Original Research Article

STUDIES ON HETEROSIS FOR YIELD AND ITS COMPONENT TRAITS IN BRINJAL (*Solanum melongena* L.)

ABSTRACT

An investigation was conducted to estimate the magnitude of heterosis in brinjal, for twenty-two characters, during *Rabi* 2021 at the Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya. 8 parental lines and the 28 F_1 hybrids obtained from the parental lines following half-diallel mating design, along with a standard variety, Pant Samrat were evaluated in randomized block design with three replications. Observations were recorded on twenty-two characters *viz*. days to 50% flowering, days to first fruit harvest, leaf area (cm²), plant height (cm), number of primary branches per plant length of fruit (cm), fruit diameter (cm), fruit length/circumference ratio, length of peduncle (cm), length of calyx (cm), number of fruits per cluster, number of fruits per plant, average fruit weight (g), fruit yield per plant (kg), crop duration, dry matter content (%), TSS (%), total phenol content (mg/100g), reducing sugars (%), non-reducing sugar (%), total sugars (%) and ascorbic acid content (mg/100g). The study revealed that significant heterobeltiosis and standard heterosis were observed for all the characters under study. The crosses P_2 x P_4 (42.42% and 25.12%) and P_1 x P_4 (41.73% and 14.15%)exhibited considerable heterosis over the better parent and the standard variety respectively, which may be commercially exploited for cultivation under sodic soils due to their high yield and desirable fruit qualities.

Keywords:*brinjal (Solanum melongena L.), heterosis, better parent, standard variety, heterobeltiosis, standard heterosis*

INTRODUCTION

Brinjal (*Solanum melongena* L., 2n=2x=24) is one of the most widely cultivated solanaceous vegetable crops in India. The fruit is botanically classified as a berry and the soft white fleshy placenta contains numerous small soft seeds embedded in it. The seeds are edible but are bitter as they contain nicotinoid alkaloids. Brinjal is referred as “vegetable of masses” as it is popular among people of all social strata (Patel *et al*., 2004).Due to the expanding population and rise in demand of the crop, there is need to further increase its productivity level. The crop improvement works in brinjal was started as early as 1900s and still exploration for a better cultivar is going on, as most of the commercial cultivars lack one or the other desirable traits (Prabakaran, 2010). Exploiting hybrid vigour has emerged as a promising approach for eggplant improvement. Nagai and Kida (1926) were the first to notice brinjal hybrid vigour. Because of the cheap cost of F_1 seed productionand the low seed demand per unit area, commercial exploitation of this phenomena has become achieved in the brinjal. With the growing popularity of F_1 hybrids in brinjal, it iscritical to obtain such hybrids with outstanding quality and high yields.

Many scientists have reported on crop manifestations of heterotic impact for many economically relevant features. It is not possible to have a single cultivar that will suit all locales and tastes. There are differences in local preferences for characteristics such as color, size, form, and flavor and there are specific germplasm suited for specific region. Therefore, it is required to improve the locally preferred varieties with high yield potential and adaptation (Akpan *et al*.,2016). In India, brinjal has a huge amount of genetic diversity for agro-morphological characters (Sidhu *et al.,*2005). This offers much scope for yield improvement through heterosis breeding. F_1 hybrids in India are more popular among farmers because of earliness, high yield potential, uniform maturity and high net return. The estimation of heterosis for fruit yield and quality parameters would be useful to judge the best hybrid combination for their commercial exploitation (Prabhu *et al.*,2005). Keeping in view the above facts, the present study was undertaken with the objective to study the manifestation of heterosis in brinjal.

