

## Exotic medicinal plants-current status and future priorities

■ VANDANA TYAGI, VEENA GUPTA AND S.P. SINGH

### SUMMARY

Augmentation of new genetic resources either through indigenous collections or by importing from other countries is an important activity of any crop improvement programme. Indian history had witnessed the invasion of many world communities like British, French, Portuguese, Dutch, Arabians, Muslims etc with whom a diverse genetic base of many crop plants were also introduced in the country's flora. Many of these species have been adapted well and naturalized in Indian climate and are being used in various facets of life. The pharmaceutical industry is also backed by many such plants. Of the forty major commercial medicinal plants utilized by the Indian pharmaceutical companies, about 27 per cent have originated in other countries. The percentage is still higher in case of commercial aromatic plants viz., 52 per cent of the total aromatic component. The gradual increase in the utilization of exotic plants by the pharma-aroma-companies is because many plants have been introduced into cultivation and are now a part of regular agriculture system. The National Bureau of Plant Genetic Resources (NBPGR), New Delhi under ICAR is instrumental in providing this genetic variability of medicinal plants at both fronts. The import of plant genetic resources into India is governed by Plant Quarantine (Regulation of Import Into India) Order, 2003. Access to genetic resources of Indian origin by foreign nationals is governed by Biological Diversity Act, 2002 of Government of India based on the principle of 'Sovereign rights of Nations' as promulgated under the legally binding Convention on Biological Diversity (CBD), 1992. The Convention provides for appropriate access to genetic resources and transfer of relevant technologies on mutually agreed terms, subject to prior informed consent.

**Key Words :** Access, BDA, Import, Medicinal plants, NBPGR

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Indian system of medicine uses about 95 per cent of its formulations from plant origin. Presently more than 250 species of medicinal plants are being grown commercially. Medicinal plants are valuable source of drugs and pharmaceuticals, favours and fragrances and other industrial products. 80 per cent of the world populations still rely on plant based raw materials for primary health care and more than 20,000 species of medicinal and aromatic plants are being used. Unique diversity in medicinal plants is seen in India

matching the diverse agro-ecological zones/conditions found in the Indian sub-continent. As per the WHO, 80 per cent of the rural population depends on herbal drugs globally for primary health care. Medicinal plants are the basis for classical system of medicine viz., Ayurveda, Sidha and Unani. Introduction /Import of genetic resources of medicinal plants in India started as early as 1940 by the erstwhile Division of Plant Introduction in IARI, New Delhi. The division was later upgraded to full fledged Institute named National Bureau of Plant Introduction in 1976 and renamed as National Bureau of Plant Genetic Resources in 1977. NBPGR operates under ICAR system controlled by the Department of Agricultural Research and Education (DARE) of the Government of India. NBPGR is now playing a very dynamic and key role in overall regulation and management of plant genetic resources (PGR) in India. NBPGR is augmenting the large amount of variability for broadening the genetic base by importing genetic wealth of different crop plants from different ecological areas of the world. These materials have been used all over the country

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by various institutes in various crop improvement programmes.

The concerns of “biopiracy” are generally centred on traditional knowledge held in ancient Indian text of various medicinal systems practiced in India. These concerns have now been addressed to some extent by the Traditional Knowledge Digital Library (TKDL), project initiative of the Government of India. The access at national level is based on the provisions of BDA, 2002 under Material Transfer Agreement (MTA). Access to Indian genetic resources by nationals of other countries is facilitated by NBPGR covered under the collaborative research projects/ MoUs/Workplans, provided such collaborative research projects conform to the policy guidelines issued by the Central Government and be approved by the Government of India (18 of 2003).

## MATERIALS AND METHODS

Director, NBPGR has been authorized to issue import permit and receive imported materials from custom authorities for its quarantine inspection and clearance. The recipient desirous of importing seed/planting material has to apply to the Director, NBPGR on a prescribed application form (*PQ Form 08*). For obtaining the Import permit the recipient is required to duly fill in and submit to Director, NBPGR, New Delhi. The IP is issued in form PQ 09 in triplicate. IP is valid for six months from the date of issue and valid for successive shipment provided the exporter and importer, bill of entry, country of origin and phytosanitary certificate are the same for the entire consignment. Validity may be extended upto one year on request, if adequate reasons in writing are justified. Import permit is non-transferable.

