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Utilization of plant genetic resources for the improvement of temperate fruit crops

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Abstract

The Himalayas provide suitable ecological niches for the prevalence of large number of temperate fruit germplasm. Seven crab apples (*Malus baccata*) have been collected from the region and evaluated for horticultural traits. Crab apple from Shillong has been found to possess a high level of resistance against powdery mildew than *M. zumi*. Its performance as root stock and resistance to woolly aphid is much superior to standard clonal root stocks M9 and MM106. It is compatible with all commercial apple varieties and produces semi-vigorous tree suitable for high density plantation. Wild pear (*Pyrus pashia* var. Kumaonii) possesses desirable traits like good propagation potential and recommended for root stock in root rot infested areas. Wild kiwi fruit (*Actinidia* spp.) is small sized and non hairy type which could be utilized for the improvement of existing varieties. It can be used as desirable rootstock. The region also inhabits many *Prunus* species and indigenous edible temperate fruits, which could be exploited for commercial traits. An unique walnut has been collected which bear fruits both terminally and laterally and therefore, it could be utilized for high density planting.

Key words: Crab apple, temperate fruits, biotic stress, vigor, graft compatibility, propagation

Introduction

Himalayas spreading from north western to north eastern India has been considered as treasure for the biodiversity of genetic resources particularly of temperate fruit crop species. A survey was carried out during 1966-70 under a PL-480 project and 56 different species/varieties and types of various genera *viz. Malus, Pyrus, Prunus, Sorbus, Docynia, Diospyrus, Cotoneaster and Actinidia* were collected and conserved at the research farm of IARI Regional Station, Shimla [1]. These germplasm offer genetic variability to various horticultural traits *viz*., adaptability to soil/agro climatic conditions, vigor, winter hardiness, drought tolerance, chilling requirement, propagation potential, resistance to diseases and pests [2, 3]. These were evaluated and categorized for various traits which could be utilized as cultivar through selection, as rootstock and in breeding programme.

Wild apples (Malus spp)

Out of five wild *Malus* species in the world *Malus sikkimensis* and *M. baccata* were reported from India. Two ideotypes of *M. sikkimensis* and six of *M. baccata* exhibited variability in shoot and leaf characteristics which determine growth behaviour, flowering and fruiting habit [4]. The nomenclature of the *M. baccata* is being maintained by suffixing the name of locality from where these were originally collected (Table 1).

Evaluation as a root stock for apple

Six indigenous *Malus baccata* were evaluated as root stock for different commercial varieties and compared with standard clonal rootstocks M9 and MM-106 for salient characters (Table 1). Based on leaf stomata count *M. baccata* Rohru appears to be very dwarf, while *M. baccata* from Khrot, Giabung and Dhak were as dwarf as M9. *M. baccata* Shillong have been found semi-vigorous, while *M. baccata* Srinagar and MM106 are vigorous. Propagation potential is a prerequisite for an ideal root stock. *M. baccata* from Shillong, Khrot and Srinagar were found superior to standard clonal rootstocks M9 and MM106 for rooting quality, rooting success (93-100 %) and graft compatibility (100%) with scions of different commercial varieties (Table 1). The growth pattern [4, 5] of apple scion variety Golden Delicious grafted on indigenous crab apples was compared with standard clonal rootstocks (M 9 and MM

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106). The growth rate of apple scions was initially vigorous but after four months it recorded slow growth at par with MM-106 exhibiting semi-vigorous growth which is a desirable trait for high density plantation [6].

The chilling requirement of *M. baccata* Shillong is appreciably lower, while *M.baccata* Srinagar is similar to M 9 and MM 106. *M. baccata* Rohru requires the least chilling units amongst all the Himalayan crab apples [7]. The lower chilling unit requirement indicates the rootstock resilience to temperature higher than ambient and its adaptability to low elevation areas. Results indicate that two indigenous crab apples from Shillong and Srinagar possess all desirable traits for an ideal rootstock (Table 1). In which *M. baccata* Srinagar is vigorous while *M. baccata* Shillong imparts semi vigorous growth to grafted commercial scion cultivars [6].

Evaluation for biotic stresses

The germplasm were evaluated for their reaction to biotic stresses *viz.,* powdery mildew (*Podosphaera leucotricha*), apple scab (*Venturia inaequalis*), white root rot (*Dematophora necatrix*) and Woolly aphid (*Eriosoma lanigerum*) for identification of resistant/tolerant species. Disease reaction to powdery mildew under artificial inoculation conditions revealed that *M. baccata* Shillong not only has delayed the appearance of mildew by 17 days but also restricted the development of mildew to 5% (mildew index). In case of *M. baccata* Srinagar though initial appearance has not been delayed but mildew development was restricted to 10.3 % (mildew index). Both indigenous crab apples possess much higher resistance than *M. zumi* (22.5 % mildew index) [8, 9] which is a recognized donor species for imparting powdery mildew resistance in apple breeding programme (Table 2).

