



PERFORMANCE OF SOME PLUM CULTIVARS GROWING IN THE HIMALAYAN TRACT OF DARJEELING

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Abstract- The present investigation was carried out to evaluate the plum cultivar growing in the Darjeeling district of West Bengal. Among the seven different plum cultivars viz. Alaucha Yellow, Durado, Green Gauge, Formosa, Lamahatta, Santa Rosa and Victoria, the cvs. Formosa and Victoria mature early (end of June). The fruit set percentage was also highest in cv. Victoria (61.50%). The average fruit weight was highest in cv. Green Gauge (57.11 g). Maximum length (7.50 cm) and diameter (4.75 cm) of fruit were recorded in cv. Formosa. However, the yield per plant was recorded highest in cv. Victoria (72.42 kg) followed by Formosa (65.69 kg). The fruits of Green Gauge showed maximum amount of total soluble solids (13.50%), reducing sugar (3.61%) and a fairly higher amount of acidity (1.20%). The TSS/acid ratio of fruit was found highest in cv. Formosa (12.71). From the present investigation, it may be suggested that plum cv. Formosa is the suitable cultivar, which showed a high yield potential and good fruit quality in Darjeeling region.

Keywords: Plum, cultivar, Darjeeling, yield, quality

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Introduction

Plum (*Prunus domestica* L.), relative of the peach, nectarine and almond is considered as one of the most popular fruit found in Himalayan region of Darjeeling and Sikkim. Plums are mostly used for fresh consumption, but very small quantity is processed into juices. It is the second most widely cultivated temperate fruit grown for dessert fruit and cannot be stored for longer duration and transport to distant market because of its highly perishable in nature. The plum fruit is known for its cooling effect and is considered best to overcome the effect of jaundice. It is a good source of vitamins, minerals, fibre and enzymes, that are good for the digestive system and positively associated with nutrient intake, improves anthropometric measurements and reduce risk of hypertension [1]. Fruits can be utilized profitably for the preparation of various kinds of processed products like jam, jelly, dry fruits etc. Plum is mainly confined to Jammu and Kashmir, Himachal Pradesh and sub mountainous tract of Uttaranchal and north-eastern states of India. The principle climatic factors determining the suitability of an area for temperate fruits are temperature, rainfall and sunlight. Low temperature is necessary for proper growth and development of temperate fruits. However, certain cultivars require less chilling temperature and are successfully grown in the sub-tropical condition.

Plum is cultivated commercially in Jammu and Kashmir, Himachal Pradesh and in the hills of Uttaranchal. They are also grown in the Nilgiri hills of South India. The area under pear in India is 14.668 ha with annual production of 187,328 tons.

Darjeeling district is the only hilly region in West Bengal having agro-climatic condition that offers excellent potential for growing temperate fruits like pear, plum, peach, strawberry etc. The hilly sub-divisions of Darjeeling district consists of varied ridges and valleys, where cultivation practice is done in terraces. Plum is most adaptable fruit crop in hilly slopes of Darjeeling, which are mainly grown in homestead garden in a small area. As an important seasonal fruit, these fruits are liked both by rich as well as poor people of the

district.

Plum in these hills of Darjeeling, have good quality fruit in comparison with other commercially growing states of India. Unfortunately much attention for increasing the area as well as its production has not been given. Plum trees need relatively less care due to its hardy nature, which enables it to flourish well even in inferior land, where other fruit trees fail to grow. The trees of plum have wide range of adaptability in soil and climatic conditions, which prevail in hills of Darjeeling. This fruit species also play significant role in the preservation of environment and effectively check the soil erosion in the fragile ecosystem of these hills.

In view of the potential of plum cultivation in Darjeeling district, the present investigation was taken up to evaluate the cultivars growing in this region and suggest the suitable cultivar for cultivation.

