CHARACTER ASSOCIATION AND PATH COEFFICIENT ANALYSIS IN SEGREGATING DISTANT CROSSES OF CHICKPEA

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ABSTRACT

Character association and path coefficient analysis provide information on scope for exploitation of the selected traits and their combinations in improving grain yields during selection of desirable types from segregating populations. Considering the importance of these two parameters in breeding programs aiming to improve grain yield and other yield attributes, character association and path coefficient analysis was performed using segregating populations of distant crosses {(desi x kabuli) and (cultivated x wild species, *Cicer reticulatum*)} in chickpea (*Cicer arietinum* L.). Overall results obtained using correlation and path-coefficient analysis indicated that selection for profuse branching, high number of pods per plant, higher 100-seed weight would lead to improved chickpea seed yield through distant hybridization besides broadening the genetic base. Therefore, these characters should receive the highest priority in selecting high yielding plants in chickpea breeding.

Key words : *Chickpea, correlations, character association, path coefficient analysis.*

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops of India covering 9.19 m ha area producing 8.80 m t of the grain. In view of the narrow genetic base of existing chickpea varieties (1) pre-breeding efforts involving diverse genotypes and closely related species need to be adequately made to broaden the genetic base and development of high yielding and efficient plant types. Character association and path coefficient analysis is known to help in identification of desirable trait combinations and traits on which selection can be practiced to ensure genetic gain during selection. In present study efforts were made to identify traits or combination of traits impacting yield gain through character association and path analysis during selection in 8 distant crosses (desi x kabuli, desi x wild- *C. reticulatum*, kabuli x wild-*C. reticulatum*) developed using one of the wild relative of chickpea, *C. reticulatum* (EC556270).

MATERIALS AND METHODS

The present study was conducted at Indian Institute of Pulses Research (IIPR), Kanpur (India) which is located at 260 27'N latitude, 80014' E longitude and 152.4 meter above the mean sea level. Experimental material comprising parents, 8F1s (4 interspecific : DCP 92-3 x *C. reticulatum*, IPC 98-12 x *C. reticulatum*, IPCK 2002-29 x C. reticulatum and JGK1 x C. reticulatum; and 4 desi x kabuli crosses:, DCP 92-3 x IPCK 2002-29, DCP 92-3 x JGK 1, IPC 98-12 x IPCK 2002-29 and IPC 98-12 x JGK1) and their 8F2s along with parents were grown in trial replicated thrice following completely randomized block design (C.R.B.D.) during rabi 2010-11 at IIPR, Kanpur. Inter row spacing of 30 cm was kept during experimentation whereas plant spacing was maintained at 10 cm. F1s were planted in single row and F_2s in 5 rows plot, whereas all parents were grown in 3 rows plot of 4 m long. Standard agronomic practices were followed to raise good crop. Observations were recorded on yield and yield attributes were recorded and quantitative data was subjected to character association and path coefficient analysis following standard procedures using WINDOSTAT.

RESULTS AND DISCUSSION

The salient results those are of practical significance in improving chickpea grain yields have been presented and discussed for parents, segregating populations and mixed populations (Parents+F_1+F_2) in present paper. In parental population, plant height (r=0.844) and seed yield per plant (r=0.768) had significantly positive correlation with seed yield per plot indicating that increase in plant height and seed yield per plant may help in improving chickpea yield. The number of pods per plant and seeds per pod also showed significant positive correlation with plot yield and whereas all fecundity traits had positive correlations with each other. Number of days to 50% flowering had significantly negative correlation with plant height