MATERIALS AND METHODS

The experimental materials for this study comprised of 37 genotypes which included 8 diverse parental lines, their 28 F_1s, obtained by crossing in a half diallel fashion, and a standard variety Pant Samrat. The genotypes were evaluated in a randomized block design with three replications, following a sapcing of 60 cm x 50 cmat the Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Ayodhya (Uttar Pradesh), Standard package of practices and management measures were followed to raise the crop. Data were recorded on five randomly selected plants in each treatment over replication for all the characters studied viz. days to 50% flowering, days to first fruit harvest, leaf area (cm²), plant height (cm), number of primary branches per plant length of fruit (cm), fruit diameter (cm), fruit length/circumference ratio, length of peduncle (cm), length of calyx (cm), number of fruits per cluster, number of fruits per plant, average fruit weight (g), fruit yield per plant (kg), crop duration, dry matter content (%), TSS (%), total phenol content (mg/100g), reducing sugars (%), non-reducing sugar (%), total sugars (%) and ascorbic acid content (mg/100g). The magnitude of heterosis in hybrids was expressed as percentage of increase or decrease of a character over better parent and standard variety in the desirable direction and was calculated using the following formula as given by Hayes *et al.* (1955)

Heterobeltiosis (%)

Standardheterosis (%)

Where,

$\overline{F_1}$ = mean value of F_1

$\overline{BP}$ = mean value of better-parent and

$\overline{SV}$ = mean value of standard variety.

RESULTS AND DISCUSSION

The range of heterosis for all the twenty-two characters studied are presented in Table 1. Negative heterosis is considered best for the maturity traits such as days to 50% flowering and days to first fruit harvest as it indicates earliness. For all the other characters studied, positive heterosis is beneficial. Heterosis for fruit yield per plant ranged from -33.67 % to 42.42 % over better parent and heterosis over standard variety varied from -51.89 to 25.12%. The result revealed that significant heterosis over better and standard varieties was observed for all the traits with minimum being in crop duration. However, significant desirable heterosis over both better parent and standardvariety was not observed for crop duration and number of fruits per plant.

Table 1. Mean values of heterosis for the twenty-two characters studied

Characters	Range of Heterosis	
	Better parent	Standard variety
Days to 50% flowering	-32.33 to 1.64	-29.03 to 7.37
Days to first fruit harvest	-26.69 to 0.88	-20.54 to 15.82
Leaf area (cm²)	-45.08 to 13.25	-27.30 to 78.12
Plant height (cm)	-36.04 to 14.75	-8.44 to 45.77

No: of primary branches per plant	-29.92 to 16.17	-15.80 to 35.48
Length of fruit (cm)	-37.95 to 37.31	-10.44 to 117.31
Circumference of fruit (cm)	-44.26 to 36.51	0.46 to 112.55
Length to circumference ratio	-57.89 to 11.96	-52.56 to 65.50
Length of pedicel (cm)	-37.05 to 33.85	-37.98 to 16.24
Length of calyx (cm)	-4.36 to 44.91	-15.18 to 47.11
No: of fruits per cluster	-14.59 to 22.44	-21.04 to 5.75
Average fruit weight	-17.83 to 36.04	-24.89 to 22.89
No: of fruits per plant	-39.44 to 7.01	-44.71 to 6.67
Fruit yield per plant (kg)	-33.67 to 42.42	-51.89 to 25.12
Crop duration	-5.16 to 4.32	-6.32 to 3.66
Dry matter content	-9.13 to 24.82	-14.30 to 24.55
TSS	-17.50 to 18.18	8.23 to 19.62
Total phenol content	-47.75 to 5.23	-46.06 to 5.25
Reducing sugars	-30.36 to 13.79	0.74 to 91.88
Non-reducing sugars	-69.83 to 18.98	5.95 to 317.86
Total sugars	-29.81 to 17.87	23.38 to 115.49
Ascorbic acid content	-34.37 to 22.31	-25.91 to 56.84

