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Heterotic potential of male sterility-based cross combinations in brinjal (*Solanum melongena* L.)

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Abstract

The utilization of male sterility-based genetic emasculation in heterosis breeding will reduce the cost of commercial hybrid seed production in brinjal. The present investigation involved the evaluation of 50 male sterility-based hybrid combinations for testing their heterotic potential for different fruit and yield traits against the commercial and high-yielding hybrid PBH-3. Among all D-9991-1 × R-2596/PB-9-3 displayed the highest heterosis for the days to 50 % flowering (-25.85 %) as well as first fruit harvest (-24.00 %). D-214-1 × R-6-22-1 was the most heterotic for fruit weight (31.41%), while D-104-1 × R-2596/PB-9-3 (48.92%) and D-9991-1 × R-2596/PB-9-3 (47.69%) were at the top for fruits per plant. D-9991-1 × R-2596-8-1-3 (143.35 %) and D-320-1 × R-2596/PB-9-3 (162.17 %) showed the highest and positive heterosis for anthocyanin and dry matter, respectively, and D-67-1 × R-2596/PB-9-3 (1.39 %) performed at par with the check hybrid PBH-3 for total phenols. Among all, four hybrid combinations viz D-104-1 × R-259-622-1(41.67%), D-104-1 × R-2596/PB-9-3(36.25%), D-9991-1 × R-2596/PB-9-3(36.11%), D-214-1 × R-3-23-1-5 (8.33%) were heterotic for fruit yield.

Keywords: Brinjal, Male sterility, Heterosis, Earliness, and Fruit yield

Introduction

Brinjal (*Solanum melongena* L., 2n=2x=24) is an often cross-pollinated vegetable crop. Its year-round cultivation and wider adaptability mainly in the tropical and subtropical areas of India enlist it among major vegetable crops of India. It is mainly self-pollinated, but heterostyly makes it an often cross-pollinated crop. Big flowers, many seeds per fruit, and low seed rate per unit area also provide great potential for exploitation of heterosis in brinjal. Since the discovery of its heterotic potential, hand emasculation and pollination has been the main technique for the production of hybrid seed. Although F1 hybrids offer an advantage of high yield, hand emasculation and pollination increase the cost of hybrid seed production. The utilization of male-sterile inbreds as a female parent does not require emasculation and is a best alternative approach to reduce seed production cost of F_1 hybrids.

Male sterility has been commercially exploited for heterosis breeding in many vegetable crops such as chilli, capsicum, cauliflower, radish and carrot (Reddy et al. 2002, Peterson 1958, Singh et al. 2019, Singh et al. 2018, Singh and Karmakar 2021). Cytoplasmic male sterility (CMS) system has been introgressed from different wild sources in brinjal. Japanese developed non-dehiscence type of male sterility with the cytoplasms of *Solanum kurzii*, *S. violaceum*, and *S. virginianum*, and complete male sterility from the cytoplasms of *S. aethiopicum* Aculeatum Group, *S. anguivi* Lam., and *S. grandifolium* C.V. Morton through repeated backcross breeding with cultivated parent (Khan and Isshiki 2008, 2010, 2011 & 2015). It offers an advantage of 100% male-sterility as compared to 50 % in GMS lines (Saxena and Hingane 2015). In the later CMS system, two independent dominant fertility restorer (*Rf*) genes were also found that could be transferred to different breeding lines for utilization in heterosis breeding (Khan and Isshiki 2015). Hybrid seed production through the cytoplasmic male sterility system requires male-sterile inbred lines, the respective maintainers, and restorer lines. Maintainer lines are used to maintain CMS lines every year. Restorer lines are used as a male parent to develop male fertile F1 hybrids for commercial production. Punjab Agricultural University has also developed different male sterile lines, their respective maintainers, and restorer lines for utilization in heterosis breeding (Garcha et al. 2017, Kaur et al. 2021). Further, the identification of the most appropriate male sterile and fertility restorer combinations

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is necessary for utilization at commercial production. Because of the availability of male sterile, respective maintainers, and restorer lines, the present investigation was planned to test the heterotic potential of male-sterility based cross combinations in brinjal.

