# CHAPTER II
# REVIEW OF LITERATURE

Several studies have been conducted on "Heterosis and combining ability analysis for seed yield and its components in sesame (*Sesamum indicum* L.)." The efforts have been made to review the available literature pertaining to heterosis, combining ability and nature of gene action in sesame under the following sub heads:

**2.1 Heterosis**

**2.2 Combining ability and gene action**

## 2.1 Heterosis

East and Shull (1905) studied the effect of the cross and self-fertilization in maize and finally Shull (1908) summarized the effect of inbreeding and cross breeding in it. Later on Shull (1914) proposed the term "Heterosis" to represent the increased or decreased vigour of the $F_1$ over its better parent or mid-parental values. The term 'heterosis' refers to the phenomenon in the $F_1$ population obtained by the crossing of two genetically dissimilar gametes or individuals showing increased or decreased vigour over the parents. To eliminate discrepancy in use of term heterosis, a new term "Heterobeltiosis" has been proposed by Bitzer *et al.* (1968). Mather and Jinks (1971) defined heterosis as the amount by which the mean of $F_1$ family exceeds its better parent. Heterosis over standard check is called as standard heterosis. The utilization of hybrid vigour as mean of maximizing the yield of agricultural crops has become one of the most significant technique in plant breeding. Heterosis breeding led to outstanding breakthrough in the productivity of several economically important crops as well as often cross pollinated crops like bajra, castor, sorghum and cotton.

Heterosis being a complex phenomenon, no conclusive or clear-cut clarification is available to account for its manifestation. However, several theories have been advanced to explain heterosis like dominance (Davenport, 1908; Keeble and Pellew, 1910; Bruce, 1910 and Jones, 1917), over dominance (East, 1908 and Shull, 1908) and epistasis (Jinks, 1954; Hayman, 1957 and Bauman, 1959). There is no evidence, however, to attribute only a single cause responsible for heterosis (Strickberger, 1976). For the present study, the literature pertaining to heterosis in sesame is reviewed as under.

Sasikumar and Sardana (1990) reported significant and positive heterosis for yield and its important attributes in 6 out 17 hybrids of sesame involving 8 diverse parents. Further, they noted that there is a good scope for commercial exploitation of heterosis as well as isolation of homozygous lines among the progenies of other heterotic $F_1$s.

Sodani and Bhatnagar (1990) evaluated hybrids resulting from ten parental diallel cross of sesame and reported high heterosis for number of capsules and branches per plant and low for plant height and capsule length. Twenty-one cross combinations exhibited significant heterosis for seed yield.

Reddy *et al*. (1992) evaluated diallel cross involving nine diverse lines of sesame for heterosis study. They found significant heterosis for seed yield. The cross combination R 84-4-2 x VS 16 gave the highest seed yield. They further noticed significant heterosis in RT 54 x R 84-4-2 for oil content.

In a 6 x 6 diallel analysis of sesame, Susmita and Sen (1992) reported high magnitude of heterosis over better and mid-parents for plant height, days to 50 per cent flowering, 1000-seed weight and seed yield.

Brindha and Sivasubramaniam (1993) evaluated six genotypes and their $F_1$ hybrids of sesame through diallel analysis for different traits. High heterosis was observed in crosses BS 6-1-1 x TSS 11, TS 11 x SI 1730 and Madhavi x SI 1730 for days to first flowering, plant height and number of branches per plant and seed yield per plant.

Patel (1993) evaluated 8 x 8 diallel crosses of sesame and found that heterosis over better parent was high for number of effective branches per plant, number of capsules and yield per plant, whereas heterosis over mid-parent was high for plant height, number of seeds per capsule and 1000-seed weight.

Fateh *et al.* (1995) carried out diallel analysis and reported that magnitudes of heterosis and heterobeltiosis were higher for number of branches per plant (154.12% and 54.50%) followed by number of capsules per plant (108.14% and 88.65%) and seed yield per plant (86.81% and 68.94%). The range of heterosis and heterobeltiosis for seed yield was -54.28 to 86.81 per cent and -56.02 to 68.94 per cent, respectively. The crosses; TMV 3 x HT 1 and PT 64 x TC 25 showed maximum heterosis over better parent.

In a 10 x 10 diallel crosses excluding reciprocal, Navadiya *et al*. (1995) recorded high heterosis for yield per plant, plant height, number of effective branches per plant and number of capsules per plant, while days to flowering, days to maturity, 1000-seed weight and oil content had low heterosis.

In a line x tester analysis involving 6 lines and 3 testers in sesame, Kumar (1996) reported superior performance of TNAU-12 x TMV-3 hybrid for various characters *viz.,* plant height, number of capsules per main stem, capsules per branch, shoot weight, root weight, oil content and seed yield based on standard heterosis and *per se* performance. The heterosis for seed yield ranged from -4.9 to 169.9 per cent.

During their study of heterosis in sesame, Mishra and Yadav (1996) observed standard heterosis in both the direction for all the characters. They observed negative heterosis for days to 50 per cent flowering and days to 80 per cent maturity. They further recorded significant and positive heterosis, heterobeltiosis and standard heterosis for number of capsules per plant, number of seeds per capsule and seed yield per plant in crosses TC-289 x Phule-1 and JF-7 x TC-25.

Padmavathi (1998) reported heterotic potential of sesame crosses in $F_1$ and $F_2$ generations. The heterosis over better parent for plant height ranged from -16.7 to 33.8 per cent with crosses showing significant positive heterosis. Only 11 crosses recorded positive and significant heterosis. The heterobeltiosis for capsule length was very low. Negative heterosis was predominant for days to maturity indicating possibility of developing early maturing types. The heterobeltiosis for seed yield ranged from -44.1 to 165.24 per cent. The 19 hybrids showed significant and positive heterosis over better parent for seed yield.

Sakhare *et al*. (1998) crossed 12 sesame genotypes and evaluated progenies for 10 yield components. The maximum heterosis was noted for seed yield per plant followed by harvest index and capsules per plant. Phule Til 1 x IC 41930 exhibited 98.2 per cent increase in seed yield over the check variety and was found promising for exploitation of heterosis at commercial level.

Alam *et al*. (1999) carried out heterosis study in sesame and recorded significant and negative heterobeltiosis for days to 50 per cent flowering. They further reported that two $F_1$'s *viz.*, B 14 x IS 5 and TSS 130 x IS 5, produced significant and positive heterobeltiosis for seed yield per plant, number of primary branches per plant and number of capsules per plant. They also observed significant positive heterobeltiosis for oil content in two crosses *viz.*, B 9 x B 14 and B 67 x TSS 6.

Govindarasu *et al*. (1999) carried out line x tester analysis using three lines and three testers and reported that the cross TMV 3 x RJS 199 expressed significant and positive heterosis, heterobeltiosis and standard heterosis for number of branches per plant, number of capsules per plant and seed yield per plant. The cross TMV 4 x RJS 199 possessed high standard heterosis for seed yield and number of capsules per plant with a range of -52.28 to 84.49 per cent and -31.10 to 28.92 per cent, respectively.

