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# HETEROSIS IN SNAKEGOURD (*Trichosanthes cucumerina* L.)

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**Abstract**

Five parents of snakegourd were crossed in a half diallel fashion to determine the magnitude of heterosis for eight important yield related characters during summer season. Both positive and negative heterosis was obtained of which few hybrids showed desirable and significant values. The cross combination $P_2 \times P_5$ (SG004 × SG025) showed the highest significant mid parental heterotic effect for earliness, fruit diameter, total fruit per plant and fruit yield per plant. Moreover, the cross combinations $P_1 \times P_2$ (SG001 × SG004), $P_2 \times P_3$ (SG004 × SG007) and $P_2 \times P_5$ (SG004 × SG025) showed the highest significant better parent heterosis effect for earliness which was reflected from days to first male and female flower, node number for first female flower. On the other hand, the hybrid $P_3 \times P_4$ (SG007 × SG018) showed the highest better parent heterosis for fruit yield per plant. These crosses could be used for exploitation of heterosis in snakegourd.

**Keywords**: Snakegourd (*Trichosanthes cucumerina* L.), yield, average heterosis, heterobeltiosis.

## Introduction

Snakegourd (*Trichosanthes cucumerina* L.) is a common annual creeper and cultivated in various parts of Bangladesh. Vegetables are cultivated in only 1.8 per cent of the total cultivatable land. Vegetable production has increased five times in the past 40 years in Bangladesh which has scored 3rd in global vegetable production, next to China and India (FAO, 2015). Summer vegetables area usually cover about 38% of the total vegetable area (BBS, 2016) of which snakegourd is an important vegetable crops in this country. A lean period at the end of winter and beginning of summer seasons when there is always a scarcity of vegetables in this country. Vegetable scarcity during that gap period can be ameliorated to some extent through improvement of cucurbitaceous crops like snakegourd.

Snake gourd is grown well from March to October both in the field and homestead garden. As a result, it can meet up the vegetable demand during early kharif season (mid March to mid June) when there is exists a scarcity of vegetable production in Bangladesh. In addition, it has got tremendous export potentiality because of its excellent keeping quality. The yield of snakegourd is very poor and its production is also restricted to only 3-4 months in Bangladesh. There is one recognized variety of snakegourd (BU Chichinga 1) released from Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). Beside that a number of cultivars with wide range of variability in size, shape and color

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of fruits are available in this country (Rashid, 1993). The available cultivars are either deep green, green or white fruited. Considering the all above opportunity to get benefit from this crop several research works are being exploited now in BSMRAU, Bangladesh Agricultural Research Institute (BARI) and other non government organization. Present harvestable yield of snakegourd is very low (6.20 t/ha) due to unavailability of high yielding variety (BBS, 2017).

Heterosis or hybrid vigor can play a vital role in increasing the yield and quality of vegetable crops. In cucurbits, heterosis was first noted by Hays and Jones (1961). Snakegourd is monoecious and highly cross-pollinated in nature. Such pollination mechanism can be exploited for the production of hybrid variety. Several workers reported heterosis for different traits in cucurbits (Ahmed, 1998; Banik, 2003 and Rahman, 2004). At present, in most advanced and developing countries of the world like USA, Japan, Netherlands, Taiwan, Thailand etc. almost all common varieties of vegetable crops are being replaced by $F_1$ hybrids. There is limited information available about the magnitude and nature of heterosis for yield and yield contributing characters in snakegourd as it is an underutilized crop. Due to monoecism, much scope for exploitation of heterosis in snakegourd exists virtually obligatory out crossing system of snakegourd open the scope of hybrid variety. In spite of that, a few numbers of superior hybrid varieties have been developed for cultivation in different countries like India, Thailand etc. However, very little attention has been given to develop high yielding hybrid variety of snakegourd. Therefore, the present research was undertaken to determine the magnitude of heterosis in snakegourd for developing high yielding snakegourd varieties or hybrid variety in Bangladesh.

