

Heterosis analysis over environments for seed yield and its attributing traits in linseed (*Linum usitatissimum* L.)

Abstract

The present study aimed to investigate the Heterosis analysis over environments for seed yield and its attributing traits in linseed (*Linum usitatissimum* L.). Linseed is commonly known as flax is a self-pollinated crop belongs to the genus *Linum* of the family *Linaceae* and order *Geranial* having 14 genera and more than 200 species. A complete set of 79 entries comprising of twelve parents, their 66 F1s and one check RLC-92 were evaluated during rabi 2020-21 at two locations i.e., ARS, Dahod, and BTRS, Anand, under two dates of sowing i.e., 2nd fortnight of October and 1st fortnight of November. In linseed, earliness in flowering is desirable trait. The perusal of data revealed that out of 66 crosses, significant 32 hybrids in E1; 39 hybrids in E2; 33 hybrids in E3 and 34 hybrids in E4, had significant negative heterosis. The magnitude of heterosis provides information on the extent of genetic diversity in parents of a cross and helps in choosing the parents for superior F1's, and to exploit hybrid vigour.

Keywords: *Linum usitatissimum*, hybrids, Heterosis analysis, biodiesel production

INTRODUCTION

India is among the largest vegetable oil economy in the world accounting for about 14 % of the world oilseed area and 8 % oilseed production (Hedge 1999). Oilseed crops are grown for edible oils, non-edible oils. Although oil compositions such as fatty acids, saturated fat and unsaturated fat in both non-edible and edible oil oils are almost similar, the edible oil contains valuable nutrient and antioxidants. Conversely, non-edible oil is not suitable for human consumption because it contains toxic substances in the oil. Non-edible oil crops are considered as an alternative feedstock for biodiesel production. The low oil yield of some non-edible crops, high FFAs, high polyunsaturated fatty acids and low unsaturated fatty acids content in oil is the major barrier for the commercial-scale biodiesel production. Non-edible oilseeds are castor and linseed.

Linseed (*Linum usitatissimum* L.) commonly known as flax is a self-pollinated crop belongs to the genus *Linum* of the family *Linaceae* and order *Geranial* having 14 genera and more than 200 species. Crop is predominantly self-pollinated, but out crossing (less than 2 per

cent) occasionally results from insect activity (Dilman, 1928). It has been cultivated for several thousand years mainly for its seed oil and its high-quality stem fibre. *Linum usitatissimum* L. is the only species of the family Linaceae (Getinet and Nigussie, 1997) with non-dehiscent or semi-dehiscent capsules suitable for modern cultivation.

Linseed stands fourth among oilseeds after groundnut, mustard and sesame. India ranked first in the world for linseed cultivation and occupies around 27% of the world acreage of 4.2 million hectares. Linseed growing countries include India, U.S.A, Canada, Argentina, Uruguay and Russia. In south west Asia and Canada, it is primarily cultivated for oil, whereas, in Russia, Egypt and northwestern European countries, it is mainly cultivated for the production of high-quality fibre for making linen fabrics and several other products. In India, linseed is cultivated on about 2.94 lakh hectares with an annual production of 1.54 lakh tones and a productivity of 525 kg/ha (Anonymous, 2020). In India, presently linseed is under cultivation in 17 states, among which Madhya Pradesh, Uttar Pradesh, Bihar, Chhattisgarh and Jharkhand cultivates about 85% of the total area. Under normal sown condition and an optimum inputs linseed can yield 16-18 q/ha and from dual purpose varieties about 10-12 quintals of fiber can be obtained in addition to the yield (14-16 q/ha). But it is cultivated with low input and biotic and abiotic stress as resulting invariably in poor seed yield.

MATERIALS AND METHODS

A complete set of 79 entries comprising of twelve parents, their 66 F₁s and one check RLC-92 were evaluated during *rabi* 2020-21 at two locations *i.e.*, ARS, Dahod, and BTRS, Anand, under two dates of sowing *i.e.*, 2nd fortnight of October and 1st fortnight of November. Trial was conducted in a randomized block design with three replications. Each entry was planted in a single row of meter 1.5 meter. Row to row and plant to plant distance was 30 cm and 10 cm, respectively. The field was ploughed until fine tilth of soil was obtained and recommended agronomical practices and plant protection measures were adopted as and when required to raise a good crop of linseed under irrigated condition.

Five competitive plants were randomly selected from the single rows of each entry in each replication and observations were recorded on these plants for all characters except days to 50% flowering and days to maturity. These characters were recorded per plot basis.

The phenomenon of heterosis has provided the most important genetic tools for improving yield of crop plants. Identification of specific parental combination capable of producing the highest level of heterotic effects in F_1 has immense value for commercial exploitation of heterosis. The magnitude of heterosis provides information on the extent of genetic diversity in parents of a cross and helps in choosing the parents for superior F_1 's, and to exploit hybrid vigour.

According to modern concept, heterosis is expression of joint effect of favorable genes, interaction between alleles, non-allelic interaction and mitochondrial genes brought together from the parents. The heterobeltiosis expressed as per cent superiority of cross over better parent value, whereas economic heterosis as check variety for character under reference, decides whether an experimental hybrid is worth exploiting or not. In general, the magnitude of heterosis for different characters varied in degree and direction with cross to cross.

Estimation of Heterosis

Heterosis was estimated in terms of two parameters *i.e.*,

Heterobeltiosis (HB)

Heterosis expressed as per cent deviation towards better parent in respect to desirable direction was worked out as per Fonseca and Patterson (1968).

$$\text{Heterobeltiosis (\%)} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$$

Where, $\overline{F_1}$ = Mean performance of F_1 hybrid

\overline{BP} = Mean performance of better parent in desired direction

Standard Heterosis (SH)

Heterosis expressed as per cent increase or decrease in hybrid (F_1) over standard check (SC) values in the desirable direction was worked out as per Meredith and Bridge (1972).

$$\text{SH (\%)} = \frac{\overline{F_1} - \overline{SC}}{\overline{SC}} \times 100$$

Where, \bar{F}_1 = Mean performance of F_1 hybrid
 \bar{SC} = Mean performance of standard check

Test of significance

The test of significance for standard heterosis and heterobeltiosis was carried out following “t” test as under.

$$t = \frac{\bar{F}_1 - \bar{SC}}{SE(\bar{F}_1 - \bar{SC})} \text{ for standard heterosis}$$

$$t = \frac{\bar{F}_1 - \bar{BP}}{SE(\bar{F}_1 - \bar{BP})} \text{ for heterobeltiosis}$$

Where,

$$SE(\bar{F}_1 - \bar{SC}) = \left[\frac{2 \text{MSe}}{r} \right]^{0.5} \text{ for individual environment}$$

$$SE S = \left[\frac{2 \text{MSe}}{r} \right]^{0.5} \text{ for individual environment and}$$

MSe = Error mean square

r = Number of replications

e = Number of environments

The calculated values were compared with the value of 1.96 (5% level) and 2.58 (1% level) for significance.

Table. 1 List of parents used in crossing programme

S. N.	Parents	Source
1	INDIRA	I.G.K.V, Raipur
2	GAURAV	CSAUAT Kanpur
3	DIPIKA	I.G.K.V, Raipur
4	SHEKHAR	CSAUAT Kanpur
5	KB 96 10	I.G.K.V, Raipur
6	ILS 264	PAU, Ludhiana
7	RLC 133	I.G.K.V, Raipur
8	K 29	AICORPO, Palampur
9	IPI 10	I.G.K.V, Raipur
10	GS 384	RRS, Gurdaspur
11	H 45	I.G.K.V, Raipur
12	KARTIKA	I.G.K.V, Raipur

Result and discussion

4.4.1 Days to 50% Flowering

In linseed, earliness in flowering is desirable trait. The perusal of data revealed that out of 66 crosses, significant 32 hybrids in E₁; 39 hybrids in E₂; 33 hybrids in E₃ and 34 hybrids in E₄, had significant negative heterosis (Table 2). The range of heterobeltiosis for flowering was -16.67 % (Gaurav × H 45) to 8.39 % (IPI 10 × GS 384) in E₁; -15.87 % (Gaurav × KB 9610 & Shekhar × RLC 133) to 7.27 % (IPI 10 × GS 384) in E₂; -18.63 % (Gaurav × KB 9610) to 17.47 % (IPI 10 × GS 384) in E₃ and -15.94 % (Gaurav × KB 9610) to 13.14 % (IPI 10 × GS 384) in E₄. The highest magnitude of heterobeltiosis in desirable direction *i.e.*, early flowering was estimated by the cross Gaurav × H 45 (-16.67 %) in E₁, cross Gaurav × KB 9610 & Shekhar × RLC 133 (-15.87) in E₂, by Gaurav × KB 9610 (-18.63 %) in E₃ and E₄ (-15.94 %). Likewise, highest magnitude of heterobeltiosis for late flowering was estimated by cross IPI 10 × GS 384

in all four environments *i.e.*, 8.39 %, 7.27 %, 17.47 % and 13.14 % in E₁, E₂, E₃ and E₄, respectively.

The negative and significance economic heterosis over standard check (RLC 92) were noted by 15, 42, 26 and 36 hybrids in E₁, E₂, E₃ and E₄, respectively, in desirable (negative) direction. The range of standard heterosis was -9.43 % (KB 9610 × K 29) to 14.47 % (Indira × Shekhar) in E₁, -16.09 % (RLC133 × H 45) to 10.34 % (Indira × Shekhar) in E₂, -16.29 (RLC 133 × K 29) % to 11.8 % (Indira × Shekhar) in E₃ and -14.29 (RLC 133 × H 45) % to 8.47 % (Indira × Shekhar) in E₄. These results are in confirmation with by Sharma *et al.* (2005), Reddy *et al.* (2013), Pali and Mehta (2014), Ram and Ahmad (2016), Ahmad *et al.* (2018), Chaure *et al.* (2018), Dhirhi *et al.* (2018), Yadav *et al.* (2018) and Mahto *et al.* (2020).

4.4.2 Days to Maturity

Out of 66 crosses, negative and desirable heterobeltiosis was observed in 27 hybrids in E₁; 35 hybrids in E₂; 29 hybrids in E₃ and 27 hybrids in E₄. Also, positive and significant heterobeltiosis was observed in five, 11, 17 and 16. E₁, E₂, E₃, and E₄, respectively (Table 3).

The minimum and maximum heterobeltiosis for days to maturity was noted by Gaurav × RLC 133 (-8.99 %) and RLC 133 × GS 384 (3.23 %) in E₁; ILS 264 × IPI 10 (-8.15 %) and Dipika × GS 384 (4.05 %) in E₂; ILS 264 × IPI 10 (-10.38 %) and RLC 133 × GS 384 (6.42 %) in E₃ and ILS 264 × IPI 10 (-8.4 %) and RLC 133 × GS 384 (6.21 %) in E₄ respectively.

Majority of crosses exhibited undesired standard heterosis. Total four, nine, 16 and seven hybrids manifested significant and negative standard heterosis in E₁, E₂, E₃ and E₄ respectively while, significant and positive standard heterosis manifested by 25, 24, 28 and 40 hybrids in E₁, E₂, E₃ and E₄ respectively. A cross Gaurav × ILS 264 depicted significant highest positive SH 7.81 %, 9.34 %, 9.65 % and 9.57 % in E₁, E₂, E₃ and E₄, respectively. Hybrid IPI 10 × H 45 have been found significant least negative standard heterosis in E₁ (-4.06 %) and E₂ (-4.52 %), IPI 10 × Kartika in E₃ (-5.85 %) in E₃ and RLC 133 × IPI 10 & IPI 10 × GS 384 in E₄ (-4.35 %). Similar results were also reported by Sharma *et al.* (2005), Reddy *et al.* (2013), Pali and Mehta (2014), Ahmad *et al.* (2018), Yadav *et al.* (2018) and Mahto *et al.* (2020).

4.4.3 Plant Height

Most of the crosses depicted significant and negative better parent heterosis in all environments among significant F₁s. Out of 66 crosses, significant heterobeltiosis for 19 hybrids in E₁; 18 hybrids in E₂; 42 hybrids in E₃ and 29 hybrids in E₄. Out of which 18 hybrids exhibited

significant and negative better parent heterosis in E₁, 14 hybrids in E₂, 33 hybrids in E₃ and 24 hybrids in E₄ (Table 4). The range of better parent heterosis for plant height at different environment was from -14.51 % (Indira × IPI 10) to 6.82 % (ILS 264 × H 45) in E₁, -10.71 % (Gaurav × IPI 10) to 5.42 % (RLC 133 × K 29 & RLC 133 × IPI 10) in E₂, -15.08 % (Gaurav × IPI 10) to 17.07 % (H 45 × Kartika) in E₃ and -13.11 % (Gaurav × IPI 10) to 9.55 % (RLC 133 × H 45 & H 45 × Kartika) in E₄.

Similarly, only two hybrids recorded significant and desired (negative) heterosis over check in E₁ with range of -11.29 (Indira × IPI 10) % to 5.91 % (Indira × Gaurav); 30 hybrids in E₂ with range of -10.67 % (IPI 10 × Kartika) to 8.99 % (Gaurav × RLC 133); 28 hybrids in E₃ with range of -8.47 % (Dipika × ILS 264) to 10.17 % (Indira × Gaurav) and 25 hybrids in E₄ with range of -9.57 % (ILS 264 × IPI 10 & KB 9610 × Kartika) to 6.91 % (ILS 264 × RLC 133). These findings are in conformity with Sharma *et al.* (2005), Reddy *et al.* (2013), Pali and Mehta (2014), Singh *et al.* (2014), Ram and Ahmad (2016), Chaure *et al.* (2018), Yadav *et al.* (2018) and Mahto *et al.* (2020).

4.4.4 Number of Primary Branches per Plant

For primary branches per plant, eight F₁s each in E₁ and E₂ and five F₁s in E₃ and zero in E₄ exhibited significant and positive HB. The better parent heterosis varied from -18.23 % (Indira × Shekhar) to 14.19 % (Indira × RLC 133) in E₁, -15.61 % (IPI 10 × Kartika) to 8.33 % (KB 9610 × ILS 264) in E₂, -16.34 % (IPI 10 × Kartika) to 10.56 % (Gaurav × K 29) in E₃ and -31.88 % (ILS 264 × K29) to 8.09 % (K 29 × H 45) in E₄ (Table 5).

The highest and lowest economic heterosis for primary branches per plant was 25.16 % (Shekhar × IPI 10) and -4.52 % (Indira × Shekhar); 24.38 % (Shekhar × KB 9610 & Shekhar × IPI 10) and -8.75 % (Indira × Dipika); 30.07 % (Gaurav × K 29 & Shekhar × IPI 10) and -12.42 % (Indira × Dipika) and 11.68 (Gaurav × Shekhar) and -31.39 (ILS 264 × K 29) in E₁, E₂, E₃ and E₄, respectively. Total 61 crosses in E₁, 52 crosses in E₂ and 41 crosses in E₃ were positive and significant. The results are in agreement with findings of Sharma *et al.* (2005), Reddy *et al.* (2013), Singh *et al.* (2014), Yadav *et al.* (2018) and Mahto *et al.* (2020).

4.4.5 Number of Secondary Branches per Plant

The positive heterosis for number of secondary branches per plant is desirable and very few crosses depicted desirable HB. Out of 66 crosses 11, 5, 32 and 1 crosses showed significant heterobeltiosis, among them, 3, 3, 6 and none of the crosses were found positive in E₁, E₂, E₃ and E₄, respectively (Table 6). Indira × RLC 133 (14.89 %) and GS 384 × H 45

(13.55 %) in E₁; Indira × IPI 10 (13.80 %) and Shekhar × KB 9610 (13.37) in E₂ and Indira × KB 9610 (15.66 %) in E₃ were the top significant heterobeltiotic hybrids. The heterosis over better parent varied from -21.62 % (ILS 264 × IPI 10) to 14.89 % (Indira × RLC 133); -14.11 % (Gaurav × H 45) to 13.80 % (Indira × IPI 10), -20.74 % (Gaurav × GS 384) to 15.66 % (Indira × KB 9610) and -15.46 % (Indira × Shekhar) to 12.34 % (Gaurav × K 29) in E₁, E₂, E₃, and E₄, respectively.

