SHORT COMMUNICATION

INDIAN JOURNAL OF ARID HORTICULTURE
2009, Vol. 4 (1) : 51-53

Estimation of genetic parameters, character associations and path analysis for fruit yield and its components in Ber (*Ziziphus muriatiana* Lamarck)

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Arid region in India is spread over 38.70 million ha covers about 12 per cent of the total area of the country. The tracts of hot arid region are found in the states of Rajasthan (19.6 m ha) followed by Gujarat (6.2 m ha), Andhra Pradesh (2.2 m ha), Punjab (1.5 m ha), Haryana (1.3 m ha), Karnataka (0.8 m ha) and Maharashtra (0.1 m ha). Farming being a difficult task in the arid tropics, the agro-climate of such regions favours the cultivation of certain fruit crops. Indian jujube (*Ziziphus mauritiana* Lamk.) commonly known as *Ber* belonging to family Rhamnaceae, 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 mt (Anon. 2006). Out of more than 90 cultivars only 11 are commonly cultivated commercially 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 coefficient of variability (GCV), phenotypic coefficient of variability (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 coefficients 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. Thus the present investigation was under taken 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.

The experimental material comprising of 9 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 accommodated 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 31.45 °C and annual minimum temperature was 16.85 °C. The soil was sandy loam and characterized with pH (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 of 7.5 x 7.5 metres. Data were recorded on fruit yield per plant (kg), fruit weight (g), fruit length (cm), fruit breadth (cm), stone weight (g), total soluble solids (TSS), acidity (%), pulp percentage and pulp: stone ratio for five years 2002-03, 2003-04, 2004-05, 2005-06 and 2006-07. The genotypic and phenotypic coefficient of variation and heritability (in broadsense) were computed 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).

The analysis of variance showed significant differences among the cultivars for all the nine traits. The high estimates (>15%) of GCV recorded for stone weight, fruit weight, pulp: stone ratio, fruit yield per 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 heritability estimates were high for all the traits (Table 1).Nanohar *et al.* (1986) also reported that the fruit weight, yield per 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) also reported moderate to high estimates of heritability for various characters along with high genetic

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gains in this crop. As characters like stone weight, fruit weight, pulp stone ratio, fruit yield per plant and total soluble salts showed high heritability estimates coupled with high genetic advances, it can be inferred 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 coefficients between different characters are depicted in table 2. The estimates of correlation coefficients showed significant positive association of fruit yield per 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 and stone weight. Pareek and Dhaka (2003) also observed that fruit length, fruit breadth, fruit weight and pulp weight had significant positive association with fruit yield. 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 will result in ultimate simultaneous improvement of fruit yield. Heritability estimates were higher for component traits as compared to fruit yield per plant. Also the GCV values were closer to PCV values for components than for fruit yield. So it can be concluded that components are less susceptible to environmental fluctuations than yield *per se* and are thus relatively more amenable to improvement.

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 per 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 suitable cultivars of *Indian jujube* for semi arid region of Punjab.

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Table 1. Estimates of genetic parameters for fruit yield and its components in Ber

Characters	GCV	PCV	Heritability (h^2)	Genetic advance	GA (%)	Mean	CV (%)
Fruit yield per 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 coefficients of seed yield and component characters in Ber

Characters	Fruit yield per plant (kg)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Total Soluble Salts (%)	Acidity (%)	Stone weight (g)	Pulp (%)	Pulp stone ratio
Fruit yield per plant (kg)	1.0000								
Fruit weight (g)	0.2577	1.0000							
Fruit length (cm)	0.0761	0.5294**	1.0000						
Fruit breadth (cm)	-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 (g)	-0.5166**	-0.3355	-0.4012*	0.1410	0.2091	0.0875	1.0000		
Pulp (%)	0.5467**	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

*Significant 5% level of probability
**Significant 1% level of probability

Table 3. Path analysis coefficients of fruit yield versus component characters in Ber.

Characters	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Total soluble salts (%)	Acidity (%)	Stone weight (g)	Pulp (%)	Pulp stone ratio	PCC* with fruit yield
Fruit weight (g)	0.6381	-0.4883	-0.7980	0.2177	0.2594	0.0907	0.3390	-0.0009	0.2577
Fruit length (cm)	0.3378	-0.9225	-0.0478	0.1838	0.2619	0.1084	0.1547	-0.0003	0.0761
Fruit breadth (cm)	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 (g)	-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	0.1340	0.4714	-0.0233	0.5329

Bold figures are direct effects
Residual effect: 0.5132

*PCC stands for phenotypic correlation coefficient