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National Herbarium of Cultivated Plants (NHCP): Importance of Voucher Specimens of Introduced Germplasm

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Herbarium specimens representing plant genetic resources introduced from abroad, are a distinctive component of the National Herbarium of Cultivated Plants (NHCP). These specimens represent diversity augmented in crops and wild species mostly not native to the Indian region. Herbarium specimens, bearing the unique identity number assigned to germplasm introduced into the Indian region, were screened, checked with primary and secondary data records for identity, source locality/area, and its availability as *ex situ* germplasm. Additional data on area of origin/ diversity of species was used to delineate specimens of value in PGR and represented as cultigens, cultivars, both popular and historic, as well as local morphotypes and ecotypes of crops, as well as wild relatives of crops.

Key Words: Crop wild relative, Cultivar, Herbarium, Introduced, Plant genetic resources, Voucher specimens

Introduction

The National Herbarium of Cultivated Plants (NHCP) is a specialized herbarium located in the National Bureau of Plant Genetic Resources (NBPGR), New Delhi focusing on representation of taxa of use or of potential importance in plant genetic resources (PGR) programmes *viz.* crop species, their wild relatives and wild economic plants. The NHCP provides reference material for identification of taxa, baseline information on locality of availability, climatic and habitat preferences of taxa, and ancillary information on source localities. Any herbarium associated with PGR has the distinctive feature of having in its holdings not only native diversity but also of exotic germplasm augmented through exploration or introduction of germplasm in the form of seeds or planting material (Nayar *et al.*, 2011). Thus, these specimens are reference material of taxa not native to the Indian region. Germplasm introduced through the NBPGR is associated with a unique identity number. Herbarium specimens of taxa bearing the germplasm identity numbers are, therefore, vouchers of materials procured from diverse localities and sourced from different germplasm collections and curators.

Herbarium specimens of a taxon, represented over time and space, have a collective value, providing a record of the diversity that is significant as germplasm; individually important specimens include vouchers from exploration programmes and experimental studies. The holdings of the NHCP cover a period of nearly seven decades; it includes the herbarium specimens of the Plant Introduction Scheme (PI) under the Botany Division of the Indian Agricultural Research Institute (IARI) commencing activities of germplasm augmentation through systematic introductions since 1946 upto 1977. Subsequently, this activity was undertaken by a separate institute for PGR, i.e. at the NBPGR. The present analysis attempts to delineate important herbarium specimens (represented in the NHCP) and associated data on introduced germplasm that make these valuable as reference material to a wide user-base.

Materials and Methods

A total of 298 taxa representing 482 germplasm accessions are present in the herbarium bearing Exotic Collection (EC) numbers assigned by the NBPGR to germplasm introduced for research purpose into India (Table 1). The germplasm was raised in experimental conditions at appropriate locations and herbarium specimens for inclusion in the NHCP were prepared from experimental farms (Plant Introduction fields/ Post-entry Quarantine Nursery, PEQN, Issapur Farm, New Delhi) at the Headquarters in Delhi, and regional stations of the NBPGR (Uttarakhand, Odisha, Andhra Pradesh, Himachal Pradesh and Kerala) or crop-based institutes. Herbarium specimens of exotic germplasm,

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Table 1. Herbarium specimens of introduced germplasm in NHCP

S. no.	Crop category	Total species	Specimens of introduced accessions	Specimens of Plant Introduction herbarium (PI)	Germplasm accessions conserved (GB/ FGB)
1	Cereals/ millets (C/M)	38	71	26	13
2	Grain legumes (Gl)	19	43	4	9
3	Fruits (Fr)	13	14	3	10
4	Vegetables (Vg)	14	38	11	11
5	Oilseeds (Os)	13	21	5	8
6	Pseudocereals (Ps)	3	6	3	3
7	Spices/ condiments (S/C)	5	5	3	-
8	Fodder/ forage grasses (FoGr)	35	53	6	2
9	Fodder/ forage legumes (FoLg)	124	190	63	7
10	Ornamentals (Orn)	11	11	11	8
11	Medicinal/ aromatic plants (M&AP)	23	30	24	5
	Total	**298**	**482**	**167**	**22**

FGB: field genebank; GB: genebank

have information on both the source area/ institution which provided the germplasm as well as the area and period during which it was raised in experimental cultivation.

