dry weight had highest genotypic and phenotypic correlation (rp-0.968, rg-0.921) with, stem fresh weight (rp-0.883, rg-0.725) and stem dry weight (rp-0.89, rg-0.722). Partitioning of correlation between different characters showed, plant height, number of secondary branches, number of inflorescences, length of inflorescence, stem fresh weight and leaf fresh weight had direct effect on root dry weight.

SATAVARI *(Asparagus racemosus)*

It is a creeper, belongs to family Liliaceae and is common throughout India and the Himalayas. It has an adventitious root system with tuberous roots that measure about 1 meter in length, tapering at both ends. The roots are used in Ayurvedic medicine, as an anodyne, aphrodisiac and galactogogue. Satavari is considered to be the main Ayurvedic rejuvenating female tonic for overall health and vitality. In the Ayurveda, *A. racemosus* is commonly mentioned as a rasayana drug which promotes general well being of an individual by increasing cellular vitality or resistance. The reputed adaptogenic effect of Satavari is attributed to its saponins content. Cultivation of the species is very limited and under cultivation, it is propagated through seeds. Fleshy roots are harvested, peeled and shade dried and used for the drug preparations.

Collection, characterization, evaluation and maintenance of germplasm

CCSHAU, Hisar: Seven genotypes were evaluated along with HAR-1 as check. Fresh fasciculated root length ranged from 23.53 cm (HRR-03-4) to 30.63 cm (HAR-03-18), fleshy root diameter ranged from 1.43 (HAR-1) to 1.57 cm (HAR-03-18), fresh fasciculated roots per plant ranged from 135.00 (HAR-8) to 186.33 (HAR-03-18), fresh fasciculated root yield per plant ranged from 2.100 kg (HAR-1) to 3.967 kg (HAR-03-18. Significantly higher fresh fasciculated root yield was in HAR-03-18 (460.91 q ha^{-1}) which was at par with HAR-03-17 (448.56 q ha^{-1}).

DMAPR, Anand: Existing germplasm was augmented to 44 accessions of *Asparagus adscendens* and eight accessions of *Asparagus racemous*. In *A. adscendens* a high root yielding line DAA-2 and profuse flowering line, DAA 12 were identified.

Effect of different organic manures on growth and root yield

MPKV, Rahuri: Application of different organic manures *viz*., FYM, vermicompost and PSB alone and in combination were investigated. Maximum plant height (81.71 cm), number of branches $plant^{-1}$ (14.25), root girth (9.27 cm) and root yield (87.29 q ha^{-1}) was recorded in treatement of FYM (5 t ha^{-1}) + vermicompost (2 t ha^{-1})+ PSB (5 kg ha^{-1}).

Seasonal activity of economically important insects

MPKV, Rahuri: Heavy infestation of red coloured bug *Brachytes bicolor* was observed during 27^{th} to 39^{th} SMW. Similarly, heavy infestation of *Eurybracid* bug, *Eurybrachys tomentosus* was observed during 25^{th} to 42^{th} SMW (2011). Maximum activity of both the bugs *i.e. Brachytes bicolor* (193.8 no. $plant^{-1}$) and *Eurybrachys tomentosus* (18.6 no. $plant^{-1}$) was maximum during 35^{th} SMW, when average maximum temperature was 28.7° C, average minimum temperature was 24.4°C, average morning relative humidity was 94.0 %, evening humidity was 74.0 % and average rainfall was 42.0 mm.

Management of red coloured bug (*Brachytes bicolor*)

MPKV, Rahuri: Two sprays of profenofos at 2 ml litre^{-1} were most effective and significantly superior over the other treatments in reducing the infestation of red coloured bug population and increasing the root yield.

Standard operating protocol for identification and quantification of saponins

DMAPR, Anand: Standard operating protocol was developed using HPLC-ELSD for the identification and quantification of sarsasapogenin in *Asparagus* extracts (Fig. 3). Sarsasapogenin content in 26 samples of *A. adscendens* and one sample of *A. racemosus* were quantified. Antioxidant assay using, DPPH assay of different extracts of *A. racemosus* and *A. adscendens* established that *A. racemosus* have higher IC_{50} value than *A. adscendens* which indicated that *A. adscendens* have higher antioxidant activity than *A. racemosus* Furthermore, TLC profile of hydrolyzed extracts of the two species showed that *A. adscendens* had more number of spots than *A. racemosus*.

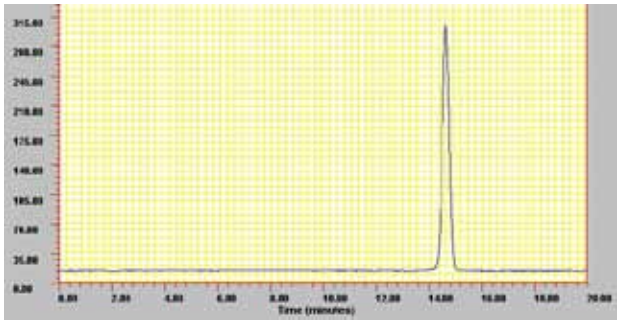


Fig 3. HPLC chromotagram of standard sarsapogenin

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

Germplasm collection and maintenance

DMAPR, Anand : Fifty accessions were collected in the year 2011-12 by exploring parts of Jodhpur and Pali districts of Rajasthan, and Surendranagar, Bhuj and Jamnagar districts of Gujarat where Senna grows in wild. These accessions were multiplied and maintained at DMAPR, Anand. Accessions differed in plant height (100-190 cm), number

of primary branches per plant (5-25), hundred seed weight (1.35-3.11g) and total sennoside content in leaves (1.29-3.55%). *Cassia holosericea* was also collected from Ralol area of Sundranagar.

Advancement of superior selections

DMAPR, Anand : Fifty single plant selections including twenty from cultivar Sona and thirty from ALFT-2 were advanced as plant to row progenies. Various morphological characters were recorded. These selections showed significant variability for days to maturity (193-277 days), plant height (60-210 cm), number of branches per plant (8-28 branches) and test weight (1.25-4.66g). Significant variability in the pod size was also observed in these selections. A small pod size selection (A2-24) was identified and renamed as DCA-121. The selection DCA-121 had pod size of 3x1cm (length x breath) which was about fifty percent smaller than cultivar ALFT-2 having pod size of 5x2 cm (Fig. 4).

Study of floral biology

DMAPR, Anand : Experiments were conducted to study flower structure, *in vitro* pollen germination, pollen viability, stigma receptivity and breeding behaviour in Senna. Flowers of Senna are bisexual, having five petals, five sepals, 10 stamens and one carpel. Of the 10 stamens, four are staminodes which are small and sterile, four are with medium sized anthers which are fertile and two with large anthers (fertile) indicating anther polymerphism (Fig. 5). Anthers were initially green and they turned to brown colour soon after dehiscence and anther showed poricidal dehiscence. Carpel is sickle shaped and ovary single celled, with 1 to 6 ovules. Enantiostyly, a form of floral asymmetry in which the style is deflected away from the main axis of the flower either to the left (left-styled) or the right (right-styled) was observed.

Fig.4. Pod size variation in ALFT-2 (big) and DCA-121 (small) of Senna

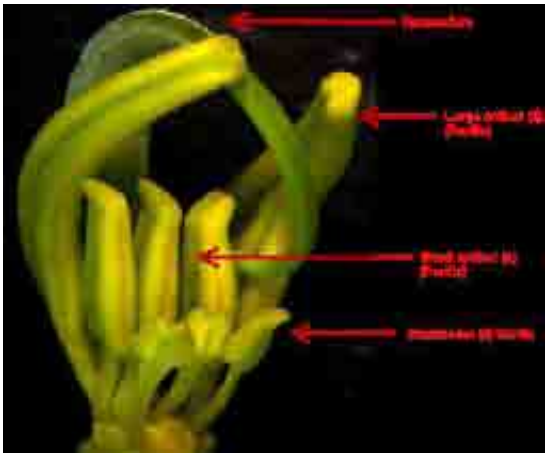


Fig. 5. Anther polymorphism in Senna

In vitro pollen germination was carried to know the viability of the pollen using Brewbaker and Kwack's medium with 30% sucrose at room temperature (relative humidity= 80%). Fresh and fully opened flowers recorded 53 percent pollen germinated. Pollen viability was tested at various temperature regimes and found that at least 10 percent pollens grains

remained viable up to five days when stored at room temperature, up to 10 days at 10°C and up to 14 days at 5°C.

The effective pollination period is closely linked with the duration of stigma receptivity. In order to determine the duration of stigma receptivity, hand pollinations were made at various intervals and found that Senna was having maximum stigma receptivity between 10.00 and 10.30 AM in the month of February and stigma remaind receptive till 12.00 noon under Anand condition (Fig. 6).