Materials and Methods

In the present investigation, plant material involved twelve CMS lines with alloplasmic cytoplasm of *S. aethiopicum* into *S. melongena* background, and seventeen restorer lines carrying the single dominant gene (*Rf*) in the homozygous state also developed through backcross breeding from the reciprocal cross. Male sterile and restorer lines were used as the female and male parent, respectively during the development of male sterility-based F_1 hybrids. Many hybrid combinations as per their selected parents were expected with cluster bearing. Therefore, PBH-3 (small round type) a highly acceptable commercial hybrid was used to check the economic heterosis of 50 hybrid combinations. During the conduct of the experiment, fifty hybrid combinations between CMS and fertility restorer inbreds were evaluated in randomized block design with three replications for yield and its contributing traits in the open field during the rainy season of 2020. The seed for each combination and check hybrid (PBH-3) were sown on nursery beds in the third week of June and seedlings were transplanted in July at a spacing of 45×60 cm. The observations were recorded on five plants for each combination in replication for different characters like plant height (cm), leaf length (cm), leaf width (cm), inter-nodal length (mm), days to 50% flowering, days to the first harvest, number of flowers/cluster, number of fruits per cluster, fruit length (cm), fruit girth (cm), fruit skin hardiness (mm/2kg), average fruit weight (g), number of fruits/ plant, fruit yield/ plant (kg), fruit yield/ acre (q), dry matter (%), anthocyanin (mg/100g) and total phenols (mg/100g). The biochemical parameters were calculated as per the methods described in AOAC by Latimer (2016).

Data of field observations on five plants was compiled replication-wise for combination. The statistical analysis was performed in randomized block design as described by Ariel and Farrington (2010). Then data were statistically analyzed using the CPCS1 (Cheema and Singh 1990) program for analysis of variance, for estimating the significance of mean sum of squares, and calculation of standard errors for each trait. Standard error from analysis of variance was used to calculate the critical difference (CD) that was further used to check the significance of heterosis. The magnitude of percent heterosis of F_1 over standard check was calculated with the following formula:

Percent heterosis over the standard check (SC) =

$$\frac{\overline{F_1} - \overline{SC}}{\overline{SC}} \times 100$$

Results and Discussion

The heterotic potential of different male sterile × restorer combinations for vegetative, earliness, and flowering traits is given in Table 1. Among various vegetative traits of male-sterile × restorer combinations, the heterosis for plant height ranged between (-42.98 to 53.75 %, and most hybrids displayed significantly positive standard heterosis over check hybrid PBH-3. The heterosis for leaf length and leaf width ranged between -24.73 to 16.78 % and -31.33 to 19.96 %, respectively, and the most of hybrid combinations remained at par with check hybrid PBH-3 for these traits. Internodal length of the most of hybrid combinations showed significantly negative heterosis. The optimum vegetative growth was observed in male sterility-based hybrid combinations and the internodal length was less as compared to the check hybrid PBH-3. It means there was the intense placement of smaller leaves on comparatively taller plants. Intensive placement of smaller leaves balanced the vegetative growth for optimum photosynthetic activity in the plants. These results of heterosis for vegetative growth traits were substantiated with the findings of Prabhu et al. (2005), Shafeeq et al. (2007), Prasath and Ponnuswami (2008), Chowdhury et al. (2010) and Kumar et al. (2017) in brinjal.

Among 50 hybrid combinations, D-PSB-1 × R-2596/ PB-9-3 (-25.85%) and D-9991-1 × R-2596/PB-9-3 (-25.85%) displayed the highest heterosis for the days to 50% flowering in desirable direction followed by D-9991-1 × R-259-621-2 (-20.22%). However, the significantly highest heterosis for the days to first harvest was showed in D-9991-1 × R-2596/PB-9-3 (-24.00%), followed by D-214-1 × R-6-22-1 (-20.00 %) and D-214-1 × R-2596/PB-9-3 (-19.34 %). D-104-1 × R-259-622-1 (39.86%) unveiled the highest in desired direction for flowers per cluster followed by D-104-1 × R-2596/ PB-9-3 (32.61%) and D-9991-1 × R-2596/PB-9-3 (28.99%). The early days to flowering, first harvest, and the number of flowers per cluster are the indicators of earliness and high yield in brinjal. The earliness in flowering, days to harvest, and the number of flowers per cluster indicated that D-9991-1 × R-2596/PB-9-3 performed the best among all the male sterility-based hybrid combinations. The heterosis for earliness was also in agreement with the studies of Shafeeq et al.