After obtaining import permit the recipient should send it to the concerned official that has agreed to supply the required germplasm for use in research with the request that the import permit in duplicate must be enclosed alongwith the seed/planting material.

Director, NBPGR is authorised to issue IP to import the seeds/plant meant for research purpose only as per clause 6 (2) of PQ Order 2003. The application form (PQ 08) can be downloaded from NBPGR website [www.nbpgr.ernet.in](http://www.nbpgr.ernet.in).

Alongwith the application form PQ 08, a demand draft of prescribed fee in favour of Director, NBPGR, New Delhi as processing fee for the issuance of IP should be sent. The fee is non-refundable. It should also be ensured that the consignment must be addressed to the Director, NBPGR. Also, the seed or planting material should not be treated with any chemical until and unless asked to do so in the import permit.

## RESULTS AND DISCUSSION

Since 1976, 3002 accessions are introduced in medicinal and aromatic plants belonging to 121 genera, 367 species from 39 countries. Some of the introduced medicinal plants which are well adapted in Indian situation are *Pelargonium* spp., Geraniums, *Pogostemon patchouli* (Patchouli), *Pimpinella*

*anisum* (Anise), *Hyocyamus* spp. (Henbane), *Rosemarinus officinalis* (Rosemary), *Mellisa officinalis* (Melisa), *Salvia splendens* (Salvia), *Lavendula officinalis* (Lavender), *Digitalis lanata* (Digitalis), *Matricharia* spp. (Chamomile) and *Eucalyptus citriodora* (Eucalyptus)

### Promising introductions in medicinal plants :

Introduced material is used in crop improvement programmes resulting in improved cultivars. The imported germplasm is made available to the concerned breeder. Some of the introductions which were reported as found promising are described in Table 1. The information is collected from the published literature or presented during meetings; the reference is mentioned against each wherever available. A particular reference is here mentioned - *Artemisia annua* a native of Indo-China which has anti-malarial properties has active constituent artemisinin. Accession EC172510 introduced from USA, established well in Indian conditions. The leaves at flowering stage had artemisinin content of 0.02 per cent and the drug is used for controlling malaria, where existing anti-malarial drugs fail. Artemisinin and arteaninum are used for cerebral thrombosis in China (Duke, 1985).

Twenty accessions of different medicinal and aromatic plants established well at different coordinated centers at GAU, Anand (Gujarat); Yercaud (TN), Solan (HP), Indore (MP) and NBPGR Regional Station Bhowali. These are *Digitalis purpurea* (EC202761 & EC303213), *D. ambigua* (EC333801-02 ex Japan), *Aconitum nepallus* (EC303220), *Solanum laciniatum* (EC303294), *Salvia sclarea* (EC182901-02, EC314221, EC314226 and EC314327), *S. officinalis* (EC314321). Seeds setting started under Solan conditions in *Silybum maritimum* (EC281897 ex France) *A. depressus* (EC340085), *Melissa officinalis* (EC273873), *Pimpinella saxifraga* (EC314319), *Papaver bracteatum* (EC179994) *Asparagus officinalis* (EC280562-63 ex Russia), *Satureja hortensis* (EC328517 ex Iran), *Hyssopus officinalis* (EC174790).

The efforts made by the Bureau in the introduction and collection of plant genetic resources of medicinal and aromatic plants during the last three decade have been successfully rewarded in the introduction of species of *Artemisia*, *Catharanthus*, *Chrysanthemum cinerariaefolium*, *Digitalis*, *Glycyrrhiza*, *Hyoscyamus*, *Lavandula*, *Matricaria*, *Rosemarinus*, *Solanum* and *Humulus lupulus*. Other important species are mentined in Table 2.

