



PERFORMANCE ASSESSMENT OF DIFFERENT STRAINS OF POMEGRANATE FOR PHYSICO-CHEMICAL AND QUALITY CHARACTERS

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ABSTRACT

Performance of different strains of pomegranate (PS-1 to PS-8) selected from different areas of the Punjab was evaluated at Horticultural Research Institute, AARI, Faisalabad, Pakistan during the year 2014 to 2017. Fruit physico-chemical parameters i.e. fruit size, fruit weight, aril size, aril weight, peel thickness, peel weight, total number of seeds, weight of seeds, total soluble solids and yield as well as organoleptic attributes were studied. The results indicate that pomegranate Selection-6 exhibited significantly higher fruit size (6031.7 mm²) and fruit weight (269 g). The lowest peel thickness (2.40 mm) and minimum peel weight (50.80 g) was recorded in PS-4. Pomegranate PS-3 depicted maximum TSS (15.32%) and highest yield (60.4 kg). Highest aril size was found in PS-8 (77.9 mm²). Maximum number of seeds (817.0) were exhibited in PS-5 while, highest weight of seeds (387.6 g) was noted in PS-2. Additionally, organoleptic attributes such as taste (8.2) and flavor (8.8) remained higher in pomegranate PS-3 while, maximum score for colour of fruit (8.6) and colour of aril (8.2) was obtained in fruits harvested from PS-5. It is concluded that PS-3 seemed to be best cultivated strain with good quality fruit and high yield.

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INTRODUCTION

Pomegranate (*Punica granatum* L.) is an ancient plant of *Punicaceae* family and valued for its flavorsome fruit and as a decorative plant for its alluring bright colour flowers. Pomegranate is native to South-west Asia, possibly Iran and some adjacent countries and extensively grown in India, Spain, Iran, USA, Afghanistan and Egypt. Being adaptable in variety of soil and climatic conditions, its cultivation was started in countries like Israel, Burma, China, Palestine and Pakistan (Sing, 2000). In Pakistan, it is grown mainly in areas of Loralai, Qallat, Multan, Bahawalpur, Liaquatpur, Dera Ismael Khan and Muzaffargarh on 9007 hectares with 40125 tonnes production (GoP, 2015). The species is mainly subtropical to mild-temperate and naturally adaptable to areas with hot summers and cool winters. It can endure temperature upto 45-48°C with dry hot winds while harshly injured by temperature below -18°C (Levin, 1995). As pomegranate relish heat and flourish in arid and semi-arid areas, it requires regular irrigation throughout dry season to obtain optimum yield and good quality fruit (Levin, 2006). Pomegranate produces best in full sun. Bark injury due to sunburn or freezing may be minimized by painting trunks white to diminish temperature fluctuation during warm days and cold nights. Generally, it is propagated through cuttings as seedlings do not produce true-to-type plants (Patil *et al.*, 2002).

Current scientific verdicts corroborate traditional use of pomegranates as a medical remedy. Pomegranate flowers, fruit, leaves, and bark contain bioactive phytochemicals that are antimicrobial and act against infectious diseases like cancer, diabetes, hypertension and atherosclerosis (Holland *et al.*, 2009). The juice has cooling effect and admired for its medicinal properties primarily for leprosy patients. The sweet type of pomegranates is supposed to be slightly laxative, whereas, the fewer sweet type is thought to be best in cardiac ache and stomach inflammation (Anon, 1998).

Now-a-days there is increasing interest of growing pomegranate as it is considered a useful product of countless benefits in human diet. Regardless of its potential in world market, it is one of the few fruits that are still not evaluated. In order to drive this medicinal and profitable fruit to commercialization, technical knowledge regarding production needs to be developed. Selection of appropriate cultivars for a certain climatic condition is prerequisite for successful cultivation of any crop. Depending on the locations or agro-climatic conditions, cultivar performance can be varied. In Pakistan, study on varietal evaluation of pomegranate is scanty and very little or no systematic endeavor has been made for this purpose. Hence the current study was conducted with the aim to assess performance of quality characters of different strains of pomegranate being cultivated in Punjab.

