



HETEROISIS BREEDING AMONG DIFFERENT CROSSES IN MARIGOLD (*TAGETES* SPP.)

Deepti Singh¹ and K. K. Misra²

Department of Horticulture (Vegetables and Floriculture), Bihar Agriculture College,
Bihar Agricultural University, Sabour, Bihar, India, BAU Publication No.0 30/2015
Assistant Professor cum Junior Scientist¹, Department of Horticulture (Veg. Sci. and Flori.),
Professor², Department of Horticulture, GBPUA&T, Pantnagar., BAU Publication No.0 30/2015

Received: 07/02/2017

Edited: 15/02/2017

Accepted: 23/02/2017

Abstract: The present investigation was carried out with 09 inbreds and 36 crosses of marigold to find out heterosis in Randomized Block Design with three replications. Hybrids were planted along with their parents (inbreds) at 50 × 50 cm spacing. Standard heterosis and heterobeltiosis for leaf biomass, flower diameter, flower longevity, average dry weight of flower, duration of flowering, flower yield/plant, shelf life of flowers and seed yield/plant in positive direction, whereas days taken to flowering and days taken to seed ripening were calculated in negative direction. Standard heterosis was observed maximum (450.07%) for seed yield/plant followed by average dry weight of flower (424.35%) and flower yield/plant (288.64%). Among all the 36 crosses, PNG × LS was found with maximum standard heterosis for economic traits like flower diameter, average dry weight of flowers and flower yield/plant. Similarly cross FD × CM was found with second highest heterotic value for flower yield/plant and gave maximum standard heterosis for seed yield/plant. Though LS × FD was one of the late flowering cross but its standards heterosis was second highest for seed yield/plant and third highest for flower yield/plant. Cross SY × LS was found with second highest heterotic value for flower diameter followed by flower longevity and average dry weight of flowers.

Key words: Diallel, Heterosis, Heterobeltiosis.

Marigold (*Tagetes* spp.) is one of the leading annual flowering plant grown for loose flower production. The common name 'marigold' derived from 'Mary's Gold' is associated with Virgin Mary of the Christian stories. Despite of being a commonly growing crop of India, origin of marigold is central and south America especially Mexico (Kaplan, 1960). Beside the pristine uses as loose flower and the bedding plant, marigold occupies anthelmintic, analgesic, anti-inflammatory, aromatic, bronchodilatory, digestive, diuretic, emmenagogue, sedative and stomachic properties (Brown, 1955). Marigold is also widely used as perfumes, herbal Gulal, insect and nematode repellent, organic manure, nutrient supplement for poultry feed, anticarcinogenic agent, antioxidant in retinotherapy and for oil extraction (Polthance and Yamazaki, 1966 and Sreekala and Raghava, 2003). Marigold belongs to family Asteraceae and is a native to Mexico. African marigold is diploid and chromosome number is 2n = 24 whereas French marigold is tetraploid with chromosome no. 2n=48. Hybridization work in African marigold was first reported by Towner

(1961). In India, Singh and Swarup (1971) started hybridization work on marigold via interspecific hybridization. Triploid hybrids were also produced by crossing *Tagetes erecta* and *Tagetes patula* which was relatively with larger double blooms (Jalil *et al.*, 1974). Crossing between genetically diverse types is a commonly employed method to induce variation than existing cultivars in terms of novel type, more yield and better flower quality. Recently, attempts have been made with considerable amount of success to develop hybrids in marigold. Very less work so far has been done on genetic improvement of *Tagetes* spp. through hybridization in India. Considering the fact, there is a need for collection, multiplication, conservation and utilization of natural wealth. Therefore, the present study was undertaken to study heterosis for floriculturally important parameters in different crosses of marigold.

Materials and Methods

The present investigation was conducted at Model Floriculture Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, during 2006-07, 2007-08 and 2008-09. In the experiment nine

parental lines of marigold were crossed in diallel mating system, where reciprocals were excluded (Griffing, 1956) Method II and Model I. The parental material for the study consisted of nine marigold genotypes *viz.*, Seraceul, Sutton Yellow, Sutton Orange, Pusa Basanti Gainda, Pusa Narangi Gainda, Bonita Bolero, Late Summer, French Dwarf and Crackerjack Mix. Pusa Narangi Gainda was used as a standard check. For developing hybrids, the flowers were emasculated just after the opening of ray florets followed by bagging. In early morning, when flowers opened, the female parts i.e., stigma was pollinated with pollens of the desired male flower. After pollination flowers were bagged with all details regarding name of parents, date of pollination, etc. Seeds reached to maturity in 45-60 days after pollination then harvested, dried and stored. Seeds of nine parents and thirty six F_1 s were sown in nursery and seedlings were ready to transplant in about 40 days and transplanted in well manured and leveled field at 50 × 50 cm distance. The experiment was laid out in a randomized block design with three replications with individual plot size 3 x 2 m². The dose of N, P, and K was supplied by urea, single super phosphate and muriate of potash, respectively. A fertilizer dose of 20:10:10 g/m² of N, P, K was given. Fungicides and insecticides was also applied to prevent wilting and attack of *Helicoverpa armigera*, respectively. All the cultural practices needed were followed to grow a successful crop. Out of 24 plants, 3 plants were randomly selected for taking observations in each replication. Detailed observations were recorded on ten important characters, namely leaf biomass, days taken to flowering, flower diameter, flower longevity, average dry weight of flower, duration of flowering, flower yield/plant, shelf life of flowers, days taken to seed ripening and seed yield/plant. For post-harvest study, flower heads of marigold were harvested at fully opened stage. The heterosis was measured as the percentage increase in F_1 values over the better parent value and the standard variety (Gardener and Eberhart, 1966). In the genetic improvement programme of flowering crop, any diversity can be

accepted if it looks appealing and be useful. Hence, in terms of days taken to flowering and seed ripening negative and positive heterosis are important for early and lateness, respectively.

Results and Discussion

The extent of heterosis was studied in all the 36 crosses involving 09 parents for important growth, flowering and seed parameters with respect to their better parent and standard check PNG. The mean sum of squares due to parents verses crosses was highly significant for all the characters, which indicates presence of significant heterosis. For leaf biomass, the average heterobeltiosis showed that BB × CM (1182.47%), PBG × BB (353.63%) and PBG × PNG (269.16%) had better performance than their better parent's performance, whereas the minimum heterobeltiosis was observed with SY × PBG (-38.10%). The results of standard heterosis depicted that LS × CM (453.28%), FD × CM (437.02%) and PBG × PNG (369.89%) came out to be the good performing hybrids in terms of leaf biomass production (Table 4). On averaging the data of two years, 19 crosses showed heterobeltiosis in negative direction for flower yield/plant and heterobeltiosis varied from -40.81% (PNG × FD) to 874.22% (SY × LS). The standard heterosis for flower yield/plant was higher in top crosses *viz.*, PNG × LS, FD × CM and SY × LS (Table 4). S x CM, S × BB and PBG × BB were the top three crosses having higher heterobeltiosis for days taken to flowering whereas crosses PNG x LS, FD x CM and S x PNG showed early flowering on standard heterosis basis (Table 1). In certain crosses i.e. PNG × LS (310.53%), SY × LS (201.05%), LS x FD (101.19%) and BB × FD (100.00%), heterosis was found more than their better parents for flower diameter whereas in terms of standard heterosis only two crosses PNG x LS (67.74%) and SY x LS (23.01%) were found outstanding for flower diameter (Table 1). The crosses SY × LS, S × FD, S × SO and PBG x FD showed higher heterobeltiosis for flower longevity whereas crosses S x SO (189.67%) and SY x LS (147.04%) were found better than the standard check for the same trait (Table 2). SY × LS and PNG × LS

were the top two crosses which had higher heterobeltiosis as well as standard heterosis for average dry weight of flowers (Table 2).