### Utilization of imported germplasm :

The main recipients of germplasm collected/introductions procured by the NBPGR have been the Directorate of Medicinal and Aromatic Plants, Anand; coordinating centers and scientist handling germplasm in different agricultural universities and other centers. Besides, the Bureau has also been evaluating and studying performance of introduced material at its headquarters and at its regional stations. These efforts have resulted in identification of several

**Table 1: Promising introductions identified in Indian conditions**

Crop	EC No/Country	Trait	Reference
<i>Anthemis nobilis</i>	EC282989/ France	Contains an essential oil and bitter glucoside	
<i>Arnica montana</i>	EC288576/USA	Dried flower heads used as medicinal tonic and possess arnicin	
<i>Catharanthus roseus</i>	EC120837/ Russia	The total leaf alkaloid yield reported in this introduction was 26-38 kg/ha with the vincristine content of $28.4 \times 10^{-4}\%$ and ajmalcine + serpentine yield of 1.79 kg/ha	Maheshwari <i>et al.</i> , 1983
<i>Chrysanthemum cineraraefolium</i>	EC138836-37 / Malawi	White and pink flowers is used on control for experiment	Gupta and Sethi, 1985
	EC145650/ Kenya	Prolific flowering habit	
<i>Digitalis lanatus</i>	EC115996/Poland	selected for higher content of glycoside	
<i>Glycyrrhiza glabra</i>	EC128587 / Pakistan	Higher glycyrrhizic acid percentage	
	EC114303 / Russia	Under cultivation in western and central part of the country produces 20-30cm long, thick stolon containing 5.5-8.0% of total glycyrrhizic acid acceptable to the user industries in the country	
	EC114304/ Russia	Under cultivation in western and central part of the country produces 20-30cm long, thick stolon containing 5.5-8.0% of total glycyrrhizic acid acceptable to the user industries in the country	
	EC 120170/	Proved relatively resistant to Rizoctonia root rot and showed response to higher yield at closer planting	
	EC144048/ Russia	Very high amount of glycyrrhizic acid (14.87%).	
<i>Helleborus niger</i>	EC288578/USA	Dried rhizomes and roots used as heart stimulant contains helleborine	
<i>Hyoscyamus muticus</i>	EC93927 and EC93928 / Germany	Acclimatized to North Indian plains	Mital and Saxena, 1977
<i>Hyoscyamus alab</i>	EC93928	Showed high alkaloid content of 0.122-0.59%	
	EC85759/Germany	Showed high herbage yield 400-500 gms/plant on fresh weight basis and 0.085-0.1065% alkaloid content	Saxena <i>et al.</i> , 1978
<i>Hyoscyamus aureus</i> var. <i>rhodes</i>	EC251945	Performed better with higher foliage yield containing 0.207% total alkaloids	
<i>Hyoscyamus muticus</i>	EC251936, EC251938	Higher herbage yield with average of 0.511% of total tropane alkaloids tested at Indore centre and of AICRP on medicinal and aromatic plants, <i>H. albus</i> (EC146198) observed superior genotype providing dry herbage yield (24.67 g/plant) and total alkaloids (0.089%).	
<i>Hyoscyamus niger</i>	EC251943	Produced higher fresh and dry herb yield of 408.33 g/plant at Indore centre.	
<i>Lavandula stoechas</i>	EC120176/ Portugal	grown at Kodaikanal centre The flowering twigs gave an oil yield 0.30% on distillation.	
<i>Lavandula angustifolia</i>	EC165432/Germany	Grown at Kodaikanal centre The flowering twigs gave an oil yield 0.30% on distillation.	
<i>Mentha piperita</i>	EC41911/Russia	Higher herbage yield, essential oil content (0.6%) and menthol (70%) was recommended for release for general cultivation	Meheswari <i>et al.</i> , 1983
	EC41912	Contained higher oil content of 0.84% in foliage	
<i>Pimpinella anisum</i>	EC22091/France	Trans-anethol rich collection	
<i>Ocimum basilicum</i>	EC176934/France	Highest percentage of oil (0.43%) and Linolol (76.86%).	
	EC338775, 78 and 81/	Methyl chavical types (0.460-91.24%),	
	EC338779, 84, 95/	Linolool types (0.266-69.19%)	
	EC 312264/	Methyl cinnamate type (16.56%)	
	EC222721/	Eugenol type.	
<i>Papaver somniferum</i>	EC196429/ Finland	Considerable amount of morphine (0.40-0.82%) and noscapine (0.12-0.27 %)	Wickstrom <i>et al.</i> , 1982
	EC196430/	Contains only morphine in large percentage (0.33-0.77%), papavarine (0.00-0.20%) and noscapine (0.03-0.04%) in leaves and stalk	and 1984.
	EC196433/ Finland	Contains morphine (0.31-0.67%) and papavarine (0.06-0.19%)	
<i>Papaver bracteatum</i>	EC196437-38	Considered to be thebaine-alpinigenine chemotyped but these strains are rich in thebaine content (30.50% and 0.48%)	Numan and Bruhn, 1977 and Phillippaon, 1983
<i>Papaver somiferum</i> ssp. <i>satigerum</i>	EC232605/ Germany	Being used in specific crossing programmes at CIMAP, Lucknow	
<i>Rosemarium</i> sp.	EC154021/U.K	0.10% essential oil	
<i>Solanum laciniatum</i>	EC113464/ USA	Contained the high solasidine content in aerial parts (0.05%) and dry berries (5.6%)	
<i>Humulus lupulus</i>	EC38868/ USA	The lupuline is the main constituent for importing the desired aroma to the beverage like beer, while resins give better taste to berarages identification of varieties late cv. cluteer Tardif-de Bourgigyne hybrid-2 (and F 51).	
	EC38804/ Japan		
	EC3496/S. Africa		
	EC39993/S. Africa		

