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Short Communication

# Heterosis studies in ash gourd [*Benincasa hispida* (Thunb) Cogn.] for yield and related traits

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**Abstract**

Ten elite inbred lines of ash gourd (*Benincasa hispida*) were selected based on their performance and were crossed in a diallel mating system (without reciprocal crosses) to generate 45 $F_1$ hybrids. These hybrids along with the parents were grown to study heterosis in 10 yield related characters. The mid and better parent heterosis was observed to be as high as ~165% for yield per vine in DAG-6 × DAG-11. The maximum negative heterosis over the best parent for days to fruit maturity was noticed in cross DAG-2 × DAG-9 (~ –10%) indicating that it can be successfully utilized in breeding for earliness in ash gourd. Two hybrids namely, DAG-1 × DAG-5 (34.33 kg) and DAG-4 × DAG-11 (31.67 kg) recording positive heterosis over the best parent to the extent of 23.5% and 14.0% respectively for yield per vine can be utilized for commercial cultivation.

**Keywords:** Diallel crossing, Hybrid vigour, Earliness, Wax gourd.

*Benincasa* is a monotypic genus belonging to the family Cucurbitaceae with a single species, *B. hispida* (Thunb.) Cogn. It is called wax gourd, winter melon, white gourd, ash gourd, white pumpkin, ash pumpkin, Chinese preserving melon, and hairy melon (when immature). Many of these names symbolise the powdery white flakes of wax that coat the fruit surface of some cultivars. This annual vine, native to the Asian tropics (including India), is grown primarily in the Old World tropics. To a lesser extent, it is also grown in the New World for its edible fruit (Walters and Deckers-Walters, 1989). The flesh is white to pale green, with a rather bland flavor (Marr et al., 2007). In China and Southeast Asia, the mature fruits are used in preparation of soup, while fruits are cooked in curries particularly in south India (Sureja *et al.* 2006). In China, India, and Cuba, mature fruits are "candied", commonly known as "petha". In China, a canned beverage is made from the fruit and the "hairy melon" is also sliced and eaten raw or cooked (Walters and Deckers-Walters 1989). In spite of its high economic importance and availability of a considerable genetic diversity in plant and fruit characters, the genetic potentialities of ash gourd are practically unexplored and very little attempt has so far been made for its genetic improvement. A rapid improvement in ash gourd could be brought about by exploiting hybrid vigour because heterosis as high as 37.6% over the best parent was recorded earlier (Sureja et al. 2006). Therefore, the present investigation was planned to estimate the magnitude of heterosis for different quantitative traits including yield by using ten inbred lines of ash gourd.

The experimental materials consisted of ten parental lines, namely DAG-1, DAG-2, DAG-4, DAG-5, DAG-6, DAG-8, DAG-9, DAG-11, DAG-12, and DAG-13, and 45 $F_1$ hybrids obtained by diallel crossing (without reciprocals). These inbred lines were selected from the active germplasm of IARI under the series named as Delhi ash gourd (DAG) and maintained by selfing. In *kharif* 2005 the performance of the parents and 45 $F_1$ hybrids was assessed in a randomized block design with three replications in the main experimental farm of IARI, New Delhi. Seeds were sown on hills keeping a distance of 6.5 m between channels and 1.5 m between hills. The width of the irrigation channels (trenches)

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was kept at 90 cm. Recommended agronomic practices were followed throughout the growing season to raise a healthy crop. Total number of male and female flowers, days to opening of male and female flowers, node number of first female flower appearance, sex ratio, days to fruit maturity, number of fruits per vine, individual fruit weight and yield per vine were recorded on five plants (excluding the border rows). The mean values for each trait were analyzed using computer software SPAR 1 (Statistical Package for Agricultural Research Data Analysis developed at Indian Agricultural Statistics Research Institute, New Delhi).

The range of percent heterosis of 45 $F_1$ hybrids, number of heterotic crosses, and three best $F_1$ hybrids in terms of performance and heterosis for flowering and yield related traits are presented in Tables 1 and 2. Results of the present study suggest that both nature and magnitude of heterosis differ from trait to trait depending on the cross combinations. Considerable heterosis was observed in the positive and negative directions. Heterosis in negative direction is desired for characters such as vine length, days to opening of first male flower and female flower, and days to fruit maturity.

