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Evaluation of pomegranate germplasm under arid conditions

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Abstract

Thirty-eight pomegranate genotypes were evaluated to assess the components of genetic variability with respect to growth, fruit yield and quality traits. Considerable variability was observed in these characters. Number of fruits and fruit yield per plant and fruit weight were observed to be highly heritable traits which also showed large magnitude of genetic advance. Thus these characters should respond favourably to simple selection procedures in cultivar improvement attempts. Out of nine popular pomegranate varieties, Jalore Seedless, G 137 and Ganesh were observed to be superior with regards to fruit yield and Mridula excelled in fruit quality, indicates promise for cultivation. However, all the nine commercial types were prone to fruit cracking (30 – 90 %). This study suggest for systematic improvement in pomegranate not only for high quality fruit yield but also free from fruit cracking under hot arid environment.

Key words: *Arid environment, genetic variability, Pomegranate, Punica granatum*

Introduction

Pomegranate (*Punica granatum* L.) is grown in arid and semi-arid tropics for its acid-sweet fruits. In India, it is mainly cultivated in Maharashtra, Rajasthan, Andhra Pradesh, Karnataka, Gujarat, Haryana and Punjab. Collections of pomegranate gremplasm have been made at the centers of All India Co-ordinated Research Project on Arid Zone Fruits (AICRP on AZF) mainly at MPKV, Rahuri and IIHR, Banglore in collaboration with NBPGR. This enabled evaluation of the germplasm under different agroclimatic regions of the country resulting in selection of genotypes suited to these regions. After establishment of National Research centre for Arid Horticulture (NRCAH) at Bikaner in 1993 and later on upgraded to the status of Central Institute for Arid Horticulture (CIAH) in September, 2000, pomegranate germplasm was assembled for evaluation and genetic improvement under hot arid environment.

To boost pomegranate production in India both for domestic and export, development of improved varieties/ hybrids is required which bear fruits having attractive rind and bold and soft grains with dark red and sweet aril (Pareek and Samadia, 1999). Assessment of variability is the basic requirement in any breeding strategy. Since most of the plant characters are governed by a group of genes and are highly influenced by environmental conditions, it is difficult to judge whether the observed variability is heritable. This necessitates assigning heritable and non-heritable components of phenotypic variation. An attempt was therefore, made to estimate the genetic variability components in the pomegranate germplasm and identify promising types on the basis of their performance under hot arid agro-climatic conditions.

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Materials and Methods

Work was initiated in 1994 to build up pomegranate repository at CIAH, Bikaner under hot arid conditions by collection of germplasm from different centers of AICRP on AZF and NBPGR stations. Field planting was initiated in 1995 and by December 1996, more than 65 collections of pomegranate including some duplicates were established. The assemblage included commercial cultivars, popular types, advanced selections and early introduced material under AICRP on AZF and NBPGR centers. Four to 5 year old 38 genotypes were included in this study. Three trees per accession were maintained in the field gene bank of which each tree served as a replication. Observations for characterization of the genotypes were started from 1997. To analyze the components of genetic variability, data recorded on 38 genotypes in the year 1999 were used. Observations on 6 trees planted in two sets of each of the commercial cultivars (nine) were recorded during 1999 and

Table 1: Plant growth and fruit quality traits of pomegranate genotypes.