Das *et al*. (2000) reported heterosis for yield and yield components in 10 $F_1$ hybrids obtained by 5 x 5 diallel cross. All the hybrids showed significant and positive heterosis and heterobeltiosis for seed yield per plant. The heterosis for seed yield per plant ranged from 25.4 to 58.2 per cent over mid-parent and from 14.3 to 55.2 per cent over better parent. The cross JS 1 x JS 3 exhibited maximum heterobeltiosis for seed yield per plant (55.2%) followed by JS 2 x JS 3 (44.3%).

Dikshit and Swain (2000) observed that heterosis in seed yield was associated with heterosis in number of capsules per plant and branches per plant. The range of relative heterosis and heterobeltiosis for seed yield was -36.8 to 83.5 per cent and -42.5 to 66.0 per cent, respectively.

Ragiba and Reddy (2000) carried out 10 x 10 diallel analysis in sesame and reported pronounced hybrid vigour for yield and most of the yield components. The cross VS 16 x JLT 16 displayed the highest heterosis over mid and better parent for seed yield per plant. Three hybrids *viz.*, Gopi Til x VS 16, X-198 x R84-4-2 and JLT 5 x R 84-4-2 recorded the highest heterosis and heterobeltiosis for number of capsules on main stem and number of primary and secondary branches. The heterosis for plant height, height to first capsule, number of capsules per plant and seed yield per plant ranged from 62.73 to 110.27 per cent, 13.24 to 30.50 per cent, 31.60 to 106.60 per cent and 5.23 to 17.09 per cent, respectively.

Durga and Raghunatham (2001) studied heterosis in 18 sesame hybrids, developed by crossing 6 lines with 3 cultivars. They observed maximum heterosis for number of secondary flowers, productive capsules on main stem, seed yield per plant, harvest index and oil yield per plant. Negative but desirable heterotic effects were observed for days to first flowering, height to first branch and first capsule, plant height and abortive capsules per plant. Low to moderate heterotic effects were exhibited by nodes to first flower, petiole length, laminal length and width, number of primary branches, days to maturity and oil percentage.

Reddy *et al*. (2001) estimated heterosis for 11 traits in 36 $F_1$ hybrids of sesame. The cross combination TKG 64 x E 8 showed significant heterosis over better parent for number of branches per plant, number of capsules per plant, capsule length, number of seeds per capsule, test weight, plant height, capsule yield per plant, seed yield per plant and oil content. TC 397 x E 8 also exhibited significant heterosis over better parent for number of branches per plant, number of capsules per plant and number of seeds per capsule.

Karuppaiyan and Sundaresan (2002) evaluated 80 $F_1$ hybrids of sesame developed through line x tester mating design and reported that standard heterosis for seed yield was between -79.2 to 68.5 per cent. A large number of crosses (52 out of 80) exhibited significant and negative heterosis. Only 7 crosses exhibited positively significant standard heterosis for seed yield. The hybrid S 0626NL 4 x Co 1 registered 68.5 per cent economic heterosis followed by Si 102 x TMV 6 and S 0626NL 4 x TMV 3 with 38.3 and 34.5 per cent, respectively.

Krishnaiah *et al*. (2003) studied 28 $F_1$'s obtained through a diallel crosses of 8 parents for 13 characters *viz.*, days to 50 per cent flowering, days to maturity, plant height, number of primary branches, number of secondary branches, capsules on the main stem, capsules on the primary branches, capsules on the secondary branches, capsule length, seeds per capsule, 1000-seed weight, seed yield per plant and harvest index and concluded that the crosses YLM 11 x T brown, Rajeswari x YLM 17 and Rajeswari x Krishna were the best combinations for yield (-32.35 to 23.24%) along with days to maturity (-16.13 to 10.10%), 1000-seed weight (-12.14 to 4.64%), seeds per capsule (-16.27 to 17.34%), capsule length (-15.13 to 11.00%), harvest index (-18.57 to 19.43%) and plant height (-42.78 to 35.70%) based on heterosis and *per se* performance.

Kumaresan and Nadarajan (2003) evaluated 48 hybrids of sesame derived from crossing 12 lines and 4 testers in a line x tester mating design. The 48 hybrids along with the 16 parents were used to estimate all the three types of heterosis for seven quantitative characters. The hybrid OMT 30 x VRI 1 had higher *per se* performance and significant standard heterosis for single plant yield and oil content. Among 48 hybrids studied, the cross OMT 30 x SVPR 1 recorded superior performance in terms of number of days to 50 per cent flowering, number of capsules and single plant yield on the basis of *per se* performance and standard heterosis.

Kumar and Ganesan (2004) evaluated 15 hybrids produced by involving five lines and three testers of sesame for nine characters. Among the hybrids, the crosses TMV 6 x T 6 and TMV 3 x T 6 showed significant and positive standard heterosis for plant height, number of branches per plant, number of capsules on main stem, number of capsules on branches, total number of capsules, capsule length, number of seeds per capsule, 1000-seed weight and seed yield per plant.

A line x tester analysis was carried out in sesame with four lines and three testers by Singh *et al*. (2005). They evaluated seven parents and 12 crosses to estimate the heterosis for ten characters *viz.,* days to 50 per cent flowering, days to maturity, plant height, number of primary branches per plant, number of capsules on the main axis, number of capsules per plant, length of capsule, number of seeds per capsule, 1000-seed weight and seed yield per plant. The hybrids TC 289 x GT 1, TC 289 x ES 3 and T 4 x JLT 8 showed significant relative heterosis, heterobeltiosis and standard heterosis for most of traits including seed yield per plant.

Kim *et al*. (2006) studied heterosis for $F_1$ population obtained by 5 x 5 half diallel crosses in sesame and reported high heterosis of $F_1$ hybrids for the number of capsules per plant, seed yield per plant and number of branches per plant.

Singh *et al*. (2007) studied heterosis in relation to combining ability for yield and its components in sesame through line x tester analysis using four lines and three testers. They reported that the range of standard heterosis for seed yield per plant was -11.74 to 29.78 per cent. The maximum heterosis was noted in the cross TC-289 x ES-3. The same cross also had high heterotic value for four other traits *viz.,* number of capsules on main axis, number of capsules per plant, number of seeds per capsule and 1000-seed weight. Five crosses *viz.,* TC 25 x ES 3, TC 25 x GT 1, TC 25 x JLT 8, T 4 x GT 1 and T 4 x ES 3 recorded significant and negative heterosis, heterobeltiosis and standard heterosis for maturity.

Thiyagu *et al*. (2007) studied the extent of heterosis in 36 $F_1$ hybrids derived from line x tester fashion for 9 traits including seed yield. Heterosis for yield was generally accompanied by heterosis for component traits. The extent of heterosis for days to 50 per cent flowering and days to maturity varied from -15.31 to 8.42 per cent and -13.09 to 13.53 per cent, respectively. The cross Uma x ORM 17 (-15.31%) for days to 50 per cent flowering and SVPR 1 x ORM 17 (-13.09%) for days to maturity recorded significant and negative heterosis. The range of heterosis for plant height, number of primary branches per plant and number of capsules per plant was ranged from -23.62 to 23.74 per cent, -35.92 to 38.57 per cent and -50.89 to 35.87 per cent, respectively.

