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# Genetic Variability, Correlation and Path Co-Efficient Analysis for Agronomic Traits in Chickpea (*Cicer arietinum* L.)

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**Abstract**

Forty genotypes of chickpea (*Cicer arietinum* L.) were studied in a field experiment conducted at the experimental field of BARI, Joydebpur, during the year 2004-2005. Significant genetic variations were observed among the genotypes for days to flower, plant height, number of branches per plant, number of pods per plant, 100-seed weight and seed yield per plant. The highest genotypic variability was observed in number of seeds per pod and seed yield, followed by number of pods per plant and branches per plant, whereas days to maturity showed the lowest genotypic co-efficient of variability. In all cases, phenotypic variances were higher than the genotypic ones. High heritability coupled with high genetic advance was observed for seed yield per plant, pods per plant, 100-seed weight and dry weight per plant, which indicates that selection could be effective for these traits. Considerable heritability was observed in pod length, seeds per pod and days to flowering. The results showed that seed yield per plant had positive and significant relation with branches per plant and pods per plant. Number of pods per plant were positively correlated with branches per plant but negatively correlated with plant height and days to first flowering. Weight of 100-seed had significant and positive correlation with days to first flowering, dry weight per plant and pod length but had negative correlation with pods per plant and seeds per pod. Days to first flowering, pod length, pods per plant, dry weight per plant had direct effect on yield. Therefore, days to first flowering, pods per plant, pod length, branches per plant and dry weight per plant are found the important characters which could be used in selection for yield.

***Keywords:*** Variability, genetic advance, heritability, chickpea, correlation, path analysis

## 1. Introduction

In Bangladesh, chickpea is the third major pulse crop after grass pea (Khesari) and lentil (Islam *et al.*, 1981). In 2007, 12613 tons of chickpea was produced from 13277 hectares of land with an average yield of 0.95 t/ha (DAE, 2007). Chickpea as a protein rich grain legume contains essential amino acids like methionine and cystine which are lacking in lysine rich cereals (Ahmed, 1994). Thus chickpea with cereals can make balanced diet in most of most the developing countries. Pulses are the cheapest source of protein. The daily per capita consumption of pulse in Bangladesh is only 10g as against 45g (Ahmed, 1994). Cultivation of chickpea has also a great value in agriculture as it adds atmospheric nitrogen in soil through the process of rhizobial symbiosis (Sharma and Jodha, 2001).

Seed yield is a complex character, which is affected by a large number of yield components.

Careful selection of desirable components may lead to the discovery of lines with higher yield than the original variety. The effectiveness of selection of plants with higher yield depends upon the extent to which the variability in yield is dependent on genetic factors. Environment has a great effect upon many of the economically important characters, which are often controlled by many genes. Thus, it becomes difficult to judge what portion of the observed variability is heritable and what portion is environmental. The progress of a breeding program is conditioned by the influence of environment, magnitude and interrelationship of genotypic and environmental variations in the plant characters. It then becomes necessary to partition the observed variability into its heritable and non-heritable components with the help of suitable genetic parameters such as genetic co-efficient of variation, heritability estimates, genetic advance etc.

The study of character is also essential for ascertaining their contribution towards yield. Direct and indirect effects of yield contributing characters on yield are also important in selecting high yielding genotypes. Path co-efficient analysis is used to detect characters having direct and indirect effects on yield.

Therefore, this study was undertaken to:
study the variability for yield and yield contributing characters
study heritability and genetic advance for yield and yield contributing characters, and
assess the relationship of yield and different yield contributing characters of chickpea.