Table 2 shows the best three heterotic hybrids for each of the characters. It is observed that for the characters such as leaf area and length to circumference ratio better parent heterosis is not exhibited by any of the progenies. None of the hybrids showed both significant heterobeltiosis and standard heterosis for the traits such as crop duration and number of fruits per plant.The highest percentage of heterosis among the hybrids was observed over standard variety for the non-reducing sugar content. It implied that the hybrids P_6 x P_8 (317.86), P_3 x P_8 (291.67) and P_1 x P_2 (266.67) are more promising for the content of non-reducing sugar than the standard variety, Pant Samrat. Highest percentage of heterosis over better parent was found for length of calyx (P_6 x P_7 (44.91), P_1 x P_3 (38.63), P_1 x P_4 (35.71)) and fruit yield per plant (P_2 x P_4 (42.42), P_1 x P_4 (41.73) and P_5 x P_7 (23.99). Two crosses P_1 x P_4 and P_2 x P_4 were found significantly heterotic over better as well as standard variety for fruit yield per plant. The nature and magnitude of heterosis varied for different traits in various hybrid combinations. For maturity traits, negative heterosis is usually desirable, because this will promote earliness in hybrids compared to parents, thereby increasing the productivity per day per unit area. A close examination of heterosis values of the maturity trait *i.e.,* days to 50 per cent flowering and days to first fruit harvest (table 2), revealed that thirteen and twelve F_1 hybrids respectively exhibited significant high heterosis in desirable direction over better parent. While, twenty-one and eleven crosses showed standard heterosis for days to 50% flowering and days to first fruit harvest, respectively over the standard variety. The significant heterosis for the maturity traits in desirable direction had been also reported by previous workers (Kumar *et al*., 2020; Deshmukh *et al*., 2020; Mistry *et al.,* 2018; Dishri*et al*., 2018; Sharma *et al.,* 2016; Rani *et al.,* 2016). For all the other traits, positive values of heterosis is considered and the results are in proximity to the work done by Choudhary *et al*. (2020); Bhatt *et al*. (2019); Shitap*et al.* (2017) and Galani *et al*.(2015). In general, the hybrids with significant heterosis for yield also expressed significant heterosis either for fruit weight or for fruits per plant and this was in agreement with the findings by Singh *et al*. (2021); Dutta *et al*. (2019); Patel *et al*. (2017), Dubey *et al*. (2014) and Pandey *et al*. (2019). Crosses showing heterosis for other yield component did not necessarily show heterosis for fruit yield. This showed that heterosis depends upon nicking for genes. Similar results have also been reported by Reddy and Patel *et al.* (2014) andKumar *et al*. (2013).

Table 2: Top three heterotic hybrids over better parent (BP) and standard variety (SV)

