Chapter - 2

Review of literature
2. REVIEW OF LITERATURE

Review of literature on various aspects related to present study is discussed below-

2.1 Concept of diallel cross and combining ability analysis

The diallel analysis has been useful for the estimation of general and specific combining ability effects and variances (Griffing, 1956). In diallel crossing system, a set of parental varieties (P) or lines are selected and crossed them in all combinations which give rise to (i) P-parental lines (ii) one set of P(P-1) / 2 F¹ crosses and (iii) one set of P(P-1) / 2 reciprocal F¹ crosses.

Sprague and Tatum (1942) designated “general combining ability” (GCA) as the average performance of a line in a series of hybrid combinations and “specific combining ability” (SCA) as those cases in which certain combinations do relatively better or worse than would be expected on the basis of average performance of the line involved. The general combining ability variance has generally been equated to additive and additive x additive type of interaction, while the specific combining ability has been equated to non additive genetic variance (Sprague and Tatum, 1942; Gilbert, 1958 and Falconer, 1960). Hayman (1954) proposed the theory and analysis of diallel crosses and pointed out that it was a potent method of investigating quantitative genetic system. Singh and Dhaliwal (1972) estimated combining ability for seed yield in F¹ and F² diallel crosses of six blackgram lines. They reported significant GCA effect for both the generations whereas SCA effects were not significant.

Handerson (1952) defined “general combining ability” as “the average merit with respect to some traits or weighted combination of traits of an indefinitely large
number of progeny of an individual or line when mated with a random sample from specified population. The merit of the progeny is measured in some specified set of circumstances”. He also defined specific combining ability as “the deviation of the average of an indefinitely large number of progeny of two individuals or lines from the value which would be specified on the basis of the known general combining abilities of these two lines or individuals and the maternal ability of the female parent”.

Lal and Waldin (1980) obtained highest SCA effects from “high X high” GCA combinations excepting seed yield in case of Blackgram. The combining ability analysis is an important method to know gene actions and it is frequently used by crop breeders to choose the parents with high GCA and hybrids with high SCA effect (Yingzhong, 1999).

Singh et al. (1987) noted highly significant GCA and SCA variances both in F₁ and F₂ generations for days to maturity, secondary branches, cluster and pods per plant, harvest index, grain yield and protein content from a diallel cross involving ten blackgram lines. They observed greater estimates of SCA variances than their respective GCA variances for all the characters indicating predominance of non-additive gene action.

Singh and Singh (1972) reported that in mungbean, both specific and general combining ability variances were important in controlling the expression of branch number, pod length and seed per pod. It was noted that general combining ability variance was higher than the specific combining ability variance.

Kalia et al. (1992) observed gene environmental interaction in combining ability for seed yield and its components in case of Blackgram. Mann and Sharma (1994) observed predominance of additive gene actions and parents and F₁, F₂
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progenies indicated significant difference for GCA among the parents and for SCA in crosses for most of the characters studied in wheat.

Hooda et al. (1989) reported that two out of six genotypes were found good combiners for most of the characters. Kadu et al. (1992) emphasized the importance of GCA for selecting parents in successful crossing programme. Baruah and Pandey (1982) studied combining ability for yield and other components in Blackgram using 10 X 10 diallel crosses. They showed that both GCA and SCA variances were highly significant for all the characters studied. Dasgupta and Das (1987) observed that for best specific combinations, parents having good GCA should be involved. Sood and Garton (1991) reported that high per se performance does not necessarily reflect their good general combining ability and non-additive components are predominant in the inheritance of the characters. Ghafoor et al. (1993) reported that non-additive gene action contributed the major portion in total genetic variance for all the characters studied. Out of five parents, one proved to be the best general combiner for pod per plant and grain yield in blackgram.

Shammugasundaram and Rangaswami (1994) observed highly significant GCA and SCA and reciprocal variances in both F₁ and F₂ generations for all the characters studied in Blackgram. They found GCA-SCA variance ratio and their estimates were similar in F₁ and F₂ generations for all the characters except for pods per plant. Govindaraj et al. (2001) reported that GCA - SCA ratio for ten characters he studied were predominantly controlled by non-additive gene.

Srivastava and Rao (1997) reported that significant GCA and SCA variances for all characters with the exception for days to 50% flowering and maturity in blackgram. Waldin and Lal (1991) studied combining ability in urdbean with ten females and three males. He found non-additive type of gene action was more
prominent in the expression of yield and its components and some male, female and cross were good combiners for yield and other characters. Singh and Tewari (1992) showed in a 10 x10 diallel in Triticale that GCA and SCA variances were significant for all the characters except yield per plant. In a study of 7 x 7 diallel without reciprocals Chandra et al.(2005) observed that the GCA and SCA variances were significant for days to maturity, plant height, pods per plant and 100-seed weight in mungbean.

In a diallel analysis in mung bean Shantipriya et al. (1999) found that non additive gene action played a predominant role in expression of all the characters except days to 50% flowering and maturity.