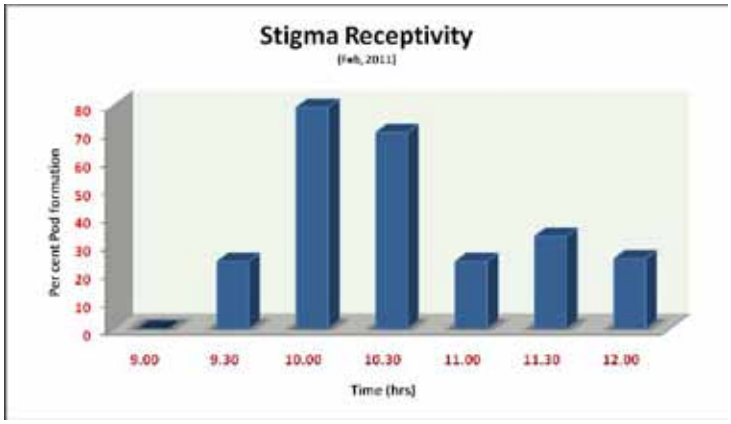


Fig. 6. stigma receptivity in Senna

Breeding system comprised of selfing, sibbing, net bagging entire plot with net before flowering to exclude insects and other pollinators. Apomixis (emasculation and bagging), emasculation and keeping the flowers open, emasculation and hand pollination with pollens from the same flower, emasculation and pollination with pollens of the same plant but different racemes, emasculation and pollination with pollens from the sister plants in a line and natural pollination (buzz pollination) were studied for two seasons, *i.e.* July-September, 2011 and March-June, 2012. For each breeding system at least two hundred buds or racemes were used. Maximum (80% in July-September and 90% March-June season) pod setting was observed when the flowers were allowed for natural pollination (buzz pollination). No pod setting was observed when bagging of individual flowers in a raceme and bunch of flowers in a raceme indicating absence of self pollination. Similarly, no pod set was observed when buds were emasculated and bagged indicating absence of apomixis. Low pod set (5% and 7%) was observed in hand pollinations with pollens of the same flower, emasculation and pollination with pollens of the same plant but different racemes (10% and 10%) and emasculation and pollination with pollens from sister plants (10 and 20%). No pod set was observed when the buds were emasculated and kept open and under insect exclusion condition which indicated that the species is not wind pollinated and role of insect in pollination success.

Effect of organic manures and PSB on growth, yield and quality

MPKV, Rahuri: Effect of organic manures (FYM and vermicompost) and PSB either alone or in combination on growth, yield and sennoside content was recorded. Maximum plant height (99.50 cm), fresh and dry weight of leaves (9.33 and 4.33 kg), LAI (0.27) and leaf yield (154.68 q ha^{-1}) were recorded for the plots supplied with FYM (5 t ha^{-1}+ Vermicompost 2 t ha^{-1}+ PSB 5 kg ha^{-1}). Maximum sennoside content (3.13 %) was obtained by the application of FYM (5 t ha^{-1}) alone.

Effect of planting time on growth, yield and quality

MPKV, Rahuri: The effect of five planting dates (10th July, 20th July, 30th July, 10th August and 20th August) on growth, yield and quality was studied. Maximum plant height (74.63

cm), fresh (14.32 kg plant^{-1}) and dry weight of leaves (7.93 kg plant^{-1}), leaf yield (121.65 q ha^{-1}) and seed yield (3.33 kg plot^{-1}) was recorded in sowing date of 10th July, which was at par with 20th July sowing. Late planting (August onwards) reduced all these parameters drastically.

Effect of spacing on growth, yield and quality

MPKV, Rahuri: Six different spacings (30x15, 30x30, 30x45, 45x15, 45x30 and 45x45 cm) were investigated for growth, yield and quality parameters. Maximum plant height (88.75 cm), fresh (11.39 kg) and dry weight of leaves (6.70 kg plant^{-1}) was recorded at a closer spacing of 30 x 15 cm. Whereas, LAI (0.44), seed (3.12 kg plot^{-1}) and leaf yields (15.48 kg plot^{-1}) were found maximum when the plants were spaced at a distance of 30x45 cm.

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 transplanting will be at 4-5 leaf stage of the seedling at the onset of monsoon. Freshly harvested material is distilled for oil extraction.

Nutrient management studies

NDUAT, Faizabad: Application of FYM (10 t ha^{-1}) along with N, P, K (30, 20, 10 kg ha^{-1}) yielded maximum herbage (157.05 q ha^{-1} as fresh, 38.33 q ha^{-1} as dry) and essential oil (38.85 l ha^{-1}), followed by application of N, P, K @ 30:20:10+ 5 t FYM and N,P,K @ 50:40:30+ 10 t FYM.

Effect of nitrogen levels and spacing on the growth and seed yield

RVSKVV, Mandsaur: The experiment comprising of five different levels of nitrogen (0, 20, 40, 50 and 60 kg ha^{-1}) and two levels of spacing (40x20 and 60x40 cm) was conducted to know their effect on growth and seed yield. The data showed that highest plant height (81.5 cm), number of branches (17 plant^{-1}), dry herbage yield (43.5 q ha^{-1}) and seed yield (19.7 q ha^{-1}) were recorded in application of higher dose of N (60 kg ha^{-1}) as compared to control. Highest plant height (67.2 cm) was recorded for closer spacing (40x25 cm) as compared to wider spacing (60x40 cm). Maximum number of branches (16 plant^{-1}), dry

herbage yield (32.8 q ha-1) and seed yield (14.6 q ha-1) were recorded at a wider spacing. The interaction between nitrogen levels and spacing was found to be non significant.

Survey of arthropod pests of medicinal and aromatic plants

Plant/crop	Local name	Scientific name	Family	Order	Pest Status
DMAPR, Anand					
Withania somnifera	Jassids	*Amrasca biguttula biguttula*	Cicadellidae	Hemiptera	Sporadic
		Nephotettix virescens			
		Aconurella prolixa			
		Balclutha incisa			
		Balclutha saltuella			
	Tree hoppers	*Leptocentrus* sp.	Membracidae	Hemiptera	Sporadic
		Tricentrus			
Cassia angustifolia	Hairy caterpillar	*Spilarctia* sp.	Arctiidae	Lepidoptera	Sporadic
Aloe barbadensis	Aphid	*Aphis gossypii*	Aphididae	Homopera	Sporadic
Chlorophytum borivilianum	Semi Looper	*Trichoplusia ni*	Noctuidae	Lepidoptera	Sporadic
	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera	Sporadic
Plantago ovata	Hairy caterpillar	*Spilarctia* sp.	Arctiidae	Lepidoptera	Sporadic
Centella asitica	Jassid	*Empoascanara plamka*	Cicadellidae	Hemiptera	Severe
Andrographis paniculata	Gram pod borer	*Helicoverpa armigera*	Noctuidae	Lepidoptera	Sporadic
	Green bug	*Nizara viridula*	Pentatomidae	Hemiptera	Sporadic
Boerhaavia diffusa	Hairy caterpillar	*Spilarctia* sp.	Arctiidae	Lepidoptera	Sporadic
Convolvulus microphyllus	Snout beetles	*Myllocerus* sp.	Curculionidae	Coleoptera	Sporadic
		Crytozemia dispar	Curculionidae	Coleoptera	Sporadic
Desmodium gangeticum	Snout beetle	*Myllocerus* sp.	Curculionidae	Coleoptera	Sporadic
	Orange band blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera	Sporadic
	Tussock caterpillar	*Olene mendosa*	Lymantridae	Lepidoptera	Sporadic
Sapindes emarginatus	Swarming bug	*Leptocoris abdominalis*	Rhopalidae	Hemiptera	Severe
Asparagus recemosus	Aphid	*Aphis craccivora*	Aphididae	Homoptera	Severe
Enicostemma exillare (=littorale	Snout beetle	*Myllocerus sp.*	Curculionidae	Coleoptera	Sporadic
	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera	Sporadic
Saraca asoca	Tussock caterpillar	*Olene mendosa*	Lymantridae	Lepidoptera	Sporadic
	Looper	*Hyposidra successaria*	Geometridae	Lepidoptera	Sporadic

BCKV, Kalyani					
Artemitia vulgaris	Bihar hairy caterpillar	*Spilarctia obliqua*	Arctiidae	Lepidoptera	Sporadic
Psoralea corylifolia	Citrus butterfly	*Papilio demoleus*	Papilionidae	Lepidoptera	Severe
Erythrina variegata	Red Spider Mite	*Eutetranychus banksi*	Tetranychidae	Prostigmata	Severe
Datura metel	Tenuipalpid mite	*Brevipalpus* sp.	Papilionidae	Lepidoptera	Severe
Gymnema sylvestre	Chrysomelid beetle	*Platycorynus* sp.	Chrysomelidae	Coleoptera	Sporadic
Tabernaemontana coronaria	Pyralid leaf folder	*Glyphodes glauculalis*	Pyralidae	Lepidoptera	Severe
Pergularia daemia	-	*Danaus chrysippus*	Nymphalidae	Lepidoptera	Sporadic
Uraria picta	Hada beetle	*Epilachna vigintioctopunctata*	Coccinellidae	Coleoptera	severe
Ocimum sanctum	Lace wing bug	*Cochlochila bullita*	Tingidae	Hemiptera	Severe
Centella asiatica	Tobacco caterpillar	*Spodoptera litura*	Notuidae	Lepidoptera	Sporadic
YSRHU, Venkataramanagudem					
Abelmoschus moschatus	Leaf hopper	*Amrasca biguttula biguttula*	Cicadellidae	Homoptera	Sporadic
	Orange band blister beetle	*Mylabris pustulata*		Coleoptera	Sporadic
	Red cotton bugs	*Dysdercus cingulatus*	Pyrrhocoridae	Hemiptera	Sporadic
	Shoot and fruit borer	*Earias vittella*	Notuidae	Lepidoptera	Severe

BETELVINE *(Piper betle)*

P. betel is a perennial evergreen dioecious climber, belonging to the family Piperaceae. It is a native of Central and Eastern Malaysia and has spread throughout tropical Asia and Malaysia; Madagascar and East Africa at a later date. The plant grows well in shady conditions having moderate temperature with high humidity. The major cultivating countries are India, Bangladesh, Srilanka, Pakistan, Malaysia, Thailand, Indonesia, Maldives, Vietnam and Papua New Guinea. In India it is cultivated in an area of about 50,000 ha. 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 is also medicinal and is used in Indian System of Medicines to cure indigestion, stomach ache, diarrhoea, flatulence and to heal wounds, bruises, swellings due to sprains, respiratory disorders, constipations, boils and gum disorders. Recent studies also revealed that the leaf improves immune system and inhibits cancer growth.

