**Mukesh Kumar**
Department of Fruit Science,
Dr. Y. S. Parmar University of
Horticulture and Forestry
Nauni, Solan, Himachal
Pradesh, India

**DD Sharma**
Department of Fruit Science,
Dr. Y. S. Parmar University of
Horticulture and Forestry
Nauni, Solan, Himachal
Pradesh, India

**Niranjan Singh**
Department of Fruit Science,
Dr. Y. S. Parmar University of
Horticulture and Forestry
Nauni, Solan, Himachal
Pradesh, India

**Bunty Shylla**
Department of Pomology,
HRTS and KVK Kandaghat,
Solan, Himachal Pradesh, India

# Evaluation of newly introduced plum (*Prunus salicina* Lindl.) cultivars under mid-hills of Himachal Pradesh

**Mukesh Kumar, DD Sharma, Niranjan Singh and Bunty Shylla**

**Abstract**
Plum is one of the important and widely cultivated fruit crop of temperate regions of the world. Santa Rosa is the predominant plum cultivar grown over 90 percent of the total area under plum cultivation in Himachal Pradesh and the predominance of single cultivar leads to monoculture like situation and create gluts in the market and the farmers do not get remunerative prices for their produce. To meet ever-changing consumer preferences and spread of harvest season, there is a need for varietal diversification with genetically improved cultivars. The experiment was laid out in Randomized Block Design with five replications of each cultivar planted at a spacing of 5 x 5 m during 2015. Observations were recorded in respect of tree vigour and fruiting parameters of fruits. Analysis of variance showed significant differences among all the cultivars for all the characters under study. Maximum tree vigour was recorded in 'Shiro' with respect to tree spread, tree volume, annual shoot growth and pruning weight. Maximum tree height and leaf area was observed in Red Beaut cultivar. The highest fruit set, fruit retention, yield and minimum fruit drop was recorded in ' Shiro'. Harvest date was recorded to be earliest (29th May) in Red Beaut cultivar with shortest duration of 96 days for maturity. Cultivar 'Frontier' recorded the maximum fruit size, weight, volume and pulp to stone ratio, whereas, quality attributes like fruit firmness, TSS, total sugars and sugar to acid ratio were found highly desirable in 'Black Amber' and all these fruit quality attributes were in close proximity to 'Duarte'. From the present investigations it can be concluded that out of newly introduced cultivars, 'Black Amber' and 'Duarte' may be suggested for cultivation in mid-hill conditions of Himachal Pradesh and can provide alternative to change the monotony of 'Santa Rosa' in order to stretch the harvesting season, fulfill consumer's ever-changing taste and better remuneration to the growers. These studies on different cultivars may be continued further at different locations prior to recommendation for commercial cultivation in sub-temperate and mid-hill conditions of Himachal Pradesh.

**Keywords:** Plum, plant growth, biochemical characteristics

## 1. Introduction
The cultivated plum (*Prunus salicina* Lindl.) which is a member of family Rosaceae and sub family Amygdaloideae. It occupies a unique position amongst the stone fruits in world fruit production and ranks next to peaches in economic importance. The term Japanese plum was applied originally to *Prunus salicina* Lindl and European plums are *P. domestica* L. and these are main plum production species in the world and in our country majority belongs to *P. salicina* group. Japanese group of plum is native to China but was domesticated in Japan and subsequently was introduced to different parts of the world. In India Japanese plums were introduced by European settlers and missionaries. In India area under plum cultivation is 24 thousand hectares with a production of 80 thousand metric tonnes Anon, (2014) [1]. In Himachal Pradesh, plums occupy a significant place both in respect of acreage and production next to apple Sharma, (2005) [2] and is cultivated in an area of 8556 hectares with a production of 15,991 metric tonnes during 2014 Anon, (2014) [1]. Areas ranging from 900 m to 1600 m amsl provide excellent and congenial climatic conditions for plum cultivation.