MATERIALS AND METHODS

A survey was conducted during 2014-2017 in different areas of the Punjab with the objective to collect the superior germplasm. Eight pomegranate selections viz. PS-1, PS-2, PS-3, PS-4, PS-5, PS-6, PS-7 and PS-8 were selected and collected from various locations (Table 1 and Table 3).

Table 1. The collection site for each variety is as under.

S. No.	Name of Selection	Collection Site
1.	PS-1	Mauza Jhalari, Muzaffar Garh road, Ali Pur.
2.	PS-2	Mauza Jhalari, Muzaffar Garh road, Ali Pur.
3.	PS-3	Chak No.252 TDA, Ladhana Layyah
4.	PS-4	Kanhati Garden, 12 Km North, Khabaki Lake, Nowshara, Khushab.
5.	PS-5	Chak No. 133-9/L, Sahiwal
6.	PS-6	Chak No. 17 G. B. Kurial, Nankana Sahib
7.	PS-7	Chak No. 17 G. B. Kurial, Nankana Sahib
8.	PS-8	Mauza Bhabrha Wala, Shahr Sultan Road, Ali Pur

During fruiting season (June-August) the orchards were surveyed; superior plants were tagged. Fruits of the plants were collected and analyzed in the Pomology Laboratory of Horticultural Research Institute, AARI, Faisalabad, Pakistan (Latitude 31.42°N, Longitude 73.09°E, Elevation 189 m). During January, 2015, the cuttings were also collected from the tagged plants and were planted in the polythene bags in the nursery of the Institute to develop the progeny garden. The experiment was carried out on approximately seven to eight years old pomegranate plants. Climate of experimental site is characterized as subtropical with hot dry summer and cold winter. Pomegranate plants were spaced 12×8 feet apart with rectangular system and received uniform cultural practices throughout the experimental period. Eight plants of similar size and vigour were included in each treatment. The treatments were replicated five times.

Data were recorded regarding fruit length, fruit width, fruit size, fruit weight, aril length, aril width, aril size, aril weight, peel thickness, peel weight, total number of seeds and weight of all seeds. The fruits were also assessed for organoleptic parameters like colour, taste, flavour and texture using hedonic scale reading (1-9) (Peryam and Pilgrim, 1957).

Hedonic scale rating

A panel of judges was asked to perform the organoleptic evaluation of fruits using arbitrary scale. On the scale 1 unit - interval was considered i.e.

1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much and 9 = Like extremely.

A digital balance (SF-400A, China) was used to calculate the fruit weight and average weight of each replicate. The fruit size and peel thickness was measured using electronic digital caliper. The final yield in kilograms was obtained by summing up the yield of all pickings. Total soluble solids were recorded using hand refractometer (BX-1, Atago, Japan). The data collected were analyzed statistically using software Statistics. Analysis of variance (ANOVA) was employed to test the overall significance, whereas least significant difference (LSD) test ($P \leq 0.05$) was employed to compare the differences among treatment means (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Physio-chemical parameters of fruit

Fruit length and width: The analyzed data indicated significant results regarding fruit length and width (Table 2). Maximum fruit length (75.04 mm) was found in PS-2 followed by PS-6 (74.53 mm) while maximum width was noted in PS-6 (80.84 mm) followed by PS-2 (77.34 mm) (Table 2). Minimum fruit length (67.03 mm) was observed in PS-5 and width (70.44mm) in PS-8. These results are in accordance with previous findings of Zaouay *et al.* (2012) and Ferrara *et al.* (2011).

Fruit size: Statistical analysis of data showed significant results. Maximum fruit size (6031.7 mm²) was noted in fruit harvested from PS-6 whereas, minimum fruit size (4858.7 mm²) was calculated in PS-5 (Table 2). Fruit harvested from PS-1, PS-3, PS-4, PS-7 and PS-8 showed average size i.e. 5326.9, 5805.7, 5457.0, 4956.9, 5270.1 and 4973.0 mm² respectively. Zaouay and Mars (2011) also found same results previously.

