Review of Literature
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The bottle gourd [Lagenaria siceraria (Mol.) Standl.] is a vegetable crop with wide genetic diversity. It is cultivated throughout the warmer regions of the world. Due to monoecious sex behaviour and large number of seeds per fruit, it is a suitable crop for production of hybrids commercially. In spite of its old history and presence of wild genetic morphological variability, very little attention has been given to understand its genetic potential. The work done on heterosis, combining ability and gene action in bottle gourd and in few other related cucurbits is reviewed under this chapter.

2.1 HETEROSIS

The term heterosis was first used by Shull (1914). Heterosis may be defined on the F₁ population obtained by crossing of two homozygous inbreds of genetically unlike parental constitution showing superiority or inferiority over both the parents in quantitative and qualitative traits. This increased productivity or superiority of the hybrids over parents is known as hybrid vigour and genetic causes of this phenomenon is known as heterosis. It may be relative heterosis (improvement over mid parent), heterobeltiosis (improvement over better parent), standard heterosis (superiority over commercial check). Various theories have been put forth to explain the genetic basis of heterosis such as favourable expression of heterozygosity and accumulation of favourable dominant alleles in the F₁ contributed by both dominant male and female parents. It is more pronounced in cross-pollinated species (Hayes and Foote, 1976). Moll and Stuber, (1974) reported that partial to complete dominance, over-dominance and epistasis are the three possible genetic causes of heterosis.
2.1.1 Bottle gourd [Lagenaria siceraria (Mol.) Standl.]

Rajendran (1981) was probably the first to report hybrid vigour as much as 266.52 percent increase over better parent in the yield of the best hybrid combination of bottle gourd at a high fertility level of the garden soil. Roy (1964) stated that 81.42 and 78.60 per cent heterosis for yield in the best two F₁ hybrids in bottle gourd. He also observed that 45 per cent of the hybrid showed heterosis for fruit weight, fruit size and yield. Choudhury and Singh (1971) observed 75 and 106 percent higher yield in two F₁ hybrids than their respective better parents. Tyagi (1973) reported significant heterosis for number of fruits per vine, length and girth of fruit and weight of fruit. Heterosis for number of fruits, fruit weight and total yield in the two F₁ crosses was reported by Sharma et al. (1984). Pal et al. (1984) observed heterosis in four F₁ hybrids over their respective better parents. F₁ hybrids which produced the female flowers at lower nodee and had 17-28 per cent thicken flesh, 20 percent higher early yield and a longer harvesting period of 65-71 versus 55-65 days. The importance of heterosis breeding for the improvement of number of traits including yield in round-fruited bottle gourd was observed by Janakiram (1985) and he found 85 per cent heterosis for yield over the best performing F₁ hybrid S.46 × S.54. Appreciable heterosis for yield and its contributing characters like maturity, number of fruits per vine, and fruit weight in long fruited bottle gourd was reported by Sirohi et al. (1988). They identified best performing hybrid S.48 × S.47 which gave 115 per cent higher yield over the commercial cultivar Pusa Summer Prolific Long and 32.70 per cent over best parental line Pusa Naveen. They also reported heterosis for vine length (0.46 to 43.37%), fruit length (0.46 to 21.90%), fruit girth (0.91 to 7.67%), number of fruits per plant, (1.35 to 22.91%) and yield per vine (0.90 to 76.46%). 48.01, 34.61 and 29.03 per cent heterosis for yield over the best parent, S.59-1-5. Sirohi et al. (1987) concluded that the increases yield in three top heterotic F₁’s of their study was due to increased fruit weight and number of fruits per vine. In the year 1989, Janakiram and Sirohi reported 148.97 per cent higher yield in a cross S.46 × S.54 than Pusa Summer Prolific Long (commercial check) and 84.5 per cent over the
best parent S.41. Heterosis for the characters namely, vine length, days to first male flower opening, fruit weight, fruit size index, number of fruits per plant and total yield per plant over better parent and top parent was reported by Pitchaimuthu (1991). According to Janakiram and Sirohi (1992) observed significant heterosis for different characters like vine length (13.58%), days to first female flower opening (-7.53%), fruit weight (58.06%) and total yield (82.96%). They also reported that F1 hybrids S.36-1 x N.C., 159812-1 and S.39xS.1-3 were best performing crosses with 76.4 and 58.1 per cent heterosis over better parent, respectively. Maurya et al. (1993) observed that 80.51 per cent heterosis over top parent for yield per vine under low temperature conditions. Singh et al. (1998) observed that the F1 ARBGH-7 x Pusa Naveen showed significant heterosis over the better parent for yield per vine, number of fruits per plant, F1 ARBGH.7 x LC 2-1 for fruit weight and days to first female flower opening F1 PBOG-61 x NDBC-56 for fruit length, girth and vine length and F1 PSPL x ARBGH-7 for days to first fruit harvest. According to Rajesh Kumar et al. (1999), the yield and its component traits in the 20 F1 hybrids revealed significant and positive heterosis for almost all the traits. Sanadla and Khandelwal (2001) conducted an experiment on Heterosis study in 9 bottle gourd cultivars. The hybrids BL-1 x IC 92374, BL-1 x Pusa Naveen and IC 92374 x PSPL were superior and exhibited significant economic heterosis for fruit yield per plant and yield components such as number of fruits and female flowers per plant and yield components such as number of fruits and female flowers per plant. Pandey et al. (2003) reported that F1 hybrid Sel.16 x PSPL showed significant heterosis over better parent for yield per plant and length of lateral shoot. Five promising hybrid and in order of merit for yield per plant were Pusa Naveen x PSPL (43.82%), 9503 x PSPL (39.05%), KLC x Pusa Naveen (31.33%), 9503 x Pusa Naveen (16.30%) and KLG x PSPL (10.52%) over the standard cultivar Pusa Naveen. According to the studies of Pandey et al. (2004) the promising F1 hybrids with significant early maturity were Sel 16 x 9503, Sel.16 x KLG and KLG x PSPL and they manifested 18.36, 15.32 and 26.29% heterosis respectively over standard variety Pusa Summer Prolific Long for yield per plant.
2.1.2 Ridge gourd \([Luffa acutangula \text{(Roxb.) L.}]\) and sponge gourd \([Luffa cylindrical \text{(Roem.) L.}]\)