**Table 2: Introduction of species in medicinal plants made since 1976**

Crop name	Active principle	Country
<i>Aconitum nepallus</i>	Cardio vascular disease	Hungary
<i>Anacyclus pyrethrum</i>	True akarkara (essential oil)	France
<i>Artemisia annua</i>	Antimalarial drug <i>artemisine</i>	China
<i>Catharanthus roseus</i>	Rich in leaf (anti cancer) and root alkaloid (Hypertension)	Russia
<i>Chrysanthemum cinerifolium</i>	Prolific flowering	Kenya
<i>Crocus sativus</i>	Essential oil and colour	Italy
<i>Digitalis lanata</i>	Higher glucoside content in foliage	Poland
<i>Digitalis lanata Digitalis purpurea</i>	High glycosides	Poland
<i>Digitalis purpurea</i>	Cardio vascular disease	Japan
<i>Digitalis ambigua</i>	Cardio vascular disease	Japan
<i>Duboisia leichhardtii</i>	Hyosine and hyoscyamine content	Australia
<i>D. myoporoides</i>	Rich source of hyoscyamine content	USA
<i>Glaucium flavum</i>	High glaucin content	France
<i>Glycyrrhiza glabra</i>	High glycyrrhizic (throat infection, cough, bronchitis)	Russia and Pakistan
<i>Glycyrrhiza foetidissima</i>	Rich in glycyrrhizic acid (4%)	Russia
<i>Humulus lupulus</i>	8 to 10% alpha acid in lupulin	USA
<i>Hypericum perforatum</i>	Essential oil	Iran
<i>Hypoxis</i>		Swaziland
<i>Lavandula officinalis</i>	Essential oil	Portugal
<i>L. angustifolia</i>	Essential oil	U K
<i>Matricaria chamomilla</i>	High essential oil	Romania
<i>Melissa officinalis</i>	Essential oil	France
<i>Mentha piperita</i>	Essential oil	Russia
<i>Mentha arvensis</i>	Essential oil	USA and Japan
<i>Mentha spicata</i>	Essential oil	USA
<i>Mentha longifolia</i>	Essential oil	USA
<i>Mentha aquatica</i>	Essential oil	USA
<i>Mentha piperita</i>	Higher herbage yield, high oil content (0.05%) and high menthol (60%)	Russia
<i>Ocimum basilicum</i>	High oil content with different aroma chemical	France and USA
<i>Panax quinquefolium</i>	High in panaquillon	Vietnam
<i>Papaver somniferum and Papaver bracteatum</i>	Rich in morphine, other alkaloids	Hungary
<i>Pimpinella anisum</i>	Higher essential oil yield with high anethole and fine aroma	France
<i>Salvia sclarea</i>	Essential oil	Hungary
<i>Salvia officinalis</i>	Essential oil	Hungary
<i>Silybum marianum</i>	High fever	Hungary
<i>Stevia rebaudiana</i>	Estevin a glucoside 150 times sweeter then sugar	Brazil and Paraguay
<i>Solanum laciniatum</i>	High solasidine (Birth control)	USA and Hungary
<i>Thymus vulgaris</i>	Thyme oil	USA
<i>Valeriana officinalis</i>	Essential oil	Iran