Plums are rich source of fiber and antioxidants that appear to provide a variety of health benefits related to cardiovascular disease, tumorogenesis and osteoporosis. Certain health benefiting compounds present in the plum fruits, such as dietary fiber, sorbitol, and isatin are known to help regulate the functioning of the body Prajapati *et al.,* (2012) [3]. Plum has assumed greater significance as fresh fruit and in processing industries and it has potential to contribute greatly to human nutrition Kim *et al.,* (2003) [4].

**Correspondence**
**Bunty Shylla**
Department of Pomology,
HRTS and KVK Kandaghat,
Solan, Himachal Pradesh, India

Plums are temperate zone fruits, but they are widely grown throughout the world, from the cold climate of Siberia to the sub-tropical conditions of the Mediterranean region Son, (2010) [5]. In India plum is grown on commercial scale in mid-hills of Himachal Pradesh, Jammu & Kashmir and Uttrakhand in north India and to a limited extent in Nilgiri hills in South India. Chanana, (2001) [6] suggested that plum can be grown in a wide range of subtropical and warm temperate climate. Plum species and cultivars are quite diverse in fruit characters such as fruit size, shape, color, texture, aroma and other quality characteristics which make their fruits desirable, as compared to other horticultural crops Baden and Byrne, (2012) [7]. On the other hand, plums exhibit limited capacity for adaptation and as a result, in each area only specific cultivars are grown.

This is only possible, if new exotic introductions are made and evaluated under local climatic conditions, however, evaluation studies in mid-hills and subtropical plains of northern India were done by few workers Lal and Mishra, (1980) [8], Tripathi *et al.,* (1984) [9], Dhatt *et al.,* 1992 [10], Singh *et al.,* (2002) [11]. Plum breeding programs throughout the world are focusing on improving fruit quantity and quality, prolonging the harvest season and developing resistance/tolerance to biotic and abiotic stress Hartmann and Petruschke, (2002) [12], Blazek, (2007) [13]. However, these new cultivars of plum have been introduced with an objective of extending the ripening period and to meet the consumer preferences. In Himachal Pradesh more area can be brought under plum cultivation by introducing new cultivars after their proper evaluation. Therefore in the present study four new introductions viz. 'Friar', 'Duarte', 'Black Amber' and 'Shiro' were evaluated and compared with existing cultivars viz. 'Santa Rosa', 'Frontier', 'Red Beaut' and 'Mariposa'. The present study was carried out with the following objectives: - (i) Evaluation of the newly introduced plum cultivars to establish a database for their future use (ii) To compare the suitability of new introductions with the existing cultivars under mid- hills of Himachal Pradesh

## 2. Materials and Methods
### 2.1 Climate and Soil
The experimental orchard lies under the sub-temperate, sub-humid mid-hill agro zone of Himachal Pradesh where, summer is moderately hot during May-June while, winter is quite severe during December-January. The annual rainfall ranges between 110-120 cm, and the major amount of which is received during June to September. The soil of the experimental orchard is gravelly loam and have pH range of 6.9.

### 2.2 Plant materials and experimental design
The study was carried out on eight cultivars of plum selected for the present studies namely Black Amber, Duarte, Friar, Shiro, Frontier, Mariposa, Red Beaut and Santa Rosa. The trees selected for the present study were of uniform size belonging to the age group of 8-9 years. In total 40 trees consisting of 5 trees per cultivar were selected for the present studies. All the trees were given uniform cultural practices and recommended nutritional doses during the course of studies. The soil is mountainous alluvial loamy soil and having pH of 6.62, organic carbon 1.58%, available N, P and K were 318.64, 16.62 and 172 kg ha-1, respectively. The plantation was composed of 8-9 years trees old plum trees; the trees were spaced 2m apart in the row, with the rows again 2m apart and trained to Modified Central leader system. The

experiment was performed on the sample size comprising of 40 trees; the trees being randomly selected. The homogeneity of the experimental area was checked by measuring tree trunk circumferences before the differentiation of the cultivars.