Materials and Methods

In order to evaluate the different cultivars of plum growing in Darjeeling, the present investigation was taken up during 2012-13. The site is located 27°18' to 26°27' N latitude and 88°53' to 87°59' E longitude and having an altitude of 600-4000 meters above mean sea level. The soil of the region is sandy loam in texture and acidic in reaction due to rich organic carbon or humus with low pH range (4.5-5.8). The climatic condition of hill zone is characterized by high rainfall (ranges between 2250-2750 mm annually), low temperature (2 - 20°C) with prolonged winter. The investigation was carried out with seven cultivars of plum viz. Alaucha Yellow, Durado, Green Gauge, Formosa, Lamahatta, Santa Rosa and Victoria, which were identified by thorough survey of this region before commencement of flowering. Four uniform trees (average of 10 years) were selected for each cultivar to serve as four replications. Evaluation was done by studying flowering behaviour and physio-chemical characteristics of the fruits. Total soluble solids (°Brix) content of fruit was determined with the use of a hand refractometer calibrated in 0 °Brix at 20 °C with the help of a temperature correction correlation chart [2]. The total titrable acidity was determined by

titrating against N/10, NaOH using phenolphthalein as indicator [3]. The total and reducing sugar content of fruits were determined by analyzing the fruits following methods of Lane and Eynon [4]. The soluble solids: acid ratio was determined by dividing the total soluble solids with total acidity percentage whereas total sugar acid ratio was determined by dividing the sugar with total acidity percentage. Data collected were subjected to statistical analysis appropriate to the design Randomized Block Design with 7 treatments and 4 replications [5]. The significance of the different sources of variation was tested by Fisher and Snedecor's *F* test probability at 0.05%. For the determination of least significance at 5% level of significance, the statistical table formulated by Fisher and Yates was consulted.

Results and Discussion

Various factors such as adequate and suitable pollination, hormonal level, enough vegetative growth, and orchard management may affect the final yield, but genotype has great influence on plant performance [6,7]. The phenological characteristics of plum cultivars are given in [Table-1]. The data show that the

onset of flowering was recorded from third week of February. Full flowering duration of evaluated cultivars showed a high range of 3 weeks. The cultivars Durado and Victoria flower in the third week of February while cultivars like Formosa, Santa Rosa and Lamahatta starts flowering at the end of February and cv. Green Gauge in the first week of March. These traits depend on environmental conditions (temperature, altitude etc.) and may change every year [8]. Cosmulescu *et al.* [9] stated that "flowering time or duration" is a feature which is influenced by climatic factor as well as genetic factor too. In general, earlier the flowering develops, the shorter its time duration. The period between the beginning of flowering and the end of it was from 3rd week of February to 1st week of March and about 3 weeks of differences occurred between cultivars. Victoria produced the maximum number of flowers (4550 flowers plant⁻¹) followed by Durado (3936 flowers plant⁻¹) and Lamahatta (2460 flowers plant⁻¹) while the cultivar Santa Rosa (1600 flowers plant⁻¹), Green Gauge (2112 flowers plant⁻¹), Alacha Yellow (2176 flowers plant⁻¹) and Formosa produced comparatively less number of flowers.

Table- 1: Flowering, fruit set and maturity in different plum cultivars under hilly region of Darjeeling

Cultivars	Flowering time	Flowers/ tree	Fruit set (%)	Fruit maturity time	Stone weight (g)	Fruit weight (g)	Yield (Kg Plant ⁻¹)
Alucha Yellow	Third week of February	2176	56.25	End of June to Second week of July	1.75	30.83	37.74
Durado	Third week of February	3936	34.75	Fourth week of June to Third week of July	1.68	25.68	35.12
Formosa	End of February	2430	50.20	Third week of June to Second week of July	1.28	53.85	65.69
Green Gauge	First week of March	2112	30.30	Fourth week of June to Second week of July	1.32	57.11	36.55
Lamahatta	End of February	2460	48.70	End of June to Third week of July	1.40	39.03	46.76
Santa Rosa	End of February	1600	32.80	Fourth week of June to Second week of July	2.20	48.20	25.30
Victoria	Third week of February	4550	61.50	Third week of June to end of July	1.75	25.88	72.42
SEm ±	-	732.245	-	-	0.145	3.057	0.015
CD at 0.05	-	1538.447	-	-	0.304	6.420	0.032

Table- 2: Fruit morphology of different plum cultivars under hilly region of Darjeeling