Fruit weight: The significant results for fruit weight of different pomegranate strains were noted. Highest fruit weight (268.6 g) was found in PS-6 followed by PS-3 (266.6 g) and PS-1 (250.4 g) while, lowest fruit weight (179.2 g) followed by (190.6 g) was observed in PS-8 and PS-4, respectively. These results confirm the findings of Zaiuay *et al.* (2012) and Tehranifar *et al.* (2010).

Aril length and width: Aril length and width of pomegranate strains were significantly affected when analyzed statistically. Maximum aril length (11.86 mm) and aril width (7.72 mm) was recorded in fruits

Table 2. Physico-chemical characteristics of various pomegranate strains.

Strains	Fruit length (mm)	Fruit width (mm)	Fruit size (mm ²)	Fruit weight (g)	Aril length (mm)	Aril width (mm)	Aril size (mm ²)	Aril weight (g)	Peel thickness (mm)	Peel weight (g)	Total No. of seeds	Weight of all seeds (g)
PS-1	71.47bc	74.48cd	5326.9c	250.4ab	9.90bcd	6.58c	65.3b	0.22abc	3.76bcd	99.80b	804.8a	178.8e
PS-2	75.04a	77.34b	5805.7ab	226a	10.06bc	7.35ab	74.0b	0.26a	4.28bc	79.40d	731.4a	387.6a
PS-3	71.92bc	75.86bc	5457.0bc	266.6a	10.06a	6.37c	64.7b	0.23b	4.02bcd	89.60c	788.2a	306.6b
PS-4	69.81cd	70.99de	4956.9de	190.6d	9.29cde	7.72a	71.76a	0.22abc	2.40e	50.80e	718.8a	125.0f
PS-5	67.03d	72.42bc	4858.7e	195.4d	9.65bcde	7.51ab	72.6b	0.24ab	3.52d	92.40bc	817a	232.2c
PS-6	74.53ab	80.84cd	6031.7a	268.6a	9.00e	7.19b	64.6b	0.25a	5.58a	109.4a	765a	203.8d
PS-7	71.01c	74.21b	5270.1cd	235.8bc	9.12de	6.17c	56.4b	0.20bc	3.67cd	88.00c	732.2a	328.3b
PS-8	70.78c	70.46e	4973.0de	179.2d	11.86a	6.56c	77.9b	0.17c	4.49b	91.60c	420.8b	104.6f
LSD at 5%	2.99	2.53	350.1	21.43	0.86	0.47	70.56	0.049	0.74	7.82	104.2	24.13

Any two means not sharing a common letter are significant at 5% level of probability

harvested from PS-8 and PS-4, respectively (Table 2). Minimum aril length (9.00 mm) and aril width (6.17 mm) was calculated in fruit of PS-6 and PS-7, respectively. Celik and Erasl (2009) also reported similar results regarding aril length and aril width of different cultivars of pomegranate.

Aril size: Pomegranate strains exhibited significant impact in terms of aril size. Highest aril size (77.9 mm²) was recorded in PS-8 while, PS-7 revealed minimum aril size (56.4 mm²) (Table 2). PS-1 (65.3 mm²), PS-2 (74.0 mm²), PS-3 (64.7 mm²), PS-4 (71.7 mm²), PS-5 (72.6 mm²) and PS-6 (64.6 mm²) showed average size. These findings are similar to those of previous workers (Celik and Erasl, 2009).

Aril weight: Analysis of variance ($P \leq 0.05$) showed significant results in case of aril weight (Table 2). Fruit harvested from PS-2 attained maximum aril weight (0.26 g) followed by PS-5 (0.24 g) whereas, fruit of PS-8 attained lowest aril weight (0.17 g). Durgac *et al.* (2008) also found the same results.

