Plant Archives Vol. 25, No. 1, 2025 pp. 389-400 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.059

ESTIMATION OF HETEROSIS ON EARLINESS AND GROWTH ATTRIBUTES OF BOTTLE GOURD (*LAGENARIA SICERARIA* MOLINA STANDL.) IN DISTINCT THREE ENVIRONMENTS

Subhash Verma[1], R.B. Verma[1]*, Ajay Bhardwaj[1] and Anand Kumar[2]

[1]Department of Horticulture (Vegetable & Floriculture), B.A.U. Sabour, Bhagalpur – 813 210, Bihar, India.
[2]Department of Genetic and Plant Breeding, B.A.U. Sabour, Bhagalpur – 813 210, Bihar, India.
*Corresponding author E-mail : rbv1963@gmail.com
(Date of Receiving-20-11-2024; Date of Acceptance-07-02-2025)

ABSTRACT

The research was conducted to assess heterosis in bottle gourd concerning both earliness and growth trait of bottle gourd on vegetable research farm Bihar Agricultural University Sabour. Six parent namely Narendra Joyti (NJ), BRBG-23 (BG-23), BRBG-65 (BG-65), Pusa Naveen (PN), BRBG-21-2 (BG-21-2) and Round Bottle Gourd (RBG) to developed 30 F_1 hybrids by 6 x 6 full diallel mating design. Three distinct sowing environments used in experiment namely E1 (February, 2022), E2 (May, 2022) and E3 (September, 2022). The result recorded for earliness traits found that the F_1 hybrids namely NJ x BG-23 and NJ x RBG (-15.44%) in E1, NJ x PN (-17.61%) in E2 and NJ x PN (-20.26%) in E3 for days to first male flower opening, while for the trait days to first female flower opening F_1 hybrids namely NJ x RBG (-18.59%) in E1, RBG x NJ (-19.35%) in E2 and NJ x PN (-22.42%) in E3 whereas for the trait days to first harvest F_1 hybrid namely PN x NJ (-17.39) in E1, RBG x NJ (-19.46%) in E2 and NJ x PN (-21.13%) in E3 showed maximum negative standard heterosis over check (Kashi Ganag). However, for growth traits such as trait vine length F_1 hybrid namely BG-65 x PN (22.94%) in E1, PN x NJ (40.26%) in E2 and NJ x BG-21-2 (24.05%) in E3 while for the trait primary branches F_1 hybrid namely BG-23 x RBG (25.46%) in E1, BG-23 x RBG (41.19%) in E2 and PN x BG-21-2 (34.57) in E3 exhibited maximum positive standard heterosis over check (kashi Ganga).

Key words : Earliness, RBD, Full diallel, Heterosis.

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl]., is a tropical and subtropical vine belonging to the Cucurbitaceae family. Bottle gourd commonly known as calabash, opo squash, lauki (in Hindi), dudhi (in Gujarati). This vegetable is widely cultivated for its edible fruit, which is commonly used in various culinary preparations across different cultures. The fruit of the bottle gourd is usually elongated and cylindrical, resembling a bottle. However, shapes may vary and some varieties produce round or club-shaped fruits. The fruit's skin colour ranges from light green to white, depending on the variety and maturity. The inner flesh of bottle gourd is white, firm, and mildly sweet when young. As the fruit matures, the flesh may become tougher and develop bitter notes. Bottle gourd is a versatile vegetable used in various culinary dishes. It is often added to soups, stews, curries, and stir-fries also used for preparation of utensils, containers, and decorative items. It contains essential nutrients such as vitamins (especially vitamin C), minerals and dietary fibre (Kumar *et al.,* 2021). It is often included in low-calorie diets and is believed to aid in weight management. It is often included in low-calorie diets and is believed to aid in weight management. The fibre content in bottle gourd may contribute to digestive health. The demand of hybrid bottle gourd is also increasing hence to fulfill the demand of hybrid there is a need of superior parents having good heterosis. Due to high remunerative prices in domestic as well as in international market, commercial cultivation of bottle gourd increases in India, which emphasizes the scope for crop improvement with the help of different hybridization approaches and heterosis breeding one of important breeding technique to crop improvement. Exploiting the potential of bottle gourd for hybrid vigour on a commercial scale holds significant promise for enhancing productivity and overall production. To establish an effective heterosis breeding program in bottle gourd, it becomes imperative to elucidate the genetic nature and magnitude of quantitative traits, as well as estimate the pre-potency of parents in hybrid combinations. The success of a bottle gourd heterosis breeding program depends on a combination of meticulous trait analysis, genetic understanding and careful selection of parent lines. Through such efforts, researchers and breeders can unlock the full potential of hybrid vigour in bottle gourd, leading to sustainable increases in productivity and commercial success on a larger scale.

