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Combining Ability and Heterosis in Snake Gourd (*Trichosanthes cucumerina* L.)

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The present investigation was carried out with 36 hybrids and they were evaluated for growth, quality, mosaic disease incidence and yield through line x tester method to identify combinations expressing high hybrid vigour in snake gourd. The significant variation in *gca, sca* and heterosis over the standard variety were noticed for all the traits. The line IC 308557 (L_4), IC 284753 (L_5), IC 546083 (L_6) and the testers Jeyamkondam Local (T_2) and Kulithalai Local (T_1) were found to be best general combiners for growth, quality, mosaic disease incidence and yield characters. Among the hybrids L_2xT_3, L_7xT_2, L_2xT_4, L_5xT_1 and L_8xT_4 were found to be the good specific combiners (*gca*) for most of the characters *viz*., growth, ascorbic acid, mosaic disease incidence and yield per vine. Among the 36 hybrids, seven *viz*., IC333314 x Kumbakonam Local (L_2xT_3), IC433526 x Kulithalai Local (L_3xT_1), IC546083 x Kulithalai Local (L_6xT_1), IC546083 x Kumbakonam Local (L_6xT_3), IC433526 x Kumbakonam Local (L_3xT_3), IC284753 x Kulithalai Local (L_5xT_1) and IC410160 x Jeyamkondam Local (L_7xT_2) exhibited highly significant positive standard heterosis for growth, quality, mosaic disease incidence and yield. These seven hybrids were found to be suitable for exploiting heterosis.

Key words: Snake gourd, *Trichosanthes cucumerina* L., Line x Tester, Gene action, Heterosis

Snake gourd (*Trichosanthes cucumerina* L.) belongs to the family Cucurbitaceae and it is an important summer vegetable that can be grown throughout the year except in extreme winter, possessing a good source of minerals, fiber and nutrients to make the food wholesome and healthy (Ahmed *et al*., 2004). It is also one of the important vegetable, which fetches more yield, per unit area, but the average yield of the crop is comparatively low. In addition, it has got tremendous export potential because of its excellent keeping quality and shelf life. There are a number of cultivars with wide range of variability in size, shape and colour of fruits available in this country. A large number of local lines are cultivated, but there is no recommended cultivar so far. Also no serious attempt has been made to upgrade the productivity of snake gourd. Effective utilization of germplasm resources and integration of genomic tools to impart efficiency and pace of breeding processes is recommended (Banga, 2012). Exploitation of heterosis in crop plants is one of the most attractive achievements in boosting up the production and productivity of snake gourd breaking the present yield barrier. Comprehensive analysis of the combining ability involved in the inheritance of quantitative traits during heterosis breeding is necessary for final evaluation (Allard, 1960 and Meena *et al.,* 2015). Combining ability analysis has greater importance in crop improvement to identification of best combiners and utilizes them in hybridization programme to produce superior hybrids, either to exploit for heterosis or to combine favourable genes (Meena *et al.,* 2015). This technique was developed by Kempthorne in 1957. In addition, the information on nature of gene action will be helpful to develop efficient crop improvement programme. General combining ability is due to additive and additive × additive gene action and is fixable in nature while specific combining ability is due to non-additive gene action which may be due to dominance or epistasis or both and is non-fixable. The presence of non-additive genetic variance is the primary justification for initiating the hybrid breeding programme (Pali and Mehta, 2014). However, the level of yield gain achieved from these hybrids is marginal. It clearly indicates that, the scope of improving the productivity of snake gourd can be achieved through genetic manipulations. Keeping these points in view, the present investigation was undertaken to determine general combining ability and specific combining ability of parental line and better parent heterosis of different cross combinations in snake gourd.

Material and Methods

The present investigation was conducted in the Department of Horticulture, Agricultural College and Research Institute, Madurai during the year 2012-13. The study comprised of 13 parents (nine lines *viz*., IC413017, IC333314, IC433526, IC308557, IC284753, IC546083, IC410160, IC202159, IC212527 have been obtained from NBPGR, New Delhi and four testers *viz*., Kulithalai Local, Jeyamkondam Local, Kumbakonam local, Palayajeyankondam Local have been collected from various location in Tamil Nadu) and their corresponding lines and tester LxT (Line x

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Tester) design was made to generate 36 F_1 hybrids (crosses). These hybrids along with 13 parents comprised the material for heterosis and combining ability studies which were evaluated in a randomized block design with three replications. Subsequently, parents and hybrid seeds were sown at a spacing of 2 m x 2 m with recommended package of practices (Crop Production Techniques of Horticultural Crops, TNAU, 2013) followed in Tamil Nadu. Observations were recorded on five randomly tagged plants in each entry on vine length, ascorbic acid content, mosaic disease incidence and fruit yield per vine. The data was analyzed for combining ability followed model of Kempthorne (1957). Heterosis based on better parent which was calculated following Mather and Jinks (1971).