### 2.3 Measurements
The data on tree height (m), tree spread (m), tree volume (m$^3$), trunk girth (cm), shoot diameter (mm), graftable scion wood (%), total number of shoots per tree, number of lateral shoots, average shoot length (cm), number of buds per shoot, internodal length (cm), pruning weight (kg/tree), leaf area (cm$^2$), Fruit length (mm), Fruit breadth (mm), Fruit weight (g), Fruit volume (cm3), Fruit flesh colour, Fruit ground colour and Fruit skin colour, TSS (°B), Titratable acidity (%), Total sugars (%), Reducing sugars (%), Non-reducing sugars (%) Observations regarding growth parameters, viz. tree height, tree spread, tree volume and leaf area. Procedure suggested by Westwood, (1978) [14] was adopted for fruit set estimation. For taking fruit yield the crop load removed from the trees at the time of harvest season was recorded as kg tree$^{-1}$. The effects on fruit quality were evaluated by determining, fruit weight (g), fruit size (mm), total soluble solids (TSS), titrable acidity, TSS: acidity ratio, total sugars, reducing sugars, non-reducing sugars, ascorbic acid and anthocyanin content as per A.O.A.C method (1980) [15] and Rangana, (2010) [16], respectively.

### 2.4 Statistical analysis
Data on growth parameters characteristics of apple to determine the significance of differences were analyzed by using Randomized Block Design (RBD)- one way analysis of variance (ANOVA) as suggested by Gomez and Gomez, (1984) [17]. In addition to show the interrelationships between pruning intensities in combination with benzyladenine and mean values of each studied plant growth parameters statistical analysis program (SPSS) was used. The level of significance was tested for different variables at 5 percent level of significance.

## 3. Results and Discussion
### 3.1 Tree characters
It is evident from the perusal of data presented in Table 1 that the evaluation of newly introduced plum cultivars significant effect on plant growth parameters. Tree height in all the eight plum cultivars studied ranged between 2.04 m in 'Friar' and 3.98 m in 'Red Beaut', followed by 'Santa Rosa' (3.65 m) and 'Mariposa' (3.48 m). The overall mean for tree height was recorded as 3.06 m. Cultivar Red Beaut was found statistically at par with 'Santa Rosa'. The plant height of 'Red Beaut' (3.98 m) was 1.95 times more as compared to that observed in the cultivar Friar (2.04 m). The maximum trunk girth (20.46 cm) was recorded in the cultivar Santa Rosa which was statistically at par with 'Red Beaut' (20.16 cm), 'Frontier' (19.86 cm) and 'Shiro' (18.98 cm), whereas, the minimum girth (13.06 cm) was attained by the cultivar Friar which showed significantly lower trunk girth as compared to the rest of the cultivars. Maximum tree spread (2.14 m) was recorded in the cultivar Shiro which was statistically higher than all other cultivars. Minimum tree spread (1.06 m) was, however, recorded for the cultivar Friar which was found to be statistically at par with cultivars Black Amber and Duarte. The highest tree volume (7.20 m$^3$) was recorded for the cultivar Shiro which was statistically at par with 'Santa Rosa' (6.78 m$^3$), 'Frontier' (6.54 m$^3$) and 'Red Beaut' (6.48 m$^3$). Minimum tree volume (1.41 m$^3$) was observed in the cultivar

