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CHARACTER ASSOCIATION AND PATH COEFFICIENT ANALYSIS IN CHICKPEA (*CICER ARIETINUM* L.) UNDER LATE SOWN CONDITIONS

PRAMILA YADAV*, DINESH KUMAR TRIPATHI[1], KHALID KAFEEL KHAN AND ASHOK KUMAR YADAV[2]

Department of Botany
Shibli National Post Graduate College,
Azamgarh (U. P.), India
*(e-mail : yadavpsc@gmail.com)

SUMMARY

A total of 45 genotypes of chickpea (*Cicer arietinum* L.) were tested for their yield performance. Among the 15 examined characters, positive and statistically highly significant correlations were found between days to maturity and number of seeds/pod; between the plant height and leaf length, leaflet length, width of leaflet, pod width and 100-seed weight; between leaf length and leaflet length, width of leaflet, pod length, pod width and 100- seed weight; between leaflet length and width of leaflet, pod length, pod width and 100-seed weight; between width of leaflet and pod length, pod width and 100-seed weight; between number of primary branches, number of secondary branches/plant and number of pods per plant; between number of secondary branches/plant and number of pods per plant; between pod length and pod width and 100-seed weight; as well as between pod width and 100-seed weight; and biological yield per plant with number of secondary branches/plant and number of primary branches/ plant. Negative and highly significant relationships were observed between leaf length and number of primary branches, number of secondary branches and number of pods per plant; between width of leaflet and number of primary branches and number of secondary branches/plant; between number of seeds per pod and 100-seed weight; biological yield per plant with leaf length and leaflet length. 100-seed weight had the maximum direct effect on seed yield (p.c.= 0.398). It was found that the indirect effects on seed yield were more positive through 100-seed weight, number of leaflets/leaf and pod length, but negative and low through leaflet length and number of seeds per pod. The present study thus suggested that selection for high yield should be based on 100-seed weight and number of leaflets/leaf in chickpea.

Key words : Correlation, path coefficient, yield, chickpea, late sown

Chickpea (*Cicer arietinum* L.) is a **rabi** season crop usually grown as a winter crop in India, Middle East, Australia and South and Central America. Today, chickpea is the third most important pulse crop (after dry bean and pea) and makes up 20% of the world pulse production. India has been leading chickpea producer since last few decades. It produces around 65-68 per cent of the total world's chickpea production. Since, India is leading producer of chickpea; any major fluctuation in chickpea production from India can be directly reflected in the world's chickpea production. Traditionally India's chickpea production has been in the range of 55-60 lakh tonnes. In India, the major pulse producing states are Madhya Pradesh (23%), Uttar Pradesh (18%), Maharashtra (14%), Rajasthan (11%), Andhra Pradesh (9%) and Karnataka (6%) where pulses are predominantly grown as rainfed crop (Ali and Kumar 2007).

Pulses are an essential source of protein in the diet of the predominantly vegetarian population and the cultivation of these legumes has a long standing tradition. Pulses are important constituents of the Indian diet and supply a major part of the protein requirement. Pulse crops, besides being rich in protein and some of the

[1]Department of Botany, Sri Durga Ji Post Graduate College, Chandeshwar, Azamgarh (U. P.), India.
[2]CSIR-Institute of Himalayan Bioresource Technology, Palampur (H. P.), India.

essential amino acids especially lysine (Chatterjee and Abrol, 1975). Gram contains 22 per cent protein, 63 per cent carbohydrates, 4.5 per cent fat, 8.0 per cent crude fibre and 2.7 per cent ash (Miao *et al.,* 2009). It is also rich in calcium, iron and niacin. Chickpeas are a helpful source of zinc, folate and protein. They are also very high in dietary fibre and hence a healthy source of carbohydrates for persons with insulin sensitivity or diabetes. Chickpeas are low in fat most of which is polyunsaturated. Nutrient profile of *desi Chana* (the small seeded variety) is different, especially the fibre content which is much higher than the light coloured variety. Recent studies by government agencies have also shown that they can assist in lowering of cholesterol in the bloodstream. Due to its high protein content and several other properties, this pulse crop requires attention to increase its production and productivity.