For flowering duration higher heterobeltiosis in desired direction was found with PBG × PNG (184.97%), S × LS (114.33%), PNG × LS (112.12%) and PBG × BB (111.28%), whereas heterosis over check parent (PNG) was higher in PNG × FD (23.25%), S × LS (21.38%) and PNG × LS (20.13%). Maximum heterobeltiosis for shelf life (157.89%) was observed with S × PBG, followed by PBG × SO (121.06%) and SY × CM (108.33%). For standard heterosis, crosses SY × CM, S × PBG and S × SO were the top three combinations for shelf life (Table 3).

Crosses SY × CM, PBG × CM, SY × PBG and SY × PNG showed higher heterobeltiosis and crosses S × PNG, PBG × LS and S × PBG showed higher standard heterosis (in negative direction) for days taken to seed ripening (Table 5). Average maximum heterobeltiosis for seed yield/plant was estimated in FD × CM (983.65%) followed by S × LS (881.13%) and LS × FD (613.07%) and maximum standard heterosis for seed yield/plant was recorded with FD × CM (450.07%) and LS × FD (324.47%) (Table 5).

Demonstration of heterosis for flower yield, quality of flowers and other traits in many floriculture crops had significant efforts to commercialize the breeding production and sale of hybrids of numerous bedding and cut flower crops. In general, heterosis refers to significant increase or decrease in F_1 performance over the mid parental value. However from plant breeder's view point, economic heterosis is more relevant (Virmani, 1994). The nature and magnitude of heterosis differ from character to character depending upon hybrid combinations. The extent of heterosis was studied in all the 36 crosses involving 9 parents for important growth, flowering and seed parameters with respect to their better parent and standard parent. The mean sum of squares due to parents v/s crosses was highly significant for all the characters which indicate presence of significant heterosis. The crop marigold

is grouped in cross-pollinated as it rarely set seeds in the peduncle when left in bagged condition. In the genetic improvement programme of flowering crop, any diversity can be accepted if it looks appealing and be useful. Hence, in terms of days taken to flowering and seed ripening negative and positive heterosis are important for early and lateness, respectively (Singh and Jauhari, 2006).

The crosses BB × PNG, BB × LS, BB × SO, PNG × LS and PBG × BB showed higher heterosis for leaf biomass with value of -80.34%, -65.20%, -64.25%, -47.15% and -13.61%, respectively (Table 6). It is imperative to mention that heterosis for early flowering is important in hybrids of floriculture crops and may greatly increase the economic yield when price differentials for early marketing are high for bedding and loose flowers whereas for staggered planting it becomes important to differentiate varieties for early, mid and late season flowering. Hence, in the present study, both components of days taken to flowering and seed ripening i.e. early and lateness were studied. The hybrids PBG × BB, BB × PNG and PBG × CM were found to be the most promising for earliness whereas crosses having higher heterosis *viz.*, LS × CM and LS × FD were found suitable for late season flowering. It would also be momentous to note that flower diameter and average dry weight of flowers are important parameters for contribution of marigold flower and seed yield, if it is grown as a commercial plant. The hybrid combination of PNG × LS, SY × LS, PBG × PNG, SY × PNG and SY × CM were found to be promising for flower diameter trait. Increased flower size (diameter) is very important aspect from the shelf life of flower point of view in marigold. Hybrids S × SO and SY × LS exhibited higher heterosis for flower longevity (189.67% and 147.04%, respectively). Hybrids PNG × LS, SY × LS, PBG × SO, S × PBG and SY × CM showed higher heterosis for average dry weight of flower. Along with highest dry weight of flower, cross PNG × LS, SY × LS and SY × CM also exhibited higher heterosis for flower yield/plant.

Crosses S × LS, PNG × FD, PBG × PNG and PNG × LS were found with large amount of heterosis for flower duration, whereas Cross SY × CM (31.64%) was found with high standard heterosis for shelf life of flowers. Generally, it has been observed that flower yield and flowering duration have positive correlations with seed yield and thus contribute in the total yield in marigold (Torres *et al.*, 2002). The above mentioned floral characters should also be considered in breeding programme. These findings are lent credence with the earlier reports of Relichova and Petrova (1988), Reddy *et al.* (1989), Kumar *et al.* (1989), Barad *et al.* (1993), Raghava (1995), Gupta *et al.* (2001) and Mohanty *et al.* (2003) in marigold. Higher manifestation of heterosis for flower yield suggested greater scope for improvement of seed yield through recombination or / and heterosis breeding.

Negative heterosis is desirable for days taken to seed ripening. Since marigold is grown in open

field condition in India, hence as soon as seed matures, the possibility to grow the next season crop becomes high. The crosses with higher negative heterosis for days taken to seed ripening were BB × PNG (-46.94%), PBG × BB (-46.44%), BB × LS (-44.91%), PBG × PNG (-38.12%) and SO × FD (-35.84%). Maximum heterosis for seed yield/plant (450.07%) was recorded in FD × CM followed by LS × FD (324.47%) (Table 6). Heterotic effects for seed parameters were also experimentally substantiated by Singh and Swarup (1971) and Gupta *et al.* (2001) in marigold. Higher manifestation of heterosis for seed yield in heterotic hybrid also revealed higher heterotic expression for several yield contributing characters. Singh and Swarup, 1971 and Gupta *et al.* 2001 noticed more seed production in hybrids. These seeds can be utilized in the next generation as in some flower crops F₂ seeds have been commercialized.