## Materials and Methods

The experiment was conducted at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh. Five parents ($P_1$=SG-001, $P_2$=SG-004, $P_3$=SG-007, $P_4$=SG-018 and $P_5$=SG-025) and their 10 $F_1$s were used as an experimental materials. Seeds were first allowed to soak in water for 24 hours followed by sown in polythene bag (size 15 × 15 cm) containing a mixture of soil and well decomposed cow dung (1:1). The experiment was laid out in a randomized complete block design (RCBD) with four replications. Final land and bed preparation was done about one week before the pit preparation. One seedling was transplanted in each pit after 25 days of seed sowing in poly bag. Recommended doses of manure and fertilizers were applied in the experimental field (BARI, 1991). Intercultural operations like irrigation, weeding, stacking etc. were done according to schedule and as necessary. Data were collected on each of the five parents and their $F_1$s for the characters days to male flower, days to female flower, node number of female flower, node number of male flower, fruit length (cm), fruit diameter (mm), average fruit weight (g), total number of fruits per plant, and fruit yield per plant (kg). Heterosis was recorded as mid parent heterosis (Hm) and better parent heterosis (Hb) according to the formula adopted by Falconar and Mackay (1996) and was estimated following Mather and Jink (1971). The significant test (t-test) was employed following given formula whether $F_1$ hybrid mean were statistically different from mid parent and better parent values (Singh and Choudhary, 2006).

## Results and Discussion

Mean performance of five parents and their 10 hybrids for eight characters are presented in Table 1. The estimates of mid parent and better parent heterosis observed in the $F_1$ generation are presented in Table 2 and Table 3, respectively. Both positive and negative heterosis was obtained for different characters of hybrids of which a few hybrids showed desirable and significant values (Table 2). In case of mid parent heterosis, most of the crosses were earlier than their mid parent except $P_1 \times P_3$ and $P_2 \times P_4$ for first male flower opening. Heterosis for earliness ranged from -1.42 to -21.18 percent (Table 2). The highest and significant negative heterosis (-21.18%) for days to first male flowering was from the hybrid $P_2 \times P_5$ followed by $P_1 \times P_2$ (-19.59). Days to first flowering is an important character as it reflects earliness or lateness of parents and their hybrids which has great importance in breeding for earliness in any crop species. In case of better parent heterosis, both positive and negative heterosis was observed in this trait. Among the ten crosses, eight crosses were earlier than their better parent where $P_1 \times P_2$, $P_1 \times P_4$, $P_1 \times P_5$, $P_2 \times P_3$, $P_2 \times P_5$ and $P_3 \times P_5$ were statistically significant. Other two crosses showed late than their better parent did. Positive heterosis ranged from 0.88% to 6.17% and negative heterosis ranged from -5.17 to -30.24. The highest negative heterobeltiotic effect (-30.24%) was found for this character in hybrid $P_1 \times P_2$. Mid parent and better parent heterosis for earliness in female flowering ranged from -0.64 to -20.08% and -3.00% to -26.2%, respectively (Table 2). The highest

**Table 1. Mean performance for eight characters of 5 × 5 diallel population in snakegourd**

| Parents / Hybrids | Days to male flower | Days to female flower | Node number of female flower | Node number of male flower | Fruit length (cm) | Fruit diameter (cm) | Number of fruits per plant | Fruit yield per plant (kg) |
|---|---|---|---|---|---|---|---|---|
| $P_1$ | 41.62 | 47.50 | 21.37 | 12.63 | 44.54 | 37.34 | 235.23 | 17.25 |
| $P_2$ | 56.65 | 58.25 | 20.62 | 13.00 | 20.16 | 41.73 | 162.08 | 15.00 |
| $P_3$ | 44.50 | 48.37 | 19.37 | 11.50 | 27.54 | 42.72 | 177.87 | 11.37 |
| $P_4$ | 52.37 | 50.12 | 23.25 | 16.65 | 21.56 | 48.75 | 164.02 | 18.62 |
| $P_5$ | 53.12 | 53.75 | 26.25 | 18.87 | 28.18 | 39.17 | 151.39 | 16.00 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** |
| $P_1 \times P_2$ | 39.50 | 43.37 | 21.50 | 11.87 | 27.05 | 41.72 | 166.62 | 12.00 |
| $P_1 \times P_3$ | 47.23 | 53.00 | 20.00 | 13.12 | 24.75 | 40.16 | 180.53 | 17.25 |
| $P_1 \times P_4$ | 37.50 | 48.5 | 22.50 | 8.50 | 35.50 | 36.02 | 170.23 | 17.87 |
| $P_1 \times P_5$ | 39.75 | 47.62 | 21.00 | 12.62 | 32.52 | 39.08 | 196.21 | 18.25 |
| $P_2 \times P_3$ | 41.62 | 43.00 | 18.37 | 9.20 | 26.84 | 44.28 | 187.49 | 12.12 |
| $P_2 \times P_4$ | 57.12 | 56.50 | 25.50 | 15.25 | 17.45 | 44.01 | 143.37 | 8.63 |
| $P_2 \times P_5$ | 43.25 | 44.75 | 17.87 | 15.00 | 26.74 | 45.57 | 195.78 | 16.00 |
| $P_3 \times P_4$ | 47.75 | 47.12 | 22.12 | 12.50 | 27.84 | 45.34 | 225.63 | 13.50 |
| $P_3 \times P_5$ | 46.00 | 46.87 | 22.00 | 14.00 | 25.63 | 41.83 | 189.98 | 14.75 |
| $P_4 \times P_5$ | 50.37 | 45.75 | 22.50 | 14.62 | 22.31 | 46.81 | 94.63 | 16.50 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** |
| Mean | 46.56 | 48.96 | 21.61 | 13.29 | 27.24 | 42.30 | 176.07 | 15.01 |
| SE(±) | 1.62 | 1.18 | 0.60 | 0.68 | 1.70 | 0.92 | 8.69 | 0.75 |