Thangavel et al. (2004) reported that in 6 X 6 diallel cross in blackgram both the additive and non additive gene action were important for plant height and seed yield per plant.

2.2 Genetic variability and other related parameters

The extent of genetic variability present in the crop defines the success rate of any breeding programme. The study of variability is an important prerequisite in plant breeding programme as it provides opportunity for selection of desired types. It is well known that variability observed in crop plants is the result of interaction of heritable and non-heritable factors, however due attention should be given to the heritable components for development of an improved variety.

Burton (1952) made comparisons among characters of genetic variability by estimating genotypic and phenotypic coefficient of variations. GCV together with heritability estimates can give the best picture of expected genetic gain out of selection. Genetic parameters and their interrelationship were studied by various crop breeders (Malik et al.,1982 ; Choudhury et al.,1984)
Veer et al. (2005) recorded both gcv and pcv were highest for no. of branches, 100-seed weight and yield per plant. High heritability estimates coupled with high genetic advance was also observed for no. of branches, 100-seed weight and yield per plant.

Heritability is one of the important parameters which helps the plant breeder in predicting the genetic advance and that genetic advance can be achieved by adopting necessary selection pressure. The knowledge on the nature and magnitude of genetic variations governing the inheritance of quantitative characters like yield and its components is essential for the genetic improvement in any crop plant. Phenotypic variability includes two components-heritable and non heritable.

Panse (1957) advocated that genetic advance under selection depends on the amount of genetic variability, the magnitude of masking effects of the environment and the intensity of selection practice. High heritability with high genetic advance indicates the concerned character is governed by additive gene action. But, if the high heritability is due to non-additive gene effects, the genetic gain will be low.

Johnson et al. (1955) reported that for reliable selection, high heritability together with high genetic advance is important. Gandhi et al. (1964) suggested that such association of high heritability with high genetic advance provides suitable conditions for making successful selection.

In India, natural genetic variability of Blackgram has been exploited to a limited extent only. A few reports in Blackgram and other related crops are reviewed below:

Singh et al. (1972) reported in blackgram that seed yield, pod number and flowering nodes exhibited a wide range of variability along with high broad sense heritability. Singh et al. (1975) observed highest heritability for plant height whereas,
the lowest heritability was found for cluster per plant, indicating effectiveness of selection for plant height in Blackgram.

Goud et al. (1977) reported that plant height, 100-seed weight and pod yield showed high GCV and PCV. Pod length showed the highest genetic advance along with high heritability.

Patil and Shah (1982) recorded high GCV and PCV for plant height and pod length, moderate estimates for cluster per plant, branches per plant, pods per plant and seed yield per plant, while seeds per pod and 100-seed weight recorded low estimates of GCV and PCV. The highest heritability was noted for days to flowering followed by plant height.

Narasimha (1984) reported that seed yield per plant, pods per plant and primary branches per plant exhibited high estimates of GCV and PCV. Heritability estimates were high for 100-seed weight, days to maturity and plant height. The character which showed high heritability also showed high genetic advance.

Patil and Narkhede (1987) reported that plant height, pods per plant, cluster per plant and seed yield showed high estimates of GCV and PCV. Plant height, pods per plant and seed yield per plant exhibited high heritability along with high genetic advance.

Anuradha et al. (1991) reported that plant height and seed per plant exhibited high GCV and PCV, seeds per pod and 100-seed weight showed low GCV and PCV, plant height showed the highest heritability coupled with highest genetic advance in Blackgram.

Yadav et al. (1991) reported in blackgram that days taken to 50% flowering, pods per plant and days to maturity showed above 80% heritability estimates. Pooran Chand (2001) observed in his experiment on blackgram that additive genetic variance
was higher than the dominance genetic variance for all the characters studied. Plant height, pods per plant and grain yield were governed by both additive and non-additive gene action. In another experiment of Pooran Chand (2000), it is revealed that both additive and dominance genetic variances were involved in the expression of most of the characters. Veeramani et al. (2005) recorded high heritability coupled with high genetic advance as % of mean for plant height, no. of branches, pods per plant and cluster per plant in all the crosses of Blackgram.

2.3 Concept of heterosis

According to Shull (1914) heterosis was measured over the mean of the parents. The term heterobeltosis is proposed for the increase of $F_1$ value over the better parent (Fanseco and Peterson, 1968). Mather and Jinks (1971) explained heterosis in $F_1$ between two homozygous parents on the basis of dominance, over dominance and dominance $\times$ dominance interaction.

First artificial hybrid was produced by Thomas Fairchild during 1717 between two flowers (i.e., *Dianthus barbatus* and *Dianthus caryophyllus*). Joseph koelreuter, one of the famous scientists made several crosses in Tobacco during 1760-1766 and reported hybrid vigour in $F_1$. Mackey (1976) stated that heterozygosity could not be a necessary condition for phenotypic expression identified as heterosis. Chen et al. (2003) reported that a Korean mungbean variety (K7) gave $F_1$ progenies with significant heterobeltosis for seed yield in many crosses.