Mishra *et al*. (2008) studied heterosis and combining ability in sesame for five traits *viz.*, number of branches per plant, capsules per plant, seeds per capsule, 1000-seed weight and yield per plant in $F_1$s of a 12 parent half diallel cross and reported that the cross Pragati x AKT 64 exhibited the highest significant and positive heterosis for branches per plant (56.36%) and 1000-seed weight (5.92%). Whereas, the cross Prachi x TC 25 exhibited the highest significant and positive heterosis for number of capsules per plant (51.28%) and number of seeds per capsule (15.32%).

Sumathi and Muralidharan (2008) worked out heterosis over mid parent, better parent and standard parent, CO 1. The cross Paiyur 1 x Cordebergea was early in flowering duration, while the cross TMV 5 x Cordebergea was having superior heterosis for mono stem/shy branching nature with desirable seed yield per plant. TMV 3 x KS 990813 was superior for number of capsules per plant and seed yield per plant. Paiyur 1 x MT 34 showed good performance for number of seeds per capsule and oil content with desirable heterosis for seed yield per plant.

Gaikwad *et al.* (2009) estimated the heterosis in ten $F_1$ hybrids for seed yield and its component traits. They reported that the cross JLT 8 x ES 3 having highest relative heterosis (38.85%), heterobeltiosis (20.57%) and standard heterosis (54.05%) for seed yield per plant.

Khan *et al*. (2009) studied half diallel set by crossing five sesame parents and reported that heterosis ranged from -40.35 to 41.46 per cent, -4.14 to 69.67 per cent and -19.22 to 255.12 per cent for number of branches per plant, number of pods per plant and seed yield per plant, respectively. Based on average heterotic effects for mid parents, the number of pods per plant (39.56%) was the main yield component contributing towards heterosis for seed yield per plant followed by branches per plant (12.14%), days to maturity (9.67%), days to flower initiation (3.07%) and plant height (2.97%). Three crosses *viz.*, TS-3 x SG-27, SG-27 x SG-43 and SG-27 x Til-89 were considered as elite crosses.

Banerjee and Kole (2010) studied heterosis for seven important yield contributing characters. They reported maximum heterosis for seed yield per plant over the mid and better parent in the crosses CST 2002 x TKG 22 (43.30%) and MT 34 x B 67 (27.22%). Mid parent heterosis for seed yield per plant was due to cumulative heterosis for various important component traits, such as capsules per plant, seeds per capsule and 1000-seed weight.

Durai *et al*. (2010) performed line x tester analysis with 8 lines and 4 testers to estimate the heterosis for 10 traits *viz.,* days to 50 per cent flowering, plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, seed weight, oil content, chlorophyll content, leaf area index and single plant yield. The range of heterosis for single plant yield varied from -32.11 to 73.81 per cent in ES-9-184 x Paiyur 1 and SI 918 x CO 1, respectively. Twenty one hybrids were found to be positively significant.

Prajapati *et al*. (2010a) carried-out 10 x 10 half diallel analysis in sesame and observed that hybrid ABT 23 x ABT 26 expressed the highest heterobeltiosis for seed yield per plant (26.95%). The cross Mrug 1 x PT 64 also manifested high heterobeltiosis for yield contributing traits *viz.,* number of capsules per plant (-27.13 to 26.76%), length of main branch (-12.39 to 22.70%), number of effective branches per plant (-29.19 to 23.97%), number of seeds per capsule (-11.24 to 11.53%), capsule length (-10.20 to 7.8%) and harvest index (-38.12 to 6.44%) on pooled basis.

Rao (2011) studied heterosis in sesame using six parent diallel and found that the estimates of heterosis over mid, better and standard parents were high in respect of seed yield in the cross E-8 x M.T.-101 followed by G-2 x M.T.-101 and S.I.-3012 x M.T.-101. The cross E-8 x M.T.-101 also recorded early duration with the highest number of branches and tallest plant height.

Padmasundari and Kamala (2012) studied five parents and its $F_1$, $F_2$, $F_3$ in randomized block design with three replicates. The cross X-79-1 x EC-351887 appeared best with highest heterosis for seed yield, branches and 1000-seed weight over standard parent, TC-25. Vm x X-79-1 is next best cross gained desirable earliness and highly significant positive, high heterosis for seed yield, short stature, pods per plant and primary branches. Heterobeltiosis was highly significant for these characters. Crosses Vm x EC-351887, Vm x EZ-351881 and Vm x EC-359007 also gained highly significant and very high desirable heterosis in seed yield.

Praveenkumar *et al*. (2012) studied heterosis in diallel analysis in sesame using ten mutant lines and reported the highest magnitude of standard heterosis for seed yield in the crosses Mutant 9 x Mutant 699 over DS-1 (45.2%) and over E-8 (108.77%); Mutant 181 x Mutant 699 over DS-1 (42.68%) and over E-8 (105.26%); and Mutant 51 x Mutant 699 over DS-1 (48.78%) and over E-8 (114.04%).

Jadhav and Mohrir (2013) conducted line x tester analysis using eight lines and six testers to assess the extent of the heterosis over mid parent, better parent standard variety, TKG-22. The results revealed that heterosis for seed yield per plant ranged from -55.79 to 84.09 per cent, -58.06 to 65.31 per cent and -28.62 to 193.10 per cent over mid parent, better parent and standard variety, respectively. The cross GSM-22 x SI-331517 showed desirable standard heterosis for seed yield per plant along with other six traits *viz.*, plant height, capsule bearing plant height, inter nodal distance, capsule length, number of nodes on main stem and1000-seed weight.

Jatothu *et al.* (2013) studied standard heterosis for 11 characters of 60 hybrids of sesame developed by crossing 10 lines and 6 testers in line x tester fashion during *rabi* 2007-08. The line x tester interactions contributed up to 79.55 per cent for capsule length followed by number of seeds per capsule (77.98%), seed yield per plant (77.15%) and number of effective primaries per plant (75.75%). The highest percentage of average heterosis was observed for seed yield per plant and number of effective primaries per plant. Five crosses *viz*., PKDS 62 x IS 562 B, SI 7818 x SI 3171, KKS 98049 x SI 3171, KKS 98049 x KMR 78 and CST 2001-5 x TKG 22 were identified as potential hybrids with high standard heterosis for seed yield over better yielding commercial hybrid check Swetha.