Peel thickness: Statistical analysis of data regarding peel thickness also revealed significant results (Table 2). Maximum peel thickness (5.58 mm) was calculated in PS-6, against minimum peel thickness (2.40 mm) in PS-4. The others strains i.e. PS-1, PS-2, PS-3, PS-5, PS-7 and PS-8 were at par statistically with peel thickness of 3.76, 4.28, 4.02, 3.52, 3.67 and 4.49 mm, respectively. These results are in accordance with previous findings of Bist *et al.* (1994).

Peel weight: The results pertaining to peel weight indicated significant difference. Fruit of PS-6 had highest peel weight (109.4g) as compared to others while, lowest peel weight (50.80g) was recorded in fruit harvest from PS-4 (Table 2).

Total number of seeds: Data regarding total number of seeds indicate significant differences when analyzed statistically (Table 2). Pomegranate Selection-5 exhibited maximum number of seeds (817) against minimum number of seeds (420.8) in PS-8 Mir *et al.* (2010) also reported similar findings.

Weight of all seeds: Analysis of variance at ($P \leq 0.05$) exhibited significant results in case of weight of all seeds in different strains (Table 2). Maximum weight of seeds (387.6g) was recorded in PS-2 and minimum weight of seeds (104.6g) was in PS-8. These results are in close agreement to the previous findings of Mir *et al.* (2010).

Total soluble solids (TSS): Total soluble solids of different strains of pomegranate showed significant results (Fig. 1). Maximum TSS (15.32%) was found in PS-3 followed by PS-4 (14.9%) while minimum TSS (11.20%) was recorded in PS-5 followed by PS-1 (11.25%) (Table 2). These results are in agreement to those of Al-Said *et al.* (2009).

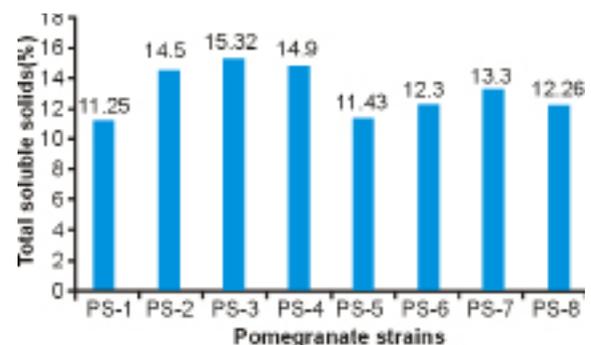


Fig. 1. Total soluble solids of various pomegranate strains.

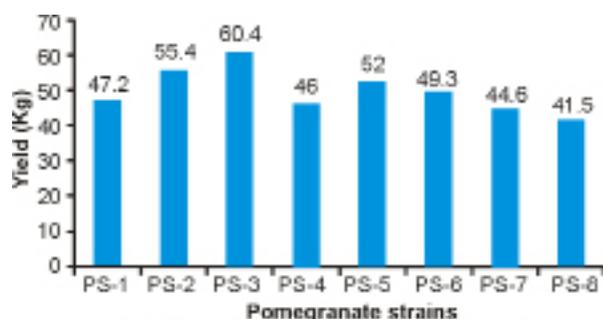


Fig. 2. Yield of various pomegranate strains.

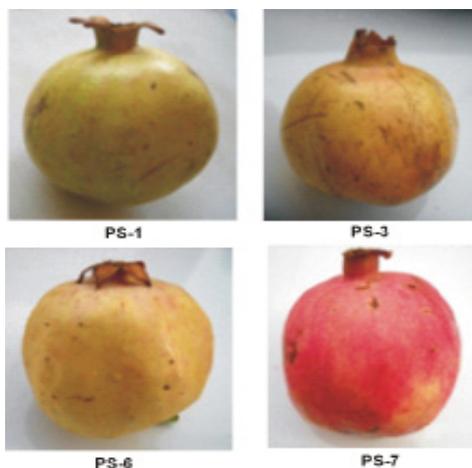
Yield : Statistical analysis of data related to yield of various pomegranate strains is presented in Fig. 2. PS-3 remained best with higher yield (60.4kg) while PS-8 gave the lowest yield (41.5kg). These results are in range with those of Mir *et al.* (2007) who studied yield parameter of different varieties of pomegranate.

