Indian J. Hort. 70(2), June 2013: 283-286

Short communication

Evaluation of promising Japanese plum genotypes for mid-hills of Himachal Pradesh

K. Kumar*, Sonali Tandon, Dinesh Singh and Vikas K. Sharma
Department of Fruit Science, University of Horticulture & Forestry, Nauni, Solan 173 230, Himachal Pradesh

ABSTRACT

Six exotic Japanese plum accessions, namely, Black Amber, Cherry Plum, Queen Rosa, Ruby Sweet, Florida 1-2 and Shiro 14-4 were evaluated under midhills conditions of Himachal Pradesh. Black Amber had lowest canopy spread, while Florida 1-2 had earlist leaf emergence and flowering. Accessions Ruby Sweet, Black Amber and Florida 1-2 were most promising for commercialization in the state.

Key words: Japanese plum, evaluation, low chilling cultivars.

Cultivation of Japanese plum (*Prunus salicina* Lindl.) in India is mainly concentrated in the North Indian hill states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand (Kaushal *et al.*, 5). Some low chilling plum varieties are also grown in comparatively warmer areas of north India (Josan *et al.*, 4). Japanese plums are grown in 21,000 ha in India with an annual production of 1,60,000 metric tonnes (FAO, 2). The leading plum cultivar in mid-hills of Himachal Pradesh is 'Santa Rosa' and its over dominance in commercial plantation leads to a monoculture like situation and the farmers do not get remunerative price for their produce. To avoid gluts in the market and to meet ever changing consumer's preferences, there is a need to have varietal diversification in plums by bringing into cultivation genetically improved new cultivars. In line with above, six plum accessions of exotic origin were assessed for their growth, phenology and fruiting, besides developing descriptors for their identification and characterization for future use.

The present studies were carried out at the Plum Germplasm Collection Block of the Department of Fruit Science, UHF, Nauni-Solan (HP) located at an altitude of 1,220 m amsl between 31°N and 77°E witnessing mild temperate climate. The experimental material included 7-8 year-old Japanese plum (*Prunus salicina* Lindl.) trees of six exotic accessions namely Black Amber, Cherry Plum, Queen Rosa, Ruby Sweet, Florida 1-2 and Shiro 14-4 grafted on wild apricot. The observations on vegetative growth, foliage and phenological characters were recorded following the standard methods. Leaf area was worked out using leaf area meter (LiCor- 3100A), leaf and fruit colour was observed as per Royal Horticultural Society Colour Chart.

*Corresponding author

To study fruit characters, 10 representative fruit samples were taken in three replicates each at optimum maturity. Fruit and stone shapes were described as per IBPGR (3) descriptor. Fruit firmness was measured with the help of 'Effigi' penetrometer using 7/16" plunger in kg/cm^2. The TSS content of fruits was determined with Erma hand refractometer (0 to 32^{o}B). The titratable acidity was calculated in terms of malic acid. Lane and Eynon's volumetric method was employed for the estimation of sugars. Flower buds at balloon stage were removed for pollen collection and pollen viability was determined using standard staining and *in vitro* pollen germination tests. For open-pollination and self-pollination studies four healthy flowering branches each were selected before anthesis in four directions in case of each accession.

Data analysis was carried out using standard statistical methods. The tree height ranged between 2.50 m (Black Amber) and 4.00 m (Florida 1-2 and Queen Rosa). Maximum trunk girth (45.90 cm) was recorded in Florida 1-2 and minimum (13.00 cm) in Black Amber (Table 1). Tree spread in NS and EW was maximum (4.10 m) in Florida 1-2 and corresponding minimum value was 1.00 m in Black Amber in both the directions. All the plum accessions studied had upright growth except Florida 1-2, Shiro 14-4 and Ruby Sweet, which exhibited semi-spreading habit. Such variation in growth characters has also been observed by Prakash *et al.* (7). Leaf area was minimum (9.31 cm^2) in Black Amber and maximum (18.23 cm^2) in Florida 1-2. Obovately shaped leaves of all the plum accessions under study were green (139A in Florida 1-2, Queen Rosa, Black Amber and Ruby Sweet, and 137A in Shiro 14-4 and Cherry Plum) with a slight variation in the shade.

The time of leaf emergence extended from last week of January in Florida 1-2 (low chilling) to last

Table 1. Tree and foliage characters of some exotic plum accessions.

