International Journal of Advanced Engineering Research and Science (IJAERS) *[Vol-3, Issue-9, Sept- 2016]*
https://dx.doi.org/10.22161/ijaers/3.9 *ISSN: 2349-6495(P) | 2456-1908(O)*

Genetic variability and correlation analysis of various traits in chickpea genotypes (*Cicer arietinum* L.) under rainfed condition in western Uttar Pradesh

Mukesh Kumar*[1], Sitaram Kushwaha[2], V K Dwivedi[3], S.S. Dhaka[4]

[1,3]J.V. College, Baraut, Bagpat (U.P.) India
[2]Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi, India
[4]Krishi Vigyan Kendra, Pilibhit (U.P) India
*Present Address- Krishi Vigyan Kendra, Pilibhit (U.P) India

Abstract— *The present studies were conducted to the estimation of correlation for quantitative traits in chickpea (Cicer arietinum L.) in the field of the department of Genetics and Plant Breeding, Janta Vedic College, Baraut Baghput (U.P.) during the crop season 2003 to 2004 under rainfed condition. The present investigation revealed that the maximum days to maturity (151) were recorded in BG 1107 and Pusa 1063, whereas three genotypes (Pusa 209, BG 2002 and Pusa 1090) took minimum days (136) to mature. There was a great variation in biological yield among genotypes that ranged from 19.43 g to 36.83 g. Number of branches ranged from 9.37 to 15.33. Number of pods plant-1 varied from 45.53 to 68 and BG 1105 exhibited maximum number of pods (68). The variation for 100-seed weight ranged from 17.05 g to 32.31 g. The highest seed yield plant-1 was recorded for genotype BG 2002 (12.68 g), Pusa 362 (12.73g) and AT-2-1184 showed minimum seed yield (7.83 g). High heritability estimates were observed for number of branches (88.12), protein content (78.65), number of pods per plants, harvest index plant height and biological yield. High heritability coupled with high genetic advance for number of branches per plant, harvest index, pods per plant, 100-seed weight and biological yield. High heritability with low genetic advance was observed for protein content plant height. Seed yield per plant showed positive and significant phenotypic correlation with number of branches, number of pods per plant, biological yield per plant, 100-seed weight and harvest index. Cluster I, VII, III and VI, respectively possessed 12, 10, 6 and 5 genotypes. Means of various traits for each character showed that genotypes with maximum number of branches, pods per plant, 100-seed weight biological yield and seed yield per plant were placed together in cluster II. Genotypes with maximum harvest index were placed in cluster VI and genotypes with maximum days to maturity were placed in cluster VII.*

Keywords— chickpea genotypes, Genetic variability, Uttar Pradesh.

I. INTRODUCTION

The grain legumes and chickpea in particular have more protein than cereals. Among the pulses, chickpea (*Cicer arietinum* L.) is the third leading grain legume in the world. Chickpea (*Cicer arietinum* L.) is an important source of vegetable protein in the world. Chickpea has been well recognized as a valuable source of dietary protein, particularly in the developing countries where supplementation of cereal based diets with legumes is the best solution to widely spread protein energy malnutrition. The per capita availability of 7.3 g per day chickpea is a source of approximately 3.1 per cent (69.5 K cal) energy and 6.3 per cent (3.4 g) protein to Indian diet besides being a major source of calcium and iron (12%). The Asian region contributes 70% to the total world's production. The major chickpea producing countries in Asia are India (65%), Pakistan (7.5%) and Turkey (6.5%). India has the distinction of being the largest chickpea producer and accounts for about 64 to 68 per cent of its total area and production in the world, respectively (Anonymous, 2004). Chickpea is grown on about 7.5 m ha area producing 6.1 m tonnes of grain, which represents 33 and 47 per cent of the national pulses acreage and production, respectively. In India, the productivity of pulse crops including chickpea is low because of several constraints like inadequate

https://dx.doi.org/10.22161/ijaers/3.9 *ISSN: 2349-6495(P) | 2456-1908(O)*

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 this crop in our country. Genetic variability is very important for the improvement of crop plants. More the variability in the population, the greater are the chances for producing desired plant types. Heritability estimates and genetic advance in a population provides information about the expected gains in the following generations. The choice of plant breeding methodology, which is to be used for upgrading the yield potential, mainly depends on the availability of reliable information about the nature and magnitude of various genotypic parameters. The knowledge of characters association and contribution of various characters to the seed yield would be useful in making the selection program more effective.