Table 1: Heterosis (%) for vegetative, earliness, flowering and fruit traits of male sterility-based F1 hybrids in brinjal

Hybrid combinations	PH	IL	LL	LW	DTFF	DTFH	FPC	FL	FD
D-214-1 × R-3-23-1-5	33.00**	-2.66	-5.35	-7.69	-1.15	-11.34**	0.72	12.94**	-5.46
D-9991-1 × R-3-23-1-6	41.25**	5.12**	16.78**	3.46	-4.52*	-10.00**	-21.01*	-13.63**	26.47**
D-9991-1 × R-3-23-1	40.95**	-6.00**	9.36**	-6.24	21.33**	8.00**	0.00	-27.41**	-15.55**
D-67-1 × R-6-22-1-5	14.96**	-27.23**	-11.16**	-8.03	-4.52*	-13.34**	0.00	-4.98*	-3.78
D-104-1 × R-6-22-1-5	40.28**	-9.34**	-8.29*	-10.81*	0.00	-10.66**	-4.35	8.42**	0.63
D-214-1 × R-6-22-1	22.97**	-8.11**	-2.27	-7.58	-7.89**	-20.00**	0.00	35.60**	-11.13**
D-9991-1 × R-6-22-1	45.05**	-9.00**	7.89*	-7.92	4.48*	-8.00**	0.00	-14.93**	-5.04
D-PB-13-1 × R-6-22-1	13.32**	-5.34**	-9.16**	-5.24	4.48*	0.00	0.72	22.89**	-11.55**
D-104-1 × R-259-621-2	25.55**	-13.09**	-3.07	1.56	15.71**	4.66**	0.72	-29.48**	0.21
D-214-1 × R-259-621-2	31.35**	-10.99**	2.87	-1.00	21.33**	0	-21.01*	7.73**	-11.34**
D-9991-1 × R-259-621-2	16.31**	-11.16**	1.54	-6.24	-20.22**	-16.66**	-21.01*	-13.25**	-2.10
D-5-1 × R-2596-8-3	21.02**	-5.15**	-3.28	-2.23	-5.63**	-10.00**	0.72	-33.92**	-6.09
D-214-1 × R-2596-8-3	26.38**	-16.53**	-0.2	3.46	-5.63**	-18.00**	0.72	5.97**	-24.58**
D-9991-1 × R-2596-8-1-3	15.65**	-18.71**	3.07	2.23	-1.15	-17.34**	0.72	-23.12**	-10.29**
D-5-1 × R-2596/PB-9-3	13.70**	-14.54**	-6.48	2.45	-5.63**	-10.00**	0.00	-20.90**	-11.97**
D-67-1 × R-2596/PB-9-3	5.61**	-11.89**	-2.14	-8.70	-1.15	-17.34**	0.00	16.69**	-12.39**
D-214-1 × R-2596/PB-9-3	5.30**	-22.32**	-0.4	-0.89	-4.52*	-19.34**	1.45	15.01**	-16.39**
D-320-1 × R-2596/PB-9-3	-0.21	-10.35**	-7.22*	-6.13	-1.15	-11.34**	-21.01*	-22.51**	25.42**
D-PSB-1 × R-2596/PB-9-3	8.75**	-8.92**	-15.91**	-12.82**	-25.85**	-16.00**	-21.74*	25.19**	-34.03**
D-9991-1 × R-2596/PB-9-3	19.38**	-24.97**	-1.20	-5.24	-25.85**	-24.00**	28.99**	-21.98**	-1.68
D-216-1 × R-6-22-1	11.39**	-35.34**	8.69*	9.48	-4.52*	-12.66**	-21.74*	14.55**	-16.60**
D-291-1 × R-6-22-1-11	-42.98**	-35.08**	-24.73**	-31.33**	-4.52*	-13.34**	-21.74*	-2.37	-53.57**
D-320-1 × R-6-22-1	0.64	-44.88**	-0.13	3.12	-5.63**	-10.00**	-16.67	-30.02**	-10.08**
D-104-1 × R-259-622-1	3.32**	-37.27**	-4.21	0.33	-4.52*	-15.34**	39.86**	-13.02**	-23.11**
D-104-1 × R-2596/PB-9-3	13.61**	-22.13**	-4.21	-14.83**	1.11	-8.00**	32.61**	-18.91**	19.12**
Range	-42.98 – 53.75	-47.94–9.34	-24.73–16.78	-31.33–19.96	-25.85–44.93	-24.00–26.00	-21.74–39.86	-58.73–35.60	-53.57–26.47
CD (P = 0.05)	2.18	2.04	1.03	0.83	1.17	1.17	0.93	0.55	0.34
CD (P = 0.01)	2.89	2.71	1.37	1.1	1.55	1.55	1.24	0.74	0.45

