REVIEW OF LITERATURE
CHAPTER II

REVIEW OF LITERATURE

The literature available on the topic under the study is reviewed under following heads:

1. Genetic variability
2. Heritability and genetic advance
3. Correlation analysis
4. Path coefficient analysis
5. Stability analysis

2.1 Genetic variability

The efficiency of selection for starting an effective breeding programme mainly depends upon the existing variability. The available information on the variability for traits influencing the seed yield in chickpea is reviewed here.

Katiyar and Singh (1979) analyzed the genetic divergence of 40 indigenous and exotic strains of chickpea and found significant differences among the varieties for all the characters under study.

Adhikari and Pandey (1983) measured genetic divergence by Mahalanobis’s $D^2$ and principal component analysis in 36 varieties obtained from
ten major chickpea growing states of India. Analysis of variance revealed highly significant differences among the strains for all the characters.

Kamble et al. (1984) studied seed yield and its component characters under irrigated and rainfed conditions and reported significant genetic variability for all the characters under both the environments.

Dumbre et al. (1984) reported wide range of variation for seeds per pod, seed yield per plant and 100 seed weight in 16 cultivars of chickpea.

Salimath and Bahl (1985) reported high coefficient of variation for pods per plant and seed weight and reported low GCV for seeds per pod.

Choudary and Khaleque (1988) studied thirteen genetically diverse chickpea strains and observed significant variation for nine characters.

Mishra et al. (1988) studied genetic parameters of variability for yield and its components in 117 genotypes of chickpea and reported that grain yield had positive association with plant spread, number of primary branches/plant, number of secondary branches/plant, pod bearing length, number of pods/plant, biological yield/plant and harvest index.

Uddin et al. (1990) reported higher heritability values for days to flowering, days to maturity, grain filling period, 100 seed weight and yield per plant except days to maturity.

Sharma et al. (1990) reported high genotypic and phenotypic coefficients of variation for secondary branches per plant and 100 seed weight in 48 diverse lines of chickpea.
Tripathi and Arora (1991) observed high coefficients of variation in chickpea for biological yield, number of secondary branches, pods per plant and seeds per pod.

Bhatia et al. (1993) studied variability and interrelationship of yield with its attributes in chickpea. They evaluated ninety-six chickpea genotypes and reported that maximum variability was observed for pods per plant.

Rao et al. (1994) estimated genetic variability in 44 varieties of *Cicer arietinum* L. and recorded high genotypic coefficient of variation for 100 seed weight, secondary branches per plant, pods per plant and seed yield per plant.

Jahagirdar et al. (1994) reported high genotypic and phenotypic coefficients of variation for pods per plant, 100 seed weight and number of secondary branches per plant in chickpea.

Charan et al. (1994) evaluated seventy genotypes for eight yield related traits and reported greater genetic variability for pods per plant and branches per plant in chickpea.

Deshmukh and Patil (1995) analyzed nine chickpea varieties of diverse origin for yield and its components. High heritability associated with high genetic advance was observed for the characters relative growth rate, net assimilation rate, crop growth rate, leaf area index.

Khorgade et al. (1995) reported that 100 seed weight, seeds per pod, days to 50 per cent flowering and branches per plant were having significant genotypic and phenotypic coefficients of variation.
Rao (1996 a) observed greater variability for seed yield and pods per plant in chickpea.

Rao (1996 b) observed substantial variability for pod bearing length, plant spread, biological yield, seed yield, 100 seed weight and harvest index. Maximum variability was observed for seed yield followed by harvest index and biological yield.

Shinde et al. (1996) gathered information on range, mean, genotypic and phenotypic coefficients of variation for eleven yield related traits in fifty two diverse genotypes in chickpea and obtained high genotypic and phenotypic coefficients of variation for number of pods per plant, seed yield and 100 seed weight.

Tripathi (1998) gathered information on thirteen yield related characters in hundred genotypes of chickpea and reported high genotypic coefficient of variation for pods per plant, seeds per plant, biological yield and seed yield per plant.