II. MATERIALS AND METHODS

Fourty chickpea (*Cicer arietinum* L.) genotypes were evaluated under rainfed condition at the Research Farm of J.V. College, Baraut, Baghpat, Uttar Pradesh during *rabi* season 2003-2004 and 2004-2005. Sowings were done timely and the other recommended cultural practices were also adopted to ensure normal crop growth and development. Data were collected on Days to 50% flowering, Days to maturity, Plant height, Number of branches/plant, Number of pods per plant , Number of seed per pod, 100- seed weight (g), Biological yield per plant, Seed yield per plant and harvest index were estimated from five randomly selected plants. The statistical analysis was carried out for different experiment separately per standard statistical procedures. Heritability and genetic advance was done as per method described by Lush (1949), Johnson *et al.* (1955) and Allard, 1960. Analysis of variance was carried out as per statistical methods proposed by Panse and Sukhatme (1967). Correlation coefficients analysis was carried out in accordance with Johnson *et al.* (1955) and Fisher and Yates (1963).

III. RESULTS AND DISCUSSION

The results of analysis of variance and other genetic parameters showed significant differences among the genotypes for all the parameters except days to 50% flowering and number of seeds per pod (Table I). Almost all the traits showed a wide range of variation except number of seeds per pod (Table I). Maximum days to maturity (151) were recorded in BG 1107 and Pusa 1063, whereas three genotypes (Pusa 209, BG 2002 and Pusa 1090) took minimum days (136) to mature. There was a great variation in biological yield among genotypes that ranged from 19.43 g to 36.83 g. Number of branches ranged from 9.37 to 15.33. Number of pods plant-1 varied from 45.53 to 68 and BG 1105 exhibited maximum number of pods (68). The variation for 100-seed weight ranged from 17.05 g to 32.31 g. The highest seed yield plant-1 was recorded for genotype BG 2002 (12.68 g), Pusa 362 (12.73g) and AT-2-1184 showed minimum seed yield (7.83 g).

Table.1: Mean performance of various quantitative and qualitative traits of chickpea genotypes

Genotypes	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches	No. of pods per	No. of seeds per	100 seed wt. (g)	Biological yield per plant (g)	Seed yield per plant (g)	Harvest index	Protein content
Pusa 362	93.00	141.00	60.27	9.43	63.00	1.30	21.68	27.41	12.73	46.48	21.83
AT-2 1185	93.33	144.67	59.67	10.87	51.97	1.28	22.61	24.40	9.45	38.15	22.53
BG 1095	93.33	145.33	60.50	11.87	49.80	1.31	24.11	22.61	8.52	37.95	22.43
BG 1091	92.00	143.00	62.93	12.60	57.57	1.37	26.07	22.68	9.95	44.00	21.37
BG 1105	92.67	145.67	62.67	13.37	68.00	1.36	22.33	28.15	10.55	37.48	25.17
Pusa 261	91.33	144.00	60.50	14.13	62.27	1.33	25.90	23.98	8.75	36.94	24.80
BG 1079	91.33	145.33	61.43	13.90	61.93	1.34	24.11	24.53	9.50	38.62	24.33
BG 1107	93.33	150.67	65.17	13.23	67.33	1.37	17.05	30.48	11.85	38.93	22.80
Pusa 391	95.33	143.33	62.97	14.30	45.53	1.37	21.89	19.43	8.89	45.77	21.93
Pusa 244	93.67	144.67	62.97	14.37	51.30	1.34	28.42	22.00	10.16	46.15	21.23
BG 1108	93.33	145.67	64.30	13.47	53.97	1.35	30.77	23.24	10.06	43.21	21.87
BG 1106	94.00	144.33	65.97	11.63	52.33	1.37	29.68	22.07	8.49	38.49	23.17
BG 1100	92.33	142.33	66.07	12.70	48.33	1.35	24.85	27.27	9.18	33.72	25.33