These specimens were validated for their identity, and checked with source data on introduction and collection. Additional information on native region of the taxa of PGR importance as well as its availability in the genebank (as seeds or in the field) was verified to delineate significant voucher specimens of introduced germplasm (Table 2).

Digital scans (jpeg images) of herbarium specimens were created using flat-bed scanner (high resolution HP Scanjet 3500C) at a resolution of 300 dpi. These images of herbarium specimens were linked to database for quick access on a family-wise and genus-wise basis, as well as by unique identity numbers assigned to herbarium specimens (HS numbers) and those assigned to the introduced germplasm (EC numbers).

Results and Discussion

A total of 482 germplasm accessions bearing EC numbers, belonging to 298 species, and represented as herbarium specimens in the NHCP, were introduced from 39 countries. There is an overall preponderance of taxa represented in genebanks, thus indicating that they may have desirable traits. Introductions from United States of America (United States Department of Agriculture, USDA), followed by Australia (Commonwealth Scientific and Industrial Research Organisation, CSIRO), and from Portugal (Botanical Garden of Coimbra), accounted for over 50% of the specimens. Nearly 20% of the accessions were from international organizations *viz*. paddy and other selected species from International Rice Research Institute (IRRI), Philippines, wild species of cereals and grain legumes from International Centre for Agricultural Research in the Dry Areas (ICARDA), Syria, *Vigna* from International Institute of Tropical Agriculture (IITA), Nigeria, and vegetable legumes and tomato from The World Vegetable Centre (AVRDC), Taiwan. Of the total herbarium specimens of introduced accessions, only 20% were from countries of their origin *viz*. local forms of *Punica* from temperate erstwhile Union of the Soviet Socialist Republic (USSR), dry fruit type of *Ziziphus* from Korea, *Vitis* from North America, *Glycine* from China, *Solanum*/ *Lycopersicon*, *Sesbania* and *Arachis* from South America, *Vicia* from Portugal, *Nigella* and *Plantago* from Iran, etc. Specimens of crop germplasm collected under collaborative exploration programmes (24) from areas adjoining India *viz*. under Indo-Nepal collaborative programme from Nepal (1960s), and under collaborative International Board for Plant Genetic Resources (IBPGR)/ NBPGR exploration programmes was another source of exotic material especially of *Solanum* and *Abelmoschus* from Nepal, Bangladesh and Sri Lanka (1989-90). The trend of exchange and circulation at the global level of a limited germplasm base among researchers (Arora

Table 2. Information used for delineating important specimens belonging to introduced germplasm in the NHCP

S. no.	Nature of data	Characteristics	Reference
1.	Herbarium specimen	Unique identity number of specimen (HS no.) Identity of taxon and nomenclature	Nomenclature check http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl
		Suitable representation of vegetative and reproductive parts for determining and confirming identity of taxon	The Plant List www.efloras.com
		Quality digital image of specimen	:
2.	Source data of specimen	1. Source area of exploration/ raising experimental material from seed or propagule	NHCP database
		2. Collector	
3.	Source information on germplasm under introduction	Source institute/ organisation, country and region of supply of germplasm Unique germplasm no. allotted by original source of collection, and collector no. and date Associated data *viz.* cultivar, localized landrace, etc.	www.nbpgr.ernet.in/qeq/ec-search.aspx http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl Rana *et al*., 2006 http://www.ersa.edu.au/case_data_avh checklists of crop varieties, heirloom lines, etc
4.	Germplasm unique identity number	EC (Exotic Collection) number allotted by NBPGR	www.nbpgr.ernet.in/qeq/ec-search.aspx
5.	Native region	Centre of origin/ diversity of the taxon	Zeven and de Wet 1982; http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl
6.	Use/ potential use of the taxon	As crop species, in breeding programmes, or as promising species with domestication potential Categorisation into crop/ wild species, crop-use category	Nayar *et al*., 2003 http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl
7.	Collection and conservation status	Gap analysis of taxa based on herbarium specimens and germplasm collections Availability in genebank as seed Conserved in field genebank	http://gisweb.ciat.cgiar.org/GapAnalysis/; NBPGR genebank data

et al., 1975; Tyagi *et al*., 2006) was further supported by this analysis.