Among the 10 yield related traits, the range of heterosis was intermediate (50% to 100%) for number of fruits per vine, while it was narrow (<50%) for days to opening of first male and female flower, and days to fruit maturity. High level of positive heterosis (>100%) was exhibited for yield per vine and fruit weight over the mid parent and better parent and a considerable amount of positive mid and better parent heterosis (between 50% and 100%) was also recorded for number

Table 1. Range of heterosis, heterotic crosses and best hybrids of ash gourd for different flowering traits.

| Particulars | Days to opening of first male flower | Days to opening of first female flower | Node to first female flower | Number of male flowers/plant | Number of female flowers/plant |
|---|---|---|---|---|---|
| Range of heterosis (%) over | | | | | |
| Better parents | –10.33 to 15.54 | –12.31 to 7.75 | –20.69 to 26.00 | –33.65 to 82.50 | –56.25 to 100 |
| Mid parents | –11.57 to 8.44 | –13.80 to 4.43 | –22.47 to 14.29 | –36.64 to 66.00 | –53.33 to 100 |
| Top parents | –7.08 to 12.62 | –11.63 to 7.76 | –5.47 to 27.41 | –0.00 to 131.58 | –61.17 to 16.67 |
| No. of heterotic crosses over | | | | | |
| Better parents | 24 | 25 | 20 | 14 | 18 |
| Mid parents | 35 | 35 | 24 | 22 | 21 |
| Top parents | 19 | 29 | 4 | 0 | 4 |
| Three best $F_1$ hybrids with heterosis (%) over | | | | | |
| Better parents | | | | | |
| 1st | –10.33 (D-1 x D-5) | –12.31 (D-13 x D-5) | –20.69 (D-2 x D-8) | –33.65 (D-8 x D-11) | 100.00 (D-2 x D-6) |
| 2nd | –6.06 (D-2 x D-4) | –9.23 (D-6 x D-5) | –17.05 (D-4 x D-6) | –25.81 (D-8 x D-13) | 90.91 (D-12 x D-11) |
| 3rd | –5.83 (D-6 x D-11) | –7.75 (D-4 x D-12) | –16.47 (D-4 x D-13) | –20.00 (D-1 x D-8) | 87.50 (D-9 x D-6) |
| Mid parents | | | | | |
| 1st | –11.57 (D-1 x D-5) | –13.80 (D-13 x D-5) | –22.47 (D-2 x D-8) | –36.64 (D-8 x D-13) | 100.00 (D-12 x D-11) |
| 2nd | –7.77 (D-4 x D-12) | –10.10 (D-6 x D-5) | –17.52 (D-4 x D-13) | –33.65 (D-8 x D-11) | 100.00 (D-9 x D-6) |
| 3rd | –6.67 (D-2 x D-4) | –9.75 (D-4 x D-6) | –17.51 (D-4 x D-6) | –29.22 (D-1 x D-8) | 86.67 (D-2 x D-6) |
| Top parents | | | | | |
| 1st | –7.08 (D-4 x D-12) | –11.63 (D-2 x D-5) | –5.47 (D-2 x D-8) | – | 16.67 (D-12 x D-11) |
| 2nd | –6.06 (D-2 x D-4) | –8.52 (D-6 x D-5) | –5.47 (D-8 x D-5) | – | 11.17 (D-5 x D-11) |
| 3rd | –4.55 (D-2 x D-9) | –8.52 (D-4 x D-11) | –4.11 (D-5 x D-11) | – | 11.17 (D-4 x D-6) |
| S. E.[1] | 1.07 | 0.90 | 1.36 | 2.84 | 0.67 |

[1]Standard error (S.E.) is calculated based on the performance of 45 $F_1$ hybrids as per the heterosis (%) value.
D= Delhi ash gourd (DAG).

of fruits per vine (Table 2). Days to opening of first male and female flower and days to fruit maturity demonstrated small negative heterosis over the mid-parent and better parent. This is consistent with the observations Sureja (2003).

In the present study, DAG-2 × DAG-8 was the best heterotic combination (in terms of better parent, and mid parent heterosis and top parent heterosis) for first flowering node of male and female flowers; DAG-13 × DAG-5 and DAG-6 × DAG-5 for days to opening of first female flowers; DAG-12 × DAG-11 for sex ratio; DAG-2 × DAG-9, DAG-2 × DAG-4 and DAG-2 × DAG-1 for days fruit maturity; and DAG-1 × DAG-11 for number fruits per vine. The best $F_1$ hybrids having maximum mid-parent and better parent heterosis were DAG-6 × DAG-11 and DAG-9 × DAG-6 for fruit weight and DAG-6 × DAG-11 and DAG-12 × DAG-11 for yield per vine. DAG-1 × DAG-5 and DAG-4 × DAG-11 produced 34.33 kg and 31.67 kg fruit yield per vine displaying positive top parent heterosis of 23.5% and 14.0%, respectively. These hybrids can be commercially exploited for higher yield. Based on the combining ability (data not shown), DAG-4 was the topmost parent for total number of female flowers per vine, number of fruits per vine, fruit weight, and yield per vine; DAG-6 for number of male flower; DAG-5 for first flowering node of female flower; and days from fruit set to maturity; DAG-2 for days to opening of male and female flower; and DAG-13 for sex ratio.