Rao and Jain (1998) observed substantial genetic variability for yield and its components. 100 seed weight had the highest genetic advance followed by pods per plant and biological yield.

Kumar et al. (1999) estimated genotypic and phenotypic coefficient of variation for seven yield related traits in 50 genotypes of chickpea and reported that GCV and PCV were higher for number of pods per plant, 100 seed weight, seed yield per plant and harvest index indicating greater variability for these traits.
Venugopal (2000) studied seventeen F6 populations of chickpea under rainfed and irrigated conditions and observed high genotypic coefficient of variation for seed yield per plant and 100 seed weight under rainfed condition and seeds per plant under irrigated condition.

Rao (2000) observed maximum variability for seed yield/plant, biological yield and plant spread when twenty one vascular wilt resistant elite chickpea genotypes were evaluated for plant type characters.

Jeena and Arora (2001) studied thirty-six genetically diverse genotypes of chickpea for genotypic and phenotypic variability in 16 quantitative attributes. The highest genotypic variability was noted for 100 seed weight followed by seed yield per plant, biological yield, secondary branches per plant and seeds per plant.

Benkova and Zakova (2002) evaluated 27 genetic resources of chickpea for selected traits. The results of Analysis of variance showed that variability of individual traits was affected by year and genotype. There was a strong dependence between length of vegetation period and between the traits.

Kashyap et al. (2003) evaluated sixty genotypes of chickpea and reported high range of phenotypic coefficient of variation for number of secondary branches, biological yield and seed yield. They also reported positive association of seed yield with biological yield, number of pods, number of secondary branches and harvest index.
2.2 Heritability and genetic advance

Heritability is the quantitative statement of the relative importance of heredity and environment. The partitioning of phenotypic variance was done by Fisher (1918).

The concept of heritability was given by Lush (1940) and defined as the ratio of genotypic variance to the total variance (phenotypic). Heritability estimates may differ from character to character in a population under study. Heritability estimates and genetic advance in chickpea reported by previous workers are reviewed here.

Dumbre et al. (1984) reported coupling of heritability with high genetic advance for seed yield and its components in chickpea.

Maloo and Sharma (1987) reported coupling of high genetic advance with high heritability for seed yield, pod number, primary branches per plant and plant height in chickpea.

Reddy and Rao (1988) reported high heritability for 100 seed weight, days to flowering, days to maturity and pods per plant in chickpea.

Sharma et al. (1990) observed highest genetic variability for secondary branches followed by pods and seed yield per plant, 100 seed weight and primary branches per plant. High heritability and genetic advance were observed for secondary branches per plant and 100 seed weight. Days to maturity and plant height also showed high heritability.
Rao et al. (1994) studied 44 varieties of chickpea and found that heritability and genetic advance were high for 100 seed weight whereas, low heritability estimates coupled with high genetic advance were observed for plant height, seed yield/plant, pods per plant and secondary branches per plant.

Johagirdar et al. (1994) found high heritability together with high genetic advance for 100 seed weight, days to 50 per cent flowering, number of secondary branches and pods per plant in chickpea.

Khargode et al. (1995) evaluated 32 genotypes of chickpea and reported high heritability for 100 seed weight and days to 50% flowering.

Tripathi (1998) evaluated 100 genotypes of chickpea for 13 characters and reported high heritability estimates coupled with high genetic advance for pods per plants, seeds per pod, biological yield and seed yield per plant.

Kumar et al. (1999) reported high heritability coupled with high genetic advance as percentage of mean for number of pods per plant, seed yield per plant and 100 seed weight.

Venugopal (2000) reported high heritability estimates for plant height, seeds per pod and seed weight under both irrigated and rainfed conditions and high expected genetic advance for pods per plant, seeds per plant and 100 seeds weight.

Sable et al. (2000) evaluated 30 chickpea genotypes during 1999-2000 and reported high heritability with high genetic advance for seed yield per plant, 100 seed weight and biological yield per plant.

