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Genetic parameters, character association and path analysis for fruit yield and its components in ber (*Ziziphus mauritiana*)

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ABSTRACT

An experiment was carried out during 2002–07 to assess the nature and genetic parameters and their utilization to develop superior genotypes of Indian jujube (*Ziziphus mauritiana* Lamk.) for Punjab region. The high estimates (>15%) of genotypic co-efficient of variation (GCV) recorded for stone weight, fruit weight, pulp stone ratio, fruits yield/plant, total soluble salts and fruit length, indicated the presence of adequate genetic variation among the genotypes and suitability of these attributes for further improvement by selection. The characters, like stone weight, fruit weight, pulp stone ratio, fruit yield/plant and total soluble salts showed high heritability estimates coupled with high genetic advances. It can therefore be inferred that these traits are under the control of additive gene action and phenotypic selection for their improvement may be effective. The estimates of correlation co-efficients showed positive significant association of fruits yield/plant with pulp percentage (0.5476) and pulp:stone ratio (0.5329), while it was negatively associated with stone weight (–0.5166) and total soluble salts (–0.3567). Path analysis revealed that fruit weight (0.6381), followed by pulp percentage (0.5050) and total soluble salts (0.4997) had quite high direct effects on fruit yield. Fruit weight showed indirect contribution via fruit length (0.3378), fruit breadth (0.4463), pulp percentage (0.4284) and pulp stone ratio (0.4115), indicating that fruit weight is the major contributor towards fruit yield/plant.

Key words: Correlation, Genetic advance, Genotypic co-efficient of variation, Heritability, Indian jujube, Path analysis and fruit yield components, Phenotypic co-efficient of variation

Indian jujube (*Ziziphus mauriatiana* Lamk.) commonly known as *Ber* belonging to family Rhamnaceae which is indigenous to India and is one of the important fruit trees that can be successfully cultivated in the hot arid regions of India. The fruits of Indian jujube are rich in vitamin C, A and B complex. In Punjab it is cultivated on 2 894 ha having annual production 43 410 million tons (GOP 2006). Out of more than 90 cultivars, only 11 are commonly cultivated in different agro-climatic regions of India (Morton 2005). The choice of a suitable cultivar is of paramount importance for its success. The breeding strategy for genetic improvement of fruit yield and its components depends upon the genetic diversity for different traits. The assessment of genetic parameters, like genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), heritability (h^2) and genetic advance is a pre-requisite for making effective selection and improvement in the base population. Path analysis based on phenotypic correlation co-efficients further unravels the contributions of different traits towards fruit yield. Presently very little information is available on this crop regarding genetic parameters to be helpful for the effective selection leading to an ideal genotype having high fruit yield. Hence, the present investigation was carried out to assess the nature and magnitude of genetic parameters and their utilization for the development of superior genotypes of Indian jujube suitable for semi-arid regions of Punjab.

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MATERIALS AND METHODS

The experimental material comprising nine different cultivars, viz 'Gola' 'Muria Murhera' 'Sandhura Narnaul' 'Katha Phal' 'Umran' 'Seb' 'Najuk' 'Chhuhara' and 'Walaiti' collected from different parts of India during 1995–96 was planted in randomized block design with four replications at PAU, Regional Research Station, Bathinda, Punjab. The average rainfall at the experimental site was 400 mm, the annual maximum temperature was 31.5 °C and annual minimum temperature was 16.9 °C. The soil was sandy loam and characterized with *p*H (8.31), organic carbon (0.32%), electrical conductivity (0.24 dS/m), available N (212 kg/ha),

available P (21.5 kg/ha) and available K (357.0 kg/ha). In each replication 3 plants of each cultivar were grown at geometrical spacing 7.5 m ×7.5 m. Data were recorded on fruit yield/plant (kg), fruit weight (g), fruit length (cm), fruit breadth (cm), stone weight (g), total soluble salts (TTS), acidity (%), pulp percentage and pulp stone ratio for five years 2002–07. The genotypic and phenotypic co-efficients of variation and heritability (in broad sense) were calculated as suggested by Singh and Choudhary (1979), while genetic advances were estimated as per the procedure of Johnson *et al*. (1955). The path analysis was carried out following Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance showed significant differences among the cultivars for all the nine traits. The high estimates (>15%) of GCV recorded for fruits yield/plant, fruit weight, fruit length, total soluble salts, stone weight and pulp:stone ratio, indicated the presence of adequate genetic variation among the genotypes and suitability of these attributes for further improvement by selection. The heritability estimates were high for all the traits (Table 1). Nanohar *et al.* (1986) also reported that the fruit weight, yield/plant and pulp: stone ratio showed high GCV. The heritability estimates were high for all the traits (Table 1). Nanohar *et al.* (1986) and Bisla and Daulta (1986) further reported moderate to high estimates of heritability for various characters along with high genetic gains in this crop. As characters, like fruit weight, pulp stone ratio, fruit yield/plant, acidity and pulp percentage showed high heritability estimates coupled with high genetic advances, it can be considered that these traits are under the control of additive gene action and phenotypic selection for their improvement will be effective. Kaushik *et al*. (2004), Saran *et al*. (2007) and Tomar and Singh (1987) also reported considerable range of genetic variability for these traits in their germplasm.