In the year 1949, Singh and Pal observed that the different interspecific crosses made between ridge gourd (both monoecious and hermaphrodite) and sponge gourd (monoecious) produced F\(_1\) hybrid which were either of the 'normal' or 'abnormal' type, depending on the varieties of the two species entering the cross. The normal type F\(_1\) plants produced their fruits, but the abnormal type F\(_1\) plants produced non-bitter fruits like the parent varieties. The abnormal type hybrids showed a decrease of 28.8 per cent in yield compared to \(Luffa acutangula \text{(Roxb.) L}\. \) the better parent. The normal type F\(_1\) hybrid showed an increase of 57.5 per cent in the yield but, since bitter fruits were produced, the increased yield was not considered of any economic importance.

Heterosis for earliness and high yield in ridge gourd was reported by Thakur and Singh (1968) when a gynoecious female was crossed with four monoecious varieties. Tozu (1981) reported that self-pollination results in inbreeding depression, while F\(_1\) hybrids exhibited some heterosis in sponge gourd \(Luffa cylindrical \text{(Roem.) L}\. \) Kadam (1995) reported significant heterosis in favourable direction for female node number, fruit/plant (19.91%) yield (17.02%) and fruiting nodes per vine (14.1%) in ridge gourd. According to Saha and Kale (2003) Co-1 recorded the highest fruit weight and fruit number per plant, followed by Jaipur and RG 108. Jaipur, which produced high yield, also produced long and heavy fruits. Kawalapur and Tendoli for vine length, Pusa Nasdar and Inampangari for female flower at lower node, Parvel for number of female flower Inampangari and Tendoli for first fruit harvest identified as promising parent as they showed high present performance for the respective characters. Heterosis over better parent and top parent were estimated for 8 traits in 45 hybrids of ridge gourd. Fruit characters and fruit yield had positive heterosis, while vine length and flowering showed negative heterosis. The three best performing F\(_1\) hybrids for yield were DRG-1 x P.N. DRG-1 x PRG -7 and DRG-1 x AAUJ-3 which manifested 93.09,
68.51 and 66.50% heterosis over top parent (DRG-1) respectively. These hybrids recorded the maximum fruit weight, fruit length and highest number of fruits per plant (Hedau and Sirohi, 2004).

