Electronic Journal of Plant Breeding, 1(5): 1339-1343(Sep 2010)
ISSN 0975-928X

Research Note

Genetic divergence, variability and character association studies in bengal gram (*Cicer arietinum* L.)

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(Received: 13 Aug 2010; Accepted: 25 Aug 2010)

Abstract:
Forty genotypes of bengalgram were studied for genetic diversity and genetic variability for seven yield attributes. The analysis of variance revealed wide genetic variation for all the traits studied. The genotypes were grouped into 8 clusters out of which cluster I and II had the maximum number with seven genotypes each. Among the characters, seed yield contributed maximum towards genetic divergence. The inter cluster D^2 values ranged from 145.02 to 1086.57. A close correspondence between the estimates of GCV and PCV was observed for days to maturity, number of pods per plant and seed yield. High heritability with high genetic advance observed for seed yield, number of pods per plant and number of fruiting branches per plant indicated additive gene action for these traits. Seed yield exhibited positive significant correlation with days to 50% flowering, days to maturity, number of fruiting branches per plant and number of pods per plant.

Key words:
Bengal gram, divergence, variability

Chickpea is an important source of protein for millions of people in developing countries. Chickpea (*Cicer arietinum* L.) is a self pollinated diploid (2n=2x=16) food legume which originated in southern Turkey (Ladizinsky and Adler, 1976) and subsequently spread to India and Europe where it is usually grown in arid climate. In addition to having high protein content (20-22%), it is also used as a protein rich animal feed and the vegetative biomass is used as fodder. It is a short duration *rabi* pulse crop and grain yield is a complex character for its improvement. Improvement of pulses emphasizes the urgency of enhancing genetic potentiality for their yield. Characterization and identification of plant varieties are important in agriculture and plant research. Assessment of genetic variability among genotypes is of great importance for genotype protection, conservation of genetic resources and broadening of the genetic base of the genotypes. It is essential to understand the genetic architect and nature of gene action governing yield and its component traits. Seed yield being a polygenic nature of inheritance, necessitates a thorough understanding of character association and its direct and indirect effects. The correlation coefficient gives the measure of relationships between traits and provides the degree to which various characters of a crop are associated with productivity. It is the result of direct and indirect effects of a number of plant characters and selection based on these characters would be more effective rather than seed yield. Path coefficient analysis is used in assessing the real contribution of various component traits towards seed yield, so that direction for desired improvement may be developed.

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The experimental material comprised 40 diverse chickpea genotypes procured from International Crops Research Institute for Semi-Arid Tropics (ICRISAT). The experiment was sown in a randomized block design with three replications during *rabi* 2009-10 at Agricultural Research Station, Tandur. Each line was accommodated in two rows of 3m length each spaced at 45 cm distance. The recommended package of practices was followed to raise a normal crop. Data were recorded on days to 50% flowering, days to maturity, plant height (cm), number of fruiting branches per plant, number of pods per plant, 100-

seed weight (g) and seed yield (kg/ha). Data were subjected to statistical analysis to work out genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability and genetic advance as per cent of mean as per standard methods. To assess the genetic diversity among the distinct genotypes, the D^2 statistics developed by Mahalonobis (1936) can be utilized. Genotypic and phenotypic coefficients of variations were computed according to Johnson *et al.,* (1955). The correlations were further partitioned into direct and indirect effects as suggested by Dewey and Lu (1959).