The magnitude of standard heterosis for this trait ranged from -4.93 % (RLC 133 × GS 384) to 31.20 % (Gaurav × Shekhar); -3.97 % (RLC 133 × Kartika & Indira × KB 9610) to 35.41 % (Gaurav × Shekhar); 0.93 % (K 29 × GS 384) to 35.25 % to (Gaurav × Shekhar); and -5.86 % (Indira × K 29) to 31.68 % (Gaurav × K 29) in E₁, E₂, E₃ and E₄, respectively. The results were in correspondence to the findings of Pali and Mehta (2014), Singh *et al.* (2014) and Yadav *et al.* (2018).

4.4.6 Number of Capsules per Plant

Relative number of capsules per plant over better parent heterosis in E₁, E₂, E₃ and E₄ varied from -5.69 % (Gaurav × KB 9610) to 17.95 % (Indira × RLC 133), -9.72 % (Shekhar × RLC 133) to 9.34 % (Indira × K 29), -9.16 % (IPI 10 × H 45) to 16.91 (Dipika × K 29) and -13.62 % (GS 384 × Kartika) to 18.39 % (Dipika × K 29), respectively (Table 7). Total 8, 16, 10 and 17 crosses showed positive and significant heterobeltiosis in E₁, E₂, E₃ and E₄, respectively. Hybrids, Indira × RLC 133 (17.95 %) and RLC 133 × Kartika (16.65 %) in E₁; Indira × K 29 (9.34 %) and Indira × RLC 133 (8.69 %) in E₂; Dipika × K 29 (16.91 %) in E₃ and Dipika × K 29 (18.39 %) in E₄ were noted the best significant heterobeltiotic hybrids for average number of capsules per plant.

Many hybrids noted desired economic heterosis. Total 39, 34, 35 and 44 crosses showed positive and significant standard heterosis. The minimum and maximum standard heterosis noted -2.01 % (Indira × H 45) and 18.63 % (RLC 133 × IPI 10); -5.64 % (RLC 133 × K 29) and 17.03 % (Shekhar × IPI 10); -7.2 % (ILS 264 × RLC 133) and 20.46 % (KB 9610 × GS 384) and -5.85 % (ILS 264 × RLC 133) and 27.81 % (KB 9610 × IPI 10) in E₁, E₂, E₃ and E₄, respectively. IPI 10 × GS 384 have been found to be best performing hybrids in all environment due to high magnitude of economic heterosis at all locations. These results are similar to the findings of Ratnaparkhi *et al.* (2005), Reddy *et al.* (2013), Pali and Mehta (2014), Singh *et al.* (2014), Ram

and Ahmad (2016), Ahmad *et al.* (2018), Chaure *et al.* (2018), Yadav *et al.* (2018) and Mahto *et al.* (2020).

4.4.7 Number of Seeds per Capsules

Number of seeds per capsules is one of the main yields contributing character who's positive heterosis is desirable for yield improvement in linseed. The highest and lowest heterobeltiosis over better parent observed 2.86 % (Indira × RLC 133) and -8.3 % (Gaurav × Shekhar) in E₁, 3.41 % (Dipika × RLC 133) and -8.46 % (Gaurav × Shekhar) in E₂, 3.21 % (Gaurav × Dipika) and -7.78 % (Shekhar × ILS 264 & KB 9610 × ILS 264) in E₃ and 4.66 % (Indira × IPI 10) and -12.2 % (Indira × Gaurav) in E₄ (Table 8). In case of better parent heterosis estimate of the best hybrids were namely, Indira × RLC 133 (2.86 %) and Shekhar × H 45 (2.66 %) in E₁; Dipika × RLC 133 (3.41 %) and Dipika × Kartika (3.33 %) in E₂; Gaurav × Dipika (3.21 %) in E₃ and Indira × IPI 10 (4.66 %) and Shekhar × RLC 133 (2.87 %) in E₄ which registered significant heterosis over better parent in desirable direction.

Majority of F₁s were poor performer than RC 92. The least performing hybrids for standard heterosis were -13.6 % (Indira × KB 9610); -12.27 % (KB 960 × K 29 & K 29 × IPI 10); -12.45 (KB 9610 × K 29) and -14.86 % (Indira × Dipika) in E₁, E₂, E₃ and E₄, respectively. The best performing hybrids were H 45 × Kartika (5.62 %), Gaurav × H 45 (4.02 %), ILS 264 × Kartika (4.02) and Shekhar × Kartika (3.21 %) in E₄. Similar finding in accordance to the above result has also been reported by Pali and Mehta (2014), Ram and Ahmad (2016), Ahmad *et al.* (2018) and Mahto *et al.* (2020).

4.4.8 Test Weight

Total 8, 38 in E₁, 7, 36 in E₂, 6, 37 in E₃ and 12, 45 in E₄ F₁s exhibit BP and SH, respectively, which indicate majority of hybrids are better than check variety but poorer than their bolder parents. The range heterobeltiosis for test weight varied from -20.38 % (Indira × Shekhar) to 29.77 % (Indira × ILS 264) in E₁, -19.38 % (Indira × Shekhar) to 33.33 % (Indira × ILS 264) in E₂, -21.72 % (Indira × Shekhar) to 30.85 % (Indira × ILS 264) in E₃ and -22.58 % (RLC 133 × GS 384) to 28.57 % (Indira × ILS 264) in E₄ (Table 9).

The crosses Indira × Kartika and KB 9610 × K 29 exhibited minimum and maximum standard heterosis in E₁, E₂ and E₃ (-15.77 % to 23.42 %, -17.81 % to 23.29 % and -17.24 % to 23.15 %, respectively) and in E₄ Indira × Kartika (-11.28 %) and Dipika × RLC 133 (32.21 %).

Top hybrids for test weight were KB 9610 × K 29 (23.42 %) and Indira × ILS 264, Shekhar × K 29 & KB 9610 × RLC 133 (19.37 %) in E₁; KB 9610 × K 29 (23.29 %) and Indira × ILS 264 & KB 9610 × RLC 133 (20.55 %) in E₂; KB 9610 × K 29 (23.15 %) and Shekhar × KB 9610 (22.66 %) in E₃ and Dipika × RLC 133 (32.21 %) and Shekhar × K 29 (30.77 %) in E₄ were the top most significant and desirable standard heterotic hybrids for test weight. Similar results were also reported by Ratnaparkhi *et al.* (2005), Sharma *et al.* (2005), Reddy *et al.* (2013), Pali and Mehta (2014), Singh *et al.* (2014), Ram and Ahmad (2016), Ahmad *et al.* (2018), Chaure *et al.* (2018) and Mahto *et al.* (2020).

4.4.9 Seed Yield Per Plant

In general, equal magnitude of HB observed in both the directions. Seed yield is the most economic important trait for improvement in linseed and plant breeders attempt to evolve varieties/hybrids in regard with high seed yield per plant. Positive heterosis is highly desirable for this character. The heterosis over better parent for seed yield per plant ranged from -21.46 % (Indira × Shekhar) to 33.22 % (Indira × ILS 264); -21.29 % (Indira × Shekhar) to 38.78 % (Indira × ILS 264); -24.55 % (Gaurav × RLC 133) to 28.8 % (Indira × ILS 264) and -25.98 % (Indira × Gaurav) to 39.51 % (Indira × ILS 264) in E₁, E₂, E₃ and E₄, respectively (Table 10). Total 16, 22, 13 and 20 hybrids manifested significant and positive heterobeltiosis in E₁, E₂, E₃ and E₄, respectively. Indira × ILS 264 [(33.22) in E₁, Indira × ILS 264 (38.78) in E₂, (28.8 %) in E₃ and (39.51 %) in E₄] were the top most significant and positive heterobeltiotic hybrids for seed yield per plant. Table 2 represents the heterobeltiosis (HB) of hybrids in pooled over environments.

The magnitude of standard heterosis for seed yield per plant is the important criteria for selection of better performing hybrid in compare to the check variety. Range of standard heterosis varied from -19.46 % (Indira × Kartika) to 27.36 % (Shekhar × H 45); -21.18 % (Indira × Kartika) to 25.27 % (Shekhar × H 45); -21.65 % (Indira × Kartika) to 34.36 % (Shekhar × GS 384) and -17.96 % (Indira × H 45) to 47.84 % (KB 9610 × IPI 10) in E₁, E₂, E₃, and E₄, respectively. Total 32, 33, 29 and 47 hybrids manifested significant and positive standard heterosis in E₁, E₂, E₃ and E₄, respectively. Crosses Shekhar × H 45 (27.36) in E₁, and in E₂ (25.27 %), Shekhar × GS 384 (34.36 %), in E₃ and KB 9610 × IPI 10 (47.84 %) in E₄ were the top most significant and desirable standard heterotic hybrids for seed yield per plant. Based on heterosis estimate Shekhar × H 45, KB 9610 × IPI 10 and Shekhar × GS 384 were found to be best suited heterotic hybrid over location for hybrid vigour improvement pertaining to seed yield per plant. Table 3 represents the standard heterobeltiosis (SH) of hybrids in pooled over environments. The results were corroborative to the reports of Ratnaparkhi *et al.* (2005), Sharma

et al. (2005), Reddy et al. (2013), Singh et al. (2014), Ram and Ahmad (2016), Chaure et al. (2018), Yadav et al. (2018) and Mahto et al. (2020).

4.4.10 Oil Content

Oil content is an important qualitative trait, high oil content is considered as a desirable quality character for superior linseed variety. Positive and significant value of oil content is desirable. Heterobeltiosis were reported in between -12.85 % (Dipika × H 45) to 5.92 % (Shekhar × GS 384) in E1; -14.48 % (Dipika × K 29) to 4.26 % (Shekhar × GS 384) in E2; -12.83 % (Indira × GS 384) to 5.51 % (Shekhar × GS 384) in E3 and -12.97 % (K 29 × IPI 10) to 5.57 % (GS 384 × H 45) in E4 (Table 11). Hybrids namely Shekhar × GS 384 (5.92 %) in E1; Shekhar × GS 384 (4.26 %), Gaurav × RLC 133 (4.18 %) and Shekhar × H 45 (4.11 %) in E2; Shekhar × GS 384 (5.51 %) in E3 and GS 384 × H 45 (5.57 %) in E4 were the best heterobeltiotic hybrids for oil content.

Range of standard heterosis reported in between -12.58 % (KB 9610 × GS 384) to 3.97 % (H 45 × Kartika) in E1, -10.87 % (KB 9610 × GS 384) to 4.88 % (Indira × ILS 264) in E2, -13.24 % (KB 9610 × GS 384) to 0.17 % (Dipika × ILS 264 & Shekahr × RLC 133) in E3 and -11.27 % (K 29 × IPI 10) to 5.32 % (IPI 10 × Kartika) in E4. The promising hybrids were H 45 × Kartika (3.97 %) and ILS 264 × RLC 133 (3.63 %) in E1; Indira × ILS 264 (4.88 %) and Dipika × ILS 264 (4.53 %) in E2; IPI 10 × Kartika (5.32 %) and KB 9610 × ILS 264 (5.15 %) in E3 and ILS 264 × RLC 133 (4.35 %) in E4 exhibited significant and positive standard heterosis. The derived results were in conformity with Ratnaparkhi et al. (2005), Sharma et al. (2005), Pali and Mehta (2014) and Ram and Ahmad (2016).

Table 2 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for days to 50 % flowering

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	-5.38*	10.69**	-3.7*	4.6**	-6.37**	7.3**	-5.8**	3.17*
2	Indira x Dipika	1.19	6.92**	1.11	4.6**	4.86**	8.99**	1.01	5.82**
3	Indira x Shekhar	1.68	14.47**	1.59	10.34**	2.05	11.8**	3.54*	8.47**
4	Indira x KB 9610	-5.95*	-0.63	-6.67**	-3.45*	-7.03**	-3.37*	-8.08**	-3.70*
5	Indira x ILS 264	-4.76*	0.63	-5.00**	-1.72	-2.70	1.12	-3.03*	1.59
6	Indira x RLC 133	-7.74**	-2.52	-7.78**	-4.6**	-5.41**	-1.69	-9.09**	-4.76**
7	Indira x K29	-4.76*	0.63	-7.22**	-4.02*	-1.08	2.81	-2.53	2.12
8	Indira x IPI 10	-4.17	1.26	-6.67**	-3.45*	-5.41**	-1.69	-6.06**	-1.59
9	Indira x GS 384	-4.76*	0.63	-12.22**	-9.2**	-9.73**	-6.18**	-10.61**	-6.35**
10	Indira x H 45	-1.79	3.77	-5**	-1.72	1.08	5.06**	-3.03*	1.59
11	Indira x Kartika	2.38	8.18**	-1.67	1.72	3.78**	7.87**	0.00	4.76**
12	Gaurav x Dipika	-7.53**	8.18**	-5.29**	2.87	-9.31**	3.93**	-4.83**	4.23**
13	Gaurav x Shekhar	-8.6**	6.92**	-4.76**	3.45*	-11.76**	1.12	-11.11**	-2.65
14	Gaurav x KB 9610	-16.13**	-1.89	-15.87**	-8.62**	-18.63**	-6.74**	-15.94**	-7.94**
15	Gaurav x ILS 264	-14.52**	0.00	-10.58**	-2.87	-16.18**	-3.93**	-12.56**	-4.23**
16	Gaurav x RLC 133	-13.44**	1.26	-9.52**	-1.72	-11.76**	1.12	-7.25**	1.59
17	Gaurav x K 29	-15.05**	-0.63	-12.7**	-5.17**	-11.27**	1.69	-7.25**	1.59
18	Gaurav x IPI 10	-16.67**	-2.52	-12.7**	-5.17**	-14.22**	-1.69	-14.49**	-6.35**
19	Gaurav x GS 384	-10.75**	4.4	-6.35**	1.72	-6.86**	6.74**	-4.35**	4.76**
20	Gaurav x H 45	-16.67**	-2.52	-13.76**	-6.32**	-17.65**	-5.62**	-15.94**	-7.94**
21	Gaurav x Kartika	-9.14**	6.29*	-4.76**	3.45*	-6.86**	6.74**	-5.8**	3.17*
22	Dipika x Shekhar	-5.59*	6.29*	-4.23**	4.02*	-6.15**	2.81	-5.56**	-1.06
23	Dipika x KB 9610	-6.79**	-5.03*	-8.09**	-8.62**	-10.38**	-7.87**	-7.94**	-7.94**
24	Dipika x ILS 264	1.85	3.77	0.58	0.00	3.28*	6.18**	6.35**	6.35**
25	Dipika x RLC 133	-4.94*	-3.14	-7.51**	-8.05**	0.55	3.37*	-7.41**	-7.41**
26	Dipika x K 29	-2.47	-0.63	-4.62**	-5.17**	0.00	2.81	-0.53	-0.53
27	Dipika x IPI 10	0.62	2.52	-1.16	-1.72	0.00	2.81	1.59	1.59