Materials and Methods

Experiment was conducted at the Vegetable Research Farm, Department of Horticulture (Vegetable and Floriculture), Bihar Agricultural College, Bihar Agricultural University, Sabour, Bhagalpur during 2022 in Summer (February, 2022), Rainy (May, 2022) and winter (September 2022), E1, E2 and E3, respectively.Six parent used in experiment namely, BRBG23 (BG-23), BRBG65 (BG-65), BRBG 21-2 (BG-21-2), Round bottle gourd (RBG), Narendra Joyti (NJ), Pusa Naveen (PN), and check parent viz., Kashi Ganga, and their 30F_1 hybrids obtained through 6 × 6 full diallel mating design for the study of heterosis. However, data recorded on earliness trait such as days to first male flower opening, days to first female flower opening, Days to first harvest, Number of nodes to first male flower appearance and Number of nodes to first female flower appearance while in case of growth traits such as vine length at the time of final harvesting (m), Inter-nodal length (cm), Peduncle length (cm) and Number of primary branches. The analysis of variance for each character was carried out for the randomized block design as suggested by Panse and Sukhatme (1967). The unit plot size 4.0 m×3.0 m and spacing of plant to plant and row to row keep on 3.0 m × 0.5 m with 8 number plant in each plot.

Results and Discussion

Earliness traits

Days to first male flower opening

Data presented in Table 1 indicated that under the environment I (E1) 10 F_1 hybrids showed significant negative mid-heterosis and 14 F_1 hybrids showed better parents heterosis and ranged from -9.29% (RBG x BG-65) to -16.55% (PN x NJ) and -8.57% (BG-23 x BG-21-2 and BG-21-2 x BG-23) to -17.14% (RBG x PN and PN x NJ) respectively. However, F_1 hybrids NJ x BG-23 and NJ x RBG exhibited maximum (-15.44%) significant standard heterosis over check (Kashi Ganga) followed by PN x NJ (-14.71%) and RBG x PN (-14.71%). For the environment II, recorded that negatively significance mid-parent heterosis that varied from -7.04% (BG-65 x RBG) to -18.47% (NJ x PN). Eighteen crosses showed significant negative better parent heterosis exhibiting maximum ranged from (-18.75%) NJ x PN to 18.06% (PN x NJ). However, F1 hybrids (NJ x PN) (-17.61%) exhibited maximum significant standard heterosis over check (Kashi Ganga) followed by PN x NJ (-16.90%) and RBG x NJ (-16.20%). In environment III, the highest percentage of significant negative mid-parent heterosis was found in the hybrid Narendra Joyti x Pusa Naveen (-21.54%), followed by PN x NJ (-20.90%) and RBG x PN (-18.00%). Out of thirty crosses, thirteen F_1 hybrids showed significant to highly significant heterobeltiosis with the maximum heterobeltiosis in NJ x PN (-21.79%), followed by PN x NJ (-21.15%) and RBG x PN (-20.65%). The highest percentage of significant negative standard heterosis over checked was found in F_1 hybrid NJ x PN (-20.26%), followed by PN x NJ (-19.61%) and RBG x PN (-19.61%) result conformed by Chandramouli *et al*. (2021) and Kumar *et at.* (2021) presented in Table 1.