**Table 2. Percent mid parent and better parent heterosis for flowering characters in snakegourd**

| Crosses | Days to male flower | | Days to female flower | | Node number of female flower | | Node number of male flower | |
|---|---|---|---|---|---|---|---|---|
| | MP | BP | MP | BP | MP | BP | MP | BP |
| $P_1 \times P_2$ | -19.59** | -30.2** | -17.96** | -25.6** | 2.38 | 0.58 | -7.32 | -8.65 |
| $P_1 \times P_3$ | 9.73** | 6.17 | 10.56** | 9.56** | -1.84 | -6.43 | 8.80 | 0.96 |
| $P_1 \times P_4$ | -20.22** | -28.4** | -0.64 | -3.24 | 0.84 | -3.25 | -41.88** | -32.6* |
| $P_1 \times P_5$ | -16.09** | -25.2** | -5.9** | -11.4** | -11.8 | -20.00** | -19.84** | -24.06 |
| $P_2 \times P_3$ | -17.67** | -26.5** | -19.34** | -26.2** | -8.12 | -10.99 | -24.89** | -29.23 |
| $P_2 \times P_4$ | 4.816 | 0.88 | 4.26** | -3.04 | 16.24** | 9.67 | 2.95 | -8.27 |
| $P_2 \times P_5$ | -21.18** | -23.6** | -20.08** | -23.2** | -23.73** | -31.9** | -5.09 | -19.87 |
| $P_3 \times P_4$ | -1.42 | -8.83 | -4.32** | -5.98 | 3.812 | -4.8 | -11.1 | -24.8** |
| $P_3 \times P_5$ | -5.76 | -13.4** | -8.2** | -12.7** | -3.56 | -16.19 | -7.82 | -25.8** |
| $P_4 \times P_5$ | -4.51 | -5.17 | -11.92** | -14.88 | -9.09 | -14.28 | -17.61** | -22.5** |

* = *P< 0.05*, ** = *P < 0.01*; MP= mid parent; BP= better parent

significant negative mid parent heterosis was found in the cross combination $P_2 \times P_5$ (-20.08%) followed by $P_2 \times P_3$ (-19.34%). Pal *et al.* (1983) found similar phenomenon in bitter gourd which might be used in future breeding program to exploit heterosis for earliness in flowering. Out of ten $F_1$ hybrids, only one showed significant positive heterosis in case of better parent heterosis. The maximum desired heterobeltiotic effect was observed by the hybrid $P_2 \times P_3$ (-26.2%) followed by $P_1 \times P_2$ (-25.6%) for this trait.