Results and Discussion

The analysis of variance revealed that the parents and hybrids differed significantly for all the characters under study indicating the presence of considerable genetic variability among the genotypes.

Table 1. Magnitude of heterosis (%) over better parent for growth, quality and yield

Hybrids	Vine length (cm)		Ascorbic acid content (mg.100g^{-1})		Mosaic disease incidence		Yield (kg vine^{-1})	
	BP	SP	BP	SP	BP	SP	BP	SP
L_1 x T_1	29.81 **	-0.59	-4.77 **	27.76 **	-75.13 **	26.80 **	-39.55 **	-20.35**
L_1 x T_2	2.17	-17.27 **	-16.31 **	-6.57 **	-77.98 **	12.26 **	-68.37 **	-19.48**
L_1 x T_3	23.29 **	2.24	17.49 **	18.07 **	-74.77 **	28.65 **	67.32 **	12.49 **
L_1 x T_4	13.47 **	5.17 **	28.95 **	29.59 **	-76.84 **	18.07 **	20.92 **	-16.69**
L_2 x T_1	8.20 **	8.20 **	-7.92 **	23.54 **	-41.33 **	-38.44 **	-11.57 **	-11.57**
L_2 x T_2	11.12 **	11.12 **	-22.17 **	-13.12 **	-17.18 **	-17.18 **	27.79 **	27.79 **
L_2 x T_3	14.15 **	14.15 **	10.94 **	10.94 **	-55.73 **	-33.63 **	-12.48 **	-12.48**
L_2 x T_4	-7.32 **	-7.32 **	28.63 **	28.63 **	-29.94 **	-29.94 **	24.10 **	24.10 **
L_3 x T_1	-20.87 **	-11.22 **	-21.74 **	10.05 **	-52.38 **	1.85 NS	9.93 **	6.60 **
L_3 x T_2	-12.17 **	-1.46	-25.41 **	4.89 **	-53.98 **	-1.57 NS	12.12 **	8.72 **
L_3 x T_3	-15.65 **	-5.37 **	-28.54 **	0.49 NS	-49.74 **	7.50 *	32.01 **	28.01 **
L_3 x T_4	-15.65 **	-5.37 **	-17.21 **	16.42 **	-60.73 **	-16.00 **	-39.05 **	-0.89NS
L_4 x T_1	1.80	10.24 **	-14.20 **	18.65 **	-94.90 **	-80.86 **	76.67 **	0.83 NS
L_4 x T_2	4.95	13.66 **	-28.58 **	-1.24 NS	-91.73 **	-69.00 **	106.10 **	43.84 **
L_4 x T_3	0.00	8.29 **	-24.14 **	4.89 **	-90.90 **	-65.86 **	102.30 **	41.19 **
L_4 x T_4	-16.22 **	-9.27 **	-11.12 **	22.90 **	-93.52 **	-75.71 **	59.35 **	49.35 **
L_5 x T_1	-25.24 **	-24.88 **	-17.87 **	11.00 **	-88.20 **	-42.25 **	87.21 **	45.37 **
L_5 x T_2	1.94	2.44 *	-22.39 **	4.89 **	-92.61 **	-63.85 **	122.83 **	47.40 **
L_5 x T_3	-1.94	-1.46	-26.29 **	-0.38 NS	-90.39 **	-52.99 **	113.89 **	0.38 NS
L_5 x T_4	-5.83	-5.37 **	-12.57 **	18.15 **	-89.11 **	-46.73 **	46.23 **	37.06 **
L_6 x T_1	9.88 **	-13.17 **	9.21 **	46.53 **	-81.87 **	-80.97 **	-71.19 **	-2.29 **
L_6 x T_2	-16.87 **	-32.68 **	-4.36 **	6.77 **	-74.18 **	-73.87 **	133.00 **	0.55 NS
L_6 x T_3	25.88 **	4.39 **	22.00 **	30.02 **	-72.49 **	-58.76 **	125.74 **	51.77 **
L_6 x T_4	16.84 **	8.29 **	30.75 **	39.35 **	-71.86 **	-71.52 **	41.63 **	-0.53NS
L_7 x T_1	31.21 **	0.49	-7.92 **	23.54 **	-51.25 **	-48.85 **	96.61 **	52.67 **
L_7 x T_2	31.33 **	6.34 **	-23.62 **	-11.52 **	-84.87 **	-86.85 **	-108.31**	-10.10
L_7 x T_3	7.06 **	-11.22 **	-4.80 **	10.28 **	-81.11 **	-71.68 **	103.11 **	0.37 NS
L_7 x T_4	8.42 **	0.49	10.00 **	27.42 **	-54.05 **	-59.65 **	49.73 **	40.34 **
L_8 x T_1	8.28 **	-17.07 **	-24.99 **	0.64 NS	-91.87 **	-83.10 **	50.14 **	16.58 **
L_8 x T_2	33.73 **	8.29 **	-42.06 **	-35.32 **	-87.08 **	-73.14 **	97.58 **	22.15 **
L_8 x T_3	-4.71	-20.98 **	34.15 **	-11.52 **	-81.61 **	-61.78 **	113.89 **	43.80 **
L_8 x T_4	21.05 **	12.20 **	24.30 **	3.53 *	-87.51 **	-74.03 **	49.12 **	39.76 **
L_9 x T_1	21.02 **	-7.32 **	-8.89 **	22.24 **	-67.55 **	-39.79 **	-75.12 **	-0.05NS
L_9 x T_2	-7.23 **	-24.88 **	-26.22 **	-17.63 **	-53.02 **	-12.81 **	-85.62 **	-10.69 *
L_9 x T_3	-25.88 **	-38.54 **	31.33 **	6.80 **	-46.44 **	-0.62 NS	80.13 **	24.15 **
L_9 x T_4	18.95 **	10.24 **	13.94 **	-5.10 **	-45.42 **	1.29 NS	-27.96 **	-16.28 *