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
28	Dipika x GS 384	-1.85	0.00	-4.05*	-4.6**	-4.37**	-1.69	-4.76**	-4.76**
29	Dipika x H 45	6.17*	8.18**	2.31	1.72	3.83**	6.74**	3.17*	3.17*
30	Dipika x Kartika	0.62	2.52	-4.62**	-5.17**	-3.28*	-0.56	-3.70*	-3.70*
31	Shekhar x KB 9610	-8.38**	3.14	-10.05**	-2.3	-10.77**	-2.25	-10.61**	-6.35**
32	Shekhar x ILS 264	-9.5**	1.89	-12.7**	-5.17**	-14.36**	-6.18**	-13.64**	-9.52**
33	Shekhar x RLC 133	-12.29**	-1.26	-15.87**	-8.62**	-10.26**	-1.69	-12.63**	-8.47**
34	Shekhar x K 29	-8.94**	2.52	-10.05**	-2.3	-7.69**	1.12	-4.04**	0.53
35	Shekhar x IPI 10	-5.03*	6.92**	-7.94**	0.00	-4.10**	5.06**	-2.53	2.12
36	Shekhar x GS 384	-4.47*	7.55**	-6.88**	1.15	-1.54	7.87**	-4.55**	0.00
37	Shekhar x H 45	-8.94**	2.52	-11.11**	-3.45*	-10.26**	-1.69	-12.12**	-7.94**
38	Shekhar x Kartika	-6.15**	5.66*	-6.35**	1.72	0.00	9.55**	-0.51	4.23**
39	KB 9610 x ILS 264	-4.38	-3.77	-5.45**	-10.34**	-2.300	-4.49**	-5.52**	-9.52**
40	KB 9610 x RLC 133	0.67	-5.66*	4.00*	-10.34**	-2.47	-11.24**	-1.19	-12.17**
41	KB 9610 x K 29	-5.88*	-9.43**	-4.49*	-14.37**	-7.27**	-14.04**	2.98	-8.47**
42	KB 9610 x IPI 10	1.34	-5.03*	-2.52	-10.92**	-7.83**	-14.04**	-4.57**	-11.64**
43	KB 9610 x GS 384	-1.29	-3.77	0.00	-5.17**	2.47	-6.74**	1.72	-6.35**
44	KB 9610 x H 45	2.68	-3.77	6.00**	-8.62**	7.41**	-2.25	8.93**	-3.17*
45	KB 9610 x Kartika	4.70	-1.89	5.88**	-6.9**	6.59**	0.00	6.11**	1.06
46	ILS 264 x RLC 133	-5.63*	-5.03*	-0.61	-5.75**	-3.45*	-5.62**	-2.76	-6.88**
47	ILS 264 x K 29	-6.88**	-6.29*	-1.82	-6.9**	-7.47**	-9.55**	-4.42**	-8.47**
48	ILS 264 x IPI 10	-4.38	-3.77	0.00	-5.17**	-5.17**	-7.3**	-1.10	-5.29**
49	ILS 264 x GS 384	-3.13	-2.52	1.82	-3.45*	0.00	-2.25	1.66	-2.65
50	ILS 264 x H 45	-5.63*	-5.03*	-5.45**	-10.34**	-5.17**	-7.3**	-3.87*	-7.94**
51	ILS 264 x Kartika	3.13	3.77	5.45**	0.00	6.32**	3.93**	2.76	-1.59
52	RLC 133 x K 29	-4.58	-8.18**	-5.77**	-15.52**	-9.7**	-16.29**	-2.38	-13.23**
53	RLC 133 x IPI 10	0.67	-5.66*	-5.66**	-13.79**	0.00	-6.74**	-2.29	-9.52**
54	RLC 133 x GS 384	-5.16*	-7.55**	-6.06**	-10.92**	6.25**	-4.49**	-1.72	-9.52**
55	RLC 133 x H 45	-2.03	-8.81**	-2.67	-16.09**	0.66	-14.04**	-2.99	-14.29**
56	RLC 133 x Kartika	3.42	-5.03*	5.88**	-6.9**	0.00	-6.18**	-1.67	-6.35**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
57	K 29 x IPI 10	0.00	-3.77	-1.89	-10.34**	3.61*	-3.37*	4.00*	-3.70*
58	K 29 x GS 384	2.58	0.00	0.00	-5.17**	4.85**	-2.81	6.90**	-1.59
59	K 29 x H 45	3.27	-0.63	7.05**	-4.02*	9.09**	1.12	12.5**	0.00
60	K 29 x Kartika	-1.31	-5.03*	1.92	-8.62**	-0.60	-6.74**	-3.33*	-7.94**
61	IPI 10 x GS 384	8.39**	5.66*	7.27**	1.72	17.47**	9.55**	13.14**	4.76**
62	IPI 10 x H 45	0.67	-5.66*	0.63	-8.05**	6.63**	-0.56	4.00*	-3.7*
63	IPI 10 x Kartika	2.68	-3.77	5.03**	-4.02*	3.59*	-2.81	-1.11	-5.82**
64	GS 384 x H 45	-2.58	-5.03*	-1.82	-6.90**	6.87**	-3.93**	3.45*	-4.76**
65	GS 384 x Kartika	4.52	1.89	5.45**	0.00	8.38**	1.69	6.67**	1.59
66	H 45 x Kartika	6.76*	-0.63	5.88**	-6.90**	-2.40	-8.43**	-3.33*	-7.94**
	Min.	-16.67	-9.43	-15.87	-16.09	-18.63	-16.29	-15.94	-14.29
	Max.	8.39	14.47	7.27	10.34	17.47	11.8	13.14	8.47
	SE (±)	1.27		0.95		0.85		0.92	
	No. of significant crosses	35	28	48	48	48	41	46	47
	No. of Significant +ve crosses	3	13	9	6	15	15	12	11
	No. of Significant -ve crosses	32	15	39	42	33	26	34	36

*, ** Significant at 5 and 1 percent levels, respectively

Table 3 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for days to maturity

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	-5.22**	2.19*	-3.66**	3.01**	-4.12**	2.05**	-5.15**	1.45
2	Indira x Dipika	0.00	0.31	-1.50	-1.20	-0.30	-2.05**	-2.01**	-0.87
3	Indira x Shekhar	0.88	6.87**	2.05*	5.12**	5.73**	7.89**	4.46**	8.70**
4	Indira x KB 9610	2.49*	2.81**	0.90	1.20	2.38**	0.58	1.43	2.61**
5	Indira x ILS 264	-1.45	6.25**	-2.25**	4.82**	-5.74**	0.88	-3.25**	3.48**
6	Indira x RLC 133	0.31	0.62	-1.80*	-1.51	-0.60	-2.34**	-1.43	-0.29
7	Indira x K29	1.83	4.37**	1.46	4.52**	0.00	3.51**	0.00	4.35**
8	Indira x IPI 10	-0.31	0.00	-1.80*	-1.51	0.60	-1.17	-0.57	0.58
9	Indira x GS 384	0.31	0.62	1.80*	2.11*	2.98**	1.17	1.43	2.61**
10	Indira x H 45	0.62	0.94	0.60	0.90	3.87**	2.05**	3.72**	4.93**
11	Indira x Kartika	1.53	3.75**	1.77*	3.92**	4.35**	5.26**	3.95**	6.67**
12	Gaurav x Dipika	-4.35**	3.13**	-3.66**	3.01**	-2.20**	4.09**	-2.17**	4.64**
13	Gaurav x Shekhar	0.00	7.81**	1.41	8.43**	2.47**	9.06**	1.63*	8.70**
14	Gaurav x KB 9610	-5.80**	1.56	-3.66**	3.01**	-6.32**	-0.29	-7.05**	-0.58
15	Gaurav x ILS 264	0.00	7.81**	1.97*	9.34**	2.46**	9.65**	2.44**	9.57**
16	Gaurav x RLC 133	-8.99**	-1.88	-7.89**	-1.51	-5.77**	0.29	-5.42**	1.16
17	Gaurav x K 29	-2.90**	4.69**	-0.28	6.63**	0.55	7.02**	1.36	8.41**
18	Gaurav x IPI 10	-7.54**	-0.31	-6.48**	0.00	-5.49**	0.58	-4.88**	1.74*
19	Gaurav x GS 384	-7.25**	0.00	-7.89**	-1.51	-10.16**	-4.39**	-7.32**	-0.87
20	Gaurav x H 45	-5.80**	1.56	-5.35**	1.20	-5.49**	0.58	-5.69**	0.87
21	Gaurav x Kartika	-2.90**	4.69**	-1.97*	4.82**	-1.92**	4.39**	-4.61**	2.03**
22	Dipika x Shekhar	-0.88	5.00**	2.05*	5.12**	4.01**	6.14**	1.39	5.51**
23	Dipika x KB 9610	0.63	-0.31	0.31	-1.81*	2.69**	0.58	2.35**	1.16
24	Dipika x ILS 264	-2.03*	5.63**	-3.93**	3.01**	-4.10**	2.63**	-2.44**	4.35**
25	Dipika x RLC 133	0.32	-0.63	1.87*	-1.51	-2.39**	-4.39**	0.59	-0.58
26	Dipika x K 29	-1.83	0.62	-4.39**	-1.51	-1.41	2.05**	-1.39	2.90**
27	Dipika x IPI 10	0.63	-0.31	2.18*	-1.20	2.39**	0.29	2.64**	1.45

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
28	Dipika x GS 384	1.26	0.31	4.05**	0.60	0.90	-1.17	0.29	-0.87
29	Dipika x H 45	-2.21*	-3.13**	0.00	-2.41**	2.39**	0.29	3.20**	2.90**
30	Dipika x Kartika	-1.53	0.62	-2.36**	-0.30	1.45	2.34**	0.85	3.48**
31	Shekhar x KB 9610	-3.24**	2.50*	0.00	3.01**	0.86	2.92**	1.67*	5.8**
32	Shekhar x ILS 264	-1.74	5.94**	-3.09**	3.92**	-0.55	6.43**	-0.54	6.38**
33	Shekhar x RLC 133	-5.31**	0.31	-4.39**	-1.51	-1.15	0.88	-0.56	3.48**
34	Shekhar x K 29	-2.95**	2.81**	-1.75*	1.20	0.00	3.51**	-1.11	3.19**
35	Shekhar x IPI 10	-7.08**	-1.56	-4.09**	-1.20	-6.3**	-4.39**	-5.01**	-1.16
36	Shekhar x GS 384	-5.90**	-0.31	-4.09**	-1.20	-1.15	0.88	-1.39	2.61**
37	Shekhar x H 45	-5.31**	0.31	-1.75*	1.20	-4.3**	-2.34**	-4.18**	-0.29
38	Shekhar x Kartika	0.29	6.25**	1.75*	4.82**	3.15**	5.26**	1.39	5.51**
39	KB 9610 x ILS 264	-4.93**	2.50*	-4.21**	2.71**	-0.27	6.73**	0.54	7.54**
40	KB 9610 x RLC 133	2.22*	0.94	1.54	-0.60	6.42**	1.75*	4.44**	2.32**
41	KB 9610 x K 29	-0.30	2.19*	-2.92**	0.00	-6.78**	-3.51**	-4.44**	-0.29
42	KB 9610 x IPI 10	-0.32	-1.56	-0.31	-2.41**	3.32**	0.00	1.77*	0.00
43	KB 9610 x GS 384	1.27	0.00	1.54	-0.60	5.20**	0.58	3.95**	-0.87
44	KB 9610 x H 45	1.27	0.00	0.92	-1.20	-0.30	-3.22**	1.74*	1.45
45	KB 9610 x Kartika	0.00	2.19*	0.00	2.11*	2.32**	3.22**	1.69*	4.35**
46	ILS 264 x RLC 133	-2.61**	5.00**	-2.25**	4.82**	-2.46**	4.39**	-1.08	5.8**
47	ILS 264 x K 29	0.00	7.81**	-0.56	6.63**	-0.82	6.14**	-0.27	6.67**
48	ILS 264 x IPI 10	-7.25**	0.00	-8.15**	-1.51	-10.38**	-4.09**	-8.40**	-2.03**
49	ILS 264 x GS 384	-7.25**	0.00	-5.62**	1.20	-4.92**	1.75*	-4.07**	2.61**
50	ILS 264 x H 45	-7.25**	0.00	-6.74**	0.00	-7.38**	-0.88	-4.88**	1.74*
51	ILS 264 x Kartika	-3.19**	4.37**	-3.93**	3.01**	-3.28**	3.51**	-1.63*	5.22**
52	RLC 133 x K 29	0.30	2.81**	-0.88	2.11*	-2.26**	1.17	-0.83	3.48**
53	RLC 133 x IPI 10	2.90**	-0.31	1.25	-2.71**	-2.11**	-5.26**	-2.65**	-4.35**
54	RLC 133 x GS 384	3.23**	0.00	2.51**	-1.51	6.42**	1.75*	6.21**	4.06**
55	RLC 133 x H 45	2.88**	0.31	1.85*	-0.60	3.92**	0.88	2.33**	2.03**
56	RLC 133 x Kartika	-2.45*	-0.31	-4.13**	-2.11*	-4.35**	-3.51**	-4.8**	-2.32**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
57	K 29 x IPI 10	-1.83	0.62	-2.63**	0.30	-1.69*	1.75*	-1.67*	2.61**
58	K 29 x GS 384	-1.22	1.25	-0.88	2.11*	-5.08**	-1.75*	-5.00**	-0.87
59	K 29 x H 45	-4.57**	-2.19*	-6.14**	-3.31**	-7.63**	-4.39**	-8.06**	-4.06**
60	K 29 x Kartika	0.3	2.81**	-2.05*	0.90	-2.26**	1.17	-0.83	3.48**
61	IPI 10 x GS 384	1.96	-2.50*	0.31	-3.92**	-2.11**	-5.26**	-2.65**	-4.35**
62	IPI 10 x H 45	-1.60	-4.06**	-2.16*	-4.52**	-1.51	-4.39**	-2.33**	-2.61**
63	IPI 10 x Kartika	-2.75**	-0.63	-3.54**	-1.51	-6.67**	-5.85**	-6.21**	-3.77**
64	GS 384 x H 45	1.92	-0.63	1.54	-0.90	0.90	-2.05**	2.62**	2.32**
65	GS 384 x Kartika	-0.61	1.56	-3.24**	-1.20	-0.87	0.00	0.85	3.48**
66	H 45 x Kartika	-2.45*	-0.31	-4.42**	-2.41**	-0.87	0.00	1.13	3.77**
	Min.	-8.99	-4.06	-8.15	-4.52	-10.38	-5.85	-8.4	-4.35
	Max.	3.23	7.81	4.05	9.34	6.42	9.65	6.21	9.57
	SE (±)	1.12		0.90		0.89		0.86	
	No. of significant crosses	32	29	46	33	46	44	43	47
	No. of Significant +ve crosses	5	25	11	24	17	28	16	40
	No. of Significant -ve crosses	27	4	35	9	29	16	27	7

