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Genetic analysis in chickpea (*Cicer arietinum*)

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Pulses are the second most important group of the crops after cereals. The global production of pulses was 61.72 million tonnes from an area of 73.2 million ha with an average yield of 843 kg/ha (Ali 2005). Chickpea (*Cicer arietinum* L.) is one of the most widely grown pulses in the world, which occupies an area of 10.61 million ha with a total annual production of 8.30 million tonnes with an average productivity of 782 kg/ha (Ali 2005). However, its productivity in India is low as that of in Mexico, Sudan, China, Israel, Lebanan, Yaman, Greece and Italy.

In India, chickpea is grown under both rainfed and irrigated conditions over an area of about 6.93 million hectare with total production of about 5.60 million tonnes and productivity of 808 kg/ha, which represents 31 and 41% of national pulses acreage and production, respectively (FAI 2005). The productivity of pulses crops including chickpea is low because of several constraints like inadequate availability of quality seed of improved varieties, cultivation of pulses on the poor and marginal lands under rainfed conditions without recommended input application and moreover, there is lack of high yielding and stable varieties of the crop in our country.

Table 1 Estimates of variability parameters for 13 characters in chickpea (pooled)

Character	Range	Mean ±SE	Heritability (broad sense)	Genotypic co-efficient of variation (GCV)	Phenotypic co-efficient of variation (PCV)	Genetic advance (GA)	Genetic advance as per cent mean
Plant height (cm)	46.73–61.37	54.35 ±0.85	78.83	5.02	6.30	4.67	9.33
Days to 50% flowering	98.92–109.33	104.00±0.98	72.88	2.59	2.96	4.62	4.75
Days to maturity	142.34–150.56	146.79±1.09	53.14	1.18	1.62	2.55	1.78
Primary branches/plant	2.27–2.95	2.60±0.14	28.33	4.33	7.81	0.15	5.42
Secondary branches/plant	3.28–4.84	4.01±0.15	55.22	9.50	11.21	0.67	17.53
Height of first pod (cm)	28.20–43.41	36.05±1.06	90.45	12.84	13.50	9.54	25.20
Pods/plant	23.08–36.78	27.57±1.19	69.59	9.83	11.83	4.78	17.34
Seeds/pod	1.19–1.56	1.35±0.16	88.67	6.66	7.02	0.18	13.03
Seeds/plant	29.16–56.70	37.48±1.78	78.14	14.05	15.92	9.76	26.20
Grain yield/plant (g)	6.80–9.62	8.50±0.35	72.29	10.23	11.62	1.52	21.63
Biological yield/plant (g)	19.87–31.59	25.55±0.95	81.14	11.50	12.61	5.51	22.01
100-seed weight (g)	19.07–29.63	24.00±0.48	90.43	10.02	10.61	4.76	19.81
Harvest index (%)	28.45–39.54	33.95±0.93	71.53	7.10	8.31	4.43	12.95

*Short note

Based on a part of Ph D thesis of the first author submitted to Chaudhary Charan Singh University, Meerut during 2008 (unpublished)

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Therefore, in the present study an attempt was made to collect the information for variability, correlation and path co-efficients for seed yield and its attributes.

The investigation was carried out with 45 genetically diverse genotypes of chickpea procured from Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut. The experiment was carried out at Research farm of Janta Vedic College, Baraut, Baghpat (Uttar Pradesh) and Sardar

Vallabh Bhai Patel University of Agriculture and Technology, during winter season (*rabi*) 2004–05 and 2005–06 under 3 planting dates. The experimental trial was laid out in randomized block design with three replications. Each plot comprised four rows of 4 m length spaced 30 cm apart with plant-to-plant spacing 10 cm. Data on the basis of five randomly taken competitive plants were recorded on 13 agronomic characters, viz days to 50% flowering, days to maturity, plant height (cm), primary branches/plant, secondary branches/plant, height of first pod (cm), pods/plant, seeds/pod, seeds/plant, biological yield/plant (g), grain yield/plant (g), harvest index (%) and 100-seed weight (g). The co-efficients of variation, heritability in broad sense and expected genetic advance were estimated as suggested by (Burton and De Vane 1953, Hanson *et al*. 1956 and Johonson *et al*. 1955) respectively.