Crop Improvement

IIHR, Bangalore: A total of ninety-eight germplasm are being maintained. Germplasm evaluation conducted at the centre showed that Godi Bangla had highest yield (141.1 leaves/vine , 8.708 lakh leaves/ha).

BCKV, Kalyani: Fifty eight germplasm and hybrids of betelvine are maintained at two borejas at Kalyani and Mondaury Farms of BCKV.

IIHR, Bangalore: Hybridization was continued among the selected parents and new crosses were also attempted along with interspecific hybridization between *P. betle* and *Phytophthora* resistant *P. colubrinum*. Seeds of the different crosses are being germinated and in some crosses seedlings are being established in the polyhouse. Most of the male hybrids expressed poor vigour and majority of the female hybrids exhibited high vigour as reported earlier.

Testing of eight hybrids along with four parental lines showed that the number of harvestable leaves per vine varied from 43.18 to 280.4. Among the hybrids, only Hy 06-4 recorded significantly higher leaf yield/vine (280) over the other hybrids and parents (SGM1 and Swarna Kapoori). Another set of thirty hybrids which were planted in the field during the years 2010 and 2011 showed that ten hybrids had desirable plant vigor and leaf traits.

Selected hybrids were also planted under shade net house (simulating *bareja* conditions) and evaluated for growth and yield. All the hybrids recorded good growth under shade net conditions. Hybrids Hy 7-04, 08-20, 06-3 and 06-8 produced more number of leaves/vine *i.e.,* 49, 47, 46 and 45, respectively.

In another trial, twenty three hybrids planted during 2011 were evaluated for growth and yield. The hybrids Hy 07-24, 07-35, 07-36, 08-20, 06-1, 06-4 and 06-11 showed good plant growth and vigor both in field and shade net conditions.

Crop Production

Efficacy of biofertilizer on Betelvine production

BAU, Islampur: Effect of application of inorganic fertilizers, manures and bio-fertilizers alone and also in combination were investigated for growth, yield and foot rot incidence. Among the seven treatments, application of vermicompost (10 ton/ha) recorded significantly higher crop growth parameters *viz*., number of branches per vine (23.94), vine elongation per month (10.97 cm), number of marketable leaves (24.17 lakh/ha) and weight of 100 leaves (204.20 gm), followed by urea+ oilcake (1:1). Response to the foot rot disease incidence varied due to the different treatments and it was reduced significantly with the application of organic manures and microbial inoculants compared to the application of inorganic nutrients alone.

Effect of plant population on yield and quality

BAU, Islampur: Three levels of plant populations (1.50, 1.75 and 2.0 lakh plants/ha) were compared with the farmers' practice (1.25 lakh plants ha^{-1}). The results showed that population density (1.50 lakh plants ha^{-1}) recorded higher number of branches per vine (14.30) and vine elongation per month (10 cm). However, number of marketable leaves per plant (22.50 and 24.07 lakh ha^{-1}) and weight of hundred leaves (227.0 and 232.7 g) were highest in higher plant populations of 1.75 and 2.0 lakh plant ha^{-1}. Disease incidence of foot rot was observed higher in wider spacing of 2.0 lakh ha^{-1} (17%), followed by farmers' practice of 1.25 lakh/ha (13.2%), whereas, it was least in plant population of 1.50 lakh/ha.

Crop Protection

Demonstration of Integrated Crop Management (ICM) of Betelvine has been carried out and reported by seven centres such as Mahatma Phule Krishi Vidyapeeth, Rahuri; Bihar Agricultural University, Islampur; Bidhan Chandra Krishi Viswavidyalaya, Kalyani; Rajendra Agricultural University, Pusa; Orissa University Of Agriculture & Technology, Bhubaneswar; Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur; and Dr. YSR Horticultural University, Venkataramannagudem. Result of the all the centers univocally highlighted the usefulness of the ICM module in increasing the crop yield (upto 40%) as well as the economic return to the farmers. This has also proved its usefulness in reducing the crop loss due to all the important diseases.

Plant Genetic Resources

Germplasm of medicinal and aromatic plants maintained at DMAPR

Sl. No.	Species	No. of Acessions
1	*Aloe spp.*	55
2	*Andrographis paniculata*	60
3	*Asparagus spp.*	88
4	*Cassia angustifolia*	50

5	*Chlorophytum borivilianum*	54
6	*Commiphora wightii*	150
7	*Cymbopogon martinii*	07
8	*Desmodium gangeticum*	52
9	*Gymnema sylvestre*	43
10	*Plantago ovata*	84
11	*Tinospora cordifolia*	35
12	*Urgenia spp*	12
13	*Withania somnifera*	140
	Total	830

Germplasm of medicinal and aromatic plants maintainedatAICRP centres

Sl. No.	Crop	Centre	Accessions
1	*Aloe barbadensis*	AAU, Anand BCKV, Kalyani CCSHAU, Hisar IGKV, Raipur IIHR, Bangalore NDUAT, Faizabad PDKA, Akola RVSKVV, Mandsaur	30 02 30 07 42 20 18 10
2	*Acorus calamus*	YSRHU, Venkataramanagudem	11
3	*Andrographis paniculata*	AAU, Anand CCSHAU, Hisar NDUAT, Faizabad	20 13 20
4	*Asparagus spp.*	AAU, Anand CCSHAU, Hisar JNKVV, Jabalpur NDUAT,Faizabad	6 24 14 24
5	*Bacopa monnieri*	KAU, Thrissur RAU, Pusa	29 11
6	*Cassia angustifolia*	AAU, Anand	17
7	*Chlorophytum borivilianum*	AAU, Anand CCSHAU, Hisar MPUAT, Udaipur RVSKVV, Mandsaur PDKV, Akola	20 12 10 24 13
8	*Commiphora wightii*	AAU, Anand MPUAT, Udaipur	33 16
9	*Cymbopogon martinii*	CCSHAU, Hisar	65
10	*Cymbopogon spp.*	CCSHAU, Hisar KAU, Thrissur NDUAT, Faizabad	46 20 16

Sl. No.	Crop	Centre	Accessions
11	*Gymnema sylvestre*	CCSHAU, Hisar JNKVV, Jabalpur	8 7
	Indigofera tintctorea	KAU, Thrissur	25
12	*Lepidium sativum*	CCSHAU, Hisar RVSKVV, Mandsaur	22 24
13	*Centella asiatica*	AAU, Jorhat BCKV, Kalyani RAU, Pusa	16 06 11
14	*Mucuna spp.*	AAU, Anand IIHR, Bangalore	20 112
15	*Nelumbo nucifera*	KAU, Thrissur	24
16	*Ocimum basilicum*	RVSKVV, Mandsaur	21
17	*Ocimum sanctum*	AAU, Anand CCSHAU, Hisar	17 12
18	*Papaver somniferum*	NDUAT, Faizabad MPUAT, Udaipur RVSKVV, Mandsaur	36 85 235
19	*Picrorhiza kurroa*	YSPUHF, Solan	20
20	*Piper longum*	AAU, Jorhat BCKV, Kalyani KAU, Thrissur OUAT, Bhubneshwar	27 04 25 14
21	*Podophyllum hexandrum*	YSPUHF, Solan	12
22	*Plantago ovata*	AAU, Anand CCSHAU, Hisar MPUAT, Udaipur NDUAT, Faizabad RVSKVV, Mandsaur	55 83 32 42 80
23	*Plumbago rosea*	KAU, Thrissur	25
24	*Plumbago zeylanica*	TNAU, Coimbatore	45
25	*Saraca asoca*	KAU, Thrissur	42
26	*Silybum marianum*	AAU, Anand	10
27	*Solanum nigrum*	TNAU, Coimbatore YSRHU, Venkataramanagudem	53 34
28	*Tinospora cordifolia*	AAU, Anand YSRHU, Venkataramanagudem BCKV, Kalyani CCSHAU, Hisar	6 13 03 20
29	*Withania somnifera*	AAU, Anand CCSHAU, Hisar IIHR, Bangalore IGKV, Raipur MPUAT, Udaipur PDKV, Akola RVSKVV, Mandsaur	40 28 190 22 76 08 119
30	*Vetiveria zizaniodes*	CCSHAU, Hisar KAU, Thrissur NDUAT, Faizabad	50 37 12

Germplasm of betelvine maintained at AICRP centres

Centres	Total collection	Catalouged
AAU, Jorhat	10	10
BCKV, Kalyani	61	61
IIHR, Hirehalli	98	98
MPKV, Rahuri	28	28
OUAT,Bhubneshwar	21	21
RAU,Pusa	11	20
BAU,Islampur	16	16
YSRHU, Venkataramanagudem	64	61

Intellectual Property Rights

DMAPR, Anand: Two elite germplasm *i.e.,* one each in Ashwagandha (*Withania somnifera*) - DWS 327 and in Isabgol (*Plantago ovata)* - DPO 14 were identified and registerded with NBPGR, New Delhi during the year. The details are as follows.