References

- Brown, D. 1955. Encyclopedia of herbs and their uses, Dorling Kindersley, London.
- Barad, A.V., Sachan, S.C.P. and Kukadiya, M.U. 1993. Heterosis in African marigold (*Tagetes erecta* L.) In: *Golden Jubilee Symposium Horticulture Research: Changing Scenario*, held at Bangalore. p. 91.
- Brown, D. 1955. Encyclopedia of herbs and their uses, Dorling Kindersley, London.
- Gardener, C.O. and Eberhart, S.A. 1966. Analysis and interpretation of the variety cross diallel and related populations. *Biometrics* 22:439-52.
- Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.* 9: 463-93.
- Gupta, Y.C., Raghava, S.P.S. and Misra, R.L. 2001. Heterobeltiosis in African marigold (*Tagetes erecta*, L.). *Indian Journal of Genetics* 61(1): 65-8.
- Jalil, R., Khoshoo, T.N. and Pal, M. 1974. Origin, nature and limit of polyploidy in marigolds. *Current Science*, **43**, 777-79.
- Kaplan, L. 1960. Historical and ethnobotanical aspects of domestication in *Tagetes*. *Economic Botany*, **12**, 200-202.
- Kumar, S., Shanmgavelu, K.G. and Irulapan, I. 1989. Hybrid vigour in marigold for economic characters. *South Indian Horticulture*, **38**, 3, 173-74.
- Mohanty, A., Mohanty, C.R. and Mohapatra, R.C. 2003. Heterosis studies in African marigold. *Journal of Ornamental Horticulture*, **6**, 1, 55-7.
- Polthance, A. and Yamazaki, K. 1966. Effect of marigold (*Tagetes patula* L.) on parasitic nematodes of rice in Northeast Thailand. *Kaen-Kasut-Khon-Kaen Agriculture Journal*, **24**, 3, 105-07.
- Raghava, S.P.S. 1995. Genetic improvement of African marigold In: Proc. National Seminar on Ornamental Horticulture and Environment, Calcutta, 111-19.

Reddy, E.N., Muthuswami, S., Irulappan, I. and Abdul Khader, M.L. 1989. Heterosis and combining ability for yield and yield components in African marigold (*Tagetes erecta* L.). *South Indian Horticulture*, **36**, 1, 51-61.

Relichova, J. and Petrova, I. 1988. Combining ability and heterosis in *Tagetes erecta* L. *Sbornik- UVTIZ, Genetika – Slechteni*, **24**, 1, 75-84.

Singh, B. and Swarup, V. 1971. Heterosis and combining ability in African marigold. *Indian J. Gen. Pl. Breed.* 31(9): 407-15.

Singh, A.K. and Jauhari, S. 2006. Assessment of snapdragon (*Antirrhinum majus* L.) germplasm for various traits. *The Indian Journal of Agriculture Sciences*, **76**, 7, 462-64.

Sreekala, C. and Raghava, S.P.S. 2003. Exploitation of heterosis for carotenoid content in African marigold (*Tagetes erecta* L.) and its correlation with esterase polymorphism. *Theoretical and Applied Genetics*, **106**, 4, 771-76.

Torres, E., Iriondo, J.M. and Perez, C. 2002. Vulnerability and determinant of reproductive success in the narrow endemic *Antirrhinum microphyllum* (Scrophulariaceae). *American Journal of Botany*, **89**, 7, 1171-179.

Towner, J.W. 1961. Cytogenetics studies on the origin of *Tagetes patula* L. Meiosis and morphology of diploid and allotetraploid *T.erecta* × *T. tenuifolia*. *American Journal of Botany*, **48**, 743-51.

Virmani, S.S. 1994. Hybrid rice technology: New developments and future prospects. In: S.S. Virmani (ed), *Selected papers from the International Rice Research Conference International Rice Research Institute*, Manila, Philippines.

Table 1: Heterobeltiosis and standard heterosis for days taken to flowering and flower diameter in crosses of marigold

Crosses	Days taken to flowering (days)						Flower diameter (cm)					
	Heterobeltiosis (%)			Standard heterosis (%)			Heterobeltiosis (%)			Standard heterosis (%)		
	I year	II Year	Average	I year	II year	Average	I year	II year	Average	I year	II year	Average
SY × S	-32.64**	-28.84**	-30.79**	-36.76**	-41.64**	-39.30**	21.82**	22.09**	44.04**	-12.53**	-15.28**	-13.97**
SY × PBG	-30.56**	-23.45**	-26.52**	-34.82**	-36.24**	-35.56**	44.12**	39.72**	41.88**	-14.71**	-16.13**	-15.48**
SY × BB	-35.31**	-30.40**	-32.93**	-39.27**	-42.93**	-41.17**	16.95**	11.97*	14.47**	-39.95**	-44.23**	-42.15**
SY × PNG	-37.09**	-46.53**	-43.85**	-40.95**	-46.52**	-43.84**	58.09**	67.38**	62.82**	-6.44*	0.47	-3.01
SY × SO	-37.09**	-33.85**	-35.52**	-40.95**	-45.76**	-43.45**	-31.62**	-53.70**	-32.49**	-59.53**	-59.98**	-59.78**
SY × LS	-63.93**	-62.46**	-63.21**	-35.09**	-38.81**	-37.03**	197.89**	104.97**	201.05**	23.15**	23.03**	23.01**
SY × FD	-61.15**	-62.72**	-61.94**	-39.83**	-47.30**	-43.72**	27.38**	-24.11**	27.38**	-53.44**	-54.45**	-53.98**
SY × CM	-36.79**	-31.35**	-34.14**	-40.67**	-43.70**	-42.24**	50.00**	18.39**	48.01**	-11.23**	-12.30**	-11.83**
S × PBG	-29.72**	-30.56**	-30.14**	-36.76**	-42.16**	-39.57**	-16.67**	-16.18**	-16.41**	-28.19**	-27.20**	-27.74**
S × BB	15.05*	-0.93	-1.61	-40.39**	-44.73**	-42.65**	28.81**	38.47**	33.62**	-33.86**	-31.03**	-32.47**
S × PNG	-28.69**	-33.17**	-31.01**	-28.69**	-33.16**	-31.01**	-29.13**	-32.34**	-30.75**	-29.07**	-32.31**	-30.75**
S × SO	-31.06**	-25.08**	-28.20**	-38.15**	-43.19**	-40.77**	18.18**	19.01**	18.60**	-15.14**	-17.41**	-16.34**
S × LS	-65.17**	-63.88**	-64.53**	-37.32**	-41.13**	-39.30**	40.00**	-19.63**	38.94**	-42.12**	-44.23**	-43.23**
S × FD	-59.17**	-59.27**	-59.22**	-36.76**	-42.41**	-39.71**	89.29**	-17.17**	75.00**	-30.81**	-42.53**	-36.77**
S × CM	2.20	-2.64	-0.22	-35.37**	-43.19**	-39.44**	-13.22**	-11.49**	-12.35**	-34.29**	-34.44**	-34.41**
PBG × BB	-43.65**	-45.68**	-5.78	-49.30**	-54.75**	-52.14**	15.25**	-37.74**	-34.58**	-40.82**	-45.94**	-43.44**
PBG × PNG	-36.77**	-43.19**	-44.67**	-36.76**	-43.19**	-40.10**	-14.65**	-27.66**	-15.67**	-26.45**	-27.63**	-27.09**
PBG × SO	-29.10**	-29.32**	-40.11**	-36.21**	-41.12**	-38.77**	10.10**	9.80**	9.95**	-5.13	-4.64	-4.94*
PBG × LS	-64.55**	-65.62**	-29.21**	-36.21**	-43.96**	-40.24**	48.42**	-28.92**	50.53**	-38.64**	-38.28**	-38.50**
PBG × FD	-59.35**	-62.00**	-65.07**	-37.04**	-46.27**	-41.84**	33.33**	-46.08**	32.14**	-51.26**	-53.17**	-52.26**
PBG × CM	-37.15**	-37.65**	-60.67**	-43.45**	-48.07**	-45.85**	-13.79**	-25.49**	-13.22**	-34.73**	-35.29**	-35.06**
BB × PNG	-45.13**	-51.15**	-37.40**	-45.12**	-51.15**	-48.26**	-48.70**	-42.98**	-45.81**	-48.65**	-42.96**	-45.81**
BB × SO	-33.85**	-22.03**	-48.26**	-40.66**	-40.87**	-40.78**	-40.40**	-39.90**	-40.15**	-47.35**	-48.06**	-47.75**
BB × LS	-63.93**	-65.30**	-28.20**	-35.09**	-43.44**	-39.44**	-20.34**	-26.49**	-23.40**	-59.09**	-63.39**	-61.29**
BB × FD	-58.27**	-58.37**	-64.61**	-35.37**	-41.13**	-38.37**	101.19**	42.74**	100.00**	-26.46**	-28.91**	-27.74**
BB × CM	19.36**	-6.61	-58.32**	-38.16**	-45.50**	-41.98**	44.91**	37.60**	41.28**	-25.59**	-31.46**	-28.60**
PNG × SO	-34.54**	-39.08**	14.21**	-34.53**	-39.07**	-36.90**	-14.35**	-16.17**	-15.27**	-14.27**	-16.13**	-15.27**
PNG × LS	-57.12**	-55.52**	-36.89**	-22.83**	-27.50**	-25.26**	310.53**	65.96**	310.53**	69.71**	66.02**	67.74**
PNG × FD	-57.19**	-56.91**	-56.33**	-33.70**	-39.07**	-36.50**	57.14**	-43.83**	57.14**	-42.56**	-43.81**	-43.23**
PNG × CM	-32.03**	-39.33**	-57.05**	-32.03**	-39.33**	-35.83**	-39.08**	-54.89**	-39.08**	-53.88**	-54.88**	-54.41**
SO × LS	-64.86**	-62.14**	-35.83**	-36.76**	-38.30**	-37.57**	-49.26**	-49.26**	-49.26**	-55.18**	-56.15**	-55.70**
SO × FD	-56.11**	-59.28**	-63.52**	-32.03**	-42.41**	-37.43**	35.71**	-43.84**	35.71**	-50.39**	-51.47**	-50.97**
SO × CM	-21.43**	-16.27**	-18.97**	-29.52**	-36.51**	-33.15**	-39.08**	-47.78**	-39.08**	-53.87**	-54.87**	-54.41**
LS × FD	-35.76**	-33.75**	-34.77**	15.61**	7.97**	11.64**	101.19**	77.89**	101.19**	-26.46**	-28.05**	-27.31**
LS × CM	-25.08**	-14.35**	-19.77**	34.83**	39.60**	37.31**	42.11**	-22.41**	42.10**	-41.26**	-42.53**	-41.94**
FD × CM	-50.00**	-51.27**	-50.63**	-22.56**	-31.10**	-27.01**	59.52**	-22.98**	-59.52**	-41.69**	-42.95**	-42.37**