The maximum negative heterosis for days to fruit maturity was obtained by the cross DAG-2 × DAG-9 (~ –10%) indicating that it can be successfully utilised in breeding for earliness in ash gourd. Two best hybrids namely, DAG-1 × DAG-5 (Fig. 1) and DAG-4 × DAG-

*Table 2.* Range of heterosis, heterotic crosses and best hybrids of ash gourd for sex ratio and yield traits.

| Particulars | Sex ratio | Number of fruits per vine | Days to fruit maturity | Fruit weight (g) | Yield per vine (kg) |
|---|---|---|---|---|---|
| *Range of heterosis (%) over* | | | | | |
| Better parents | –51.69 to 165.90 | –50.00 to 87.51 | –10.16 to 15.54 | –58.51 to 115.00 | –77.25-164.69 |
| Mid parents | –54.95 to 105.90 | –36.84 to 87.50 | –10.28 to 12.98 | –48.94 to 120.51 | –72.46-166.29 |
| Top parents | –8.71 to 165.78 | –50.00 to 25.00 | –5.08 to 15.53 | –64.69 to 19.63 | –82.43-23.36 |
| No. of heterotic crosses over | | | | | |
| Better parents | 20 | 15 | 11 | 8 | 11 |
| Mid parents | 24 | 21 | 22 | 19 | 14 |
| Top parents | 1 | 4 | 3 | 4 | 2 |
| *Three best $F_1$ hybrids with heterosis (%) over better parents* | | | | | |
| 1st | –59.59 (D-12 x D-11) | 11.67 (D-4 x D-6) | –10.16 (D-2 x D-9) | 115.00 (D-6 x D-11) | 164.69 (D-6 x D-11) |
| 2nd | –37.75 (D-6 x D-11) | 87.50 (D-5 x D-11) | –8.93 (D-4 x D-6) | 81.82 (D-9 x D-6) | 128.23 (D-12 x D-11) |
| 3rd | –30.00 (D-2 x D-6) | 50.00 (D-1 x D-5) | –8.29 (D-2 x D-4) | 72.33 (D-2 x D-11) | 94.64 (D-9 x D-6) |
| Mid parents | | | | | |
| 1st | –54.95(D-12 x D-11) | 87.50 (D-5 x D-11) | –10.28 (D-2 x D-9) | 120.51 (D-6 x D-11) | 166.29 (D-6 x D-11) |
| 2nd | –40.46(D-6 x D-11) | 62.50 (D-9 x D-6) | –10.27 (D-2 x D-1) | 95.12 (D-9 x D-6) | 141.88 (D-12 x D-11) |
| 3rd | –34.50(D-2 x D-6) | 50.00 (D-2 x D-11) | –10.09 (D-2 x D-4) | 74.88 (D-2 x D-11) | 107.62 (D-1 x D-11) |
| Top parents | | | | | |
| 1st | –8.71 (D-12 x D-11) | 25.00 (D-5 x D-11) | –5.00 (D-2 x D-9) | 19.63 (D-1 x D-5) | 23.50 (D-1 x D-5) |
| 2nd | – | 8.25 (D-8 x D-13) | –3.11 (D-2 x D-4) | 10.59 (D-4 x D-11) | 14.00 (D-4 x D-11) |
| 3rd | – | 8.25 (D-4 x D-12) | –2.54 (D-2 x D-1) | 1.27 (D-1 x D-6) | – |
| S. E.[1] | 3.38 | 32.13 | 1.51 | 0.39 | 1.97 |

[1]Standard error (S.E.) is calculated based on the performance of 45 $F_1$ hybrids as per the heterosis (%) value.
D= Delhi ash gourd (DAG).

*Figure 1.* Fruits of $F_1$ cross DAG-1 × DAG-5 (oblong, 26.0 cm long and 29.0 cm diameter, with average fruit weight of 8.5 kg).

11 (Fig. 2) displaying positive top-parent heterosis 23.50% and 14.00%, respectively for yield per vine can be taken up for commercial cultivation.

## References

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*Figure 2.* Fruits of $F_1$ cross DAG-4 × DAG-11 (oblong, 24.50 cm long and 32.0 cm diameter, with average fruit weight of 7.8 kg).

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