Only two crosses were significantly different than the mid parent for number of node for female flowering. Mid parent heterosis for earlier female flower node number varied from -1.84 to 16.24 percent (Table 2). The highest negative mid parent heterosis was observed in hybrid $P_2 \times P_5$ (-23.73%), indicating desirable combination for lesser node number to female flower. Similar findings were reported by Banik (2003) in snakegourd, Singh and Joshi (1979) in bitter gourd and Solanki *et al.* (1982) in cucumber. The cross combination $P_2 \times P_4$ exhibited highly significant and positive heterosis (16.24) for this trait. In case of better parent heterosis both positive and negative heterosis was observed for this trait. The positive heterosis ranged from 0.58 to 9.67% and negative heterosis ranged from -3.25 to -31.9 percent. The most desirable combination for this trait was $P_2 \times P_5$. Heterosis for node number for male flower ranged from -5.09 to -41.88 percent. The highest mid parental heterotic effect (-41.88%) for this trait was found in $P_1 \times P_4$ followed by $P_2 \times P_3$ and $P_1 \times P_5$. For better parent heterosis, both significant positive and negative heterosis over better parent was observed. The highest desirable heterobeltiotic effect (-32.67%) was found in the cross combination $P_1 \times P_4$. Similar results were found by Banik (2003) and Rahman (2004) in snake gourd and Singh and Joshi (1979) in bitter gourd.

Out of ten cross combinations only four hybrids ($P_1 \times P_4$, $P_2 \times P_3$, $P_2 \times P_5$ and $P_3 \times P_4$) exhibited significant and positive heterosis for fruit length (Table 3 and Fig. 1) and others

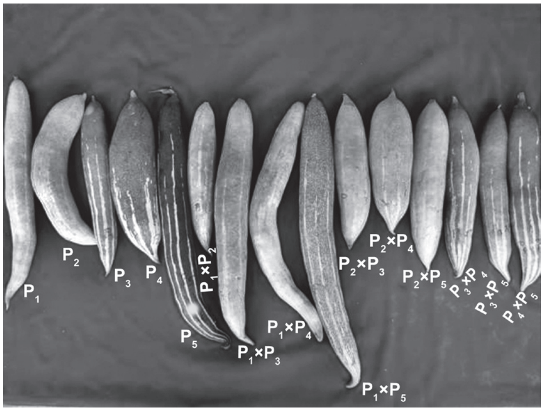


**Fig. 1. Different fruit morphotypes of five parents ($P_1$= SG001, $P_2$= SG004, $P_3$=SG007, $P_4$= SG018 and $P_5$= SG025) and ten $F_1$'s (a = $P_1 \times P_2$, b=$P_1 \times P_3$, c= $P_1 \times$ P4, d = $P_1 \times P_5$, e = $P_2 \times P_3$, f = $P_3 \times P_4$, g = $P_2 \times P_5$, h = $P_3 \times P_4$, i = $P_3 \times P_5$, j = $P_4 \times P_5$).**

showed significant and negative heterosis over mid parent heterosis. The highest mid parent heterotic effect was observed in hybrid $P_1 \times P_4$ (14.33%) followed by $P_3 \times P_4$ (13.42%) and $P_2 \times P_3$ (12.55%). These hybrids might be used in future breeding program to exploit heterosis for larger fruit size. Seven cross combinations showed significant and negative heterosis for this trait and others showed non-significant positive or negative heterosis in case of better parent heterosis (Table 3). The negative heterosis ranged from -2.53 to -38.9% and only hybrid $P_3 \times P_4$ showed non-significant and positive heterosis. Ahmed (1998) reported both positive and negative heterosis over better parent for fruit length in snakegourd.

Three hybrids ($P_1 \times P_4$, $P_2 \times P_5$ and $P_4 \times P_5$) exhibited significant mid parent heterosis, but the highest significant and positive mid parent heterosis was shown by the cross combination $P_2 \times P_5$, which can be used as a desirable combination for large fruit. In case of better parent heterosis, the hybrids $P_1 \times P_4$, $P_2 \times P_4$ and $P_2 \times P_5$ exhibited significant heterosis, but the highest significant and positive better parent heterosis was found in the cross combination $P_2 \times P_5$ for large fruit.

