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COMPARATIVE ANALYSIS OF DIFFERENT PLUM CULTIVARS ON BASIS OF THEIR YIELD AND QUALITY ATTRIBUTES

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ABSTRACT

Seven cultivars of plum (Plum red buet, hersimmor, fazal-e-mannani, santa rosa, methlay, wickson and cherry plum seitha) were evaluated for their performance under climatic conditions of Soan Valley, Punjab during 2018-19. Experiment was laid according to randomized complete block design (RCBD) with seven treatments, replicated four times. Parameters studied for the experiment included flower initiation (date), flowering duration (days), fruit setting (%) and fruit drop (%) during flowering and fruit setting stage. After fruit harvesting organoleptic and physico-chemical characters were studied for all varieties. Results showed that earlier flowering was observed in Plum Red Buet and Santa Rosa. Shortest flowering duration was observed in fazal-e-mannani (6 days) while highest fruit setting percent (23%) and minimum fruit drop (10.81%) was observed in plum cv. methlay. Maximum fruit yield (48.56 kg/tree) was found in methlay. Fazal-e-mannani showed highest hedonic scale reading for all sensory parameters. Maximum fruit size (1250 mm^2) and weight (32.94 g) was found in wickson, whereas highest stone weight (1.3 g), total sugars (6.33%), reducing sugar (3.86%) and non-reducing sugars (2.41%) were observed in fazal-e-mannani. Plum red buet and Methlay had maximum TSS (14.5°Brix). Santa rosa depicted maximum value for TA (1.24%). Therefore, it was concluded that methlay was the highest yield producing cultivar of plum while better fruit quality was found in fazal-e-mannani.

KEYWORDS: *Prunus domestica*; organoleptic; biochemical performance; production; Pakistan

INTRODUCTION

Plum (*Prunus domestica* L.) is one of the popular stone fruits of hilly areas of Pakistan. Plum tree is deciduous. It can be easily grown on wide range of soils and adapted to different climatic conditions (Mahato *et al.,* 2015). Plum is one of the important stone fruit crops of Pakistan, mainly grown in hilly areas of the country. It is being cultivated in Mardan, Mastong, Nowshera, Peshawar, Pishin, Quetta, Kalat, Soan Valley, Murree hills and Swat. With respect to its cultivation it stands at 17th position in total plum production of the world (GoP, 2009). Khyber Pakhtunkhwa has major shares (47%) in total production of the country; whereas, the share by Punjab is very nominal i.e., almost 5% (GoP, 2019). Most of the plum produced is consumed locally, however, a slight share is also exported to the Gulf countries, Sri Lanka and Bangladesh (Shahzad *et al.,* 2013).

Plum fruits are known for their nutritional and health values (Ertekina *et al.,* 2006). Since ancient times, plums have been used in ayurvedaic for various health issues (Nakatani *et al.,* 2015). Because of their biologically active compounds that includes anthocyanins, aromatic substances, carotenoids (lutein, cryptoxanthin and zeaxanthin), carbohydrates (fructose, glucose and sucrose), enzymes, fiber (pectins), minerals potassium (K), iron (Fe), calcium (Ca), organic acids (citric acid and mallic acid), phenolics and tannins (Birwal *et al.,* 2017). The consumption of plum regulates the functioning of the digestive system, helps body to fight against infectious diseases and scavenges harmful radicals, protect body against cancer as well as help in fighting against obesity. Consumption of plum prevents muscular degeneration and heart disease (Birwal *et al.,* 2017). Among other health benefits of plum it is believed to have cooling effects which is considered to overcome the jaundice (Gunnes, 2003).

