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STUDY OF MORPHOLOGICAL VARIABILITY AMONG FIFTY ACCESSIONS OF POMEGRANATE (*PUNICA GRANATUM* L.)

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ABSTRACT
The experiment was conducted to study the diversity of fifty accession of pomegranate selected from more than two year old plants of Horticulture Instructional Farm and AICRP on Arid Zone Fruits, S. D. Agricultural University Sardarkrushinagar during Ph.D. work in the year 2010-2014). On the basis of morphological analysis of fifty accessions of pomegranate the variety Bhagwa ranked first in respect of fruits / plant and other yield contributing characters under study except leaf area. Phenotypic and genotypic coefficient of variation were high for number of fruits / plant followed by number of flowers / plant, leaf area and number of primary branches / plant. The heritability (broad sense) estimates were high for number of fruits per plant followed by number of flowers / plant and leaf area. The genetic advance expressed in per cent of mean was high for number of fruits / plant and number of flowers / plant; moderately high for leaf area, stem girth, number of primary branches / plant, N-S plant spread and E-W plant spread where as it was low for plant height. Since fruits / plant is important component of yield, it showed significant positive correlations with number of flowers / plant, number of primary branches / plant, E-W plant spread and N-S plant spread at both phenotypic and genotypic levels. Its correlation with stem girth was also significant at genotypic level only. Therefore selection may be done for these traits for yield improvement in pomegranate.

KEYWORDS: Genotypic Coefficient of Variation **(**GCV), Phenotypic Coefficient of Variation (PCV), Genetic Advance (GA).

INTRODUCTION

Pomegranate (*Punica granatum* L.) belongs to the family Punicaceae which has a single genus Punica and two species *P. granatum* L. and *P. protopunica* Balf (Jbir *et al*. 2008). it is important tropical, subtropical region fruit crop and grown from Iran, Afghanistan, Baluchistan to the north India (Himalayas) (Stover and Mercure, 2007) and has been cultivated since ancient times (Ozgen *et al*., 2008) of Asia, Europe and Africa (Morton and Miami, 1987). Pomegranate is commercially grown in Morocco, Turkey, Tunisia, Spain, Egypt, Iran, Afghanistan, Baluchistan, India and to some areas of the United States , China, Russia and Japan (Hayes, 1957; Kumar, 1990). India is the largest producer of pomegranate with 1345.72 million tonnes production. Out of this, nearly 90000 hectare area is covered in Maharashtra, which produces fruits of 945.00 million tonnes (about 70 % of the total production). In Gujarat 9.3 thousand hectare area is under pomegranate cultivation with production of 99.33 million tonnes and productivity of 10.6 MT/hectare in 2013-14 (Anonymous 2014). The major growing states of pomegranate are Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Madhya Pradesh, Telangana and Rajasthan in the India. Out of three main seasons fruiting for *Haste bahar* are regulated to obtain good quality fruits of pomegranate. Pomegranate tree bears hermaphrodite flowers in different cultivars ranged up to 49% (Mir *et al.,* 2012). The fruit juice contained high per cent sugar, an exceedingly high level of vitamin A, C & E and very effective for leprosy (Morton and Miami, 1987). The consumption of fruit also helps in cell repairs mechanisms due to presence of antioxidants. The fruit is a rich source of polyphenols, and tannins also (Chauhan and Kanwar, 2012). In addition plant growth, the micro-nutrients play major role in disease and fruit cracking incidences in pomegranate crop (Mir *et al.,* 2012). Anar-butterfly and fruit cracking incidences are major limiting factors for its cultivation which are mostly common throughout the world.

More than 250 germplasm lines are available in India. The National Research Centre on Pomegranate, Solapur is the main working centre of pomegranate. At present, 187 (both exotic and indigenous) germplasm are available at its national field gene bank. In the last 50 years, ten pomegranate cultivars have been identified and released for commercial cultivation. Bhagawa, Ganesh and Sinduri are popular varieties among farmers (Chandra *et al.*, 2010). Pomegranate varieties *viz*., Ganesh, Bhagwa, Ruby, Arakta and Mridula are being cultivated in Maharashtra and Gujarat.

Experimental Materials

For diversity study of more than 2 years old pomegranate, fifty accessions (Table 4) were selected from Horticulture Instructional Farm and AICRP on Arid Zone Fruits, S. D. Agricultural University.