The magnitude of heterosis provides a basis for genetic diversity and a guide to the choice of parents for developing superior F_1 hybrids, so as to exploit hybrid vigour and or for building better gene pools to be employed in population improvement (Gupta *et al*., 2006). The estimates of heterosis for growth, quality, mosaic disease incidence and yield traits are presented in Table 2.

In this investigation, out of 36 hybrids, 18 showed significant positive heterosis and ten had significant negative heterosis over better parent for the trait vine length. The extent of heterosis over better parent was -25.88 (L_9 x T_3) to 33.73 (L_8 x T_2) per cent. Among the 36 hybrids 14 showed significant positive heterosis over standard variety and the extent of heterosis over standard variety ranged between -38.54 (L_9 x T_3) and 14.15 (L_2 x T_3) per cent. With respect to ascorbic acid content, the positive relative heterosis was observed in 20 hybrids. A total of 12 hybrids showed positive heterobeltiosis. The highest heterobeltiosis value was 34.15% (L_8 x T_3). The highest standard heterosis was recorded in L_6 x T_1 (46.53%). Twenty five hybrids registered significant and positive standard heterosis.

In respect to mosaic disease incidence, all the hybrids showed significant negative heterosis over better parent. Heterobeltiosis ranged from -94.90 (L_4 x T_1) to -17.18 (L_2 x T_2) %. The magnitude of heterosis over standard variety was in the range of -86.85 (L_7 x T_2) to 28.65 (L_1 x T_3) %. Twenty seven hybrids exhibited significant negative heterosis in desirable direction. For the trait yield per vine, the hybrid obtained from the cross L_8 x T_3 (141.39%) registered the highest magnitude of heterosis in positive direction followed by L_6 x T_3 (139.27 %). The per cent heterosis of F_1s over better parent value ranged from -108.31 (L_7 x T_2) to 133.00 % (L_6 x T_2). Among them, 26 crosses exhibited significant positive heterosis over better parent. The hybrid obtained from the cross L_6 x T_2 (133.00 %) registered the highest magnitude of heterosis in positive direction followed by L_6 x T_3 (125.7%).