Genotype	Plant growth behaviour	Fruit weight (g)	Aril taste	Mellowness of seed	Aril colour
Achikdana	D	152.5	Sour	Hard	Red
Agah	D	132.8	Sour	Hard	Whitish pink
A.K.Anar	D	185.0	Sour	Hard	Light pink
Alah	D	62.5	Sour	Hard	Pink
Bassein Seedless	D	175.2	Slightly sweet	Hard	Whitish pink
Bedana Suri	E	221.5	Slightly sweet	Hard	Whitish pink
Bedana Thin Skin	E	186.4	Slightly sweet	Hard	Whitish pink
Boseka Link	D	75.4	Sour	Hard	Whitish pink
Coimbatore White	E	187.5	Slightly sweet	Hard	Whitish pink
Dholka	E	252.5	Sweet	Hard	Whitish pink
Dorseta Malus	D	169.8	Sour	Hard	Light pink
G 137	E	245.1	Sweet	Soft	Light pink
Ganesh	E	229.1	Sweet	Soft	Light pink
GKVK 1	E	210.5	Sweet	Soft	Light pink
Gul-e-Shah	D	121.2	Sour	Hard	Red
Gul-e-Shah Red	D	85.6	Sour	Hard	Pink
Gul-e-Shah Rose Pink	D	152.4	Sour	Hard	Dark red
Jalore Seedless	E	265.4	Sweet	Soft	Pink
Jodhpur Red	E	196.5	Sweet	Hard	Pink
Jyoti	E	225.7	Sweet	Soft	Light pink
Kabul	E	154.1	Sweet	Very hard	Whitish pink
Kabul IIHR	E	165.5	Sweet	Hard	Whitish pink
Kajaki Anar	D	98.5	Sour	Hard	Light pink
Khog	D	132.5	Sour	Hard	Pink
Mridula	E	102.7	Sweet	Soft	Dark red
Musket	E	221.5	Sweet	Medium hard	Whitish pink
P 13	E	231.1	Sweet	Medium hard	Whitish pink
P 23	E	237.5	Sweet	Slightly hard	Light pink
P 26	E	245.1	Sweet	Slightly hard	Light pink
Patna 5	E	175.2	Sweet	Hard	Light pink
Siah Sirin	D	137.5	Sour	Hard	Pink
Sirin Anar	D	129.1	Sour	Hard	Red
Speen Danedar	D	137.5	Sour	Hard	Pink
Speen Sacarin	D	170.5	Sour	Hard	Red
Surkh Anar	D	122.1	Sour	Hard	Whitish pink
Sur Sukker	D	85.9	Sour	Hard	Whitish pink
Tebest	D	90.1	Sour	Hard	Red
Yarcaud HRS	E	195.2	Sweet	Hard	Whitish pink
CD (P=0.05)*	-	16.6	-	-	-
CV (%)	-	6.1	-		-

*— Significant, D—Deciduous, E—Evergreen.

2000. Pooled data for these two years were used in statistical analysis for varietal performance. The fruits of *mrig bahar* flowering (July- August) were retained and harvested during December - January. Physico-chemical characteristics were recorded on five randomly selected fruits from each replication. Data were subjected to analysis for ANOVA and biometrical components adopting standard statistical procedures suggested by Panse and Sukhatme (1985), Burton (1952) and Johnson *et al.* (1955).

Results and Discussion:

Genetic variability

The analysis of variance revealed that the genotypes differed significantly with respect to height and spread of plant, TSS, weight, length and breadth of fruit and number and yield of fruits per tree. The data on fruit quality traits such as aril taste and colour and mellowness of grains and plant growth behaviour of the genotypes presented in Table 1 show wide variation. It is evident that only a few genotypes viz., Jalore Seedless, Ganesh, G 137, Mridula, P 23, P 26, GKVK 1, Jyoti and Musket possess the desirable traits such as sweet taste, soft to less hard seed and pink to red aril colour and could be used for table purpose. The Russian, Iranian, and other introduced genotypes from Central Asia did not produce desirable fruit quality under the hot arid environment. However, the colour of fruit rind and aril in cultivars Gul-e-Shah Rose Pink, Gul-e-Shah Red, Khog, Kabul, Sirin Anar, etc. were attractive and could be used in breeding programme to infuse these traits in the popular cultivars.

