



## Research Article

# GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS IN YIELD AND YIELD COMPONENTS IN CHICKPEA (*Cicer arietinum* L.) GENOTYPES UNDER LATE SOWN CONDITION

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**Abstract-** Thirty eight chickpea varieties were studied to find out genetic variability, genetic association and path coefficient analysis for grain yield and its attributing characters. Both genotypic and phenotypic variances were highly significant for all the traits with little higher phenotypic coefficient of variation. The low differences between the phenotypic and genotypic coefficients of variations indicated low environmental influences on the expression of these characters. High heritability coupled with high genetic advance were obtained with harvest index, seeds per pod, total number of pods per plant, seed yield per plant, days to maturity. Genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients in most of the traits. Harvest index, 100-seed weight, seeds per pod, number of effective pods per plant, total number of pods per plant, number of primary branches per plant per plant and plant height were the most important characters, which possessed positive association with seed yield per plant. Path coefficient analysis revealed that among the different yield contributing characters harvest index, 100-seed weight, seeds per pod, total number of pods per plant, number of secondary branches per plant, plant height, days to maturity and days to 50% flowering influenced seed yield per plant directly. Thus, selection for yield in chickpea through these characters would be effective.

**Keywords-** Chick pea, Genetic Variability, Correlation, Path Analysis

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## Introduction

Chickpea [*Cicer arietinum* (L.)  $2n=2x=16$ ] belongs to genus *Cicer*, family fabaceae, and sub family papilionaceae. It is an annual, self-pollinating, diploid pulse crop with a genome size of 750 Mbp. It is an important food legume of the semiarid tropics and the warm temperate zones and widely cultivated in Asia, Africa (East and North) and the Mediterranean Europe. India is producing 9.53 mt of chickpea with 960 kg/ha productivity from an area of 9.93mha area which is one of the major chickpea producing country [Project Co-ordinator's report 2014-15]. As a grain legume, it plays a significant role in the nutrition of the rural and urban poor in the developing world with providing a protein-rich supplement to cereal based diets particularly of vegetarians and subsistence farmers who cannot afford meat. Chickpea is usually grown in winter-season but during the past three decades, there is notable shift in the growing environment from the cooler environments of northern India to the warmer environments of central and southern India due to harmful effect of terminal drought and heat stresses. There are major constraints in warmer short-season environments for chickpea production.

The variability for the characters of economic importance is the basic prerequisite for improvement. Lack of adequate variability has been implicated as one of the major limitation in improving the productivity of chickpea. The extent of genetic variability has been considered as an important factor, which is an essential prerequisite for a successful hybridization aimed at producing high yielding progenies. The knowledge of heritability helps the plant breeder in predicting the behaviour of the succeeding generations, making desirable selection and assessing the magnitude of genetic improvement through selection. Correlation coefficient show linear relation between different characters. The aim of correlation studies is

primarily to know the association of yield component characters with yield. Determination of correlation coefficients between various characters helps to obtain best combinations of attributes in chickpea crop for obtaining higher return per unit area. Correlation studies not clearly reveal such sort of information and inadequate knowledge about interrelationships of heritable traits may lead to negative results. On the other hand, partitioning of total correlation into direct and indirect effect by path analysis helps in making the selection more effective. Studies on path co-efficient also provide useful information regarding the direct and indirect effects of different yield component characters on grain yield and thus aid in the identification of effective selection criteria for effective yield improvement.

The present study was, therefore, conducted to assess the extent of genetic variability, characters correlation, heritability, genetic advance and path coefficient for thirteen traits in 38 genotypes of chickpea. The information obtained will be utilized in devising the breeding strategy in chickpea improvement

## Material and Methods

Thirty eight chickpea genotypes including twenty seven *desi* and eleven *kabuli* were evaluated and screened for heat tolerance under normal condition during Rabi season 2012-2013 following randomized completely block design (RCBD) with three replications. The research was conducted under All India Coordinated Research Project on Chickpea (AICRP on Chickpea) at Seed Breeding Farm, Department of Plant Breeding and Genetics, J.N.K.V.V., Jabalpur, situated in subtropical to semi-arid climate regions. All the recommended cultural practices were adopted to maintain a healthy crop growth. Data regarding yield and thirteen attributing traits viz., days to flower initiation, days to 50% flowering, days to pod

initiation, days to maturity, plant height( cm), number of primary branches per plant, secondary branches per plant, total number of pods per plant, effective pods per plant, seeds per pod, 100-seed weight(g) and harvest index( %) were recorded for all the chickpea genotypes. Genotypic and phenotypic coefficients of variation (GCV and PCV) were calculated by the formula given by [1] heritability in broad sense ( $h^2$ ) by [2] and genetic advance given by [3]. The character association was estimated from variance and covariance components as given [4]. While the direct and indirect effects of component traits on grain yield were measured by path analysis as described by [5].