They were raised from cuttings and planted at an experimental farm following Randomized Block Design (RBD) with three replications. The three plants of each fifty genotypes were planted at 4.5 X 3 m spacing. The

following observations were recorded are plant height (cm), East- West plant spread (cm), North-South plant spread (cm), girth of stem (cm), number of primary branches, numbers of flowers / plant, number of fruits / plant and leaf area (cm^2) in all the fifty selected plants of each replication. The selected one superior plant has rapid growth, height and diameter was selected as a one replication of the same age of more than 2 year old growing at same site. Total three plants were selected for three replications. The stem was straight with minimum taper and reasonably clear of primary branches reassembly. Trees with internodal branches were not considered.

Statistical analysis

Statistical analysis were subjected to record data for various characters and morphologically analyzed as Randomized block design (RBD) as per procedure of ANOVA Panse and Sukhatme (1978), the coefficients of phenotypic and genotypic variations were calculated by formula suggested by Burton (1952), Heritability and Genetic advance proposed by Allard (1960) at 5 per cent selection intensity using the constant K as 2.06. The expected genetic advance as expressed in per cent of mean was calculated by method suggested by Johnson *et al.* (1955). The phenotypic, genotypic and environmental correlation coefficients for all the characters were worked out. For this purpose, data were subjected to covariance analysis.

Morphological analysis

For morphological observation the data on the eight traits *viz.*, plant height, E-W plant spread, N-S plant spread, stem girth, number of primary branches / plant, number of flowers / plant, number of fruits / plant and leaf area were analyzed through RBD. Genetic variability parameters, heritability and genetic advance of the traits were estimated. Replication wise mean values of the data of each accession were subjected to statistical analysis. The analysis of variance (ANOVA in table 1) provides mean squire for replication varieties and error from which different variability parameters were estimated.

RESULTS

The variation among genotypes for these characters was found highly significant. Maximum plant height was recorded in the variety Bhagwa (175.833 cm) and minimum in Kazil Anar (71.25 cm) followed by Ahor Seedless (81.5 cm), with general mean 122.472 cm. Maximum East-West and North-South plant spread was recorded in the variety Bhagwa (171.667 cm &179.167 cm) and minimum for Damini (50.0 cm & 40.0 cm) respectively. The character showed high range of variability with general mean 106.779 cm and 109.14 cm. Highest stem girth**s** were recorded in the variety Bhagwa (22.56 cm) and minimum in Kazil Anar (4.5 cm) with general mean 10.192 cm. Maximum numbers of primary branches / plant were recorded in the variety Bhagwa (7.333) and minimum in Saharanpur (2.333), with general mean 4.48. The highest numbers of flowers / plant was recorded in the variety Bhagwa (48.0) and minimum in Surat Anar (4.33). Maximum number fruits / plant were recorded in the variety Bhagwa (15.0) and minimum in China Orange, Utakal and Alah with general mean 4.43. Maximum leaf area was recorded in EC- 24685 (6.680 cm^2) while minimum in Guleshah Red (1.820 cm^2).

Genotypic and Phenotypic coefficient of variation (GCV) / (PCV)

Higher expression of genotypic coefficient of variation was observed for number of fruits / plant (52.00), number of flowers / plant (51.95) and leaf area (28.68), whereas, plant height (15.78) showed lowest magnitude of genotypic coefficient of variation (Table 2). Phenotypic coefficient of variation ranged from 19.48 (plant height) to 55.71 (number of fruits / plant). Number of flowers / plant (55.65) also showed high phenotypic coefficient of variation and plant height showed lowest (19.48) phenotypic coefficient of variation. Highest heritability was recorded for leaf area (93.8) followed by number of flowers / plant (87.2) and number of fruits / plant (87.1), N-S plant spread (75.8), E-W plant spread (67.5) and plant height (65.6). The highest value of GA (per cent of mean) was observed for number of fruits / plant (99.99), number of flowers / plant (99.91) and for leaf area (57.35) and plant girth (51.03) was also of higher magnitude. While it was moderate for (N-S) Plant spread (43.12) and number of primary branches / plant (43.08). The lowest value was observed for plant height (26.34).