## 2. Materials and Methods

An experimental comprising 40 chickpea genotypes (Table 1) was conducted in a randomized block design with three replication at the Research farm of Bangladesh Agricultural Research Institute (BARI), Gazipur during Rabi season (December to April) 2004-2005. The unit plot size was two rows of 3 meter length. The inter row to row and plant to plant spacing were maintained at 40 cm and 10 cm, respectively. Recommended fertilizer doges, cultural practices and all plant protection measures were followed to ensure a good crop. The data on 10 morphological characters namely days to first flowering, days to 50% flowering, days to pod maturity, plant height (cm), dry matter weight (g), number of branches per plant, number of pods per plant, number of seeds per plant, pod length (cm), 100 seeds weight (g), seed yield per plant (g) were recorded on five randomly selected plants.

The data were subjected to statistical analysis using MSTATC software. The mean values were separated by DMRT. Components of genetic parameters like genotypic and phenotypic variance, genotypic and phenotypic coefficient of variation, heritability, genetic advance, genotypic and phenotypic correlation coefficient and path analysis were estimated following Singh and Choudhury (1979).

## 3. Result and Discussion

### *3.1. Variability Studies*

The analysis of variance showed a narrow range of variation and significant differences for all the characters studied (Table 2). Coefficient of variation at phenotypic and genotypic levels was relatively high in seed yield per plant, pods per plant, branches per plant and dry matters weight. For days to first flowering, days to 50% flowering of the plant, days to maturity and pod length variations were very low. The magnitude of PVC was higher than GVC for all the characters indicating the influence of environment of these traits.

The highest heritability was observed in seeds per pod followed by pod length, days to 50% flowering, days to first flowering, seed yield per plant and dry matters of plant. These traits showed high habitability indicating additive gene effect. The genetic advance under selection was low. The present study for high habitability for these characters was conformed to those observed by Chandra (1968), Joshi (1972) and Indu (1985) in different chickpea trials.

**Table 1.** List of the genotypes used in the experiment.

| Sl. No. | Accession No. | Varieties/Genotypes | Source |
|---|---|---|---|
| 01 | 301 | ICCL-4951 | BARI, Bangladesh |
| 02 | 302 | ICCL-22320 | BARI, Bangladesh |
| 03 | 303 | ICCL-87322 | BARI, Bangladesh |
| 04 | 304 | BARI Chola-1 | BARI, Bangladesh |
| 05 | 305 | BARI Chola-2 | BARI, Bangladesh |
| 06 | 306 | BARI Chola-3 | BARI, Bangladesh |
| 07 | 307 | BARI Chola-4 | BARI, Bangladesh |
| 08 | 308 | BARI Chola-6 | BARI, Bangladesh |
| 09 | 309 | BARI Chola-7 | BARI, Bangladesh |
| 10 | 310 | BARI Chola-5 | BARI, Bangladesh |
| 11 | 311 | 94-012-98V-4006 | BARI, Bangladesh |
| 12 | 312 | 920854-21 | BARI, Bangladesh |
| 13 | 313 | 97039-1226 | BARI, Bangladesh |
| 14 | 314 | 97-132 F-99V-4005 | BARI, Bangladesh |
| 15 | 315 | 97C-016-9 | BARI, Bangladesh |
| 16 | 316 | 97164-1001 | BARI, Bangladesh |
| 17 | 317 | 98238-1065 | BARI, Bangladesh |
| 18 | 318 | 98070-1069 | BARI, Bangladesh |
| 19 | 319 | 98346-1045 | BARI, Bangladesh |
| 20 | 320 | 98351-1023 | BARI, Bangladesh |
| 21 | 321 | 99026 | BARI, Bangladesh |
| 22 | 322 | 99017-1003 | BARI, Bangladesh |
| 23 | 323 | 99038-1015 | BARI, Bangladesh |
| 24 | 324 | 99042-1012 | BARI, Bangladesh |
| 25 | 325 | 99044-1010 | BARI, Bangladesh |
| 26 | 326 | 99080-1006 | BARI, Bangladesh |
| 27 | 327 | 99139-1003 | BARI, Bangladesh |
| 28 | 328 | S-95342 | BARI, Bangladesh |
| 29 | 329 | HEERA-98 PBC 4010 | BARI, Bangladesh |
| 30 | 330 | 99185-1035 | BARI, Bangladesh |
| 31 | 331 | BINA Chola-4 | BINA, Bangladesh |
| 32 | 332 | BINA Chola-2 | BINA, Bangladesh |
| 33 | 333 | CPC-814 | BINA, Bangladesh |
| 34 | 334 | CPM-834 | BINA, Bangladesh |
| 35 | 335 | CPM-851 | BINA, Bangladesh |
| 36 | 336 | CPC-830 | BINA, Bangladesh |
| 37 | 337 | CPM-860 | BINA, Bangladesh |
| 38 | 338 | Hyprochola | BINA, Bangladesh |
| 39 | 339 | CPC-823 | BINA, Bangladesh |
| 40 | 340 | BINA-3 | BINA, Bangladesh |