Plums are mostly used for fresh consumption, as well as processed into dried plums, juices, jam and jellies (Nikolić *et al.,* 2012; Mahato *et al.,* 2015). Processing

of plums usually depend on drying of freshly harvested plums, canning and preparation of beverages. Now a day's plums are usually dried using dehydrators while earlier they were sundried (Bhutani and Joshi, 1995). There are many plum cultivars being cultivated around the world, yet not surprisingly it has different places of origins and heritage around the world. Generally, plums were categorized into European plum (believed to be originated 2000 years ago near the Eastern Europe or Western Asia) and Japanese plums (they originated in China and introduced in Japan 200-400 years ago) (Bhutani and Joshi, 2005). Plums may have been one of the first fruits domesticated by humans. Their remains were found in Neolithic age archaeological sites along with olives, grapes and figs. Now, in Europe mostly 'European plum' (*Prunus domestica*), in America 'American plum' (*Prunus americana),* in South Asia 'Cherry plum' and in western Asia 'Damson plum' (*Prunus salicina)* is being cultivated (Birwal *et al.,* 2017). Plum fruits vary in colour, size ranging from marble to baseball, flavor, shape ranges from round, oval, heart shape to torpedo and texture (from soft to crunchy) (Shane, 2017). Fruit characteristics like colour, flavor, texture and taste are considered important for its selection (Birwal *et al.,* 2017). In Pakistan different plum cultivars such as fazl-e-mananai, faramusa beauty, black diamond, red beauty, late mananai and etc are being cultivated. They can be grown in different climatic conditions but avoiding extreme climatic conditions. Soan valley is situated in the north west of District Khushab, Punjab. The temperature is mild to pleasant in the summer and cold in winters. Its mean maximum temperature 42°C and lowest temperature is -3°C and average temperature remains in the range of 33°C (Abbas *et al.,* 2016). Average rain received by valley is 350-500 mm. These conditions are favourable for the cultivation of plum. As plum trees prefer good drainage soil with adequate rainfall during the summer with low humidity. Plum is a temperate fruit and it requires chilling to produce fruit. Thus, Soan valley provides favourable condition for plum cultivation. Therefore, the current experiment was carried out to find out the response of various plum cultivars in the Potohar region i.e., Soan valley, with respect to the physico-chemical characters, yield and most suitable cultivars of plum for cultivation in the region.

MATERIALS AND METHODS

To find out the performance of different plum cultivars in Soan valley, Pakistan the investigations were carried-out during 2018-19. This site was located 32°58' N 72°15' E and 1,530 m above sea level. The maximum mean temperature was 42°C and minimum temperature was -3°C and average temperature remains in the range of 33°C (Abbas *et al.,* 2016). Seven cultivars of plum i.e., plum red buet, hersimmor, fazal-e-mannani, santa rosa, methlay, wickson and cherry plum seitha were evaluated regarding their performance under climatic conditions of Soan Valley. Seven-year-old plants of each variety, budded on wild apricot locally called "desi plum" were selected as an experimental material. Single tree was taken as an experimental unit, replicated four times. Fruits were harvested at full maturity and their physiochemical analyses were carried out in the laboratory of Horticultural Research Institute, Faisalabad, Pakistan.

All the experimental trees were subjected to similar cultural practices. Plum trees were irrigated by making basins with underground water via submersible pump. Nitrogen (N) 500 g/plant was applied in split dose i.e. before flowering and at fruit set stage. Phosphorus (P) and potassium (K) @ 225 g/plant along with 30 kg FYM per plant were applied during December. Parameters studied during the research trial include flower initiation, flowering duration, fruit setting, fruit drop, yield, physical fruit quality (fruit size, fruit weight, stone weight), organoleptic fruit quality and bio-chemical fruit quality (Total soluble solid (TSS), total sugars, reducing sugars and non-reducing sugars).

At flowering and fruit setting stage, flower initiation (date), flowering duration (days) fruit setting %age and fruit drop %age was calculated. Yield per plant was measured by plucking fruits per plant at random during month of May to August and average was calculated (Abbas *et al.,* 2016). After fruit harvesting average size of fruit (mm^2) was measured using Digital Vernier Caliper (Series 532, Mitutoyo, Japan). Average weight of fruit (g) and average weight of stone (g) were calculated with electrical weigh balance (SF-400) (Abbas *et al.,* 2016).