Friar which was at par with 'Black Amber' and 'Duarte'. The maximum annual shoot growth (99.6 cm) was registered for the cultivar Shiro which was at par with 'Red Beaut' (95.2 cm). However minimum annual shoot growth (72.1 cm) was observed in 'Friar' and was at par with the values of 'Black Amber', 'Duarte', 'Frontier', 'Mariposa'and 'Santa Rosa'. The maximum pruned wood weight was recorded as 2.22 kg in cultivar Shiro which was found to be significantly higher than rest of the cultivars. The minimum value of pruning weight was 1.13 kg in 'Friar' which was statistically at par with cultivars 'Black Amber', 'Duarte', 'Frontier', 'Mariposa' and 'Santa Rosa'. Maximum leaf area was observed in 'Red Beaut' (18.36 cm$^2$) and minimum leaf area was recorded in cultivar Black Amber (12.53 cm$^2$). Cultivars Santa Rosa (15.79 cm$^2$), Mariposa (14.79 cm$^2$) and Duarte (14.71 cm$^2$) were found to be statistically at par with each other in terms of average leaf area.

The canopy spread varied from 1.07 × 1.16 m to 2.14 × 2.19 m, and such variations in growth characters has also been observed by Kumar et al., (2013) [18]. In the present study tree height and trunk girth varied from 13.06 to 20.46 cm which was observed to be in accordance with the work of Kuden et al., (1994) [19]. In annual shoot growth the cultivar Shiro excelled with highest shoot extension (99.6 cm). Similar result was observed by Sosna and Kortylewska, (2010) [20] and they found that the cultivar Shiro had significantly longer annual shoots. Further the corresponding pruning weight also depends on the growth character of the cultivars. Cultivar Shiro had the maximum annual shoot growth as well as the maximum pruning weight. Among the four introduced cultivars (Duarte, Black Amber, Friar, Shiro), 'Shiro' exhibited a strong growth in overall tree characters. Such strong growth has also been reported by Grzyb, (2002) [21] in the same cultivar. Average leaf area showed a difference from 12.53 cm$^2$ to 18.36 cm$^2$ in the current study which is supported by the findings of Kuden et al., (1994) [22] who reported leaf area in seven Japanese plum cultivars ranging from 10.75 cm$^2$ to 23.09 cm$^2$. Further Sharma, (1999) [23] reported leaf area in 'Frontier', 'Red Beaut' and 'Santa Rosa' to be 14.76 cm$^2$, 17.51 cm$^2$ and 15.72 cm$^2$ respectively, which supports the results observed in the present study.

**3.2 Physical characteristics**
From the data on fruit length (Table 2) it is evident that the mean fruit length varied from 33.92 to 45.99 mm and overall average fruit length was 40.85 mm. Fruit length was maximum in cultivar Frontier (45.99 mm), whereas, minimum length was recorded in 'Shiro' (33.92 mm). The maximum in cultivar Frontier (46.38 mm), whereas, the minimum fruit breadth was recorded in the cultivar Shiro (33.93 mm). The overall average fruit breadth was 41.63 mm. The highest fruit weight was obtained in the cultivar Frontier with an average weight of 60.00 g followed by 'Mariposa' with 57.06 g, whereas, minimum fruit weight was recorded in 'Shiro' (24.63 g). Maximum fruit volume of 61.70 cm$^3$ was recorded in the cultivar Frontier followed by 'Mariposa' (58.70 cm$^3$), whereas, minimum fruit volume of 25.38 cm$^3$ was observed in 'Shiro'. The flesh colour of fruit was red purple in 'Duarte', 'Frontier' and 'Mariposa', orange red in 'Black Amber', while yellow in 'Friar', 'Shiro', 'Santa Rosa' and 'Red Beaut'. Fruit ground colour was red purple in the cultivars, 'Duarte', 'Black Amber', 'Friar' and 'Mariposa', grey purple in 'Frontier' and 'Santa Rosa', red in 'Red Beaut' and yellow in 'Shiro'. The fruit skin colour varied considerably in different cultivars. It was found to be red purple (60A) in

'Duarte', 'Black Amber', 'Friar' and 'Mariposa', yellow (15 C,D) in 'Shiro', grey purple (187 A,B) in 'Frontier', grey purple (187 A) in 'Santa Rosa', while red (45A,B) in 'Red Beaut' respectively.