Jeena and Arora (2001) reported high genetic advance with high amount of heritability in thirty six genetically diverse genotypes of chickpea.
Singh et al. (2001) reported that most of the quantitative traits are controlled by both additive and non-additive type of gene action and suggested population improvement approach for genetic improvement of agronomic traits in chickpea.

2.2 Correlation analysis

Direct selection for complex traits like yield is often not very effective. Indirect selection for some of the component traits associated with seed yield may be rewarding. Thus, knowledge of the nature and extent of inter relationship between yield and its attributes will be of great utility to the breeders in formulating selection strategies aimed for improving the seed yield by utilizing correlation measures and the intensity of association between any two characters. This concept of correlation was later elaborated and discussed by Fisher (1918) and Wright (1921) for plant breeding programmes. A brief review of correlation studies on seed yield and its components in chickpea is summarized as below.

Salimath and Bahl (1986) and Singh et al. (1998) reported positive correlation of seed yield with primary branches, secondary branches and pods per plant in chickpea.

Sindhu and Prasad (1987) reported positive correlation of days to maturity, 100 seed weight, pods per plants, seeds per pod and harvest index with seed yield in chickpea.
Choudhary and Khaleque (1988) studied correlations among yield traits in chickpea and found positive correlation coefficients between number of secondary branches and plant height, seed yield and pods per plant, and seed weight.

Ali (1990) made correlation studies in indigenous genotypes of chickpea and revealed that grain yield was positively correlated with plant height, days to flowering days to maturity and grain mass. Positive association was also seen between grain mass and days to flowering.

Uddin et al. (1990) reported higher phenotypic and genotypic coefficients of variation for yield per plant, 100 seed weight and pods per plant. The correlation study revealed that yield per plant had significant positive correlations with pods per plant, 100 seed weight, conventional harvest index and primary branches per plant.

Chinna et al. (1991) studied relationship of seed yield and some morphological characters in chickpea under rainfed conditions and observed that seed yield had a high correlation with pods per plant and number of secondary branches. Highest direct positive effect was observed for pods per plant on seed yield.

Tripathi and Arora (1991) studied analysis of variance and revealed that seed yield was positively associated with biological yield, number of pods, plant height, number of secondary branches, harvest index, number of secondary branches, harvest index, seeds per pod and length of pod bearing branch. Seed yield showed negative correlation with first pod forming nod.
Bhatia et al. (1993) reported strong positive correlation of grain yield with biological yield and harvest index. They also found significant positive correlation of biological yield with number of pod bearing nodes, pods per plant, branches per plant and plant height. The significant and negative association of harvest index was observed with number of nodes to first pod from the base, total nodes and days to 50% flowering.

Sarvaliya and Goyal (1994) studied nine yield related traits in seventy six genotypes of chickpea and reported significant association of seed yield with 100 seed weight, primary branches per plant, pods per plant, days to maturity and days to 50% flowering.

Khargode et al. (1995) estimated correlation among nine traits in thirty genotypes of chickpea under normal and late sown conditions. They found that seed yield had significant positive associations with biological yield per plant, pods per plant, branches per plant, harvest index and 100 seed weight, whereas, days to maturity and seeds per pod had negative association with seed yield per plant under both the conditions.

Deshmukh and Patil (1995) reported positively correlation of grain yield with pods/plant and harvest index in chickpea.

Fernandez and Johnston (1995) evaluated seed vigour testing in lentil, bean and chickpea; they reported that there was no clear relationship between the germination and emergence speed indices among species.

Rao (1996 a) studied correlation in forty genotypes of chickpea derived through multiple courses. The reproductive period, pods and pod weight/plant,
harvest index and 100 seed weight had positive association with seed yield, where as, seeds/pod had negative association with seed yield.

Rao (1996 b) evaluated sixteen bold seeded chickpea genotypes for developmental traits viz. pod bearing length, plant spread, biological yield, seed yield, 100 seed weight and harvest index and reported positive correlation of seed yield with harvest index, biological yield and 100 seed weight.

Cinsoy and Yaman (1998) evaluated 125 Chickpea population for 17 yield related traits at different locations and observed significant positive correlation between pods per plant and seeds per plants where as, they observed negative association of duration of flowering and plant height with seed weight.