*,** significant at 5% and 1% levels, respectively; Note: PH-plant height, IL- internodal length, LL-leaf length, LW-leaf width, DTFF-days to 50% flowering, DTFH- days to first harvest, FPC-flowers per cluster, FL- fruit length, FD-fruit diameter

(2007), Chowdhury et al. (2010), Balwani et al. (2017) and Kumar et al. (2017).

Standard heterosis for yield and its contributing traits of male-sterile × restorer based F1 hybrids are shown in Table 2. Among 50 male sterility-based hybrids, the significantly highest and positive heterosis for fruit yield per plant and fruit yield per acre was observed in hybrid combination D-104-1 × R-259-622-1 (41.67%). It was further contributed by high heterosis average fruit weight (24.03 %), fruits per plant (14.12%), and fruits per cluster (7.07%). Secondly, D-104-1 × R-2596/PB-9-3 (36.25%) showed the significantly positive heterosis for fruit yield per plant and fruit yield per acre that was added up through positive heterosis for fruits per plant (48.92%), fruits per cluster (7.07%), and fruit girth (19.12%). Thirdly, D-9991-1 × R-2596/PB-9-3 displayed significantly highest and positive heterosis (36.11%) for fruit yield per plant as well as fruit yield per acre that was mainly augmented through fruits per plant (47.69%). The hybrid vigour of contributing traits such as number of fruits per cluster, number of fruits per plant, fruit weight resulted in high heterosis for yield potential of best hybrid combinations over check hybrid PBH-3. It also depended upon the genetic divergence and combining ability to contribute traits available in the male sterile and restorer inbreds used in particular hybrid combinations. The results were substantiated by the findings of Shafeeq et al. (2007), Makani et al. (2013), Balwani et al. (2017) and Khobragade et al. (2019).

Heterosis for biochemical traits of male sterility-based F_1 hybrids is also presented in Table 2. Among 50 hybrid combinations, D-9991-1 × R-2596-8-1-3 (143.35%) showed significantly maximum and positive heterosis for dry matter followed by D-9991-1 × R-6-22-1 (129.62 %); D-320-1 × R-2596/PB-9-3 (162.17%) revealed significantly highest and positive heterosis for anthocyanin followed by D-67-1 × R-2596/PB-9-3 (157.45%), D-PSB-1 × R-2596/PB-9-3 (157.28%) and D-9991-1 × R-2596/PB-9-3 (151.99%) and D-67-1 × R-2596/PB-9-3 (1.39%) performed at par with the check hybrid PBH-3 for total phenols. Similarly, the positive heterosis for these biochemical traits was reported by Singh (2000), Kaur et al. (2001), Singh (2013), and Balwani et al. (2017). Among biochemical traits, anthocyanin and phenols are major antioxidants and ability to scavenge free radicals. Anthocyanin is important for providing colour to the fruit (Cao et al. 1996). Thus, Anthocyanin is the main component of brinjal peel and because of its antioxidant properties, it was found to be efficient in reducing the risk of cancer

Table 2: Heterosis (%) for yield and quality traits of male sterility-based F1 hybrids in brinjal