https://dx.doi.org/10.22161/ijaers/3.9 *ISSN: 2349-6495(P) | 2456-1908(O)*

BG 1092	92.00	143.33	66.17	13.67	53.63	1.30	26.91	29.03	10.15	35.12	25.47
BGD 112	92.67	144.67	67.20	14.27	56.97	1.28	29.22	29.37	10.18	34.65	25.53
BG 1024	93.67	143.00	66.23	14.73	59.93	1.24	32.31	28.73	9.76	33.98	24.23
BG 1098	92.00	140.33	64.37	11.30	49.27	1.32	24.38	29.83	8.33	27.94	22.33
Pusa 93	91.33	140.33	63.60	10.43	50.63	1.35	27.79	23.83	8.60	37.97	22.90
AT-2 1113	91.67	141.67	64.57	10.67	52.27	1.35	28.92	21.77	9.98	46.38	23.77
Pusa 267	94.00	146.67	65.60	12.10	52.67	1.30	27.82	21.63	11.71	54.16	24.67
BG 390	92.33	149.00	65.60	12.83	55.90	1.25	24.44	24.53	10.38	42.32	24.40
Pusa 1063	93.00	150.00	63.67	13.50	57.07	1.28	27.86	24.70	9.86	39.90	24.97
Pusa 372	93.67	147.67	63.63	13.10	54.07	1.31	27.21	25.00	9.25	36.87	25.40
BG 2001	94.33	142.00	63.30	12.03	52.23	1.34	22.62	24.57	7.85	32.04	26.10
Pusa 256	94.67	142.67	62.73	10.00	49.37	1.25	27.58	26.27	10.50	40.01	25.20
BG 1086	94.00	144.67	62.50	10.00	48.33	1.31	21.16	27.23	9.08	33.21	25.20
BGD 72	92.67	142.67	60.87	10.07	52.70	1.36	20.41	29.17	9.24	31.64	24.87
Pusa 1090	92.67	138.67	55.60	10.60	59.73	1.36	20.00	32.47	10.34	31.85	24.07
AT-2-1184	92.33	141.00	59.23	9.83	46.93	1.23	27.34	24.77	7.83	31.64	24.53
BG 1094	93.00	142.00	56.63	9.37	50.27	1.29	25.17	26.97	9.20	34.11	22.43
BG 391	94.00	142.33	54.93	9.37	50.73	1.33	22.43	29.57	9.34	31.59	21.63
BG 372	94.67	140.67	54.93	9.90	49.53	1.31	19.67	30.83	8.56	27.75	21.97
Pusa 209	93.67	136.00	52.87	10.33	54.57	1.29	19.28	28.47	8.93	31.40	24.00
AT-2-1133	93.00	140.67	57.03	11.17	52.37	1.31	21.48	28.13	8.19	29.04	25.00
BG 1065	92.00	144.00	59.13	11.67	50.83	1.31	20.73	29.43	8.78	29.77	25.40
BG 1077	92.67	145.00	57.83	11.67	49.70	1.25	17.67	32.43	10.54	32.50	25.07
BG 1088	92.00	146.00	60.00	12.63	56.37	1.28	29.63	32.10	11.31	35.22	24.13
Pusa 1080	92.33	146.67	61.27	13.87	57.97	1.27	20.81	33.23	9.83	29.54	22.80
Pusa 1053	92.67	144.00	61.57	14.50	59.90	1.28	21.12	34.97	10.56	30.23	22.53
BG 2002	93.33	136.33	60.33	15.33	62.53	1.34	30.36	36.83	12.68	34.44	22.87
Mean	92.98	143.55	61.67	12.12	54.50	1.31	24.59	27.10	9.73	36.53	23.76
Range	91.33	136.00	52.87	9.37	45.53	1.23	17.05	19.43	7.83	27.75	21.23
	95.33	150.67	67.20	15.33	68.00	1.37	32.31	36.83	12.73	54.16	26.10
SED	1.10	2.15	1.49	0.51	2.41	0.05	2.13	1.84	0.82	2.67	0.58
CD at 5%	2.26	4.40	3.04	1.05	4.92	0.09	4.35	3.76	1.67	5.47	1.18
Mean squre (g)	2.82	29.60**	37.72**	9.14**	89.73**	0.01	45.69**	48.27**	4.22**	108.08**	6.00**

The estimation of genetic variability is prerequisite for breeding programs aimed at crop improvement. The evaluation of exotic germplasm under taken in the present study revealed significant differences among the genotypes for biological yield, number of branches, number of pods plant-1, 100 seed weight, seed yield plant-1 and harvest index. Among these traits, number of branches, number of pods per plant, seed yield per plant biological yield/plant and harvest index showed considerably high genotypic component of variability. The high phenotypic variance as compared to genotypic variance signifies the role of environment in character expression. The estimates of genotypic and phenotypic variances provide information on the extent of variability. The heritable portion of this variation is determined by the estimates of heritability. Therefore, heritability estimates give better idea about possible gain through selection.