The co-efficients of correlation were computed following the method suggested by Al-Jibouri *et al*. (1958) and path co-efficients were calculated by employing the method suggested by Dewey and Lu (1959).

The extent of variability present in 45 genotypes of chickpea was measured in terms of mean, range, phenotypic co-efficient of variation, genotypic co-efficient of variation, haritability and genetic advance (Table 1). Days to maturity (142.34 to 150.56), days to 50% flowering (98.92 to 109.33), plant height (46.73 to 61.37), seeds/plant (29.16 to 56.70), harvest index (28.45 to 39.54), height of first pod (28.20 to 43.41), pods/plant (23.08 to 36.78), biological yield/plant

Table 2 Estimates of genotypic (G) and phenotypic (P) correlation co-efficients among different characters chickpea (pooled)

Character		Plant height (cm)	Days to 50% flowering	Days to maturity	Primary branches/ plant	Secondary branches/ plant	Height of first pod (cm)	Pods/ plant	Seeds/ pod	Seeds/ plant	Grain yield/ plant (g)	Biological yield/ plant (g)	100-seed weight (%)	Harvest index (%)
Plant height (cm)	G	1.00	0.165	0.044	0.062	0.089	0.148	0.193	0.021	0.152	0.104	0.113	0.161	0.011
	P	1.00	0.148	0.058	0.015	0.014	0.115	0.121	–0.001	0.094	0.077	0.098	0.106	–0.021
Days to 50% flowering	G		1.00	0.029	0.006	–0.078	–0.083	–0.010	–0.006	–0.016	0.009	0.010	0.031	–0.067
	P		1.00	0.094	–0.041	–0.014	–0.045	0.009	0.014	0.013	0.017	0.037	0.005	–0.056
Days to maturity	G			1.00	0.107	0.299	–0.001	0.277	0.040	0.199	0.232	0.226	0.011	0.029
	P			1.00	–0.033	0.099	0.008	0.157	0.017	0.121	0.144	0.164	0.001	–0.046
Primary branches/ plant	G				1.00	–0.028	0.230	0.022	0.086	0.058	0.214	0.095	0.020	0.140
	P				1.00	0.010	0.114	0.034	0.072	0.060	0.096	0.070	–0.014	0.018
Secondary branches/ plant	G					1.00	–0.028	0.161	0.126	0.156	0.107	0.082	–0.124	–0.041
	P					1.00	0.038	0.159	0.103	0.159	0.130	0.132	–0.089	0.031
Height of first pod (cm)	G						1.00	0.114	0.095	0.132	0.075	0.115	0.028	–0.051
	P						1.00	0.092	0.008	0.113	0.083	0.135	0.032	–0.071
Pods/plant	G							1.00	0.314*	0.865**	0.564**	0.492**	–0.146	0.007
	P							1.00	0.297*	0.901**	0.567**	0.486**	–0.130	–0.049
Seeds/pod	G								1.00	0.725**	0.471**	0.369*	–0.327*	0.038
	P								1.00	0.673**	0.402**	0.316*	–0.322*	0.051
Seeds/plant	G									1.00	0.633**	0.535**	–0.191	0.018
	P									1.00	0.605**	0.506**	–0.237	0.056
Grain yield/ plant (g)	G										1.00	0.774**	0.192	0.133
	P										1.00	0.738**	0.188	0.199
Biological yield/plant (g)	G											1.00	0.132	–0.412**
	P											1.00	0.131	–0.437**
100-seed weight (g)	G												1.00	0.114
	P												1.00	0.073
Harvest index (%)	G													1.00
	P													1.00

* $P = 0.05$ and ** $P = 0.01$level of significance, respectively
G, Genotypic level; P, phenotypic level