The NHCP includes herbarium of the erstwhile Plant Introduction Division (PI) of the IARI, New Delhi. Taxa represented in NHCP, categorised according to use, were well represented in the PI as well as the NHCP herbaria for cereals and millets, vegetable crops as well as herbage grasses and legumes (Table 1). Grain legumes were the priority for addition in the NHCP, besides species of herbage use belonging to *Crotalaria*, *Lathyrus*, *Vicia* and *Vigna*. Among grasses in *Eragrostis*, *Megathyrsus*, *Panicum*, *Paspalum* and *Sorghum* were represented. In contrast, for medicinal and aromatic plants, as well as ornamentals, larger representation in PI herbarium was a reflection of increasing focus on indigenous diversity during subsequent periods. This analysis, therefore, highlights the value of herbarium specimens in representing changing trends in PGR.

Voucher herbarium specimens have value as cultivars of crops, selections bred for valuable traits and landraces (Table 3). These are distinct variants with observable traits, which may or may not be recognised as distinct taxonomic entities under the genus or species. However, these are significant from the point of view of PGR study and utilization. These specimens are maintained as representatives of infraspecific variants in the NHCP. Furthermore, these local variants or selections from wild species, were often distinguishable by additional features such as colour of leaves, leaf thickness often not observable on the specimen and needing photographic record or additional descriptive data along with specimen for reference. Examples of these were, *mantegazzianus* type of *Amaranthus caudatus,* a local cultivar of Argentina bearing condensed and rounded inflorescence spikes in place of long feathery and often drooping inflorescence and earlier considered a distinct subspecies (Zeven and de Wet, 1982; Hanelt, 1986); Westerwoldicum, a form of ryegrass (*Lolium multiflorum* subsp. *multiflorum*) developed by selected harvesting for earliness in the Netherlands, and used in systematic breeding of annual ryegrass (De Haan, 1955; Humphreys *et al*., 2009); *Sorghum sudanense,* taxonomically considered part of the wild and weedy species, *S.* x *drummondii* selected and