High heritability estimates were observed for number of branches (88.12), protein content (78.65), number of pods per plants, harvest index plant height and biological yield Table 2. These values of estimates of genetic advance as percent of mean were higher specifically for the traits like

https://dx.doi.org/10.22161/ijaers/3.9 *ISSN: 2349-6495(P) | 2456-1908(O)*

biological yield, 100- seed weight, number of branches, harvest index, number of pods per plant and seed yield. It was observed that the high heritability coupled with high genetic advance for number of branches per plant, harvest index, pods per plant, 100-seed weight and biological yield. High heritability with low genetic advance was observed for protein content plant height. The estimates of habitability were generally high for most of the traits particularly for seed weight, number of branches, number of pods per plants, seed yield, biological yield and harvest index. Similar findings have been reported by various other workers for these different characters (Setty *et al.*, 1977, Mandal and Bahl, 1980, Sandhu and Singh, 1970, Malhotra and Singh 1973, Raju *et al.*, 1978, Mishra *et al.*, 1988, Sharma *et al.* 1990., Rao *et al.*, 1994, Jahagirdar *et al.*, 1996, Wahid and Ahmad, 1998, Nimbalkar, 2000, Singh *et al.*, 2002 and Muhammad *et.al.*, 2003). The present study indicated that protein content had high heritability Muhammad *et al.* (2002) also obtained similar results for protein content in chickpea.

Table.2: Estimates of heritability, genetic advance GCV and PCV pooled over the environments

S. No.	Characters	Mean	Min	Max	Heritability(%)	Genetic Advance	GA as % means	GCV (%)	PCV (%)
1.	Days to 50% flowering	92.98	91.33	95.33	55.39	0.47	0.50	0.62	1.58
2.	Days to maturity	143.55	136.00	150.67	52.03	4.08	2.84	1.91	2.65
3.	Plant height (cm)	61.67	52.87	67.20	77.60	6.15	9.97	5.49	6.23
4.	No. of branches	12.12	9.37	15.33	88.12	3.30	27.24	14.09	15.01
5.	No. of pods per plant	54.50	45.53	68.00	75.64	9.31	17.09	9.54	10.97
6.	No. of seeds per pods	1.31	1.23	1.37	46.12	0.02	1.51	1.82	4.54
7.	100 seed wt. (g)	24.59	17.05	32.31	65.61	6.01	24.43	14.64	18.07
8.	Biological yield (g per plant)	27.10	19.43	36.83	73.94	6.72	24.80	14.00	16.28
9.	Seed yield (g per plant)	9.73	7.83	12.73	51.88	1.54	15.82	10.66	14.80
10.	Harvest index (%)	36.53	27.75	54.16	75.17	10.17	27.85	15.60	17.99
11.	Protein content (%)	23.76	21.23	26.10	78.65	2.47	10.41	5.70	6.43

Grain yield is a complex character that is outcome of interaction between many plant traits, which are in turn influenced by their genetic makeup and environment, where plant is grown. Therefore, the direct evaluation and improvement of grain yield itself may be misleading due to involvement of environmental component. Therefore, it is very important to analyze the data for relative contribution of various components to yield performance. The simple correlation analysis is an important tool for this purpose. Correlation co-efficient of yield and its components in chickpea indicated that number of branches per plant, number of pods per plant, biological yield and harvest index showed positively and significantly correlated with yield (Table 3). However, negative association of protein content with grain yield was also obtained. Significant and positive correlation of number of pods per plant was found with number of branches, 100-seed weight. Biological yield per plant was positively correlated with number of pods plant-1 and negative association was found with harvest index, 100 seed weight. 100-seed weight showed strong positive association with plant height and number of branches per plant. Plant height were positively correlated with days to maturity, number of branches per plant, 100 seed weight, harvest index and protein content. In view of this information on relationship between seed yield per plant and various other characters was obtained. Similar findings have been reported in chickpea by other workers, (Khorgade, 1988, Sharma and Maloo, 1989, Singh *et al.*, 1997 Yadav *et al.*, 1999 and and Arora *et al.*, 2003)

https://dx.doi.org/10.22161/ijaers/3.9 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table.3: Phenotypic correlation of various quantitative and qualitative traits of pooled over the environments