**Table3: Medicinal plants Introduced/Imported for research purposes (2001-2011)**

Name	Country	Recipient institute
<i>Abrus precatorius</i>	Denmark (1), UK (1)	NRC M& AP, Anand; IIHR, Bangalore
<i>Aloe ferox</i>	South Africa	Osmania University, Hyderabad
<i>Angelica sylvestris</i>	Hungary	NRC M& AP, Anand
<i>Anthemis austriaca</i>	Hungary	NRC M& AP, Anand
<i>Antirrhinum majus</i>	UK	GBPUAT, Pantnagar;IIHR, Banalore
<i>Antirrhinum sp.</i>	UK	IARI, New Delhi (Divioson of Floriculture)
<i>Asclepias syriacca</i>	Hungary	NRC M& AP, Anand
<i>Atropa belladona</i>	Denmark (1), Slovakia (2), UK (1)	NRC M& AP, Anand
<i>Camphotheca acuminata</i>	China	Institute of Managemement and Sciences, Bangalore
<i>Cassia angustifolia</i>	UK	IIHR, Bangalore
<i>Centaurea crocodylium</i>	Denmark	NRC M& AP, Anand
<i>Centaurea cyanus</i>	Hungary, Denmark	NRC M& AP, Anand
<i>Centaurea diluta</i>	Denmark	NRC M& AP, Anand
<i>Centaurea eirophora</i>	Denmark	NRC M& AP, Anand
<i>Centaurea solstitialis</i>	Denmark	NRC M& AP, Anand
<i>Chicorium intybus</i>	Vietnam	IIVR, Varanasi; IARI, New Delhi
<i>Crossandra sp.</i>	Sri Lanka	IIHR, Bangalore
<i>Cupressus semipervirensi</i>	Hungary	NRC M& AP, Anand
<i>Cytage ovuli</i>	Germany	NRC M& AP, Anand
<i>Datura stramonium</i>	Denmark	NBPGR Regional Station Thrissur
<i>Datura stramonium</i> var. <i>inermis</i>	Denmark	NBPGR Regional Station, Thrissur
<i>Datura stramonium</i> var. <i>stramonium</i>	Denmark	NBPGR Regional Station Bhowali & Thrissur
<i>Dianthus fruticosus</i>	UK	IIHR, Bangalore
<i>Galium aparine</i>	UK	Plant Quarantine Division, NBPGR
<i>Geranium cineareum</i>	Denmark	NRC M& AP, Anand
<i>Geranium dissectum</i>	Denmark	NRC M& AP, Anand
<i>Geranium palustre</i>	Denmark	NRC M& AP, Anand
<i>Geranium platopetalum</i>	Denmark	NRC M& AP, Anand
<i>Geranium robertianum</i>	UK	Plant Quarantine Division, NBPGR
<i>Glaucium flavum</i>	Denmark	NRC M& AP, Anand
<i>Glycyrrhiza echinata</i>	Russia	NRC M& AP, Anand; JNKVV, Jabalpur
<i>Glycyrrhiza uralensis</i>	Russia	NRC M& AP, Anand; JNKVV, Jabalpur
<i>Hypericum adpressum</i>	USA	Department of Botany & Microbiology, University of Mysore
<i>Hypericum cistifolium</i>	USA	Department of Botany & Microbiology, University of Mysore
<i>Hypericum denticulatum</i>	USA	
<i>Hypericum foliosum</i>	Denmark	
<i>Hypericum gentianoides</i>	USA	
<i>Hypericum hirsutum</i>	USA	
<i>Hypericum humifusum</i>	USA	
<i>Hypericum hyericoides</i>	USA	
<i>Hypericum majus</i>	USA	
<i>Hypericum mitchellianum</i>	USA	
<i>Hypericum monogynum</i>	USA	
<i>Hypericum oblongifolium</i>	USA	
<i>Hypericum olypicum</i>	Slovakia	NRC M& AP, Anand
<i>Hypericum orientale</i>	Slovakia	NRC M& AP, Anand
<i>Hypericum perforatum</i>	Denmark (4), USA (31), Slovakia (1)	NRC M& AP, Anand; Department of Botany, University of Delhi
<i>Hypericum punctatum</i>	USA	Department of Botany & Microbiology, University of Mysore
<i>Hypericum pymmidatum</i>	Slovakia	NRC M& AP, Anand
<i>Heracleum spondylium</i>	Hungary	NBPGR RS, Bhowali
<i>Hypericum tetrapetalum</i>	Slovakia	Department of Botany & Microbiology, University of Mysore