Table 3. Significant herbarium specimens of introduced species in NHCP

S. No.	Botanical Name	EC No.	HS No.	Crop Categ.	Remarks
1.	*Aegilops crassa* Boiss.	EC 573228	HS 20750	CM	GB
2.	*Aegilops kotschyi* Boiss.	EC 573277	HS 20751	CM	GB
3.	*Aegilops lorentii* Hochst. (=*A. biuncialis* Vis.)	EC 573205	HS 20745	CM	GB
4.	*Aegilops searsii* Feldman & Kislev ex K.Hammer	EC 383069	HS 20749	CM	GB
5.	*Aegilops speltoides* Tausch	EC 573334	HS 20743	CM	GB
6.	*Aegilops triuncialis* L.	EC 575781	HS 20748	CM	GB
7.	*Avena sativa* L.	EC 056175	HS 08484	CM	GB; cv. Kent
8.	*Hordeum agriocrithon* A.E.Åberg	EC 015585	HS 05196	CM	GB
9.	*Hordeum murinum* L.	EC 015582	HS 03189	CM	GB
10.	*Hordeum vulgare* L. subsp. *spontaneum* (K.Koch) Thell. (=*H. spontaneum* K.Koch)	EC 015580	HS 03192	CM	GB
11.	*Triticum monococcum* L.	EC 541168	HS 20755	CM	GB
12.	*Triticum monococcum* L. subsp. *aegilopoides* (Link) Thell. (=*T. boeoticum* Boiss.)	EC 577242	HS 20752	CM	GB
13.	*Triticum turgidum* L.	EC 272647	HS 20754	CM	GB; cv. Ambral
14.	*Lolium multiflorum* Lam. (=*L. westerwoldicum* Breakw.)	EC 013440	HS 03339	FoGr	Selection
15.	*Panicum coloratum* L. var. *markarikariense* Gooss. (=*P. markarikariense* (Gooss.) Rensb.)	EC 180404	HS 08725	FoGr	Local drought tolerant variant of fodder value
16.	*Phalaris aquatica* L. (=*P. tuberosa* L.)	EC 002409	HS 03551	FoGr	GB
17.	*Phalaris minor* Retz.	EC 001835	HS 03558	FoGr	GB
18.	*Sorghum bicolor* nothosubsp. *drummondii* (Steud.) de Wet ex Davidse (=*S. sudanense* (Piper) Stapf)	EC 000716	HS 04798	FoGr	Selection from wild plants
19.	*Lathyrus aphaca* L.	EC 309558	HS 08528	FoLg	GB
20.	*Lathyrus chrysanthus* Boiss.	EC 309562	HS 08642	FoLg	GB
21.	*Lathyrus pseudocicera* Pamp.	EC 309554	HS 08533	FoLg	GB
22.	*Sesbania bispinosa* (Jacq.) W.Wight	EC 493681	HS 17890	FoLg	GB
23.	*Sesbania cannabina* (Retz.) Pers.	EC 466696	HS 16608	FoLg	GB
24.	*Sesbania tetraptera* Hochst. ex Baker	EC 435749	HS 17897	FoLg	GB
25.	*Vicia lutea* L. subsp. *vestita* (Boiss.) Rouy (=*V. muricata* Ser.)	EC 001939	HS 04069	FoLg	GB
26.	*Punica granatum* L.	EC 104350	HS 07199	Fr	cv. Achik Dona
27.	*Punica granatum* L.	EC 062811	HS 08079	Fr	cv. Gulsha Rose Pink
28.	*Ziziphus jujuba* Mill.	EC 280769	HS 19178	Fr	FGB; cv. Moodeung/Ja 5
29.	*Vitis acerifolia* Raf.	EC 452210	HS 19168	Fr	FGB
30.	*Vitis aestivalis* Michx.	EC 452212	HS 19170	Fr	FGB
31.	*Vitis amurensis* Rupr.	EC 452213	HS 19169	Fr	FGB
32.	*Vitis arizonica* Engelm.	EC 452207	HS 19177	Fr	FGB
33.	*Vitis cinerea* (Engelm.) Engelm. ex Millardet	EC 452214	HS 19173	Fr	FGB
34.	*Vitis cinerea* Engelm.) Engelm. ex Millardet var. helleri (L.H.Bailey) M.O.Moore (=*V. berlandieri* Planch.)	EC 452209	HS 19166	Fr	FGB
35.	*Vitis ficifolia* Bunge	EC 452206	HS 19165	Fr	FGB