S N	Characters	Days to maturity	Plant height (cm)	No. of branches	No. of pods per	No. of seeds per	100 seed wt. (g)	Biological yield per plant (g)	Seed yield per plant (g)	Harvest index	Protein content
1.	Days to 50% flowering	0.162	0.037	-0.021	-0.178	0.044	-0.103	0.033	0.037	0.005	0.007
2.	Days to maturity		0.518**	0.344**	0.152	-0.001	-0.004	-0.112	0.130	0.202*	0.171
3.	Plant height (cm)			0.476**	0.124	0.130	0.414**	-0.241**	0.157	0.361**	0.232*
4.	No. of branches				0.407**	0.040	0.310**	0.083	0.246**	0.148	0.068
5.	No. of pods/ plant					0.104	-0.011	0.377**	0.611**	0.130	-0.018
6.	No. of seeds / pods						-0.017	-0.102	0.004	0.106	-0.094
7.	100 seed wt. (g)							-0.306**	0.122	0.377**	0.047
8.	Biologi. yield/plant (g)								0.397**	-0.616**	0.081
9.	Seed yield / plant (g)									0.465**	-0.105
10.	Harvest index (%)										-0.205*
11.	Protein content (%)										1.000

*Significant at 5%; ** significant at 1% level

Cluster diagram based on Euclidean dissimilarity constructed by Ward's method revealed seven clusters at 50% linkage distance (Fig. 1). Cluster I, VII, III and VI, respectively possessed 12, 10, 6 and 5 genotypes. Means of various traits for each character showed that genotypes with maximum number of branches, pods per plant, 100-seed weight biological yield and seed yield per plant were placed together in cluster II. Genotypes with maximum harvest index were placed in cluster VI and genotypes with maximum days to maturity were placed in cluster VII (Table 4). The cluster analysis supported the results of correlation analysis, both indicated that pods per plant, secondary branches per plant and biological yield per plant may be improved simultaneously and put together in a single genotype for yield improvement. This was obvious from the fact that all the three components are positively associated with yield and with themselves. Furthermore, genotypes with high mean values for these characters and those with high grain yield were grouped in same cluster. It can be suggested from the present investigation that the exotic material evaluated in this study can be exploited for yield improvement through improvement and pyramiding of component traits such as branches, biological yield plant^{-1} and number of pods plant^{-1}.

Table.4: Cluster mean and SE of various quantitative and qualitative traits of chickpea genotypes

Cluster and Mean		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches	No. of pods per	No. of seeds per	100 seed wt. (g)	Biological yield /pl (g)	Seed yield per plant (g)	HI (%)
I	Mean	93.33	142.50	60.27	11.35	50.05	1.31	21.02	27.55	8.71	31.80
	SE±	0.89	2.67	3.85	1.38	2.39	0.04	3.92	2.97	0.85	2.88
II	Mean	93.00	136.25	59.80	15.20	62.10	1.33	30.28	36.30	12.59	34.69

	SE±	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
III	Mean	91.96	142.92	55.25	11.09	53.25	1.34	25.84	28.71	10.02	35.00
	SE±	0.93	2.73	1.00	2.54	3.07	0.02	4.09	3.10	1.01	1.92
IV	Mean	94.08	144.50	64.05	13.44	50.78	1.36	27.69	21.68	9.40	43.40
	SE±	1.28	0.50	1.32	1.64	4.34	0.02	4.90	1.92	1.22	3.44
V	Mean	90.92	142.50	62.10	12.26	55.97	1.32	27.71	21.71	8.98	41.42
	SE±	0.72	1.00	2.38	2.09	3.82	0.06	1.69	0.58	0.79	3.12
VI	Mean	93.80	142.95	62.07	10.45	53.66	1.28	24.45	25.64	11.57	45.58
	SE±	1.22	1.35	2.14	0.91	5.80	0.02	2.68	2.61	1.01	6.25
VII	Mean	92.72	146.77	63.83	13.42	59.60	1.29	24.01	29.45	10.49	35.94
	SE±	0.52	2.47	2.11	0.97	4.72	0.04	5.65	2.89	0.87	4.18