Maximum fruit firmness (2.42 kg/cm$^2$) was recorded in the cultivar Black Amber which as statistically at par with 'Friar' (2.36 kg/cm$^2$), 'Mariposa' (2.18 kg/cm$^2$) and 'Frontier' (2.16 kg/cm$^2$). The minimum fruit firmness (1.76 kg/cm$^2$) was observed in the cultivar Duarte which was found statistically at par with 'Red Beaut' (1.98 kg/cm$^2$), 'Santa Rosa' (2.06 kg/cm$^2$) and 'Shiro' (2.08 kg/cm$^2$). The highest fruit yield (7.30 kg/tree) was recorded in the cultivar Shiro followed by 'Frontier' (7.02 kg/tree). However, minimum yield (3.76 kg/tree) was recorded in 'Red Beaut' which was found to be statistically at par with cultivars Friar (4.01 kg/tree), Duarte (4.13 kg/tree), Black Amber (4.51 kg/tree) and Mariposa (4.20 kg/tree). The maximum pulp to stone ratio (48.31) was recorded in the cultivar Frontier closely followed by 'Red Beaut' (45.84). The minimum pulp to stone ratio (20.17) was recorded in cultivar Shiro which was significantly lower than rest of the cultivars. Observations on adherence of pulp to stone are presented in Table 4. The cultivars Duarte and Santa Rosa were clingstone while 'Shiro', 'Red Beaut', and 'Mariposa' were semi-clingstone, whereas, 'Black Amber', 'Friar' and 'Frontier' were found to be of freestone nature (Table 3).

The fruit characters of various cultivars recorded during the research work has been discussed in the given paragraph. A high variability in average fruit weight and size has also been reported in plum by Dhatt et al., (1982) [24] in different parts of Punjab state. One of the important characteristics of the plum fruit is its size. Large fruited cultivars are preferred both for fresh consumption and for processing purpose. The largest fruits were observed in the cultivar Frontier (45.99 × 46.38 mm) followed by 'Duarte' (45.98 × 42.14 mm) and the smallest fruits were obtained in 'Shiro' (33.92 × 33.93 mm). Similar trend in fruit size was also observed by Bist and Sharma, (1996) [25]. This might be due to variation in climatic conditions during the year.

**3.3 Biochemical characteristics**
The data presented in Table 4 reveals that the TSS values ranged from 12.92 °B to 15.16 °B and overall average TSS was found to be 13.84 °B. Highest TSS (15.16 °B) was recorded in cultivar Black Amber which was significantly higher than all the other cultivars. The minimum TSS (12.92 °B) was recorded in the cultivar Shiro which was statistically at par with 'Red Beaut' (13.04 °B). The highest acidity (1.66%) was recorded in the cultivar Mariposa, whereas, the minimum acidity (1.28%) was found in the cultivar Black Amber. 'Red Beaut' (1.33%) and 'Duarte' (1.35%) were statistically at par with 'Black Amber' in terms of titratable acidity. Maximum total sugars content (8.19%) was observed in 'Black Amber' followed by 'Mariposa' (8.08%) and 'Frontier' (8.05%), whereas, minimum total sugars (7.49%) was recorded in the 'Santa Rosa'. Maximum reducing sugars (6.52%) was recorded in the cultivar Mariposa which was at par with the cultivars Frontier (6.51%), Black Amber (6.43%), Red Beaut (6.31%) and Duarte (6.27%). The minimum reducing sugars (5.18%) was found in the cultivar Shiro. The maximum non-reducing sugars (2.54%) was recorded in the cultivar Shiro which was significantly higher than the rest of the cultivars. Minimum non-reducing sugars (1.16%) was recorded in the cultivar Red Beaut which was statistically at par with 'Santa Rosa' (1.36%), 'Frontier'

(1.46%), 'Duarte' (1.43%), 'Mariposa' (1.48%) and 'Black Amber' (1.67%). The maximum sugar to acid ratio (6.38) was observed for the cultivar Black Amber which was significantly higher than other cultivars. While, the minimum value was reported for 'Mariposa' (4.87) which was statistically at par with 'Frontier' (5.05), 'Shiro' (5.12), 'Friar' (5.24) and 'Santa Rosa' (5.28).