**Table 2.** Estimation of statistical and genetical parameters of characters for different genotypes of chickpea.

| Character | Mean | Range | MS | $\sigma^2_p$ | $\sigma^2_g$ | $\sigma^2_e$ | Heritability | GA (5%) | GA (% of mean) | PCV | GCV | ECV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DFF | 69.38 | 64-78 | 42.26* | 15.69 | 13.28 | 2.41 | 84.64 | 6.91 | 9.95 | 5.71 | 5.25 | 2.24 |
| DF | 76.73 | 69-102 | 114.61 | 41.65 | 36.24 | 5.89 | 87.01 | 11.57 | 15.08 | 8.41 | 7.85 | 3.16 |
| DM | 109.58 | 104-121 | 49.98* | 34.05 | 7.96 | 26.09 | 23.38 | 16.40 | 14.97 | 5.33 | 2.57 | 4.66 |
| PH | 46.25 | 31-59 | 118.52 | 68.95 | 24.79 | 44.16 | 35.95 | 6.15 | 13.29 | 17.95 | 10.77 | 14.37 |
| DW | 23.33 | 12.73- | 44.44* | 81.71 | 66.37 | 15.34 | 81.23 | 15.13 | 64.83 | 38.75 | 34.92 | 16.79 |
| BP | 7.71 | 4.33-14.67 | 19.15* | 12.67 | 9.24 | 3.43 | 72.92 | 5.35 | 69.39 | 46.17 | 39.43 | 24.02 |
| PP | 63.67 | 16-126.3 | 1882.4 | 1310.3 | 986.06 | 324.31 | 75.25 | 56.11 | 88.97 | 57.40 | 49.79 | 28.55 |
| SP | 1.20 | 1-2.21 | 0.49** | 0.17 | 0.16 | 0.01 | 94.12 | 0.80 | 66.62 | 34.36 | 33.33 | 8.33 |
| PL | 18.08 | 15-25 | 16.21* | 6.26 | 4.97 | 1.29 | 89.39 | 4.09 | 22.63 | 13.84 | 12.33 | 6.28 |
| SW | 14.68 | 9.33-27.9 | 54.41* | 23.92 | 15.25 | 8.67 | 63.75 | 6.42 | 43.75 | 33.32 | 26.60 | 20.05 |
| SY | 9.40 | 2.6-16.40 | 40.69* | 29.82 | 24.38 | 5.44 | 81.75 | 9.19 | 97.83 | 58.09 | 52.53 | 24.81 |

** Significant at 1% level of significance, * Significant at 5% level of significance.

MS=Mean square, $\sigma^2_p$=Phenotypic variance, $\sigma^2_g$=Genotypic variance, $\sigma^2_e$=Environmental variance, PCV=Phenotypic coefficient of variation, GCV=Genotypic coefficient of variation, ECV = Environmental coefficient of variation.

In case of days to maturity the genotypic (2.57) and phenotypic (5.33) coefficient of variations were low. The heritability for the character was low (23.38) indicating non-additive gene effect for the character indicating that this trait was greatly influenced by the environment. The genetic advance under selection was low for the trait. This suggests that the expected improvement through selection for this character would be minimum and would limit the individual plant selection for any improvement for this trait. Islam *et al.* (1982) reported low genotypic co-efficient of variation for days to maturity in Chickpea. Ram *et al.* (1978) reported low habitability and low genetic advance for the trait in chickpea which are in conformity with the results of the present study.