## Results and Discussions

Coefficient of variation provides a relative measure of variance among the different traits. The value of phenotypic coefficient of variation for all the traits under study was found to higher than genotypic coefficient of variation [Table-1]. In late sown condition, high genotypic coefficient of variation was found for 100-

seed weight (28.5%), total number of pods per plant (28.1%), seed yield per plant (25.4%) and effective pods per plant (24.8%), whereas high phenotypic coefficient of variation was found for number of effective pods per plant (32.5%), total number of pods per plant (29.0%), 100-seed weight (28.8%) and seed yield per plant (27.2%). It indicates the preponderance of additive genetic effect for these characters. Selection of these traits will be effective. Results were in accordance with the findings of [6-8]. In any crop improvement programme, the most basic information required by a breeder is the extent of the inheritance capacity of the genotype for different character under consideration. Highest heritability was found for 100 seed weight (98.4%), followed by harvest index (97.7%), total number of pods per plant (94.2%), seeds per pod (94.1%), days to maturity (92.4%) and days to pod initiation (86.6%), seed yield per plant (86.6%), days to pod initiation (86.6%), days to 50% flowering (84.4%), days to flower initiation (81.2%), plant height (72.3%) and number of effective pods per plant (58.3%). Similar results have been reported by [9-12].

**Table-1** Genetic parameters of variability in chickpea genotypes under late planting condition

| Characters       | Grand mean | Range |      | Coefficient of variation |         | $h^2$ (B) % | GA as % of mean |
|------------------|------------|-------|------|--------------------------|---------|-------------|-----------------|
|                  |            | Min.  | Max. | PCV (%)                  | GCV (%) |             |                 |
| FI               | 36.3       | 31.7  | 37.7 | 9.1                      | 8.2     | 0.8         | 15.2            |
| F <sub>50%</sub> | 41.1       | 33.3  | 47.3 | 8.9                      | 8.2     | 0.8         | 15.4            |
| PI               | 46.0       | 37.3  | 51.3 | 8.5                      | 7.9     | 0.9         | 15.1            |
| DM               | 75.9       | 67.3  | 81.0 | 5.1                      | 4.9     | 0.9         | 9.7             |
| PH(cm)           | 39.4       | 32.5  | 47.0 | 8.5                      | 7.3     | 0.7         | 12.7            |
| PB               | 2.7        | 2.0   | 3.0  | 16.6                     | 2.1     | 0.0         | 0.5             |
| SB               | 9.0        | 6.7   | 11.7 | 22.0                     | 1.9     | -0.0        | -0.3            |
| TNPPP            | 46.2       | 24.7  | 90.0 | 29.0                     | 28.1    | 0.9         | 56.1            |
| EPPP             | 36.6       | 19.0  | 63.7 | 32.5                     | 24.8    | 0.6         | 39.0            |
| SPP              | 1.1        | 0.6   | 1.5  | 19.8                     | 19.2    | 0.9         | 38.4            |
| 100SW(g)         | 26.6       | 12.1  | 45.4 | 28.8                     | 28.5    | 1.0         | 58.3            |
| HI(%)            | 40.7       | 24.8  | 57.8 | 19.4                     | 19.2    | 1.0         | 58.3            |
| SYPP             | 8.8        | 4.4   | 14.7 | 27.2                     | 25.4    | 0.9         | 48.6            |

Abbreviation: FI=flower initiation, F50%=days to 50% flowering, PI=pod initiation, DM=days to maturity, PH=plant height, NPB=number of primary branches, NSB=number of secondary branches, TNPPP=total number of pods per plant, EPPP=effective pods per plant, SPP=seeds per plant, 100-SW=100-seed weight, HI (%)=harvest index, SYPP=seed yield per plant

Characters showing high heritability coupled with high genetic advance as percentage of mean were 100 seed weight, harvest index, number of effective pods per plant, total number of pods and seed yield per plant. These findings were in agreement with [9,13-15]. The correlations were estimated to find out the characters which can be given utmost consideration during selection. Correlation analysis [Table-2] revealed that the days to flower initiation showed positive and significant correlation with days to 50% flowering (0.9843), days to pod initiation (0.9369), days to maturity (0.8968), plant height (0.2721), total number of pods per plant (0.2972), number of effective pods per plant (0.2688) and harvest index (0.2626) while, days to 50% flowering exhibited positive and significant correlation with days to pod initiation (0.9515), days to maturity (0.9156), total number of pods per plant (0.2894), number of effective pods per plant (0.2556), seeds per pod