The fruit biochemical characteristics recorded during the research work has been discussed in the given paragraph. The total soluble solids in the studied cultivars ranged from 12.92 ºB to 15.16 ºB and these values are in accordance with the findings of Thakur et al., (2014) [26]. Similar observations were recorded by Son et al., (2010) [27] who reported Total soluble solids varying from 11.53 to 16.06 ºB in the set of cultivars they studied, whereas, Moghaddam et al., (2011) [28] reported a larger variation in total soluble solids from 12.1 percent (Angelono) to 23.55 percent (Blu Fre). Titratable acidity showed a narrow range of variation from 1.28 to 1.60 percent in the current study. The observations of present study

regarding titratable acidity are in accordance with the results of Chaudhary et al., (1987) [29] and Bist and Sharma, (1996) [25] who reported values ranging from 1.09 percent (Prune Plum) to 2.92 percent (Alubokhara). The total sugars content varied from 7.49 (Santa Rosa) to 8.19 percent (Black Amber) which is in coordination with the results of Bist and Sharma, (1996) [25], who recorded high total sugars value of 8.99 percent in the cultivar 'Frontier'. The findings of Thakur, (2012) [30] on reducing and non-reducing sugars are also in accordance with the present study. The sugar to acid ratio was found highest in the cultivar Black Amber (6.38) followed by 'Duarte' (5.77), whereas, lowest in 'Mariposa' (4.87). Similar range of variations was reported by Nergiz and Yildez, (1997) [31]. Wide variations in physico-chemical characteristics were observed during the present study as well as by Bilgu and Seferoglu, (2005) [32]. These variations might be assigned to the specific genetic makeup of the cultivars, their management and effect of ecological conditions as reported by Son (2010) [27].

**Table 1:** Tree characters of different plum cultivars

| Cultivars | Tree Height (m) | Trunk girth (cm) | Spread (m) | Tree volume (m³) | Annual shoot growth (cm) | Pruning weight (kg) | Average leaf area (cm²) |
|---|---|---|---|---|---|---|---|
| Duarte | 2.70 | 16.92 | 1.19 | 2.23 | 77.8 | 1.18 | 14.71 |
| Black Amber | 2.45 | 15.54 | 1.07 | 1.59 | 76.5 | 1.16 | 12.53 |
| Friar | 2.04 | 13.06 | 1.06 | 1.41 | 72.1 | 1.13 | 13.18 |
| Shiro | 2.84 | 18.98 | 2.14 | 7.20 | 99.6 | 2.22 | 13.08 |
| Frontier | 3.32 | 19.86 | 1.77 | 6.54 | 79.6 | 1.31 | 14.38 |
| Santa Rosa | 3.65 | 20.46 | 1.86 | 6.78 | 81.2 | 1.62 | 15.79 |
| Red Beaut | 3.98[a] | 20.16 | 1.68 | 6.48 | 95.2 | 1.80 | 18.36 |
| Mariposa | 3.48 | 15.82 | 1.47 | 4.17 | 80.9 | 1.38 | 14.79 |
| C.D0.05 | 0.29 | 1.78 | 0.22 | 1.34 | 10.10 | 0.59 | 1.17 |