Estimation of correlation coefficients

Plant height shows highly significant and positive correlation with E-W plant spread, N-S plant spread and stem girth at phenotypic level. These three characters also show significant positive correlation (table 3). The correlation of plant height with number of primary branches per plant at genotypic level was also positive and significant (Verma, *et al;* 2010). The E-W plant spread exhibited significant and highly significant and positive correlation with N-S plant spread, stem girth, number of primary branches / plant, number of flowers / plant and number of fruits / plant at both level (GCV & PCV) respectively. The N-S plant spread had significant positive correlation at genotypic level with stem girth, number of primary branches / plant and number of flowers and fruits / plant while these association at phenotypic level was also positive significant. The correlation between stem girth with number of primary branches / plant was significant only at genotypic level while it was positive and significant with number of flowers / plant at phenotypic as well as genotypic levels. Number of primary branches / plant had significant positive correlation with number of flowers / plant at both level. The leaf area which is an important physiological trait did not show positive correlation with any of the characters under study. Perusal of results revealed that high genotypic and phenotypic variances indicated enormous scope for selection of desirable and individual genotypes for greater chances of success in breeding programme. These results corroborated with the findings reported in pomegranate for plant height, plant spread E-W & N-S, number of fruits / plant and leaf area by Sharma and Bist, (2005); Wani *et al*. (2012), for plant height, plant spread E-W & N-S and number of fruits / plant by Meena *et al.* (2009), for plant height and spread by Mir *et al*. (2010), for number of fruits / plant and leaf area by Drogoudi *et al*. (2005), for number of fruits / plant by Samadia and Pareek (2006) and Durgac *et al*. (2008).

TABLE 1: Analysis of variance (ANOVA) for different characters of pomegranate varieties / accessions

Source	Degree of freedom (DF)	Total Sum of square (SS)	Mean of square (MS)	F Cal	F Tab	C.D.	CV%
Height of plant (cm)							
Replication	2	566.8	283.4	1.45		22.72	11.42
Genotypes	49	64522.2	1316.7**	6.73	1.49		
Error	98	19168.9	195.6				
Total	149	84258.0					
(E-W) Plant spread (cm)							
Replication	2	716.1	358.0	1.17		28.47	16.41
Genotypes	49	108875.5	2221.9**	7.24	1.49		
Error	98	30090.6	307.0				
Total	149	139682.4					
(N-S) Plant spread (cm)							
Replication	2	828.1	414.0	1.89		24.06	13.57
Genotypes	49	111933.9	2284.3**	10.42	1.49		
Error	98	21491.1	219.2				
Total	149	134253.2					
Stem girth							
Replication	2	1.9	0.97	0.43		2.44	14.76
Genotypes	49	1308.8	26.71**	11.80	1.49		
Error	98	221.8	2.26				
Total	149	1532.6					
No. of primary branches							
Replication	2	1.12	0.560	1.12		6.09	15.76
Genotypes	49	205.44	4.193**	8.41	1.49		
Error	98	48.88	0.499				
Total	149	255.44					
No. of flowers/ plant							
Replication	2	46.89333	23.447	2.91		4.59	19.94
Genotypes	49	8402.593	171.481**	21.35	1.48		
Error	98	787.11	8.032				
Total	149	9236.593					
No. of fruits/ plant							
Replication	2	4.573333	2.287	2.9194		1.43	19.99
Genotypes	49	817.36	16.681**	21.297	1.48		
Error	98	76.76	0.783				
Total	149	898.6933					
Length of leaf area (cm^2)							
Replication	2	0.55	0.277	2.26		0.57	7.35
Genotypes	49	280.4	5.722**	46.67	1.49		
Error	98	12.0	0.123				
Total	149	292.9					

** indicates significant at 0.01 per cent level.

TABLE 2: Estimation of mean, range, heritability, coefficient of variation and genetic advance (in per cent) for different characters in pomegranate varieties / accessions

Sr. No.	Character	Mean	Range	PCV	GCV	H^2	GA	GA % of Mean
1	Plant height	122.47	71.25 – 175.833	19.48	15.78	65.6	32.27	26.34
2	(E-W) Plant spread	106.78	50.0 – 171.667	28.79	23.66	67.5	42.77	40.05
3	(N-S) Plant spread	109.14	40.0 – 179.167	27.60	24.04	75.8	47.07	43.12
4	Stem girth	10.19	4.50 – 22.567	31.66	28.01	78.3	5.20	51.03
5	No. of primary branches / plant	4.48	2.33 – 7.333	29.36	24.77	71.2	1.93	43.08
6	No. of flowers / plant	14.21	4.33 – 48.0	55.65	51.95	87.2	14.19	99.91
7	No. of fruits / plant	4.43	2.0– 15.33	55.71	52.00	87.1	4.42	99.99
8	Leaf area	4.76	1.82 – 6.680	29.60	28.68	93.8	2.73	57.35