Cultivars	Fruit shape	Fruit length (cm)	Fruit diameter (cm)	Peel colour	Pulp color	Fruit taste
Alucha Yellow	Roundish	6.18	4.33	Greenish yellow with red blush	Amber with red	Sourysweet
Durado	Flat to oval	5.78	3.25	Greenish purple	Amber with red	Soury sweet
Formosa	Oval roundish	7.50	4.75	Greenish yellow with red	Firm amber	Sweet
Green Gauge	Roundish to cordate	7.38	4.61	Yellow	Yellowish firm	Sweet with flavour
Lamahatta	Cordate	6.38	4.43	Greenish purple with red	Firm amber	Soury sweet
Santa Rosa	Conical oblong to cordate	6.90	3.63	Purplish red	Light amber with red	Soury sweet with flavour
Victoria	Conical oblong	5.43	4.00	Yellow with dahlia pink	Yellowish juicy	Soury sweet
SEm ±		0.519	0.324	-	-	-
CD at 0.05		1.090	0.681	-	-	-

Length of optimum harvest period besides uniformity of fruit ripening considerably depends upon the degree of fruit set. Maximum fruit set (61.50%) was recorded in cv. Victoria followed by Alacha Yellow (56.25%) and Formosa (50.20%). These variations in fruit set percentages might be due to their genetic makeup as suitable growth and vigor was necessary for optimum photosynthesis to supply enough carbohydrates for strong fruit sink and higher yield [7]. Apart from other fruit maturity indices, firmness of fruit texture, which is also influenced by type of cultivar, is an important indicator of pears maturity [10, 11]. Moreover, Najafzadeh and Arzani [12] showed strong correlation between maturity and colour scales in

different pear cultivars as these scales were increases simultaneously with fruit maturity [13]. The cvs. Victoria and Formosa mature in the third week of June to end of July whereas cvs. Alacha Yellow and Lamahatta mature at the end of June to second and third week of July and cvs. Durado, Santa Rosa and Green Gauge in the fourth week of June to second to third week of July. Variation in fruit weight can be related to type of cultivar [12]. Cv. Green Gauge (57.11 g) produced the heaviest fruit as compared to Formosa (53.85 g), Santa Rosa (48.20 g) and Durado (25.68 g). The average fruit weight of plum cultivars ranged from 25.68 g to 57.11 g. As per report of Jacimovic *et al.* [14], this character can

be correlated with fruit size. The current season shoot growth might be influenced by various applied treatments but it is inherently influenced by genotypes [15,16]. Tree size is affected by genotypes [17,18] and suitable shoot growth and vigor was necessary for optimum photosynthesis to supply enough carbohydrates for strong fruit sink and higher yield [7]. Maximum yield was noted in cv. Victoria (72.42 kg plant⁻¹) followed by cv. Formosa (65.69 kg plant⁻¹) and cv. Lamahatta (46.76 kg plant⁻¹). The other cultivars showed 25.30 to 37.74 kg yield plant⁻¹ in a year.

There is an extensive diversity in fruit skin color in some crops and can be an important indicator for quality and maturity of some plum cultivars. Plum must have attractive appearance as it is mostly marketed for fresh consumption. Variations in shape of fruits were observed among the plum cultivars. The shape of the fruits was round to cordate, conical oblong, flat to oval or roundish conical. However, cordial shaped fruit was observed in cv. Lamahatta. The fruit of cv. Green Gauge was yellowish in colour while it was greenish yellow with red blush in Alauha Yellow and Formosa, purplish red in Santa Rosa and greenish purplish in Durado at maturity. It is obvious that in most markets fruit size is an important character for final yield, with better marketability and also better return [19]. Fruit length varied among different cultivars and this characteristic was strongly influenced by genotypes [16,20,21]. Length of fruit was maximum in cv. Formosa (7.5 cm) followed by cv. Green Gauge (7.38 cm) and Santa Rosa (6.9

cm) compared with cv. Victoria (5.43 cm). It has been reported that genotypic variations with respect to leaf characters provide the tree with a better situation in terms of photosynthetic products as higher photosynthetic activity leads to increase in fruit size [7,22]. The diameter of fruit does not show remarkable variation among the different plum cultivars studied in this experiment. Maximum diameter of fruit was observed in cv. Formosa (4.75 cm) followed by Green Gauge (4.61 cm) while the least diameter of fruit was noted in cv. Victoria. Lamahatta, Santa Rosa, Durado and Alauha Yellow showed 4.43 cm, 3.63 cm, 4.00 cm, and 4.33 cm diameter of fruit, respectively. The least value of stone weights were recorded in cv. Formosa (1.28 g) whereas cultivar Santa Rosa recorded highest stone weight (2.2 g).