Table 3: Contd.....

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<i>Hyopis hemerocallidea</i>	Swaziland	Jamia Hamdard University, New Delhi
<i>Hyoscyamus albus</i>	Denmark	NRC M& AP, Anand
<i>Hyoscyamus niger</i>	Denmark (3), USA (13)	NRC M& AP, Anand; NBPGR Regional Station, Bhowali
<i>Hyoscyamus niger</i> var. <i>annuus</i>	Germany	NRC M& AP, Anand
<i>Hyoscyamus niger</i> var. <i>niger</i>	Germany	NRC M& AP, Anand
<i>Hyoscyamus niger</i> var. <i>pallidus</i>	Germany	NRC M& AP, Anand
<i>Hyoscyamus pusillus</i>	Denmark	NBPGR Regional Station, Bhowali
<i>Hyssopus officinalis</i>	Denmark	NBPGR Regional Station, Bhowali
<i>Impatiens arguta</i>	UK	Plant Quarantine Division, NBPGR
<i>Impatiens auriecoma</i>	UK	
<i>Impatiens balfourii</i>	UK	
<i>Impatiens balsomina</i>	UK	
<i>Impatiens capensis</i>	UK	
<i>Impatiens glandulifera</i>	UK	
<i>Impatiens hawkeri</i>	UK	
<i>Impatiens namchabarwensis</i>	UK	
<i>Impatiens noli-tangere</i>	UK	
<i>Impatiens omeiana</i>	UK	
<i>Impatiens tinctoria</i>	UK	
<i>Impatiens wallerana</i>	UK	
<i>Lavandula angustifolia</i>	UK	IHBT, Palampur
<i>Lavandula latifolia</i>	Slovakia	NRC M& AP, Anand
<i>Lavandula officinalis</i>	UK	IHBT, Palampur
<i>Lavandula intermedia</i>	UK	IHBT, Palampur
<i>Limonium</i> sp.	UK	IIHR, Bangalore; GBPUAT, Pantnagar
<i>Melissa officinalis</i>	Denmark, Hungary	NRC M& AP, Anand; NBPGR Regional Station, Bhowali
<i>Mentha arvensis</i>	Japan	Germplasm Evaluation Division, NBPGR
<i>Mentha longifolia</i>	Denmark (1), Slovakia (1)	NRC M& AP, Anand
<i>Mentha rotundifolia</i>	Denmark	NRC M& AP, Anand
<i>Mentha spicata</i>	Denmark	NBPGR Regional Station, Bhowali
<i>Matricaria chamomilla</i>	Japan	Germplasm Conservation Division, NBPGR
<i>Matricaria maritima</i>	Hungary	NBPGR Regional Station, Bhowali
<i>Malva sylvestris</i>	Hungary	NBPGR Regional Station, Bhowali
<i>Malva moschata</i>	Denmark	IARI, New Delhi (Division of Floriculture)
<i>Malva neglecta</i>	Denmark	NRC M& AP, Anand
<i>Malva parviflora</i>	Denmark	NRC M& AP, Anand
<i>Origanum vulgare</i>	Denmark (1) Hungary (1), Slovakia (1)	NRC M& AP, Anand
<i>Papaver argemone</i>	Denmark	
<i>Papaver dubium</i>	Denmark(2), Hungary (1)	
<i>Papaver fugax</i>	Denmark	
<i>Papaver hybridum</i>	Denmark	
<i>Papaver lateritum</i>	Denmark	
<i>Papaver rhoeas</i>	Denmark (2), Hungary (1)	
<i>Papaver somniferum</i>	Denmark (2), UK(2)	NRC M& AP, Anand; NBRI, Lucknow
<i>Papaver bracteatum</i>	Germany	NBRI, Lucknow
<i>Papaver somniferum</i> ssp. <i>sominiferum</i>	Germany	NBRI, Lucknow
<i>Pelargonium odoratissimum</i>	UK	IIHR, Bangalore
<i>Plantago afra</i>	Denmark	NRC M& AP, Anand
<i>Plantago amplexicaulis</i>	Denmark	
<i>Plantago arenaria</i>	Denmark	
<i>Plantago aristata</i>	Denmark	
<i>Plantago atrata</i>	Denmark	

