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Heterosis Studies in Bottle Gourd [*Lagenaria siceraria* (Mol) Standl]

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Abstract

Forty five F_1 hybrids developed from a diallel set involving ten parents (excluding reciprocals) in bottle gourd were evaluated in randomized block design with two replications during *kharif* 2016 at the Main Vegetable Research Station, Anand Agricultural University, Anand. This study was aimed to study the extent of heterosis over better parent and standard check NDBGH 4. Analysis of variance indicated presence of considerable variability among genotypes for all the characters under study. The cross combinations ABGS 11-23 x DBG 5, ABG 1 x Arka Bahar and DBG 6 x DBG 5 showed highly positive significant heterosis over standard check for fruit yield per plant. While, crosses ABGS 11-22 x Punjab Komal and DBG 6 x Punjab Komal showed significant negative heterosis over standard check for earliness.

Keywords

Bottle gourd; Heterosis; Hybrid

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol) Standl] is one of the most important cucurbitaceous vegetables due to prolific bearing habit, low cost of cultivation and its utility as a cooked vegetable. It is the only cultivated species among the six species of *Lagenaria* having a somatic chromosome number 2n = 2x = 22. Considerable genetic diversity exists in this crop, which can be utilized for the exploitation of hybrid vigour. The size of the flower and monoecious condition makes the hybridization easy and convenient in this crop. The fruits being larger in size contain many seeds per fruit. The amount of cross pollination ranges from 60 to 80 per cent [1]. Hence, the present investigation was taken up to find out the best Heterotic combination for exploitation of heterosis in bottle gourd.

Materials and Methods

The experimental material comprised of 10 diverse parents *viz.*, ABG 1, ABGS 11-17, ABGS 11-22, ABGS 11-23, DBG 6, Pusa Naveen, PSPL, Arka Bahar, DBG 5 and Punjab Komal. The crosses were made in diallel fashion excluding reciprocals, during *kharif* 2015. The Forty five F_1 hybrids along with their 10 parents and one standard check NDBGH 4 were evaluated in randomized complete block design with two replications. Each entry was sown in a single row accommodating seven plants with inter and intra row spacing of 2 and 1 meter, respectively at the Main Vegetable Research Station, Anand Agricultural University, Anand. This was done during *kharif* 2016. Recommended cultural practices were adopted to raise the crop. Observations were recorded on net five plants in each experimental unit for five maturity characters *viz.*, days to opening of first male flower, days to opening of first female flower, first male flowering node number, first female flowering node number and days to first picking from the date of sowing. Four quality characters *viz.*, total soluble solids (˚Brix), total sugar content (%), total chlorophyll content (mg/100 g) and fruit yield per plant (kg) were analysed. The analysis of the variance technique reviewed by Panse and Sukhatme were followed to test the significant difference between the genotypes for all the characters [2]. Magnitude of heterosis was calculated as percentage of F_1 performance in favourable direction over better parent and standard check NDBGH 4.

Results and Discussion

The analysis of variance (Table 1) indicated that the mean square due to genotypes were highly significant for all characters under study. The mean square differences among parents were found to be highly significant for all the traits except for days to first picking. This indicates the presence of variability among parents. Significant differences were observed among hybrids for all the characters. The range of heterosis by hybrids over their better parent and standard check NDBGH 4 were analysed. Number of hybrids showing significant desirable heterosis over better parent and standard check NDBGH 4 and superior crosses based on estimates of heterobeltiosis and standard heterosis are presented in Table 2. The negative estimates of heterosis were considered desirable for all maturity traits *viz.*, days to opening of first male flower, days to opening of first female flower, first male flowering node number, first female flowering node number and days to first picking, whereas for remaining four characters, positive estimates of heterosis was considered favourable.

For the fruit yields per plant, the estimates of heterosis ranged from -68.12 to 79.55% and -48.31 to 125.23% over better parent and standard check, respectively. Out of 45 crosses, 10 and 28 crosses recorded significant positive Heterobeltiosis and standard heterosis, respectively. The hybrid ABG 1 x Arka Bahar (79.55%) registered the highest heterosis over better parent followed by ABGS 11-23 x DBG 5 (60.53%) and ABG 1 x DBG 6 (47.52%). Whereas, the hybrid ABGS 11-23 x DBG 5 (125.23%) exhibited the maximum heterosis over standard check NDBGH 4 followed by ABG 1 x Arka Bahar (94.46%) and DBG 6 x DBG 5 (92.00%). Similar results were reported earlier by Dubey and Ram, Kumar et al., Singh et al., Janaranjani et al., Ray et al., Ghuge et al. and Adarsh et al. [3-9].