DWS 327 (INGR 11026) : A dwarf (25- 30 cm) early maturing (120-130 days) with high withanolide A content (>1.75 mg g^{-1} dry weight).

DPO 14 (INGR 11035): An early maturing (80-85 days) mutant line with high harvest index (>22%).

Agricultural Knowledge Management Unit (AKMU)

Strengthening of Herbal Gardens Network

Attempts are continued for strengthening of herbal gardens network at **www.herbalgardenindia.*org*** under the project "Strengthening, Up-gradation and Maintenance of web based Herbal Gardens Network for quality planting material supply in India". A number of 25 herbal gardens were registered newly under this network during this period (Table 1). Also about 200 species photographs were appended to this existing database. The information related to herbal gardens, availability of species in each garden has been updated. The species

information based on plant habits viz., herb, shrub, tree and climber have been collected, compiled and updated in the database. List of newly registered herbal gardens is as follows.

1. Herbal Garden - Trikuta Hills, Katra
2. Sita Ashok Herbal Garden, Pune
3. AUS UPVAN, Ranchi
4. Late Tatyasaheb Ringangaokar Udyan, Nagpur
5. Dhanvantri CCMB Herbal Garden, Hyderabad
6. Coastal Ecosystem Herbal Garden, Annamalainagar
7. Herbal Garden of NIU - Kottigepalya, Bangalore
8. Siddha Medicinal Plants Garden, Mettur
9. Venknath Herbal Garden Loni, Shrigonda
10. Mahesh Munot Vidyalaya, Rahuri
11. Ambejalgaon Herbal Garden, Kargat
12. Gangangiri Maharaj Herbal Garden, Sangamner
13. Sant Teresa Herbal Garden, Shrirampur
14. Herbal Garden - Janta Vidyalay , Lohoner
15. Renuka Mata Herbal Garden, Sinnar
16. Dr. Baliram hire Adivasi Vidaylaya, Dari Herbal, Dari
17. Herbal Garden - Saraswati Madhyamik Vidyalaya,, Malegaon
18. Herbal Garden - D.R. Bhosale Vidyalaya, Deogaon
19. Adarsh Herbal Garden, Sundarde
20. Mathama Gandhi Bunidhi Vidhyalaya, Akkalkuwa
21. Jijamata Madhyamik Vidyalaya, Erondol
22. Herbal Garden - Haribahau Chavan Primary Ashram School,, Lonje
23. Herbal Garden - Samaj Vikas Vidyalaya, Shindad
24. Jawahar Navoday Vidyala, Wardha
25. Vivekanand Sec. Vidyalaya, Mangali (Rvt.), Mangali

Databases

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

General Information

GENERAL INFORMATION

Committee meetings

Research Advisory Committee (RAC)

Ninth Research Advisory Committee meeting was held on April 19, 2011 at DMAPR under the chairmanship of Dr. B. R. Tyagi, Ex Deputy Director, CIMAP, Lucknow. Other members participated in the meeting are : Dr. R.C. Srivastava, Joint Director, Botanical Survey of India, Kolkata, Dr. G.S.R. Murthy, Ex. Head, Division of Plant Physiology and Biochemistry, IIHR, Bangalore, Dr. Y.B. Tripathi, Head, Department of Medicinal Chemistry, Institute of Medicinal Science, BHU, Varanasi, Dr. Umesh Srivastava, ADG (Hort.II), ICAR, New Delhi, Dr. Satyabrata Maiti , Director, DMAPR, Anand and Dr. Vandana Joshi, Principal Scientist (Eco. Botany) as Member Secretary, RAC. The meeting started with the welcome note proposed by Dr. Vandana Joshi. The Chairman initiated proceedings with introductory remarks of RAC members. Dr. Yamini B. Tripathi highlighted the importance of research in the field of herbal products and also the importance of computer applications in planning the medicinal plants research. Dr. Umesh Srivastava underlined the importance of in situ conservation of medicinal plants and also to make available the quality seed/ planting materials to the farmers. Dr. G.S.R. Murthy, mentioned about the importance of prioritization of research in medicinal and aromatic plants (MAP) since priorities are changing over the time due to shifting of emphasis on health care needs of people. He also pointed out the need of organic farming and marketing problems faced by the MAP growers. The importance of taxonomy in authentication of medicinal plants was highlighted by Dr. R.C. Srivastava. Further, he emphasized the need for documentation of traditional knowledge available in MAP, use of tools like bar coding to ratify the problems with classical taxonomy and establishment of the authenticity of medicinal products in context of adulteration using DNA marker. Thereafter, the Chairman highlighted the importance of meticulous literature review before planning any research proposal. He also emphasized the orientation of research should be based on stakeholders needs. An interaction meeting of research scientists and various stakeholders for planning, prioritization and execution of research activities was suggested by him. After the appraisal of the action taken on recommendations made during the last RAC meeting by the Member Secretary, research findings in germplasm collection, characterization, maintenance, breeding, biotechnology, crop production, crop protection and phytochemistry and computer application were presented before the RAC by Drs. P Manivel , Principal Scientist (Plant Breeding) and Vipin Chaudhary, Senior Scientist (Agricultural Entomology). Dr. Y.B. Tripathi delivered a lecture on the topic “Polyherbal formulation for diabetic complications: leads for collaborative research”. An interaction among scientists, Chairman and Members on refinement of ongoing research activities was also held leading to drawing the recommendation for the next year. The meeting ended with the vote of thanks proposed by Dr. P. Manivel.

Institute Research Committee (IRC)

The 20th Institute Research Committee Meeting was held as a follow up action of RAC under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR, Boriavi during April 20-21, 2011. Dr. B.R. Tyagi, Chairman, RAC, DMAPR was also present as a special invitee on first day of the meeting to discuss the new research project proposals submitted by the newly joined scientists. Dr. P. Manivel, Principal Scientist (Plant Breeding) and Secretary, IRC, welcomed the Chairman and members of IRC. Drs. Smitha, G.R. and N.A. Gajbhiye were congratulated for getting the Ph. D. degree during last year. Dr Manivel also reminded the house about the points suggested by Honourable DG, ICAR during his visit to the directorate last year. Dr. Satyabrata Maiti, in his introductory remarks, welcomed Dr. B. R. Tyagi for the meeting and emphasized that the new projects should be prepared only after thorough literature search for analyzing the existing gaps in our knowledge. Further, he also mentioned that importance of healthy criticism in research activities and need of being cautious in publicity. Dr. B. R. Tyagi, advised the scientists for multidisciplinary research and suggested writing a review article on the selected topic before proposing a new research proposal. Thereafter, the action taken report of the last IRC recommendations was presented by Member Secretary. New project proposals were presented by the newly joined scientists. After detailed discussions of the projects, some modifications were suggested in new research proposals. The findings of research projects and targets to be accomplished during next year were also thoroughly discussed. At the end, the Member Secretary proposed vote of thanks to the Chairman and members.

Institute Management Committee (IMC)

The 23rd IMC meeting was held on February 25, 2012 at DMAPR under the Chairmanship of Dr. Dr. Satyabrata Maiti, Director, DMAPR. Dr. Umesh Srivastava, Assistant Director General (Horticulture-II), Dr. G.G.Rao, Dr. R.S. Kurothe, Dr. Vipin Chaudhary, Sh. Mangal Singh and Sh. K .Raghnadhan were the others members present in the meeting. A brief report of progress achieved by the directorate and action taken report of the last meeting were presented by Sh. Raghnadhan, Member Secretary. Agenda items, research and development activities of the directorate were discussed by the committee members.

EXTENSION ACTIVITIES

Training cum Workshop on Growing Importance of Medicinal and Aromatic Plants

A two day Training cum Workshop on "Growing Importance of Medicinal and Aromatic Plants" was organised at DMAPR, Anand during April 15-16,2011 by Fragrance and Flavour development Centre, Kannauj. Honourable Sh. Bharat Singh Solanki, Minister of State for Railways, Government of India, inaugurated the programme. One hundred participents including forty farmers attended the training.