(-0.647), 100 seed weight (-0.941) and seed yield per plant (-0.635). Number of days to maturity exhibited significantly negative correlations with plant height (-0.563) and 100-seed weight (-0.771) only. Genotypic correlations of seed yield per plot were found significantly positive with days to first flower, days to 50% flowering, days to first pod appearance and days to 50% podding, primary and secondary branches per plant indicating importance of these traits in selection from segregating populations. Genotypic correlation of pods per plant was found positive and significant with seeds per pod (0.991) and protein content (0.651) whereas 100-seed weight showed positive association with seed yield per plot. For phenotypic correlations similar trend was found for most of the fecundity traits. Pods per plant had significantly positive phenotypic correlation with seeds per pod and protein content whereas moderate and significant negative correlation with 100-seed weight and seed yield per plot. Secondary branches were found to have greater influence on seed yield per plot. Highly significant and positive genotypic correlation of seeds per pod and seed yield per plant had positive correlation with plot yield and all the fecundity traits (related to earliness) showed negative correlation with seed yield when correlation coefficients were estimated using quantitative data for F_1 generation. Genotypic correlations in F_1 generation exhibited positive correlation of 100-seed weight with yield per plot whereas seeds per pod had positive correlation with seed yield per plant. The phenotypic correlation among fecundity traits were found positively significant but had negative correlation with seed yield indicating that selection for earliness may lead to reduced seed yield. Simple correlation coefficients were also worked out among different traits using F_2 data. Plant height and seed yield per plant had highly significant and positive correlation with seed yield per plot. The genotypic correlation were also studied in F_2 populations of chickpea which has shown highly significant and positive correlation of fecundity traits (days to first flower, days to 50% flower, days to first pod appearance, days to 50% podding, and days to maturity) with seed yield per plot. Plant height, 100-seed weight and seed yield per plant had negative correlation with seed yield per plot at genotypic level. The negative correlation of seed yield per plant with plot yield may be due to over growth of chickpea plants leading to lodging. Similar trend was observed for phenotypic correlations as well and seed size had significantly negative correlation with seed yield per plot. Character association analysis for pooled populations ($F_1 + F_2$) displayed significant and positive genotypic and phenotypic correlations between seed yield per plot and days to 50% podding and primary branches per plant. However, pooled analysis using quantitative data recorded on parents, F_1 and F_2 generation together indicated significantly positive genotypic correlations of days to maturity and primary branches per plant with plot yield. However, plant height had positive genotypic correlation with seed yield per plant and seed yield per plant with protein content. At the same time phenotypic correlation of days to 50% podding and pods per plant with seed yield per plot. Days to first flower appearance, days to 50% flowering had negative correlations with seed yield per plant at level phenotypic. It is established fact that under irrigated condition, secondary branches are more important than the primary branches per plant. In present study primary branches per plant had positive correlation with seed yield per plant whereas highly significant had negative correlation between secondary branches per plant and 100-seed weight indicating that duration available for development of pod to maturity had large influence on seed size. Correlations worked out also indicated that number of pods per plant had highly significant and positive correlation with seeds per pod and seed yield per plant, which was expected also. The results are in conformity with the earlier finding of (2).

The grain yield was positively correlated with number of pods per plant in parents, F_1, F_2 generations. In F_2 generation, pods per plant showed positive but non-significant correlation both at genotypic and phenotypic level with grain yield per plant indicating that improvement in seed yield can be achieved by selecting desirable segregants from segregating populations developed through distant hybridization based on pods per plant. The present results are in agreement with the earlier reports of (3). The seed yield per plant also showed positive correlation with seed size and in agreement with the earlier findings (2) as they had also suggested that selection based on pods per plant and 100-seed weight can help in achieving higher chickpea yield.