In eastern Uttar Pradesh, sowing of chickpea is delayed in many cases due to late harvesting of paddy. In such cases varieties/genotypes must be selected that are most suitable for such conditions, so that production and productivity both may be increased. Seed yield being the most important and polygenically controlled complex character, influenced by many environmental factors, hence it is not an efficient character for selection. Inter-relationship among direct and indirect effects of component characters of yield is important in predicting the correlated response to direct selection (Thakur and Sirohi, 2009). Correlation analysis for seed yield provides opportunity for selection and leads to a directional model based on yield and its components in field experiments (Khan and Qureshi, 2001). The present study was undertaken to elucidate the association between yield and its attributes in chickpea, under late sown conditions.

MATERIALS AND METHODS

Forty five chickpea genotypes/varieties were obtained from the Head, Pulses Research Laboratory, Genetics Division, I. A. R. I., New Delhi and the Head, Department of Genetics and Plant Breeding, N. D. University of Agriculture and Technology, Kumarganj, Faizabad (U. P.). These genotypes/varieties were : Pant G-186, 486-18, GCP-105, Vishal, BG-256, Udai, ICCV-15676, ICC-11535, Anupam, BG-261, J. B. 315, B. G. 209, BG-391, Green-112, BG-1108, BG-376, BG-2019, BG-1101, BG-390, EC-539009, BG-1107, Pusa-1088, BG-1044, ILC-2002, ICCV-88503, BG-1103, Pusa-372, ICRISAT-3070, KLB-97-5, NDL. 2-96-21, KLB-97-8, IPL-110, KLB-97-7, IPC-2002-36, KLB-97-8, Awarodhi, BG-203, Pusa-256, ICRISAT-3074, BG-1105, BG-1053, ICRISAT-3073, BG-1073, K-850 and H. O. O.108. The experimental trial was laid out in randomized block design in three replications at the Agricultural Research Farm of S. D. J. Post Graduate College Chandeshwar, Azamgarh, U. P. during 2008-09. Each plot comprised three rows of 3 m length, spaced 30 cm apart with plant to plant spacing of 10 cm. Observations were recorded on randomly selected 10 competitive plants in each replication for days to 50 per cent flowering, days to maturity, plant height, leaf length, number of leaflets/leaf, leaflet length, width of leaflet, number of primary branches, number of secondary branches, number of pods per plant, pod length, pod width, number of seeds/pod, 100-seed weight, seed yield/plant and biological yield/plant. The coefficients of correlations were computed as per the methods suggested by Al-Jibouri *et al*. (1958) and path coefficients were calculated by employing the method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Analysis of variance of 45 chickpea genotypes showed significant differences for different traits. Positive and highly significant relationships were observed between days to maturity and number of seeds/pod, between plant height and leaf length, leaflet length, width of leaflet, pod width and 100-seed weight; between leaf length and leaflet length, width of leaflet, pod length, pod width and 100-seed weight; between leaflet length and width of leaflet, pod length, pod width and 100-seed weight; between width of leaflet and pod length, pod width and 100-seed weight; between number of primary branches and number of secondary branches, number of pods/plant; between number of secondary branches and number of pods/plant; between pod length and pod width, 100-seed weight; between pod width and 100-seed weight; biological yield per plant with number of secondary branches/plant and number of primary branches/plant. Negative and highly significant relationships were determined between leaf length and number of primary branches, number of secondary branches, number of pods/plant; between width of leaflet and number of primary branches, number of secondary branches; between number of seeds/pod and 100-seed

TABLE 1
Phenotypic correlation coefficients among 16 characters in chickpea (*Cicer arietinum* L.)

