Introduction, Collection, Evaluation and Utilization of Fruit Germplasm

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In order to strengthen the germplasm pool of various fruit crops, steps were taken to collect, evaluate, maintain and utilize as commercial cultivars, rootstock and breeding material in crop improvement programmes. Germplasm of 25 fruit crops numbering 1529 accessions were collected from various exotic and indigenous sources, and evaluated for various purposes in the last 50 years at the Indian Agricultural Research Institute, New Delhi. In all, 88 accessions have been utilized for one or the other purposes. It is a matter of interest that out of 979 collections made from exotic sources only 92 (9.39%) survived in the field/nursery as against 38.2% survival in indigenous collections. This indicates that more care is needed to handle exotic germplasm in our country and make duplicate sets of material available at different places to avoid risk on their survival during various phases of their growth and development.

Key Words: Evaluation, Fruit Germplasm, Introduction, Utilization

Genetic variability is a pre-requisite for improvement in fruit crops. Whereas considerable diversity exists in agronomic traits in different fruit crops, the diverse genotypes combining sources of resistance to several biotic and abiotic stresses and fruit quality traits together are scarce in India. Therefore, it was considered appropriate to tap exotic and unexplored indigenous sources of germplasm of potential fruit crops. Genetically diverse types could thus effectively be employed to incorporate desirable traits of fruit quality, productivity, dwarf plant stature, tolerance to biotic and abiotic stresses, etc. to expand crop areas in unconventional geographical locations by evolving/selecting suitable scion variety and root stock to realize higher production of quality fruits. The Division of Fruits and Horticultural Technology of the Indian Agricultural Research Institute, New Delhi, since its inception as the Division of Horticulture in 1956 therefore, placed greater emphasis on collection and introduction of fruit germplasm by mutual germplasm exchange through personal contacts and later on through the National Bureau of Plant Genetic Resources (NBPGR) and it's management in an organized manner.

Materials and Methods

Germplasm of 25 fruit crops viz, mango, citrus, grape, guava, apple, pear, peach, fig, loquat, papaya, phalsa, strawberry, pomegranate, tamarind, nectarine, litchi, cashew nut, macademia nut, avocado, khirni, *Annona* species, capegooseberry and bael was collected from within the country and exotic sources using appropriate collection methodology under strict quarantine and maintained in the fields following appropriate cultural practices. Seed material was germinated in sterilized sand and/or soil after seed treatment. Germinated seedlings and plants raised from cuttings were maintained with utmost care. These germplasm were evaluated for various attributes and characterized using IPGRI descriptors list for morphological and molecular characters.

Results and Discussion

Indigenous and exotic germplasm collections of various fruit crops were evaluated for survival, growth and fruiting, fruiting quality and also for their utility as breeding material. The head-wise results are presented below:

Germplasm Collection, Documentation and Utilization

In all, 1529 accessions were assembled in a phased manner from various indigenous and exotic sources, of which 302 exist in the fields. Germplasm was subjected to field evaluation and characterization before utilization (Table 1). Eighty eight accessions have so far been utilized for various purposes. Despite reasonable efforts, large numbers of collections have vanished due to one or the other unfavorable factors. It is evident from the data (Table 1) that out of 550 accessions collected from indigenous sources, 210 (38.2%) survived in the field. Among 998 introduced accessions from the exotic sources only 92 (9.3%) survived.

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Table 1. Fruit germplasm holding and utilization at IARI, New Delhi (1956-2001)