The extent of heterosis from days of opening of first male flower varied from -5.16 to 14.63% over better parent and -11.95 to 7.08% over standard check. Only 1 cross, ABG 1 x ABGS 11-22 (-5.16%) showed significant negative heterosis over better parent, while, crosses ABGS 11-22 x Punjab Komal and DBG 6 x Punjab Komal registered highest negative standard heterosis followed by Arka Bahar x Punjab Komal (-11.50%). These results were in accordance with findings of Singh et al. [10] and Singh et al. [11]. The estimates of heterosis for days to opening of first female flower, ranged from -8.45 to 21.83 %

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Table 1: Analysis of variance for nine characters in bottle gourd. *, ** significance at 5% and 1%, respectively.

Character	Source of variation						
	Replications	Genotypes	Parents	Hybrids	Parents vs. Hybrids	Check vs. Hybrids	Error
	[1]	[55]	[9]	[44]	[1]	[1]	[55]
Fruit yield per plant	1.05	3.22**	3.51**	3.21**	0.78	3.15**	0.37
Days to opening of first male flower	1.56	9.06**	15.63**	7.96*	0.12	7.18	4.70
Days to opening of first female flower	0.33	13.26**	24.13**	11.30**	5.91	9.64	5.62
First male flowering node number	36.13**	13.00**	14.14**	12.11**	46.80**	5.58	1.96
First female flowering node number	16.73*	16.29**	20.61**	15.25**	35.67**	2.09	2.90
Days to first picking	73.94*	31.08**	11.31	36.37**	7.03	0.13	11.14
Total soluble solids	0.03	0.56**	0.70**	0.47**	0.40**	3.70**	0.02
Total sugar content	0.01	1.43**	1.38**	1.36**	0.66**	5.95**	0.08
Total chlorophyll content	0.02	0.26**	0.27**	0.26**	0.0004	0.8**	0.008

Table 2: Identification of superior crosses in bottle gourd based on heterosis.