Contract research

A contract research for developing good agricultural practices of Mamejo (Enicostemma axillare) was carried out by the Directorate for M/s Shree Dhootapapeshwar Limited, Mumbai. A cheque for Rs. 2.00 lakh was delivered to the directorate by M/s Dhootpapeshwar Limited in a small ceremony on June 09, 2011. This opens the further contract research possibilities and capabilities of the Directorate.

Training toolkit on GACP of medicinal plants released

Adoption of GACP by farmers and collectors is essential for compliance of quality standards of world herbal market to consolidate our position. In this context, a unique toolkit comprising of Good Agricultural and Collection Practices (GACP) illustrated booklet, training manual, training video and illustrated cause and effect of training tool was jointly released Dr. S. Ayyappan, Secretary, DARE & Director General , ICAR and Dr. Gavin Wall, FAO, in presence of Dr. Satyabrata Maiti, Director, DMAPR and other dignitaries from DBT, QCI, ICAR Hqs and NMPB by on May 30,2011 at New Delhi. This toolkit was developed under a project implemented by FAO in India and Bhutan with the grant support from the International Fund for Agriculture Development (IFAD). Dr. S. Ayyappan and Dr. Gavin Wall expressed their views on skill development for evaluation of medicinal plants from natural ecosystem. In the function, a short film on the subject was also screened.

Keynote speech delivered by the Director, DMAPR in Egypt

Dr. Satyabrata Maiti, the Director, DMAPR, was specially invited as a keynote speaker in the launching ceremony of the EMAP Project workshop on "Establishing an Egyptian Quality Scheme for Medicinal and Aromatic Plants" under upgrading the medicinal and aromatic Plants (MAP) value chain-access to export market organized jointly by United Nations Industrial Development organization (UNIDO), State Secretariat of the Economic Affairs SECO, Switzerland, Ministry of Industry and Foreign Trade, Egypt during November 16-17, 2011. The project was launched for four years for upgrading MAP sector by establishing an integrated quality and safety scheme, improving varieties, increasing productivity, reducing loss and upgrading production and processing technologies. In his speech, Dr. Maiti , shared the Indian experience in introduction of quality schemes in medicinal and aromatic plants Sector. Development of good agricultural practices protocol of Egyptian medicinal and aromatic plants followed by the certification of produce through third party certification agency following the national certification standards were highlights of his speech. He mentioned that it is necessary to place these protocols and standards in the website for acceptance of the international buyers. Two more lectures on Indian value

chain of MAP and GAP certification were delivered by him before the working group of the workshop.

Institute visit

During the year more than eight hundred visitors including farmers, students and individuals visited the directorate. Farmers were mainly from three states namely Gujarat (101), Madhya Pradesh (38) and Rajasthan (114). Students (337) were mainly from Ayurvedic and Pharmacy colleges. The visitors were briefed about the use and agro-techniques of different medicinal plants with special reference to mandated crops of the directorate. The supply of quality planting material to the visitors was ensured to as per their requirement.

Resource generation

During the year a, revenue of ₹ 2, 63,500.00 was generated through sale of farm produce. Besides that, under Revolving Fund Scheme a revenue of ₹. 3, 53,000.00 was generated through sale of seeds and planting material.

Media meet organized

A media meet was organized on March 28, 2012 under the aegis of National Agricultural Innovation (NAIP) project "Mobilizing Mass Media Support for Sharing Agro-Information. The meet was chaired by Dr. Satyabrata Maiti, Director, DMAPR and was attended by twenty five media persons both from electronic and print media located in Anand and Vadodra.

OTHER ACTIVITES

Brainstorming Discussion on Prioritization of MAP Research for the 12th Plan

A brain-storming discussion was organised by the DMAPR, Anand on 23rd August 2011 to discuss and prioritize researchable issues in the area of MAPs for the 12th five year plan period. Scientists, entrepreneurs and CEOs from some of the industries and representatives of other stakeholders participated in the discussion.The notable participants were Dr. Umesh Srivastava, Assistant Director-General (Horticulture-II), ICAR, Dr. B. R. Tyagi, Chairman RAC, DMAPR; Dr. G. S. R. Murti, Member RAC; Dr. R. C. Srivastava, Member RAC; Dr. Harish Padh, Vice Chancellor, SP University Anand; Sh. Shyam Varshney, Director, Som Extract Ltd, Delhi; Dr. K. B. Kathiria, Director Research, AAU, Anand; Dr. Surendra Bhatt, Natural Solution Inc., Vadodara; Dr. Pratik Patel, Vasu Health Care, Vadodara; Dr. C. J. Shishoo, Director, PERD, Ahmedabad; Prof M. Daniel, Prof & Head, Dept. of Botany, M. S. Univ., Vadodara; Dr. A. R. V. Murthy, Principal, J P Ayurveda College, Anand; Prof. R. H. Parikh, Principal, RP College of Pharmacy, Changa, Anand; Dr. Geetha Patel, Vice President, Cadilla; Mr. S. C. Pant, CEO, SMPB, Ahmedabad and Dr. S. Sriram, Head, Medicinal Units AAU, Anand .

The inaugural cum first session was held under the Chairmanship of Dr. U. Srivastava, and Co-Chairmanship of Dr. G. S. R. Murti. The meeting started with welcome address by Dr. Satyabrata Maiti, Director, DMAPR and introductory address by Dr. U. Srivastava. Thereafter, Dr. S. Maiti delivered a talk on current status of on-going R&D activities at DMAPR and its significant achievements. Dr. Srivastava presented the scenario of the MAPs sector starting from ancient to the present level. He stressed the importance of this sector in coming years for its sustainability and for the mankind. He also reminded of the recommendations of Planning Commission for MAPs sector for which he opined that an in-depth knowledge is required so that different trends in this sector can be taken care of. Further, he emphasized that in future linkages need to be strengthened between private and public sectors for taking research and trade in MAPs to the maximum extent for the betterment of agricultural growth. Dr. Maiti highlighted the importance of MAP in ushering in food and health security. He mentioned that for quantum jump in yield potential increase in the resource use efficiency of the MAPs, i.e., to produce "more from less" is required. He also mentioned about the constraints of MAPs sector particularly about poor data base in MAPs, lacking quality standard as well as inefficient, informal, secretive and opportunistic marketing system. There is a lack of desire to collaborate and cooperate among different stakeholders. Therefore, he urged that DMAPR should take initiative to do both short and long term research of national importance. He further stressed that this can be achieved only through team based programmes focusing on basic, strategic and applied research

Dr. B. R. Tyagi, stressed on establishing close linkages between industry and R&D organizations like DMAPR, thereby, allowing mid-way corrections , if required, in the on-going research programmes at DMAPR. He also suggested that it is possible to create a success story in case of a selected medicinal or aromatic plant through close interaction of its user industry, DMAPR and growers which can be used as a model to set the tune of research activities for other selected MAPs.

In the beginning of second session, Dr B.R. Tyagi, Chairman mentioned that the main purpose of the meeting was establishment of linkages between the DMAPR, industry and the stake holders. He suggested that the research programme for the mandate crop of directorate should accordingly be framed for the next five year plan. Dr. R.C. Srivastava, suggested that some more crops particularly for diseases like malaria and tuberculosis should be included in the list of mandate crop of the directorate. Quality issues were discussed thoroughly in this session also. Dr. Tyagi mentioned that we should be clear about the quality, i.e. quality of raw material should be ensured at DMAPR level. Accreditation of the laboratory (ISO 9000/NABL) was suggested by him. In this context, Dr. Maiti, highlighted that DMAPR has excellent laboratory facility but cosmetic modification is only to be done and ISO certification of DMAPR laboratories will be undertaken. Dr. B.R. Tyagi also mentioned the need for proper post harvest management and storage facilities to retain the quality of the medicinal and aromatic crops produce.

In the end, Dr. B. R. Tyagi emphasized on the development of scientific infrastructure and identification of some of the important challenging programmes. He also stressed the importance of already known concept, which should be translated into products through linkages and broad based research. The chairman thanked all the participants for their active involvement in the discussion.

XIX Group Meeting of AICRPMAP&B

The 19th Group Meeting of the All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine was organised at Dr. Y.S.Parmar University of Horticulture and Forestry, Nauni,Solan, Himachal Pradesh during September 21-24,2011. Dr. Satyabrata Maiti, Project Coordinator, AICRPMAP&B, presented the salient achievements made by various Co-coordinating centers. Dr. Umesh Srivastava, ADG (Hort.II),ICAR, New Delhi, presented future prospects of the project in ICAR and explained about the functioning of the AICRP and its journey. He expressed satisfaction on overall development of the project and reiterated that per capita annual consumption of drugs of 125 is the lowest in the world mainly because of medicinal plants. The demand for plant based therapeutics is increasing in both developing and developed countries due to the growing recognition that they are natural products, having no or littler side effects, easily available at affordable prices and sometimes the only source of health care available to the poor. He, further emphasized that the programmes such as management of germplasm, development of varieties suitable for region,generation of production technology, partenership and network information with extension activities etc. should be carried out the under AICRP. He also informed the house that the functioning of AICRP is being examined critically in the council and all steps will be taken to run the project smoothly so as to achieve the targets set for AICRP.