(19.87 to 31.59), 100-seed weight (19.07 to 29.63), grain yield/plant (6.80 to 9.62), secondary branches/plant (3.28 to 4.84), primary branches/plant (2.27 to 2.95) and seeds/pod (1.19 to 1.56). Genetic variability for many of these traits had also been reported earlier by (Jeena e*t al*. 2005, Khan *et al*. 2006 and Durga *et al*. 2007). In general, estimates of phenotypic co-efficient of variation (PCV) were comparable with genotypic co-efficient of variation (GCV) for all the traits. However, the estimates of PCV were, in general, higher than the estimates of GCV for all the characters (Table 1). This may result due to the involvement of environment and genotypic×environment effect in characters expression. The genotypic and phenotypic co-efficient of variation were found maximum for number of seeds/plant (14.05 and 15.92), followed by height of first pod (12.84 and 13.50), biological yield/plant (11.50 and 12.61), grain yield/plant (10.23 and 11.62), whereas minimum being for days to maturity (1.18 and 1.62). Other characters have low to moderate estimates of GCV and PCV. These observations in conformity with the findings of some earlier workers (Pratap *et al*. 2004 and Jeena *et al*. 2005).

The efficiency of selection not only depends on the magnitude of genetic variability but also on the heritability of the characters. The high heritability (>70%) in broad sense (Table 1) was recorded for all the traits except days to maturity (53.14), secondary branches/plant (55.22) and primary branches/plant (28.33). These observations are in conformity with the findings of (Pratap *et al*. 2004, Jeena *et al*.2005 and Sharma *et al*. 2005). The high heritability denotes high proportion of genetic effects in the determination of these traits and can be adopted for improving grain yield in chickpea.

The genetic advance as per cent of mean was maximum for seeds/plant (26.20), height of first pod (25.20), biological yield/plant (22.01), 100-seed weight (19.81), grain yield/plant (21.63) and pods/plant (17.34), whereas it was minimum for

Table 3 Estimates of genotypic and phenotypic path co-efficient for thirteen characters of chickpea (pooled)

Character		Plant height (cm)	Days to 50% flowering	Daysto maturity	Primary branches/ plant	Secondary branches/ plant	Height of first pod (cm)	Pods/ plant	Seeds/ pod	Seeds/ plant	Biological yield/ Plant (g)	100– seed weight (g)	Harvest index (%)	'r' values grain yield/ plant
Plant height (cm)	G	**–0.019**	0.007	–0.001	–0.004	–0.001	0.031	0.037	–0.053	0.045	0.089	0.001	–0.003	0.104
	P	**–0.002**	0.000	0.003	0.000	0.000	–0.001	0.008	–0.006	0.016	0.082	–0.002	–0.020	0.077
Days to 50% flowering	G	–0.003	**0.026**	–0.001	–0.013	0.000	–0.012	0.049	0.025	–0.072	0.011	0.005	0.003	0.009
	P	0.000	**–0.001**	0.001	0.000	–0.001	0.001	0.004	–0.004	0.001	0.042	–0.006	–0.021	0.017
Days to maturity	G	–0.006	0.003	**–0.018**	0.011	–0.001	0.031	0.077	–0.043	–0.046	0.263	–0.005	–0.033	0.232
	P	0.001	0.002	**0.007**	0.000	–0.001	0.001	0.011	–0.001	–0.007	0.196	0.000	–0.062	0.144
Primary branches/ plant	G	0.003	–0.006	–0.008	**0.035**	0.001	–0.012	0.059	0.041	–0.102	0.119	0.005	0.065	0.214
	P	0.001	0.001	0.000	**0.001**	0.001	0.000	–0.001	0.008	–0.011	0.077	–0.001	0.011	0.096
Secondary branches/ plant	G	0.001	–0.003	–0.008	–0.007	**0.013**	0.010	0.035	0.055	–0.066	0.186	–0.028	–0.059	0.107
	P	0.001	–0.001	0.001	0.000	**–0.007**	0.000	0.016	0.003	0.008	0.180	–0.020	–0.031	0.130
Height of first pod (cm)	G	–0.008	–0.001	–0.006	0.001	0.001	**0.156**	0.048	–0.170	0.021	0.090	0.013	–0.031	0.075
	P	–0.001	0.002	0.003	0.001	0.000	**0.003**	–0.001	–0.003	0.043	0.109	0.013	–0.042	0.083
Pods/plant	G	–0.012	–0.002	–0.002	0.003	0.000	0.037	**0.406**	–0.050	–0.345	0.545	0.012	–0.055	0.564**
	P	0.000	0.000	0.002	0.000	–0.002	0.001	**0.016**	0.006	0.000	0.516	0.014	–0.012	0.567**
Seeds/pod	G	–0.001	–0.003	–0.005	0.004	0.003	0.131	0.199	**–0.019**	–0.208	0.402	0.016	0.000	0.471**
	P	0.000	0.000	–0.001	0.000	0.001	0.003	0.007	**0.032**	0.028	0.347	0.010	0.001	0.402**
Seeds/plant	G	–0.009	–0.006	–0.003	–0.004	0.002	0.086	0.307	0.031	**–0.265**	0.576	–0.004	–0.049	0.633**
	P	0.000	0.000	0.001	0.000	–0.002	0.002	0.013	0.022	**0.066**	0.542	0.000	–0.001	0.605**
Biological yield/plant (g)	G	0.001	0.000	–0.003	–0.008	0.007	–0.012	0.153	0.050	–0.107	**1.063**	0.011	–0.404	0.774**
	P	0.000	0.000	0.004	0.000	0.000	0.000	0.002	0.012	0.036	**1.054**	0.008	–0.407	0.738**
100–seed weight (g)	G	0.000	0.005	–0.001	–0.003	–0.001	0.032	–0.049	–0.170	0.152	0.086	**0.093**	0.067	0.192
	P	0.000	0.000	0.001	–0.001	0.002	0.001	–0.013	–0.019	0.012	0.084	**0.068**	0.047	0.188
Harvest index (%)	G	–0.010	–0.004	0.003	0.012	–0.006	0.035	–0.139	–0.054	0.199	–0.583	0.000	**0.666**	0.133
	P	0.000	–0.002	0.003	0.000	0.000	0.001	–0.013	–0.011	0.043	–0.562	–0.003	**0.724**	0.197