Characters	DM	PH	LL	NL/L	LtL	WL	NPB	NSB	NP/P	PL	PW	NS/P	100.SW	YPP	BY
DF	0.079	-0.23	-0.211	0.314*	-0.114	-0.082	0.280	0.241	0.112	-0.026	-0.016	0.111	-0.016	0.209	0.195
DM		-0.238	-0.120	-0.030	-0.263	-0.172	0.047	0.167	0.201	-0.110	-0.201	0.465**	-0.194	0.148	-0.035
PH			0.438**	-0.030	0.395**	0.439**	-0.364*	-0.279	-0.267	0.346*	0.452**	-0.355*	0.407**	0.094	-0.144
LL				0.201	0.620**	0.559**	-0.456**	-.457**	-.399**	0.589**	0.499**	-0.317*	0.512**	0.160	-0.375*
NL/L					-0.109	-0.072	0.130	0.198	0.120	0.140	0.147	-0.113	0.117	0.355*	0.050
LtL						0.778**	-0.377*	-0.371*	-0.364*	0.650**	0.678**	-0.259	0.561**	-0.008	-0.311*
WL							-0.409**	-.426**	-0.367*	0.703**	0.624**	-0.310*	0.698**	0.174	-0.251
NPB								0.532**	0.546**	-0.304*	-0.195	0.277	-0.334*	0.032	0.289
NSB									0.456**	-0.247	-0.146	0.296	-0.371*	0.018	0.700**
NP/P										-0.269	-0.125	0.224	-0.375*	0.182	0.347*
PL											0.725**	-0.202	0.693**	0.328*	-0.064
PW												-0.246	0.620**	0.209	-0.014
NS/P													-.455**	-0.090	0.255
100SW														0.360*	-0.072
YPP															0.112

DF : Days to 50% flowering, DM : Days to maturity, PH : Plant height (cm), LL : Leaf length (cm), NL/L : Number of leaflets per leaf, LtL : Leaflet length (cm), WL : Width of leaflet (cm), NPB : Number of primary branches per plant, NSB : Number of secondary branches per plant, NP/P : Number of pods per plant, PL : Pod length (cm), PW : Pod width (cm) NS/P : Number of seeds per pod, 100SW : 100-seed weight (g), YPP : Seed yield per plant (g) and BY : Biological yield per plant.
*,**Significant at P=0.05 and P=0.01 levels, respectively.

TABLE 2

Path coefficients analysis considering seed yield as dependent and other 15 characters as independent traits at phenotypic level in chickpea

Characters	DF	D M	PH	LL	NL/L	LtL	WL	NPB	NSB	NP/P	PL	PW	NS/P	100SW	BY	Correlation with YPP
DF	**0.138**	0.010	-0.019	-0.016	0.057	0.034	-0.007	-0.006	-0.008	0.036	-0.007	0.002	0.001	-0.006	0.051	0.209
D M	0.011	**0.128**	-0.02	-0.009	-0.005	0.078	-0.014	-0.001	-0.005	0.065	-0.03	0.025	0.002	-0.077	-0.008	0.148
PH	-.032	-0.031	**0.083**	0.033	-0.005	-0.117	0.035	0.008	0.009	-0.087	0.094	0.056	-0.002	0.162	-0.020	0.094
LL	-.029	-0.015	0.036	**0.076**	0.036	-0.184	0.045	0.009	0.015	-0.129	0.16	-0.062	-0.002	0.204	-0.047	0.160
NL/L	0.043	-0.004	-0.002	0.015	**0.181**	0.032	-0.006	-0.003	-0.006	0.039	0.038	-0.018	-0.001	0.046	0.004	0.355
LtL	-.016	-0.034	0.033	0.047	-0.02	**-0.297**	0.062	0.008	0.012	-0.118	0.176	-0.084	-0.001	0.223	0.109	-0.008
WL	-.011	0.022	0.036	0.042	-0.013	-0.231	**0.080**	0.008	0.014	-0.119	0.19	-0.077	-0.002	0.278	0.003	0.174
NPB	0.039	0.006	-0.03	-0.035	0.024	0.112	-0.033	**-0.021**	-0.017	0.177	-0.082	0.024	0.001	-0.133	0.006	0.032
NSB	0.033	0.022	-0.023	-0.035	0.036	0.11	-0.034	-0.011	**-0.032**	0.148	-0.067	0.018	0.001	-0.148	-0.047	0.018
NP/P	0.015	0.026	-0.022	-0.03	0.022	0.108	-0.029	-0.011	-0.015	**0.324**	-0.073	0.015	0.001	-0.149	0.109	0.182
PL	-.004	-0.014	0.029	0.045	0.025	-0.193	0.056	0.006	0.008	-0.087	**0.271**	0.09	-0.001	0.276	-0.035	0.328
PW	-.002	-0.026	0.037	0.038	0.027	-0.201	0.05	0.004	0.005	-0.04	0.197	**-0.123**	-0.001	0.247	0.004	0.209
NS/P	.015	0.06	-0.029	-0.024	-0.2	0.077	-0.025	-0.006	-0.01	0.073	-0.055	0.03	**0.005**	-0.181	-0.028	-0.090
100SW	-.002	-0.025	0.034	0.039	0.021	-0.166	0.056	0.007	0.012	-0.122	0.188	-0.076	-0.002	**0.398**	-0.018	0.360
BY	0.006	-0.001	-0.004	-0.011	0.002	-0.009	-0.008	0.009	0.021	0.010	-0.002	-0.001	0.008	-0.002	**0.030**	0.112