Yadav et al. (2005) studied on hybrid vigour in pigeon pea where 36 hybrids were developed using 12 lines and 3 testers. They found three crosses have high heterotic effects for yield per plant as well as for number of pods per plant, number of seeds per pod and 100-seed weight. Khapre et al. (2005) recorded a high degree of
heterosis for seed yield and other yield components over standard check variety in pigeonpea.

In a study of 21 crosses of mungbean resulting from 7x7 diallel excluding reciprocals it was observed that the highest heterosis to the extent of 26.1% over mid parent and 22.8% over better parent for seed yield per plant in BM4 X TARM18, which exhibited high heterosis percentage for either one or more yield components (Dethe and Patil, 2008). In a study on four cross combinations of mungbean, Soehandi and Srinivas (2005) found that all crosses exhibited significant yield heterosis over mid parent and better parent.

Loganathan (2001) observed in his experiment on blackgram that pronounced hybrid vigour for yield and most of the yield components. Heterosis was to the extent of 58.74% and 52.65% over mid parent and better parent respectively. 30 different hybrids of Urdbean resulting from 6 x 6 complete diallel indicated a pronounced hybrid vigour for yield and most of the yield components. Heterosis was recorded up to the extent of 101.74 % and 103.48 % over the mid parent and better parent respectively for grain yield per plant Sarvanan et al. (2004).

2.4 Selection in segregating generations

Knott (1972) and Alessandroni and Scalfati (1973) reported the effective selection for grain yield and other component traits in F_2 generation of wheat.

In Blackgram, Rahman and Bahl (1986) reported that the selection in F_3 can be fruitful for seeds per pod and 100-seed weight. however, selection for podsper plant and grain yield in early generation may not show any relationship with later generation performance for these traits.
Malleshappa et al. (1988) revealed that the expected gain for seed yield was realized to a considerable extent in F₄ generation in case of Blackgram. Natre et al. (1984) concluded from his study in cowpea that it is possible to select promising lines in F₂ itself.

Voigt and Weber (1960) found F₄ generations were superior in yield to those selected by bulk and pedigree method in case of soybean crosses. Simmonds (1979) reported that classical pedigree selection was effective in early generations only for traits with high heritability. Rahman et al. (1986) reported that selection for seeds per pod and 100-seed weight would be effective in F₃ generation however selection for pods per plant in early generation may not show any relationship with later generations.

Inheritance studies in blackgram by Dahiya and Waldin (1982) using generation mean indicated the importance of both additive and dominance effects for all the characters investigated, with dominance components showing higher magnitude than the additive component for seed yield, number of pods per plant. Chakravarty and Baruah (1998) also reported that both additive and non-additive gene actions were important in controlling the inheritance of plant height, days to 50% flowering, days to maturity, pods per cluster, seeds per pod, 100-seed weight, in a study of six generations of a Blackgram cross. They suggested that any breeding method that can exploit both the gene actions like reciprocal recurrent selection method, could generally improve these traits in Blackgram.

Sarvanan et al. (2003) emphasized that if a character is influenced less by the environment and controlled by additive types of genes, selection can be made directly for the improvement of this particular character at an early stage and if the character is
controlled by a non-additive types of genes, then the selection for this trait should be
delayed and performed safely in the advanced succeeding generations.

Yield is a complex character and is the resultant expression of several
polygenic characters. It has large environmental effects. Hence the knowledge on the
correlation between yield and its component characters as well as the inter-correlation
between the component characters is essential for simultaneous selection for
characters influencing the yield. In breeding, correlation has been used by plant
breeders to assist in identifying traits that are useful as selection criteria to improve
crop yield (Dewey and Lu, 1959; Milligan et al., 1990).

2.5 Protein content

The major part of the population in India is suffering from low uptake of
protein which creates problem of malnutrition. The nutritive quality of Blackgram
mainly understands the percentage of protein present in the seeds. Several earlier
studies show negative correlation between protein content and grain yield (Borah and
Goswami, 1995). Siddique (1985) suggested that it is desirable to assess the yield
before the quality evaluation and recommendation for general cultivation.

In mungbean, Sandhu et al. (1979) observed that seed yield did not show any
association with protein content while Vidyadhar et al. (1984) found positive
association of protein content with seed yield.

Vijaylakshmi et al. (2001) did their experiment on chickpea and high protein
content was recorded in segregants which could be used to enhance the nutritional
value of chick pea.
Revanappa et al. (2004) conducted an experiment on 29 advance breeding lines and observed that protein content varied widely as location varied. Highest protein content was recorded 27.20% followed by 26.0%.

Bajpai et al. (2005) recorded that negative significant association of seed protein was accounted with primary branches, pod length, 100-seed weight and seed yield. Although a negative correlation was observed between yield and crude protein, enough variation occurred to select plants which combined relatively high yield with high crude protein.