Organoleptic parameters

Colour of fruit/maturity time: Colour of fruit and maturity time is given in Table 3. Higher hedonic scale reading (8.06) was obtained by fruits harvested from PS-5 while lower (5.8) was recorded in fruits of PS-8 (Table 4). Similar results were reported by Caliskan and Bayazit (2012).

Table 3. Colour of fruit and maturity time.

Name of Variety	Colour of fruit	Maturity time
PS-1	Greenish yellow	2 nd week of July- to August
PS-2	Reddish yellow	1 st week of August to end August
PS-3	Yellowish	2 nd week of July- to August
PS-4	Yellow with blush	1 st week of July- to early August
PS-5	Reddish	1 st week of July- to early August
PS-6	Yellow to off white	2 nd week July- to August
PS-7	Reddish	1 st week of August to end August
PS-8	Yellowish	2 nd week of August to early September



Pictorial presentation of pomegranate strains

Taste: Data on taste of fruit depicted significant results. Maximum hedonic reading (8.2) was calculated in PS-3 against minimum hedonic reading (5.4) in PS-5. Other selections were at par statistically, (Table 4).

Table 4. Organoleptic evaluation of various pomegranate strains.

Name of strains	Colour of fruit	Taste	Flavour	Texture	Colour of aril
Pomegranate selection-1	6.4bc	6.4b	6.00b	5.4b	6.4bcd
Pomegranate selection-2	7.2ab	6.00b	6.4b	5.6b	5.8d
Pomegranate selection-3	6.8bc	8.2a	8.8a	6.8ab	7.6ab
Pomegranate selection-4	7.00ab	6.4b	6.2b	7.4a	6.2cd
Pomegranate selection-5	8.06a	5.4b	5.8b	6.2ab	7.4abc
Pomegranate selection-6	6.60bc	6.4b	6.8b	5.3b	5.8d
Pomegranate selection-7	8.00a	5.8b	5.6b	6.00ab	8.2a
Pomegranate selection-8	5.8c	6.1b	6.00b	5.6b	5.6d
LSD	1.10	1.28	1.37	1.61	1.39

Any two means not sharing a common letter are significant at 5% level of probability

Flavour: Fruit of PS-3 exhibited higher hedonic scale reading (8.8) followed by PS-6 (6.8) while, minimum hedonic reading (5.6) was recorded in fruits of PS-7 followed by PS-5 (5.8) (Table 4).

Texture: Significant differences in texture of fruit were noted. Pomegranate PS-4 remained best with hedonic scale reading (7.4) while least hedonic reading (5.3) was found in PS-6.

Colour of aril: Different strains of pomegranate exhibited significant results in terms of color of flesh (Table 4). Fruit of PS-7 had higher hedonic scale reading (8.2) when compared to others and lower reading (5.6) was observed in fruit harvested from PS-8. These results are supported by previous findings of Al-Said *et al.* (2009).

CONCLUSION

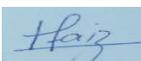
In conclusion, pomegranate selection PS-3 proved as the best with maximum fruit weight, TSS and yield. Moreover, organoleptic parameters such as taste and flavour also remained best in this selection. It is recommended that pomegranate PS-3 can be grown commercially for good quality fruit and better yield.

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CONTRIBUTION OF AUTHORS

S. No.	Author name	Contribution	Signature
1.	Malik Moshin Abbas	Conducted survey, selected strains, established multiplication block, wrote manuscript	
2.	Sahar Rashid	Performed analysis, planted pomegranate varieties, reviewed literature and wrote introduction of paper	
3.	Hira Faiz	Planted pomegranate varieties, obtained and analysed the data	
4.	Muhammad Ashfaq	Supervised the research work	
5.	Saeed Ahmad	Guided technically, provided the references for discussion of the paper, helped in analysis of fruit varieties, improved the write up of research paper	