Plant height showed a wide range of difference in genotypic (24.79) and phenotypic (68.95) variances (Table 1). This indicates that the genotypes were greatly influenced by the environment on the expression of this character. The genotypic co-efficient of variation (10.77) was considerable but the phenotypic co-efficient of variation (17.95) was high for this trait. The character showed a low heritability (35.59) and considerable genetic advance under selection. Parshuram *et al.* (2003) observed moderate estimates of habitability for the character in chickpea. Khoskhui and Niknejad (1972) showed low heritability for the trait.

In case of dry weight of plant, there were differences between the phenotypic coefficient of variation (38.75) and genotypic coefficient of variation (34.92) which indicated environmental influence in expression of this character. The high heritability (81.23%) together with high genetic advance percent of mean (64.83%) indicated the effectiveness for selection of this character.

In case of branches per plant the genotypic variance (9.25) was lower than the phenotypic variance (12.67) indicating that the trait was influenced by environment and genetic factor controlling the character had low expressivities. The genotypic co-efficient of variation was considerable (39.43) but the phenotypic co-efficient of variation was high (46.17) for the trait (Table 4). The heritability for the character was high (72.92).

The genetic advance under selection was considerable (69.39). These indicated that improvement for the trait through selection is possible. This finding is supported with the result reported by Mohammad *et al*. (2003). They observed the high heritability coupled with high genetic advance for this trait which revealed that additive gene effects are important in determining the character.

High heritability coupled with high genetic advance was observed in case of pods per plant indicating that this character was governed largely through the additive gene effect as reported by Parshuram *et al***.** (2003), Chavan (1994), Joshi (1972) and Chandra (1968). Asawa *et al*. (1977) also observed high genetic coefficient of variation in chickpea, which was in conformity with the present study. High heritability with moderate genetic advance (22.63) in percent of mean indicates that the trait pod length might be taken into consideration while selecting a suitable genotype.

High heritability coupled with high genetic advance and high genotypic co-efficient of variation conformed additive gene action for the character 100 seed weight. Jahagirdar *et al.* (1996) and Khorgade *et al.* (1985) in separate trials of chickpea observed high genetic co-efficient of variation, high values of heritability accompanied with high estimate of genetic advance for this trait. Joshi (1972) observed high estimates of heritability for this character in chickpea. Ram *et al.* (1978) also observed high estimate of heritability and high genetic advance for the character. All these results are in conformity with the findings of the present study.

**Table 3.** Correlation coefficients among different characters for forty genotypes of chickpea.

| Characters | DF | DM | PH | DW | BP | PP | SP | PL | SW | SY |
|---|---|---|---|---|---|---|---|---|---|---|
| DFF | **0.823**** | 0.369* | -0.128 | 0.328* | -0.005 | -0.043 | -0.178 | 0.296 | 0.310* | 0.093 |
| DF | | **0.428**** | -0.225 | 0.413** | -0.021 | 0.049 | -0.176 | 0.334* | 0.259 | 0.145 |
| DM | | | **-0.051** | 0.157 | -0.003 | 0.018 | -0.042 | 0.381* | 0.109 | 0.040 |
| PH | | | | **-0.025** | 0.045 | -0.138 | 0.079 | -0.035 | 0.034 | -0.039 |
| DW | | | | | **0.144** | 0.201 | -0.128 | 0.174 | 0.315* | 0.268 |
| BP | | | | | | **0.489**** | -0.095 | -0.042 | 0.125 | 0.465** |
| PP | | | | | | | **-0.078** | -0.141 | -0.097 | 0.754** |
| SP | | | | | | | | **-0.161** | -0.211 | -0.171 |
| PL | | | | | | | | | **0.450**** | 0.100 |
| SW | | | | | | | | | | **0.306** |

** Significant at 1% level of significance, * Significant at 5% level of significance.

DFF = Days to first flowering, DF = Days to 50% flowering, DM = Days to pod maturity, PH = Plant height (cm), DW = Dry matter weight (g), BP = Number of branches per plant, PP= Number of pods per plant, SP = Number of seeds per pod, PL = Pod length (mm), SW = 100 seeds weight (g), SY = Seed yield per plant (g).