The phenotypic correlation co-efficients between different characters are depicted in Table 2. The estimates of correlation co-efficients showed significant positive association of fruit yield/plant with pulp percentage (0.5467) and pulp: stone ratio (0.5329), while negative association with stone weight (–0.5166) and total soluble salts (–0.3567). Among the other components fruit weight was positively correlated with all other traits expect stone weight and acidity. Fruit length as well as breadth showed positive association with total soluble salts, while negative association with acidity. Pulp percentage and pulp: stone had negative association with total soluble salts, acidity and stone weight. Significant association among fruit yield components indicated that correlated response to selection for these traits

Table 1 Estimation of genetic parameters for fruit yield and its components in ber

Character	GCV	PCV	Heritability (h^2)	Genetic advance	GA (%)	Mean	CV (%)
Fruit yield/plant (kg)	19.88	21.18	88.08	19.01	38.44	49.45	7.31
Fruit weight (g)	22.82	23.45	94.66	9.26	45.73	20.25	5.42
Fruit length (cm)	17.19	17.38	97.87	1.51	35.03	4.31	2.54
Fruit breadth (cm)	11.12	11.18	99.02	0.68	22.80	2.96	1.10
Total soluble salts (%)	18.28	18.56	97.01	0.43	37.08	1.17	3.21
Acidity (%)	10.95	11.01	98.87	3.70	22.42	16.51	1.17
Stone weight (g)	36.64	36.93	98.45	0.32	74.89	0.42	4.59
Pulp (%)	1.32	1.33	97.75	2.52	2.68	93.99	0.20
Pulp:stone ratio	22.69	24.86	83.31	7.17	42.66	16.80	10.15

Table 2 Phenotypic correlation co-efficients of fruit yield and component characters in ber

Character	Fruit yield / plant	Fruit weight	Fruit length	Fruit breadth	Total soluble salts (%)	Acidity (%)	Stone weight	Pulp (%)	Pulp:stone ratio
Fruit yield/plant	1.0000								
Fruit weight	0.2577	1.0000							
Fruit length	0.0761	0.5294**	1.0000						
Fruit breadth	–0.0687	0.6995**	0.0419	1.0000					
Total soluble salts (%)	–0.3567*	0.4357**	0.3678*	0.6134**	1.0000				
Acidity (%)	–0.1454	–0.4871**	–0.4917**	–0.5068**	–0.2527	1.0000			
Stone weight	–0.5166**	–0.3355	–0.4012*	0.1410	0.2091	0.0875	1.0000		
Pulp (%)	0.5477**	0.6713**	0.3064	0.2503	–0.3442*	–0.3647*	–0.5940**	1.0000	
Pulp:stone ratio	0.5329**	0.6450**	0.2412	0.1433	–0.3861*	–0.2217	–0.4958**	0.9336**	1.0000

*P=0.05; **P=0.01

Table 3 Path analysis co-efficient of fruit yield versus component characters in ber

Character	Fruit weight	Fruit length	Fruit breadth	Total soluble salts (%)	Acidity (%)	Stone weight	Pulp (%)	Pulp:stone ratio	PCC* with fruit yield/ plant
Fruit weight	*0.6381*	–0.4883	–0.7980	0.2177	0.2594	0.0907	0.3390	–0.0009	0.2577
Fruit length	0.3378	*–0.9225*	–0.0478	0.1838	0.2619	0.1084	0.1547	–0.0003	0.0761
Fruit breadth	0.4463	–0.0386	*–1.1409*	0.3065	0.2699	–0.0381	0.1264	–0.0002	–0.0687
Total soluble salts (%)	0.2780	–0.3393	–0.6998	*0.4997*	0.1346	–0.0565	–0.1738	0.0005	–0.3567
Acidity (%)	–0.3108	0.4536	0.5782	–0.1263	*–0.5326*	–0.0236	–0.1842	0.0003	–0.1454
Stone weight	–0.2141	0.3701	–0.1609	0.1045	–0.0466	*–0.2702*	–0.3000	0.0007	–0.5166
Pulp (%)	0.4284	–0.2827	–0.2855	–0.1720	0.1942	0.1605	*0.5050*	–0.0012	0.5467
Pulp:stone ratio	0.4115	–0.2225	–0.1635	–0.1929	0.1181	0.340	0.4714	*–0.0233*	0.5329

Residual effect: 0.5132; *PCC, Phenotypic correlation co-efficient italics figures are direct effects

will increase improvement of fruit yield. Heritability estimates were higher for component traits as compared to fruit yield/plant. Also the GCV values were closer to PCV values for components than for fruit yield.

Path analysis carried out to estimate the direct and indirect contributions of various component traits for recommending a reliable selection criterion revealed that fruit weight (0.6381), followed by pulp percentage (0.5050) and total soluble salts (0.4997) had high direct effects on fruit yield (Table 3). Fruit weight also showed indirect contribution via fruit length (0.3378), fruit breadth (0.4463), pulp percentage (0.4284) and pulp: stone ratio (0.4115) revealing that fruit weight is the major contributor towards fruit yield/plant. Fruit length and fruit breadth also contributed via total soluble salts and pulp percentage. Highest direct effect of fruit length was also reported by Pareek and Dhaka (2003). It is concluded that during selection due weightage should be paid to fruit weight, total soluble salts and pulp percentage for the development of high-yielding cultivars of *Indian jujube* for semi-arid region of Punjab.

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