S. No.	Botanical Name	EC No.	HS No.	Crop Categ.	Remarks
36.	*Vitis girdiana* Munson	EC 452211	HS 19172	Fr	FGB
37.	*Vitis riparia* Michx.	EC 452208	HS 19171	Fr	FGB
38.	*Cicer pinnatifidum* Jaub. & Spach	EC 015562	HS 05241	Gl	GB
39.	*Lathyrus cicera* L.	EC 309561	HS 08644	Gl	GB
40.	*Phaseolus vulgaris* L.	EC 405211	HS 10242	Gl	GB
41.	*Pisum sativum* L.	EC 334161	HS 16042	Gl	GB; cv. Dwarf Gray Sugar
42.	*Vigna radiata* (L.) R.Wilczek	EC 398899	HS 10116	Gl	GB
43.	*Vigna radiata* (L.) R.Wilczek	EC 398938	HS 10117	Gl	GB
44.	*Vigna unguiculata* (L.) Walp.	EC 367710	HS 15486	Gl	GB
45.	*Vigna unguiculata* (L.) Walp.	EC 472257	HS 15487	Gl	GB
46.	*Vigna unguiculata* (L.) Walp.	EC 501045	HS 15491	Gl	GB; cv. Green Pixie
47.	*Anacyclus pyrethrum* (L.) Link	EC 281897	HS 10013	M&A	GB
48.	*Abelmoschus moschatus* Medik.	EC 316073, EC 329390	HS 17955, HS 17956	M&A	GB
49.	*Digitalis grandiflora* Mill. (=*D. ambigua* Murray)	EC 333802	HS 10023	M&A	GB
50.	*Digitalis purpurea* L.	EC 207361	HS 10022	M&A	GB
51.	*Datura stramonium* L. var. *tatula* (L.) Torr. f. *bernhardii* (C.E.Lundstr.) Danert (=*D. bernhardii* C.E.Lundstr.)	EC 019706	HS 02902	M&A	Selection made in USA
52.	*Cotoneaster franchetii* Bois	EC 024577	HS 18523	Orn	FGB
53	*Cotoneater salicifolius* Franch.	EC 027475	HS 19164	Orn	FGB
54.	*Crataegus coccinea* L. forma *wendlandii* hort. ex Lavallée	EC 024499	HS 18123	Orn	FGB
55.	*Rosa brunoni* Lindl. (=*R. moschata* non Herrm.)	EC 018586	HS 08346	Orn	FGB
56.	*Rosa luciae* Franch. & Rochebr. ex Crép. (=*R. wichuraiana* Crép.)	EC 033173	HS 19871	Orn	FGB
57.	*Rosa multiflora* Thunb.	EC 031218	HS 19625	Orn	FGB
58.	*Rosa* x *damascena* Mill.	EC 025987	HS 19970	Orn	FGB
59.	*Spiraea douglasii* Hook.	EC 024706	HS 18520	Orn	FGB
60.	*Helianthus annuus* L.	EC 494379, EC 494423	HS 16034, HS 16033	Os	GB
61.	*Brassica napus* L.	EC 389916	HS 17030	Os	GB; cv. Profit of canola
62.	*Brassica napus* L.	EC 400804	HS 16019	Os	GB; cv. Westar of canola
63.	*Brassica nigra* (L.) W.D.J.Koch	EC 289661	HS 17035	Os	GB
64.	*Brassica rapa* subsp. *dichotoma* (Roxb.) Hanelt (cv-grp. Brown sarson)	EC 191597, EC 333596	HS 17004, HS 17006	Os	GB
65.	*Crambe hispanica* subsp. *abyssinica* (Hochst. ex R.E.Fr.) Prina (=*C. abyssinica* Hochst. ex R.E.Fr.)	EC 499724	HS 16029	Os	GB
66.	*Eruca vesicaria* subsp. *sativa* (Mill.) Thell. (=*E. sativa* Mill.)	EC 400072	HS 16032	Os	GB
67.	*Sinapis alba* L.	EC 390162	HS 16049	Os	GB
68.	*Amaranthus caudatus* L. (=*A. caudatus* subsp. *mantegazzianus* (Pass.) ined.; *A. mantegazzianus* Pass.)	EC 013953	HS 04651	Pc	Local variant
69.	*Amaranthus caudatus* L. (=*A. edulis* L.)	EC 150188	HS 07061	Pc	GB
70.	*Amaranthus hypochondriacus* L.	EC 169611, EC 359422	HS 07091, HS 09743	Pc	GB