Path analysis was performed to have better understanding of inter-relationship of characters with yield and among themselves. In parental population, days to first pod appearance had maximum direct positive effect on seed yield per plot followed by plant height and days to 50% podding whereas days to first flower had maximum negative direct effect on yield. The indirect effect of days to first flowering via seed yield per plant and 100-seed weight was more pronounced at genotypic level. Days to first pod appearance had maximum direct positive effect on seed yield per plot (0.524) followed by plant height and days to 50% podding whereas days to first flower had maximum negative (-1.749) direct effect on yield. (4) also reported positive direct effect of plant height on chickpea yield whereas (5) reported substantial contribution of period from flowering to maturity towards yield. The indirect effect of days to flowering via 100-seed weight, days to 50% flowering via 100-seed weight, days to first pod via 100-seed weight, days to maturity via 100-seed weight and secondary branches per plant via 100-seed weight, whereas seed yield per plant had maximum positive indirect effect via days to first flowering and negative indirect effect of days to 50% flowering via days to first flowering (-1.538) at genotypic level when only parents were included in analysis. At phenotypic level days to 50% podding had maximum direct positive effect (0.755) whereas days to first flower had maximum negative direct effect on seed yield per plot (-1.737). The indirect contribution of days to first flower appearance was higher via seed yield per plant and 100-seed weight (1.316) whereas negative indirect effect of days to first flowering via days to first pod was more towards yield. These finding were supported by various earlier workers (6, 7). The indirect contribution of days to first flower appearance was highest via seed yield per plant followed by 100-seed weight whereas negative indirect effect of days to first flowering via days to first pod was found maximum towards yield at phenotypic level. Similarly, path coefficient analysis using F_1s populations indicated maximum positive direct effect on plot yield for pods per plant followed by secondary branches per plant, 100 seed weight and seeds per pod whereas maximum but negative direct effect was of protein content followed by days to first flower and days to maturity (-0.505) on seed yield at genotypic level. In F_1s generation, pods per plant showed maximum positive direct effect on plot yield followed by secondary branches per plant, 100-seed weight and seeds per pod on seed yield at genotypic level. The maximum direct effect of pods per plant followed by secondary branches per plant and 100-seed weight was found on grain yield in chickpea in present investigations. (8) also reported positive direct effect of pods per plant and 100-seed weight on grain yield in chickpea. Similarly in F_2s generation, path coefficient analysis was performed as selection from early generation become important in self pollinated crops like chickpea to reduce the material load in advanced generations. (6) also found similar results when performed path analysis in segregating populations. Further, 100-seed weight showed positive indirect effect via days to maturity and seeds per pod on seed yield per plot. Highest direct effect due to days to 50% podding followed by days to first flower and pods per plant whereas maximum negative direct effect was due to days to maturity followed by days to first pod and number of primary branches per plant. It may be due to the fact that most of the pods developed at the start of cool season i.e. January does not produce viable seeds or pod abortion takes place due to high humidity, poor solar light and cool temperature (9). Phenotypic path analysis indicated that days to 50% podding had maximum direct effect on yield due to days to first flower appearance and pods per plant whereas maximum negative direct effect was due to protein content followed by days to maturity, days to first podding and number of primary branches per plant. Maximum indirect effect of 50% podding via pods per plant followed by seeds per pod was noticed in present study. Path analysis was carried out using F_1 and F_2 populations together for plot yield indicated maximum direct effect of days to 50% podding followed by days to maturity, plant height, secondary branches per plant and 100-seed weight whereas maximum negative direct effect was observed for days to first podding followed by days to first flower, primary branches per plant and pods per plant on seed yield per plot. Days to 50% podding had positive indirect effect via days to 50% flowering, days to first podding and via days to first flower whereas maximum negative indirect effect was due to days to 50% podding via 100-seed weight and via days to first flower at phenotypic level. Path analysis was also performed using parents, F1s and F2s together at genotypic levels to understand behavior at direct and indirect effects of various yields attributes on plot yield in mixed population. Pooled analysis indicated maximum direct effect of days to 50% podding followed by days to maturity, pods per plant, secondary branches per plant and days to first flower whereas maximum negative direct effect was due to days to 50% flowering followed by primary branches per plant, days to first podding, protein content and plant height. The indirect effect of days to 50% podding via days to 50% flowering was maximum followed by days to maturity via primary branches per plant and primary branches per plant via 100-seed weight. The maximum (phenotypic) direct effects was observed due to seed yield per plant followed by days to 50% podding, days to maturity, secondary branches per plant and seeds per pod whereas negative direct effect was maximum due to primary branches per plant followed by days to first podding, days to 50% flowering and days to first flower on plot yield. The maximum indirect effect due to 50% podding via days to 50% flowering followed by days to 50% podding via days to first podding, days to 50% podding via pods per plant, days to 50% podding via days to maturity and due to primary branches per plant via 100-seed weight whereas negative indirect effect was maximum due to days to first podding via days to 50% flowering followed by primary branches per plant via pods per plant, primary branches per plant via days to 50% podding and primary branches per plant via days to first flowering and via days to 50% flowering on chickpea yield when mixed population involving parents, F_1s and F_2s were considered together during path analysis. Similar results have been reported by (6).

In present study, significant interrelationships among desirable traits combination has helped in pinpointing the importance of yield attributes like primary branches per plant, secondary branches per plant, pod per plant and seed yield per plant in chickpea improvement. Path analysis also highlighted importance of these traits in improving grain yield of chickpea. The direct effects of pods per plant and secondary branches per plant but it was negative for days to first flower and days to maturity in pooled population. In segregating generations, direct effects due to pods per plant on yield were positive indicating that one can rely upon this character during selection from segregating generations for higher yield as pods per plant also had positive correlation with grain yield per plot in present study. It is a fact that under cool and long growing environment maximum pods are found on secondary branches per branches which ultimately contribute to per plant yield resulting in higher grain yield. Overall results obtained using correlation and path-coefficient analysis indicated that selection for high number of pods per plant, 100-seed weight would lead to high seed yield. Therefore, these characters should receive the highest priority in selecting high yielding plants in chickpea breeding.

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