*, ** Significant at 5 and 1 percent levels

Table 4 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for plant height

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	1.03	5.91*	-3.06	6.74**	-2.01	10.17**	-3.88	5.32*
2	Indira x Dipika	-6.74**	-3.23	-1.08	2.81	0.00	5.65**	1.55	4.79*
3	Indira x Shekhar	-2.07	1.61	-3.78	0.00	-6.95**	-1.69	-7.22**	-4.26
4	Indira x KB 9610	-5.70*	-2.15	-4.86*	-1.12	-2.14	3.39*	-1.55	1.60
5	Indira x ILS 264	-7.77**	-4.3	-5.41**	-1.69	-10.7**	-5.65**	-3.09	0.00
6	Indira x RLC 133	-2.59	1.08	1.08	5.06*	-6.95**	-1.69	-1.55	1.60
7	Indira x K29	-9.84**	-6.45**	-7.03**	-3.37	-2.14	3.39*	-3.61	-0.53
8	Indira x IPI 10	-14.51**	-11.29**	-8.11**	-4.49*	-8.02**	-2.82	-10.82**	-7.98**
9	Indira x GS 384	-7.77**	-4.3	-3.24	0.56	-5.88**	-0.56	-2.06	1.06
10	Indira x H 45	-4.66*	-1.08	-7.03**	-3.37	-4.81**	0.56	-1.55	1.60
11	Indira x Kartika	-4.15	-0.54	-4.86*	-1.12	0.53	6.21**	1.03	4.26
12	Gaurav x Dipika	-1.54	3.23	-4.08*	5.62**	-5.03**	6.78**	-4.37*	4.79*
13	Gaurav x Shekhar	-4.62*	0.00	-6.63**	2.81	-8.04**	3.39*	-6.31**	2.66
14	Gaurav x KB 9610	-8.21**	-3.76	-8.67**	0.56	-3.02*	9.04**	-7.77**	1.06
15	Gaurav x ILS 264	-0.51	4.3	-4.59*	5.06*	-9.55**	1.69	-10.68**	-2.13
16	Gaurav x RLC 133	0.00	4.84*	-1.02	8.99**	-9.55**	1.69	-10.19**	-1.6
17	Gaurav x K 29	-2.05	2.69	-2.55	7.3**	-14.07**	-3.39*	-11.65**	-3.19
18	Gaurav x IPI 10	-6.67**	-2.15	-10.71**	-1.69	-15.08**	-4.52**	-13.11**	-4.79*
19	Gaurav x GS 384	-9.23**	-4.84*	-9.18**	0.00	-10.05**	1.13	-12.62**	-4.26
20	Gaurav x H 45	-2.56	2.15	-7.14**	2.25	-11.06**	0.00	-6.8**	2.13
21	Gaurav x Kartika	-5.13*	-0.54	-7.65**	1.69	-9.05**	2.26	-4.85*	4.26
22	Dipika x Shekhar	-2.72	-3.76	-0.58	-3.37	6.25**	5.65**	3.66	5.32*
23	Dipika x KB 9610	-1.14	-6.45**	0.00	-5.06*	-5.11**	-5.65**	-9.42**	-7.98**
24	Dipika x ILS 264	-3.98	-9.14**	0.00	-5.06*	-8.47**	-8.47**	-6.81**	-5.32*
25	Dipika x RLC 133	1.69	-2.69	1.78	-3.37	-2.84	-3.39*	-8.38**	-6.91**
26	Dipika x K 29	-0.55	-2.15	4.73*	-0.56	-10.27**	-6.21**	-4.71*	-3.19
27	Dipika x IPI 10	-3.41	-8.6**	-4.14	-8.99**	-5.11**	-5.65**	-8.38**	-6.91**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
28	Dipika x GS 384	-2.27	-7.53**	-2.96	-7.87**	-5.68**	-6.21**	-9.42**	-7.98**
29	Dipika x H 45	1.14	-4.3	3.55	-1.69	5.11**	4.52**	1.05	2.66
30	Dipika x Kartika	0.57	-4.84*	2.37	-2.81	7.95**	7.34**	0.52	2.13
31	Shekhar x KB 9610	-5.43*	-6.45**	-0.58	-3.37	-0.58	-3.95*	-0.56	-4.79*
32	Shekhar x ILS 264	-2.17	-3.23	0.00	-2.81	2.26	2.26	0.54	-0.53
33	Shekhar x RLC 133	-2.17	-3.23	-2.31	-5.06*	1.16	-1.69	6.11*	1.6
34	Shekhar x K 29	-0.54	-1.61	1.16	-1.69	-4.32**	0.00	-1.05	0.53
35	Shekhar x IPI 10	-2.72	-3.76	-2.31	-5.06*	0.00	-3.39*	-1.11	-5.32*
36	Shekhar x GS 384	-2.17	-3.23	-1.16	-3.93	-1.75	-5.08**	-0.56	-4.79*
37	Shekhar x H 45	-3.80	-4.84*	-2.31	-5.06*	-1.17	-4.52**	-1.67	-5.85*
38	Shekhar x Kartika	-8.15**	-9.14**	-1.73	-4.49*	-4.09*	-7.34**	0.56	-3.72
39	KB 9610 x ILS 264	4.55	-1.08	1.8	-4.49*	7.34**	7.34**	4.30	3.19
40	KB 9610 x RLC 133	-0.56	-4.84*	0.00	-6.18**	-3.49*	-6.21**	0.56	-5.32*
41	KB 9610 x K 29	-4.92*	-6.45**	-4.19	-10.11**	-10.27**	-6.21**	-4.71*	-3.19
42	KB 9610 x IPI 10	2.89	-4.30	-0.60	-6.74**	0.58	-2.82	1.13	-4.79*
43	KB 9610 x GS 384	1.73	-5.38*	-2.99	-8.99**	0.61	-6.21**	-0.57	-6.91**
44	KB 9610 x H 45	-1.14	-6.45**	2.99	-3.37	2.42	-4.52**	1.12	-4.26
45	KB 9610 x Kartika	2.89	-4.3	-1.20	-7.3**	-0.61	-7.34**	-3.95	-9.57**
46	ILS 264 x RLC 133	3.37	-1.08	1.80	-4.49*	9.04**	9.04**	8.06**	6.91**
47	ILS 264 x K 29	-2.73	-4.3	-2.99	-8.99**	0.00	4.52**	-2.62	-1.06
48	ILS 264 x IPI 10	-2.27	-7.53**	-3.59	-9.55**	-7.91**	-7.91**	-8.6**	-9.57**
49	ILS 264 x GS 384	-5.11*	-10.22**	-4.19	-10.11**	-6.78**	-6.78**	-6.45**	-7.45**
50	ILS 264 x H 45	6.82**	1.08	4.19	-2.25	-5.65**	-5.65**	-3.76	-4.79*
51	ILS 264 x Kartika	3.41	-2.15	2.40	-3.93	-6.21**	-6.21**	-3.23	-4.26
52	RLC 133 x K 29	-0.55	-2.15	5.42*	-1.69	-4.86**	-0.56	-4.71*	-3.19
53	RLC 133 x IPI 10	-1.12	-5.38*	5.42*	-1.69	0.00	-2.82	-0.56	-6.38**
54	RLC 133 x GS 384	-0.56	-4.84*	1.81	-5.06*	5.81**	2.82	6.78**	0.53
55	RLC 133 x H 45	3.37	-1.08	1.8	-4.49*	11.05**	7.91**	9.55**	3.72
56	RLC 133 x Kartika	-1.12	-5.38*	0.00	-6.74**	0.58	-2.26	0.56	-5.32*

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
57	K 29 x IPI 10	-1.64	-3.23	2.42	-5.06*	-5.95**	-1.69	-7.33**	-5.85*
58	K 29 x GS 384	1.64	0.00	4.85*	-2.81	-10.27**	-6.21**	-7.85**	-6.38**
59	K 29 x H 45	-5.46*	-6.99**	0.00	-6.18**	-4.86**	-0.56	-4.19	-2.66
60	K 29 x Kartika	-4.92*	-6.45**	2.42	-5.06*	0.00	4.52**	-1.57	0.00
61	IPI 10 x GS 384	3.61	-7.53**	1.25	-8.99**	2.92	-0.56	1.13	-4.79*
62	IPI 10 x H 45	-3.41	-8.6**	-2.4	-8.43**	-1.75	-5.08**	-2.81	-7.98**
63	IPI 10 x Kartika	-2.91	-10.22**	-1.24	-10.67**	0.00	-3.39*	2.82	-3.19
64	GS 384 x H 45	-1.70	-6.99**	-0.6	-6.74**	4.27*	-3.39*	-2.25	-7.45**
65	GS 384 x Kartika	-2.91	-10.22**	-0.62	-10.11**	1.84	-6.21**	2.82	-3.19
66	H 45 x Kartika	4.55	-1.08	3.59	-2.81	17.07**	8.47**	9.55**	3.72
	Min.	-14.51	-11.29	-10.71	-10.67	-15.08	-8.47	-13.11	-9.57
	Max.	6.82	5.91	5.42	8.09	17.07	10.17	9.55	6.91
	SE (±)	1.42		1.19		0.92		1.46	
	No. of significant crosses	19	29	18	36	42	45	29	30
	No. of Significant +ve crosses	1	27	4	6	9	17	5	5
	No. of Significant -ve crosses	18	2	14	30	33	28	24	25

*, ** Significant at 5 and 1 percent levels,

Table 5 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for number of primary branches per plant

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	-0.56	15.48**	-9.19**	5*	-15**	0	-5.81	6.57
2	Indira x Dipika	7.98**	13.55**	-10.43**	-8.75**	-13.55**	-12.42**	0.00	5.11
3	Indira x Shekhar	-18.23**	-4.52**	-10.42**	7.5**	-8.65**	10.46**	4.23	8.03
4	Indira x KB 9610	-5.39**	1.94	5.45*	8.75**	0.00	4.58	1.41	5.11
5	Indira x ILS 264	-3.66*	1.94	-1.79	3.13	-3.12	1.31	0.00	3.65
6	Indira x RLC 133	14.19**	9.03**	2.67	-3.75	-9.4**	-11.76**	-1.41	2.19
7	Indira x K29	-9.15**	-3.87*	-10.65**	-5.62*	-13.13**	-9.15**	-4.93	-1.46
8	Indira x IPI 10	-9.74**	13.55**	-8.29**	17.5**	-14.36**	13.07**	-9.4	-1.46
9	Indira x GS 384	1.23	5.81**	4.71*	11.25**	6.79**	13.07**	2.11	5.84
10	Indira x H 45	-7.91**	5.16**	-6.63**	5.63*	-12.78**	2.61	-1.41	2.19
11	Indira x Kartika	7.48**	1.94	5.30*	-0.62	-3.40	-7.19**	-2.11	1.46
12	Gaurav x Dipika	-4.44**	10.97**	1.08	16.88**	-5.00*	11.76**	-7.74	4.38
13	Gaurav x Shekhar	1.1	18.06**	0.52	20.63**	-3.78	16.34**	-1.29	11.68
14	Gaurav x KB 9610	-8.89**	5.81**	-4.32*	10.63**	-6.11**	10.46**	-4.52	8.03
15	Gaurav x ILS 264	-4.44**	10.97**	-5.41**	9.38**	-8.89**	7.19**	-9.03	2.92
16	Gaurav x RLC 133	2.78	19.35**	-0.54	15**	-1.67	15.69**	-3.87	8.76
17	Gaurav x K 29	5.56**	22.58**	8.11**	25**	10.56**	30.07**	-3.87	8.76
18	Gaurav x IPI 10	-1.03	24.52**	-3.41	23.75**	-5.45**	24.84**	-8.39	3.65
19	Gaurav x GS 384	0.00	16.13**	5.41**	21.88**	3.89	22.22**	-10.32	1.46
20	Gaurav x H 45	-1.67	14.19**	6.49**	23.13**	7.22**	26.14**	-4.52	8.03
21	Gaurav x Kartika	-2.22	13.55**	-4.86*	10**	-5.00*	11.76**	-9.68	2.19
22	Dipika x Shekhar	-1.10	15.48**	-7.29**	11.25**	-6.49**	13.07**	1.39	6.57
23	Dipika x KB 9610	1.20	9.03**	4.24	7.50**	6.88**	11.76**	-4.17	0.73
24	Dipika x ILS 264	2.44	8.39**	4.17	9.38**	0.63	5.23	-5.56	-0.73
25	Dipika x RLC 133	0.61	5.81**	-0.61	1.25	-5.16	-3.92	-4.17	0.73
26	Dipika x K 29	1.83	7.74**	-4.14	1.25	-8.75**	-4.58	-3.47	1.46
27	Dipika x IPI 10	-11.79**	10.97**	-11.71**	13.13**	-16.34**	10.46**	-6.04	2.19

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
28	Dipika x GS 384	1.84	7.1**	4.12	10.63**	2.47	8.50**	-6.25	-1.46
29	Dipika x H 45	-3.95**	9.68**	0.55	13.75**	-6.67**	9.80**	5.56	10.95
30	Dipika x Kartika	1.84	7.1**	4.29	6.25**	2.58	3.92	-1.39	3.65
31	Shekhar x KB 9610	3.31*	20.65**	3.65	24.38**	0.54	21.57**	1.45	2.19
32	Shekhar x ILS 264	-1.66	14.84**	-3.65	15.63**	-4.86*	15.03**	0.00	0.73
33	Shekhar x RLC 133	1.66	18.71**	-7.29**	11.25**	-6.49**	13.07**	5.07	5.84
34	Shekhar x K 29	-4.42**	11.61**	-8.33**	10.00**	-7.03**	12.42**	5.07	5.84
35	Shekhar x IPI 10	-0.51	25.16**	-2.93	24.38**	-1.49	30.07**	-6.71	1.46
36	Shekhar x GS 384	-8.84**	6.45**	-9.37**	8.75**	-8.11**	11.11**	0.71	2.92
37	Shekhar x H 45	2.21	19.35**	1.04	21.25**	-0.54	20.26**	-2.9	-2.19
38	Shekhar x Kartika	-6.08**	9.68**	-7.29**	11.25**	-9.73**	9.15**	4.29	6.57
39	KB 9610 x ILS 264	1.80	9.68**	8.33**	13.75**	5.63*	10.46**	2.17	2.92
40	KB 9610 x RLC 133	-2.99	4.52**	1.21	4.38	0.00	4.58	0.00	0.73
41	KB 9610 x K 29	0.60	8.39**	2.37	8.13**	0.63	5.23	2.90	3.65
42	KB 9610 x IPI 10	-12.82**	9.68**	-10.24**	15**	-16.34**	10.46**	-1.34	7.30
43	KB 9610 x GS 384	-1.20	6.45**	-1.18	5.00*	-7.41**	-1.96	-1.43	0.73
44	KB 9610 x H 45	-5.08**	8.39**	-2.21	10.63**	-4.44	12.42**	2.90	3.65
45	KB 9610 x Kartika	-1.20	6.45**	1.82	5.00*	0.00	4.58	-1.43	0.73
46	ILS 264 x RLC 133	-1.22	4.52**	-0.60	4.38	-2.5	1.96	-1.45	-0.73
47	ILS 264 x K 29	1.83	7.74**	-2.37	3.13	0.00	4.58	-31.88**	-31.39**
48	ILS 264 x IPI 10	-8.21**	15.48**	-11.71**	13.13**	-15.84**	11.11**	-2.68	5.84
49	ILS 264 x GS 384	1.22	7.1**	-4.71*	1.25	-8.02**	-2.61	-3.57	-1.46
50	ILS 264 x H 45	-6.21**	7.1**	-2.21	10.63**	-6.67**	9.8**	1.45	2.19
51	ILS 264 x Kartika	1.83	7.74**	1.19	6.25**	-3.75	0.65	0.00	2.19
52	RLC 133 x K 29	0.00	5.81**	-2.96	2.50	-1.87	2.61	-0.74	-2.19
53	RLC 133 x IPI 10	-8.21**	15.48**	-11.71**	13.13**	-14.36**	13.07**	-6.04	2.19
54	RLC 133 x GS 384	4.94**	9.68**	3.53	10.00**	-0.62	5.23	4.29	6.57
55	RLC 133 x H 45	-2.82	10.97**	0.00	13.13**	-5.56*	11.11**	4.41	3.65
56	RLC 133 x Kartika	10.81**	5.81**	6.62**	0.63	-2.01	-4.58	-6.43	-4.38