Parimala *et al.* (2013) found that, all characters showed in variable crosses depicted heterosis in both positive and negative directions indicating that genes with negative as well as positive effects were dominant. The cross JCS-596 x Swetha showed highest positive heterosis for number of branches per plant over mid parent. The range of heterosis for number of capsules per plant was -74.27 to 50.74 per cent over better parent. Maximum positive heterosis for number of capsules per plant was exhibited by NIC 8283 x KMR-74 over mid parent and better parent. The magnitude of heterosis was 103.62 per cent and 98.53 per cent over mid parent and better parent for yield per plant respectively. The hybrids Rajeswari x Swetha, Chandana x Swetha, JCS-596 x KMR-74, JCS-596 x Swetha and NIC 8283 x KMR-74 recorded highly significant positive standard heterosis for plant height. Maximum significant standard heterosis for number of capsules per plant was found in the crosses NIC-8283 x KMR-74, Chandana x Swetha and NIC-8392 x Swetha. The crosses Chandana x Swetha (36.63%) and NIC-8283 x KMR-74 (18.26%) exhibited highest standard heterosis for seed yield per plant. The crosses JCS-596 x Swetha, NIC-8283 x KMR-74 and Chandana x Swetha can be utilized in heterosis breeding.

Salunke *et al.* (2013) studied hybrid vigour in sesame through diallel analysis for yield and its components in sesame. Seven genotypes were crossed in a diallel fashion, including reciprocals, to obtain 42 hybrids. Out of these, 23 showed significant and positive heterosis over their MP value, 16 over corresponding better parent value, 17 over commercial check variety DSS-9 and 12 over commercial check variety CO-1 value for seed yield. The hybrid combinations Dhauri Local x DSS-9 and DSS 9 x Dhauri Local exhibited significant positive heterosis for seed yield per plant.

Vavdiya *et al.* (2013) conducted an experiment in sesame to assess the extent of heterosis for 15 quantitative traits including seed yield per plant. Twelve lines and four testers were crossed in a line x tester fashion to develop 48 $F_1$s. Heterosis was worked-out over better parent and standard variety, G.Til-4. The standard heterosis for seed yield per plant ranged from -12.32 to 137.39 per cent. The crosses NIC-75 x G.Til-10, IC-81564 x G.Til-10, NIC-75 x G.Til-4, AT-238 x G.Til-10 and Borda-1 x G.Til-10 were good heterotic combinations for seed yield per plant, which recorded 137.39 per cent, 128.74 per cent, 111.34 per cent, 100.42 per cent and 90.84 per cent standard heterosis, respectively. The heterosis for seed yield per plant was associated with the heterosis expressed by its component characters.

Chaudhari *et al.* (2015) assessed the extent of heterosis for eleven quantitative traits in sesame. Heterosis was worked out over better parent and standard varieties Gujarat Til-4 and TKG-22. Five hybrids *viz*., Gujarat Til-1 x JLS-116, Gujarat Til-2 x JLS-116, Gujarat Til-3 x AKT-64, Patan-64 x JLS-9707-2 and Patan-64 x JLT-408 showed desirable heterobeltiosis for seed yield per plant along with other six major yield contributing characters. The crosses Gujarat Til-3 x AKT-64, Gujarat Til-3 x PKV-NT-11, Gujarat Til-3 x JLS-9707-2 and Gujarat Til-3 x JLS-116 were the best heterotic combinations for seed yield, which recorded 85.81 and 98.08, 63.38 and 74.13, 63.38 and 74.13, 54.28 and 64.43 per cent standard heterosis over Gujarat Til-4 and TKG-22, respectively.

Kumar *et al.* (2015) studied the extent of heterosis under four different environments for yield and its component traits in sesame. Diallel mating design excluding reciprocals was used to develop 28 $F_1$ crosses from 8 parents. Heterosis was worked out over mid parent, better parent and standard check, GT-2. For seed yield, crosses Pbtil-1 x AT-124, GT-10 x Pbtil-1 and GT-2 x PT-64 in $E_1$, crosses GT-10 x TMV-3, GT-2 x PT-64 and GT-10 × Pbtil-1 in $E_2$ and crosses TMV-3 x C-1013, TMV-3 x Pbtil-1 and GT-10 x Pbtil-1 in environment $E_3$ having high *per se* performance along with significant mid parent, better parent and standard heterosis.

Tripathy *et al.* (2016a) estimated heterosis over better parent (Hb) in a set of diallel crosses comprising 12 diverse sesame varieties, for fourteen morpho-economic traits *viz*., days to initial flowering, days to cessation of flowering, duration of flowering, days to maturity, height to first capsule, plant height, number of primary branches/plant, number of capsules/plant, capsule length, capsule breadth, number of seeds/capsule, 500-seed weight, oil content and seed yield/plant. Sixty out of 66 hybrids revealed significant positive heterosis for seed yield. T13 x E8 was considered as the best heterotic cross combination which had yield advantage of 93 per cent over the best high yielding parent CST 785. Besides, Pratap x RT 103 exhibiting second highest Hb value for number of capsules/plant, resulted significantly higher seed yield with second highest positive heterosis. Similarly, CST 785 x E8 with first highest and second highest significant positive Hb value for capsule number and number of primary branches, had also shown to be equivalent to third highest position in terms of significant heterobeltiosis for seed yield/plant. Pratap x T13 and Pratap x Madhabi harbour *per se* oil content more than 58 per cent which resulted in maximum heterobeltiosis for the trait among the crosses.

**2.2 Combining ability and gene action:**

The choice of parents for hybridization possesses a serious problem to the plant breeders. The usual approach of choosing parents is on the basis of *per se* performance. The performance of the parents, however, does not always provide a good indication of the superiority of its hybrids. It is of common experience that certain combinations nick well to produce superior hybrids, whereas others involving equally promising parents produce disappointing hybrids as the combining ability often depends upon complex interaction system among genes. Therefore, it is very essential to study combining ability of parents selected for hybridization. Combining ability has been defined as the ability of a line to transmit its characteristics to its progeny.

The concept of general and specific combining ability as a measure of gene action was proposed by Sprague and Tatum (1942). With this method, the total genetic variance is partitioned into the effect of general and specific combining ability. The general combining ability is defined as the average performance of a line in a series of crosses and is considered as a measure of additive gene action. Whereas, the specific combining ability is the deviation in performance of a cross combination from that predicted on the basis of the general combining ability of the parents involved in the crosses. It is considered as a measure of non-additive gene action. The sca effect helps to sort out superior crosses with respect to yield and different characters, which could be used further in breeding programmes to exploit transgressive segregants. Green (1948) reported that combining ability was an inherited trait and suggested that segregants with relatively high proportion of favourable genes would occur more often in the progenies of crosses of high combining ability inbreds than in the progenies of cross where one or both parents were lower in combining ability. Henderson (1952) defined specific combining ability in terms of interactions that those were due to the consequences of intra-allelic gene interaction (dominance) and also due to inter-allelic (epistasis) gene action. Kempthorne (1957) discussed general and specific combining ability variances in terms of covariances of half and full-sibs in a random mating population [$\sigma^2$gca=Cov.(H.S.) and $\sigma^2$sca =Cov.(F.S.) – 2Cov.(H.S.)].

Several methods have been developed to estimate the combining ability of inbreds in different crops *viz.*, top cross (Jenkins and Brunson, 1932); poly cross (Tysdal *et al.*, 1942); diallel cross analysis (Griffing 1956 a & b) and line x tester analysis (Kempthorne, 1957).