Ten fruits were selected at random for juice extraction. After juice extraction TSS (ºBrix) was measured with digital refractometer (SF-400A, China). Titrateable acidity (TA) was calculated by titrating juice against 0.1N NaOH. Reducing sugars, non-reducing sugars and total sugars were determined according to method described earlier by Khan *et al.* (2015).

Flavor of fruit, texture of fruit, colour of pulp and taste of fruit were measured using hedonic scale. On the scale the 1-unit intervals were considered: dislike extremely (1), dislike moderately (2), dislike very much (3), dislike slightly (4), neither like nor dislike (5), like slightly (6), like moderately (7), like very much (8) and like extremely (9). A committee of judges was made and the fruits of all the cultivars were given to them

for filling the performa to assess each variety. Experts were instructed to lightly polish the surface of the fruit with a soft towel to remove dust, spray deposit, bloom, or other surface residues.

Experiment was laid out according to randomized complete block design (RCBD). Statistically data was analyzed using the Fishers analysis of variance and treatments were compared using the least significant difference (LSD) test at 5% probability level (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Seven cultivars of plum (plum red buet, hersimmor, fazal-e-mannani, santa rosa, methlay, wickson and cherry plum seitha) were evaluated for their reproductive and fruit quality characteristics under Soan Valley condition to find out the most suitable cultivars to be cultivated there for commercial production.

Results (Table 1) showed that flower initiation started in all cultivars in month of February. Earliest flowering was observed in santa rosa followed by fazal-e-mannani, while cherry plum seitha flower at last. Maximum flowering duration (12 days) was observed in cherry plum seitha and minimum duration (6 days) was found in fazal-e-mannani. Highest fruit setting was found in methlay (23.24%) while least fruit set (17.14%) was calculated in hersimmor. Fruit drop showed statistical significance among all treatments. Minimum fruit drop (10.81%) was observed in methlay, whereas maximum fruit drop was calculated in hersimmor (17.92%). Similarly, maximum yield was calculated in Methlay (48.56 kg), whereas minimum yield was found in cherry plum seitha. Flower initiation, fruit set, fruit drop and yield is controlled by various factors such as availability of pollinator, pollination, hormonal balance, fertilizer application and management practices (Lezzoni *et al.,* 1991), but these parameters are also controlled by genotype (Mahato *et al.,* 2015). Among various cultivars fazal-e-mannani showed to have earliest flower initiation and minimum duration for flowering. According to Mahato *et al.* (2015) earlier the flowering starts, the shorter its time duration. Highest yield was found in Methlay that could be attributed to the fact that it's a varietal character as well as minimum fruit drop and highest fruit set which was recorded in plum cultivar methlay. Thus, methlay proved to be better as compared to other cultivars of plum regarding fruit set and yield in climatic conditions of Soan Valley.

All the treatments showed significant difference in the physical fruit quality parameters i.e., fruit length, width, size, weight and seed weight) (Table 2). Maximum fruit length (35.45 mm), fruit width (38.92 mm) and fruit size (1379.8 mm^2) was found in fazal-e-mannani, whereas, minimum fruit length (20.73 mm), fruit width (20.97 mm) and fruit size (435 mm^2) was observed in cherry plum seitha (Table 2). Maximum fruit weight was calculated in Wickson (32.94 g) (Table 3). Highest seed weight (1.3 g) was calculated in fazal-e-mannani, followed by wickson (1.14 g) (Table 2). The results showed that better fruit size was observed in Fazal-e-mannani

Table 1. Comparison for flower initiation (date), flowering duration (days), fruit setting%, fruit drop% and yield of different plum cultivars grown in Soan Valley