Hybrid combinations	FRPC	FSH	AFW	FPP	FYPP	FYPA	DM (%)	TPH (mg/100g)	ANTH (mg/100g)
D-214-1 × R-3-23-1-5	-28.62**	-26.32**	26.34**	-17.40**	8.33*	8.33*	20.38**	-57.55**	61.18**
D-9991-1 × R-3-23-1-6	-35.76**	-31.58**	-52.84**	-7.48**	-35.00**	-35.00**	23.70**	-42.84**	46.49**
D-9991-1 × R-3-23-1	-28.62**	-31.58**	-25.23**	-32.75**	-53.19**	-53.19**	17.77**	-43.43**	82.97**
D-67-1 × R-6-22-1-5	-28.62**	-31.58**	-5.46**	-26.78**	-42.50**	-42.50**	25.87**	-56.36**	54.72**
D-104-1 × R-6-22-1-5	-42.90**	-26.32**	12.96**	-49.87**	-38.06**	-38.06**	23.70**	-51.62**	95.84**
D-214-1 × R-6-22-1	-21.48*	-33.42**	31.41**	-38.86**	-5.97	-5.97	22.40**	-49.58**	11.28**
D-9991-1 × R-6-22-1	-50.04**	-71.05**	-32.98**	-23.11**	-15.56**	-15.56**	129.62**	-56.04**	-0.81
D-PB-13-1 × R-6-22-1	-14.35	-43.95**	26.69**	-28.53**	-15.97**	-15.97**	2.89	-32.59**	-11.40**
D-104-1 × R-259-621-2	-14.35	-65.79**	-25.21**	-25.41**	-39.17**	-39.17**	0.72	-44.36**	101.07**
D-214-1 × R-259-621-2	-21.48*	-35.00**	-8.03**	-28.94**	-42.92**	-42.92**	18.64**	-53.55**	14.89**
D-9991-1 × R-259-621-2	-35.76**	-39.47**	-21.18**	-67.94**	-64.58**	-64.58**	-6.50**	-17.57**	141.50**
D-5-1 × R-2596-8-3	-35.76**	-53.42**	-40.17**	-55.17**	-65.97**	-65.97**	13.15**	-13.60**	130.09**
D-214-1 × R-2596-8-3	-28.62**	0.79	-15.90**	-18.75**	-36.94**	-36.94**	-1.01	-2.00**	20.41**
D-9991-1 × R-2596-8-1-3	-21.48*	-24.47**	-33.74**	7.87**	-26.94**	-26.94**	143.35**	-6.87**	62.44**
D-5-1 × R-2596/PB-9-3	-21.48*	-31.58**	-50.00**	-47.42**	-59.03**	-59.03**	21.53**	-15.69**	104.93**
D-67-1 × R-2596/PB-9-3	-21.48*	2.63	-40.00**	31.44**	-10.00**	-10.00**	-5.20*	1.39*	157.45**
D-214-1 × R-2596/PB-9-3	-14.35	-0.79	-25.63**	28.39**	1.25	1.25	6.36**	-8.93**	109.88**
D-320-1 × R-2596/PB-9-3	-28.62**	-40.26**	-22.87**	-55.31**	-61.53**	-61.53**	27.60**	-8.55**	162.17**
D-PSB-1 × R-2596/PB-9-3	-35.76**	2.63	-32.90**	-56.53**	-68.33**	-68.33**	16.47**	-12.95**	157.28**
D-9991-1 × R-2596/PB-9-3	-21.48*	-7.89*	-15.32**	47.69**	36.11**	36.11**	8.24**	-4.02**	151.99**
D-216-1 × R-6-22-1	-42.90**	-71.84**	22.54**	-18.34**	1.53	1.53	29.62**	-35.99**	22.55**
D-291-1 × R-6-22-1-11	-35.76**	-63.95**	-7.04**	0.53	-4.86	-4.86	32.37**	-45.47**	8.08**
D-320-1 × R-6-22-1	-28.62**	-65.79**	-58.48**	-60.32**	-62.50**	-62.50**	40.61**	-36.64**	43.14**
D-104-1 × R-259-622-1	7.07	-39.47**	24.03**	14.12**	41.67**	41.67**	33.53**	-45.93**	4.00*
D-104-1 × R-2596/PB-9-3	7.07	-61.32**	-11.41**	48.92**	36.25**	36.25**	14.31**	-53.17**	131.87**
Range	-50.04–7.07	-71.84–2.63	-87.46–31.41	-97.70–48.92	-99.03 – 41.67	-99.03 – 41.67	-9.10 – 143.35	-59.73 – 1.39	-11.40 – 162.17
CD (P = 0.05)	0.81	0.28	2.06	1.23	0.18	23.36	0.30	2.00	1.96
CD (P = 0.01)	1.08	0.37	2.74	1.63	0.24	31.03	0.39	2.66	2.6