The data on genotypic means, range and biometrical estimates of variability presented in Table 2 indicate wide variability in fruit weight (60.1-340.1 g), number of fruits per plant (4.13-44.98), fruit yield per plant (0.489-10.905 kg), fruit length (4.81-9.89 cm), fruit breadth (4.81-8.19 cm), TSS (12.3-17.6 °Brix), plant height (131.2-245.5 cm) and plant spread (99.2-249.5 cm). In general, the estimates of phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) but the closer correspondence between PCV and GCV for all the quantitative traits revealed that genotypic effects were important in the expression of the characters. Both PCV and GCV were high for fruit yield per plant (76.01 and 73.84), number of fruits per plant (57.96 and 57.92) and fruit weight (34.11 and 33.56), indicating better scope of phenotypic selection to enhance the fruit yield in pomegranate. Similar findings have been reported earlier by Manohar *et al.* (1981) for aril weight, rind weight, fruit weight, number of fruit/tree, fruit yield/tree and acidity in pomegranate.

The magnitude of heritability indicates the extent of reliability in identifying the genotypes on the basis of phenotypic expression. In the present studies, high heritability was observed for all the economical quantitative traits. The broad sense heritability ranged from 90.5 to 99.86 per cent. This high estimate of heritability is helpful to base the selection programme on phenotypic performance in pomegranate. The expected genetic advance as percentage of mean (genetic gain) ranged from 16.32 to 147.22 per cent. This was very high for fruit yield per plant (147.22), number of fruits per plant (119.23), and fruit weight (68.03). This indicates that the level of improvement could be considerable in these traits. The lower genetic gain recorded in TSS (16.32), fruit size and plant growth characters indicates that these traits could not be improved to the desire level as such.

Heritability estimates in conjunction with genetic advance are helpful in predicting its resultant effects for selecting the best individuals (Johnson *et. al*, 1955). Selection based on high heritability and high genetic advance is more helpful than on the basis of low genetic gain. Heritability mainly due to additive gene effects would be associated with high genetic gain and that due to non-additive gene effects with low genetic gain. In the present investigation high heritability along with high genetic advance was recorded in the characters, *viz.* number of fruits per plant, fruit yield per plant and fruit weight. Besides high estimates of GCV was also recorded. This shows that these characters could be considered reliable tools for selection and opens up the possibility of improvement in these characters in pomegranate. These finding are in conformity with the results of Manohar *et al.* (1981).

Performance of popular cultivars in arid environment

Pooled statistical analysis revealed highly significant differences in the existing pomegranate cultivars in all the characters (Table 3). In growth performance the cultivars Jalore Seedless, Jodhpur Red, G 137, P 23 and P 26 proved better under hot arid conditions. Pareek (1978) reported that pomegranate cultivars showed vigorous, semi-vigorous and dwarf vegetative growth characters. The varietal variations in plant growth characters under arid conditions were also reported by Prasad and Bankar (2000). The minimum plant height (162.6 cm) and spread (168.6 cm, mean of north-south + east-west) was recorded in cultivar Mridula. The highest number of 47.24 fruits per plant was recorded in Mridula followed by 40.5 in Jalore Seedless and the lowest (11.6) in Dholka. The heaviest fruit (250.15 g) was produced in the cultivar Jalore Seedless followed by Jodhpur Red (235.3 g). The fruit weight in other varieties *viz.*, Ganesh, G 137, P 23 and P 26 were ranged between 194.75 to 212.48 g. However, Mridula cultivar produced the smallest 105.7 g fruits. Fruit length and breadth ranged from 5.38 to 7.77 cm and 5.46 to 8.01 cm, respectively. The highest fruit yield per plant was recorded in Jalore Seedless (9.78 kg). The cultivars Jodhpur Red, Ganesh and G 137 were *at par* with a moderate fruit load of about 6.5 kg. The fruit yield in Mridula was only 4.94 kg in spite the highest number of fruits per tree. This was obviously because of the small sized fruits (105.7 g) in that cultivar. The variation

Table 2 : Components of genetic variability in pomegranate germplasm.