Table 2: Heterobeltiosis and standard heterosis for flower longevity (days) and Average dry weight of flowers (g) in crosses of marigold

Crosses	Flower longevity (days)						Average dry weight of flowers (g)					
	Heterobeltiosis (%)			Standard heterosis (%)			Heterobeltiosis (%)			Standard heterosis (%)		
	I year	II year	Avera	I year	II year	Average	I year	II year	Average	I year	II year	Average
SY × S	173.91**	177.27**	175.56**	117.28**	114.03**	115.72**	152.94**	206.95**	177.69**	-1.65	3.22	1.01
SY × PBG	179.49**	197.29**	188.16**	87.96**	92.98**	90.50**	91.91**	133.04**	110.75**	-25.39**	-21.64**	-23.33**
SY × BB	155.18**	175.87**	165.51**	27.61**	40.35**	33.96**	12.40	16.67*	14.47*	-61.12**	-61.11**	-61.01**
SY × PNG	79.31**	91.23**	85.22**	79.34**	91.23**	85.28**	81.62**	113.91**	96.41**	-29.39**	-28.07**	-28.55**
SY × SO	33.33**	-25.68**	27.96**	10.37	-3.51	3.51	9.56	26.95**	17.53**	-57.40**	-57.31**	-57.24**
SY × LS	359.38**	341.94**	350.80**	153.49**	140.35**	147.04**	973.53**	1139.13**	1049.41**	317.38**	316.67**	318.17**
SY × FD	84.61**	111.54**	98.08**	-17.23	-3.51	-10.40	-46.23**	-47.40**	-46.81**	-67.41**	-67.54**	-67.39**
SY × CM	202.85**	208.57**	205.72**	82.79**	89.47**	86.15**	226.47**	284.35**	252.99**	26.93**	29.24**	28.41**
S × PBG	192.31**	227.03**	209.21**	96.59**	112.28**	104.42**	118.14**	109.64**	113.85**	34.08**	33.63**	34.21**
S × BB	248.28**	248.27**	248.28**	74.17**	77.19**	75.71**	222.31**	224.57**	223.40**	11.50**	8.19**	10.14**
S × PNG	132.61**	145.45**	138.88**	84.52**	89.47**	87.02**	-29.43**	-28.87**	-29.15**	-29.39**	-28.66**	-28.84**
S × SO	267.39**	272.73**	270.00**	191.43**	187.72**	189.67**	182.05**	216.12**	199.04**	25.79**	43.27**	34.78**
S × LS	225.00**	216.13**	220.64**	79.34**	71.93**	75.71**	2.98	5.67	-6.02*	-30.82**	-29.24**	-29.86**
S × FD	296.15**	288.47**	292.30**	77.61**	77.20**	77.45**	-40.09**	-40.76**	-40.42**	-63.69**	-63.45**	-63.47**
S × CM	154.29**	148.57**	151.43**	53.47**	52.63**	53.09**	9.36*	6.98*	8.19*	-26.53**	-28.36**	-27.24**
PBG × BB	10.34	17.24	13.79	-44.82**	-40.35**	-42.59**	-52.09**	-48.17**	-50.11**	-70.56**	-66.96**	-68.70**
PBG × PNG	-44.83**	-45.62**	-45.22**	-44.82**	-45.62**	-45.20**	-46.00**	-11.47**	-11.78**	-45.97**	-43.57**	-44.64**
PBG × SO	212.82**	235.13**	223.68**	110.38**	117.54**	113.98**	216.67**	214.20**	215.43**	41.22**	42.40**	42.17**
PBG × LS	159.38**	158.06**	158.73**	43.13**	40.35**	41.79**	-30.70**	-40.37**	-35.57**	-57.40**	-61.99**	-59.59**
PBG × FD	261.54**	269.23**	265.39**	62.10**	68.42**	65.28**	-74.06**	-75.36**	-74.70**	-84.28**	-84.80**	-84.49**
PBG × CM	128.57**	128.57**	128.57**	37.96**	40.35**	39.18**	-13.10**	-15.26**	-14.17**	-37.39**	-38.31**	-37.68**
BB × PNG	-39.66**	-43.86**	-41.74**	-39.64**	-43.86**	-41.72**	-62.86**	-60.64**	-61.76**	-62.84**	-60.53**	-61.59**
BB × SO	41.38*	37.93*	39.66**	-29.30**	-29.83**	-29.54**	-32.70**	-33.55**	-33.12**	-69.99**	-69.88**	-69.86**
BB × LS	17.24	17.24	17.24	-41.37**	-40.35**	-40.85**	-54.55**	107.02**	23.83**	-84.28**	-30.99**	-57.83**
BB × FD	130.77**	96.15**	113.46**	3.46	-10.52	-3.44	80.17**	83.33**	81.70**	-37.68**	-38.89**	-38.12**
BB × CM	124.14**	103.44**	113.79**	12.09	3.51	7.86	64.47**	71.06**	67.66**	-43.11**	-42.98**	-42.90**
PNG × SO	12.50	13.33	12.90	-6.88	-10.52	-8.67	182.06**	-27.09**	77.81**	25.79**	-66.96**	-19.86**
PNG × LS	-24.14**	38.71**	38.09**	-24.13**	-24.56**	-24.32**	603.88**	601.17**	602.52**	419.15**	426.90**	424.35**
PNG × FD	153.84**	146.15**	150.00**	13.81	12.28	13.08*	-46.57**	-12.32**	-12.05**	-46.54**	-45.90**	-46.09**
PNG × CM	94.29**	88.57**	91.43**	17.26	15.79*	16.56*	51.19**	47.39**	49.30**	8.92**	7.31**	8.40**
SO × LS	46.87**	54.84**	50.79**	-18.95*	-15.79*	-17.36**	-25.00**	-27.74**	-26.36**	-66.55**	-67.25**	-66.81**
SO × FD	-33.33**	-31.11**	-32.26**	-44.82**	-45.61**	-45.19**	53.20**	44.51**	48.88**	-31.68**	-34.51**	-32.90**
SO × CM	74.29**	65.71**	70.00**	5.19	1.75	3.51	-47.62**	-20.00**	-17.68**	-62.27**	-63.74**	-62.90**
LS × FD	92.31**	88.46**	90.38**	-13.77	-14.03	-13.88*	-20.54**	-22.57**	-21.55**	-41.40**	-41.82**	-41.45**
LS × CM	87.50**	103.23**	95.24**	3.47	10.53	6.99	-26.19**	-28.41**	-26.15**	-46.83**	-46.20**	-46.38**
FD × CM	30.77	23.07	26.92	-41.37**	-43.86**	-42.59**	-20.24**	-14.69**	-23.95**	-42.54**	-47.37**	-44.78**