In the present investigation, line x tester analysis (Kempthorne, 1957) analogous to North Carolina Design-II (Comstock and Robinson, 1952) was used for the estimation of combining ability of lines as well as testers in sesame. The available reports pertaining to the combining ability studies in sesame using different biometrical methods have been reviewed as under:

While studying combining ability in sesame, Narkhede and Sudhirkumar (1991) found significant GCA and SCA variances for number of primary branches per plant, capsules per plant, length of capsule, length of effective main stem, test weight, yield per plant, oil content, protein content and iodine number indicating the importance of additive and non-additive gene action for all these characters.

Kadu *et al*. (1992) studied combining ability in sesame and reported the importance of both additive and non-additive gene actions for number of capsules per plant, capsule length, 500-seed weight, oil content and seed yield per plant. However, the magnitude of GCA variance was larger in magnitude than SCA variance for all these characters except for number of capsules per plant, 500-seed weight and oil content indicating preponderance of additive gene action.

In a 9 x 9 diallel crosses of sesame, Reddy *et al*. (1992) observed that gca and sca effects were highly significant for capsules per plant, 1000-seed weight, length of capsule, oil content and yield per plant. Higher magnitude of GCA variance than SCA variance and higher GCA/SCA variance ratio for oil content indicated that its inheritance was predominantly under the control of additive gene action. While, the seed yield was predominantly under the control of non-additive type of gene action.

Patel (1993) carried out combining ability analysis in sesame and reported that variances due to GCA, SCA and reciprocals were significant for days to initial flowering, days to maturity, plant height, length of capsule and number of seeds per capsule. However, the predictability ratio showed the predominance of additive gene action for days to initial flowering, days to maturity and non-additive gene action for plant height, length of capsule and number of seeds per capsule.

Durga *et al*. (1994) studied combining ability and gene action by using 6 lines x 3 testers in sesame. Estimates of GCA and SCA variances indicated the predominance of non-additive gene action for days to maturity, height to first branch and first capsule, plant height, petiole length, productive capsules on main stem, seed yield per plant, oil yield per plant and harvest index. Among the lines, DORS 102 was good general combiner for earliness and dwarf plant type. Among the testers, Tapi was considered as good general combiner for seed yield and other component characters like earliness and number of primary and secondary branches.

In a genetic analysis of ten lines and three testers, Ram (1995) observed higher magnitude of the variance due to GCA than SCA, suggesting that non-additive gene action was predominant for plant height, primary branches per plant, capsules per plant and seed yield per plant. TMV-3 and Co-1 were good general combiners for all the characters, while the good specific combinations were B-67 x Co-1, C-7 x Co-1 and G.Til-1 x C-6 for plant height, number of branches per plant, number of capsules per plant and seed yield.

Jayprakash and Subramanian (1996) studied combining ability through line x tester analysis and observed significance of non-additive gene action for days to 50 per cent flowering, earliness, plant height, capsules per plant and seed yield per plant. IS-242 and SVPR-1 were identified as good general combiners for earliness, whereas SVPR-1, SI-1003 and TN-8454 were good general combiners for plant height, capsules per plant and seed yield per plant. TSS-4 x SVPR-1 and TN-8454 x Co-1 expressed high sca effect for days to flowering, plant height, capsules per plant and seed yield per plant.

While studying combining ability through diallel analysis, Backiyarani *et al*. (1997) reported significance of additive and non-additive gene actions for seed yield and its component characters. However, additive genetic variance was predominant for days to first flowering, plant height, number of primary branches, number of capsules, oil percent and single plant yield. Two parents *viz.,* TMV-6 and TNAU-65 were good general combiners for oil percentage as well as single plant yield. The majority of the hybrids with high sca effect involved at least one parent with high gca effect.

Manivannan (1997) carried out combining ability analysis in sesame and reported that the variances due to SCA were greater than the variances due to GCA, which indicated the predominant role of non-additive gene effect in the expression of seed yield. Two lines *viz.*, S 0584 and TMV 5 and a tester SVPR 1 were good general combiners for seed yield.

A 5 x 5 diallel crosses were evaluated for combining ability by Das and Chaudhary (1998) in sesame. The ratio of GCA variance to SCA variance indicated a predominance of non-additive gene action for seed yield per plant and some of its components. For number of branches per plant, both additive and non-additive gene actions were equally important.

Mansouri and Ahmadi (1998) studied the combining ability through diallel analysis in sesame and found highly significant differences for plant height, number of capsules per plant, 1000-seed weight, seed yield per plant and seed oil content. They reported predominant role of additive gene action for plant height, number of capsules per plant, yield per plant and oil per cent. However, 1000-seed weight showed non-additive variance.

Das and Gupta (1999) studied combining ability in sesame using 8 x 8 diallel crosses for seed yield, yield components and oil content. Additive genetic variance was of greater importance for number of primary branches per plant, number of secondary branches per plant, number of capsules per plant and seed yield per plant, while both additive and non-additive genetic variances were equally important for days to flowering, 1000-seed weight and oil content. Variety B 9 was good general combiner for seed yield and its major components and the cross B14 x B 9 emerged as the best specific combiner for seed yield and its components. For augmenting seed yield and oil content simultaneously, the cross combination MT 67–52 x TC 25 was found promising.

Sakhare *et al*. (2000) performed 12 x 12 diallel cross analysis and reported that the relative estimates of variance due to SCA were higher in magnitude than the corresponding estimates due to GCA for 1000-seed weight, seed yield per plant, oil percent and harvest index, indicating the role of non-additive gene action in the inheritance of these characters. They further reported that days to 50 per cent flowering had predominance of additive gene action.

Manivannan and Ganesan (2001) evaluated 52 $F_1$s developed by line x tester design using twenty six genotypes as lines and two varieties as testers for four characters *viz.,* plant height, number of branches per plant, number of capsules per plant and seed yield per plant. The magnitude of SCA variance was more than GCA variance for all the characters. It showed the preponderance of non-additive gene action including additive x additive. Fourteen lines namely SI 861, SI 1770, SI 2257, SO 573, IS 200, IS 207, IS 305, IS 534, RJS 2, BS 6-1-1, TSS 11, Paiyur 1, Gene 9101 and Thiruvellore local showed significant gca effect for seed yield per plant and also for yield components.

Solanki and Gupta (2001) performed line x tester analysis involving 11 females and 3 males and revealed a greater magnitude of SCA variances for seed yield per plant, capsules bearing plant height, branches per plant, number of capsules per plant and 1000-seed weight, indicating the importance of non-additive gene action. Whereas, greater GCA variances for days to maturity and plant height indicated the importance of additive gene action. Among the females, IS-225-2 for seed yield and IS-186-1 for early maturing and capsules per plant were the best general combiners. Among the male parents, RT-305 was the best general combiner for all the characters except capsules per plant. Four crosses, IS-147 x RT-274, HT-24 x RT-274, IS-240(B) x RT-305 and NIC-8409 x RT-274 were the best for both seed yield and capsules per plant.