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
57	K 29 x IPI 10	-9.23**	14.19**	-9.76**	15.63**	-15.35**	11.76**	-12.75*	-5.11
58	K 29 x GS 384	2.44	8.39**	4.71*	11.25**	3.09	9.15**	-1.43	0.73
59	K 29 x H 45	-0.56	13.55**	1.66	15.00**	-7.78**	8.5**	8.09	7.30
60	K 29 x Kartika	1.83	7.74**	-1.78	3.75	-7.5**	-3.27	-2.86	-0.73
61	IPI 10 x GS 384	-6.15**	18.06**	-4.88**	21.88**	-11.39**	16.99**	-6.71	1.46
62	IPI 10 x H 45	-2.05	23.23**	-3.41	23.75**	-7.43**	22.22**	1.34	10.22
63	IPI 10 x Kartika	-11.79**	10.97**	-15.61**	8.12**	-16.34**	10.46**	-6.04	2.19
64	GS 384 x H 45	-4.52**	9.03**	-6.63**	5.63*	-10.56**	5.23	-0.71	1.46
65	GS 384 x Kartika	3.09	7.74**	-0.59	5.63*	0.62	6.54*	-1.43	0.73
66	H 45 x Kartika	5.08**	20**	1.1	14.38**	0.56	18.3**	7.86	10.22
	Min.	-18.23	-4.52	-15.61	-8.75	-16.34	-12.42	-31.88	-31.39
	Max.	14.19	25.16	8.33	25	10.56	30.07	8.09	11.68
	SE (±)	0.08		0.30		0.13		0.15	
	No. of significant crosses	31	63	32	54	40	45	2	1
	No. of Significant +ve crosses	8	61	9	52	5	41	-	-
	No. of Significant -ve crosses	23	2	23	2	35	4	2	1

*, ** Significant at 5 and 1 percent levels,

Table 6 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for number of secondary branches per plant

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	-1.72	22.33**	-2.19	23.32**	-7.58*	19.85**	0.63	17.95*
2	Indira x Dipika	-3.8	-0.16	-2.65	7.94	-6.86	10.76*	-5.65	4.03
3	Indira x Shekhar	11.23	23.65**	-8.51	3.97	5.09	18.74**	-15.46*	0.18
4	Indira x KB 9610	4.05	5.58	-12.58*	-3.97	15.66**	17.81**	-7.17	-2.75
5	Indira x ILS 264	5.79	16.91*	4.25	14.51*	-5.15	2.60	3.23	11.17
6	Indira x RLC 133	14.89*	16.58*	-5.03	4.32	10.62*	15.96**	0.17	4.95
7	Indira x K29	6.58	11.66	-10.06	-1.21	-13.78**	3.34	-11.99	-5.86
8	Indira x IPI 10	0.41	22.00**	13.8*	28.15**	3.62	22.08**	-4.77	13.37
9	Indira x GS 384	-10.09	-1.97	3.30	13.64*	-13.69**	4.08	-5.09	5.86
10	Indira x H 45	4.26	12.64	1.55	13.3*	4.61	13.73**	-11.07	0.00
11	Indira x Kartika	3.07	4.60	5.66	16.06*	-0.71	3.15	-2.97	1.65
12	Gaurav x Dipika	-7.65	14.94*	-8.90	14.85*	-8.87*	18.18**	-0.78	16.3
13	Gaurav x Shekhar	5.41	31.2**	7.40	35.41**	4.29	35.25**	8.04	28.02**
14	Gaurav x KB 9610	-14.64**	6.24	-8.63	15.2*	-9.01*	18**	1.56	19.05*
15	Gaurav x ILS 264	-2.24	21.67**	1.64	28.15**	-8.30*	18.92**	-0.16	17.03*
16	Gaurav x RLC 133	-18.07**	1.97	-2.19	23.32**	-19.6**	4.27	-5.47	10.81
17	Gaurav x K 29	-9.89	12.15	3.56	30.57**	-11.87**	14.29**	12.34	31.68**
18	Gaurav x IPI 10	-14.64**	6.24	-1.64	24.01**	-12.59**	13.36**	-2.92	15.57
19	Gaurav x GS 384	-11.21*	10.51	-3.15	22.11**	-20.74**	2.78	-0.47	16.67*
20	Gaurav x H 45	-8.44	13.96*	-14.11**	8.29	-3.43	25.23**	-6.72	9.34
21	Gaurav x Kartika	-8.71	13.63*	-5.89	18.65**	-8.01*	19.29**	1.25	18.68*
22	Dipika x Shekhar	3.10	14.61*	-3.19	10.02	-10.76**	6.12	-7.42	9.71
23	Dipika x KB 9610	-3.16	0.49	-8.26	1.73	-8.74*	8.53	-11.13	-2.01
24	Dipika x ILS 264	-5.35	4.60	2.80	13.99*	-11.39**	5.38	4.49	15.20
25	Dipika x RLC 133	8.54	12.64	-7.48	2.59	-6.08	11.69*	-8.14	1.28
26	Dipika x K 29	-8.31	-3.94	-2.65	7.94	-10.06*	7.79	-11.3	-2.20
27	Dipika x IPI 10	-7.7	12.15	2.76	15.72*	-13.42**	2.97	-3.38	15.02

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
28	Dipika x GS 384	-7.38	0.99	-9.81	0.00	-9.38*	9.28*	-10.34	0.00
29	Dipika x H 45	2.13	10.34	8.82	21.42**	-5.62	12.24**	7.17	20.51*
30	Dipika x Kartika	2.85	6.73	5.3	16.75*	-12.79**	3.71	-4.65	5.13
31	Shekhar x KB 9610	10.64	22.99**	13.37*	28.84**	3.94	17.44**	-1.24	17.03*
32	Shekhar x ILS 264	-9.01	1.15	3.34	17.44**	-2.63	10.02*	-11.75	4.58
33	Shekhar x RLC 133	1.62	12.97	-10.94	1.21	-4.6	7.79	-9.89	6.78
34	Shekhar x K 29	1.92	13.30	-5.47	7.43	0.62	20.59**	-4.17	13.55
35	Shekhar x IPI 10	-0.68	20.69**	9.73	24.7**	4.09	22.63**	6.62	26.92**
36	Shekhar x GS 384	0.74	11.99	-7.90	4.66	-5.38	14.1**	-7.88	9.16
37	Shekhar x H 45	-10.49	-0.49	9.57	24.53**	4.60	18.18**	-1.24	17.03*
38	Shekhar x Kartika	6.35	18.23**	-3.19	10.02	1.48	14.66**	5.56	25.09**
39	KB 9610 x ILS 264	-5.20	4.76	-1.15	3.80	10.12*	19.11**	2.55	10.44
40	KB 9610 x RLC 133	2.92	4.11	5.20	1.38	-1.24	3.53	7.73	9.71
41	KB 9610 x K 29	-7.99	-3.61	-2.39	5.7	-9.75*	8.16	-5.14	1.47
42	KB 9610 x IPI 10	-6.76	13.3	2.91	15.89*	0.31	18.18**	-1.85	16.85*
43	KB 9610 x GS 384	6.02	15.6*	-0.94	8.98	-15.08**	2.41	2.3	14.1
44	KB 9610 x H 45	-3.8	3.94	-5.57	5.35	8.87*	18.37**	2.44	15.2
45	KB 9610 x Kartika	-2.11	-0.99	12.2	12.78	1.43	5.38	2.19	2.38
46	ILS 264 x RLC 133	-4.75	5.25	6.74	12.09	7.03	15.77**	-7.99	-0.92
47	ILS 264 x K 29	0.30	10.84	-2.39	5.7	-12.54**	4.82	3.74	11.72
48	ILS 264 x IPI 10	-21.62**	-4.76	0.46	13.13*	-12.6**	2.97	-1.08	17.77*
49	ILS 264 x GS 384	-2.67	7.55	-1.1	8.81	-0.77	19.67**	-0.82	10.62
50	ILS 264 x H 45	1.93	12.64	-7.59	3.11	8.19	17.63**	-6.03	5.68
51	ILS 264 x Kartika	3.71	14.61*	7.07	12.44	-4.80	2.97	-4.42	2.93
52	RLC 133 x K 29	5.33	10.34	-2.55	5.53	-10.22**	7.61	2.91	10.07
53	RLC 133 x IPI 10	-16.76**	1.15	2.61	15.54*	-4.41	12.62**	-6.00	11.9
54	RLC 133 x GS 384	-12.8*	-4.93	7.54	18.31**	-4.62	15.03**	-8.21	2.38
55	RLC 133 x H 45	-4.56	3.12	-1.24	10.19	2.22	11.13*	2.28	15.02
56	RLC 133 x Kartika	13.19	14.12*	-4.47	-3.97	13.98**	19.48**	1.44	3.3

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
57	K 29 x IPI 10	1.62	23.48**	3.37	16.41*	7.59	28.94**	-4.31	13.92
58	K 29 x GS 384	-5.42	3.12	-8.01	1.21	-16.31**	0.93	-5.75	5.13
59	K 29 x H 45	-7.29	0.16	-0.31	11.23	-6.81	11.69*	1.79	14.47
60	K 29 x Kartika	-8.31	-3.94	-5.74	2.07	-6.81	11.69*	-1.88	4.95
61	IPI 10 x GS 384	-5.14	15.27*	-0.15	12.44	-4.92	14.66**	-6.77	10.99
62	IPI 10 x H 45	-12.43*	6.40	3.68	16.75*	-11.97**	3.71	-0.62	18.32*
63	IPI 10 x Kartika	-2.03	19.05**	5.21	18.48**	-0.63	17.07**	4.00	23.81**
64	GS 384 x H 45	13.55*	23.81**	12.38*	25.39**	0.62	21.34**	-5.21	6.59
65	GS 384 x Kartika	-6.48	1.97	5.02	15.54*	-14.77**	2.78	4.27	16.3
66	H 45 x Kartika	13.37*	22.5**	-0.31	11.23	14.16**	24.12**	1.63	14.29
	Min.	-21.62	-4.93	-14.11	-3.97	-20.74	0.93	-15.46	-5.86
	Max.	14.89	31.2	13.8	35.41	15.66	35.25	12.34	31.68
	SE (±)	1.36		1.27		0.83		1.50	
	No. of significant crosses	11	22	5	32	32	42	1	16
	No. of Significant +ve crosses	3	22	3	32	6	42	-	16
	No. of Significant -ve crosses	8	-	2	-	26	-	1	-

*, ** Significant at 5 and 1 percent levels,

Table 7 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for number of capsules per plant

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	8.73**	7.39*	0.52	-3.24	9.74**	8.63**	6.84**	9.12**
2	Indira x Dipika	6.84*	4.92	2.40	-2.23	6.00*	2.91	9.89**	7.19**
3	Indira x Shekhar	-1.34	11.64**	-5.45**	7.59**	-1.58	11.3**	-6.17**	10.38**
4	Indira x KB 9610	-1.70	3.36	-1.54	-0.11	-1.43	2.56	4.81*	11.58**
5	Indira x ILS 264	8.11*	5.15	6.78**	0.22	0.00	-1.43	1.54	0.60
6	Indira x RLC 133	17.95**	14.72**	8.69**	2.01	0.43	-2.5	-0.92	0.13
7	Indira x K29	12.26**	9.18**	9.34**	2.62	8.88**	5.71*	10.37**	7.65**
8	Indira x IPI 10	0.24	16.4**	0.78	15.52**	-4.81*	11.96**	-5.74**	14.64**
9	Indira x GS 384	1.01	12.09**	-4.48*	4.75*	-1.25	7.85**	-4.05*	13.44**
10	Indira x H 45	-3.79	-2.01	-2.28	-4.19*	1.84	2.26	-3.13	0.86
11	Indira x Kartika	0.51	-0.34	1.43	-4.8*	-3.23	-3.87	-0.34	-1.46
12	Gaurav x Dipika	6.35	5.04	5.57**	1.62	-1.2	-2.2	3.32	5.52*
13	Gaurav x Shekhar	3.07	16.62**	0.69	14.57**	-0.74	12.25**	-0.51	17.03**
14	Gaurav x KB 9610	-5.69	-0.84	-1.49	-0.06	-6.8**	-3.03	-9.13**	-3.26
15	Gaurav x ILS 264	1.25	0.00	1.57	-2.23	0.60	-0.42	0.39	2.53
16	Gaurav x RLC 133	1.36	0.11	4.47*	0.56	-5.53*	-6.48*	-2.54	-0.47
17	Gaurav x K 29	5.89	4.59	4.47*	0.56	2.34	1.31	1.24	3.39
18	Gaurav x IPI 10	-3.18	12.42**	-2.87	11.33**	-7.74**	8.51**	-9.3**	10.31**
19	Gaurav x GS 384	0.81	11.86**	-2.85	6.53**	0.76	10.05**	-2.81	14.9**
20	Gaurav x H 45	7.8*	9.79**	5.07*	3.02	4.09	4.52	0.70	4.86*
21	Gaurav x Kartika	2.65	1.79	3.19	-0.67	1.14	0.48	-3.52	-1.46
22	Dipika x Shekhar	-0.15	12.98**	-0.79	12.9**	-0.37	12.67**	-2.55	14.64**
23	Dipika x KB 9610	0.48	5.65	4.57*	6.09**	0.4	4.46	-2.25	4.06
24	Dipika x ILS 264	3.08	1.23	3.27	-1.40	1.63	0.18	2.96	2.00
25	Dipika x RLC 133	4.10	2.24	2.81	-1.84	-0.25	-4.22	-1.78	-0.73
26	Dipika x K 29	1.99	0.17	1.17	-3.41	16.91**	12.25**	18.39**	14.37**
27	Dipika x IPI 10	-2.75	12.93**	-5.36**	8.49**	-7.94**	8.27**	-3.61*	17.23**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
28	Dipika x GS 384	1.71	12.87**	2.49	12.4**	-5.34*	3.39	-7.03**	9.91**
29	Dipika x H 45	1.48	3.36	4.04*	2.01	-0.65	-0.24	-5.56*	-1.66
30	Dipika x Kartika	1.92	1.06	2.51	-2.12	1.74	1.07	9.08**	7.85**
31	Shekhar x KB 9610	-0.89	12.14**	-3.93*	9.32**	-1.53	11.36**	-2.26	14.97**
32	Shekhar x ILS 264	0.25	13.43**	-4.32*	8.88**	-4.00	8.57**	-2.94	14.17**
33	Shekhar x RLC 133	-4.35	8.23*	-9.72**	2.74	-4.00	8.57**	-8.03**	8.18**
34	Shekhar x K 29	-3.81	8.84**	-4.07*	9.16**	-7.52**	4.58	-11.48**	4.13
35	Shekhar x IPI 10	1.06	17.35**	2.09	17.03**	-0.51	17.01**	0.27	21.96**
36	Shekhar x GS 384	2.57	16.06**	1.57	15.58**	5.52*	19.33**	4.73*	23.82**
37	Shekhar x H 45	-4.65	7.89*	-6.43**	6.48**	-6.58**	5.65*	-5.77**	10.84**
38	Shekhar x Kartika	-4.3	8.28**	-4.61**	8.54**	-3.16	9.52**	-2.94	14.17**
39	KB 9610 x ILS 264	1.86	7.11*	2.31	3.80	4.75	8.98**	8.5**	15.5**
40	KB 9610 x RLC 133	-1.49	3.58	-1.98	-0.56	-3.89	0.00	-2.81	3.46
41	KB 9610 x K 29	-4.42	0.50	-0.61	0.84	1.03	5.12*	14.31**	21.69**
42	KB 9610 x IPI 10	-4.43	10.97**	-2.63	11.61**	-1.52	15.82**	5.09**	27.81**
43	KB 9610 x GS 384	0.15	11.14**	-0.15	9.49**	10.29**	20.46**	-2.59	15.17**
44	KB 9610 x H 45	5.11	10.52**	4.13*	5.64**	1.6	5.71*	1.56	8.12**
45	KB 9610 x Kartika	0.48	5.65	3.14	4.63*	-1.72	2.26	-9.19**	-3.33
46	ILS 264 x RLC 133	3.11	0.22	1.37	-5.08*	-5.85*	-7.20**	-6.85**	-5.85**
47	ILS 264 x K 29	4.66	1.73	5.78**	-0.95	7.00**	5.47*	3.69	2.73
48	ILS 264 x IPI 10	-3.9	11.58**	-4.43*	9.55**	-5.41*	11.24**	-4.87**	15.7**
49	ILS 264 x GS 384	4.34	15.78**	2.90	12.84**	10.02**	20.17**	4.16*	23.15**
50	ILS 264 x H 45	0.77	2.63	1.65	-0.34	1.72	2.14	1.85	6.05**
51	ILS 264 x Kartika	3.22	2.35	5.95**	-0.61	0.42	-0.24	6.25**	5.26*
52	RLC 133 x K 29	5.2	-1.57	3.05	-5.64**	5.11	0.42	-2.83	-1.80
53	RLC 133 x IPI 10	2.17	18.63**	1.51	16.36**	2.07	20.05**	4.16*	26.68**
54	RLC 133 x GS 384	0.71	11.75**	1.53	11.33**	-2.29	6.72**	-1.80	16.1**
55	RLC 133 x H 45	6.87*	8.84**	5.3**	3.24	-0.77	-0.36	-1.79	2.26
56	RLC 133 x Kartika	16.65**	15.67**	4.88*	-1.62	10.3**	9.58**	5.79**	6.92**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
57	K 29 x IPI 10	-1.78	14.05**	-1.61	12.79**	-3.79	13.15**	-4.54*	16.1**
58	K 29 x GS 384	-0.55	10.35**	-3.72*	5.58**	-5.34*	3.39	-4.9*	12.44**
59	K 29 x H 45	1.59	3.47	1.54	-0.45	8.95**	9.4**	13.42**	18.1**
60	K 29 x Kartika	2.43	1.57	4.17*	-2.29	2.22	1.55	5.92**	4.72*
61	IPI 10 x GS 384	1.45	17.8**	1.95	16.86**	2.12	20.11**	4.49*	27.08**
62	IPI 10 x H 45	-1.25	14.66**	0.00	14.63**	-9.16**	6.84**	-3.34	17.56**
63	IPI 10 x Kartika	-4.24	11.19**	-2.83	11.39**	-5.92**	10.65**	-4.49*	16.17**
64	GS 384 x H 45	-0.40	10.52**	-1.88	7.59**	-5.45*	3.27	-4.39*	13.04**
65	GS 384 x Kartika	-2.47	8.23*	-6.26**	2.79	-3.27	5.65*	-13.62**	2.13
66	H 45 x Kartika	5.22	7.16*	6.09**	4.02*	-1.60	-1.19	-0.38	3.73
	Max.	17.95	18.63	9.34	17.03	16.91	20.46	18.39	27.81
	Min.	-5.69	-2.01	-9.72	-5.64	-9.16	-7.20	-13.62	-5.85
	SE (±)	1.89	-	1.16	-	1.41	-	1.11	-
	No. of significant crosses	8	39	28	38	24	37	36	45
	No. of Significant +ve crosses	8	39	16	34	10	35	17	44
	No. of Significant -ve crosses	-	-	12	4	14	2	19	1