Character details are given in Table 1.
Bold figures are direct effects.

weight; biological yield per plant with leaf length and leaflet length (Table 1).

Path analysis was employed to establish the intensity of independent variables (days to 50% flowering, days to maturity, plant height, leaf length, number of leaflets/leaf, leaflet length, width of leaflet, number of primary branches, number of secondary branches, number of pods per plant, pod length, pod width, number of seeds/pod, 100-seed weight) on the dependent one i. e., grain yield/plant (Table 2).The analysis being a more precise method partitions the direct and indirect effects of individual traits (independent) on grain yield/plant (dependent). This analysis also helps breeders to identify the characters that could be used as selection criteria in chickpea breeding programme (Ali *et al.*, 2009). 100-seed weight had the greatest direct effect on seed yield (.0.398). Also, its indirect effect on seed yield more positive through 100-seed weight, number of leaflets/leaf and pod length, but negative and low through leaflet length and number of seeds/ pod. The strong direct effect of 100-seed weight with low positive correlation and significant positive correlation (0.360) with the seed yield character were observed. The second highest direct effect on seed yield was of the number of pods/plant (0.324). 100-seed weight had positive indirect effect on seed yield via most of the observed characters. Number of leaflets/leaf (0.355), pod length (0.328), pod width (0.209), days to 50 per cent flowering (0.209), number of pods/plant (0.182), width of leaflet (0.174) and leaf length (0.160) were the third highest positive direct contributors to seed yield following pod length and number of leaflets/leaf. Days to 50 per cent flowering had positive and high indirect effects on seed yield via days to 50 per cent flowering (0.138).

The results of the present study showed that even through the relationships (correlations) among some characters were significant (Table 1), the path coefficient values were found non- significant (Table 2). According to these results, linear relations among examined characters were insufficient in plant breeding programmes. As in our research, Erman *et al.* (1997), Guier *et al.* (2001) and Ciftci *et al.* (2004) also found positive and significant relationships between seed yield and number of leaflets/leaf and pod length and 100-seed weight and negative but not significant relationships were between seed yield and leaflet length and number of seeds per pod. In present research, the high and positive relations were observed between the number of leaflets/ leaf and seed yield (r=0.355) was similar to the results of Singh and Geletu (1990) and Guier *et al.* (2001). The highest and positive relationships observed between seed yield and 100-seed weight (0.360) were similar to Erman *et al.* (1997) and Ciftci *et al.* (2004). As results, determining the linear relations among components affecting yield was insufficient to determine selection in chickpea breeding activities. Also, it was essential that the amount of direct and indirect effect of the causal components on the effect components was determined. The present study thus suggests that selection for high seed yield should be based on 100-seed weight and number of pods/plant in chickpea.

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