Dr. K. R. Dhiman, Hon'ble Vice Chancellor of the University in presidential address expressed thanks to the ICAR authority for giving third opportunity to host this group meeting in this University. He briefed that India has a huge biodiversity and North-West Himalayas are a well-known treasure house of medicinal plants. The ancient scriptures and the mythology are full with references about the healing plants from the Himalayas. Himachal Pradesh, having a geographical area of 55,673 sq. kms (about 1.7% of the country's geographical area), aptly showcases this medicinal plant richness and diversity of the zone that is spread over its different agro-climatic zones and vegetation types stretching from an altitude of about 300 m along the Punjab plains to more than 6000 m along the inner Himalayan ranges. The state harbours more than 3500 species of flowering plants, out of which about 800 species are estimated to be used for some or other medicinal purposes within and outside the state.

The group meeting was divided into seven sessions including four technical sessions such as Crop Improvement, Crop Production, Crop Protection ,Phytochemistry. Data of experimental trials conducted at various centres during 2010-11 were presented and therafter,technical programme for the year 2011-12 was formulated. Plenary session was held on September 23, 2011 under the Chairmanship of Dr. Dr. K. R. Dhiman. Recommendations of each session and technical programme were presented in plenary session for approval by the house.

Dr. R. C. Rana, Head, AICRP on Medicinal and Aromatic Plants & Betelvine, YSPUHF, Solan centre proposed vote of thanks at the end.

Official Language Implementation

Four quarterly meetings of official Language Implementation Committee to review the progress of use of Hindi in day to day work in the Institute was organised. Proceedings of these meetings were regularly sent to Hindi Cell, ICAR, New Delhi. Besides, all efforts were made to popularize Hindi in the DMAPR by adding Hindi magazines and books in the library. In addition, Hindi translation, reply to the Hindi letters, summary of annual report publication in Hindi, comparing in Hindi in meetings etc. were done to promote Hindi among the staff.

The official language implementation day (14th September) was celebrated in the DMAPR by organising a Hindi Fortnight from 14th -28th September, 2011 under the aegis of Official Language Implementation Committee (OLIC) of the Institute. During the entire fortnight several competitions viz., Essay writing, Letter writing, General hindi, Poem recitation, GK quiz and Extempore etc were organised. On 28th September, 2011, the closing ceremony was organized. Smt. Daksha J Panchal, Hindi Officer, Central Bank of India, Anand graced the occasion as Chief Guest, Sh. Anand Prakash Rai, PGT (Hindi), Kendryia Vidyala, V. V. Nagar, Anand was the Guest of Honour and Dr. Satyabrata Maiti, Director and President, OLIC chaired the session. Runners and winners of the various competitions were presented the certificate and prizes.

Mobilizing Mass Media Support for Sharing Agro-Information under the NAIP

DMAPR, Anand was included in World Bank funded project "Mobilizing Mass Media Support for Sharing Agro-Information "under NAIP. Strengthening of agricultural communication, creation of an interactive and multi-layered communication system, building up and harnessing synergy of inter-institutional communication platform in participatory mode and capacity building for agricultural communication in different modes and media are the main objectives of the project.

International Year of Forest and Chemistry Celebrated at DMAPR, Anand

The International Year of Forest was celebrated at the Directorate of Medicinal and Aromatic Plants Research (DMAPR), Anand on September 17,2011. Shri Bala Prasad, Chief Executive Officer, National Medicinal Plants Board, Government of India, New Delhi, was the Chief Guest of the function. A special lecture on "Management of India's forest: past, present and future" was delivered by the Chief Guest. In his lecture, he highlighted the role of forests in drug discovery and need of conservation of the endangered species.

A special function was also organised at the directorate to commemorate International Year of Chemistry 2011 on November,2011. Dr. C Devakumar, Assistant Director General

(Education Planning and Development), Indian Council of Agricultural Research, New Delhi, was the Chief Guest of the function. Dr. Devakumar, delivered a lecture on "CHEMISTRY IN THE SERVICE OF HUMAN WELFARE". He described chemistry as the central science, an enabling science and as a way of thinking, it challenges us to perceive, to examine, to test and then to understand that everything around.

Training Cum Awareness Programme Organized

Training on commercial production of medicinal and aromatic plants was organized during November 12-13, 2011 at the directorate. Also, a training cum awareness programme on protection of plant varieties and farmers right (PPV&FR) Act for farmers, researchers and students was organized at the directorate in collaboration with Protection of Plant Varieties and Farmers Rights Authority (PPV&FRA) of India, New Delhi on 26th November, 2011. The training programme was structured with both lectures on PPV&FR Act and visit to DUS (distinctness, uniformity and stability) testing field. Sixty two participants from different districts of Gujarat participated in the programme.

National And State Level Seminars Organized

Seminar on physiological and molecular interventions on sustainable crop productivity under changing climatic conditions was organized on January 17, 2012. Another state level seminar on sustainable collection and profitable cultivation of aromatic and medicinal Plants in Gujarat held was organized on January18, 2012.

International Women's Day Celebration

DMAPR celebrated International Women's Day (IWD) (March 8, 2012). The function was organized by the Women's Committee, DMAPR. Since the day fell on Holi which is an important public holiday, the IWD was observed on March 9, 2012. Different entertainment games viz., Rangoli competition, memory game, Innovative health food preparation, etc were conducted, where the women members of the staff and family members of DMAPR participated enthusiastically. The staff members of DMAPR contributed money for donation to an Old Age Home at Lambhvel. The formal function was kept in the auditorium of DMAPR in the afternoon under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. Ms. Viji Varghese, Centre Head, Zydus Hospital, Anand was the Chief guest in the function. The function started with welcoming the guests by Dr. Geetha K.A., Chairperson. Ms. Viji Varghese, in her special lecture, reminded the audience about the empowerment of women for the well being of the society. Dr. Satyabrata Maiti and Ms. Viji Varghese jointly presented the prizes to the winners of various competitions. Dr. Ruchi Banasal, delivered vote thanks. The function was followed by Medical Counseling by a team of doctors from Zydus hospital, Anand which was led by Dr. Rama Srivastava, Gynecologist. Other members of the team were Dr. Shivani Patel, Physiotherapist, Ms. Vidhi Dave, Dietician and Dr. Ansif Abraham, Head of Business Development and Marketing.

Distinguished Visitors

- Dr. N. K. Tyagi, Member, ASRB, New Delhi on April 8, 2011
- Sh. Bharat Sinh Solanki, Minister of State (Railways), Govt. of India on April 15, 2011
- Dr. B. R. Tyagi, Ex. Deputy Director, CIMAP, Lucknow on April 19, 2011; August 23,2011
- Dr. Umesh Srivastava, ADG (Hort. II), ICAR, New Delhi on April 19, 2011; August 23,2011
- Dr. R. C. Srivastava, Joint Director, Botanical Survey of India, Kolkata on April 19, 2011; August 23,2011
- Dr. GSR Murthi, Ex. Director (Acting), IIHR, Bangalore on April 19, 2011; August 23,2011
- Prof. Y. B. Tripathi, Dept. of Medicinal Chemistry, IMS, BHU, Varanasi on April 19, 2011
- Dr. Nawab Ali, Ex. DDG (Eng.), ICAR on June 26, 2011
- Dr. Umesh Srivastava, Assistant Director General (Horticulture-II), ICAR, New Delhi, on August 23,2011
- Dr. Harish Padh, Vice Chancellor, Sardar Patel University, V.V.Nagar, Anand, on August 23,2011
- Dr. K.B. Kathiria, Director of Research, AAU, Anand, on August 23,2011
- Shri Bala Prasad, Chief Executive Officer, National Medicinal Plants Board, Government of India, New Delhi on September 17,2011
- Dr. P.L. Gautam, Chairperson, PPV&FRA, Govt. of India, New Delhi on October 8, 2011
- Dr. C. Devakumar, Assistant Director General (Education Planning and Development), ICAR, New Delhi, on November 23,2011
- Dr. A. Ray, Professor of Chemical Sciences, CHARUSAT, Changa on November 24, 2011
- Padmashree Prof. P. Pushpangadan, DG, AIHBPD, Trivandrum on February 29,2012
- Prof. S. R. Yadav, Dept. of Botany, Shivaji University, Kolhapur on February 29,2012
- Dr. C. K. Katiyar, Vice President & Head, Health Care Research, Dabur India, Ltd., Delhi on February 29,2012
- Dr. S. Edison, Formerly Director, CTCRI, Trivandrum on February 29,2012
- Dr. S. K. Pareek, Retd. Principal Scientist, NBPGR, New Delhi on February 29,2012
- Dr. Bhag Mal, Formerly Coordinator, Bio-diversity International, New Delhi on February 29, 2012

Deputations/Meetings Attended by the Director

- Attended the selection committee meeting for Plant Genome Savior Community Award 2009-10 at NBPGR, New Delhi on April 5,2011 .
- Attended a divisional meeting under the chairmanship of DDG (Hort.) at NASC, New Delhi on April 11,2011.