Taste of fruit is influenced by various environmental factors. Insufficient water supply at the time of fruit development causes a higher content of soluble solids in fruits as during the ripening of fruits starch converts into sugars, the sweetness increases and the taste of fruits [23,24]. The best score for taste with respect to sweetness of fruits are observed in Green Gauge and Formosa while in other cultivars it was found a blend of sour and sweet [Table-2]. It has been reported that TSS is another quality factors and used as one of the important harvest index [25] and varied in different cultivars [26,11]. The total soluble solid content of fruits was noted 13.5% in cv. Green Gauge, 13.0% in Santa Rosa, 12.5% in Victoria compared with 10% in Alauha Yellow.

Table-3: Fruit quality of different plum cultivars under hilly region of Darjeeling

Cultivars	Total soluble solids (°Brix)	Total Sugar (%)	Reducing Sugar (%)	Non-reducing sugar (%)	Acidity (%)	TSS/acidity ratio	Sugar/acidity ratio
Alauha Yellow	10.0	5.58	3.45	2.13	0.98	10.21	5.69
Durado	11.5	5.32	3.50	1.82	0.91	12.50	5.78
Formosa	12.5	5.44	3.08	2.53	0.95	12.71	5.66
Green Gauge	13.5	5.38	3.61	1.76	1.20	11.16	4.45
Lamahatta	11.5	5.65	3.58	2.08	0.96	11.86	5.82
Santa Rosa	13.0	5.80	3.00	1.76	1.23	10.24	4.57
Victoria	11.5	5.35	3.48	1.87	1.08	11.57	4.95
SEm ±	0.088	0.170	0.060	0.182	0.017	-	-
CD at 0.05	0.185	0.357	0.126	0.383	0.036	-	-

The maximum total sugar content of fruit was observed in Santa Rosa (5.80%) followed by Lamahatta (5.65%), Alauha Yellow (5.58%) and Formosa (5.44%) compared with 5.35% in Victoria and 5.38% in Green Gauge. The maximum reducing sugar content of fruit was recorded in Green Gauge (3.61%) followed by Lamahatta (3.58%), Durado (3.50%), Alauha Yellow (3.45%) and Victoria (3.48%), compared with 3.0% in Santa Rosa and 3.08% in Formosa. The maximum non-reducing sugar content of fruit was observed in Santa Rosa (2.80%) followed by Formosa (2.53%). The minimum was noted in Green Gauge (1.76%). The fruits of cultivars like Durado (1.82%), Victoria (1.87%) and Lamahatta (2.08%) were also low in non-reducing sugar content. Acidity is related with aroma of fruit, which is combination of sugars, organic acids, and aromatic substances [10,11]. Fruit acidity showed wide variation among the studied cultivars and maximum fruit acidity was recorded in cv. Santa Rosa (1.23%) followed by Green Gauge (1.20%) and Victoria (1.08%). The lowest acidity content was observed in Durado (0.91%). The fruits of cultivars like Formosa (0.95%), Lamahatta (0.96%) and Alauha Yellow (0.98%) were also low in acidity content.

The maximum TSS/acid ratio (12.71) was recorded in cv. Formosa followed by cv. Durado (12.50). However, minimum ratio was recorded in cv. Alauha Yellow (10.21). The fruit of Santa Rosa (10.24) was also low in TSS/acid ratio. The flavour and quality of fruits of genus *Pyrus* are related to their organic acid composition and content, as well as to the ratio of sugar and organic acid [27]. The ratio of sugar to organic acids in these fruits is primarily determined by the organic acid content because the organic acid content exhibits a wider range in the fruit than the sugar content [28]. The different cultivars showed considerable variations in sugar/acid ratio of fruits. Maximum sugar/acid ratio was observed in cv. Lamahatta (5.82) followed by Durado (5.78), Formosa (5.66). Other varieties showed lower sugar/acid ratio in their fruits viz. Green Gauge (4.45), Santa Rosa

(4.57) and Victoria (4.95).

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