Table 3: Contd.....

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<i>Plantago debilis</i>	Denmark	
<i>Plantago hookeriano</i>	Denmark	
<i>Plantago lagopus</i>	Denmark	
<i>Plantago lanceolata</i>	Denmark	
<i>Plantago major</i>	Denmark	
<i>Plantago maritima</i> ssp. <i>serpentina</i>	Slovakia	
<i>Plantago media</i>	Denmark	
<i>Plantago orbignyana</i>	Denmark	
<i>Plantago palagonica</i>	Denmark	
<i>Plantago subspatulata</i>	Denmark	
<i>Podophyllum hexandrum</i>	UK	IIHR, Bangalore
<i>Pogostemon heyneanus</i>	Denmark	NRC M& AP, Anand
<i>Salvia nemorosa</i>	Hungary	NBPGR Regional Station, Bhowali
<i>Salvia reflexa</i>	Denmark	NRC M& AP, Anand
<i>Salvia officinalis</i>	Hungary	NBPGR Regional Station, Bhowali
<i>Salvia argentea</i>	Denmark	IARI, New Delhi (Division of Floriculture)
<i>Salvia sclarea</i>	Hungary, Slovakia	NRC M& AP, Anand; NBPGR Regional Station, Bhowali
<i>Salvia splendens</i>	Slovakia	NRC M& AP, Anand
<i>Salvia splendens</i> var. <i>violacea</i>	Slovakia	NRC M& AP, Anand
<i>Salvia officina</i>	Slovakia	NRC M& AP, Anand
<i>Salvia forinacea</i>	Slovakia	NRC M& AP, Anand
<i>Salvia</i> sp.	Denmark	NRC M& AP, Anand
<i>Satureja nepeta</i>	Slovakia	NRC M& AP, Anand
<i>Satureja montana</i>	Slovakia	NRC M& AP, Anand
<i>Senna alata</i>	USA	DMAPR, Anand
<i>Senna alexandrina</i>	USA	DMAPR, Anand; Aligarh Muslim University, Aligarh
<i>Senna angulata</i>	USA	DMAPR, Anand
<i>Senna corymbosa</i>	USA	DMAPR, Anand
<i>Senna occidentalis</i>	USA	Aligarh Muslim University, Aligarh
<i>Senna</i> sp.	Denmark (4), USA (4)	DMAPR, Anand
<i>Senna uniflora</i>	USA	NRC M& AP, Anand
<i>Sida rhombifolia</i>	Denmark	NRC M& AP, Anand; IARI, New Delhi (Division of Floriculture)
<i>Silphinum laciniatum</i>	USA	NRC M& AP, Anand
<i>Silybum marianum</i>	Denmark	NRC M& AP, Anand
<i>Stevia</i> sp	Canada	AP Netherland Biotech, Seunderabad
<i>Taxus bacata</i>	Hungary	NRC M& AP, Anand
<i>Tephrosia candida</i>	USA	Aligarh Muslim University, Aligarh
<i>Tephrosia purpurea</i>	USA	Aligarh Muslim University, Aligarh
<i>Tephrosia</i> sp.	USA	Aligarh Muslim University, Aligarh
<i>Thuja occidentalis</i>	Hungary	NRC M& AP, Anand
<i>Thuja orientalis</i>	Hungary	NRC M& AP, Anand
<i>Thymus comphoratus</i>	Slovakia	NRC M& AP, Anand
<i>Urtica dioica</i>	UK	Plant Quarantine Division, NBPGR

promising genotypes, some of which have been released as varieties for commercial cultivation.