*P = 0.05 and ** P = 0.01 level of significance, respectively

Residual effect, G = –0.0010 and P = –0.0020

The bold figures represent direct effect

days to maturity. In the present investigation, high heritability coupled with high genetic advance observed for height of first pod, seeds/plant, pods/plant, biological yield/plant, 100-seed weight and harvest index might be due to large additive gene effects which revealed that the selection criteria based on these traits will improve seed yield. The results are in confirmation with the findings of (Pratap *et al*. 2004, Burli *et al*. 2004, Jeena *et al*. 2005 and Tadele *et al*. 2005).

On the basis of heritability and expected genetic advance as per cent for different traits studied in the present investigation, selection criteria based on seeds/plant, height of first pod, biological yield/plant, grain yield/plant, 100-seed weight, harvest index and pods/plant may be useful for further developing high-yielding genotypes.

In the present investigation, in general, the genotypic correlation co-efficient was observed to be higher than that of phenotypic correlation co-efficient indicating the existence of strong inherent association for various traits and phenotypic selection may be rewarded (Table 2). Grain yield/ plant exhibited positive association with biological yield/ plant, seeds/plant, pods/plant and seeds/pod at genotypic and phenotypic levels. Thus, it can be inferred that selection based on these traits in combination, will result in identifying high-yielding genotypes. Similar finding for most of these traits have been also reported by (Jeena *et al*. 2005 and Obaidullah *et al*. 2006).

It was observed that biological yield per plant exhibited positive and significant association with seeds/plant, pods/ plant and seeds/pod, which closely agreed with the observations of (Jeena *et al*. 2005 and Obaidullah *et al*. 2006). Seeds/plant exhibited positive and significant association with pods/plant and seeds/pod. Seeds/pod exhibited positive and significant association with pods/plant, whereas harvest index exhibited negative association with biological yield/ plant, which closely in agreement with the findings of Obaidullah *et al*. (2006).

Results on the genotypic and phenotypic path co-efficients revealed high direct contribution of biological yield/plant towards harvest index (%), followed by pods/plant, height of first pod and 100-seed weight (Table 3). Harvest index (%), seeds/plant, pods/plant and seeds/pod contributed mainly via biological yield/plant. The contribution of residual factors that influenced grain yield was low at both genotypic and phenotypic levels indicating that the characters included in the present investigation were sufficient enough to account for the variability in the dependent character, i e grain yield/ plant. The results on the path analysis indicated that the biological yield/plant is most pronounced character contributing directly towards harvest index (%), followed by pods/plant, height of first pod and 100-seed weight to grain yield/plant and most of the other component characters associated to grain yield over contributing indirectly through this character.