Indigenous crab apples were evaluated for apple scab at hot spot under natural disease pressure. *M. baccata* from Shillong, Srinagar and Khrot exhibited moderate level of resistance [10]. Evaluation for disease reaction to white root rot (*Dematophora necatrix)* showed that none of the crab apples possess resistance to white root rot at high level of disease pressure whereas indigenous crab apples from Srinagar and Shillong exhibited tolerance [11, 12] at low disease pressure (Table 3).

Woolly aphid infestation is one of the important limiting factor for the cultivation of apple plantation in the country. It not only infest the aerial parts in spring

Table 1. Salient characteristics of *Malus baccata* types

Species	Average number of stomata/ microscopic field (100x10X)	Vigor	Propagation potential	Chilling unit (hrs.)	Rooting in mound layers	Rooting quality	Graft success with Golden Delicious	Relative rate of growth of layer	Reaction to woolly aphid	Reaction to powdery mildew	Reaction to apple scab
M9	7.48b	Dwarf	Poor	1593	38	Good	85	1.22	R	S	S
MM 106	10.48b	Semi-vigorous	Good	1593	70	Good	87	1.66	S	S	MR
M. baccata (Shillong)	7.10b	Semi-vigorous	Very good	1427	93	Profuse	100	1.26	R	R	MR
M. baccata (Khrot)	7.18b	Dwarf	Very good	1593	93	Profuse	67	1.11	S	S	MR
M. baccata (Giabung)	7.22b	Dwarf	Good	1461	60	Good	75	1.17	S	S	MS
M. baccata (Dhak)	7.96b	Dwarf	poor	1593	35	Good	100	1.32	S	S	S
M. baccata (Srinagar)	10.20c	Vigorous	Very good	1553	100	Profuse	100	1.78	S	R	MR
M. baccata (Rohru)	4.14a	Very Dwarf	Very poor	1461	10	Poor	66	1.20	S	S	MR

S = susceptible; R = resistant; MR = moderately resistant and MS = moderately susceptible.

Table 2. Disease reaction of *Malus species* to powdery mildew

S.N.	Species	Incubation period (Days)	Mildew index on young leaves	Mildew index on old leaves	Disease reaction
1.	*M. spectabilis*	7	93.5 (76.6)*	81.8 (64.8)*	S
2	*M. purpuria*	7	11.3 (19.6)	8.7 (17.0)	R
3	M 9	7	77.5 (62.5)	32.9 (34.9)	S
4	(*M. micromalus*) Nagasaki zumi	7	84.5 (69.2)	35.2 (36.4)	S
5	*M. crimson brilliant*	7	79.8 (69.3)	80.4 (63.7)	S
6	M 27	7	82.2 (65.0)	51.7 (45.9)	S
7	*M. baccata* (Dhak)	7	89.8 (71.5)	82.8 (65.5)	S
8	*M. baccata* (Kinnaur)	7	89.9 (71.7)	61.7 (51.7)	S
9	*M. prunifolia*	7	61.7 (51.7)	42.6 (40.7)	MS
10	*M. prunifolia var ringoasami*	7	32.9 (34.9)	27.8 (31.7)	MR
11	*M. baccata* (USA)	7	97.9 (82.6)	96.4 (79.5)	S
12	MM 106	7	45.4 (42.3)	35.6 (36.6)	MR
13	*M. baccata* (Khrot)	7	96.9 (80.5)	92.5 (75.6)	S
14	*M 26*	7	77.5 (61.8)	71.4 (57.7)	S
15	*M. zumi*	9	22.5 (28.3)	20.0 (26.6)	R
16	M 4	7	47.4 (43.5)	40.5 (39.5)	MS
17	*M. baccata* (Shillong)	17	5.0 (12.8)	3.9 (11.5)	R
18	*M. prunifolia* (Maruba)	13	17.4 (24.6)	13.3 (21.4)	R
19	*M. baccata* (Kashmir)	7	10.3 (18.6)	7.2 (15.6)	R
20	*M. eseltine*	7	43.5 (41.2)	36.8 (37.4)	MR
21	M 7	7	80.4 (63.7)	61.5 (51.6)	S
	CD		12.2	7.6	

*=aricson value; S = Susceptible; R = Resistant; MS = Moderately susceptible; MR = Moderately resistant.

Table 3. Mortality rate (%) of different temperate fruit species at variable disease pressure of *Dematophora necatrix*

No. of grain inocula	Per cent mortality of different root stocks				
	M. baccata Kashmir	*M. purpuria*	*M.prunifolia/ ringo asami*	*Pyrus pashia/ kumaonii*	*Cydonia oblonga*
100	100.0	100.0	88.8	66.6	66.6
50	100.0	88.8	44.4	16.6	50.0
25	88.8	55.5	22.2	0.0	16.6
10	66.6	22.2	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
Check (No inoculum)	0.0	0.0	0.0	0.0	0.0

season affecting the growth adversely but also forms galls in the roots, resulting in restricted root/shoot growth and declined yields. Evaluation of indigenous crab apples revealed that *M. baccata* Shillong possesses a very high level of resistance against woolly aphid by restricting the gall development in the roots and aphid population on aerial parts [13]. The grafted plants of Spur Type Red Delicious on *M. baccata* Shillong of 25 year old at farmer's field has not recorded any incidence of woolly aphid at different locations.