Devi *et al*. (2002) studied six parent diallel crosses including reciprocals and reported the preponderance of additive gene action for number of flowers per plant, reproductive efficiency, number of seeds per capsule, total number of seeds per plant and number of filled seeds per plant. On the other hand, non-additive gene action was found to be important for number of ill-filled seeds per plant and seed yield per plant. The genotypes TNDU-120 and TMV-3 were identified as good general combiners for most of the reproductive traits studied. The hybrid Paiyur-1 x TMV-3 showed a high *per se* performance coupled with high specific combining ability effect for the majority of the traits.

Kar *et al*. (2002a) carried-out combining ability analysis for yield and yield components in a half-diallel set and reported the predominance of additive genetic variance for days to maturity, while for days to 50 per cent flowering, branches per plant, capsules on main stem, capsules per plant, capsule length and seed yield per plant non-additive gene action was important.

Kar *et al*. (2002b) studied combining ability of sesame through line x tester analysis using fourteen lines and three testers and revealed preponderance of non-additive gene action for plant height, height upto first capsule, branches per plant, nodes on main stem, capsules on main stem, capsules per plant, capsule length, capsule breadth, seeds per capsule, 1000-seed weight and seed yield per plant. G.Til 1, Sel. 73, Sel. 33, Sel. 123 and Uma were good general combiners for seed yield and yield contributing characters.

Sankar and Kumar (2003) carried out line x tester analysis using eight genotypes as lines and four varieties as testers to study the combining ability for six important economic traits in sesame. The results revealed significant additive and non-additive genetic effects for all the traits. However, additive gene action was predominant for plant height and non-additive gene action was predominant for days to 50 per cent flowering, number of primary branches per plant, number of capsules per plant, oil percentage and single plant yield.

Saravanan and Nadarajan (2003) carrried out combining ability analysis for seed yield and yield components using a 8 x 8 half diallel cross of sesame and reported that additive genetic variance was of greater importance for days to 50 per cent flowering, plant height, number of primary branches per plant, 1000-seed weight, oil content, harvest index and phyllody incidence, while non-additive genetic variance played a major role for number of capsules per plant, number of seeds per capsule, leaf area index, chlorophyll content and single plant yield. The variety Co 1 was the best general combiner and the hybrid YLM 123 x AHT 123 was emerged as the best specific combiner for seed yield and its components *viz.,* number of branches per plant, number of capsules per plant, number of seeds per capsule, 1000-seed weight and harvest index.

Babu *et al*. (2004) carrried out combining ability analysis for nine quantitative traits in sesame crosses. The study revealed the importance of non-additive gene action in the inheritance of days to 50 per cent flowering, number of primary branches per plant, number of capsules per plant, oil content and seed yield per plant. Additive gene action was observed for days to maturity and 1000-seed weight. Both additive and non-additive gene actions were observed for plant height and number of seeds per capsule.

Kumar *et al*. (2004) studied general and specific combining ability of 30 sesame crosses along with 13 parental lines for 7 characters *viz.,* plant height, number of branches per plant, number of capsules per plant, capsule length, number of seeds per capsule, 1000-seed weight and yield per plant and concluded that the tester SVPR-1 was a good general combiner for seed yield per plant. The crosses AUS 29 x SVPR-1 and AUS 15 x RT 125 showed the highest and significant sca effect for yield per plant, number of seeds per capsule and number of capsules per plant. The combining ability variances indicated the preponderance of non-additive gene action for all the characters studied, indicating the scope for heterosis breeding in crop improvement.

Mothilal and Manoharan (2004) studied combining ability through a line x tester analysis involving 3 female and 8 male parents of sesame for different characters. They found that variances due to SCA were higher than that of GCA indicating the predominance of non-additive gene action for plant height, number of branches, fruiting stem length, number of capsules and seed yield, while GCA variances were higher than SCA variances for 1000-seed weight indicating the preponderance of additive gene action. TMV 4 was a good general combiner for number of capsules, 1000-seed weight and seed yield per plant. The good specific combiners for seed yield were TMV 3 x Si 1160, TMV 3 x Si 102, TMV 3 x Vinayak and TMV 3 x Si 0535.

A line x tester analysis was carried out by Vidhyavathi *et al*. (2005) using seven lines and four testers in sesame and found preponderance of non-additive gene action for days to 50 per cent flowering, days to maturity, plant height, number of primary branches, number of capsules per plant and seed yield per plant and additive gene action for 1000-seed weight and oil content. Two parents *viz.,* IS 184 and TNAU 2031 were good general combiners for earliness and the parents namely, SI 66 and TMV 5 were good general combiners for seed yield per plant.

Prajapati *et al*. (2006) evaluated 10 x 10 half diallel crosses in sesame to assess the nature and magnitude of components of variation and reported that the SCA variances were higher for days to maturity, plant height, number of capsules per plant, capsule length, seeds per capsule and seed yield per plant, indicating the predominance of non-additive gene action. While, the GCA variances were higher for days to 50 per cent flowering, number of branches per plant, 1000-seed weight and oil content. The cultivars PT 64, TMV 3 and AT 103 were the best general combiners for number of capsules per plant, capsule length, 1000-seed weight and seed yield per plant. The hybrid, TMV 3 x C 1013 was emerged as the best specific combiner for seed yield per plant.

El-Shakhess and Khalifa (2007) carried out line x tester analysis using four lines and four testers in sesame. The magnitude of SCA variances was greater than GCA for yield; yield components, charcoal rot and *Fusarium* wilt resistance, indicating the importance of non-additive gene effect in the inheritance of the studied characters. Among the lines, MGS 36-2 recorded desirable gca effect for number of branches per plant, number of capsules per plant, seed yield per plant and oil percentage. Among testers, two genotypes *viz.,* Toshkal and MGS 11-47 were the best general combiners for plant height, length of fruiting zone, number of capsules per plant, capsule length, seed yield per plant and seed index.

Gawade *et al*. (2007) carried out combining ability analysis involving eight genotypes of sesame and found that SCA variances were greater than GCA variances for all the 10 characters *viz.*, days to 50 per cent flowering, days to maturity, plant height at harvest, number of branches per plant, number of internodes per plant, number of capsules per plant, length of capsule, number of seeds per capsule, oil content and seed yield per plant, indicating the preponderance of non-additive gene action in the inheritance of these traits. PT-1 and JLT-54 were good general combiners for plant height at harvest, number of branches per plant, number of internodes per plant, number of capsules per plant, number of seeds per capsule and seed yield per plant. The cross combinations JLT-54 x Hawari, PT-1 x JLSV-4 and PT-1 x Hawari showed significant sca effect for seed yield per plant.

Anuradha and Reddy (2008) studied nature of gene action in biparental progeny of the cross DCB 1799 x Gowri in NCD II design for various traits and reported that seed yield and yield traits like number of primary branches, seeds per capsule, 1000-seed weight, biological yield and harvest index advocated the importance of dominance variance, while plant height, capsules on main stem and capsules on primary branches registered the importance of additive gene action.