In case of grain yield per plant, high genotypic and phenotypic co-efficient of variation, high heritability and high genetic advance in percentage of mean indicated that the genotypes were genetically different in respect of this character and the result suggests that the individual plant selection for this character would be effective and satisfactory for further improvement of this trait. Joshi (1972) reported high genetic advance for yield per plant in chickpea, which was similar to that found in the present study.

### *3.2. Correlation studies*

Correlation coefficients among the yield and yield contributing traits for forty chickpea genotypes are presented in Table 3. Seed yield per plant was found significantly associated with branches per plant and pods per plant. Ciftci *et al*. (2004) reported positive correlation of seed yield with branches per plant and pods per plant. Mohammad *et al*. (2003) reported that seed yield per plant had positive and significant correlation with pods per plant.Days to first flowering were positively correlated with days to 50% flowering, days to pod maturity, dry weight of plant and 100 seed weight. The significant positive correlation of days to 50% flowering with days to pod maturity, dry weight of plant and pod length indicated that selection for increased number of days to flowering may lead to increase in pod length.

Days to maturity having significant and positive relationship with pod length. Oroan *et al.* (1977) observed positive relationship of days to maturity with 100 seed weight. These results were in conformity with the present findings. A high degree of significant and positive association was observed for first flowering and 50% flowering. Thus, it was concluded that selection for the trait would lead to increase in plant height and to decrease seed yield per plant and pods per plant. From the relationship between the plant height with other traits it was clear that selection for the short individuals may lead to increase the grain yield per plant and pods per plant.

Primary branches per plant had a very strong positive association with pods per plant and seed yield per plant (Table 3). Selection for higher number of primary branches per plant also suggests for increasing pods per plant. Many authors reported positive relationship between primary branches per plant and yield per plant. From the report of Singh (1968) and Gupta (1972), Primary branches per plant were found to be positively correlation with yield per plant. Islam and Begum (1985) also reported for positive relationship of the character with pods per plant. The findings the present study are in good agreement with those of the others.

Pods per plant showed strong positive relationship with yield per plant and branches per plant but negative relationship with 100 seed weight, pod length and seeds per pod. 100 seed weight showed significant positive correlation with pod length, dry weight per plant and days to first flowering. Positive relationship between 100 seed weight and yield per plant was observed from the study of Khan (1949), Bhardwej and Singh (1972), Joshi (1972), Lal *et al.* (1976) and Islam *et al.* (1984) in different chickpea trials. These findings admitted the finding of the present study. From above mentioned relationship it might be concluded that selection for increased weight of 100 seed would lead to increase in yield per plant. Based on correlation study of the characters, primary branches per plant, pods per plant and 100 seed weight can be considered as selection criteria for the improvement of grain yield in chickpea.

### *3.3. Path coefficient Analysis*

Results of the path coefficient analysis for component characters on seed yield in chickpea is presented (Table 4), which indicates that pods per plant had indirect effect but the highest and significant contribution on seed yield. Branches per plant were shown to have direct effect with the positive and significant contribution on seed yield per plant.