High density plantation

A planting density trial was carried out by selecting *M. baccata* Shillong as root stock with scion variety Spur Type Red Delicious. The experiment was carried out on 30 % hill slope, which revealed that planting distance of 3m x 3m accommodating 1111 trees/ha is an ideal density for stable and sustainable yield [5, 6]. Based on twenty years studies at research farm and on farm

research at farmer's field, *Malus baccata* Shillong has proved an ideal promising rootstock for conventional as well as high density planting. Even at 30 % slope with drip irrigation facility it yielded more than 25 tons/ ha. It has been released as "Pusa Apple Rootstock 101".

Wild pear (Pyrus spp.*)*

Collected *Pyrus* spp *viz., P. jacquimontiana, P. polycarpa, P. Pashia, P. calleryana, P. Pashia* var. Kumaonii and *P. Pyrifolia* were evaluated for different horticultural traits. Four species of *Pyrus* were evaluated as rootstock for pear (cv. Bartlett). Observations on shoot growth, trunk diameter, leaf status for nitrogen, reducing sugars, starch and Yield were recorded. *Pyrus calleryana* has indicated signs of dwarfing effect combined with symptoms of graft incompatibility at initial stage [14]. Evaluation for root rot at graded disease pressure in sick plot showed that *P. pashia* var. Kumaonii was resistant. It possesses profuse root volume with deep root system and recommended as rootstock for steep slopes, soils with moisture stress conditions and root rot infested areas [11].

Prunus (Prunus spp.*)*

Eight *Prunus* species *viz*., *Prunus nepaulensis, P. cornuta, P. cerasoides, P. armeniaca*, *P. persica, P. salicina, P.* sp. behimi and *P. wallichii*. *P. jacquimontii* collected from Himalayas were characterized for salient features *viz*., growth vigor on the basis of stomata density, grafting compatibility with plum scion cv. Santa Rosa/ Satsuma and propagation potential through mound layers (Table 4). *P. salicina* was found vigorous and compatible with both the scion varieties and high propagation potential with mound layering/ air layering techniques [15]. *P. cornuta* has been found a suitable rootstock for cherry. Initial grafting trials revealed that *P. japonica* was most dwarfing root stock for peach, apricot and almond. Fruiting was recorded in the same season after grafting in case of peach (Shan-e-Punjab) and apricot (New Castle) indicating precocity. It can also be utilized as an ornamental plant (Fig. 1). *P. nepaulensis* (Fig. 2) occurring in wild conditions in Meghalaya is

Fig. 1. *Prunus japonica* as a ornamental plant

Fig. 2. Khasi Cherry *(Prunus nepaulensis)*

Fig. 3. Salient features of wild Kiwi from NEH Region

Table 4. Salient features of *Prunus* spp. in the Himalayas

Species	Stomatal density (10x × 40x)	Grafting compatibility with scion cv. Santa Rosa/ Satsuma	Percentage rooting in mound layers/ air layers
P. nepaulensis	28.7	0 (D)	0.00
P. cornuta	20.6	0 (D)	87.5
P. ceresoides	15.7	0 (D)	94.4
P. armeniaca	57.7	20 (C)	48.7
P. persica	23.5	27 (C)	06.7
P. salicina	52.2	50 (C)	73.1 (81.3)
P. sp. Behimi	23.2	7 (C)	33.3 (55.0)
P. wallichii	48.1	0 (D)	0.67 (66.7)
P. jacquimontii	-	-	0.0

C=Compatible, D= Dead wood in graft union

gaining commercial importance as dessert fruit and for processing [16]. Selection of plants having high yield and quality fruit with higher pulp/stone ratio were done for further multiplication.

Walnut (Juglans spp.*)*

A walnut clone was collected from forest of district Chamba in Himachal Pradesh possessing unique characteristics of bearing nuts both laterally (69.91%) and terminally (30.09). It gave fruiting second year after grafting, which otherwise comes in bearing after 10-12 years. The nut is thin shelled with light cream yellow coloured kernel and excellent in taste [17]. It possesses a very desirable trait of shelling (50%) and oil content (55%). In organoleptic tests its astringency was rated significantly lower than market samples. Considering all the desirable commercial characteristics the accession is christened as "Pusa Khor". Its multiplication is done for distribution to growers.

Wild Kiwi

The occurrence of wild kiwi fruit (*Actinidia callosa*) (Fig. 3) in the forest of Dirang, Shergaon, Bombdilla and Zero areas of Arunachal Pradesh has been reported [18]. Local inhabitant consume these fruits and call it *thumri/ khusugung/thumberg*. The measurement of largest fruit recorded an average of 21 mm length, 13 mm width and 2.3 g fruit weight. Cross section of fruit showed numerous small light brown seeds embedded in the light green flesh. The fruits were oval with flat ends, borne in clusters of two to five fruits per peduncle, skin without hairy growth. These desirable fruit traits could be utilized for commercial purposes besides using as donor for non-hairy trait for improving the existing cultivars.

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