- Attended the Discussion with the controller of examination, education division at KAB II, New Delhi on April 12, 2011.
- Attended awareness programme on NMPB voluntary certification scheme for medicinal plant produce for certification bodies at Mumbai on April 28, 2011.
- Attended the expert committee meeting on S&T for women at INSA, New Delhi during May 3-4, 2011.
- Attended the 1st meeting of the expert committee for consideration of proposal of proposal of National Mission on Medicinal Plants at Hyderabad on May 7, 2011.
- Attended awareness programme on NMPB voluntary certification scheme for medicinal plant produce for certification bodies at Hyderabad on May18, 2011.
- Attended a joint release programme of GACP training toolkit by the DG, ICAR and FAOR at Krishi Bhawan, New Delhi on May 30, 2011.
- Attended awareness programme on NMPB voluntary certification scheme for medicinal plant produce for certification bodies at Raipur on June1, 2011.
- Attended the first meeting of national committee on post harvest technology and Value Addition at NASC Complex, New Delhi on June 10, 2011.
- Attended a meeting of the horticulture sub-Committee for XII Plan under the Chairmanship of DDG (H) at IARI, New Delhi on June 24, 2011 .
- Attended the ICAR Directors' meet at NBPGR, New Delhi on July 15,2011
- Attended the ICAR Foundation Day Ceremony at NASC, New Delhi on July 16, 2011
- Attended the XXIII meeting of plant germplasm registration committee at NBPGR, New Delhi on July 18, 2011.
- Attended the Project Coordinators' meet at Krishi Bhawan, New Delhi on July 25, 2011
- Attended the 2nd meeting of the working sub-group of Horticultural Crops at New Delhi on 26.7.2011
- Attended national workshop on 'Conservation and Sustainable Utilization of *Commiphora wightii* (Guggal)' at Gandhinagar during September15-16, 2011.
- Attended XIX group meeting of the AICRP on Medicinal & Aromatic Plants and Betelvine at Dr. YSPUH&F, Nauni- Solan during September 21-24, 2011.
- Attended the second special meeting of the Vice Chancellors of SAUs at NASC, New Delhi during September 26-27, 2011.
- Attended national research advisory committee (Agriculture, Veterinary and Herbal) as a Member at IIM, Ahmedabad on October 9, 2011.
- Presented the report of NMPB project entitled "Strengthening, Up-gradation and Maintenance of web based Herbal Gardens Network for Quality Planting Material Supply in India" at Nirman Bhawan, New Delhi on October 10, 2011.
- Attended a meeting of working group on Agricultural Research and Education for 12th Plan at AAU, Anand on October 12, 2011.
- Attended the 94th meeting of expert committee on S&T for women at HLFPPT, Noida during October 20-21, 2011.

- Delivered a key note address in the launching event of the EMAP Project : Upgrading the Medicinal and Aromatic Plants Value Chain – Access to Export Markets to present the Indian experience in upgrading the medicinal and aromatic plants sector in Cairo, Egypt during November 13-18, 2011.
- Chaired a technical session in the workshop-cum-conference "NTFP Marketing: Issues and Strategies" at Raipur and presented a paper on the Indian experience on upgrading MAP Sector through certification on November 29, 2011.
- Attended a meeting of the selection committee for 'Plant Genome Saviour Community Award – 2010-11' at PPV&FRA, New Delhi on December 27, 2011.
- Attended the first meeting of the reconstituted task force on biotechnology based programme for women at the Department of Biotechnology, New Delhi during January 9-10, 2012.
- Attended the 18th meeting of central sub-committee on crop standards, notification and release of varieties for horticultural Crops under the chairmanship of Dr. H. P. Singh, DDG (Hort.) at IIVR on January 20, 2012.
- Attended the review meeting of the QRT in respect to the DMAPR and AICRP on MAPB at KAB II, New Delhi under the chairmanship of the DDG (Horticulture) on February 8, 2012.
- Delivered a lecture in the 12th congress of the international society for ethnopharmacology [ISE] held at Kolkata on February 18, 2012.

Human resource development

Name	Details	Date
International training		
P. Manivel	Training on marker assisted selection at Cornell University, Ithaca, New York, USA	May 1- July 31, 2011
Dr. Geetha, K.A.	Training on apomixes at Department of Cytogenetics and Genome Analysis, Leibniz Institute of Plant Genetics and Crop Plant Research (IPK),Corrensstraße3 Gatersleben, Germany	May 1- July 31, 2011
National training		
Dr. Vipin Chaudhary	Training on integrated pest management (IPM) at Extension Education Institute, AAU, Anand	July 11-16, 2011
Dr. Nagaraja Reddy	National Training on "Allele mining" at Indian Institute of Spices Research, Calicut	September12- 25, 2011
	Creative writing in agriculture at Indian Institute of Mass Communication, Delhi	12-16 March, 2012

R.P. Meena	Training on monitoring and forecasting of plant disease epidemics under climate change at Division of Plant Pathology,IARI, New Delhi	October 10-November 1, 2011
Mrs. Daya Rani Chellani	Training programme on installation and operation of SOUL at Information and Library Centre, Ahmedabad	January 30 – February 3, 2012
Dr. A. P. Trivedi	Training Programme on Employers Perspective on Labour related Laws at NAARM, Hyderabad	August 4-6-2011
Dr. Raghuraj Singh	Creative writing in agriculture at Indian Institute of Mass Communication, Delhi	March12-16, 2012
Seminar/symposia/meetings		
Dr. B.B. Basak	AICRP on soil test based crop recommendation (STCR) at IISS, Bhopal National seminar on development of soil science 2011 at UAS,Dharwad	July 28-29, 2011 November 16-19, 2011
Dr. Manish Das Dr. V.S. Rana Dr. N.A. Gajbhiye	Brainstorming meeting on prioritization of plant physiology and biochemistry research for 12th plan at IARI, New Delhi	August 5-6, 2011
Dr. Geetha K.A. Dr. N.A. Gajbhiye	'Conservation and Sustainable Utilization of *Commiphora wightii* (Guggal)' at Gandhinagar.	September15-16, 2011.
Dr. Vipin Chaudhary	National meeting on agricultural entomology for the 21 century: the way forward at National Bureau of Agriculturally Important Insects, Bengaluru National symposium on resource utlisation through integrated farming system and biodiversity conservation in drylands at RRS CAZRI, Kukma, Bhuj, Gujarat	August 25-26,2011 December 20-22, 2011
Dr. Ruchi Bansal	National stakeholders meeting on climate change at CRIDA, Hyderabad	September 19-20, 2011
Dr. Satyanshu Kumar	Brainstorming meeting on high value phytochemicals at IISR, Calicut 80th annual meeting of the society of biological chemists at CIMAP, Lucknow 12th congress of the international society for ethnopharmacology [ISE] held at Kolkata Symposium on green chemistry and technology for sustainable development at GCET, Anand	October 3, 2011 November 12-15, 2011 February 16-18, 2012 February 24-25, 2012.

Dr. V.S. Rana	National NMR workshop on hands-on NMR 500 MHz: understanding and applications Central University of Gujarat, Gandhinagar	January 9, 2012
	Symposium on green chemistry and technology for sustainable development at GCET, Anand	February 24-25, 2012.

PUBLICATIONS

Research Papers

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Chaudhary, V. and Saravanan, L. 2011. Biology and seasonal incidence of *Epilachna vigintioctopunctata* (F.) (Coleoptera: Coccinellidae) on Ashwagandha [*Withania somnifera* (L.) Dunal] in Charotur region of Gujarat. *Pest Management in Horticultural Ecosystems,* ***17:*** *132-139*.

Saravanan, L. and Chaudhary, V. 2011. Life history and seasonal incidence of *Asparagus* beetle, *Lema downsei* Baly (Coleoptera: Chrysomelidae: Criocerinae) on *Asparagus racemosus* in India. *Annals of Plant Protection Sciences,* **20 :** 83-87.

Samantaray, S., Phurailatpam, A., Bishoyi, A. K., Geetha, K. A. and Maiti, S. 2012. Identification of sex-specific DNA markers in betel vine (*Piper betle* L.). *Genetic Resources and Crop Evolution*. **59:** 645–653.

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Patel, D.H., Panchal, D.B. and Shriram, S. 2010. Effect of different types of green manures on seed yield in Isabgol (*Plantago ovata* Forsk.), *Gujarat Agricultural Universities Research Journal*, **35:** 91-93.

Upadhyay, N. V., Sheikh, J.A., Patel, D.H. and Patel, M.A. 2011.Physiology and biochemical study on Kalmegh (*Andrographis paniculata* Wall. Ex. Nees), *Annals of pharmacy and pharmaceutical Science*, **2:** 35-36.

Upadhyay, N. V., Sheikh, J.A., Patel, D.H. and Patel, M.A. 2011. Effect of harvesting stage in growth and yield of Satavari (*Asparagus racemosus* Wild). *International Journal of plant sciences*, **6:** 343-344.