*, ** Significant at 5 and 1 percent levels,

Table 8 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for number of seeds per capsules

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	-0.75	-3.31**	-1.47	-3.25*	-1.61	-4.67**	-12.2**	-10.44**
2	Indira x Dipika	-2.68*	-6.62**	-1.52	-6.14**	-3.31*	-8.95**	-11.67**	-14.86**
3	Indira x Shekhar	0.00	-5.15**	1.89	-2.89*	0.41	-4.28**	-1.23	-3.21*
4	Indira x KB 9610	-4.08**	-13.6**	-2.34	-9.75**	1.32	-10.12**	0.00	-8.43**
5	Indira x ILS 264	-4.81**	-5.51**	1.50	-2.17	-1.56	-1.56	-1.61	-1.61
6	Indira x RLC 133	2.86*	-7.35**	0.78	-6.86**	0.43	-8.56**	-1.75	-9.64**
7	Indira x K29	-3.27*	-12.87**	-3.52*	-10.83**	0.88	-10.51**	0.00	-8.43**
8	Indira x IPI 10	-3.89**	-9.19**	-3.03*	-7.58**	1.25	-5.45**	4.66**	-0.80
9	Indira x GS 384	-7.69**	-11.76**	-4.85**	-7.94**	-5.37**	-10.89**	-6.17**	-8.43**
10	Indira x H 45	-4.18**	-7.35**	0.38	-4.33**	-4.37**	-6.23**	-9.56**	-8.84**
11	Indira x Kartika	-5.43**	-4.04**	1.11	-1.44	-3.07*	-1.56	-5.04**	-1.61
12	Gaurav x Dipika	1.51	-1.10	2.57	0.72	3.21*	0.00	-1.18	0.80
13	Gaurav x Shekhar	-8.3**	-10.66**	-8.46**	-10.11**	-1.61	-4.67**	-6.69**	-4.82**
14	Gaurav x KB 9610	-2.64*	-5.15**	0.00	-1.81	1.61	-1.56	-5.91**	-4.02**
15	Gaurav x ILS 264	-1.11	-1.84	-1.10	-2.89*	-2.72	-2.72	0.00	2.01
16	Gaurav x RLC 133	-2.64*	-5.15**	-4.41**	-6.14**	-6.43**	-9.34**	-9.45**	-7.63**
17	Gaurav x K 29	-3.4**	-5.88**	-5.15**	-6.86**	-0.40	-3.5*	-6.3**	-4.42**
18	Gaurav x IPI 10	-1.51	-4.04**	-1.47	-3.25*	-2.81	-5.84**	-2.36	-0.40
19	Gaurav x GS 384	-0.75	-3.31**	-0.37	-2.17	0.80	-2.33	-4.72**	-2.81*
20	Gaurav x H 45	1.51	-1.10	0.74	-1.08	1.59	-0.39	1.97	4.02**
21	Gaurav x Kartika	-1.81	-0.37	-0.37	-2.17	-1.92	-0.39	-2.33	1.20
22	Dipika x Shekhar	-2.3	-6.25**	0.00	-4.69**	-1.63	-6.23**	-4.1**	-6.02**
23	Dipika x KB 9610	-3.45**	-7.35**	0.38	-4.33**	-1.24	-7.00**	-5**	-8.43**
24	Dipika x ILS 264	-2.22	-2.94*	3.00*	-0.72	-3.11*	-3.11*	0.00	0.00
25	Dipika x RLC 133	2.30	-1.84	3.41*	-1.44	1.65	-4.28**	1.25	-2.41
26	Dipika x K 29	-4.6**	-8.46**	-1.14	-5.78**	-3.31*	-8.95**	-5**	-8.43**
27	Dipika x IPI 10	-6.51**	-10.29**	-2.65	-7.22**	-2.48	-8.17**	-6.25**	-9.64**
28	Dipika x GS 384	0.00	-4.04**	1.49	-1.81	0.83	-5.06**	0.82	-1.61

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
29	Dipika x H 45	1.90	-1.47	1.89	-2.89*	1.19	-0.78	-0.4	0.4
30	Dipika x Kartika	-4.35**	-2.94*	3.33*	0.72	-5.36**	-3.89*	-7.75**	-4.42**
31	Shekhar x KB 9610	-1.16	-6.25**	-2.27	-6.86**	-2.45	-7**	-6.15**	-8.03**
32	Shekhar x ILS 264	-4.44**	-5.15**	1.12	-2.53	-7.78**	-7.78**	-2.41	-2.41
33	Shekhar x RLC 133	0.78	-4.41**	2.27	-2.53	2.04	-2.72	2.87*	0.8
34	Shekhar x K 29	-3.49**	-8.46**	-3.03*	-7.58**	-3.67*	-8.17**	-6.56**	-8.43**
35	Shekhar x IPI 10	1.16	-4.04**	1.52	-3.25*	-1.22	-5.84**	-2.05	-4.02**
36	Shekhar x GS 384	0.77	-3.68**	1.87	-1.44	2.45	-2.33	-1.64	-3.61**
37	Shekhar x H 45	2.66*	-0.74	3.03*	-1.81	-2.78	-4.67**	1.20	2.01
38	Shekhar x Kartika	-1.45	0.00	0.37	-2.17	0.00	1.56	-0.39	3.21*
39	KB 9610 x ILS 264	-4.44**	-5.15**	-4.49**	-7.94**	-7.78**	-7.78**	-8.43**	-8.43**
40	KB 9610 x RLC 133	0.00	-11.4**	1.22	-10.11**	-1.28	-10.12**	-3.93**	-11.65**
41	KB 9610 x K 29	-1.65	-12.5**	0.00	-12.27**	-1.32	-12.45**	-3.57*	-13.25**
42	KB 9610 x IPI 10	0.39	-5.15**	-3.41*	-7.94**	1.25	-5.45**	2.12	-3.21*
43	KB 9610 x GS 384	-4.62**	-8.82**	-7.09**	-10.11**	0.00	-5.84**	-4.94**	-7.23**
44	KB 9610 x H 45	-1.90	-5.15**	-4.17**	-8.66**	-0.79	-2.72	-3.19*	-2.41
45	KB 9610 x Kartika	-5.8**	-4.41**	-0.74	-3.25*	-7.66**	-6.23**	-3.88**	-0.4
46	ILS 264 x RLC 133	-0.37	-1.10	2.25	-1.44	-2.72	-2.72	1.61	1.61
47	ILS 264 x K 29	-3.33**	-4.04**	-1.12	-4.69**	-6.23**	-6.23**	-3.61**	-3.61**
48	ILS 264 x IPI 10	-0.37	-1.10	0.75	-2.89*	-1.56	-1.56	-0.80	-0.80
49	ILS 264 x GS 384	-2.96*	-3.68**	-1.49	-4.69**	-4.28**	-4.28**	0.00	0.00
50	ILS 264 x H 45	-3.7**	-4.41**	0.75	-2.89*	-5.06**	-5.06**	-2.79*	-2.01
51	ILS 264 x Kartika	0.00	1.47	2.96*	0.36	0.00	1.56	0.39	4.02**
52	RLC 133 x K 29	0.41	-10.66**	2.85	-8.66**	0.00	-8.95**	-0.44	-8.43**
53	RLC 133 x IPI 10	-0.78	-6.25**	-3.03*	-7.58**	0.00	-6.61**	-1.27	-6.43**
54	RLC 133 x GS 384	-3.85**	-8.09**	-5.6**	-8.66**	1.65	-4.28**	1.23	-1.2
55	RLC 133 x H 45	-5.7**	-8.82**	1.14	-3.61**	-6.35**	-8.17**	-7.57**	-6.83**
56	RLC 133 x Kartika	-7.25**	-5.88**	-2.22	-4.69**	-5.75**	-4.28**	-5.04**	-1.61
57	K 29 x IPI 10	-7.78**	-12.87**	-7.95**	-12.27**	-6.25**	-12.45**	-5.08**	-10.04**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
58	K 29 x GS 384	-1.15	-5.51**	-2.61	-5.78**	-2.48	-8.17**	-8.64**	-10.84**
59	K 29 x H 45	-3.42**	-6.62**	-4.55**	-9.03**	-6.35**	-8.17**	-6.77**	-6.02**
60	K 29 x Kartika	-6.16**	-4.78**	-0.74	-3.25*	-5.75**	-4.28**	-5.04**	-1.61
61	IPI 10 x GS 384	0.38	-4.04**	0.37	-2.89*	2.89	-3.11*	-0.41	-2.81*
62	IPI 10 x H 45	0.00	-3.31**	1.14	-3.61**	-2.38	-4.28**	-1.99	-1.2
63	IPI 10 x Kartika	-2.17	-0.74	1.11	-1.44	-5.36**	-3.89*	-1.16	2.41
64	GS 384 x H 45	-0.76	-4.04**	-3.73**	-6.86**	-1.19	-3.11*	-0.40	0.40
65	GS 384 x Kartika	-4.71**	-3.31**	0.74	-1.81	-2.30	-0.78	-1.55	2.01
66	H 45 x Kartika	-2.54*	-1.1	0.74	-1.81	0.00	1.56	1.94	5.62**
	Min.	-8.3	-13.6	-8.46	-12.27	-7.78	-12.45	-12.2	-14.86
	Max.	2.86	1.47	3.41	0.72	3.21	1.56	4.66	5.62
	SE (±)	0.10		0.12		0.13		0.10	
	No. of significant crosses	34	53	21	45	22	48	33	39
	No. of Significant +ve crosses	2	-	5	-	1	-	2	4
	No. of Significant -ve crosses	32	53	16	45	21	48	31	35