S. No.	Crop	No. of collections made			No. of collections existing			No. of collections utilized		
		Indigenous	Exotic	Total	Indigenous	Exotic	Total	Indigenous	Exotic	Total
1	*Annona* species	3	1	4	2	0	2	0	0	0
2	Cape gooseberry	0	9	9	0	0	0	0	0	0
3	Citrus	10	268	278	10	23	33	8	8	16
4	Fig	0	18	18	0	0	0	0	0	0
5	Grape	115	437	552	11	25	36	2	11	13
6	Guava	10	6	16	6	0	6	2	0	2
7	Loquat	0	5	5	0	0	0	0	0	0
8	Mango	157	69	226	74	17	91	20	2	22
9	Papaya	56	36	92	2	0	2	6	0	6
10	Pear	12	4	16	5	0	5	2	1	3
11	Peach	30	54	84	0	1	1	0	1	1
12	Phalsa	5	1	6	5	1	6	5	1	6
13	Plum	18	6	24	0	0	0	1	1	2
14	Pomegranate	20	21	41	20	21	41	6		6
15	Strawberry	31	29	60	0	0	0	0	0	0
16	Apple	10	6	16	8	1	9	2	01	3
17	Tamarind	0	1	1	0	0	0	0	0	0
18	Nectarine	0	3	3	0	0	0	0	0	0
19	Litchi	7	0	7	2	0	2	0	0	0
20	Cashewnut	3	0	3	0	0	0	0	0	0
21	Macadamia nut	0	1	1	0	0	0	0	0	0
22	Ber	60	2	62	50	2	52	8	2	10
23	Avocado	1	1	2	1	1	2	0	0	0

Mango (*Mangifera indica* L.)

Of 226 collections made from exotic and indigenous sources, 91 survived in the field and 22 have so far been utilized for various purposes. Exotic collection 'Eldon' has been identified and released with popular name as 'Pusa Surya' for commercial cultivation. Fruit of this variety has thick peel with red colour on apricot yellow surface exposed to sun and long shelf-life making it suitable for long distance transport. 'Dushehari' and 'Neelam' have been utilized as parents for developing Amrapali and Mallika cultivars. Exotic 'Sensation' has been utilized as a pollen parent with 'Amrapali' for developing promising hybrid H-13-1 with red peel and long shelf life (Pandey, 1993), which has now been released as cv. Pusa Arunima. Other germplasm collections are under investigation for their utility either as a variety or parent for using in breeding programme. 'Anupam' has been found to be a dwarfing inter-stock for 'Amrapali' on seedling rootstock thus making it possible to induce dwarfness further for accommodating more number of trees per unit area (Pandey 1990). 'Kurukan' has been found as a potential salt tolerant rootstock and 'Bhadauran' possesses resistance to malformation malady.

Grape (*Vitis* spp.)

In grape, accessions were made from exotic (437) and indigenous (115) sources, which were evaluated and characterized morphologically (Singh, *et al.*, 1971 and 1972; Yadav, *et al.*, 1971 and 1976). Due to some natural adverse conditions, most of them were damaged and 36 exist in the field. Thirteen accessions have so far been utilized for a variety of purposes. Exotic cv Thompson Seedless and Perlette have become successful commercial cultivars in India. Other exotic collections like Katta Kurghan, Beauty Seedless, Madeleine Angevine, Rubired, Angoor Kalan and indigenous cv. Hur were utilized as parents in breeding programmes (Singh, *et al*, 1972, Jindal *et al.*, 1984). Seeded cultivar Hur was made seedless with gibberellic acid application

(Yadava, *et al.*, 1977). Pusa Seedless, is a clonal selection of Thompson Seedless; Pusa Urvashi (Hur x Beauty Seedless), Pusa Navrang (Madeleine Angevine x Rubired) have been evolved and released for commercial cultivation (Jindal, *et al.*, 2004). The latter two varieties have shown field resistance against anthracnose. Salt Creek and Dogridge have been found to be of great potential as salt tolerant rootstocks. Solonis x Othello-1613, an interspecific hybrid, has been found tolerant to nematodes.

Citrus Species

A total of 278 exotic (268) and indigenous (10) accessions was made, of which 33 now exist in the field.

Table 2. Some of the important accessions of fruits utilized for specific purposes