	Traits	BP	SV
1.	Days to 50% flowering	P_6 X P_7 (-32.33)	P_1 X P_2 (-29.03)
		P_3 X P_4 (-28.70)	P_4 X P_7 (-29.03)
		P_3 X P_7 (-27.35)	P_5 X P_7 (-29.03)
2	Days to first fruit harvest	P_6 X P_8 (-26.69)	P_2 X P_4 (-20.54)
		P_3 X P_8 (-20.20)	P_1 X P_4 (-19.53)
		P_5 X P_8 (-19.81)	P_1 X P_8 (-19.19)
3.	Leaf area	-	P_1 X P_3 (78.12)
		-	P_2 X P_3 (73.23)
		-	P_3 X P_6 (47.30)
4	Plant height	P_7 X P_8 (14.75)	P_1 X P_2 (45.77)
		P_6 X P_8 (14.12)	P_2 X P_4 (45.27)
		P_5 X P_7 (13.08)	P_2 X P_8 (45.18)
5	No: of primary branches per plant	P_6 X P_7 (16.17)	P_1 X P_4 (35.48)
		-	P_1 X P_2 (32.44)
		-	P_2 X P_4 (14.82)
6	Length of fruit (cm)	P_2 X P_8 (37.31)	P_2 X P_8 (117.31)
		P_2 X P_4 (35.20)	P_2 X P_4(97.01)
		P_2 X P_5 (19.50)	P_5 X P_8 (79.32)
7	Circumference of fruit (cm)	P_4 X P_8 (36.51)	P_6 X P_7 (112.55)
		-	P_1 X P_7 (107.11)
		-	P_5 X P_7 (106.31)
8	Length to circumference ratio	-	P_2 X P_8 (65.50)
		-	P_1 X P_8 (60.92)
		-	P_2 X P_4 (56.60)
9	Length of pedicel (cm)	P_5 X P_6 (33.85)	P_3 X P_6 (16.24)
		P_3 X P_6 (10.34)	-
		-	-
10	Length of calyx (cm)	P_6 X P_7 (44.91)	P_2 X P_3 (47.11)
		P_1 X P_3 (38.63)	P_3 X P_4 (35.18)
		P_1 X P_4 (35.71)	P_1 X P_3 (31.45)
11	No: of fruits per cluster	P_3 X P_6 (22.44)	--
		-	-
		-	-
12	Average fruit weight	P_2 X P_4 (36.04)	P_6 X P_7 (22.50)
		P_1 X P_4 (24.24)	P_3 X P_7 (20.61)
		-	P_2 X P_7 (18.95)
13	No: of fruits per plant	-	-
		-	-
		-	-
14	Fruit yield per plant (kg)	P_2 X P_4 (42.42)	P_2 X P_4 (25.12)
		P_1 X P_4 (41.73)	-
		P_5 X P_7 (23.99)	-
15	Crop duration	-	-
		-	-
		-	-

16	Dry matter content	P_3 X P_7 (24.82)	P_2 X P_6 (24.55)
		P_2 X P_6 (22.65)	P_2 X P_5 (17.22)
		P_3 X P_8 (21.17)	P_3 X P_7 (15.01)
17	TSS	P_5 X P_7 (18.18)	P_4 X P_8 (19.62)
		P_6 X P_7 (13.75)	P_1 X P_8(18.35)
		P_1 X P_6 (13.13)	P_4 X P_7 (18.35)
18	Total phenol content	P_2 X P_3 (5.87)	P_3 X P_8 (5.25)
		P_3 X P_7 (5.23)	P_1 X P_2 (4.77)
		P_3 X P_8 (4.88)	P_2 X P_8 (4.65)
19	Reducing sugars	P_2 X P_3 (13.79)	P_2 X P_3 (91.88)
		P_2 X P_4 (10.46)	P_4 X P_5 (62.73)
		P_1 X P_6 (6.25)	P_2 X P_5 (60.89)
20	Non-reducing sugar	P_6 X P_8 (18.98)	P_6 X P_8 (317.86)
		P_6 X P_7 (18.56)	P_3 X P_8 (291.67)
		P_3 X P_8 (11.53)	P_1 X P_2 (266.67)
21	Total sugar	P_6 X P_8 (17.87)	P_6 X P_8 (115.49)
		P_3 X P_8 (9.40)	P_1 X P_4 (103.94)
		-	P_3 X P_8 (100.00)
22	Ascorbic acid content	P_2 X P_4 (22.31)	P_4 X P_8 (56.84)
		-	P_3 X P_8 (56.78)
		-	P_2 X P_8 (55.28)

CONCLUSION

The above findings indicated that some pureline has strong heterotic capability compared to other ones during hybridization process. This may be due to diverse parent and favorable cross combination. As the performance of hybrids developed upon the heterotic capability of the parents involved, from economic point of view it will be useful to select and utilize the pure line with strong heterotic capability for important traits associated with yield in order to achieve higher fruit yield in F_1 hybrids through exploitation of heterosis. Since earliness, desirable fruit shape and color are the important considerations for choice of elite high yielding F_1 hybrids, the decision for final selection of a hybrid for commercial cultivation should also take into account the earlier three factors *i.e* earliness, fruit shape and colour traits along with the latter *i.e*. high fruit yield and other desirable qualitative attributes for market preference.

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