Days to first female flower opening

For environment I, recorded that the F_1 hybrid PN x NJ (-19.24) recorded the maximum negative mid parent heterosis over NJ x RBG (-16.17%) and RBG x PN (-15.23%). While, in better parent heterosis, negatively significant heterosis in the desirable direction showed maximum in NJ x RBG (-20.13%) followed by PN x NJ (-19.50%) and RBG x BG-65 (-19.25%). F_1 hybrids NJ x RBG (-18.59%) exhibited the maximum significant standard heterosis over check in the negative direction followed by hybrids PN x NJ (-17.95%) and BG-23 x RBG (-16.67%). In environment II, F_1 hybrids RBG x NJ recorded maximum significant negative heterosis over both mid-parent heterosis (-19.87%) and better parent heterosis (-20.38%) followed by NJ x PN (-19.75%) over mid-parent and BG-21-2 x BG-23 (-20.12%) over better parent. The highest percentage of significant negative standard heterosis over check was found in the hybrids RBG x NJ (-19.35%) followed by NJ x PN (-18.71%). Out of thirty F_1 hybrids, nine hybrids were found to be heterotic in a desirable direction over the standard heterosis. In environment III, the highest percentage of significant negative relative heterosis (-26.65%) was found in the hybrids NJ x PN, followed by PN x NJ (-25.50%) and BG-23 x RBG (-21.07%). Maximum negative significant heterobeltiosis (-27.68%) was found in the hybrids NJ x PN followed by PN x NJ (-26.55%) and BG-23 x RBG (-23.12%). The highest percentage of significant negative standard heterosis over check was found in the hybrids NJ x PN (-22.42%) followed by PN x NJ (-21.21%), BG-23 x RBG, and RBG x PN (-19.39%) similar result was reported by Sanjivani *et al.* (2020) and Rambabu *et al.* (2021) shown in Table 2.

Days to first harvest

In environment I, recorded that the results of heterosis for this trait revealed that the F_1 hybrids PN x NJ exhibited maximum significant negative heterosis over mid parent (-21.24%), (-22.45%) over better parent and (-17.39%) over check (Kashi Gamga) followed by NJ x RBG (-17.77%), NJ x PN (-17.65%) over mid parent and NJ x RBG (-20.92%) and RBG x BG-65 (-20.51%) over better parent heterosis, while F_1 hybrid PN x NJ (-17.39) followed by BG-23 x RBG and RBG x PN (-16.85%) exhibited significant negative heterosis over check (Kashi Ganag). In environment II, observed that the F_1 hybrid NJ x PN (-18.92% -19.35%) had maximum negative heterosis in both mid and better parent, followed by RBG x NJ (-18.58%, -19.02%) and PN x NJ (-18.38%, -18.82%) in mid-parent and better parent heterosis respectively, while among thirteen F_1 hybrid, RBG x NJ (-19.46%) showed maximum negative heterosis over check followed by NJ x PN (-18.92%) and PN x NJ (-18.38%). In environment III, found that the F_1 hybrid NJ x PN (-25.55%, -26.79%, -21.13%) exhibited maximum negative heterosis in mid, better and standard heterosis respectively followed by PN x NJ (-24.57%, -25.84% and -20.10%) and RBG x PN (-21.43%, -23.76% and -20.62%) in mid, better and standard heterosis over the check (Kashi Gamga) respectively similar result conformed by Adarsh *et al.* (2017) and Rambabu *et al.* (2021) shown in Table 3.

Number of nodes to first male flower appearance

Estimates of average heterosis among the crosses for the number of nodes to first male flower appearance**,** in environment I, recorded that the twenty-six crosses were negatively significant over the mid-parent with the maximum values in F_1 hybrid namely NJ x PN (-40.00%) followed by BG-65 x BG-21-2 and BG-21-2 x BG-65 (-35.14%). In the case of heterobeltiosis, most of the crosses were negatively significant except NJ x BG-23, BG-21-2 x BG-23, BG-21-2 x NJ, BG-21-2 x RBG (-10.53%), BG-65 x NJ (-5.26%) and BG-65 x RBG (-5.56%), while, maximum negative significant heterobeltiosis was observed in F_1 hybrid NJ x PN (-42.86%). In standard heterosis the maximum negatively significant standard heterosis was observed in five F_1 hybrid namely NJ x PN, BG-23 x RBG, BG-65 x BG-21-2, BG-21-2 x BG-65, RBG x BG-23 (-33.33%) over the check (Kashi Ganga). Estimates of relative heterosis in environment II, observed that out of thirty crosses, 21 crosses had negatively significant over mid-parent heterosis, and maximum mid- parent heterosis was observed in F_1 hybrid namely NJ x BG-23 (-29.87%) followed by PN x BG-21-2 (-27.03%), and PN x BG-23 (-26.03%). In the case of better parent heterosis it was observed that F_1 hybrid NJ x BG-23 (-32.50%) followed by RBG x NJ (-30.00%) and PN x BG-21-2 (-28.95%) showed maximum better parent heterosis however in standard heterosis it ranged from -15.63% (NJ x BG-23, PN x BG-23, PN x BG-21-2, RBG x PN) to 31.25% (NJ x RBG). In environment III, recoded that the relative heterosis indicated-maximum negative mid- parent heterosis in F_1 hybrid namely BG-65 x BG-21-2 (-34.78%), followed by PN x BG-21-2 (-31.91), BG-21-2 x PN (-23.40%), NJ x PN, BG-23 x BG-65, BG-65 x BG-23 and PN x RBG (-22.73%), whereas, in heterobeltiosis, most of the crosses showed significant differences except NJ x RBG (-9.52%), BG-23 x BG-21-2, BG-21-2 x BG-65 (-4.17%), BG-23 x RBG (-9.09%), PN x BG-65 (-8.70%), RBG x NJ (-4.76%) and RBG x BG-23 (-4.55%) which did not show non-significant. F_1 hybrid namely BG-65 x BG-21-2 (-37.50%) had maximum negative better parent heterosis. However, in standard heterosis, sixteen crosses recorded negative significant standard heterosis, with the maximum negative standard heterosis in F_1 hybrid namely BG-65 x BG-21-2 (-28.57%) and PN x BG-21-2 (-23.81%) similar results by Adarsh *et al.* (2017) and Chandramouli *et al.* (2021) presented in Table 4.