Mehta, K., Das, Y.B., Upadhyay , N.V. and Doshi, S. B. 2011. Studied genetic variations among the *Azotobacter chroococcum* isolate using randomly amplified polymorphic DNA (RAPD) marker, *Asian Journal of Bio Sciences,* **6:** 51-58.

Gaikwad, V.P., Patel, R.B., Bhosale, N.D., Shinde, V.T. and Patel, D.H. 2011. Effect of organic manures and bio-fertilizer on yield and quality of Safed musali (*Chlorophytum borivilianum*, Sant. and Fern), *An Asian Journal of Soil Science*, **6:** 111-113.

Gaikwad, V.P., Bhosale, N.D., Patel, D.H., Patel, R.B., and Chaudhari, N.J. 2011.Growth and yield of Safed musali (*Chlorophytum borivilianum* Santapau and Fernandes) as

influenced by bulky and concentrated organic manures grown under loamy sand oil, *Advance Research Journal of Crop Improvement*, **2:** 135-137.

BCKV, Kalyani

Das, B. K. and Talukdar, B. 2011. Record of Journal of Mycopathological Research invasive *Quadrastichus erythrinae* Kim, gall wasp of *Erythrina variegata* L. from eastern India with notes on gall morphologies, *Insect Environment*, **17:** 9-11.

Mohanty, B., Datta, P., Dasgupta, B. and Sengupta, D. K. 2011. Integrated management of foot rot and leaf rot of Betelvine. *SAARC Journal of Agriculture*, **9:** 83-91.

Datta, P., Dasgupta, B. and Das, S. 2011. Efficacy of *Trichoderma* spp. against *Sclerotium rolfsii*, *Journal of Mycopathological Research*, **49:** 31-38.

Mohanty, B., Dasgupta, B. and Poi, S.C. 2011. A study on protein content and protein profiles of *Phytophthora parasitica* isolates in relation to their serological groupings, *Journal of Mycopathological Research*, **49:** 179-181.

Datta, P., Dasgupta, B. and Sengupta, C. 2011. Standardization of inoculum for mass multiplication of *Trichoderma*. *Journal of Mycopathological Research*, **49:** 187-189.

Mohanty, B., Dasgupta, B. and Datta, P. K. 2011. Effect of irrigation regime and IW:CPE ratio on survival of *Phytophthora parasitica* Dastur causing foot and leaf rot of betelvine (*Piper betle* L.), *Journal of Mycopathological Research*, **49:** 353-355.

Sengupta, D.K., Dasgupta, B. and Datta, P.2011. Management of foot rot of Betelvine (*Piper betle* L.) caused by *Phytophthora parasitica* Dastur, *Journal of Crop and Weed*, **7:** 179-183.

Datta, P., Dasgupta, B. and Sengupta, D.K. 2011. Efficacy of *Trichoderma* spp against *Phytophthora parasitica* and *Pythium* spp. causing foot rot and leaf rot of Betelvine (*Piper betle* L.), *Journal of Crop and Weed*, **7:** 202-209.

CCSHAU, Hisar

Jaglan, S., Siwach, P., Singh,N., Yadav , O.P. and Punia, S. 2011. Optimization of ISSR marker to evaluate genetic diversity in *Plantago ovata* germplasm. *Annals of Agri-Bio Research*, **16:** 17-21.

NDUAT, Faizabad

Singh, V., Singh, O.P., Ojha, C.M., Pande, S.K. and Singh, T.P. 2012. Effect of farm yard manure along with inorganic fertilizers in Tulsi (*Ocimum sanctum* L.), *South Indian Horticulture*, **60:** 143-145.

TNAU, Coimbatore

Suganthy, M., Sakthivel, P. and Janak, I. 2012. Seasonal incidence of arthropod fauna associated with musk mallow, *Abelmoschus moschatus* Medicus, *South Indian Horticulture*, **60:** 173-178.

Suganthy. M. and Sakthivel, P. 2012. Seasonal incidence of *Lepidopteran* pest complex of mint in Coimbatore, Tamil Nadu, *South Indian Horticulture*, **60:** 193-196.

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Meena, B. and Marimuthu, T. 2012. Exploitation of bio-control agents for the management of jasmine wilt, *South Indian Horticulture*, **60:** 187-189.

Dr. YSRUH, VR Gudem

Priya, T., Sunitha, B.P., Sudha Vani, V., Rama Devi, P. and , Sivaji, K. 2012. Performance of *Ocimum* species in coastal region of Andhra Pradesh, *South Indian Horticulture*, **60:** 57-59.

YSPUHF, Solan

Behera, M.C. and Raina, R. 2012. *Gentiana kurroo* - a critically endangered bitter herb, *International Journal of Medicinal and Aromatic Plants*, **2:** 22-29.

Shah. I.A., Sharma, Y.P., Raina, R. and Rana, R.C. 2011. Pollination studies in *Swertia chirayita* – a critically endangered medicinal plant of Western Himalayas, *Open Access Journal of Medicinal and Aromatic Plants*, **2:** 14-17.

Raina, R. and Mehra, T.S. 2011. Scope of re-incorporation of selected medicinal plants in forest ecosystems, *The Indian Forester*, **137:** 840 – 846.

Singh, J., Rajasekaran, A., Raina, R. and Rana, R. 2011. Evaluation of different collections of *Hypericum perforatum* L. in Himachal Pradesh for biomass yield and hypericin content, *The Indian Forester*, **137:** 868- 871.

Behera, M.C and Raina, R. 2011. Histology and ash analysis of *Gentiana kurroo* Royle – an endangered medicinal plant, *International Journal of Farm Sciences* **1:** 75-82.

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Patel, A., Patel, S.L. and Manivel, P.. 2012. Comparison of male sterile and fertile plants of Ashwagandha (*Withania somnifera* (L.) Dunal) for physiological traits. In: Zonal seminar on physiological and molecular interventions on sustainable crop productivity under changing climatic conditions held at AAU, Anand, Gujarat on January 17, 12p.

Kumar, S., Shah, S. and Dhanani, T. 2012. Antioxidant potential of extracts from three important medicinal plants *Terminalia bellerica*, *Terminalia chebula* and *Vitex negundo*. In: 12th International congress of ethno-pharmacology held at Kolkata during February 24-25, 118p.

Dhanani, T., Shah, S., Gajbhiye, N.A. and Kumar, S. 2012. Effect of green extraction methods on yield and phytochemical constituents of *Withania somnifera*. In: National symposium on green chemistry and technology for sustainable development held at V.V Nagar, Anand, during February 24-25, 62p.

Bishoyi, A. K., Samantray, S. Geetha, K.A. and Maiti, S. 2011. Assessment of genetic variability in guggal [(*Commiphora wightii*) Arnot. Bhandari] using RAPD and ISSR markers. Paper presented in National workshop on Conservation and sustainable utilization of *Commiphora wightii* (Guggal) at Gandinagar, Gujarat during 15-16th September 2011.

Kawane, A. Geetha, K.A. and Maiti S. . 2011. Study of polyembryony in Guggal (*Commiphora wightii*). Paper presented in National workshop on Conservation and sustainable utilization of *Commiphora wightii* (Guggal) at Gandinagar, Gujarat during 15-16th September 2011.

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Geetha, K.A. and Maiti, S. (2012). Medicinal plant biodiversity, conservation and utilization: an Indian Perspective. 12th International Congress of Ethnopharmacology: Traditional Medicine and Globalization- The future of Ancient Systems of Medicine. P. 16

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Das, B. K. and Das, S. C. 2011. Recent occurrence of two invasive alien gall wasps (Hymenoptera: Eulophidae) in Eastern India with a note on their nature of infestation and mode of dispersal. In: International symposium on system intensification towards food and environmental security held at BCKV, Kalyani during February 24- 27, pp. 268-269.

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CCSHAU, Hisar

Yadav, I.S, Yadav, O.P., Hooda, J.S., Madan, V.K. and Deen. M.K.2012. Planting material of aromatic and medicinal plants: its availability, constraints and strategies to make future demand in Haryana. In : Seminar on new perspectives in aromatic and medicinal plants held at CCS HAU, Hisar during Feb. 8-9, pp. 26-28.

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Lakra, B.S., Yadav, I.S. and Yadav, O.P. 2012. Pathosis, pathometry and integrated management of soft rot of *Aloe vera*. In: Seminar on new perspectives in aromatic and medicinal plants held at CCS HAU, Hisar during Feb. 8-9, pp. 43-45.

Madan, V.K., Yadav, I.S., Yadav, O.P., Kumar, A. and Singh, S. 2012. Therapeutic uses and chemistry of tulsi/basil (*Ocimum* species). In: Seminar on new perspectives in aromatic and medicinal plants held at CCS HAU, Hisar during Feb. 8-9, pp. 51-54.

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IIHR, Bangalore

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KAU, Trichur

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MPUAT, Udaipur

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PERSONNEL

DMAPR

Director

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

Scientific

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

Vandana Joshi, M.Sc. , Ph.D., Principal Scientist (Economic Botany) upto November 13,2011

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

Manish Das, M.Sc. ,Ph.D., Senior Scientist (Plant Physiology)

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

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

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