Table 3: Heterobeltiosis and standard heterosis for flowering duration and shelf life of flowers) in crosses of marigold

Crosses	Flowering duration (days)						Shelf life of flowers (days)					
	Heterobeltiosis (%)			Standard heterosis (%)			Heterobeltiosis (%)			Standard heterosis (%)		
	I year	II year	Average	I year	II year	Average	I year	II year	Average	I year	II year	Average
SY × S	41.63**	45.61**	43.54**	12.00**	10.13**	11.08**	42.85**	53.84**	48.15**	0.10	11.11	5.31
SY × PBG	84.32**	90.91**	87.60**	-23.99**	-20.25**	-22.15**	-28.57**	25.00	-25.93*	-49.95**	-44.44**	-47.34**
SY × BB	51.19**	60.79**	55.93**	-2.77	3.80	0.47	109.09**	100.00**	104.77**	15.15*	11.11	13.21
SY × PNG	-22.46**	-25.64**	-24.03**	-22.46**	-25.63**	-24.02**	64.29**	69.23**	66.67**	15.11*	22.22*	18.48*
SY × SO	0.00	5.02	2.21	-21.23**	-20.57**	-20.90**	-26.32**	-33.33**	-29.73**	-29.93**	-33.33**	-31.54**
SY × LS	46.39**	55.03**	50.41**	-12.61**	-17.09**	-14.82**	64.29**	53.84**	59.25**	15.11*	11.11	13.21
SY × FD	61.46**	69.89**	65.72**	-4.61	5.38	0.32	64.29**	69.23**	66.67**	15.11*	22.22*	18.48*
SY × CM	-11.78**	20.08**	13.71**	-14.77**	-9.17*	-12.01**	127.27**	92.31**	108.33**	25.12**	38.89**	31.64**
S × PBG	100.75**	96.21**	98.49**	-17.22**	-18.03**	-17.63**	127.27**	200.00**	157.89**	25.12**	33.33**	29.10**
S × BB	79.43**	74.51**	76.99**	15.39**	12.67**	14.04**	81.82**	90.00**	85.72**	0.10	5.56	2.68
S × PNG	26.80**	17.04**	21.93**	3.39	-2.21	0.63	10.00	16.67	13.15	10.11	16.67	13.21
S × SO	4.69	15.10**	9.78*	-17.54**	-10.75**	-14.19**	31.58**	22.22*	27.02**	25.12**	22.22*	23.75**
S × LS	107.2**	122.48**	114.33**	23.70**	18.99**	21.38**	4.76	5.00	4.88	10.11	16.67	13.21
S × FD	43.75**	26.02**	34.80**	-15.07**	-21.84**	-18.40**	-26.32**	-30.00**	-24.32**	-29.93**	-22.22*	-26.28**
S × CM	-16.88**	7.57	-11.23**	-19.69**	-10.12**	-14.98**	36.36**	-25.00*	-26.83**	-24.92**	-16.67	-21.01**
PBG × BB	108.95**	113.63**	111.28**	-13.84**	-10.75**	-12.32**	27.27**	75.00**	47.37**	-29.93**	-22.22*	-26.28**
PBG × PNG	186.57**	183.33**	184.97**	18.15**	18.35**	18.26**	-36.36**	-61.11**	-63.16**	-64.96**	-61.11**	-63.14**
PBG × SO	93.29**	91.67**	92.48**	-20.30**	-19.94**	-20.12**	100.00**	150.00**	121.06**	10.11	11.11	10.59
PBG × LS	101.49**	104.54**	103.01**	-16.92**	-14.55**	-15.75**	-54.16**	-50.00**	-52.17**	-44.94**	-38.89**	-42.07**
PBG × FD	81.34**	87.12**	84.21**	-25.23**	-21.84**	-23.56**	-47.37**	-50.00**	-48.65**	-49.95**	-50.00**	-49.97**