Where,
PCV = Phenotypic coefficient of variation
GCV = Genotypic coefficient of variation
H^2 = Heritability
GA = Genetic Advance

The simplest estimates of variability are range in this study for eight characters with wide range of variation were observed for all the characters such as number of flowers / plant reflected the widest range fallowed by number of fruits / plant, stem girth and N-S plant spread. Other characters *viz.* leaf area, E-W plant spread, number of primary branches / plant and plant height showed moderate range of variation. These results are in agreement with the earlier findings of Durgac *et al.*,

(2008), Meena *et al.* (2009), Mir *et al.*, (2010) and Wani *et al.* (2012).

The high productivity of Bhagwa at Sardarkrushinagar was due to high number of fruits / plant as well as other component characters. Mir *et al.* (2010) and Chandra *et al.*, (2010) also reported high productivity of Bhagwa due to its superiority for number of fruits / plant.

TABLE 3: Phenotypic (r_p) and genotypic (r_g) correlation coefficients among different characters

Character		Plant height (cm)	(E-W) plant spread (cm)	(N-S) plant spread (cm)	Stem girth (cm)	No. of primary branches/ plant	No. of flowers/ plant	No. of fruits/ Plant	Leaf area (cm^2)
Plant height (cm)	r_p	1.000	0.542*	0.548*	0.498*	0.223	0.182	0.153	0.089
	r_g	1.000	0.630**	0.603**	0.601**	0.297*	0.225	0.187	0.130
(E-W) Plant Spread (cm)	r_p		1.000	0.836*	0.554*	0.347*	0.415*	0.344*	0.127
	r_g		1.000	0.952**	0.638**	0.474**	0.579**	0.425**	0.173
(N-S) Plant Spread (cm)	r_p			1.000	0.621*	0.336*	0.465*	0.315*	0.022
	r_g			1.000	0.687**	0.461**	0.564**	0.393*	0.038
Stem girth (cm	r_p				1.000	0.233	0.335*	0.293	0.059
	r_g				1.000	0.282*	0.396*	0.329*	0.093
No. of primary branches/ plant	r_p					1.000	0.364*	0.323*	-0.028
	r_g					1.000	0.414	0.427*	-0.038
No. of flowers/ plant	r_p						1.000	0.657**	-0.140
	r_g						1.000	0.772**	-0.153
No. of fruits/ plant	r_p							1.000	-0.230
	r_g							1.000	-0.253
Leaf area (cm^2)	r_p								1.000
	r_g								1.000

*,** indicates significant at 0.05 & 0.01per cent level, respectively

TABLE 4: Phenotypic variation for eight characters in fifty varieties / accessions of pomegranate