Treatments	Flower initiation (Date)	Flowering duration (Days)	Fruit setting (%)	Fruit drop (%)	Yield (kg/plant)
Plum red buet	2nd Feb	9 c	20.33 c	15.21 bc	34.75 c
Hersimmor	15th Feb	7cd	17.14 e	17.92 a	36.68 c
Fazal-e-mannani	4th Feb	6 d	20.54 c	14.60 c	39.19 b
Santa rosa	2nd Feb	10 b	18.63 d	12.80 d	31.87 d
Methlay	10th Feb	8 cd	23.24 a	10.81 e	48.56 a
Wickson	12th Feb	10 b	20.77 c	15.91 b	35.36 c
Cherry plum seitha	22nd Feb	12 a	21.65 b	15.27 bc	20.85 e
LSD (P ≥ 0.05)	NS	0.99	0.58	0.45	2.35

NS = Represents not significant. Means within a column followed by the same letter are not significant at P ≤ 0.05, LSD = Least significant difference test

Table 2. Comparison for fruit size, fruit weight and seed weight of different plum cultivars grown in Soan Valley

Treatments	Fruit length (mm)	Fruit width (mm)	Fruit size (mm^2)	Fruit weight (g)	Seed weight (g)
Plum red buet	34.57 a	36.15 ab	1250.9 b	28.25 c	0.88 c
Hersimmor	31.04 b	30.23 b	938.90 d	31.07 b	0.88 c
Fazal-e-mannani	35.45 a	38.92 a	1379.8 d	23.75 e	1.30 a
Santa rosa	30.94 b	29.04 c	898.50 b	25.40 d	1.12 b
Methlay	32.19 b	29.39 c	945.91 d	26.35 d	0.58 d
Wickson	33.31 ab	31.50 b	1049.5 c	32.94 a	1.14 b
Cherry plum seitha	20.73 c	20.97 d	435.08 e	4.5 f	0.54 d
LSD (P ≥ 0.05)	1.23	1.35	23.5	2.3	0.06

Means within a column followed by the same letter are not significant at P ≤ 0.05, LSD = Least significant difference test

Table 3. Sensory evaluation of fruit taste, texture, pulp colour and flavor of seven different plum cultivars grown in Soan Valley

Treatments	Taste (Score)	Texture (Score)	Pulp colour (Score)	Flavor (Score)
Plum red buet	7 b	7 b	7 b	7 b
Hersimmor	6.8 b	7 b	7 b	6 cd
Fazal-e-mannani	7.7 a	8 a	8 a	8 a
Santa rosa	7 b	5.4 bc	6.4 bc	5.4 d
Methlay	7.2 b	7 b	7 ab	7 b
Wickson	6.7 b	6.4 c	6 c	6.4 bc
Cherry plum seitha	6 c	3.2 e	4.2 d	3.2 e
LSD (P ≥ 0.05)	0.56	0.8	0.67	1.2

Means within a column followed by the same letter are not significant at P ≤ 0.05, LSD = Least significant difference test

Table 4. Evaluation of biochemical characteristics TSS, titratable acidity, reducing sugars, non-reducing sugars and total sugars of seven different plum cultivars

Treatments	TSS %	Titratable acidity %	Reducing sugars %	Non-reducing sugars %	Total sugars %
Plum red buet	14.6 a	0.84 ab	3.69 b	2.40 a	6.24 b
Hersimmor	14.3 ab	1.04 ab	2.81 f	1.83 d	4.72 e
Fazal-e-mannani	14.7 a	1.13 ab	3.86 a	2.41 a	6.33 a
Santa rosa	13.7 b	1.24 a	2.88 e	1.83 d	4.74 e
Methlay	13.9 b	0.92 ab	3.47 c	2.16 b	5.67 c
Wickson	13.7 b	0.96 ab	3.19 d	2.06 c	5.24 d
Cherry plum seitha	10.8 c	0.55 b	2.13 g	1.07 e	3.67 f
LSD (P ≥ 0.05)	0.32	0.07	0.5	0.88	1.3

TSS = Total soluble salt, Means within a column followed by the same letter are not significant at P ≤ 0.05, LSD = Least significant difference test

(Table 2). The change in fruit size, fruit weight and seed weight might be influenced by various phenotypic factors but it was mainly affected by genotype of plant (Arzani, 1994). It can be observed that fazal-e-mannani has highest fruit length, width, size and seed weight. Thus, showing that plum cultivar fazal-e-mannani resulted in better physical fruit quality in Soan valley.