*, ** Significant at 5 and 1 percent levels,

Table 9 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for test weight

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	-13.73**	-9.46**	-12.66**	-8.68**	-15.56**	-6.4*	-21.05**	-7.69**
2	Indira x Dipika	0.90	0.90	0.46	0.46	3.92	4.43	-4.29*	3.08
3	Indira x Shekhar	-20.38**	-6.76**	-19.38**	-5.02*	-21.72**	-5.91*	-19.48**	-4.62*
4	Indira x KB 9610	-5.64**	13.06**	-6.44**	12.79**	-8.43**	12.32**	-6.58**	16.41**
5	Indira x ILS 264	29.27**	19.37**	33.33**	20.55**	30.85**	21.18**	28.57**	24.62**
6	Indira x RLC 133	0.51	-10.81**	0.52	-10.96**	2.70	-6.40*	3.17	0.00
7	Indira x K29	-4.07**	16.67**	-5.62**	15.07**	-5.49**	18.72**	-5.95**	21.54**
8	Indira x IPI 10	-1.02	-12.16**	-3.61	-14.61**	-1.08	-9.85**	-4.23*	-7.18**
9	Indira x GS 384	-12.79**	1.35	2.41	16.44**	2.50	21.18**	-3.23*	23.08**
10	Indira x H 45	1.52	-9.91**	-2.06	-13.24**	-3.24	-11.82**	-7.94**	-10.77**
11	Indira x Kartika	-5.08**	-15.77**	-7.22**	-17.81**	-9.19**	-17.24**	-8.47**	-11.28**
12	Gaurav x Dipika	-3.43**	1.35	-3.06	1.37	-13.78**	-4.43	-13.6**	1.03
13	Gaurav x Shekhar	-6.15**	9.91**	-4.65*	12.33**	-5.74**	13.3**	-3.03	14.87**
14	Gaurav x KB 9610	-7.52**	10.81**	-7.95**	10.96**	-9.24**	11.33**	-8.23**	14.36**
15	Gaurav x ILS 264	-3.86**	0.90	-1.75	2.74	-6.22**	3.94	-9.21**	6.15**
16	Gaurav x RLC 133	-11.16**	-6.76**	-1.75	2.74	-14.67**	-5.42*	-12.72**	2.05
17	Gaurav x K 29	-8.89**	10.81**	-11.24**	8.22**	-14.12**	7.88**	-14.68**	10.26**
18	Gaurav x IPI 10	-13.3**	-9.01**	-3.49	0.91	-16.00**	-6.9**	-16.23**	-2.05
19	Gaurav x GS 384	-3.10**	12.61**	1.20	15.07**	-2.08	15.76**	-6.85**	18.46**
20	Gaurav x H 45	1.72	6.76**	3.06	7.76**	-2.67	7.88**	-2.63	13.85**
21	Gaurav x Kartika	-2.58*	2.25	-0.44	4.11	-8**	1.97	-10.53**	4.62*
22	Dipika x Shekhar	-5.38**	10.81**	-6.98**	9.59**	-11.48**	6.40*	-3.03	14.87**
23	Dipika x KB 9610	-4.14**	14.86**	-6.82**	12.33**	-8.84**	11.82**	-5.76**	17.44**
24	Dipika x ILS 264	-4.5**	-4.5**	-6.85**	-6.85**	-5.88*	-5.42*	-6.19**	1.03
25	Dipika x RLC 133	-2.25	-2.25	-1.83	-1.83	-1.96	-1.48	22.86**	32.31**
26	Dipika x K 29	-6.67**	13.51**	-5.62**	15.07**	-9.8**	13.3**	-4.76**	23.08**
27	Dipika x IPI 10	3.6**	3.6**	0.00	0.00	-1.47	-0.99	2.86	10.77**
28	Dipika x GS 384	-9.3**	5.41**	-4.82*	8.22**	-10**	6.4*	-14.11**	9.23**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
29	Dipika x H 45	-5.41**	-5.41**	-4.11	-4.11	-7.35**	-6.9**	-7.14**	0.00
30	Dipika x Kartika	3.15*	3.15*	3.20	3.20	2.94	3.45	4.29*	12.31**
31	Shekhar x KB 9610	-1.88	17.57**	-3.79*	15.98**	0.00	22.66**	0.82	25.64**
32	Shekhar x ILS 264	-3.08**	13.51**	-4.65*	12.33**	-3.69	15.76**	1.30	20**
33	Shekhar x RLC 133	-2.69*	13.96**	-4.65*	12.33**	-1.64	18.23**	0.00	18.46**
34	Shekhar x K 29	-1.85	19.37**	-3.37	17.81**	-5.10*	19.21**	1.19	30.77**
35	Shekhar x IPI 10	-6.92**	9.01**	-9.3**	6.85**	-9.02**	9.36**	-5.19**	12.31**
36	Shekhar x GS 384	-5.38**	10.81**	-5.81**	10.96**	-4.10	15.27**	-5.65**	20**
37	Shekhar x H 45	1.54	18.92**	0.00	17.81**	0.82	21.18**	6.06**	25.64**
38	Shekhar x Kartika	-1.92	14.86**	-3.1	14.16**	-6.56**	12.32**	-2.60	15.38**
39	KB 9610 x ILS 264	-3.76**	15.32**	-3.41	16.44**	-4.82*	16.75**	-4.94**	18.46**
40	KB 9610 x RLC 133	-0.38	19.37**	0.00	20.55**	-0.80	21.67**	2.06	27.18**
41	KB 9610 x K 29	1.48	23.42**	1.12	23.29**	-1.96	23.15**	-2.38	26.15**
42	KB 9610 x IPI 10	-5.64**	13.06**	-6.82**	12.33**	-6.43**	14.78**	-4.12**	19.49**
43	KB 9610 x GS 384	-6.02**	12.61**	-8.71**	10.05**	-3.61	18.23**	-8.06**	16.92**
44	KB 9610 x H 45	-11.28**	6.31**	-9.09**	9.59**	-8.43**	12.32**	-9.88**	12.31**
45	KB 9610 x Kartika	-6.77**	11.71**	-10.23**	8.22**	-8.43**	12.32**	-6.17**	16.92**
46	ILS 264 x RLC 133	0.98	-6.76**	4.55	-5.48*	1.60	-5.91*	12.64**	0.51
47	ILS 264 x K 29	-16.67**	1.35	-19.1**	-1.37	-17.65**	3.45	-16.67**	7.69**
48	ILS 264 x IPI 10	-1.95	-9.46**	0.00	-9.59**	1.60	-5.91*	10.34**	-1.54
49	ILS 264 x GS 384	-6.98**	8.11**	-6.43**	6.39**	-8.33**	8.37**	-12.9**	10.77**
50	ILS 264 x H 45	-2.44	-9.91**	-0.51	-10.05**	-0.53	-7.88**	8.62**	-3.08
51	ILS 264 x Kartika	0.00	-7.66**	6.06*	-4.11	1.60	-5.91*	8.62**	-3.08
52	RLC 133 x K 29	-15.56**	2.7*	-14.61**	4.11	-15.69**	5.91*	-12.3**	13.33**
53	RLC 133 x IPI 10	1.59	-13.51**	3.85	-13.7**	6.10	-14.29**	6.51**	-7.69**
54	RLC 133 x GS 384	-16.28**	-2.7*	-13.65**	-1.83	-21.25**	-6.9**	-22.58**	-1.54
55	RLC 133 x H 45	3.17*	-12.16**	7.14*	-10.96**	10.37**	-10.84**	11.83**	-3.08
56	RLC 133 x Kartika	16.32**	-0.45	20.33**	0.00	19.64**	-0.99	17.24**	4.62*
57	K 29 x IPI 10	-3.33**	17.57**	-5.62**	15.07**	-4.71*	19.7**	-2.78	25.64**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
58	K 29 x GS 384	-2.22*	18.92**	-2.25	19.18**	-3.53	21.18**	-2.38	26.15**
59	K 29 x H 45	-10.37**	9.01**	-11.24**	8.22**	-12.16**	10.34**	-10.71**	15.38**
60	K 29 x Kartika	-11.48**	7.66**	-10.11**	9.59**	-13.33**	8.87**	-15.48**	9.23**
61	IPI 10 x GS 384	-7.75**	7.21**	-4.42*	8.68**	-7.92**	8.87**	-16.13**	6.67**
62	IPI 10 x H 45	18.97**	-6.76**	21.43**	-6.85**	20.5**	-4.43	16.77**	0.00
63	IPI 10 x Kartika	8.42**	-7.21**	10.00**	-9.59**	21.43**	0.49	0.00	-10.77**
64	GS 384 x H 45	-1.16	14.86**	0.40	14.16**	1.25	19.7**	-0.81	26.15**
65	GS 384 x Kartika	-4.65**	10.81**	-3.61	9.59**	-5.00*	12.32**	-10.48**	13.85**
66	H 45 x Kartika	19.47**	2.25	26.67**	4.11	25.00**	3.45	25.86**	12.31**
	Min.	-20.38	-15.77	-19.38	-17.81	-21.72	-17.24	-22.58	-11.28
	Max.	29.27	23.42	33.33	23.29	30.85	23.15	28.57	32.31
	SE (±)	0.09		0.16		0.17		0.12	
	No. of significant crosses	48	57	37	50	41	54	50	52
	No. of Significant +ve crosses	8	38	7	36	6	37	12	45
	No. of Significant -ve crosses	40	19	30	14	35	17	38	7

*, ** Significant at 5 and 1 percent levels,

Table 10 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for seed yield per plant

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	-6.81	-5.91	-10.18**	-10.21**	-8.67*	-2.91	-25.98**	-9.78**
2	Indira x Dipika	4.91	-1.11	3.14	-4.47	7.79	-2.05	-6.26	-6.00
3	Indira x Shekhar	-21.46**	-1.21	-21.91**	-1.01	-22.67**	0.27	-25.41**	1.91
4	Indira x KB 9610	-8.49**	0.92	-6.87**	1.29	-8.55*	3.55	-0.38	18.92**
5	Indira x ILS 264	33.22**	18.68**	38.78**	18.43**	28.80**	17.65**	39.51**	23.34**
6	Indira x RLC 133	21.94**	-5.22	15.98**	-10.34**	6.32	-16.54**	4.57	-9.47**
7	Indira x K29	10.61**	10.98**	10.73**	8.11**	8.31	12.32**	9.37**	19.85**
8	Indira x IPI 10	12.48**	-7.11*	12.34**	-7.96**	12.39*	-4.56	8.84*	5.59
9	Indira x GS 384	-18.67**	0.26	-12.85**	6.28*	-4.14	16.54**	-12.91**	27.88**
10	Indira x H 45	5.27	-18.18**	4.35	-19.33**	7.85	-15.34**	-8.81*	-17.96**
11	Indira x Kartika	-6.49	-19.46**	-2.23	-21.18**	-6.17	-21.65**	-5.86	-13.94**
12	Gaurav x Dipika	4.30	5.31	4.57	4.54	-12.13**	-6.59	-11.75**	7.56*
13	Gaurav x Shekhar	-8.92**	14.57**	-9.19**	15.12**	-6.51	21.22**	-6.28*	28.04**
14	Gaurav x KB 9610	-5.43	4.29	-2.00	6.59*	-6.13	6.29	-12.85**	6.22
15	Gaurav x ILS 264	-1.89	-0.94	-1.68	-1.71	-5.19	0.78	-8.86**	11.09**
16	Gaurav x RLC 133	-12.34**	-11.49**	-7.07**	-7.11**	-24.55**	-19.79**	-22.97**	-6.12
17	Gaurav x K 29	8.01*	9.05*	5.25*	5.21*	-0.70	5.56	-10.52**	9.06*
18	Gaurav x IPI 10	-2.7	-1.76	3.49	3.45	-10.53*	-4.89	-11.71**	7.61*
19	Gaurav x GS 384	-1.13	21.9**	-0.87	20.89**	2.36	24.45**	-9.9**	32.3**
20	Gaurav x H 45	14.84**	15.95**	12.94**	12.9**	5.68	12.34**	1.88	24.17**
21	Gaurav x Kartika	2.76	3.75	2.48	2.45	-3.95	2.11	-14.4**	4.33
22	Dipika x Shekhar	-6.66*	17.41**	-7.17**	17.68**	-13.3**	12.42**	-9.39**	23.8**
23	Dipika x KB 9610	1.98	12.46**	4.12	13.24**	-4.08	8.61	-6.25*	11.91**
24	Dipika x ILS 264	-0.50	-6.20	-0.16	-7.52**	0.49	-8.21	2.80	3.08
25	Dipika x RLC 133	4.13	-1.85	4.25	-3.44	-0.63	-9.7*	27.84**	28.18**
26	Dipika x K 29	3.83	4.18	7.01**	4.47	11.64**	15.77**	17.68**	28.95**
27	Dipika x IPI 10	11.34**	4.96	10.99**	2.81	8.31	-1.58	17.44**	17.76**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
28	Dipika x GS 384	-7.38*	14.18**	-4.21*	16.82**	-14.04**	4.51	-19.53**	18.17**
29	Dipika x H 45	2.22	-3.64	3.29	-4.33	1.45	-7.81	-1.52	-1.25
30	Dipika x Kartika	7.35	1.19	9.56**	1.48	10.57*	0.47	15.44**	15.76**
31	Shekhar x KB 9610	-1.66	23.7**	-4.62*	20.91**	-2.01	27.05**	-2.75	32.87**
32	Shekhar x ILS 264	-2.88	22.16**	-4.79*	20.69**	-10.61**	15.9**	-2.14	33.7**
33	Shekhar x RLC 133	-6.27*	17.9**	-9.12**	15.2**	-3.71	24.85**	-5.45*	29.18**
34	Shekhar x K 29	-5.37	19.03**	-6.17**	18.94**	-11.66**	14.54**	-8.71**	24.72**
35	Shekhar x IPI 10	-2.43	22.73**	-3.86	21.87**	-7.07*	20.5**	-3.76	31.5**
36	Shekhar x GS 384	-1.45	23.97**	-1.25	25.18**	3.62	34.36**	-2.40	43.32**
37	Shekhar x H 45	1.25	27.36**	-1.18	25.27**	-5.86	22.06**	4.03	42.13**
38	Shekhar x Kartika	-1.11	24.4**	-3.13	22.8**	-3.55	25.06**	-0.47	35.98**
39	KB 9610 x ILS 264	6.2	17.12**	4.97*	14.17**	3.67	17.39**	5.01	25.36**
40	KB 9610 x RLC 133	-0.55	9.67**	-0.05	8.71**	-3.45	9.33*	-2.57	16.31**
41	KB 9610 x K 29	-1.56	8.56*	0.05	8.82**	0.10	13.34**	11.55**	33.17**
42	KB 9610 x IPI 10	7.97*	19.07**	7.8**	17.25**	11.01**	25.7**	23.84**	47.84**
43	KB 9610 x GS 384	-7.43*	14.13**	-8.79**	11.24**	10.33**	34.13**	-14.92**	24.93**
44	KB 9610 x H 45	1.07	11.46**	-0.17	8.58**	2.01	15.51**	-0.72	18.52**
45	KB 9610 x Kartika	2.25	12.76**	2.19	11.15**	-4.90	7.68	-5.68	12.59**
46	ILS 264 x RLC 133	3.77	-7.56*	5.94*	-9.59**	-7.00	-15.05**	8.72*	-3.89
47	ILS 264 x K 29	-1.38	-1.04	-1.65	-3.99	-1.35	2.31	-2.63	6.69
48	ILS 264 x IPI 10	12.17**	-0.07	14.89**	-1.96	12.86**	3.09	16.49**	13.01**
49	ILS 264 x GS 384	-2.18	20.59**	-3.63	17.53**	2.51	24.63**	-7.12**	36.4**
50	ILS 264 x H 45	-0.73	-11.56**	2.81	-12.27**	-2.22	-10.69*	12.05**	0.81
51	ILS 264 x Kartika	7.63	-4.11	12.21**	-4.24	4.38	-4.66	16.13**	6.16
52	RLC 133 x K 29	-9.9**	-9.6**	-7.75**	-9.94**	-6.54	-3.08	-7.01*	1.90
53	RLC 133 x IPI 10	16.49**	-3.79	15.34**	-5.51*	13.23*	-3.85	12.85**	9.48**
54	RLC 133 x GS 384	-18.92**	-0.05	-18.1**	-0.11	-21.78**	-4.90	-23.04**	13.01**
55	RLC 133 x H 45	12.94**	-12.83**	18.12**	-12.1**	4.43	-18.39**	2.72	-7.59*
56	RLC 133 x Kartika	25.84**	8.39*	25.35**	1.06	24.39**	3.87	20.44**	10.1**

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
57	K 29 x IPI 10	16.48**	16.88**	18.15**	15.35**	14.4**	18.64**	19.83**	31.3**
58	K 29 x GS 384	0.62	24.05**	-0.52	21.32**	-5.36	15.06**	-13.87**	26.47**
59	K 29 x H 45	5.11	5.46	4.19	1.72	6.85	10.8*	16.88**	28.07**
60	K 29 x Kartika	3.75	4.10	6.36*	3.84	2.10	5.88	2.74	12.58**
61	IPI 10 x GS 384	-1.67	21.22**	0.27	22.29**	4.19	26.66**	-10.31**	31.7**
62	IPI 10 x H 45	25.18**	3.39	25.89**	3.14	15.08**	-2.29	19.8**	16.22**
63	IPI 10 x Kartika	18.93**	2.44	23.09**	0.85	26.67**	7.56	9.45*	6.18
64	GS 384 x H 45	-1.12	21.91**	-3.12	18.15**	-1.52	19.73**	-2.49	43.19**
65	GS 384 x Kartika	-5.95*	15.95**	-7.12**	13.27**	-3.12	17.78**	-19.26**	18.56**
66	H 45 x Kartika	25.8**	8.36*	33.15**	7.35**	24.32**	3.81	34.65**	23.1**
	Min.	-21.46	-19.46	-21.91	-21.18	-24.55	-21.65	-25.98	-17.96
	Max.	33.22	27.36	38.78	25.27	28.8	34.36	39.51	47.84
	SE (±)	0.15		0.99		0.70		0.74	
	No. of significant crosses	28	40	38	45	25	37	45	52
	No. of Significant +ve crosses	16	32	22	33	13	29	20	47
	No. of Significant -ve crosses	12	8	16	12	12	8	25	5

*, ** Significant at 5 and 1 percent levels,

Table 11 Estimation of heterobeltiosis (BP) and standard heterosis (SH) for oil content