S.No.	Species	Attributes	Utilization
1	Mango (*Mangifera indica* L.)		
	Eldon	Red colour and thick peel	As variety
	Neelum	Regular bearing and dwarf in North India	As parent
	Mallika	Good fruit quality	As variety
	Sensation	Red peel, long shelf life	As parent
	Anupam	Dwarfing interstock	As interstock for Amrapali
	Kurakan	Salt tolerant	As rootstock
	Bhadauaran	Resistant to malformation	As parent
2	Grape (*Vitis vinifera* L.)		
	Thompson Seedless	Raisin variety and wider adaptability	As table and raisin variety and breeding material for good yield, quality & seedlessness.
	Perlette (EC-28410)	Translucent berry, early ripening, seedlessness	As a table variety & breeding material
	Katta Kurghan (EC-42365)	Large berry	Seeded material for increased berry size, breeding material.
	Beauty Seedless (EC-28389)	Prolific bearing and earliness	As juice variety & parent
	Madeleine Angevine	Wine making, earliness, low vigour	As a parent for earliness, wine making
	Rubired (EC-28415)	Wine making	As a parent for red coloured berry
	Cardinal (EC-24662)	Early maturity & loose cluster red peel	As table variety and parent for beg berry and red colour
	Hur	Reflex stamen, sweetness	As breeding material
	Salt Creek	Salt tolerance	As rootstock
	Dogridge	Salt tolerance	As rootstock
	Solonis x Othello-1613	Nematode resistance	Nematode resistant rootstock
	Pearl of csaba (EC-28395)	Earliness, Muscat flavour	Parent for earliness and Muscat flavour
3	*Citrus* species		
	Kinnow *(C. nobilis X C. deliciosa)*	Excellent fruit quality, juiciness	Commercial cultivation
	Rangpur lime (EC-18981)	Salt tolerance	Rootstock
	Mosambi & Pineapple (*Citrus sinensis* Osbeck) (EC-115795)	Sweet juicy fruit	As a variety
	Kagazi Kalan	Tolerant to canker	As avariety
	Rough lemon (*Citrus jambhiri*) (EC-25833)	Vigorous rootstock, wide adaptation, resistant to Phytophthora	As a rootstock
	Grapefruit (EC-36731)	Juice making	Many yarieties for commercial cultivation
	Cleopatra mandarin (*Citrus reticulata*) (EC-18989)	Tolerant to salt, tristeza, exocortis and xyloporosis	As a rootstock
	Citranges cv. Troyer citrange (*C. sinensis x P. trifoliata)* (EC-22050)	Adapts well to wide range of soil,& resistant to soil-borne diseases, nematodes	As semi-dwarfing rootstock
	Trifoliate orange *(Poncirus trifoliata)* (EC-31974)	Cold hardyness, dwarf, resistance to soil borne diseases and nematodes	As rootstocks
4.	*Mallus, Pyrus* and *Prunus*		
	Mallus baccata var. Himalaica	Dwarf	As dwarfing rootstock, resistant to Collar rot and root rot
	Mallus sikkimensis	Dwarf (Apomictic), resistant to root rot	As dwarfing rootstock, resistant to powdery mildew
	Pyrus pashia	Dwarf	As a rootstock
	Pyrus pyrifolia var. kumaoni	Dwarf	Dwarf rootstock
	Paja (*Prunus cerasoieds)*	Evergreen	Avenue plantation
	Prunus salicina	Adaptable to wide range of soils	Commercial cultivation.

Most of the germplasm was damaged in phases due to decline. Exotic collection Kinnow mandarin was recommended for commercial cultivation in North West plains. Nagpur mandarin, Pineapple, Malta and Mosambi sweet oranges and Kagzi Kalan lemon attained commercial status, and occupy a sizable area in different parts of India. Rough lemon, Troyer citrange, Cleopatra mandarin, citranges and trifoliate orange have been found useful as root stocks for various purposes.

Papaya (*Carica papaya L.*)

A total of 92 collections was made from exotic (36) and indigenous (56) sources. Papaya breeding programme was undertaken with cv. 'Ranchi' as base material for selection at IARI Regional Station, Pusa (Bihar), resulting into the development and release of several varieties like Pusa Delicious, Pusa Majesty, Pusa Giant and Pusa Dwarf. Among them Pusa Majesty and Pusa Delicious are gynodioecious lines by selection for several generations. Pusa Nanha is a mutant induced by physical mutagenesis.

Guava (*Psidium guajava L.*)

In guava, 16 collections were made from various sources, of which 3 cultivars occupy the place of commercial importance. Guava aneuploid No. 82 has been developed through crossing diploid with seedless (triploid) variety using indigenous germplasm (Sharma, 1992). This aneuploid No. 82 imparts dwarfness to vigourous cv. Allahabad Safeda, which enables to raise guava in high-density plantation (Sharma *et al.*, 1992).