The analysis of variance revealed significant differences among the genotypes for all the traits studied. Based on D^2 statistics and Tocher's method (Rao, 1952), 40 accessions were grouped into 8 clusters (Table 1). Cluster I and II had the maximum number with seven genotypes followed by cluster IV and cluster VI with six genotypes, cluster III and cluster V with five genotypes and cluster VII with three genotypes. Cluster VIII was solitary with single genotype indicating its distinctiveness from the germplasm accessions with respect to traits considered. Similar findings were reported by Mahto *et al*, (1995) in linseed. The cluster VIII recorded the highest seed yield (1500 kg/ha), number of pods per plant (36) and days to maturity (116) followed by cluster VII with highest number of fruiting branches per plant (9) with more number of days to 50% flowering (Table 2). Seed yield contributed more than 90% followed by number of pods per plant (1.15%) and days to maturity (0.77%) towards total genetic divergence (Table 3).Average inter and intra cluster D^2 values among 40 genotypes (Table 4) revealed that cluster VII followed by cluster V and VI had the maximum intra cluster values viz.,116.89, 93.44 and 89.81 respectively indicating existence of diverse genotypes that fell in these clusters. The inter cluster D^2 values ranged from 145.02 to 1086.57 (Table 4). Minimum inter cluster D^2 values were observed between cluster I and III indicating the close relationship among the genotypes included in these clusters. Maximum inter cluster values were observed between clusters V and VIII (1086.57) followed by clusters V and VII (946.62) which indicated that genotypes included in these clusters were genetically diverse and may give rise to high heterotic response in early generations if utilized repeatedly in the crossing programme, which in turn may release hidden variability by breaking tight linkages, if any, as reported by Thoday (1960).A close correspondence between the estimates of GCV and PCV was noted especially in case of days to maturity, number of pods per plant and seed yield indicating less environmental influence in the expression of these traits. Number of fruiting branches per plant and number of pods per plant recorded high GCV and PCV estimates. Low estimates of GCV and PCV were recorded for days to maturity and plant height culminated into low genetic advance as per cent of mean. Estimate of heritability and genetic advance in combination are more important for selection than heritability alone. High heritability combined with high genetic advance observed for seed yield, number of pods per plant and number of fruiting branches per plant indicated that these characters were controlled by additive gene effects and phenotypic selection would be highly effective. Similar results were reported earlier by Krishnaiah *et al*., (2002) in sesamum. Days to maturity revealed high heritability and medium genetic advance which might be due to predominance of non-additive gene action and / or less genetic variability for these traits in the present material. Correlation studies provide better understanding of yield components which helps the plant breeder during selection (Table 5). Seed yield was found to be significantly and positively correlated with days to 50% flowering, days to maturity, plant height, number of fruiting branches per plant and number of pods per plant. Days to maturity showed positive significant association with number of fruiting branches per plant. Number of pods per plant recorded significant positive association with days to 50% flowering and plant height. A positive significant association of days to 50% flowering with days to maturity, number of fruiting branches per plant and number of pods per plant and their positive association with seed yield indicated that these are the major yield contributing characters in bengal gram and a selection for these traits would possibly be helpful in getting a quantum jump in yield increase of this crop. Path coefficient analysis based on genotypic correlation revealed almost same pattern of direct and indirect influence of different characters on seed yield. Thus, the results based on genotypic correlations indicated that days to maturity had large and positive direct effect on seed yield followed by number of fruiting branches per plant, number of pods per plant and plant height. Whereas, days to flowering had negative direct effect on seed yield. Similar results were reported by Patil and Duhoon (2007) in Niger. Days to maturity had high direct effect in positive direction and it had positive indirect effects via, days to 50% flowering, number of fruiting branches per plant and plant height resulting in positive association with seed yield. The positive direct effect of number of fruiting branches per plant was manifested through indirect positive effects via, days to 50% flowering, days to maturity and plant height. Thus, for improving the seed yield and developing high yielding genotypes of

bengalgram due emphasis should be placed on number of fruiting branches per plant, number of pods pr plant and days to maturity. As all these traits had high heritability coupled with high to moderate genetic advance, it may be possible to have a rapid gain by mass selection. Since, late flowering and maturity beyond certain limit is not desirable, greater emphasis should be laid on early flowering and early maturing genotypes.