Ahmed et al. (1998) estimated correlations between economic traits in chickpea and observed positive and significant correlation of seed yield per plant with various yield components viz. seeds/ plant, pods/ plant and plant height in chickpea. Seed weight was negatively correlated with number of pods per plant and seeds per pod. Seeds per pod were negatively correlated with protein content. Genetic correlations were observed to be higher than the phenotypic correlation coefficients.

Kumar et al. (1999 a) reported high heritability of days to first flower, days to maturity and total reproductive period in chickpea.

Rao (2000) made association analysis in twenty one vascular wilt resistant elite chickpea genotypes and reported that pod bearing length, developmental period, plant spread and biological yield had positive association with seed yield.
Developmental period, biological yield and 100 seed weight had positive associated with harvest index.

Roozrokhl et al. (2002) reported significant correlation between seed yield and speed of germination and electrical conductivity in chickpea.

2.4 Path coefficient analysis

Seed is the product of interactions of many component characters. The study of association between various yield attributes and yield provides a basis for further breeding programmes. However, the correlation study does not reveal the direct and indirect contribution of individual character towards seed yield. In such situation, the path analysis provides an effective measure to find out the direct and indirect contribution of traits towards the seed yield. The previous studies in the field of path analysis in chickpea are reviewed here.

Singh et al. (1985) reported that in chickpea, seeds per pod had the highest direct effect on yield, while most of the characters influenced the seed yield indirectly via pods per plant.

Salimath and Bahl (1986) reported that branches per plant, pods per plant and 100 seed weight had positive direct contribution towards seed yield.

Singh and Paroda (1986) reported that in chickpea, pods per plant had the highest positive direct effect on seed yield followed by seeds per pod. Whereas, 100 seed weight showed negative direct effect towards seed yield.

Reddy and Rao (1988) reported that seeds per plant and 100 seed weight had positive direct effect towards seed yield in chickpea.
Choudhary and Khaleque (1988) showed existence of high positive direct effect of pods per plant and number of primary branches per plant on yield.

Uddin et al. (1990) reported positive direct effects of days to maturity, pods per plant, 100 seed weight, harvest index, plant height and primary branches per plant towards seed yield in fifty four genetically diverse chickpea genotypes.

Jadhav et al. (1992) studied path coefficients in chickpea and reported greatest positive direct effect of seed size on grain yield per plant. Harvest index and number of branches per plant also had appreciable direct contribution towards seed yield.

Arora and Kumar (1994) performed path coefficient analysis in chickpea and observed that 100 seed weight, harvest index and pods per plant had positive direct effects on seed yield per plant.

Sarvaliya and Goyal (1994) reported positive direct effects of pods per plant and 100 seeds weight towards grain yield in chickpea.

Bhattacharya et al. (1995) carried out path analysis in chickpea and reported that under stress condition, the maximum direct effect on seed yield was exerted by biological yield followed by harvest index.

Khargode et al. (1995) reported high positive direct effect of pods per plant, primary branches per plant and 100 seed weight towards contributing to seed yield in chickpea.

Shamsuzzaman et al. (1994) studied path coefficient analysis in F2 segregating populations of chickpea. Path coefficient analysis indicated that
seeds/plant and plant height were imported yield contributing characters as they had positive direct effects on the seed yield.

Manjare et al. (1997) carried out path coefficient analysis and observed that number of branches per plants, days to 50% flowering and number of seeds per pod exhibited high direct effects on seed yield per plant. Whereas, pods per plant influenced the seed yield through number of branches per plant and plant spread.

Kumar et al. (1999) found that harvest index and biomass per plant registered high positive direct effects towards seed yield. Number of pods per plant and 100 seed weight had negative direct effect on yield.

Khedar and Maloo (1999) worked out genotypic and phenotypic correlations for forty genetically diverse genotypes for seed yield and its components and reported significant positive correlation of seed yield with pods per plant, primary branches per plant and 100 seed weight. The analysis indicated that pods per plant had the highest direct effect on seed yield followed by seeds per pod, 100 seed weight and primary branches per plant.