(0.2007) and harvest index (0.2814). Days to pod initiation exhibited positive and significant correlation with days to maturity (0.9729), total number of pods per plant (0.2879), number of effective pods per plant (0.2518). Days to maturity had significant correlation with total number of pods per plant (0.2981) and number of effective pods per plant (0.2348) whereas, Plant height with 100 seed weight (0.3221). Primary branches exhibited positive and significant correlation with number of effective pods per plant (0.2331) and Number of secondary branches per plant with total number of pods per plant (0.2457) and number of effective pods per plant (0.3672). Total pods per plant had significant and positive correlation with number of effective pods per plant (0.8756). These traits seem to be major yield factors; hence selection of these characters will be effective for improvement on seed yield. These findings are in accordance with earlier [16-20].

**Table-2** Phenotypic Correlation Coefficient analysis for yield and its contributing traits in chickpea under late planting condition

| Char.            | FI     | F 50%     | PI        | DM        | PH(cm)    | PB      | SB      | TNPP     | EPPP      | SPP     | 100 SW     | HI (%)     |
|------------------|--------|-----------|-----------|-----------|-----------|---------|---------|----------|-----------|---------|------------|------------|
| FI               | 1.0000 | 0.9843*** | 0.9369*** | 0.8968*** | 0.2721**  | 0.0492  | 0.0217  | 0.2972** | 0.2688**  | 0.1920* | -0.5285*** | 0.2626**   |
| F <sub>50%</sub> |        | 1.0000    | 0.9515*** | 0.9156*** | -0.2886** | 0.0553  | 0.0191  | 0.2894** | 0.2556**  | 0.2007* | -0.5309*** | 0.2814**   |
| PI               |        |           | 1.0000    | 0.9729*** | -0.2278*  | 0.0585  | 0.0049  | 0.2879** | 0.2518**  | 0.1385  | -0.5121*** | 0.1549     |
| DM               |        |           |           | 1.0000    | -0.2043*  | 0.0343  | -0.0242 | 0.2981** | 0.2348*   | 0.1161  | -0.5244*** | 0.1762     |
| PH(cm)           |        |           |           |           | 1.0000    | -0.0371 | -0.0203 | -0.2353* | -0.1907*  | -0.0198 | 0.3221***  | -0.3774*** |
| PB               |        |           |           |           |           | 1.0000  | 0.1739  | 0.1598   | 0.2331*   | 0.0844  | 0.0129     | 0.0330     |
| SB               |        |           |           |           |           |         | 1.0000  | 0.2457** | 0.3672*** | -0.0262 | -0.0393    | -0.0243    |
| TNPPP            |        |           |           |           |           |         |         | 1.0000   | 0.8756*** | 0.0772  | -0.4619*** | 0.0937     |
| EPPP             |        |           |           |           |           |         |         |          | 1.0000    | 0.1438  | -0.3765*** | 0.0985     |
| SPP              |        |           |           |           |           |         |         |          |           | 1.0000  | -0.3909*** | 0.1711     |
| 100SW(g)         |        |           |           |           |           |         |         |          |           |         | 1.0000     | -0.1933*   |
| HI(%)            |        |           |           |           |           |         |         |          |           |         |            | 1.0000     |

Abbreviation: FI=flower initiation, F50%=days to 50% flowering, PI=pod initiation, DM=days to maturity, PH=plant height, NPB=number of primary branches, NSB=number of secondary branches, TNPPP=total number of pods per plant, EPPP=effective pods per plant, SPP=seeds per plant, 100-SW=100-seed weight, HI (%)=harvest index, SYPP=seed yield per plant.

Path coefficient analysis is the most widely used biometrical technique in plant breeding. The information obtained from this technique, also helps in making selection based on component characters of yield. It helps in understanding the cause of association between two variables. Traits viz., Days to 50% flowering (0.5014), Days to maturity (0.1226), plant height (0.1462), Number of secondary

branches per plant (0.0976), Total number of pods per plant (0.3433), Effective pods per plant (0.3181), Seeds per pod (0.0656), 100 seed weight (0.7298), Harvest index (0.2358) expressed positive direct effect on seed yield per plant [Table-3].