Table 2. General combining ability effects of parents

Parents	Vine length (cm)	Ascorbic acid (mg.100g^{-1})	Mosaic disease incidence	Yield (kg vine^{-1})
Line				
L_1	0.50 *	1.22 **	5.48 **	-5.49 **
L_2	5.19 **	0.41 **	0.90 **	-2.35 **
L_3	-1.16 **	-0.38 **	3.38 **	-3.10 **
L_4	4.78 **	0.20 *	-2.95 **	3.37 **
L_5	-1.91 **	-0.30 **	-1.04 **	3.52 **
L_6	-2.41 **	3.54 **	-2.81 **	2.68 **
L_7	1.34 **	0.39 **	-2.40 **	2.46 **
L_8	-0.41	-3.60 **	-2.96 **	-0.04 NS
L_9	-5.91 **	-1.48 **	2.40 **	-1.03 **
SE	0.2329	0.0961	0.0927	0.0861
Tester				
T_1	-1.31 **	1.78 **	-0.27 **	-0.63 **
T_2	-0.12	-3.07 **	-0.27 **	-0.50 **
T_3	-0.92**	-0.42 **	0.49 **	0.68 **
T_4	2.36**	1.72 **	0.05 NS	0.46 **
SE	0.1553	0.0641	0.0618	0.0574

* Significant at 5% level ; * *Significant at 1% level

The important criterion to assess the hybrids for heterosis breeding was through better parent (heterobeltiosis) and standard variety (standard heterosis) (Allard, 1960). Though, the heterosis are important, Kadambavanasundaram (1980) suggested that the heterotic expression over standard variety should alone be given due importance for commercial exploitation of hybrid vigour. Hence, the crosses, which showed significantly higher value of standard heterosis over Kumbakonam Local (T_3) followed by Kulithalai Local (T_1) for growth, yield, quality and disease traits are taken into account. Significant heterosis over standard variety was observed for all the growth, quality, disease resistance and yield traits in L_2xT_3, L_3xT_1, L_6xT_1 and L_6xT_3 followed by L_3xT_3, L_5xT_1 and L_7xT_2 which expressed significantly high standard heterosis for all the traits. From this discussion, it is clear that the above said hybrids are highly suitable for heterosis breeding. Similar findings were reported by Banik (2003) and Rahman (2004) in snake gourd, Podder *et al*. (2010) in snake gourd, Narasannavar *et al*. (2014) in ridge gourd, and Bairwa *et al*. (2015) in ridge gourd. It can be concluded that, the hybrids L_2xT_3, L_3xT_1, L_6xT_1, L_6xT_3, L_3xT_3, L_5xT_1 and L_7xT_2 with high heterotic values for growth, quality, yield and mosaic disease incidence could be utilized successfully in further breeding programmes.

The results revealed that significant differences existed among the genotypes and the parents for all the characters (Table 2). The variance due to the lines was significant for all the traits under the study, indicating that the existence of enormous amount of genetic variability for growth, quality and yield traits among the lines (female), Similarly, testers (male) and interaction between lines x testers exhibited significant differences for all the traits (Table 3).

In the present study, the line L_4 was adjudged as the best general combiner, since it expressed significant *gca* effects for two characters *viz.,* mosaic disease incidence and fruit yield per vine. The next best general combiner was L_5 with high *gca* for fruits yield per vine. This was followed by L_6 (mosaic disease incidence), which showed good general combining ability for different traits. Among the lines, IC 308557 (L_4), IC 284753 (L_5) and IC 546083 (L_6) were also considered as good general combiners, because of high *gca* values for the growth, quality, mosaic disease incidence and yield characters. Among the testers, T_2 was adjudged to be the good general combiner, as it showed significantly favourable *gca* effect for traits such as vine length, fruit yield per vine and mosaic disease incidence. The next best was T_1 with good general combining ability for two traits *viz.,* ascorbic acid content and mosaic disease incidence. From the above points, it could be inferred that IC 308557 (L_4), IC 284753 (L_5), IC 546083 (L_6), Jeyamkondam Local (T_2) and Kulithalai Local (T_1) were the best general combiners, since they expressed good *gca* effects for majority of the growth, quality and yield characters.