PBG × CM	78.36**	106.82**	92.48**	-26.45**	-13.61**	-20.12**	-9.09	37.50	10.52	-49.95**	-38.89**	-44.71**
BB × PNG	34.93**	17.16**	26.15**	-13.22**	-24.37**	-18.72**	-35.00**	-33.00**	-34.21**	-34.93**	-33.33**	-34.18**
BB × SO	36.85**	28.43**	32.69**	-11.99**	-17.09**	-14.51**	-47.37**	-44.44**	-45.95**	-49.95**	-44.44**	-47.34**
BB × LS	26.80**	43.78**	34.71**	-24.30**	-23.09**	-23.71**	-54.17**	-50.00**	-52.17**	-44.95**	-38.89**	-42.07**
BB × FD	30.73**	31.63**	31.19**	-22.77**	-18.35**	-20.59**	45.45**	40.00*	42.85**	-19.92**	-22.22*	-21.01**
BB × CM	-34.08**	-34.00**	-34.04**	-36.31**	-37.34**	-36.82**	45.45**	50.00*	47.62**	-19.92**	-16.67	-18.37*
PNG × SO	42.19**	51.84**	46.91**	12.00**	17.72**	14.82**	-15.00*	-11.11	-10.81	-14.91	-11.11	-13.11
PNG × LS	96.91**	129.58**	112.12**	17.54**	22.79**	20.13**	-29.17**	-22.72*	-26.08**	-14.91	5.56	-10.48
PNG × FD	104.69**	102.55**	103.61**	20.92**	25.64**	23.25**	-20.00**	-5.56	-10.81	-19.92**	-5.56	-13.11
PNG × CM	-9.55*	-10.13**	-7.49**	-12.61**	-10.12**	-11.39**	45.45**	30.77*	37.50**	-19.92**	-5.56	-13.11
SO × LS	43.81**	71.01**	56.47**	-14.15**	-8.54*	-11.39**	-42.10**	-44.44**	-43.24**	-44.94**	-44.44**	-44.71**
SO × FD	76.04**	63.27**	69.59**	4.00	1.27	2.65	-31.58**	-27.77*	-29.73**	-34.93**	-27.78*	-31.54**
SO × CM	-12.10**	-12.67**	-12.38**	-15.07**	-17.09**	-16.07**	-47.37**	-44.44**	-45.95**	-49.95**	-44.44**	-47.34**
LS × FD	20.83**	31.96**	25.35**	-28.61**	-29.43**	-29.01**	-26.32**	-36.36**	-24.32**	-29.93**	-22.22*	-26.28**
LS × CM	18.04**	30.18**	23.69**	-29.54**	-30.38**	-29.96**	100.00**	61.53**	79.17**	10.11	16.67	13.21
FD × CM	29.69**	25.51**	27.58**	-23.38**	-22.15**	-22.78**	-42.10**	-38.89**	-40.54**	-44.94**	-38.89**	-42.08**

Table 4: Heterobeltiosis and standard heterosis for flower yield/plant and leaf biomass in crosses of marigold

Crosses	Flower yield/plant (g)						Leaf Biomass (g)					
	Heterobeltiosis (%)			Standard heterosis (%)			Heterobeltiosis (%)			Standard heterosis (%)		
	I year	II year	Averag	I year	II year	Average	I year	II year	Average	I year	II year	Average
SY × S	58.38	71.08*	59.97	-45.57**	-45.28**	-45.23**	-45.21**	-42.02**	-43.65**	101.93*	98.74**	100.32**
SY × PBG	-71.53**	-74.78**	-73.18**	-84.44**	-84.94**	-84.68**	-38.69**	-37.49**	-38.10**	125.97*	114.26**	120.046*
SY × BB	-48.92	-33.98	-41.89	-86.30**	-83.23**	-84.82**	-44.40**	-57.71**	-50.90**	104.92*	44.94	74.55**
SY × PNG	-49.54**	91.45*	-44.32**	-49.53**	-38.76**	-44.32**	-62.17**	-38.10**	-50.41**	39.42	112.17**	76.28**
SY × SO	-83.74*	-73.90*	-76.76**	-94.13**	-91.65**	-92.92**	-14.37	43.92**	40.47**	215.62*	246.55**	231.30**
SY × LS	788.99**	976.71**	874.22**	221.07**	244.40**	232.36**	-78.25**	-80.64**	-79.54**	257.46*	265.05**	261.31**
SY × FD	-90.59**	-69.66*	-89.32**	-91.53**	-90.30**	-90.93**	-79.56**	-73.59**	-76.78**	154.45*	178.45**	166.62**
SY × CM	588.25**	762.26**	667.25**	148.57**	175.80**	161.75**	-64.27**	-65.36**	-64.80**	31.67	15.74	25.12
S × PBG	33.69	35.17	34.57	-53.96**	-51.18**	-52.61**	36.20	5.59	21.21	79.33	28.89	54.29
S × BB	292.07**	337.57**	313.48**	5.14	11.15	8.05	197.17**	183.57**	190.37**	253.06*	227.91**	240.33**
S × PNG	-53.24**	-51.30**	-52.30**	-53.24**	-51.30**	-52.30**	198.60**	195.39**	197.00**	254.77*	241.59**	248.10**
S × SO	204.93**	266.08**	234.54**	-7.22	11.37	1.78	70.62**	148.60**	44.12**	293.68*	187.47**	239.89**
S × LS	-64.94**	-67.47**	-66.27**	-56.59**	-51.97**	-54.39**	-81.28**	-83.35**	-82.40**	207.70*	213.91**	210.85**
S × FD	-75.21**	-70.88**	-73.25**	-77.68**	-76.88**	-77.29**	-88.93**	-88.56**	-88.89**	37.74	17.49	27.49
S × CM	136.55**	154.50**	145.47**	-18.71	-8.09	-13.57	83.06**	86.47**	84.87**	117.49*	115.64**	116.56**
PBG × BB	29.29	85.18	55.60	-65.33*	-52.96**	-59.34**	-40.69	414.19**	353.63**	-21.91	-5.53	-13.61
PBG × PNG	-67.35**	-64.15**	-65.80**	-67.35**	-64.15**	-65.80**	252.65**	286.37**	269.16**	364.34*	375.28**	369.89**
PBG × SO	151.19**	154.62**	152.85**	-23.57	-22.54*	-23.07*	-18.67	-21.53*	47.94*	87.66*	88.94**	88.31**
PBG × LS	-65.46**	-77.50**	-71.82**	-57.24**	-66.79**	-61.86**	-90.98**	-91.49**	-91.32**	48.28	58.33**	53.37
PBG × FD	-73.48**	-60.88**	-58.63**	-76.12**	-76.64**	-76.37**	-92.15**	-91.49**	-91.84**	-2.23	-10.29	-6.31
PBG × CM	-34.26	-43.57*	-41.32*	-66.67**	-66.29**	-66.49**	-22.18	70.85**	65.50**	111.14*	110.17**	110.66**
BB × PNG	-74.04**	-66.63**	-70.45**	-74.04**	-66.62**	-70.45**	-78.50	-82.12**	-80.34**	-78.50	-82.12**	-80.34**
BB × SO	15.03	13.72	14.41	-69.15**	-71.11**	-70.10**	-83.25**	-86.32**	-84.84**	-61.37	-67.06*	-64.25*
BB × LS	-86.97**	-90.96**	-89.07**	-83.88**	-86.64**	-85.22**	-97.99**	-98.05**	-98.03**	-67.10	-63.34*	-65.20*
BB × FD	-70.99**	-71.56**	-71.25**	-73.89**	-77.41**	-75.59**	-87.81**	-84.97**	-86.49**	51.78	58.04*	55.14
BB × CM	58.94	69.90	64.10	-57.38**	-56.83**	-57.12**	1140.11**	1226.80**	1182.47**	144.70*	143.75**	144.23**
PNG × SO	-65.55**	-58.82**	-62.29**	-65.55**	-58.81**	-62.29**	100.42*	97.06**	98.72**	100.42*	97.06**	98.73**
PNG × LS	291.15**	285.96**	288.64**	291.16**	285.97**	288.64**	-96.83**	-97.16**	-97.01**	-47.81	-46.50	-47.15
PNG × FD	-41.53**	-40.04**	-40.81**	-41.53**	-40.04**	-40.81**	46.57	-86.04**	-87.21**	46.57	47.15	46.86
PNG × CM	-1.78	135.75**	113.75**	-1.78	15.75	6.70	174.37**	170.62**	172.47**	174.37*	170.63**	172.47**
SO × LS	-63.64**	-72.09**	-68.11**	-54.99**	-58.80**	-56.84**	78.75**	-77.90**	-76.53**	312.44*	316.66**	314.59**
SO × FD	-43.92**	-39.52**	-41.93**	-49.51**	-51.97**	-50.70**	-20.36	-82.74**	-84.08**	83.74	81.93**	82.83**
SO × CM	17.58	22.50	19.96	-64.23**	-62.73**	-63.50**	41.06*	40.08**	35.16**	225.47*	237.33**	231.48**
LS × FD	266.00**	250.43**	258.95**	229.53**	178.32**	204.73**	-88.83**	-90.16**	-83.93**	83.51	85.58**	84.57**
LS × CM	388.64**	346.72**	368.68**	147.71**	119.33**	133.97**	-65.75**	-71.17**	-68.68**	463.06*	443.72**	453.28**
FD × CM	662.12**	522.42**	595.59**	286.35**	205.60**	247.24**	-56.44**	-49.56**	-53.24**	442.42*	431.74**	437.02**