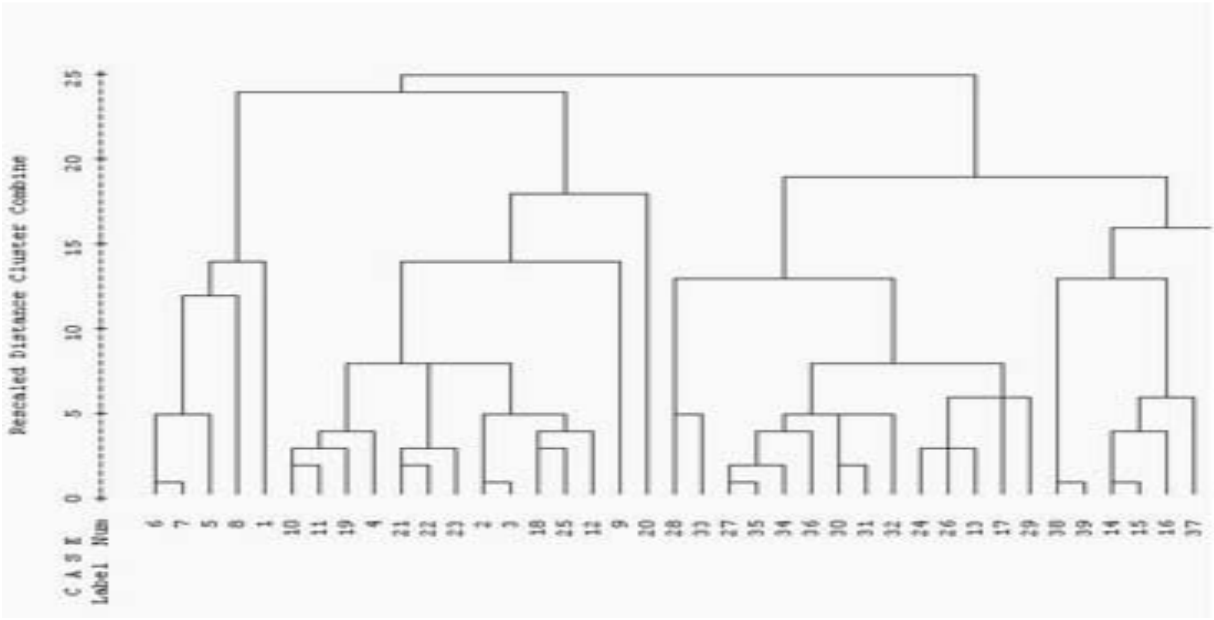

Fig. 1: Dendogram of forty chickpea genotypes

(Setty *et al*., 1977, Mandal and Bahl, 1980, Sandhu and Singh, 1970, Malhotra and Singh 1973, Raju *et al*., 1978, Mishra *et al.*, 1988, Sharma *et al*., Rao *et al*., 1994, Jahagirdar *et al*., 1996, Wahid and Nimbalkar, 2000, Singh *et al*., 2002 and Muhammad *et al*., 2003). The present study indicated that protein content had high heritability Muhammad *et al*. (2002) also obtained similar results for protein content in chickpea.

REFERENCES

[1] Anonymous, (2004). Hindu Survey of Agriculture in India.
[2] ALLARD, R. W.: (1960) Principles of Plant Breeding. New York: John Wiley
[3] Arora, P.P. (1991). Genetic variability and its relevance in chickpea improvement. *Internat. Chickpea Newslett.*, **25**: 9-10.
[4] Arora, P.P., Jeena, A.S. and Upreti, M.C. (2003). Path analysis for yield improvement in chickpea. *Agric. Sci. Dig.*, **23**(2): 116-118.
[5] Fisher, R.A. and Yates, F. (1963). Statistical Tables for Biological, Agricultural and Medical Research. 6th edn., Oliver and Boyd Ltd., Edinburg.
[6] Grafius, J.E. (1956). Components of yield in oats : A geometrical interpretation . *Agron. J.*, **48**: 419-423.
[7] Jahagirdar, J.E., Patil, R.A. and Dhond, V.M. (1996). Genetic variability and its relevance in chickpea improvement. *PKV Res. J.*, **20**(1): 13-14.
[8] Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimates of genetic and environmental variability in soybean. *Agron. J.*, **47**: 314-318.

[9] Khorgade, P.W. (1988). Correlation studies in bengal gram (*Cicer arietinum* L.) with emphasis on path analysis. *Annals Plant Physiol.*, **2**(2): 201-211.