S. No.	Botanical Name	EC No.	HS No.	Crop Categ.	Remarks
71.	*Solanum lycopersicum* L. var. *lycopersicum* (=*Lycopersicon esculentum* Mill.)	EC 001129	HS 09095	Vg	cv. Burwood Prize
72.	*Solanum lycopersicum* L. var. *lycopersicum* (=*Lycopersicon esculentum* Mill.)	EC 315490	HS 09086	Vg	cv. Mountain Delight
73.	*Solanum lycopersicum* L. var. *lycopersicum* (=*Lycopersicon esculentum* Mill.)	EC 130053	HS 09105	Vg	GB
74.	*Solanum lycopersicum* L. var. *lycopersicum* (=*Lycopersicon esculentum* Mill.)	EC 315478	HS 09109	Vg	GB
75.	*Solanum melongena* L.	EC 169769	HS 07089	Vg	GB
76.	*Solanum melongena* L.	EC 316224	HS 18316	Vg	GB; collection from Nepal
77.	*Solanum peruvianum* L. (=*Lycopersicon peruvianum* (L.) Mill. var. *peruvianum*)	EC 315457	HS 09101	Vg	GB
78.	*Solanum pimpinellifolium* L. (=*Lycopersicon pimpinellifolium* (L.) Mill.)	EC 274046	HS 09099	Vg	GB

cv: cultivar; FGB: field genebank; GB: genebank. Crop category: CM, cereals and millets, FoGr, fodder grasses, FoLg, Fodder legumes, Fr, fruits, Gl, grain legumes, M&A, medicinal and aromatic plants, Orn, ornamentals, Os, oilseeds, Pc, pseudocereals, Vg, vegetables.

bred for forage purpose (Boonman, 1993); and *Panicum coloratum* var. *markarikariense*, a salt-tolerant ecotype, native of the floodplains with low rainfall (Markarikari area of Botswana) in southern Africa and distributed widely as drought-tolerant germplasm (http://www.fao.org/ag/AGP/AGPC/doc/GBASE/data/pf000277.htm) and having bluish green, glaucous and fleshy leaves as compared to var. *coloratum* (http://www.tropicalforages.info/key/Forages/Media/Html/Panicum_coloratum.htm).

Cultivars/ local types/ old and heirloom lines of crop plants were some of the other reference specimens available in the NHCP, viz. *Avena sativa* cv. Kent (http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl), a popular check variety for oats cultivation in the Indian subcontinent; *Pisum sativum* cv. Dwarf Gray Sugar, an edible snow pea under continuous cultivation for over 200 years (http://casfs.ucsc.edu/documents/for-the-gardener/peas.pdf); and *Lycopersicon esculentum* cv. Burwood Prize, an heirloom cultivar from Australia (http://naldc.nal.usda.gov/download/36965/PDF); and local germplasm of *Punica granatum* from the Middle East region such as Achik Dona and Gulsha Rose Pink represented sources of material used in breeding for traits such as high yield and red colour of fruits.

Wild relatives of major crops are better represented as introduced germplasm more so than crops, particularly of seed producing species viz. *Oryza*, *Triticum*/ *Aegilops*, *Avena*, *Hordeum*, *Secale*, *Panicum* and *Setaria* (29) among cereals and millets, grain legumes such as *Arachis*, *Cicer*, *Lathyrus* and *Lens* (7). Besides these, species of herbage value (116), among vegetables species of *Solanum/ Lycopersicon* (5), selected species of medicinal importance, viz. *Nigella*, *Plantago* and *Datura* (9), and, among fruits, *Vitis* (8) are also represented. These were mostly wild species native of other megadiversity regions and hence introduced for their potential importance in breeding and selection. The important ones (both PI and NHCP collections) are also conserved in the genebank (Table 1).