2.1.3 Bitter gourd (*Momordica charantia* L.)

Sirohi and Choudhury (1978) reported heterosis for all the ten characters studied except the number of days to first fruit harvest in bitter gourd. They reported 84.00 per cent heterosis over the top parent Pusa Do Mousami in the cross Pusa Do Mousami x S-144. The minimum and maximum heterosis observed was 0.30 and 126.47 per cent for days to first harvest and total yield per plant, respectively. Singh and Joshi (1980) studied 10 crosses involving five inbreds and observed heterobeltiosis for plant height (21.23%), fruit length (29.91%), fruits per plant (13.7 - 34.4%) and yield (16.8%). Pal *et al.* (1983) observed very limited manifestation of heterosis in crosses studied, possibility due to very narrow genetic diversity of parents. Heterobeltiosis for vine length (0.4 - 27.1%), fruits per plant (0.2 - 47.2%), and yield (64%) was reported by Srivastava and Nath in the year 1983. They also reported negative heterosis to the tune of 16.7 per cent for days to first female flower opening. Ranpise (1985) observed significant relative heterosis, heterobeltiosis and standard heterosis for vine length, fruits per plant and yield per plant. Relative heterosis, heterobeltiosis and standard heterosis for yield and yield components was reported by Gopalkrishnan (1986). Suribabu *et al.* (1986) observed crosses like Pusa Do Mousami x Coimbatore Long and MC 23 x Uyyalawada Local as most promising for yield. Choudhary (1987) studied 55 hybrids in 11 x 11 diallel and observed maximum relative heterosis for yield per plant (275.43%). He reported heterobeltiosis for yield (253.94%), fruit diameter (93.12%), fruit weight (85.12%) and fruit flesh thickness (74.12%). The F$_{1}$ hybrid C96 x Green bitter gourd recorded 53.05 per cent heterosis for yield over top parent Khadneshi Mali and adjudged most promising hybrid.