Character/ Accession	Tree height (m)	Tree spread (m)		Leaf area (cm^2)
		NS	EW	
Black Amber	2.50	1.00	1.00	9.31
Cherry Plum	3.00	1.20	1.30	13.88
Queen Rosa	4.00	1.50	1.70	10.94
Ruby Sweet	3.10	1.50	1.70	12.37
Florida 1-2	4.00	4.10	4.10	18.23
Shiro 14-4	3.90	2.30	2.90	14.69
Mean	3.42	1.93	2.12	13.24

week of February in Shiro 14-4 (Table 2). Spread of bud burst time over a months period indicate high degree of variation and raises the possibility of selecting late leafing genotypes. On the other hand, leaf fall varied between first week and second week of November, depicting less variation. The duration of flowering varied from 13 to 18 days. The flowering (full bloom) was earliest (second week of February) in Florida 1-2 and latest (second week of March) in Shiro 14-4. Similar variation in flowering duration was also observed by Sud (8) and Josan *et al.* (4) in plum cultivars. High variation recorded in flowering period would pave the way for developing late flowering plums to avoid damage due to spring frosts of common occurrence under mid hill conditions. As regards the time of fruit ripening, all the six plum accessions were early to mid season extending from as early as 20th May in Florida 1-2 to as late as 7th June in Black Amber and Ruby Sweet. However, these varieties ripened 2-3 weeks earlier to Santa Rosa (mid June), the commercially important plum cultivar of mid-hills, thus assumes greater significance from marketing point of view.

The highest pollen viability using 1.0 per cent aceto-carmine was observed in Florida 1-2 (89.45%) and minimum in Shiro 14-4 (67.40%). Pollen viability when tested with 0.1 per cent erythrosin B ranged from 63.12 per cent (Shiro 14-4) to 84.25 per cent (Black Amber). Pollen germination under *in vitro* was maximum (76.20%) in Florida 1-2 and minimum (64.85%) in Black Amber (Fig. 1). All the six plum accessions recorded significant differences for pollen viability (with aceto-carmine and erythrosin B) and pollen germination. The pollen viability levels obtained through staining tests in the present study were recorded high in different plum cultivars to the extent of upto 90.0 to 93.05 per cent. The pollen viability as assessed by *in vitro* pollen germination test varied from 64.85 per cent in Black Amber to 76.20 per cent in Florida 1-2, clearly suggesting no signs of pollen sterility.

Highest fruit set was recorded in Shiro 14-4 under open (37.37%) or natural pollination (35.65%), whereas, a lowest (4.06%) was recorded in Ruby Sweet and Queen Rosa (Fig. 1). The latter accessions were at par with Black Amber and so were Cherry Plum and Florida1-2. Fruit set upon selfing (Fig. 1) by bagging ranged from 0.17 per cent in Black Amber to 35.36 per cent in Shiro 14-4. Florida 1-2 and Cherry

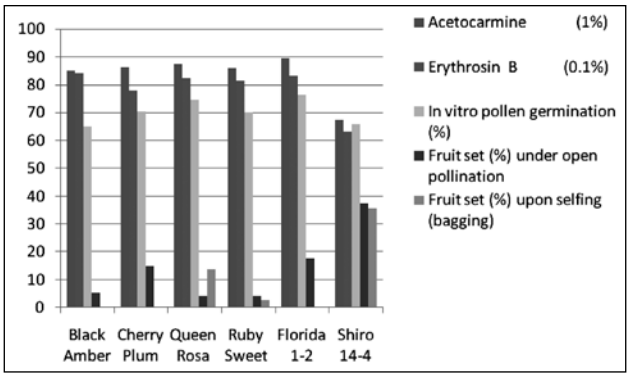


Fig. 1. Pollen viability and fruit-set in some exotic plum accessions.

Table 2. Phenological characters of some exotic plum accessions.

Accession	Time of leaf emergence	Time of flowering			Flowering duration (days)	Time of petal fall	Time of harvesting	Time of leaf fall
		1st flower	Full bloom (>75%)	Last flower				
Black Amber	22nd Feb	17th Feb	1st March	3rd March	15	7th March	7th June	15th Nov
Cherry Plum	22nd Feb	18th Feb	2nd March	4th March	15	7th March	27th May	10th Nov
Queen Rosa	18th Feb	18th Feb	28th Feb	2nd March	13	6th March	27th May	14th Nov
Ruby Sweet	18th Feb	19th Feb	2nd March	4th March	14	8th March	7th June	15th Nov
Florida 1-2	25th Jan	24th Jan	8th Feb	10th Feb	18	13th Feb	20th May	2nd Nov
Shiro 14-4	24th Feb	26th Feb	10th March	12th March	15	16th March	26th May	18th Nov