[10] Kumar, S. and Sirohi, A. (2004). Genetic variability and its relevance in chickpea improvement. National Symposium on : *Second Generation Problem in Agriculture and Its Remedies*., 26-27 November, 2004.

[11] Lather, V.S. (1999). Genetic improvement for yield in chickpea. Plant ideotype approaches. In: Food Security and Crop Science, SSARM, Hisar, pp. 207-211.

[12] Lush, J.L. (1949). Heritability of quantitative characters in farm animals. Proc. 8th Congr. *Gent. Herediates*, Suppl. pp. 356-375.

[13] Malhotra, R.S. and Singh, K.B. (1973). Genetic variability and genotype-environment interaction in bengal gram. *Indian J. Agric. Sci.*, **43**: 914-917.

[14] Mandal, A.K. and Bahl, P.N. (1980). Estimation of variability and genetic correlations in chickpea. *Ann. Agric. Res.*, **1**: 136-140.

[15] Mishra, R., Rao, S.K. and Kouto, G.K. (1988). Genetic variability, correlation studies and their implication in selection of high yielding genotypes of chickpea. *Indian J. Agric. Res.*, **22**: 51-57.

[16] Muhammad, A., Ahmad, B., Haqqani, A.M. (2003). Genotype-environment interaction for grain yield in chickpea (*Cicer arietinum* L.). *Pakistan J. of Botany.* **35**(2): 181-186.

[17] Muhammad, A., Bakhsh, A., Bashir, M. and Haqqani, A.M. (2002). Determining the heritability and relationship between yield and yield components in chickpea (*Cicer arietinum* L.). *Pakistan J. of Bot.*, 34(3): 237-245.

[18] Nimbalkar, R.D. (2000). Genetic variability and heritability studies and scope for improvement in chickpea. *J. Maharashtra Agril. Univ.*, **25**(1): 109-110.

[19] Panse, V.G. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers. ICAR Pub., New Delhi, pp. 152-155.

[20] Raju, D.B., Mehra, R.B. and Bahl, P.N. (1978). Genetic variability and correlation in chickpea. *Trop. Grain Legume Bull.*, **13-14**: 35-39.

[21] Rao, S.S., Sinha, R. and Das, G.K. (1994). Genetic variability, heritability, expected genetic advance and correlation studies in chickpea. *Indian J. Pulses Res.*, **7**(1): 25-27.

[22] Sandhu, S.K. and Mandal, A.K. (1989). Genetic variability and character association in chickpea (*Cicer arietinum* L.). *Genetic Ka*, **21**(2): 135-139.

[23] Sandhu, T.S. and Singh, N.B. (1970). Genetic variability and regression studies in gram (*Cicer arietinum* L.). *J. Res. Punjab Agric. Univ., Ludhiana*, **7**: 423-427.

[24] Setty, A.N., Patil, M.S. and Hiramath, K.G. (1977). Genetic variability and correlation studies in *Cicer arietinum* L. *Mysore J. Agric. Sci.*, **11**: 131-134.

[25] Sharma, B.D., Sood, B.C. and Malhotra, V.V. (1990). Study of variability, heritability and genetic advance in chickpea. *Indian J. Pulses Res.*, **3**(1): 1-6.

[26] Sharma, P.P. and Maloo, S.R. (1989). Phenotypic stability in chickpea (*Cicer arietinum* L.). *Madras Agric. J., India*, **76**(7): 400-405.

[27] Singh, A.K., Niranjan, J.S. and Shrivastava, M.P. (1997). Stability analysis for harvest index in late sown chickpea. *Bhartiya Krishi Anusandhan Patrika*, **12**(2): 81-84.

[28] Singh, N.P., Ram, R., Krishna, R and Singh, A.P. (2002). Assay on direct selection parameters in chickpea (*Cicer arietinum* L.). *Prog. Agric.*, **2** (2): 169-170.

[29] Wahid, M.A. and Ahmed, R. (1998). Genetic variability, correlation studies and their implication in selection of high yielding genotypes in chickpea (*Cicer arietinum* L.). *Sarhad J. Agric.*, **15**(1): 25-28.

[30] Yadav, V.S., Dhirendra Singh, Yadav, S.S., Kumar, J. and Singh, D. (1999). Correlation and path analysis in chickpea. *Ann. Agril. Res.*, **20**(4): 461-464.