Sr. No.	Accessions / Germplasm	Height of plant (cm)	(E-W) Plant spread (cm)	(N-S) Plant spread (cm)	Girth (cm)	Number of primary branches	Number of flowers/ plant	Number of fruits/ Plant	Length of leaf area (cm^2)
1.	Bhagawa	175.83	171.67	179.17	22.57	7.33	48.00	15.33	2.87
2.	Achikdana	126.67	75.00	74.17	7.33	5.00	13.33	2.67	3.31
3.	Ahor seedless	81.50	81.23	83.73	4.60	4.33	16.00	7.33	4.80
4.	Bedana Sedana	117.50	105.00	105.33	10.33	3.67	11.33	4.67	3.45
5.	Bedana Suri	112.50	143.17	156.67	14.83	5.33	16.33	6.00	2.08
6.	Bassein Seedless	128.33	114.17	125.00	12.67	7.00	11.33	2.67	5.62
7.	Damini	112.50	50.00	40.00	7.00	2.67	8.33	2.33	6.19
8.	G R Pink	140.00	93.73	77.50	8.50	4.33	7.33	4.67	5.27
9.	Jallore Seedless	93.75	77.50	95.00	8.73	2.67	7.67	3.67	4.31
10.	Jyoti	112.50	96.67	95.00	10.13	4.67	16.00	2.67	4.92
11.	Jodhpur Red	150.83	130.83	141.67	9.93	4.00	12.00	4.33	2.59
12.	Kerala collection	112.50	103.33	95.83	10.67	3.67	15.00	2.33	5.24
13.	Maha	134.17	105.83	106.67	8.73	5.33	8.67	3.00	6.57
14.	Nimali	105.00	108.73	81.27	11.67	2.67	8.00	3.00	6.20
15.	Sirin Anar	132.50	121.67	118.33	10.67	6.00	19.33	6.00	5.30
16.	Saharanpur	152.50	129.17	136.67	12.33	2.33	13.33	6.00	5.98
17.	Spin Sakaharin	112.50	101.67	105.83	10.67	3.33	7.67	3.00	5.16
18.	Uttkal	120.83	114.17	112.50	9.33	4.67	19.33	2.00	6.10
19.	IC-318703	135.00	162.50	155.00	13.00	4.67	20.33	6.33	4.94
20.	IC-318705	133.33	115.00	117.83	9.50	5.67	18.00	4.67	5.31
21.	IC-318718	128.33	140.00	159.17	11.17	5.33	20.00	2.67	4.55
22.	IC-318753	138.33	129.17	134.17	11.33	3.67	26.33	6.00	5.57
23.	IC-318779	103.33	110.83	114.17	9.13	3.33	13.00	2.67	5.24
24.	IC-318790	116.67	120.83	118.33	9.33	2.67	18.00	3.67	5.26
25.	A. K. Anar	128.33	86.67	89.50	9.67	4.33	7.67	2.33	3.72
26.	Sinduri	110.00	103.75	103.33	11.33	5.00	21.33	7.67	4.42
27.	Chawala	91.85	118.75	102.50	6.33	4.00	21.00	6.67	5.17
28.	Mriduala	89.00	70.00	86.42	7.23	4.67	15.00	5.67	2.29
29.	Phule Arkta	111.67	130.00	131.60	12.40	3.67	24.67	7.00	5.22
30.	EC-4347	131.67	114.17	120.83	11.07	6.00	11.33	6.33	6.63
31.	EC-104348	90.83	86.67	88.17	8.07	4.67	8.00	5.00	5.52
32.	EC-24685	131.67	162.50	86.67	9.93	7.00	8.33	3.67	6.68
33.	EC-62812	136.67	115.00	131.67	9.50	4.67	24.33	2.67	5.21
34.	Alah	145.00	107.50	120.83	10.40	4.67	6.33	2.00	4.76
35.	Bosckalinsi	116.67	57.50	78.77	6.93	2.33	5.67	3.00	1.87

36.	Borekaunk	80.00	67.50	81.67	9.33	4.00	12.67	2.67	4.46
37.	Co-White	136.67	112.50	99.17	11.73	3.67	6.00	2.67	2.14
38.	Dorsata	116.67	84.17	101.67	11.37	4.33	16.33	3.00	5.41
39.	Gulesah Red	139.17	122.50	113.17	4.70	5.33	21.00	7.00	1.82
40.	Kabul	140.00	115.00	135.83	12.17	5.33	14.67	6.67	5.41
41.	Kabuli Yellow	128.33	98.33	78.33	11.33	4.67	16.00	6.00	6.03
42.	Kazil Anar	71.25	68.75	73.40	4.50	6.33	19.00	7.33	1.91
43.	Kandhari	125.00	58.75	63.33	9.23	3.67	8.33	4.00	3.15
44.	Kabuli Canoor	131.25	86.25	85.00	8.33	4.33	6.67	4.00	5.97
45.	Spendanadar	129.17	105.00	106.67	9.93	3.33	12.00	3.67	6.46
46.	Yercaud	145.00	119.17	133.33	17.33	4.67	5.00	2.33	4.96
47.	Surat Anar	121.67	95.83	98.33	9.33	4.00	4.33	2.67	5.69
48.	Tabesta	117.50	111.67	119.00	11.53	5.33	16.00	2.33	5.01
49.	Jodhpur Collection	165.00	155.00	155.00	11.23	5.67	18.33	5.33	5.96
50.	China Orange	116.67	84.17	101.67	10.50	4.00	5.67	2.00	5.49
	Grand Mean	122.47	106.78	109.14	10.19	4.48	14.21	4.43	4.764
	S. Em.	8.07	10.12	8.55	0.87	0.41	1.63	0.51	0.20
	C.D. (at 0.05)	22.72	28.47	24.06	2.44	1.15	4.59	1.43	0.57
	C.V.%	11.42	16.41	13.57	14.76	15.76	19.94	19.99	7.35

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