#### Future thrust :

Although, NBPGR has introduced sufficient number of exotic germplasm in medicinal and aromatic plant which are representing quite large amount of crop variability with respect to various desirable traits, but now emphasis is on for introduction of germplasm resources with desirable attributes to enhance use of genetic resources for crop improvement programme. Introduction or import of medicinal plants are subjected to various limitations in the current regime as Institutions holding useful genetic material are hesitant to share genetic wealth due to apprehension of loss of

International trade. Countries having origin of diversity, either do not grow these medicinal species or have no interest in collection of genetic stocks or collaborate in such activity proposed in their country. Keeping in view the possible mechanisms may be to enter into bilateral agreements or reciprocal exchange to be done as common interest. Exchange from Industry to industry in partnership mode is another option. Formulations of collaborative programmes for give and take in terms of economic value are the way ahead.

CBD provides for access to genetic resources and transfer of technologies on mutually agreed terms, subject to Prior Informed Consent. At national level various regulatory mechanisms have been put in place, which govern access to plant genetic resources occurring in India. Facilitated access

Name of the plant	Specific traits	Source country
Opium poppy ( <i>Papaver somniferum</i> )	Annual temperate type collections having high morphine content (more than 1%) suitable for morphine production in the country High seed yield lines for producing edible oil (morphine free types)	Hungary, Tasmania and Australia
<i>Papaver bracteatum</i>	For breeding programme germplasm which have high range of variability in latex yield Cultivars resistant/ tolerant to downy mildew	Finland Germany, Finland, Hungary, Bulgaria and Turkey
Senna ( <i>Cassia angustifolia</i> )	Rich sennoside content (upto 4.5%) low flowering/ more leafy biomass type germplasm	Egypt, Sudan
Psyllium ( <i>Plantago ovata</i> )	Genetic stocks with high swelling, mucilaginous seed, non shattering types, response to inputs, more genetic variability in respect of more spike length, tillering and resistant to downy mildew	Iran and Iraq.
Periwinkle ( <i>Catharanthus roseus</i> )	High total alkaloid (2.5%) germplasm with more branches, thick root type and leafy biomass lines	Brazil, Canada and Madagascar
Solanum ( <i>Solanum laciniatum</i> )	Germplasm rich in solasodine content and (steroidal drugs)	Vietnam
Egyptian henbane ( <i>Hyoscyamus muticus</i> )	Short duration type with large biomass and high total alkaloid content	Gulf countries
Kalmegh ( <i>Andrographis paniculata</i> )	Germplasm rich in andrographaloid content (upto 2%) and wild races	Sri Lanka and Malaysia
Basil ( <i>Ocimum basilicum</i> )	Germplasm rich in methyl chavicol, methyl cinnamate and euginol compound	USA, Germany, Turkey and Hungary
Asgand ( <i>Withania somniferum</i> )	Rich alkaloid (withaniol) content, un-branched, pencil thick and long cylindrical root type	Pakistan, Malaysia, Indonesia, Libya, Nigeria and Ghana
Vetiver ( <i>Vetiveria zizanioides</i> )	High oil yield with superior aroma, genetic materials	Indonesia, Reunion Islands, Haiti, Guatemala, Mexico and Brazil
<i>Plantago macrocarpa</i>	useful gene for indehiscent capsules	North America
Lemongrass ( <i>Cymbopogon citratus</i> )	high yielding lines	Mediterranean region, Pakistan, Malaysia, Indonesia, Libya, Nigeria and Ghana



to plant genetic resources for food and agriculture under the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), 2001 under Multilateral System (MLS) ensures facilitated exchange to all member countries, for the crops of Annex 1 of ITPGRFA. MLS however, does not cover any medicinal plants hence, no benefit is expected from MLS for medicinal plants.

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