Trait	Range of heterosis % over		Superior crosses over		Superior crosses based on	
	BP (Better parent)	SC (Standard check)	BP	SC	Heterobeltiosis	Standard heterosis
FYP	-68.12 (ABGS 11-23 x PSPL) to 79.55 (ABG 1 x Arka Bahar)	-48.31 (ABGS 11-23 x PSPL) to 125.23 (ABGS 11-23 x DBG 5)	10	28	ABG 1 x Arka Bahar (79.55**) ABGS 11-23 x DBG 5 (60.53**) ABG 1 x DBG 6 (47.52**)	ABGS 11-23 x DBG 5 (125.23**) ABG 1 x Arka Bahar (94.46**) DBG 6 x DBG 5 (92.00**)
DOFMF	-5.16 (ABG 1 x ABGS 11-22) to 14.63 (ABGS 11-22 x DBG 6)	-11.95 (ABGS 11-22 x Punjab Komal, DBG 6 x Punjab Komal) to 7.08 (PSPL x Arka Bahar)	1	7	ABG 1 x ABGS 11-22 (-5.16*)	ABGS 11-22 x Punjab Komal (-11.95*) DBG 6 x Punjab Komal (-11.95*) Arka Bahar x Punjab Komal (-11.50*)
DOFFF	-8.45 (ABG 1 x ABGS 11-22) to 21.83 (ABG 1 x Punjab Komal)	-14.37 (ABGS 11-22 x Punjab Komal) to 10.27 (PSPL x Arka Bahar)	1	5	ABG 1 x ABGS 11-22 (-8.45**)	ABGS 11-22 x Punjab Komal (-14.37**) DBG 6 x Punjab Komal (-12.32*) ABGS 11-23 x DBG 6 (-11.29*)
FMFN	-20.59 (ABGS 11-22 x ABGS 11-23) to 65.41 (ABGS 11-23 x Punjab Komal)	-29.41 (DBG 6 x Pusa Naveen) to 11.31 (ABGS 11-23 x PSPL, PSPL x Arka Bahar)	2	15	ABGS 11-22 x ABGS 11-23 (-20.59**) DBG 6 x Pusa Naveen (-9.30*)	DBG 6 x Pusa Naveen (-29.41**) ABGS 11-17 x DBG 6 (-26.70**) ABGS 11-22 x ABGS 11-23 (-26.70**)
FFFN	-8.45 (ABG 1 x ABGS 11-22) to 21.83 (ABG 1 x Punjab Komal)	-26.62 (ABGS 11-23 x DBG 5) to 15.83 (ABGS 11-23 x Arka Bahar)	9	11	ABG 1 x ABGS 11-22 (-8.45**) ABGS 11-17 x Arka Bahar (-6.87**) ABGS 11-23 x DBG 6 (-5.26**)	ABGS 11-23 x DBG 5 (-26.62**) DBG 6 x Pusa Naveen (-18.71**) DBG 6 x PSPL (-17.99**)
DFP	-10.43 (ABGS 11-17 x Arka Bahar) to 22.22 (ABGS 11-23 x PSPL)	-12.39 (ABGS 11-22 x Punjab Komal) to 16.81 (ABGS 11-23 x PSPL)	6	1	ABGS 11-17 x Arka Bahar (-10.43**) ABG 1 x Arka Bahar (-9.57**) DBG 6 x DBG 5 (-8.04**)	ABGS 11-22 x Punjab Komal (-12.39*)
TSS	-50.00 (Pusa Naveen x Punjab Komal) to 70.00 (ABG 1 x Arka Bahar)	-50.00 (ABG 1 x DBG 6, ABGS 11-17 x DBG 6, ABGS 11-17 x DBG 5, PSPL x Arka Bahar) to 0.00 (ABGS 11-23 x DBG 6)	6	-	ABG 1 x Arka Bahar (70.00**) ABG 1 x DBG 5 (60.00**) ABGS 11-22 x ABGS 11-23 (34.62**)	-
TSC	-53.55 (ABG 1 x DBG 6) to 62.78 (ABG 1 x DBG 5)	-59.80 (ABG 1 x DBG 6) to 0.00 (ABGS 11-23 x DBG 6)	7	-	ABG 1 x DBG 5 (62.78**) ABG 1 x Arka Bahar (62.06**) ABGS 11-22 x ABGS 11-23 (26.63**)	-
TCC	-49.25 (ABG 1 x Pusa Naveen) to 88.07 (Pusa Naveen x Punjab Komal)	-49.50 (ABG 1 x Pusa Naveen, DBG 6 x DBG5) to 1.49 (Pusa Naveen x Punjab Komal)	12	-	Pusa Naveen x Punjab Komal (88.07**) Pusa Naveen x DBG 5 (64.23**) Pusa Naveen x Arka Bahar (59.06**)	-

*, ** significance at 5% and 1%, respectively. Traits: Fruit yield per plant (FYP), Days to opening of first male flower (DOFMF), Days to opening of first female flower (DOFFF), First male flowering node number (FMFN), First female flowering node number (FFFN), Days to first picking (DFP), Total soluble solids (TSS), Total sugar content (TSC) and Total chlorophyll content (TCC).

over better parent and -14.37 and 10.27% over standard check. The hybrid ABG 1 x ABGS 11-22 (-8.45%) depicted the highest significant heterosis over better parent. Whereas ABGS 11-22 x Punjab Komal (-14.37%) was found earliest to standard check followed by DBG 6 x Punjab Komal (-12.32%) and ABGS 11-23 x DBG 6 (-11.29%) for the trait. These findings were in accordance with the reports of Singh et al., Singh et al., Yadav and Kumar and Ghuge et al. [10-13].