Table 5: Heterobeltiosis and standard heterosis for days taken to seed ripening and seed yield/plant in crosses of marigold

Crosses	Days taken to seed ripening (days)						Seed yield/plant (g)					
	Heterobeltiosis (%)			Standard heterosis (%)			Heterobeltiosis (%)			Standard heterosis (%)		
	I year	II year	Average	I year	II year	Average	I year	II year	Average	I year	II year	Average
SY × S	55.78**	57.67**	56.73**	-6.91**	-3.47	-5.19**	168.38**	157.62*	163.32**	-68.76**	-71.28**	-69.97**
SY × PBG	-18.45**	-22.13**	-20.31**	-20.93**	-22.44**	-21.68**	-67.32**	-67.78**	-67.54**	-86.21**	-87.49**	-86.83**
SY × BB	-21.80**	-26.84**	-24.35**	-24.19**	-27.14**	-25.66**	-47.47**	115.72	-41.68*	-77.84**	-74.71**	-76.33**
SY × PNG	-19.11**	-21.72**	-20.57**	-19.10**	-22.04**	-20.57**	-64.87**	-63.25**	-11.49	-64.86**	-63.25**	-64.08**
SY × SO	-25.99**	-27.66**	-26.84**	-28.25**	-27.96**	-28.10**	-85.93**	-81.87**	-84.05**	-94.06**	-92.95**	-93.53**
SY × LS	-32.85**	-32.58**	-32.72**	2.64	3.47	3.05*	-66.94**	-66.79**	-66.87**	-64.31**	-61.33**	-62.87**
SY × FD	-54.27**	-53.05**	-53.67**	-34.76**	-34.08**	-34.42**	-85.00**	-79.90**	-82.65**	-93.67**	-92.19**	-92.96**
SY × CM	-8.81**	-9.43**	-9.12**	-11.58**	-9.79**	-10.69**	80.13**	93.22**	86.16**	-24.01**	-24.96**	-24.47**
S × PBG	14.77**	13.04**	13.91**	-3.66	-4.48	-4.07**	232.92**	273.39**	251.97**	-61.24**	-58.38**	-59.87**
S × BB	31.29**	38.00**	34.68**	-21.54**	-15.51**	-18.53**	107.22**	193.34**	147.74*	-75.88**	-67.30**	-71.75**
S × PNG	69.72**	60.00**	64.82**	1.42	-2.04	-0.31	-71.71**	-68.86**	160.12*	-71.71**	-68.86**	-70.34**
S × SO	23.92**	24.82**	24.38**	10.57**	10.82**	10.70**	477.57**	625.59**	547.22**	-32.77**	-19.11*	-26.19**
S × LS	-45.48**	-45.74**	-45.62**	-16.67**	-16.73**	-16.70**	809.67**	961.53**	881.13**	5.88	18.33*	11.88
S × FD	-36.89**	-34.74**	-35.83**	-9.96**	-8.36**	-9.16**	-62.71**	-64.01**	-63.33**	-77.59**	-78.79**	-78.17**
S × CM	31.97**	29.00**	30.47**	-21.13**	-21.02**	-21.08**	-40.96**	187.07**	169.69**	-70.41**	-67.99**	-69.25**
PBG × BB	-37.29**	-35.51**	-36.39**	-47.36**	-45.51**	-46.44**	370.87**	531.09**	443.43**	-38.12**	-26.02**	-32.29**
PBG × PNG	-38.62**	-37.76**	-38.18**	-38.62**	-37.75**	-38.18**	23.102**	37.40**	29.84**	2.15	9.7.3	5.81
PBG × SO	7.02**	-1.15	5.44**	-10.16**	-12.24**	-11.20**	-77.77**	-78.30**	-78.03**	-88.20**	-87.88**	-88.04**
PBG × LS	-36.97**	-37.10**	-37.03**	-3.66	-3.46	-3.56*	-68.54**	-64.15**	-66.48**	-73.90**	-71.38**	-72.68**
PBG × FD	-26.07**	-23.98**	-25.04**	5.48**	6.74*	6.12**	43.08**	48.05**	45.46**	-14.04*	-12.75	-13.41
PBG × CM	-17.92**	-17.39**	-17.65**	-31.09**	-30.21**	-30.65**	-49.86**	-46.12**	-48.10**	-58.39**	-56.97**	-57.71**
BB × PNG	-47.97**	-45.92**	-46.95**	-47.97**	-45.92**	-46.94**	-74.69**	-74.99**	-74.83**	-74.68**	-74.99**	-74.83**
BB × SO	-33.48**	-34.49**	-33.98**	-40.65**	-41.84**	-41.91**	-67.14**	-65.79**	-66.47**	-82.56**	-80.89**	-81.75**
BB × LS	-64.50**	-63.56**	-64.03**	-45.73**	-44.08**	-44.91**	187.41**	233.76**	208.40**	-62.22**	-60.87**	-61.58**
BB × FD	-50.86**	-52.33**	-51.59**	-29.87**	-33.06**	-31.46**	314.16**	343.13**	327.28**	-45.57**	-48.06**	-46.76**
BB × CM	19.05**	18.92**	18.98**	-28.86**	-28.16**	-28.51**	-54.85**	-53.93**	-54.40**	-77.37**	-76.30**	-76.85**
PNG × SO	-31.30**	-33.46**	-32.38**	-31.30**	-33.47**	-32.38**	-56.82**	-49.53**	-53.22**	-77.08**	-71.81**	-74.55**
PNG × LS	-49.34**	-48.94**	-49.14**	-22.56**	-21.63**	-22.09**	-60.50**	-58.72**	-59.64**	-60.50**	-58.72**	-59.64**
PNG × FD	-51.71**	-46.37**	-49.07**	-31.09**	-24.69**	-27.90**	-58.95**	-48.59**	-54.01**	-75.34**	-69.71**	-72.63**
PNG × CM	-23.37**	-25.31**	-24.34**	-23.37**	-25.31**	-24.33**	-67.02**	-61.72**	-64.47**	-67.02**	-61.71**	-64.47**
SO × LS	-57.32**	-57.58**	-57.45**	-34.37**	-34.89**	-34.82**	140.75**	133.19**	137.02**	27.80**	30.21**	28.97**
SO × FD	-54.71**	-54.65**	-54.68**	-35.37**	-36.32**	-35.84**	-43.87**	-44.69**	-44.27**	-70.21**	-69.11**	-69.67**
SO × CM	-22.78**	-22.99**	-22.88**	-31.09**	-31.63**	-31.36**	64.18**	90.76**	65.55**	-17.39*	-1.87	-9.91
LS × FD	-31.25**	-31.39**	-31.32**	5.08**	5.31	5.20**	631.24**	593.10**	613.07**	339.31**	308.42**	324.47**
LS × CM	-22.61**	-25.00**	-23.81**	18.30**	15.11**	16.71**	68.89**	63.37**	66.19**	-15.35*	-15.97*	-15.63*
FD × CM	-46.58**	-44.33**	-45.47**	-23.78**	-21.84**	-22.81**	1032.88**	931.97**	983.65**	467.84**	430.83**	450.07**