**Table-3** Genotypic Path coefficient analysis for yield and its component characters in chickpea under late planting condition

| Characters       | FI             | F <sub>50%</sub> | PI             | DM             | PH (cm)       | PB             | SB             | TNPPI         | EPPP           | SPP           | 100SW         | HI (%)        | Genotypic correlation coefficient with SY/plant (g) |
|------------------|----------------|------------------|----------------|----------------|---------------|----------------|----------------|---------------|----------------|---------------|---------------|---------------|-----------------------------------------------------|
| FI               | <b>-2.0769</b> | -2.523           | -1.9692        | -1.9528        | 0.6800        | -0.5600        | 0.0379         | -0.6746       | -0.6182        | -0.5001       | 1.1973        | -0.6367       | -0.3557                                             |
| F <sub>50%</sub> | -2.2289        | <b>-2.2458</b>   | -2.1543        | -2.1410        | 0.7706        | -0.4916        | 0.0873         | -0.7114       | -0.6600        | -0.5483       | 1.2811        | -0.7082       | -0.3374                                             |
| PI               | 11.7519        | 11.8375          | <b>12.3407</b> | 12.3542        | -3.4500       | 3.8203         | 5.4351         | 3.8274        | 3.4472         | 2.0009        | -6.7065       | 1.1377        | -0.3403                                             |
| DM               | -7.9388        | -8.0142          | -8.4160        | <b>-8.4068</b> | 2.2680        | -3.7587        | -1.8917        | -2.7017       | -2.4850        | -1.0815       | 4.5659        | -1.5680       | -0.2929                                             |
| PH(cm)           | -0.0952        | -0.0993          | -0.0809        | -0.0781        | <b>0.2894</b> | -0.1073        | 0.0240         | -0.0822       | -0.0753        | -0.0006       | 0.1150        | -0.1315       | 0.2040                                              |
| PB               | -0.0609        | -0.0492          | -0.0696        | -0.1006        | 0.0834        | <b>-0.2250</b> | 0.1273         | -0.1977       | -0.1692        | -0.1880       | -0.0504       | -0.0214       | 1.0266                                              |
| SB               | 0.0034         | 0.0073           | -0.0823        | -0.0421        | -0.0155       | 0.1058         | <b>-0.1870</b> | 0.3513        | 0.1359         | -0.0327       | -0.0909       | -0.0172       | -0.9404                                             |
| TNPPI            | 1.3422         | 1.3033           | 1.2760         | 1.3222         | -1.1678       | 3.6155         | -7.7293        | <b>4.1142</b> | 4.2010         | 0.3565        | -1.9791       | 0.4139        | 0.2705                                              |
| EPPP             | -0.9644        | -0.9480          | -0.9011        | -0.9535        | 0.8395        | -2.4260        | 2.3450         | -3.2940       | <b>-3.2259</b> | -0.7125       | 1.6095        | -0.4976       | 0.3433                                              |
| SPP              | 0.1972         | 0.1991           | 0.1322         | 0.1049         | -0.0017       | 0.6815         | 0.1425         | 0.0707        | 0.1801         | <b>0.8156</b> | -0.3339       | 0.1460        | -0.1456                                             |
| 100SW(g)         | -0.6652        | -0.6554          | -0.6244        | -0.6240        | 0.4564        | 0.2572         | 0.5583         | -0.5527       | -0.5732        | -0.4704       | <b>1.1489</b> | -0.2268       | 0.5193                                              |
| HI(%)            | 0.3709         | 0.3798           | 0.2086         | 0.2247         | -0.5474       | 0.1148         | 0.1101         | 0.1212        | 0.1858         | 0.2157        | -0.2378       | <b>1.2045</b> | <b>0.0948</b>                                       |

Env-1—(R square= 0.5544 Residual effect= 0.6675

Env-2—(R square= 0.3579 Residual effect= 0.8013

Abbreviation: FI=flower initiation, F50%=days to 50% flowering, PI=pod initiation, DM=days to maturity, PH=plant height, NPB=number of primary branches, NSB=number of secondary branches, TNPPI=total number of pods per plant, EPPP=effective pods per plant, SPP=seeds per plant, 100-SW=100-seed weight, HI (%)=harvest index, SYPP=seed yield per plant.

The significantly positive association and high direct effect on seed yield suggest that selection should be oriented towards more number of effective pods, high harvest index and plant height and thus ultimate resulting in higher seed yield. The highly significant and positive association among the various yield-attributing traits indicates immense scope for the seed yield improvement in chickpea.

1-7.

**Conflict of Interest: None declared**

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