*,** significant at 5% and 1% levels, respectively; Note: FRPC- fruits per cluster, FSH-fruit skin hardiness, AFW-average fruit weight, FPP-fruits per plant, FYPP-fruit yield per plant, FYPA-fruit yield per acre, DM-dry matter, TPH-total phenol, ANTH- anthocyanin

and cardiovascular diseases. Therefore, the biochemical composition of male sterility-based hybrids can be given due importance during their selection for commercial release.

Based on heterosis for fruit yield per plant and fruit yield per acre, eight hybrid combinations were shortlisted. Per se performance for yield contributing and fruit quality traits of these hybrid combinations is given in Table 3. Among all male sterility based hybrids, D-104A × R-259-622-1 presented highest heterosis for fruit yield per acre (41.67%) followed by D-104A × R-2596/PB-9-3 (36.25%), D-99A × R-2596/PB-9-3 (36.11%) and D-214A × R-3-23-1-5 (8.33%) combinations. Per se performance of D-104-1 × R-259-622-1 indicated the highest yield (452.20q/ acre and 3.40kg/plant) that was mainly contributed by fruits per

Table 3: Per se performance for yield contributing and biochemical traits of promising male sterility-based F1 hybrids in brinjal

Hybrid combinations	Heterosis	Per se performance for yield and contributing traits				Per se performance for biochemical traits		
	FYPA	FYPA (q)	FYPP (kg)	FPP	AFW (g)	DM (%)	TP (mg/100g)	ANTH (mg/100g)
D-104-1 × R-259-622-1	41.67**	452.20	3.40	56.00	146.76	9.24	79.85	51.47
D-104-1 × R-2596/PB-9-3	36.25**	434.91	3.28	73.08	104.83	7.91	69.15	114.75
D-9991-1 × R-2596/PB-9-3	36.11**	434.47	3.27	72.47	100.20	7.49	141.74	124.71
D-214-1 × R-3-23-1-5	8.33*	345.80	2.60	40.53	149.50	8.33	62.69	79.77
D-216-1 × R-6-22-1	1.53	324.08	2.44	40.07	94.00	8.97	94.52	60.65
D-214-1 × R-2596/PB-9-3	1.25	323.19	2.43	63.00	88.00	7.36	134.48	103.87
D-291-1 × R-6-22-1-11	-4.86	303.68	2.28	49.33	145.00	9.16	80.53	53.49
D-214-1 × R-6-22-1	-5.97	300.14	2.26	30.00	155.50	8.47	74.45	55.07
PBH-3 (check)	-	319.20	2.40	49.07	118.33	6.92	147.67	49.49
CD (P = 0.05)	23.36	23.42	0.18	1.23	2.07	0.30	2.01	1.96
CD (P = 0.01)	31.03	31.14	0.23	1.63	2.75	0.39	2.67	2.60