Venugopal (2000) reported that under rainfed condition, 100 seed weight, pods per plant and pod bearing length had direct positive effect on seed yield.

Yadav et al. (2002) reported that correlation and path coefficients are important tools for generating information regarding relationship among traits for use in selection. They studied parameters in 40 chickpea genotypes which were planted at two locations. Estimates of genotypic correlation exhibited positive and highly significant association among traits like grain yield, biological yield and harvest index. The phenotypic correlations also showed the same pattern of
association. Path coefficients at genotypic as well as at phenotypic levels showed that harvest index, biological yield and 100 seed weight made direct contribution towards influencing grain yield.

2.5 Stability analysis

Singh et al. (1988) studied stability for days to 50% flowering, plant height, primary and secondary branches per plant under normal, late and very late sown conditions and reported significant mean squares due to genotype and environment interaction for all the characters studied.

Sharma and Maloo (1989) analysed the stability using data from three yield components in 21 genotypes grown under 3 environments and found significant genotype x environment interaction for primary branches per plant and yield per plant.

Singh and Singh (1990) analysed 66 chickpea genotypes under nine environments and reported significant mean squares due to genotypes, environments and genotype x environment for majority of the yield traits.

Katiyar et al. (1992) studied stability parameters for seed yield, seeds per pod and harvest index in 19 genotypes of chickpea and reported significant differences among the genotypes and environments.

Singh et al. (1993) studied on genetic diversity and stability for 7 characters in 20 chickpea genotypes grown under 6 environments and observed highly significant differences due to genotypes, environment and genotype environment interaction for all the characters.
Kumar et al. (1996) conducted multilocation international trial of 16 genotypes of desi and kabuli chickpea. They reported significant genotype environment interaction for the trait.

Patil et al. (1996) studied 7 yield related characters in 20 chickpea genotypes grown at 3 locations and reported significant genotypes environment interactions for all the yield traits.

Rao (1996) evaluated sixteen bold seeded chickpea for developmental traits. Simple regression analysis indicated the substantial contribution of period from flowering to maturity, pod bearing length 100 seed weight on seed yield.

Popaighat et al. (1999) studied yield stability of 19 chickpea cultivars sown at different dates (early, optimum, late and every late). The analysis of variance for stability parameters showed that major portion of genotype environment interaction was linear in nature for all the characters. Stability for seed yield assessed on the basis of mean performance, regression coefficient and deviation from regression indicated that the varieties Phule G-12 and Vishal were the most stable across the environments.

Tiwari et al. (2000) studied a set of 21 chickpea varieties under 4 environments created by changing the dates of sowing and grown the crop under rainfed and irrigation conditions. They reported that the genotypes Pusa 212, Pusa 240, Pusa 256, Pusa 261, Pusa 329, Pusa 262, Pusa 369, Pusa 390, K 850 and C 235 showed wide adaptability as they possessed high mean values and least deviation from the regression.
Rao (2000) evaluated twenty one vascular wilt resistant chickpea genotype for plant type characters and on the basis of simple regression analysis he reported substantial contribution of pod bearing length, plant spread and biological yield towards seed yield.

Sood et al. (2001) conducted stability analysis on 32 genotypes of chickpea grown over three years i.e. during 1990-1993 and reported significant mean squares due to genotypes, environments, genotypes environment interaction, Environment (Linear), G x E (Linear) for all the traits under the study.

Rao and Rao (2003) reported that the mean squares due to environment were significant for all the characters. The significant genotype (G) environment (E) interaction indicated that the phenotypic expression of genotypes varied with the change in environment. However, G x E interaction (Linear) and pooled deviation were found significant for all the characters except pooled deviation for plant height, harvest index and yield per plant indicating significant contribution of both linear and non linear components.

Sohane et al. (2003) studied 21 genotypes of chickpea for stability of grain yield under normal, early and late sown conditions and reported significant genotype x environment interaction for seed yield.