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
1	Indira x Gaurav	-1.85	0.15	-1.72	2.44	-1.83	0.00	-7.39**	-0.98
2	Indira x Dipika	-1.76	1.89	-4.31*	1.17	-3.67*	-1.87	-5.81**	0.71
3	Indira x Shekhar	-3.99*	-2.03	-5.67**	-1.68	-4.67**	-2.89	-7.14**	-0.71
4	Indira x KB 9610	-5.62**	-3.70*	-5.2**	-1.19	-5.5**	-3.74*	-10.71**	-4.53*
5	Indira x ILS 264	0.35	2.39	0.62	4.88**	-2.17	-0.34	-3.90*	2.75
6	Indira x RLC 133	-3.09	-1.12	-2.70	1.41	-2.50	-0.68	-2.99	3.73
7	Indira x K29	-6.51**	-4.60*	-6.81**	-2.87	-5.08**	-3.31	-11.54**	-5.41**
8	Indira x IPI 10	-8.56**	-6.70**	-11.72**	-7.98**	-8.92**	-7.22**	-10.87**	-4.70*
9	Indira x GS 384	-10.42**	-8.60**	-12.51**	-8.81**	-12.83**	-11.21**	-12.37**	-6.3**
10	Indira x H 45	-9.71**	-7.87**	-10.31**	-6.52**	-11.17**	-9.51**	-10.54**	-4.35*
11	Indira x Kartika	-2.93	-0.95	-1.91	2.24	-3.08	-1.27	-6.56**	-0.09
12	Gaurav x Dipika	-7.09**	-3.63*	-6.75**	-1.40	-2.84	-4.07*	-3.27	-0.27
13	Gaurav x Shekhar	-3.23	-6.34**	-2.35	-4.61*	3.49	-4.41*	-3.99*	-1.69
14	Gaurav x KB 9610	-0.18	-3.39	2.29	-0.08	4.56*	-2.72	0.90	-0.71
15	Gaurav x ILS 264	-0.47	0.02	-2.08	1.14	0.35	-3.40	-2.11	-1.24
16	Gaurav x RLC 133	-5.21**	-3.74*	4.18*	1.80	-1.79	-2.38	-1.65	0.44
17	Gaurav x K 29	-5.33**	-5.69**	-4.10*	-3.11	-1.24	-5.69**	-6.35**	-4.53*
18	Gaurav x IPI 10	-7.24**	-10.22**	-5.43**	-7.62**	-1.84	-9.34**	-8.07**	-7.99**
19	Gaurav x GS 384	0.80	-2.44	-1.05	-3.34	0.09	-7.56**	1.32	-4.61*
20	Gaurav x H 45	-0.89	-3.98*	3.43	1.03	-3.08	-3.9*	4.81*	-1.33
21	Gaurav x Kartika	-0.14	1.05	-0.54	1.84	-1.20	-2.12	-9.01**	-4.97*
22	Dipika x Shekhar	-1.96	1.68	-4.77**	0.68	1.29	0.00	-1.89	1.15
23	Dipika x KB 9610	-5.97**	-2.47	-5.43**	-0.02	-2.58	-3.82*	-3.44	-0.44
24	Dipika x ILS 264	-1.48	2.19	-1.13	4.53*	1.46	0.17	-0.86	2.22
25	Dipika x RLC 133	-10.27**	-6.93**	-9.7**	-4.52*	-7.34**	-7.89**	-6.11**	-3.19
26	Dipika x K 29	-11.93**	-8.66**	-14.48**	-9.59**	-8.43**	-9.59**	-9.98**	-7.19**
27	Dipika x IPI 10	-4.37*	-0.81	-5.81**	-0.42	-2.84	-4.07*	-1.20	1.86

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
28	Dipika x GS 384	-6.64**	-3.16	-6.35**	-0.98	-1.46	-2.72	-1.89	1.15
29	Dipika x H 45	-12.85**	-9.61**	-10.16**	-5.01**	-6.76**	-7.56**	-9.55**	-6.74**
30	Dipika x Kartika	-4.12*	-0.56	-1.87	3.75*	-1.89	-2.80	-2.38	1.95
31	Shekhar x KB 9610	-5.77**	-8.99**	-4.01*	-6.27**	-3.92*	-10.61**	-9.01**	-6.83**
32	Shekhar x ILS 264	-2.91	-2.44	-4.45*	-1.30	-0.88	-4.58**	-5.29**	-3.02
33	Shekhar x RLC 133	0.32	1.88	3.46	1.09	0.77	0.17	-5.37**	-3.11
34	Shekhar x K 29	-7.61**	-7.96**	-7.63**	-6.68**	-4.00*	-8.32**	-8.75**	-6.57**
35	Shekhar x IPI 10	-3.01	-7.26**	-3.3	-5.57**	-3.13	-10.53**	-8.58**	-6.39**
36	Shekhar x GS 384	5.92**	-1.24	4.26*	-0.78	5.51**	-2.55	-2.95	-0.62
37	Shekhar x H 45	-2.31	-5.35**	4.11*	-0.73	-6.85**	-7.64**	-8.41**	-6.21**
38	Shekhar x Kartika	-2.20	-1.04	-2.25	0.09	0.34	-0.59	-2.12	2.22
39	KB 9610 x ILS 264	1.02	1.52	-1.20	2.06	1.59	-2.21	4.22*	5.15**
40	KB 9610 x RLC 133	-6.59**	-5.14**	-0.68	-2.95	-3.5*	-4.07*	-5.04**	-3.02
41	KB 9610 x K 29	-8.14**	-8.49**	-6.37**	-5.41**	-3.02	-7.39**	-10.01**	-8.25**
42	KB 9610 x IPI 10	-0.36	-3.78*	1.35	-1.03	0.55	-6.45**	-4.61*	-4.53*
43	KB 9610 x GS 384	-9.48**	-12.58**	-8.73**	-10.87**	-6.75**	-13.24**	-6.49**	-7.99**
44	KB 9610 x H 45	-7.11**	-10.01**	-5.3**	-7.53**	-10.45**	-11.21**	-7.03**	-8.52**
45	KB 9610 x Kartika	-5.44**	-4.31*	-5.03**	-2.76	-5.57**	-6.45**	-7.39**	-3.28
46	ILS 264 x RLC 133	2.04	3.63*	0.2	3.51	0.51	-0.08	2.17	4.35*
47	ILS 264 x K 29	-3.87*	-3.4	-6.62**	-3.54	1.50	-2.29	-0.78	1.15
48	ILS 264 x IPI 10	-4.06*	-3.59*	-5.31**	-2.19	-5.29**	-8.83**	-5.28**	-4.44*
49	ILS 264 x GS 384	-3.59*	-3.12	-6.2**	-3.11	-2.12	-5.77**	-5.45**	-4.61*
50	ILS 264 x H 45	-1.24	-0.76	-4.46*	-1.31	-2.83	-3.65*	-4.4*	-3.55
51	ILS 264 x Kartika	0.17	1.36	-1.29	1.97	-1.71	-2.63	-7.48**	-3.37
52	RLC 133 x K 29	0.24	1.79	0.93	1.97	0.00	-0.59	-1.04	1.06
53	RLC 133 x IPI 10	-7.33**	-5.89**	0.53	-1.77	-7**	-7.56**	-7.91**	-5.94**
54	RLC 133 x GS 384	-11.01**	-9.63**	-4.86*	-7.04**	-9.48**	-10.02**	-9.21**	-7.28**
55	RLC 133 x H 45	-2.71	-1.21	2.87	0.51	-4.7**	-5.26**	-5.56**	-3.55
56	RLC 133 x Kartika	-2.99	-1.49	-1.72	0.64	0.60	0.00	-1.61	2.75

S.N.	Crosses	E ₁		E ₂		E ₃		E ₄	
		BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)	BP (%)	SH (%)
57	K 29 x IPI 10	-6.45**	-6.82**	-3.96*	-2.98	-4.53*	-8.83**	-12.97**	-11.27**
58	K 29 x GS 384	-7.51**	-7.86**	-8.62**	-7.69**	-7.2**	-11.38**	-10.79**	-9.05**
59	K 29 x H 45	-2.21	-2.59	-6.08**	-5.11**	-5.22**	-6.03**	-4.79*	-2.93
60	K 29 x Kartika	0.59	1.78	-0.67	1.72	-3.51*	-4.41*	-2.55	1.77
61	IPI 10 x GS 384	-1.37	-5.68**	-2.60	-4.89**	-0.75	-9.59**	-3.63	-3.55
62	IPI 10 x H 45	-5.88**	-8.81**	3.07	0.66	-2.40	-3.23	0.18	0.27
63	IPI 10 x Kartika	0.22	1.41	-1.28	1.08	-1.54	-2.46	0.85	5.32**
64	GS 384 x H 45	-0.43	-3.53*	4.02*	-0.82	-2.74	-3.57*	5.57**	-0.80
65	GS 384 x Kartika	-1.27	-0.09	-2.58	-0.24	-1.97	-2.89	-4.67*	-0.44
66	H 45 x Kartika	2.75	3.97*	0.63	3.04	-0.77	-1.61	-1.87	2.48
	Min.	-12.85	-12.58	-14.48	-10.87	-12.83	-13.24	-12.97	-11.27
	Max.	5.92	3.97	4.26	4.88	5.51	0.17	5.57	5.32
	SE (±)	0.70		0.73		0.68		0.73	
	No. of significant crosses	32	34	36	21	27	38	43	28
	No. of Significant +ve crosses	1	2	4	3	2	-	3	3
	No. of Significant -ve crosses	31	32	32	18	25	38	40	25

*, ** Significant at 5 and 1 percent levels

REFERENCES

- Ahamad, A., Ansari, A., Paul, A., & Bhusan, S. (2018). Studies of heterosis and inbreeding depression for seed yield and its components in linseed (*Linum usitatissimum* L.). *Journal of Agricultural Science and Engineering*, 147-150.
- Anonymous. (2020). Annual report on linseed. AICRP on Linseed, Kanpur.
- Bhateria, S., Sood, S., & Pathania, A. (2006). Genetic analysis of quantitative traits across environments in linseed (*Linum usitatissimum* L.). *Euphytica*, 150 (1-2), 185-194.
- Chaure, P. L., Dhone, P. U., Mahajan, M. M., & Misal, A. M. (2018). Studies on heterosis for yield and yield components in linseed (*Linum usitatissimum* L.). *Journal of Pharmacognosy and Phytochemistry*, 7 (1), 1331-1334.
- Dabholkar, A. R. (1999). "Elements of Bio Metrical Genetics" (revised and enlarged edition), Concept Publishing Company, New Delhi, India, pp: 302-418.
- Dhirhi, N., Mehta, N., & Singh, S. (2018). Estimation of Heterosis for Seed Yield and Its Attributing Traits in Linseed (*Linum usitatissimum* L.). *International Journal of Current Microbiology and Applied Sciences*, 7 (11), 2332-2341.
- Kang, S. J., Lee, S. H., & Park, K. S. (1998). DNA polymorphisms at alpha-Gpdh locus of *Drosophila melanogaster* in Korean population. *Genes & Genetics Systems*, 73 (4), 227--235.
- *Kempthorne, O. (1957). An Introduction to Genetic Statistics. John Wiley and Sons. Inc., New York.
- *Koelreuter, J. G. (1766). In: Principles of Plant Breeding (R. W. Allard Ed.). John Wiley and Sons, Inc., New York, pp. 214.
- Kumar, M., Singh, P. K., Singh, N. P., & Kumar, M. (2000). Line \times tester analysis for seed yield and its components in linseed (*Linum usitatissimum* L.). *Annals of Agricultural Research*, 21 (4): 485-489.
- Mahto, C., Rahman, M. H., & Mahto, C. (2020). Heterosis for yield and yield components in linseed (*Linum usitatissimum* L.). *Journal of Research, Birsa Agricultural University*, 8 (1), 85-87.
- *Meredith, W. R., & Bridge, R. R. (1972). Heterosis and gene action in cotton, *G. hirsutum* L. *Crop Science*, 12, 304-310.
- Mohammadi, A. A., Saeidi, G., & Arzani, A. (2010). Genetic analysis of some agronomic traits in flax (*Linum usitatissimum* L.). *Australian Journal of Crop Science*, 4 (5), 343-352.
- Pali, V., & Mehta, N. (2014). Combining ability and heterosis for seed yield and its attributes in linseed (*Linum usitatissimum* L.). *The Bioscan*, 9 (2), 701-706.
- Panse, V. G., & Sukhatme, P. V. (1967). Statistical methods for research workers. ICAR, New Delhi, 220-40.
- Patial, R., Paul, S., Sharma, D., Sood, V. K., & Kumar, N. (2019). Morphological characterization and genetic diversity of linseed (*Linum usitatissimum* L.). *Journal of Oilseeds Research*, 36 (1), 8-16.
- Paul, S., & Kumar, N. (2016). Selection criteria of linseed genotypes for seed yield traits through
- Plaisted, R. L., & Peterson, L. C. (1959). A technique of evaluating the ability of selection to yield consistency in different seasons or locations. *American Journal of Potato Research*, 36, 381-389.

- Ram, A., & Ahamad, E. (2016). Heterosis and inbreeding depression for seed yield, its components and qualitative characters in linseed (*Linum usitatissimum* L.). *Journal of Crop Science and Biotechnology*, 5 (7), 23-24.
- Ratnaparkhi, R. D., Dudhe, M. Y., Gawande, N. D., & Bhongle, S. A. (2005). Heterosis in relation to combining ability effects in linseed. *Annual Review of Plant Physiology*, 18 (2), 182- 186.
- Reddy, M. P., Arsul, B. T., Shaik, N. R., & Maheshwari, J. J. (2013). Estimation of heterosis for some traits in linseed (*Linum usitatissimum* L.). *Journal of Agriculture and Veterinary Sciences*, 2 (5): 11-17.
- Richharia, R. H. (1962). Linseed. The Indian Central Oilseeds Committee, Hyderabad, India, 155.
- Schuster, A., & Friedt, W. (1998). Glucosinolate Content and Composition as Parameters of Quality of Camelina Seed. *Industrial Crops and Products*, 7 (2): 297-302.
- Sharma, R., Tiwari, S. K., Singh, P., & Kant, R. (2005). Heterobeltiosis and inbreeding depression in linseed. *Agricultural Science Digest*, 25 (1), 35-37.
- *Shull, G. H. (1908). The compositions of field maize. Annual report - American Breeder's Association, 4, 296-301.
- Singh, R. K. and Chaudhary, B. D. (1977). *Biometrical Methods in Quantitative Genetic Analysis*, Kalyani Publishers, New Delhi, India.
- Singh, P. K., Srivastava, R. L., Narain, V., & Dubey, S. D. (2009). Combining ability and heterosis for seed yield and oil content in linseed (*Linum usitatissimum* L.). *Indian Journal of Agricultural Sciences*, 79 (3), 229-232.
- Singh, V. K. (2014). Estimation of heterosis for yield and its contributing attributes in linseed (*Linum usitatissimum* L.). *The Ecoscan*, 6, 81-84.
- Sprague, G. F., & Tatum, L. M. (1942). General versus specific combining ability in single crosses of corn. *Agronomy Journal*, 34, 923-932.
- Srivastava, R. L., Srivastava, S. K., Dubey, S. D., & Kerkhi, S. A. (2004). Heterosis and combining ability estimates in linseed under salt affected soil. *Indian Journal of Agricultural Research*, 48 (3-4), 193-197.
- Vavilov, N. I. (1935). Studies on the origin of cultivated plants. *Bulletin of Applied Botany and Plant Breeding*, 16, 39-145.
- Yadav, P. C., Yadav, R. K., Vishwanath, Y. P., & Kumar, S. (2018). Heterosis and Inbreeding Depression for Seed Yield and its Related Morphological Traits in Linseed (*Linum usitatissimum* L.). *International Journal of Current Microbiology and Applied Sciences*, 7 (1), 3088-3098.
- Yates, F., & Cochran, W. G. (1938). The analysis of group of experiments.