Wild taxa of cereals and millets were mainly native of the Central Asian/ West Asian/ Mediterranean/ European regions (number of accessions represented in NHCP given in parenthesis)- *Aegilops* (wild relative of *Triticum*, 9), wild and weedy species of *Avena* (2: *A. fatua*, 1, and *A. sterilis* subsp. *ludoviciana*, 1); in *Hordeum vulgare*, the progenitor taxon, subsp. *spontaneum* (1), weedy form subsp. *agriocrithon* (1), *H. bulbosum* (3) and *H. murinum* (1), besides *H. stenostachys* (1), a wild species of the South American region; *Oryza* was represented by collections belonging to different genomes viz. AA: *O. rufipogon*-*O. nivara* (6), *O. barthii* (1) and *O. longistaminata* (1), BB/ BBCC: *O. eichingeri* (8) and *O. punctata*-*O. minuta* (2); CC: *O. officinalis* (4); CCDD: *O. latifolia* (3); EE: *O. australiensis* (1); FF: *O. brachyantha* (3); and HHJJ: *O. ridleyi* (1); progenitor species of *Secale cereale*, *S. vavilovii* (1); and of *Panicum*, extending to the Indian region, *P. antidotale* (3). Introduced species of wild

relatives of crop taxa represented species that were not only a priority for utilization, but for systematic study as well.

Solanum/ Lycopersicon (tomato group), native of the South American region, was represented by the wild species, *L. cheesmaniae* (1) and *L. pimpinellifolium* (4), and were the closest relatives of tomato and potential sources of resistance to drought and disease; and *L. chilense* (2), *L. hirsutum* (4) and *L. peruvianum* (5), belonging to its secondary genepool, were sources of disease, pest and drought resistance. *Solanum* (brinjal group), was represented by the wild species *S. sisymbriifolium* (1), native of South America and a potential source of disease and pest resistance. Some of the introduced species of wild and weedy relatives of crops also extended their distribution as weeds of disturbed areas, viz. *Nigella sativa*, *Plantago lanceolata*, *Trifolium dubium* and *T. tomentosum* (Pradheep *et al*., 2011) and *Solanum sisymbriifolium* (Kohli *et al*., 2012), naturalized in the Indian region. These also served as reference specimens of taxa contributing naturalized weeds.

Many of the wild species in NHCP represented taxa that were well collected and represented in the germplasm in the genebank and herbarium specimens globally (http://gisweb.ciat.cgiar.org/GapAnalysis/). *Triticum monococcum* subsp. *aegilopoides* and *Vicia hyaeniscyamus* present in NHCP were poorly represented in genebank/ herbarium collections worldwide (http://www.fao.org/docrep/005/y4586e/y4586e08.htm for medicinal plants).

A total of 35 species belonging to 19 genera of grasses were of fodder/ forage value, native to the Central Asian/ Near East/ Mediterrranean and European regions and others of the North/ Central/ South American regions and African regions. Legumes used as fodder and forages/ vegetables and cover crops accounted for 124 species belonging to 14 genera. Majority of the taxa were temperate species native to the Central Asian, Near East, Mediterranean centres and extending to the European region (Zeven & de Wet, 1982) and introduced as germplasm from USA, South America or Australia. The source area and source institute/ country of diversity introduced in herbage grasses and legumes thus by and large represent germplasm. Specimens of taxa of herbage value, therefore, had a collective value representing diversity augmented through collection missions organised at the international level by CSIRO, Australia, FAO, USDA and other agencies to New World, Europe, Africa and the Mediterranean and Near East regions (Whyte, 1958), and systematic selection and breeding work, undertaken during early part of the 19th century in Europe and Mediterranean areas (Humphreys *et al*., 2009; Small, 2011) and introduced to other regions.

Conclusion

Nearly 70 herbarium specimens were delineated for their specific importance out of a total of 482 specimens of introduced germplasm represented in the NHCP; besides, all wild species, both closely related ones and others that were more of herbage value were significant additions for taxonomic and systematic study of crop taxa. Secondly, the analysis brought out the different parameters to be documented to work out that the PGR value of herbarium specimens as and when they are added, thereby ensuring that all distinctive characters are represented in the form of specimens, images, photographs and study of micro-morphological characters. Lastly, a collective value could be estimated for specimens belonging to related species or closely related genera; in the present analysis species (41) of the *Medicago-Trigonella-Trifolium* complex was one such example.

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