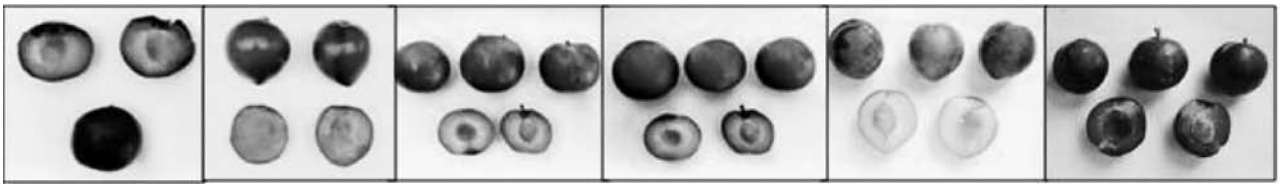
Plum were at par with Black Amber in terms of fruit set under this mode of pollination. All the accessions were observed to set better fruits under open-pollination compared to self-pollination. However, there is a need to further ascertain the factors responsible for low fruit set upon selfing in Black Amber, Cherry Plum, Ruby Sweet and Florida 1-2 to rule out partial self-unfruitfulness, if any.

The heaviest fruits were observed in Ruby Sweet with average fruit weight of 49.12 g, whereas, the fruits were lightest (25.12 g) in Cherry Plum (Table 3; Fig. 2). Fruit size (length × breadth × thickness) was maximum (43.81 mm × 41.27mm × 40.26 mm) in Ruby Sweet and minimum (31.79 mm × 33.12 mm × 33.79 mm) in Cherry Plum. Fruits borne by all plum accessions were round in shape. The colour of fruits was Red Purple in all the accessions. However, slight variation was observed in the shade of the colour. The flesh colour was Orange Red (31A) in Florida 1-2, Cherry Plum and Ruby Sweet; Orange Red (30A) in Queen Rosa and Shiro 14-4 and Red Purple (60A) in Black Amber. All other plum accessions were of clingstone type except Shiro 14-4 (semi-clingstone) and Black Amber (freestone). Ovate stone shape was common except Ruby Sweet (rounded stone) and Florida 1-2 (elongated). Josan *et al.* (4) also observed variation in fruit quality characteristics of plum cultivars. The smallest (length × breadth × thickness) stones (15.48 × 10.75 × 5.62 mm) weighing 0.77 g were found in Cherry Plum (Table 3). Maximum pulp to stone ratio (41.52) was found in Ruby Sweet followed by Florida 1-2 which had 41.20 pulp : stone ratio. The fruits with minimum (20.95) pulp : stone ratio were obtained in Black Amber. The fruit firmness varied from 0.75 kg/cm^2 in Shiro 14-4 to 1.02 kg/cm^2 in Cherry Plum and Black Amber.

Data pertaining to chemical characters of fruits of plum accessions are presented in Table 4. The highest TSS content was in Black Amber (16.95°B) and Queen Rosa (9.7°B) recorded the lowest, which were significantly different from other genotypes. Highest acidity of 2.59% in Florida 1-2 and lowest was 1.12% in Ruby Sweet. The total sugars content ranged from 6.07% (Queen Rosa) to 8.95% (Shiro 14-4). All the plum accessions studied were significantly different except Cherry Plum and Florida 1-2, which were statistically at par. Reducing sugars varied from 3.24 per cent in Queen Rosa to 6.21 per cent in Ruby Sweet. Maximum content of non-reducing sugars was 4.15 per cent in Shiro 14-4 and the lowest was 0.69 per cent in Ruby Sweet. The highest sugar : acid ratio was 6.21 (Ruby Sweet) and the lowest was 2.40 (Florida 1-2). Cherry Plum and Black Amber were at par with Queen Rosa in terms of sugar : acid ratio. The sugar : acid ratio is an important factor in

Table 3. Fruit and stone characteristics (physical) of some exotic plum accessions.