Raghunaiah *et al*. (2008) studied heterosis and combining ability for yield and yield components in 24 sesame hybrids and their ten parents and revealed that SCA variances were higher than GCA variances, indicating the preponderance of non-additive gene action for all the traits studied except days to 50 per cent flowering. EC-310447, KIS-282-2, Swetha and JCS-9426 were the best combiners for seed yield per plant along with their major yield contributing traits.

Sumathi and Muralidharan (2008) evaluated 30 crosses developed by using five lines and six testers in a line x tester mating design. The SCA variances were greater than GCA variances for the traits days to 50 per cent flowering, days to maturity, number of capsules, capsule length, number of seeds per capsule, 100-seed weight, seed yield per plant and oil content suggesting that these characters were governed predominantly by non-additive genetic components. The line TMV3 showed high gca effect for seed yield, days to 50 per cent flowering, days to maturity, plant height, number of capsules and oil content, while the tester, KS 990812 recorded high gca effect for number of capsules. The specific combining ability effects showed that out of thirty hybrids, four hybrids *viz.*, CO 1 x Cordebergea, Paiyur 1 x KS 99153, TMV 4 x MT 34 and TMV 5 x KS 99037 showed significant positive sca effect for single plant yield.

Bharathikumar and Vivekanandan (2009) carried out combining ability analysis in sesame through L x T design with nine lines and five testers for yield and yield contributing characters *viz.*, days to maturity, plant height, number of branches per plant, number of capsules per plant, capsule length, number of seeds per capsule, 1000-seed weight, oil content and seed yield per plant. Non-additive gene action was predominant for all the traits studied. Combining ability analysis revealed that three parents *viz.*, RT 125, VS 9701 and CO 1 were good general combiners for five traits including seed yield per plant. Considering both *per se* performance and gca effect, the parents VS 9701, Ajit 131 and SVPR 1 were found to be the best. Better segregants can be obtained from the hybrid combinations RT 125 x CO 1, VS 9701 x CO 1 and Uma x CO 1 for seed yield and yield contributing characters.

Hadiya *et al*. (2009) carried out line x tester analysis using ten lines and five testers for seed yield and its attributing traits in sesame and revealed that the GCA variances were higher than SCA variances for days to 50 per cent flowering, plant height, number of branches per plant, number of capsules per plant and length of capsule, suggesting involvement of additive gene action. For days to maturity, seed yield per plant, test weight and oil content, the SCA variances were higher than GCA variances, which indicated greater role of non-additive gene action. G.Til-10, AT-238 and AT-130 among lines and G.Til-2 and BAVJ-1 among testers were good general combiners for days to maturity, number of capsules per plant, test weight, oil content and seed yield per plant. The cross combination AT-130 x AT-114 showed significant and positive sca effect for seed yield per plant.

Mishra *et al*. (2009) studied combining ability and nature of gene action involved in the inheritance of seed yield and its components in sesame using a half diallel set of twelve elite varieties. They reported that the gene action was largely additive for primary branches and predominantly additive for plant height and 1000-seed weight. Both additive and non-additive gene actions were equally important for days to maturity and seeds per capsule. Additive gene action played a greater role in case of capsules per plant, while non-additive gene action played a greater role in the inheritance of seed yield. The varieties VRI-1 and GT-10 were good general combiners for capsules per plant; Kalika and HT-1 for seeds per capsule; AKT-64 and Pragati for 1000-seed weight and Uma, GT-10, Akt-64 and Kalika for seed yield.

Prajapati *et al*. (2009) studied combining ability and gene action through half diallel set of 10 sesame genotypes for seed yield per plant, 1000-seed weight, oil content and protein content. They reported that the ratio $\sigma^2$gca/$\sigma^2$sca was less than unity suggesting the major role of non-additive gene action for the inheritance of all the characters except for protein content. The parents, C 1013, AT 123 and GT 2 were found to be good general combiners for seed yield. The parents C 1013, Mrug 1 and Tapi were good general combiners for oil content, while Tapi, C 1013 and PT 64 were good general combiners for protein content.

Shekhat *et al*. (2009) evaluated 10 x 10 half diallel crosses in $F_1$ and $F_2$ generations to study the combining ability and nature of gene action in sesame. They reported that the variances due to GCA and SCA were significant for all the traits, indicating that both additive and non-additive gene effects played an important role in the expression of all the characters. The GCA variances were lower than the SCA variances for all characters except for plant height and days to maturity, indicating preponderance of non-additive gene action in the expression of these characters. The parent ABT-22 was good general combiner along with high *per se* performance for number of effective branches per plant, length of capsule, 1000-seed weight, oil content and leaf area index. Two parents *viz.,* ABT-23 and AT-34 were good general combiners for yield in both $F_1$ and $F_2$ generations. The parents AT-190, AT-92 and G.Til-2 were good general combiners for plant height in both $F_1$ and $F_2$ generations.

Yamanura *et al*. (2009) carried out a line x tester analysis of 19 parents and 90 crosses in sesame and reported that the character, 1000-seed weight had a fixable additive genetic variance which can be improved by simple selection, whereas the characters *viz.,* plant height, days to 50 per cent flowering, days to maturing, length of the capsule, total number of capsules per plant, oil content, seed yield per plant and seed yield per ha showed the predominance of non-additive gene action which can be improved by biparental mating. The parents DS-13, DS-16, DS-10 (females) and E-8, TSES-2, TSES4, DS-1 (males) were found to be good combiners for seed yield per plant.

Mandal *et al*. (2010) carried out eight parent diallel analysis excluding reciprocals for various quantitative characters and concluded that both additive and non-additive genetic components were involved in determining the expression of the characters, but non-additive type of gene action predominated in all these characters. Kanke white was good general combiner for oil content and average general combiner for number of secondary branches per plant. They further reported that the crosses RTF-46 x Kayamkulam and Kanke white x RT-125 were the best specific combiners for seed yield per plant.

Parameshwarappa and Salimath (2010) carried out line x tester analysis in sesame using four lines and three testers to study the combining ability for yield and yield attributes *viz.,* days to maturity, plant height, number of primary branches per plant, number of capsules on the main axis, number of seeds per capsule, 1000-seed weight and seed yield per plant. General and specific combining ability variances showed major contribution of additive gene action for all the nine characters studied except number of seeds per capsule. Lines GM 38-1-2 and Dhawri-1 were good general combiners for most of the characters including seed yield per plant.

Prajapati *et al*. (2010b) studied combining ability through 10 x 10 diallel analysis for yield and its component traits in sesame. Non-additive genetic variance was of greater importance for plant height, length of main branch, number of capsules on main branch, number of capsules per plant, capsule length, number of seeds per capsule, seed yield per plant and harvest index. Based on general combining ability, parents C 1013, AT 123 and GT 2 were found to be good general combiners for yield and yield contributing traits. The cross combinations *viz.*, GT 2 x GT 10, Mrug 1 x PT 64 and C 1013 x ABT 23 had highly significant sca effect for seed yield and most of the yield attributing traits.