**Table 2:** Physical characteristics of different plum cultivars

| Cultivars | Fruit size | | Fruit weight (g) | Fruit volume (cm³) | Fruit colour | | |
|---|---|---|---|---|---|---|---|
| | Fruit length (mm) | Fruit breadth (mm) | | | Fruit flesh colour | Fruit ground colour | Fruit skin colour |
| Duarte | 45.98 | 42.14 | 51.21 | 52.37 | red purple | red purple | red purple (60A) |
| Black Amber | 34.25 | 37.33 | 32.49 | 34.03 | orange red | red purple | red purple (60A) |
| Friar | 37.93 | 45.49 | 50.19 | 51.86 | yellow | red purple | red purple (60A) |
| Shiro | 33.92 | 33.93 | 24.63 | 25.38 | yellow | yellow | yellow (15 C,D) |
| Frontier | 45.99 | 46.38 | 60.00 | 61.70 | red purple | grey purple | grey purple (187 A,B) |
| Santa Rosa | 42.06 | 41.52 | 46.60 | 48.75 | yellow | grey purple | grey purple (187 A) |
| Red Beaut | 41.79 | 44.15 | 47.77 | 48.82 | yellow | red | red (45A,B) |
| Mariposa | 44.89 | 42.14 | 57.06 | 58.70 | red purple | red purple | red purple (60A) |
| C.D0.05 | 1.61 | 1.52 | 4.09 | 4.31 | - | | - |

**Table 3:** Fruit characters of different plum cultivars

| Cultivars | Fruit firmness (kg/cm2) | Fruit Yield (kg) | Pulp/stone ratio | Adherence to stone |
|---|---|---|---|---|
| Duarte | 1.76 | 4.13 | 38.57 | Clingstone |
| Black Amber | 2.42 | 4.51 | 26.94 | Freestone |
| Friar | 2.36 | 4.01 | 34.72 | Freestone |
| Shiro | 2.08 | 7.30 | 20.17 | Semi-cling |
| Frontier | 2.16 | 7.02 | 48.31 | Freestone |
| Santa Rosa | 2.06 | 5.60 | 37.01 | Clingstone |
| Red Beaut | 1.98 | 3.76 | 45.84 | Semi-cling |
| Mariposa | 2.18 | 4.20 | 40.42 | Semi-cling |
| C.D0.05 | 0.31 | 1.57 | 1.98 | |

**Table 4:** Biochemical characteristics of different plum cultivars

| Cultivars | TSS (°B) | Titratable acidity (%) | Total sugars (%) | Reducing sugars (%) | Non-reducing sugars (%) |
|---|---|---|---|---|---|
| Duarte | 14.22 | 1.35 | 7.78 | 6.27 | 1.43 |
| Black Amber | 15.16 | 1.28 | 8.19 | 6.43 | 1.67 |
| Friar | 13.44 | 1.46 | 7.65 | 5.62 | 1.93 |
| Shiro | 12.92 | 1.55 | 7.84 | 5.18 | 2.54 |
| Frontier | 13.72 | 1.60 | 8.05 | 6.51 | 1.46 |
| Santa Rosa | 14.12 | 1.42 | 7.49 | 6.06 | 1.36 |
| Red Beaut | 13.04 | 1.33 | 7.53 | 6.31 | 1.16 |
| Mariposa | 14.08 | 1.66 | 8.08 | 6.52 | 1.48 |
| C.D0.$_{05}$ | 0.43 | 0.08 | 0.35 | 0.35 | 0.53 |



| Black Amber | Duarte | Friar | Shiro |
|---|---|---|---|



| Mariposa | Red Beaut | Santa Rosa | Frontier |
|---|---|---|---|

**Fig 1:** Photographs showing old standard plum cultivars under study

## 4. Conclusion
From the preliminary study conducted on different plum cultivars, it can be concluded that the plum cultivar Shiro was found to be vigorous. Some while 'Black Amber' and 'Duarte' were found to be promising with respect to fruit biochemical characters and matures in mid and late season, respectively. Therefore, it can be suggested that 'Black Amber' and 'Duarte' may be suitable for cultivation under mid-hills condition of Himachal Pradesh and can be better alternatives to change the monotony of 'Santa Rosa' in order to stretch the harvesting season, fulfill consumer ever-changing taste and provide better remuneration to the growers.

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