These parents could be used in the breeding programme to improve yield along with quality characters. It may be inferred that the quality and yield genotypes can maintain their superiority in combining ability effects. The ratio of GCA and SCA exhibited non-additive gene action for vine length, ascorbic acid, mosaic disease incidence and yield per vine. This was also reported by Podder *et al*. (2010) in snake gourd, Narasannavar *et al*. (2014) in ridge gourd, and Bairwa *et al*. (2015) in ridge gourd. Such an absence of parallelism may be due to epistatic interactions.

Among the hybrid L_2xT_3 and L_7xT_2 excelled with superior *sca* effects for three characters *viz.,* vine length, mosaic disease incidence and fruits yield per vine. The crosses L_2xT_4, L_5xT_1 and L_8xT_4 were the next best specific combiners for all traits. In

Table 3. Specific combining ability effects of hybrids

Hybrids	Vine length (cm)	Ascorbic acid (mg.100g^{-1})	Mosaic disease incidence	Yield (kg vine^{-1})
L_1 x T_1	2.35	0.05 NS	0.75 **	-0.08 NS
L_1 x T_2	-7.39**	-1.03 **	-0.55 **	0.12 NS
L_1 x T_3	3.41**	0.57 **	0.15 NS	-2.49**
L_1 x T_4	1.63	0.42 *	-0.35 NS	-2.96 **
L_2 x T_1	2.16	0.13 NS	-0.51 **	0.10 NS
L_2 x T_2	2.47	-1.35 **	1.40 **	2.04 **
L_2 x T_3	4.82 **	0.15 NS	-0.83 **	-2.19 **
L_2 x T_4	-9.46 **	1.07 **	-0.06 NS	0.05 NS
L_3 x T_1	-1.44	-1.42 **	0.62 **	-2.96 **
L_3 x T_2	2.37	2.54 **	0.31 NS	-2.50 **
L_3 x T_3	1.17	-0.87 **	0.36 NS	1.67 **
L_3 x T_4	-2.11	-0.26 NS	-1.29 **	3.78 **
L_4 x T_1	3.62 **	-0.51 *	-0.45 *	-0.95 **
L_4 x T_2	4.18 **	0.91 **	0.62 **	0.77 **
L_4 x T_3	2.23	-0.69 **	0.13 NS	-1.15 **
L_4 x T_4	-10.04 **	0.29 NS	-0.30 NS	1.33 **
L_5 x T_1	-7.69 **	-1.33 **	1.09 **	1.18 **
L_5 x T_2	5.12 **	2.47 **	-0.84 **	1.61 **
L_5 x T_3	3.92 **	-1.10 **	-0.63 **	-0.57 **
L_5 x T_4	-1.36	-0.04 NS	0.38 *	-2.22 **
L_6 x T_1	-1.19	0.96 **	-0.60 **	-1.43 **
L_6 x T_2	-12.38 **	-1.05 **	0.04 NS	1.52 **
L_6 x T_3	7.42 **	0.31 NS	0.63 **	2.48 **
L_6 x T_4	6.14 **	-0.22 NS	-0.07NS	-2.57 **
L_7 x T_1	2.06	0.14 NS	1.87 **	4.26 **
L_7 x T_2	3.87 **	-1.06 **	-1.52 **	-2.49 **
L_7 x T_3	-4.33 **	0.05 NS	-0.93 **	-1.52 **
L_7 x T_4	-1.61	0.87 **	0.59 **	-0.25 NS
L_8 x T_1	-5.19 **	0.18 NS	-0.63 **	-3.25 **
L_8 x T_2	6.62 **	-1.18 **	0.26NS	-1.83 **
L_8 x T_3	-7.58 **	0.27 NS	0.51 **	2.99 **
L_8 x T_4	6.14 **	0.74 **	-0.14 NS	2.09 **
L_9 x T_1	5.31 **	1.79 **	-2.13 **	3.12 **
L_9 x T_2	-4.88 **	-0.24 NS	0.29 NS	0.76 **
L_9 x T_3	-11.08 **	1.32 **	0.61 **	-1.47 **
L_9 x T_4	10.64 **	-2.87 **	1.23 **	-2.42 **
SEd	0.4658	0.1923	0.1854	0.1723

* Significant at 5% level   * *Significant at 1% level

general, among the 36 hybrids studied, the hybrids L_2xT_3, L_7xT_2, L_2xT_4, L_5xT_1 and L_8xT_4 were the good specific combiners for majority of growth, quality and yield characters. The *sca* effects of hybrids have been attributed to the combination of positive favourable genes from different parents or might be due to the presence of linkage in repulsion phase (Sarsar *et al.,* 1986). Hence, selection of hybrids based on *sca* effects would excel in their heterotic effect. Similar results were obtained by Podder *et al*. (2010) in snake gourd, Narasannavar *et al*. (2014) in ridge gourd, and Bairwa *et al*. (2015) in ridge gourd found that these yield and yield contributing trait was under the control of non-additive gene action.