Ber (*Ziziphus* sp.)

In ber, 62 indigenous collections were made, of which 52 exist in the fields. All the genotypes are under assessment for their suitability for commercial cultivation and as sources of resistance against biotic and abiotic stresses (Sharma, 1997). 'Tikadi' and 'Ilaichi' escaped fruit fly and powdery mildew. *Ziziphus nummularia* and *Zizyphus rotundifolia* have been found useful as dwarfing rootstock for cultivar of *Z. mauritiana*. Molecular characterization of ber using different DNA markers has been taken up by this division (Fig. 1).

Genetic diversity among 41 accessions of ber (*Ziziphus* spp.) belonging to cultivated *Ziziphus. mauritiana* and wild relative *Z. nummularia* have been investigated using RAPD, ISSR and AFLP. The level of polymorphism recorded within each species was 72.3% for *Z. mauritiana* and 87.1% for *Z. nummularia*. Several species-specific and unique fragments were identified, which could be effectively used to distinguish different accessions from each other. Similarly, coefficients ranging from 0.145-0.86 suggested that *Ziziphus* belonging to India has genetic relationship among the accessions based on broad genetic base. Cluster analysis revealed complete separation of the accessions of the two species into distinct groups.

Pomegranate (*Punica granatum L.*)

Forty-one collections made from various sources are maintained in the fields. Several genotypes are under evaluation for their suitability as a variety or as breeding material.

Temperate Fruit Crops

Germplasm of apple, peach, plum and pear collected under temperate and sub-tropical conditions (Table. 1) include pomes and stone fruits collected from indigenous sources (Randhawa, 1987). Collections of temperate fruit crops have been maintained at IARI, Regional Station, Amartara Cottage, Shimla. In all, 16 collections of *Malus* were made from indigenous and exotic sources. *Malus baccata* var. *himalaica* appeared to be a dwarfing rootstock with a great degree of compatibility with Golden Delicious. It has also been found to be partially resistant to collar rot (*Phytophthora cactorus*), root rot (*Dematophora necatrics*) and wooly aphis (*Eriosoma lanigarum*). *Malus sikkimensis* has been found to be resistant to powdery mildew and collar rot. Sixteen collections of *Pyrus* species were made from indigenous and exotic sources. *Pyrus pashia* is an easy rooting material by stooling (Yadav *et al.* 1971) and as a root stock, it has been found to impart dwarfness and Pyrus *pyrifolia* var. *Kumaoni* offers resistance to powdery

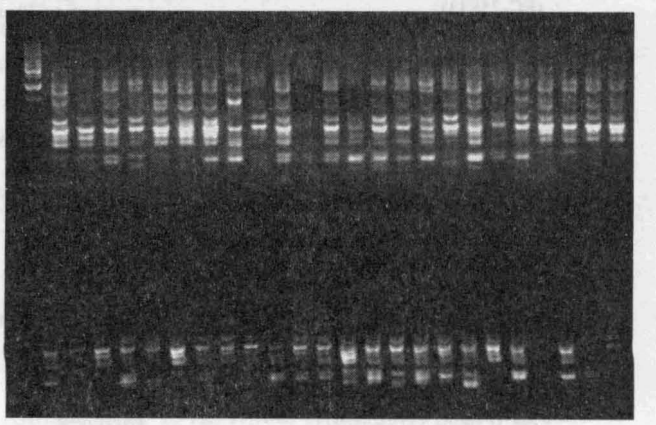

Fig. 1: RAPD profile of Zizyphus spp. *with OPD-7*

mildew. For genus *Prunus*, 30 collections were made from different sources for evaluation and utilization. Seeds of *Prunus rufa* failed to germinate. *Prunus jenkinsii* was found susceptible to severe cold. *Prunus cerasoides* is an evergreen plant and could best be utilized as an avenue plantation. *Prunus salicina* has been found to make a satisfactory union with plum cvs. Santa Rosa and Satsuma. The seedlings of *Prunus persica* have been found to be a successful root stock for peach, plum, apricot and almond. Germplasm evaluation of strawberry has revealed potential for commercial cultivation (Kaul, 1962; Rajput, 1965).

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