Sensory evaluation of different plum cultivars showed significant difference when grown in Soan valley (Table 3). Best organoleptic properties like taste (7.7), texture (8), pulp colour (8) and flavor (8) were recorded in fazal-e-mannani (Table 3). While, least likable taste (6), texture (3.2), pulp colour (4.2) and flavor (3.2) were calculated in cherry plum seitha. Other *cv*. of plum such as hersimmor, santa rosa and methlay showed similar score in respect to taste, texture, pulp colour and flavor (Table 3). Organoleptic quality of fruit is influenced by various agricultural practices as well as environmental conditions (Abbas *et al.,* 2016). Shortage of water at the time of fruit development causes a higher content of soluble solids in fruits as during the ripening of fruits complex process occurs that converts carbohydrates/ starch into sugars that improves the taste, flavor and texture of fruits (Mahato *et al.,* 2015). The results showed that among different plum cultivars being grown in Soan Valley fazal-e-mannani proved to have better quality regarding taste, texture, pulp colour and flavor.

Biochemical characters of different plum cultivars showed statistical significance when cultivated in climatic condition of soan valley (Table 4). Highest TSS was calculated in fazal-e-mannani (14.7%), followed by red buet (14.6%) and hersimmor (14.3%). Least TSS was calculated in cherry plum seitha (10.8%). Maximum titratable acidity (TA) was found in santa rosa (1.24%), while minimum TA was observed in cherry plum seitha (0.55%). Fazal-e-mannani showed maximum reducing sugars (3.86%), non-reducing sugars (2.41%) and total sugars (6.33%). Whereas, minimum reducing sugars (2.13%), non-reducing sugars (1.07%) and total sugars (3.67%) were calculated in cherry plum seitha. Biochemical fruit parameters have direct effect on the the quality of fruits (Karadeniz and Sen, 1990). TSS is another important quality parameter that are also used as harvest index (Arzani *et al.,* 2008) and varied in different cultivars. As it is observed that highest TSS, total sugars, reducing sugars and non-reducing sugars were recorded in fazal-e-mannani at time of harvest and similarly it has better organoleptic characters. According to Chen *et al.* (2007), fruit acidity is directly proportional to the fruit aroma that results from combination of sugars, organic acids and aromatic substances. Plum cultivars studies showed wide variation in acidity and maximum TA was calculated in cv. santa rosa.

Acidity is related with aroma of fruit, which is combination of sugars, organic acids and aromatic substances (Chen *et al.,* 2007). Fruit acidity showed wide variation among the studied cultivars and maximum TA was recorded in *cv.* santa rosa.

CONCLUSION

All plum cultivars showed variation regarding reproductive growth and fruit quality under climatic conditions of Soan Valley. It was concluded that highest yield was reported in methlay, whereas best fruit quality was found in plum cultivar fazal-e-mannani. On basis of this research it was recommended that plum cultivar fazal-e-mannani and methlay should be cultivated commercially in Soan Valley.

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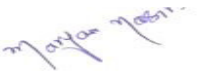
CONTRIBUTION OF AUTHORS

Sr. No.	Author's name	Contribution	Signature
1.	Malik Allah Bakhsh	Designed, planned, executed the experiment in the field and reviewed the manuscript	
2.	Malik Mohsin Abbas	Conducted the expeirment, collected data and wrote-up the manusucript	
3.	Maryam Nasir	Helped in data collection and write-up preparation	
4.	Muhammad Maaz Aziz	Laid-out the experiment and proof read the manuscript	
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