Accession	Fruit wt. (g)	Fruit size (L × B × T) (mm)	Stone size (L × B × T) (mm)	Stone wt. (g)	Pulp/ stone ratio	Firmness (kg/cm^2)	Fruit skin colour	Fruit flesh colour	Stone shape	Stone adherence
Black Amber	37.77	36.21 × 35.86 × 38.59	20.45 × 14.67 × 7.11	1.65	20.95	1.02	Red purple (60 A)	Red purple (60 A)	Ovate	Free
Cherry Plum	25.12	31.79 × 33.12 × 33.79	15.48 × 10.75 × 5.62	0.77	34.42	1.02	Red purple (59 A)	Orange red (31 A)	Elongated	Cling
Queen Rosa	42.92	37.55 × 41.20 × 41.56	16.68 × 15.07 × 7.97	1.15	27.97	0.87	Red purple (59 B)	Orange red (30 A)	Rounded	Cling
Ruby Sweet	49.12	43.81 × 41.27 × 40.26	22.37 × 15.74 × 7.13	1.20	41.52	0.77	Red purple (59 A)	Orange red (31 A)	Ovate	Cling
Florida 1-2	41.05	41.94 × 39.39 × 38.57	20.97 × 15.98 × 8.01	1.00	41.20	1.00	Red purple (59 A&B)	Orange red (31 A)	Rounded	Cling
Shiro 14-4	33.80	36.54 × 35.35 × 35.04	20.92 × 14.92 × 8.11	1.17	29.02	0.75	Red purple (59 A)	Orange red (30 A)	Ovate	Semi-cling
$CD_{0.05}$	1.09	0.91 × 1.09 × 1.33	0.90 × 0.88 × 0.83	0.24	13.33	0.21				



Black Amber | Florida 1-2 | Cherry Plum | Ruby Sweet | Queen Rosa | Shiro 14-4

Fig. 2. Variations in fruits characteristics of some exotic plum accessions.

Table 4. Fruit characteristics (chemical) of some exotic plum accessions.

Accession	TSS (°Brix)	Titratable acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Sugar/acid ratio
Black Amber	16.95	2.07	6.64	5.00	1.55	3.20
Cherry Plum	13.15	1.83	6.20	3.91	2.17	3.38
Queen Rosa	9.70	1.69	6.07	3.24	2.68	3.57
Ruby Sweet	15.02	1.12	6.94	6.21	0.69	6.21
Florida 1-2	13.10	2.59	6.26	4.27	1.88	2.40
Shiro 14-4	14.15	2.26	8.95	4.58	4.15	3.95
$CD_{0.05}$	0.45	0.07	0.25	0.23	0.26	0.40

determining the consumer acceptability of any edible fruit. Similar variations in the chemical quality of the plum fruits have been recorded by different workers (Josan *et al.*, 4; Erturk *et al.*, 1).

The present studies did indicate that some of these accessions, *viz.*, Ruby Sweet (large fruit size and weight, high TSS, sugar: acid and pulp : stone ratio), Black Amber (firm fruits, freestone, high TSS) and Florida 1-2 (early maturity and high pulp : stone ratio) do possess one or more horticulturally desirable characteristics (shown in parentheses above) and thus can be future candidate varieties for commercialization under mid-hills of North-western Himalayas.

REFERENCES

1. Erturk ,Y., Ercisli, S. and Tosun, M. 2009. Physico-chemical characteristics of wild plum fruits (*Prunus spinosa* L.). *Int. J. Pl. Prod.* **3**: 89-92.
2. FAO. 2009. Statistical Database. http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor
3. IBPGR, 1984. *Plum Descriptors.* D. Cobianchi and R. Watkins (Eds.), Rome, Italy, 31.
4. Josan, J.S., Sharma, J.N., Mehrotra, N.K. and Monga, P.K. 1999. Performance of some plum cultivars under arid-irrigated region of Punjab. *Indian J. Hort.* **56**: 299-303.
5. Kaushal, R., Parmar, R., Sharma, S.D. and Bist, H.S. 2004. Floral, morphological and flowering studies in stone plum and apricot cultivars. *Indian J. Hort.* **61**: 276-77.
6. Mohapatra, R.K.D. and Sharma, S.D. 1997. Physico-chemical characteristics of twelve plum cultivars of Himachal Pradesh. *J. Fd. Sci. Tech.* **34**: 78-79.
7. Prakash, V., Singh, M.P., Dimri, D.C. and Nautiyal, M.C. 2003. Evaluation of different plum (*Prunus* sp.) cultivars under mid-hill conditions of Uttaranchal. *Pantnagar J. Res.* **1**: 7-9.
8. Sud, G. 1979. Studies on the pollination requirement of plum cultivar 'Climax'. *Indian J. Hort.* **36**: 423-26.

Received: July, 2011; Revised: November, 2012; Accepted: February, 2013