None of the cross combination exhibited significant and positive heterosis over mid

**Table 3. Percent mid parent and better parent heterosis for yield related characters in snakegourd**

| Crosses | Fruit length | | Fruit diameter | | Total number of fruits per plant | | Fruit yield per plant | |
|---|---|---|---|---|---|---|---|---|
| | MP | BP | MP | BP | MP | BP | MP | BP |
| $P_1 \times P_2$ | -10.87** | -33.3** | 5.5 | -0.03 | -19.32 | -30.44** | -23.56 | -43.6** |
| $P_1 \times P_3$ | -27.29** | -38.9** | 0.3 | -5.99 | 7.39 | 0.00 | -6.00 | -19.12 |
| $P_1 \times P_4$ | 14.33** | -12.4** | -16.3** | -26.1** | -1.87 | -5.07 | -25.9** | -37.3** |
| $P_1 \times P_5$ | -5.3** | -19.8** | 2.1 | -0.2 | 9.77 | 5.80 | 3.51 | -13.87 |
| $P_2 \times P_3$ | 12.55** | -2.53 | 4.8 | 3.7 | -11.41 | -18.48 | 3.66 | -13.90 |
| $P_2 \times P_4$ | -16.33** | -19.1** | -2.7 | -9.7** | -39.7** | -46.51** | -43.7** | -52.5** |
| $P_2 \times P_5$ | 10.63** | -5.12 | 12.6** | 9.2** | 12.28 | 0.00 | 35.27** | 16.20 |
| $P_3 \times P_4$ | 13.42** | 1.11 | -0.8 | -7.0 | -12.90 | -16.27 | 26.13** | 23.85** |
| $P_3 \times P_5$ | -7.99** | -9.05** | 2.1 | -2.0 | -4.45 | -7.81 | 7.67 | 3.40 |
| $P_4 \times P_5$ | -10.3** | -20.9** | 6.4** | -3.9 | 2.73 | 2.32 | 10.5 | 8.04 |

* = *P< 0.05*, ** = *P < 0.01*; MP= mid parent; BP= better parent

and better parent for total number of fruits per plant (Table 3). Only one cross combination $P_2 \times P_4$ showed significant and negative heterotic value over mid parent. The range of negative heterotic value was -1.87 to -39.7 and positive heterotic value ranged from 2.73 to 12.28. In case of better parent heterosis, two cross combination ($P_1 \times P_2$ and $P_2 \times P_4$) showed significant and negative heterosis value. The cross combinations $P_1 \times P_3$ and $P_2 \times P_5$ showed no heterosis or zero heterosis. Similar results were also reported by Podder (2006) in snake gourd and Mohanty and Mishra (1999) in pumpkin.

In case of mid parent heterosis, two crosses ($P_1 \times P_4$ and $P_2 \times P_4$) showed significant and negative heterosis and two crosses ($P_2 \times P_5$ and $P_3 \times P_4$) combination showed significant and positive heterosis for fruit yield per plant. Positive heterosis ranged from 3.51 to 35.27 % (Table 3) and the cross combination $P_2 \times P_5$ showed the highest positive heterotic value (35.27%) followed by $P_3 \times P_4$ (23.85%). In case of better parent heterosis, the range of positive heterosis was 3.40 to 23.85% and three crosses out of ten showed significant and negative better parent heterosis. The cross combination $P_3 \times P_4$ showed highest positive heterotic value (23.84%). Latif (1993) reported two $F_1$ hybrids showed highly significant and positive heterosis and one showed significant and negative heterosis over its mid parental value for fruit weight in a five parent half diallel cross in ribbed gourd. Both positive and negative heterosis over better parent for yield contributing characters in snakegourd was reported by Ahmed (1998) and Sirohi and Chaudhary (1978, 1986). Banik (2003) and Rahman (2004) also found similar results in snakegourd. Therefore, the hybrids with significant positive mid and better parent heterosis might be used in future breeding program to exploit heterosis.

## Conclusion

The cross combination $P_2 \times P_5$ (SG004 × SG025) showed the highest significant mid parental heterotic effect for earliness, fruit diameter and fruit yield per plant. Again the cross combination $P_1 \times P_4$ (SG001 × SG018) also performed considerable mid parental heterotic effect for earliness and fruit length. The cross combinations $P_1 \times P_2$ (SG001 × SG004), $P_2 \times P_3$ (SG004 × SG007) and $P_2 \times P_5$ (SG004 × SG025) showed the highest significant better parent heterosis effect for earliness exhibited from days to first male and female flower, node number for first female flower. The hybrid $P_3 \times P_4$ (SG007 × SG018) showed the highest better parent heterosis for fruit yield per plant. This cross could be used for exploitation of heterosis in snakegourd.

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## Declaration

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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