Table 6: The performance of F₁'s over the standard cultivar (PNG) during both the years (2005-2006 and 2006-2007)

Characters	Crosses	Mean value						Standard heterosis (%)		
		F ₁ hybrid			Standard			I Year	II Year	Average
		I Year	II Year	Average	I Year	II Year	Average			
Days taken to flowering (days)	PBG × BB	60.67	58.67	59.67	119.67	129.67	124.67	-49.30	-54.75	-52.14
	BB × PNG	65.67	63.33	64.50				-45.12	-51.15	-48.26
	PBG × CM	67.67	67.33	67.50				-43.45	-48.07	-45.85
	LS × CM	161.33	181.00	171.11				34.83	39.60	37.31
	LS × FD	138.33	140.00	139.11				15.61	7.97	11.64
Flower diameter (cm)	PNG × LS	13.00	13.00	13.00	7.67	7.83	7.75	69.71	66.02	67.74
	SY × LS	9.43	9.63	9.53				23.15	23.03	23.01
	PBG × PNG	5.63	5.67	5.66				-5.13	-4.64	-4.94
	SY × PNG	7.16	7.87	7.52				-6.44	0.47	-3.01
Flower Longevity (days)	SY × CM	6.80	6.87	6.83				-11.23	-12.30	-11.83
	S × SO	56.33	54.67	55.50	19.33	19.00	19.17	191.43	187.72	189.67
	SY × LS	49.00	45.67	47.33				153.49	140.35	147.04
	SY × S	42.00	40.67	41.33				117.28	114.03	115.72
	PBG × SO	40.67	41.33	41.00				110.38	117.54	113.98
Average dry weight of flowers (g)	SY × CM	35.33	36.00	35.62				96.59	112.28	104.42
	PNG × LS	6.05	6.00	6.03	1.17	1.14	1.56	419.15	426.90	424.35
	SY × LS	4.87	4.75	4.81				317.38	316.67	318.17
	PBG × SO	1.65	1.62	1.63				41.22	42.40	42.17
	S × PBG	1.56	1.52	1.54				34.08	33.63	34.21
Duration of flowering (days)	SY × CM	1.48	1.47	1.48				26.93	29.24	28.41
	S × LS	134.00	125.00	129.50	108.33	105.33	106.83	23.70	18.99	21.38
	PNG × FD	131.00	132.00	131.50				20.92	25.64	23.25
	PBG × PNG	128.00	124.67	126.33				18.15	18.35	18.26
	PNG × LS	127.33	129.33	128.33				17.54	22.79	20.13
Shelf life of flowers (days)	S × BB	125.00	118.67	121.87				15.39	12.67	14.04
	SY × CM	8.33	8.33	8.33	6.67	6.00	6.33	25.12	38.89	31.64
	S × PBG	8.33	8.00	8.11				25.12	33.33	29.10
	S × SO	8.33	7.33	7.87				25.12	22.22	23.75
	SY × PNG	7.67	7.33	7.50				15.11	22.22	18.48
Leaf Biomass (g)	SY × FD	7.67	7.33	7.50				15.11	22.22	18.48
	BB × PNG	50.96	44.62	47.79	237.11	243.42	240.27	-78.50	-82.12	-80.34
	BB × LS	78.00	89.23	83.62				-67.10	-63.34	-65.20
	BB × SO	91.60	81.18	86.39				-61.37	-67.06	-64.25
	PNG × LS	123.74	130.21	126.98				-47.81	-46.20	-47.15
Flower yield/plant (g)	PBG × BB	185.16	240.01	212.58				-21.91	-5.53	-13.61
	PNG × LS	1821.34	1687.21	1754.29	465.64	437.15	451.39	291.16	285.97	288.64
	FD × CM	1323.81	1335.89	1329.85				286.35	205.60	247.24
	LS × FD	1103.52	1216.62	1304.53				229.53	178.32	204.73
	SY × LS	1494.99	1505.53	1500.26				221.07	244.40	232.36
Days taken to seed ripening	SY × CM	1157.40	1205.67	1181.54				148.57	175.80	161.75
	BB × PNG	159.00	162.67	160.87	164.00	163.33	163.67	-47.97	-45.92	-46.94
	PBG × BB	86.33	89.00	87.87				-47.36	-45.51	-46.44
	BB × LS	89.00	91.33	90.11				-45.73	-44.08	-44.91
	PBG × PNG	100.67	101.67	101.11				-38.62	-37.75	-38.12
Seed yield/plant (g)	SO × FD	106.00	104.00	105.00				-35.37	-36.32	-35.84
	FD × CM	411.91	357.30	384.61	72.54	67.31	69.93	467.84	430.83	450.07
	LS × FD	318.67	274.90	296.79				339.31	308.42	324.47
	SO × LS	92.71	87.65	90.18				27.80	30.21	28.97
	S × LS	76.80	79.65	78.23				5.88	18.33	11.88
PBG × PNG	74.10	73.86	73.98				2.15	9.73	5.81	