Therefore, it can be inferred that effectiveness of selection for grain yield in chickpea could be enhanced by inclusion of biological yield as a selection criteria along with pods/ plant, seeds/pod and seeds/plant.

SUMMARY

Forty five genotypes of chickpea were evaluated during 2004–05 and 2005–06 at two locations under three planting dates. The genotypic and phenotypic co-efficients of variation were found maximum for number of seeds/plant. The high heritability in broad sense was recorded for all the traits except days to maturity. The genetic advance as per cent mean was maximum for seeds/plant. The genotypic correlation co-efficient was observed to be higher than that of phenotypic correlation co-efficient indicating the existence of strong inherent association for various traits and phenotypic selection may be rewarded. Grain yield/plant exhibited stable positive association with biological yield/plant, followed by seeds/plant, pods/plant and seeds/pod at genotypic and phenotypic levels. Thus, it can be inferred that effectiveness of selection for grain yield in chickpea could be enhanced by inclusion of biological yield as a selection criteria along with pods/plant, seeds/pod and seeds/plant.

REFERENCES

Ali, Masood 2005. Global pulse production-trends and challenges. *National Symposium on Legumes for Ecological Sustainability: Emerging Challenging and Opportunities,* held during 3–5 November 2007 at IIPR, Kanpur.

Al-Jibouri H A, P A Millar and H F Robinsion. 1958. Genotypic and environmental variance and covariance in an upland cotton cross of inter-specific origin. *Agronomy Journal* **50**: 633–6.

Burli A V, More S M, Gare B N and Dodake S S. 2004. Studies on genetic variability and heritability in chickpea under residual soil moisture condition. *Journal of Maharashtra Agricultural University* **29**(3): 353–4.

Burton G W and De vane E H. 1953. Estimating heritability in tall fescue (*Festuca arundimaceae*) from replicated clonal material. *Agronomy Journal* **45**: 478–81.

Dewey D R and Lu K H. 1959. A correlation and path coefficient of components of crested wheat grass seed production. *Agronomy Journal* **51**: 515–8.

Durga K K, Murty S S N, Rao Y K and Reddy M V. 2007. Genetic studies on yield and yield components of chickpea. *Agricultural Science Digest* **27**(3): 2001–03.

FAI 2005. *Fertilizer Statistics*, 2004–05. Fertilizer Association of India, New Delhi.

Hanson G H, Robinson H F and Comstock R E. 1956. Biometrical studies of yield in segregating populations of Korean Lespedeza. *Agronomy Journal* **48**: 267–82.

Jeena A S and Arora P P and Upreti M C. 2005. Divergence analysis in chickpea. *Agricultural Science Digest* **22**(2): 132–3.

Johonson H W, Robinson H F and Comstock R E. 1955. Estimates of genetic and environmental variability in soybean. *Agronomy Journal* **47**: 314–8.

Khan H, Ahmad S Q, Ahamad F, Khan M S and Iqbal N. 2006. Genetic variability and correlations among quantitative traits

in gram. *Sarhad Journal of Agriculture* **22**(1): 55–9.

Obaidullah S, Munawar-Khan, Iqbal-Ahmad and Humayun-Khan 2006. Genotypic and phenotypic correlation analysis of some important characters in gram. *Indus Journal of Plant Sciences* **5**(1): 701–4.

Pratap A, Basandrai D and Sood B C. 2004. Variability and heritability studies in early maturity chickpea genotypes. *Indian Journal of Pulses Research* **17**(2): 177–8.

Sharma L K, Saini D P, Kaushik S K and Vaid B. 2005. Genetic variability and correlation studies in chickpea (*Cicer arietinum* L). *Journal of Arid Legumes* **2**(2): 415–6.

Tadele A, Haddad N I, Malhotra R and Samarah N. 2005. Induced polygenic variability in Kabuli chickpea (*Cicer arietinum* L.) lines. *Crop Research, Hisar* **29**(1): 118–28.