According to Vahab (1989) relative heterosis and heterobeltiosis for days to first female flower opening (negative heterosis), yield per plant and
fruits per plant. He also observed 117.17 per cent and 43.09 per cent heterosis over the better parent in the cross Arka Harit x MC 79 in the first and second season, respectively. Lawande and Patil (1989, 1990a) studied 55 F₁ hybrids derived from 11 breeding lines. They found maximum and significant heterosis for yield per vine (86.07%), number of fruits (62.92%) and fruit weight (20.07%). However fruit length, fruit diameter and seeds per fruit did not show any heterosis. Finally they concluded that hybrids having very high heterotic effect may not be always higher yielder. Caline (1993) studied 10 F₁ hybrids in six generation mean analysis. She observed hybrid Pusa Vishesh X Arka Harit, Pusa Do Mousami x Kalyanpur Sona and MC 64 x Pusa Do Mousami as best performing F₁ crosses with 54.00, 38.59 and 36.24 per cent heterosis over top parent (Pusa Vishesh) respectively. Munshi and Sirohi (1993) studied that 45 F₁ hybrids in a 10 x 10 diallel (without reciprocals). They reported heterosis over better parent and equal parent for all the characters studied except days to first fruit harvest. The best F₁ hybrid Pusa Vishesh x Arka Harit recorded 58.02 per cent heterosis over Pusa Vishesh. In the year 1994, Kennedy studied 60 crosses of bitter gourd in a line x tester mating design and reported significant relative heterosis in 37 crosses, heterobeltiosis in 19 crosses and standard heterosis 35 crosses. He also reported positive and significant heterosis for total yield and fruit number but negative heterosis for fruit weight, fruit length and fruit diameter. Khattra et al. (1994) observed maximum heterosis in cross, ACC. 23 x ARU-41 for total yield and marketable yield per plant. Highest heterotic values were recorded by cross, Pusa Do Mousami x Priya for days to anthesis of first female flower, days to first harvest, fruit length and number of fruits per plant. Tendulkar (1997) studied 28 F₁ hybrids. He found F₁ hybrid Pusa Vishesh x Pusa Do Mousami showed 43.23 per cent heterosis for yield over top parent and 63.79 per cent superiority over commercial check (Pusa Do Mousami). According Deepali Tewari (1999), Ample amount of heterosis was found for yield over local check and better parent, the best performing hybrid was PBIG x PBIG-2 which showed 25.75% heterosis over better parent. Singh et al. (2000) observed appreciable heterosis over better and standard parents for all the traits studied. In
order of merit F₁ hybrid BG-11 x BG25, BG-11 x BG-29 and BG-5 x BG-25 were recorded to be three best performing F₁ hybrids for fruit yield per plant. The best performing F₁ hybrid BG-11 x BG-25 recorded 100% higher yield over standard parent (Pusa DO-Mausami). Choubey (2004) observed the highest standard heterosis for fruit yield in Kalyanpur Sona x Kalyanpur Barahmasi (41.9%) followed by PBIG 68 x Kalyanpur Sona and PBIG1 x PBIG1 (10%) over both the seasons. F₁ PBIG68 x Kalyanpur Sona showed the desirable positive heterosis (49.9%) over both the seasons and for fruit length F₁ hybrid PBIG2 x PBIG2 (82.34%) PBIG2 x PBIG4 (64.57%) and Kalyanpur Sona x kalyanpur Barahmasi (55.66%) observed to be highly heterotic for yield over both the seasons of the study.

2.2. COMBINING ABILITY

The concept of combining ability is of great importance in crop improvement, to identify the best combiners and utilize them in hybridization, either to exploit for heterosis or to combine favourable fixable genes. It has originated through intensive hybridization work in maize. The term combining ability is defined as the relative ability of a genotype to transmit its desirable traits to its progenies. The term general and specific combining ability were originally defined by Sprague and Tatum (1942) in relation to diallel crossing system. They defined the term 'general combining ability' as the average performance of a line (or population) in a series of crosses, while specific combining ability is the deviation of the cross from the performance predicted on the basis of general combining ability of the parent involved. The former is a measure of additive genetic factors while the latter is due to non-additive genetic factors (Sprague and Tatum, 1942).