*,** significant at 5% and 1% levels, respectively; Note: FYPA-fruit yield per acre, FYPP-fruit yield per plant, FPP- fruits per plant, AFW-average fruit weight, DM-dry matter, TPH-total phenol, ANTH- anthocyanin

plant (56.00), average fruit weight (146.76 g). It has also 9.24 % dry matter, 79.85 mg/100g total phenols, and 51.47mg/100g anthocyanin content. Secondly, D-104-1 × R-2596/PB-9-3 produced 434.91quintals and 3.28kg fruits yield per acre and per plant that was mainly contributed by fruits per plant (73.08) and average fruit weight (104.83g). This particular combination also had 7.91% dry matter, 69.15mg/100g total phenols, and 114.75mg/100g anthocyanin content. Third combination, D-9991-1 × R-2596/PB-9-3, yielded 434.47quintals and 3.27kg fruit yield per acre and per plant, respectively that was mainly augmented by fruits per plant (72.47) and average fruit weight (100.20g) with good biochemical parameters such as dry matter (7.49%), total phenols (141.74mg/100g) and anthocyanin content (124.71mg/100g). The fourth hybrid with significant heterosis was D-214A × R-3-23-1-5 that yielded 345.80quintals fruits per acre. The check hybrid PBH-3 was highly acceptable commercial hybrids with encouraging results for most of these traits. There were also some hybrid combinations, D-216A × R-6-22-1, D-214A × R-2596/PB-9-3, D-291A × R-6-22-1-11, and D-214A × R-6-22-1 that remained at par with the check hybrid and can be considered promising male sterility based combinations.

Conclusion

The hybrids combinations D-104A × R-259-622-1, D-104A × R-2596/PB-9-3, and D-99A × R-2596/PB-9-3 performed significantly better than the commercial check PBH-3. The hybrid combination D-104A × R-259-622-1 showed significantly positive heterosis for plant height, flowers per cluster, fruits per cluster, average fruit weight, number of fruits per plant, and fruit yield per plant. The remaining two hybrids also showed significantly positive heterosis for most of the yield and related traits. Therefore, these hybrids can be commercially exploited after assessing the stability for yield and related traits.

Lkkjka'k

ओज प्रजनन में नर बन्ध्यता आधारित आनुवांशिक विपुंसन के उपयोग से बैंगन में वाणिज्यिक संकर बीज उत्पादन की लागत कम हो जायेगी। वर्तमान परीक्षण में वाणिज्यिक और उच्च उपज वाले संकर पी.बी.एच.–3 के विपरीत विभिन्न फलों और उपज लक्षणों के लिए उनकी ओज क्षमता के परीक्षण के लिए 50 नर बन्ध्यता आधारित संकर संयोजनों का मूल्यांकन शामिल किया गया। सभी संकरों में डी.–9991–1 x आर.–2596 / पी.बी.–9–3 में 50 प्रतिशत पुष्पन (–25.85 प्रतिशत) के साथ–साथ पहली तुड़ाई (–24.00 प्रतिशत) दिनों के लिए उच्चतम ओज प्रदर्शित की गयी। संकर संयोजन डी.–214–1 x आर.–6–22–1 फल वजन (31.41 प्रतिशत) के लिए सबसे अधिक ओज था, जबकि डी.–104–1 x आर.–2596 / पी.बी.–9–3 (48.92 प्रतिशत) और डी.–9991–1 x आर.–2596 / पी.बी.–9–3 (47.69 प्रतिशत) फल प्रति पौध के लिए ओज मूल्य सबसे शीर्ष पर पाया गया। डी.–9991–1 x आर.–2596–8–1–3 (143.35 प्रतिशत) और डी.–320–1 x आर.–2596 / पी.बी.–9–3 (162.17 प्रतिशत) ने एंथोसायनिन और शुष्क पदार्थ के लिए उच्चतम और सकारात्मक क्रमशः ओज प्रदर्शित किये और डी.–67–1 x आर.–2596 / पी.बी.–9–3 (1.39 प्रतिशत) ने कुल फिनोल के लिए नियंत्रक संकर पी.बी.एच–3 के बराबर प्रदर्शन किया। सभी में, चार संकर संयोजनों जैसे–डी.–104–1 x आर.–259–622–1 (41.67 प्रतिशत), डी.–104–1 x आर.–2596 / पी.बी.–9–3 (36.25 प्रतिशत), डी.–9991–1 x आर.–2596 / पी.बी.–9–3 (36.11 प्रतिशत), डी.–214–1 x आर.–3–23–1–5 (8.33 प्रतिशत), फलों की उपज के लिए ओज प्रदर्शित किये।

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