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Table 1: Average inter and intra cluster distances in bengal gram

	I	II	III	IV	V	VI	VII	VIII
I	54.33	322.62	145.02	305.36	491.03	161.09	463.08	600.27
II		65.90	456.17	620.61	184.39	186.53	778.35	917.81
III			59.99	175.34	624.58	289.07	331.08	465.99
IV				70.27	789.10	451.58	176.90	302.88
V					93.44	350.20	946.62	1086.57
VI						89.81	608.86	747.19
VII							116.89	158.54
VIII								0.00

Table 2: Cluster means for various yield attributes in bengal gram

	Days to flowering	Days to maturity	Plant height (cm)	Number of fruiting branches per plant	Number of pods per plant	100-seed weight (g)	Seed yield (kg/ha)
I	57.86	105.00	33.14	7.00	25.86	25.74	901.00
II	53.86	97.00	28.71	5.71	19.00	18.77	583.57
III	54.60	99.00	34.00	9.00	26.40	18.77	1036.00
IV	56.83	105.17	32.00	7.83	29.50	23.09	1200.83
V	51.20	73.60	27.00	5.00	19.80	21.42	416.00
VI	54.33	96.17	29.17	6.17	20.50	21.38	755.50
VII	60.67	108.00	30.00	9.00	22.67	19.74	1357.67
VIII	53.00	116.00	32.00	6.00	36.00	22.61	1500.00

Table 3: Per cent contribution towards genetic divergence in bengal gram

Character	**% contribution**
Days to 50% flowering	0.38
Days to maturity	0.77
Plant height (cm)	0.00
Number of fruiting branches per plant	0.13
Number of pods per plant	1.15
100-seed weight (g)	0.13
Seed yield (kg/ha)	97.44

Table 4: Genetic parameters for various quantitative traits in bengal gram

Character	Mean	PCV	GCV	Heritability (bs)(%)	GA as % of mean
Days to 50% flowering	55.32	114.53	14.78	1.7	3.93
Days to maturity	98.12	17.53	17.05	99.6	35.98
Plant height (cm)	30.67	18.93	13.27	49.2	19.17
Number of fruiting branches per plant	6.90	48.17	41.48	74.2	73.59
Number of pods per plant	23.72	40.12	39.66	97.3	80.59
100-seed weight (g)	21.53	25.18	20.83	68.4	35.50
Seed yield (kg/ha)	874.07	35.14	35.11	100.0	72.33

Table 5: Genotypic correlation coefficients in bengal gram

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of fruiting branches per plant	Number of pods per plant	100-seed weight (g)	Seed yield (kg/ha)
Days to 50% flowering	1.0000	0.2209*	0.1425	0.3342*	0.2113*	0.1957	0.2344*
Days to maturity		1.0000	0.1901	0.2188*	0.0331	0.0306	0.5020*
Plant height (cm)			1.0000	0.1071	0.3428*	0.0267	0.4040*
Number of fruiting branches per plant				1.0000	-0.0077	0.0080	0.4058*
Number of pods per plant					1.0000	0.0817	0.3589*
100-seed weight (g)						1.0000	0.1217

Table 6: Direct and Indirect effects of different traits in bengal gram

Character / Cross	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of fruiting branches per plant	Number of pods per plant	100-seed weight (g)	Correation coefficient with Seed yield (kg/ha)
Days to 50% flowering	**-0.0677**	-0.0150	-0.0097	-0.0226	-0.0143	-0.0133	0.2344
Days to maturity	0.0874	**0.3956**	0.0752	0.0866	0.0131	0.0121	0.5020
Plant height (cm)	0.0290	0.0387	**0.2037**	0.0218	0.0698	0.0054	0.4040
Number of fruiting branches per plant	0.1075	0.0703	0.0344	**0.3215**	-0.0025	0.0026	0.4058
Number of pods per plant	0.0603	0.0094	0.0978	-0.0022	**0.2853**	0.0233	0.3589
100-seed weight (g)	0.0179	0.0028	0.0024	0.0007	0.0075	**0.0915**	0.1217

Residual effect: 0.5162