2.2.1 Bottle gourd [Lagenaria siceraria (Mol.) Standl.]

Sivakami et al. (1987) studied combining ability in long fruited bottle gourd in a 10 x 10 diallel cross. The mean square of g.c.a. as well as s.c.a. was highly significant for all nine characters studied including yield per
vine. This indicated the importance of both additive and non-additive genetic variance for the expression of the characters. They suggested that improvement of bottle gourd can be brought about by both selection and hybridization method of breeding. Janakiram and Sirohi (1988) reported in a 10 x 10 diallel cross excluding reciprocals that the estimated components of variance of g.c.a. were larger than those for s.c.a. for all the nine characters studied except days to first male flower and female flower opening and fruit polar diameter. The parental lines S-52 and S-54 were reported as best general combiners for number of characters including total yield per vine. The F₁ hybrid S. 46 x S-54 was the best specific combiner for fruit weight and yield per vine. Singh et al. (1996) studied seven divergent lines and their F₁ hybrids in bottle gourd. They reported that Rajendra Chamatkar, Dholi safed and Pusa Naveen were the best combiners for yield contributing characters. Parents Pusa Naveen and Dholi Safed were reported most suitable for rainy season in respect of yield. F₁ hybrids between Rajendra Chamatkar x Faizabadi and Dholi Safed x Faizabadi were good specific combiners for several characters in both summer and kharif season. Singh et al. (1999) reported that parents, PSPL, LC₂-1, PBOG-40, NDBG-55 and POBG-61 were good general combiner for days to early female flower opening, POBG-40, Pusa Naveen and LC₂-1 for early harvesting, NDBG-56 and PBOG-40 for fruit length, LC₂-1 for fruit girth, PBOG-4, PBOG-61 and PSPL for weight per fruit, ARBGH-7 for number of fruits, PSPL and NDBG-55 for vine length, PBOG-40, ARBGH-7 and PBOG-61 for yield per vine. F₁ cross ARBGH-7 x LC₂-1 showed best s.c.a. effects for yield per vine. ARBGH-7 x PBOG-40 for fruit length, Pusa Naveen x LC₂-1 for fruit girth, ARBGH-7 x LC₂-1 for fruit weight and days to first female flower opening, ARBGH-7 x NDBG-56 for fruit number and PSPL x LC₂-1 for first harvest. Samadia and Khandelwal (2002) studied in a 9 x 9 diallel crosses excluding reciprocals, that the mean squares of general combining ability (g.c.a) and specific combining ability (s.c.a) were highly significant for all the traits studied. Cultivar Banswara local-1, Pusa Naveen, IC 93374 and Pusa Summer Prolific Long were good general combiners for yield and its contributing traits. Dubey and Mourya (2003) reported that out of nine parents and in
bottle gourd, VL-4 was observed to be the best general combiner as it exhibited high g.c.a. effect in desirable direction for most of the traits studied. F₁ cross UL-2 x UL-4 showed the highest s.c.a. effects for total fruit yield and F₁ UL-2 x UL-10 for number of days to first harvest. Pandey et al. (2004) observed Pusa Naveen as the best general combiner for all the traits studied. Most of the crosses revealed highly significant s.c.a. effect as regard s.c.a. effects. The promising F₁ hybrids with significant early maturity were Sel. 16 x 9503, Sci 16 x KLG and KLG x PSPL respectively for yield per plant. Maury et al. (2004) reported that NDBG-15 had significantly positive g.c.a. effects for number of primary branches per main stem. Among the lines, Pusa Naveen was a good general combiner for 10 different characters including early fruit yield per plant. The testers, PBOC-61 and PBOC-91 were good general combiners and for all the characters including early fruit yield per plant.

2.2.2 Bitter gourd (Momordica charantia L.)

Pal et al. (1983) reported high g.c.a. for days to female flower initiation and fruits per plant in line x tester mating design in bitter gourd. The cultivar namely, ‘Monsoon Miracle’ had best high g.c.a. for yield, fruit weight, fruit size and fruit cavity size.