Characters	Range	Mean	CD (5%)	CV (%)	GCV (%)	PCV (%)	h^2 (broad sense)	GA	Genetic gain (%)
Plant height (cm)	131.2 - 245.5	199.63	7.14	2.2	11.04	11.26	96.19	44.55	22.31
Plant spread (cm)	99.2 – 249.5	192.65	6.04	1.9	15.02	15.15	98.38	59.13	30.69
Fruit weight (g)	60.1 – 340.1	168.48	16.67	6.1	33.56	34.11	96.81	114.63	68.03
Fruit length (cm)	4.81 – 9.89	6.48	0.45	4.3	13.19	13.86	90.50	1.79	27.58
Fruit breadth (cm)	4.81 – 8.19	6.41	0.24	2.4	12.34	12.56	96.45	1.60	24.96
Number of fruits/plant	4.13 – 44.98	17.42	0.60	2.1	57.92	57.96	99.86	20.77	119.23
Fruit yield/plant (kg)	0.49 – 10.90	3.20	0.93	18.0	73.84	76.01	94.40	4.72	147.22
TSS (°Brix)	12.3 – 17.6	15.13	0.23	1.0	7.99	8.05	98.58	2.47	16.32

Table 3 : Growth and fruit yield characters of commercial pomegranate genotypes

Genotype	Plant height (cm)	Plant spread (cm)	Fruits /plant	Fruit yield /plant (kg)	Fruit weight (g)	Weight of 100 aril (g)	TSS° (Brix)	Juice (%)	Seed waste (%)
Jalore Seedless	211.2	192.0	40.5	9.78	250.15	21.47	17.38	54.55	9.85
Jodhpur Red	209.6	243.1	29.1	6.61	235.30	19.74	15.60	42.52	24.28
Ganesh	190.6	222.3	32.3	6.06	194.75	20.78	16.03	47.25	11.77
G 137	220.0	248.2	33.1	6.83	211.56	19.73	15.14	50.60	11.95
Mridula	162.6	168.6	47.2	4.94	105.77	13.57	14.31	58.80	10.05
P 23	227.6	253.7	20.6	4.34	212.48	16.56	16.91	50.57	13.46
P 26	218.6	198.3	22.5	4.53	210.29	18.74	16.93	50.97	12.93
Dholka	205.7	241.3	11.6	2.20	201.20	13.75	15.68	49.32	13.13
GKVK 1	190.0	193.3	22.6	4.54	207.52	17.62	16.59	42.55	14.43
Mean	207.5	218.9	27.4	5.25	200.90	17.85	15.88	48.58	13.84
Sd	22.19	28.52	10.75	2.12	37.74	2.65	1.07	5.89	4.04
CD (P=0.05)*	14.05	8.46	2.27	0.17	8.18	0.09	0.39	1.91	0.71

in fruit weight and size seems to be genotypic as also reported by Prasad and Bankar (2000). The boldness of aril is an important quality trait. The cultivar Jalore Seedless produced the largest aril size (0.22 g) followed by Ganesh (0.21 g) and G 137 (0.20 g). Cultivar Mridula produced the smallest aril (0.14 g). However, the juice content was significantly higher in Mridula (58.8 %) followed by Jalore Seedless (54.55 %) and G 137 (50.60 %). Thus, cultivars differed significantly in juice and seed content, mellowness of seeds and boldness of aril as also reported by Mali and Prasad (1999) and Prasad and Bankar (2000). Desai *et al.* (1992) observed positive and significant correlation between plant spread and fruit yield. Similarly, the fruit number and fruit weight with yield. Thus, the cultivars producing large number of fruits also have genetical potential for bigger fruits. The cultivars producing big sized fruits also had bolder arils. On the basis of varietal performance it is concluded that the cultivars Jalore Seedless, G 137, Ganesh and Mridula are potential under hot arid conditions The cultivars Jalore Seedless, G 137 and Ganesh are high yielding and better in fruit quality except aril colour. It is also found that the fruit quality of Mridula excelled the above three cultivars. However, it is disappointing that all these varieties are prone to fruit cracking. Moreover, this problem is very serious in Jodhpur, Red, Jalore Seedless, G 137 and Ganesh under hyper hot arid conditions. This suggest for systematic improvement in the Jalore Seedless, a locally adapted superior genotype to evolve dark red, soft and bold seeded types.

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