Praveenkumar *et al*. (2012) studied combining ability and gene action in inter-mutant hybrids of sesame using ten mutant lines for quantitative traits *viz.*, plant height, days to 50 per cent flowering, days to maturity, number of capsules per plant, capsule length, number of seeds per capsule, 1000-seed weight, oil content and seed yield per plant. General and specific combining ability variances showed major contribution of non-additive gene action for all the characters except for days to maturity. Mutant lines *viz.*, Mutant 274, Mutant 699, Mutant 353 and Mutant 450 were the best general combiners for seed yield.

Abatchoua *et al.* (2014) genetically screened 12 promising lines for eight characters in sesame. GCA/SCA ratio indicated that both dominant and additive gene effects were significant for these parameters with a predominance of non-additive effects. Genetic analysis demonstrated that the parents differed for their general combining ability (GCA) and the crosses showed specific combining ability (SCA). Association between GCA effects and mean characters in most cases implied that parental sesame lines with high values of the characters have superior combining ability. For these traits, recurrent selection might be a useful breeding strategy.

Ahmed *et al.* (2014) studied combining ability for seed yield, yield components and other morphological traits in six sesame parental lines and their 15 $F_1$ hybrids crossed in half diallel for two consecutive seasons. For seed yield (kg/ha) and the yield related characters *viz.*, 1000- seed weight and the yield per plant, significant positive SCA effects were observed by the crosses, Kenana-2 x Gd002SPSN-12 and Promo x Gd2002SPSN-12, whereas negative significant effects were showed by Gadarif-1 x Umshagera. Khidir and Promo recorded a positive significant GCA effects and Promo was the best combiner than other parental lines for earliness, since it recorded negative SCA values. Therefore, Khidir, Promo and Gd2002SPSN-12 could be recommended to produce progeny having high yield and early maturing hybrids, through recurrent selection or reciprocal cross.

Azeez and Morakinyo (2014) employed five distinct accessions of sesame in a diallel mating to study combining abilities and assess potentials for seeds oil quality improvement. Cross S 530 x PACH exhibited good combination for 1000-seed weight, seed weight per plant, seed oil and protein contents (%). Seeds of cross 65-8B x PACH showed exceptional high level of linoleic acid (52.08%) and unsaturated fatty acids (94.45%), suggesting the possibility of developing superior cultivars with improved oil quality through selection in segregating population.

Shekhawat *et al.* (2014) carried out a line x tester analysis in sesame with ten lines and four testers. Studies revealed the preponderance of non-additive gene action for days to 50 per cent flowering, days to maturity, plant height, number of effective branches, number of capsules per plant, number of seeds per capsule, capsule length and additive gene action for 1000-seed weight and seed yield per plant. Three parents, ES-274, SSM and TILAK were good general combiners for earliness and parents namely, G. Til-3, G.T.-4, BHACAU-1 and VRI (SV)-1 were good general combiners for seed yield per plant. Eight hybrids had superior *per se* performance for seed yield, its component characters and earliness. With regard to seed yield, three hybrids had both the parent as desirable combiners. Crosses involving VRI (SV)-1 as line performed better with all the testers under study indicating that this genotype can be utilized in future breeding programmes. The crosses, BHACAU-7 x G.T.-4, VRI (SV)-1 x G.T.-1, VRI (SV)-1 x G.T.-2, VRI(SV)-1 x G.T.-3 and VRI (SV)-1 x G.T.-4 recorded significant sca effects and the gene action might be of additive type of epistasis.

Joshi *et al.* (2015) carried out combining ability analysis for eleven characters in sesame using 10 lines *viz*., ES-246, AT-24, SPS-19, BAVJ-1, TNAU-2, Kalyanpur-2, Mota Liliya-1, Ingorola-7, SI-968 and Timbi-3 as females and 4 testers RT-125, Guj.Til-1, Guj.Til-2 and Guj.Til- 10 as males crossed in line x tester mating design. The female parents ES-246, BAVJ-1, Kalyanpur-2, Ingorola-7 and male parent Guj.Til-1 were found as the good general combiners for seed yield per plant. The cross combinations Timbi-3 x Guj.Til-10, TNAU-2 x Guj.Til-2 and SI-968 x Guj.Til-2 showed high *per se* performance and significant sca effects for yield per plant, such crosses would be exploited for future use.

Meenakumari *et al.* (2015) studied the general and specific combining ability in sesame through 6 x 6 diallel analysis for yield and yield contributing characters. Based on general combining ability, the parents G.Til-1, Borda-1, G.Til-2 and G.Til-10 were good general combiners for seed yield per plant, plant height, number of branches per plant, number of internodes per plant, length of capsule, number of capsules per plant and number of seeds per capsule. Borda-1 x G.Til-10, Kalyanpur-2 x Borda-1, G.Til-1 x Borda-1 and G.Til-2 x China were the best specific combiners for seed yield and its components.

Reddy *et al.* (2015) studied the nature and magnitude of gene action and extent of heterosis in a set of 21 hybrids The parent G.Til-3 was found to be the best general combiner for seed yield per plant, number of capsules per plant, number of seeds per capsule and number of branches per plant, whereas KMR-74 was good combiner for number of branches per plant and seed yield per plant. The crosses, KMR-74 x Patan-64, KMR-24 x G.Til- 3, KMR-74 x KMR-77 and G.Til-3 x G.Til-10 exhibited high SCA effect and showed highly significant positive standard heterosis for seed yield per plant. Hence, it was suggested that yield can be improved by exploitation of hybrid vigour through heterosis breeding.

Pawar and Monpara (2016) employed eight diverse genotypes of sesame in a half diallel mating design to study combining abilities and assess potentials for earliness and seed yield improvement. The results showed that variances due to specific combining ability (SCA) and general combining ability (GCA) for all studied traits were significant. Predictability ratio revealed preponderance of non-additive gene effect for all the characters. Among the parents, AT 158 and AT 177 were good general combiners for earliness along with the former for seed yield and later for plant height. RT 54 for seed yield and days to maturity and ABT 33 for reproductive period and plant height were identified as good general combiners. Most good specific combination for seed yield involved average x low general combiner. Two crosses were identified for developing early maturing high yielding genotypes. Parents like AT 158, AT 177, RT 54 and ABT 33 could be utilized in multiple crossing programme and further intermating of segregants followed by recurrent selection could be an appropriate approach to select desirable recombinants for seed yield and earliness.

Tripathy *et al.* (2016b) studied 12 x 12 half diallel crosses of sesame which indicated importance of both dominant and additive gene action. E 8, Phule Til 1 and CST 785 emerged as a good general combiner for high seed yield. Among the crosses, Pratap x RT103, CST 785 x E8, BS5-18-6 x Phule Til-1, T13 x E8 exhibited positive and significant SCA effect indicating non-additive gene action for high seed yield. Study of various genetic parameters revealed that a number of groups of genes or loci having recessive alleles with increasing effect might be involved in realization of high seed yield and involvement of modifiers in the background genotype could not be ruled out.