Srivastava and Nath (1983) observed significant g.c.a. and s.c.a. effects for days to flowering, fruits per plant, fruit weight and total yield per plant in a 10 x 10 diallel cross and its parental lines. In another study of 30 crosses in a 6 x 6 diallel mating, Gopalkrishnan (1985) observed parent MDU-1 as best general combiner for weight, size, number of fruits per plant and total yield. The cross Priya x MDU-1 was reported to have high g.c.a. effect. The parents CO-1, Green Long, Hissar selection, Delhi Local and CO-2 were reported as best general combiners. They also observed significant s.c.a. effects in favourable direction in maximum crosses for fruit weight, fruits per vine, and yield per vine. According to Choudhari and Kale (1991) Coimbatore Local and Hisar selection as good general combiners for 10 and 9 characters, respectively. The g.c.a. and s.c.a. effects were significant for 11 of 13 characters studied. Munshi and Sirohi
(1993) reported that when either one or two of parental lines and having high g.c.a. effects for yield and its component characters were involved in the crosses, the F/ hybrid showed promising result. High magnitude of s.c.a. variance for majority of the characters studied except number of primary branches, fruit length, fruit yield per vine and crop duration was reported by Kennedy (1994). Khattri et al. (1994a) observed Pusa Do Mausami as best general combiner for fruit length, average fruit weight and total yield. In their studies maximum g.c.a. effects were exhibited by parent ACC.32 for fruit diameter, fruit number, anthesis of first female flower opening and marketable yield. Dewadas et al. (1995) reported cv. MC-13 as good general combiner for seeds per fruit and 100 seed weight and MC-64 for field emergence, seedling length and seedling dry weight. Tandulkar (1997) studied heterosis and combining ability in 28 F/ hybrids for yield and yield contributing characters. He found that hybrids Pusa Vishesh x Pusa Do Mausami, Sel-2 x Sel-12-1 and Sel-1 x S-12-1 showed highly significant s.c.a. effects for yield and yield contributing characters.Ram et al. (1999) observed bitter gourd lines, namely Narendra and VRBT 46 were good general combiners for marketable fruit yield. White VRBT was a good general combiner for fruit length, fruit girth and number of seeds per fruit. The crosses faisalabad x VRBT 46, IC 44410 B x VRBT 46, IC 50516 x VRBT 77, MC 48 X VRBT 78 and Narendra X VRBT 78 combined well for earliness. According to Khattri et al. (2000), bitter gourd Selection ARV-41 exhibited highest g.c.a. for earliness, fruit girth number of seeds per fruit, number of fruits per vine and marketable yield per plant. Parental lines Punjab 14 and Pusa Do Mausami (PDM) showed high g.c.a. effects for most of the characters white F/ B.L. 240-1 X PDM and Palwal Selection x PDM showed high s.c.a. effect for number of fruits per vine and marketable yield per plant and Palwal Selection x Punjab-14 for earliness. Bhave et al. (2004) reported that ‘Konkan Tara’ and ‘Priya’ were the best general combiners for fruit yield and number of fruits per plant and the cross RHR-1 x Priya was the best specific combination for yield. Singh et al. (2004) studied 8 x 8 diallel crosses excluding reciprocals and reported estimated component of variance of g.c.a. which were highly significant for all the characters studied except node number to first male flower, vine
length, and fruit yield. The parental line 'Kalyanpur Sona' showed the highest g.c.a. for earliness in the both season (monsoon and summer). The F₁ hybrid with the best s.c.a. effects were PBIG86 x Kalyanpur Baramasi and PBIG 2 x Kalyanpur Baramasi for earliness, PBIG 56 x Kalyanpur Baramasi and Kalyanpur Sona x PBIG 4 for fruit yield per vine.

2.3 GENE ACTION

In order to devise a right breeding technique, the nature of gene action governing different traits should be known beforehand. Since most of the characters in which heterosis is manifested are governed by polygenes, the study of inheritance of these characters is important in ascertaining the genetic basis of heterosis. Of the several biometrical methods available for studying the inheritance of metric traits, the diallel analysis is widely adopted. The diallel cross analysis furnishes useful information on the study of genetic mechanism of the inheritance of quantitative characters, particularly in respect of gene actions including epistasis and additive gene effects, the order of dominance in the parents, degree of dominance, distribution of positive and negative alleles and their linkage and the estimation of general and specific combining abilities of the parental lines involved.

2.3.1 Bottle gourd [Lagenaria siceraria (Mol.) Standl.]

Sharma et al. (1983) observed partial dominance for days to first male flower opening and female flower opening in two crosses of bottle gourd. They found over dominance for number of fruits, weight of fruit and total marketable yield of bottle gourd. An experiment with 10 x 10 diallel cross without reciprocals was conducted by Janakiram and Sirohi (1987) and observed over dominance for vine length, days to male flower opening, days to harvest, equatorial diameter, fruit weight and yield. In majority of the characters non-additive gene action was predominant. Sirohi et al. (1988) studied 66 F₁ hybrids of bottle gourd in a 12 x 12 diallel cross (excluding reciprocals) and they observed over dominance for vine length, days of first fruit harvest, fruit diameter, number of fruits per plant,
fruit weight, yield per plant. Additive gene action was involved in the inheritance of fruit length only. There was asymmetry of distribution of genes with positive and negative effects in all the characters showing dominance. They suggested that the predominance of non-additive genetic variance (over dominance and low narrow sense heritability) for majority of the characters including yield per plant might be exploited for production of F1 hybrids in bottle gourd. Gene action for important fruit characters utilizing generation means were reported by Janakiram and Sirohi (1990 and 1991). They found that the magnitude of dominance x dominance effect for days to fruit maturity was larger than that of other epistatic interaction. Duplicate epistasis was found in most of the interacting crosses. Pitchaimuthu (1991) confirmed the preponderance of duplicate epistasis in several important characters studied. He reported over-dominance gene action for vine length, days to male and female flower opening, days to harvest, number of fruits per plant and total yield. Maurya et al. (1993) reported the non-additive gene action for all the characters except for node number at which first female flower appears. Kushaw and Ram (1996) reported highly significant additive and dominance components for fruit diameter and fruit length in bottle gourd over two season studies. The additive component was more pronounced and important indicating the need of pure line breeding method for improvement the fruit size in bottle gourd.