Hence, this cross can be utilized for breeding programme to evolve high yielding varieties. The crosses, L_2xT_3, L_7xT_2, L_2xT_4, L_5xT_1, and L_8xT_4 recorded significant sca effects and the gene action might be of additive type of epistasis. These crosses also can be utilized for breeding programme. However, selection should be postponed to later generation due to the presence of additive type of epistatic gene action.

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References

Ahmed, A.M., T. P. Reddy and G. Neeraja. 2004. Heterosis for fruit yield and yield components in ridge gourd [*Luffa acutangula* (Roxb.) L.]. *Journal of Research ANGRAU.* **34(1):** 15-20.

Allard, R.W. 1960. Principles of plant breeding. John Wiley and Sons. *Inc.,* U.S.A. p.485.

Bairwa, S. K., A. K, Soni, B. Singh and P. K. Yadav. 2015. Combining ability studies in ridge gourd [*Luffa acutangula* (Roxb.) L.]. *The Bioscan* **10(4):** 1969-1974

Banga, S.S. 2012. Germplasm enhancement in indian mustard: some exiting new developments. In: “Souvenir of XIX Annual AICRP Group Meet on Rapeseed-Mustard”, Birsa Agricultural University, Ranchi, India pp. 29-34.

Banik, B.R. 2003. Variability, gene action and heterosis in snake gourd (*Trichosanthes anguina* L.). Ph.D. Dissertation. Department of Genetics and Plant Breeding, BSMRAU, Salna, Gazipur, Bangladesh.

Crop Production Techniques of Horticultural Crops, Tamil Nadu Agricultural University, 2013.

Kadambavanasundaram, M. 1980. Heterotic system in cultivated species of Gossypium. An appraisal (Abst). Genetic and crop improvement of heterotic systems. **In:** Pre-congress scientific meeting of XV International Congress of Genetics, TNAU, Coimbatore, pp.20.

Kempthorne, O. 1957. An introduction to genetic statistics. *J. Wiley and Sons, Inc.,* New York.

Mather, K. and J.L. Jinks. 1971. Biometrical Genetics. Chapman and Hall, New York.

Meena, H. S., A. Kumar, B. Ram, V. V. Singh, P. D. Meena, B. K. Singh, and D. Singh. 2015. Combining ability and heterosis for seed yield and its components in Indian Mustard (*Brassica juncea* L.). *Journal of Agricultural Science and Technology* **17:** 1861-1871.

Narasannavar, A.R., V. D. Gasti, T. Shantappa, R. Mulge, T. B. Allolli. and N. Thammaiah. 2014. Heterosis studies in ridge gourd [*Luffa acutangula* (L.) Roxb.] *Karnataka J. Agric. Sci*., **27 (1):** (47-51.

Pali, V and N. Mehta. 2014. Combining ability and heterosis for seed yield and it’s attributes in Linseed (*Linum usitatissimum* L.). *The Bioscan.* **9(2):** 701-706.

Podder, R., M. G. Rasul, A.K.M.A. Islam, M. A. K. Mian. and J. U. Ahmed. 2010. Combining ability and heterosis in snake gourd (*Tricosanthes cucurminata* L). *Bangladesh J. Pl. Breed. Genet.,* **23(2):** 01-06.

Rahman, A. K. M. M. 2004. Genotype-environment interaction, heterosis and sex modification in snake gourd (*Trichosanthes anguina* L.). Ph. D. Department of Genetics and Plant Breeding, BSMRAU, Salna, Gazipur, Bangladesh.

Sarsar, S.M., B.A. Patil. and S.S. Bhatade. 1986. Heterosis and combining ability in upland cotton. *Indian Journal Agricultural Science*. **56 (8):** 567-573.

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