**Table 4.** Path coefficient showing direct (bold value) and indirect effects of different characters on yield in chickpea.

| Characters | DFF | DF | DM | PH | DW | BP | PP | SP | PL | SW | Correlation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DFF | **2.817** | 0.130 | -0.214 | 0.106 | -0.059 | 0.006 | -1.094 | -0.887 | -0.375 | -0.034 | 0.093 |
| DF | 0.262 | **1.404** | -0.457 | 0.103 | 0.165 | 0.0008 | -0.741 | -0.147 | -0.212 | 0.072 | 0.145 |
| DM | 0.408 | 0.435 | **-1.476** | 0.118 | 0.507 | 0.009 | 0.082 | -0.204 | -0.089 | 0.048 | 0.040 |
| PH | 0.112 | 0.363 | -0.437 | **0.400** | -0.270 | -0.004 | 0.098 | -0.093 | -0.280 | 0.032 | -0.039 |
| DW | -0.109 | 0.153 | -0.493 | -0.071 | **1.519** | -0.0001 | -0.115 | -0.021 | -0.302 | -0.069 | 0.268 |
| BP | 0.755 | 0.047 | -0.562 | -0.070 | -0.065 | **0.024** | 0.011 | 0.024 | -0.006 | -0.015 | 0.465** |
| PP | 1.310 | 0.442 | 0.051 | -0.016 | 0.074 | -0.0001 | **-2.352** | -0.386 | 0.906 | -0.054 | 0.754** |
| SP | 2.124 | 0.175 | -0.256 | 0.031 | 0.027 | -0.0005 | -0.771 | **-1.177** | -0.280 | 0.077 | -0.171 |
| PL | -0.481 | -0.136 | 0.060 | -0.051 | -0.209 | - | -0.971 | 0.150 | **2.194** | -0.127 | 0.100 |
| SW | 0.281 | -0.296 | 0.208 | -0.038 | 0.305 | 0.0011 | -0.369 | 0.264 | 0.809 | **-0.344** | 0.306 |

Residual effect: 0.345

The direct and indirect analysis clearly showed that days to maturity had indirect negative effect on yield per plant through seeds per pod and 100 seed weight. The positive indirect effect of plant height on yield per plant was through first days to flowering, pods per plant and 100 seed weight but had negative indirect effect on yield per plant through days to maturity, dry weight per plant, primary branches per plant and seeds per pod.

Positive indirect effect for primary branches per plant on yield was recorded through days to first flowering, days to 50% flowering, seeds per pod and pods per plant. The trait also showed indirect negative effect on yield per plant through days to maturity and plant height.

Singh *et al*. (1978) and Katiyar (1979) in their experiments on chickpea observed direct effect of primary branches per plant on yield, which supports the present findings. Direct and indirect effects of pods per plant on yield in chickpea were reported by Sandhu and Singh (1972). The direct effect of the character on yield was also supported by Chand *et al.* (1975) in chickpea. Singh *et al.* (1978) found positive direct effect of pods per plant in a study of chickpea. All these results agree with those of the present study.

The residual effect of path co-efficient analysis was quite high (0.345). Depending on path analysis the characters days to flowering, dry weight per plant and pod length can be used as selection criteria for developing early flowering with short duration for pod maturity type genotypes. The characters days to flowering, plant height, dry weight per plant, pod length and 100 seed weight were considered as selection criteria for the improvement of the crop yield.

**4. Conclusions**

Genetic variability was done to find out the more variable characters which might be used in the hybridization programme. From this present study days to flower, plant height, number of branches per plant, number of pods per plant, 100 seed weight and seed yield per plant are more variable character among these genotypes. Correlation and path co-efficient analysis was done to find out the relationship among the yield and yield contributing characters. From this present study showed that seed per plant has positive and significant relation with branches per plant and pods per plant. Number of pods per plant are positively correlated with branches per plant but negatively correlated with plant height and days to first flowering. Weight of 100-seed had significant and positive correlation with days to first flowering, dry weight per plant and pod length but had negative correlation with pods per plant and seeds per pod. Days to first flowering, pod length, pods per plant, dry weight per plant had direct effect on yield. Therefore, days to first flowering, pods per plant, pod length, branches per plant and dry weight per plant are the important characters which could be used in selection for yield.

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