2.3.2 Ridge gourd [**Luffa acutilangula (L.) Roxb.**]

Sahni et al. (1987) observed high genetic advance associated with high heritability for fruit weight in ridge gourd indicating additive gene effects. But for fruits per vine, female flowers per vine, node number for the appearance of female flower and branches per plant, high heritability was not associated with high genetic advance indicating the presence of non-additive gene action. Sirohi and Hedau (2004) recorded additive and dominant factors for fruit length, fruit weight, fruit diameter and number of fruits per plant. For fruit length and fruit weight, the additive component of genetic variance was more pronounced than the dominant component.
Over dominance was significant for fruit diameter, fruit weight and yield. The narrow sense heritability was less than 0.5 for number of fruits per plant and fruit yield per plant, indicating the predominance of dominance gene action.

2.3.3 Bitter gourd (*Momordica charantia* L.)

Sirohi and Choudhury (1979) reported predominance of additive and additive x additive components for days to first fruits harvest and number of fruits per plant and duplicate epistasis, dominance and dominance x dominance effect for vine length. The total yield per plant was reported to be controlled by complementary epistasis, dominance and dominance x dominance. Additive gene action with partial dominance for vine length, days to first fruit harvest, fruit length, fruit diameter, fruit flesh thickness, number of fruits per plant and fruit weight was reported by Sirohi and Choudhury (1983) in an eight parent diallel cross. Gopalkrishanan (1985) reported additive gene action for number of primary branches and mean fruit weight. He also reported additive and non-additive gene action for vine length, number of fruits per vine, fruit diameter, number of seeds per plant and dominance for ascorbic acid. Lowande and Patil (1990b and 1991) reported the presence of both additive and non-additive gene action for different characters in 11 x 11 diallel cross. They reported that the dominance component was more pronounced for number of fruits per vine, fruit weight, diameter of fruit and yield per vine while length was more influenced by additive component. Kennedy (1994) found predominance of non-additive gene action for majority of the characters except for number of primary branches per vine, fruit length, fruit yield per vine and crop duration. Mishra et al. (1994) reported that both additive and non-additive gene action were involved in the expression of fruits per plant, fruit length, fruit width, fruit weight and yield. A total of 45 hybrids in a 10 x 10 diallel cross excluding reciprocals were studied by Munshi and Sirohi (1993). They observed over-dominance for days to first male and female flower opening, days to first fruit harvest, fruit girth, number of fruits per plant, average fruit weight and
yield per plant. They also observed that additive gene action was involved in the inheritance of vine length, fruit length and fruit flesh thickness. Rajput et al. (1996) reported additive gene effects for all the characters studied except days to first fruit harvest which was under non-additive control. Additive and non-additive gene effects were observed for seed per fruit, 100 seed weight and seedling length. Over dominance was also observed for all the characters studied except seeds per fruit. It is concluded that production and use of F1, hybrid seeds is appropriate to improve seed yield and quality in bitter gourd (Sevadas-V S and Ramdas-S, 1997). Tewari et al. (1998) studied gene effect using generation mean analysis in parental, F1, F2, BC1 and BC2 generations of the crosses PBIG-1 x PBIG and PBIG-2 x PBIG-3 for 8 characters in bitter gourd. The result showed involvement of epistatic gene action in most cases as factor A, B and C were significant. This was further strengthened by significant 'i', 'j' and 'l' for most of the characters in both in crosses.