For first male flowering node number, the extent of heterosis varied from -20.59 to 65.41% over better parent and -29.41 to 11.31% over standard check. The crosses showing highly significant heterobeltiosis were ABGS 11-22 x ABGS 11-23 (-20.59%) followed by DBG 6 x Pusa Naveen (-9.30%), while cross DBG 6 x Pusa Naveen (-29.41%) exhibited the maximum standard heterosis followed by

ABGS 11-17 x DBG 6 (-26.70%) and ABGS 11-22 x ABGS 11-23 (-26.70%). These results were in agreement with reports of Yadav and Kumar, Ray et al. and Ghuge et al. [7,12,13]. For first female flowering node number, the range was from -8.45 to 21.83% and -26.62 to 15.83% over better parent and standard check, respectively. The cross ABG 1 x ABGS 11-22 (-8.45%) exhibited maximum significant heterobeltiosis, followed by ABGS 11-17 x Arka Bahar (-6.87%) and ABGS 11-23 x DBG 6 (-5.26%), whereas, cross ABGS 11-23 x DBG 5 (-26.62%) exhibited maximum significant standard heterosis followed by DBG 6 x Pusa Naveen (-18.71%) and DBG 6 x PSPL (-17.99%). The findings confirmed the observations of Dubey and Maurya, Padma et al, Yadav and Kumar, Ghuge et al. and Adarsh et al. [9,12,13]. In case of first picking, heterosis varied from -10.43 to 22.22% over better parent and -12.39 to 16.81% over standard check. The highest significant heterobeltiosis in desirable direction was observed with cross ABGS 11-17 x Arka Bahar (-10.43%) followed by ABG 1 x Arka Bahar (-9.57%) and DBG 6 x DBG 5 (-8.04%). While, only one cross ABGS 11-22 x Punjab Komal (-12.39%) depicted significant standard heterosis in desirable direction. These results were in concordance to the findings of Pal et al. Dubey and Ram and Adarsh et al. [3,9].

Among quality characters, the heterotic effect in respect to better parent varied from -50.00 to 70.00% for total soluble solids, with 6 hybrids showing significant positive heterobeltiosis. Hybrid ABG 1 x Arka Bahar (70.00%) depicted highest heterobeltiosis followed by ABG 1 x DBG 5 (60.00%) and ABGS 11-22 x ABGS 11-23 (34.62%). The extent of heterosis over standard check ranged from -50.00 to 0.00%. Total 42 hybrids exhibited significant heterosis but none of them showed positive effect. These results partially confirmed the observations of Janaranjani et al. [6] as they recorded moderate estimates of standard heterosis in both the directions. The extent of heterosis for total sugar content, varied from -53.55 to 62.78% and -59.80 to 0.00% over better parent and standard check, respectively. For the total sugar content, the F1 ABG 1 x DBG 5 (62.78%) exerted the highest positive heterobeltiotic effect followed by ABG 1 x Arka Bahar (62.06%) and ABGS 11-22 x ABGS 11-23 (26.63%). Total 38 F1 hybrids exhibited significant heterosis over standard check but none of them recorded significantly desirable standard heterosis. The range of heterosis for total chlorophyll content was -49.25 to 88.07% and -49.50 to 1.49% over better parent and standard check, respectively. The F1 Pusa Naveen x Punjab Komal (88.07%) depicted the highest heterobeltiosis followed by Pusa Naveen x DBG 5 (64.23%) and Pusa Naveen x Arka Bahar (59.06%), while none of the crosses recorded significant positive standard heterosis for the trait.

The identification and utilization of the most heterotic and useful crosses are very important in hybrid approach to make the commercial cultivation of hybrid beneficial. For fruit yield the hybrids ABGS 11-23 x DBG 5, ABG 1 x Arka Bahar and DBG 6 x DBG 5 recorded the highest estimates of heterosis over standard check. The developmental characters, such as component characters of growth and earliness are important for adaptation and acceptance of the hybrids in varying ecological conditions. For earliness, the hybrid ABGS 11-22 x Punjab Komal recorded maximum significant standard heterosis in desirable direction followed by DBG 6 x Punjab Komal for days of opening first male flower to days of opening of first female flower. This continued till days of first picking. These hybrids also depicted significant estimates of standard heterosis for fruit yield per plant.

In the present study of heterosis it was observed that heterosis is not only responsible to fruit yield but also for maturity and quality traits. Crosses ABGS 11-23 x DBG 5, ABG 1 x Arka Bahar and DBG 6 x DBG 5 were found to be suitable for exploitation of yield heterosis on commercial scale. Whereas, crosses ABGS 11-22 x Punjab Komal and DBG 6 x Punjab Komal may be exploited in future breeding programmes for development of early maturing varieties.

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