Number of nodes to first female flower appearance

Estimates of average heterosis and heterobeltiosis among the crosses for number of nodes to first female flower appearance in environment I, observed that the F_1 hybrids namely BG-23 x BG-21-2, BG-65 x RBG (-28.77%) had maximum negatively significant mid-parent heterosis and BG-65 x RBG (-31.58%) in better parent heterosis, followed by BG-23 x BG-21-2 (-29.73%) and BG-65 x BG-23 (-28.95%), however, in standard heterosis most of the crosses showed negatively significant except NJ x BG-65, BG-23 x NJ, BG-65 x BG-21-2 and RBG x BG-65 (-8.57%) with maximum negatively significant standard heterosis in BG-23 x BG-21-2 and BG-65 x RBG (-25.71%) over the check (Kashi Ganga). Estimates of relative heterosis in environment II, recorded that the twenty-six crosses had significantly negative heterosis over mid-parent and ranged from -30.36% (BG-23 x BG-65) to 12.50% (BG-65 x BG-23) with maximum negative relative heterosis in BG-23 x BG-65 (-30.36%), PN x BG-21-2 (-29.52%) and PN x RBG (-26.21%). Whereas in heterobeltiosis twenty-six crosses displayed negative heterosis over the better parent that ranged from -31.58% (BG-23 x BG-65) to 10.53% (BG-65 x BG-23) and with maximum in BG-23 x BG-65 (-31.58%), PN x BG-21-2 (-30.19%), and PN x RBG (-26.92%). However standard heterosis ranged from -27.45% (PN x BG-21-2) to 23.53% (BG-65 x BG-23) with maximum negative significant standard heterosis over check (Kashi Ganga) in BG-21-2 x PN, RBG x BG-21-2 (-17.65%), PN x RBG (-25.49%) and BG-23 x BG-65 (-23.53%). In environment III, observed that the F_1 hybrid namely BG-65 x BG-21-2 (-31.65%), RBG x BG-65 (-27.03%) and RBG x BG-23 (-23.94%) had maximum negative significant mid-parent heterosis, whereas in heterobeltiosis it ranged from -32.50% (BG-65 x BG-21-2) to 8.33% (BG-23 x PN) with maximum in F_1 hybrid namely BG-65 x BG-21-2 (-32.50%), RBG x BG-65 (-30.77%) and PN x BG-65 (-27.50%). However, in standard heterosis, F_1 hybrid namely BG-65 x BG-21-2, RBG x BG-23, RBG x BG-65 (-20.59%), followed by NJ x BG-23 and PN x BG-21-2 (-14.71%) indicated maximum negative significant standard heterosis over the check (Kashi Ganga) result conformed with Chandramouli *et al.* (2021) presented in Table 5.

For growth traits

Vine length at the time of final harvesting (m)

In environment I, recoded that the twenty-seven F_1 hybrids had maximum positive heterosis over mid-parent, twenty-two F_1 hybrids were over better parent and twelve F_1 hybrids were over standard check (Kashi Ganga). F_1 hybrids BG-65 x PN (28.39%), followed by RBG x PN and BG-23 x BG-21-2 (27.55%, 26.92%) showed maximum positive significant mid-heterosis Hybrids BG-65 x RBG (25.07%) followed by BG-65 x PN (24.51%) and BG-23 x BG-21-2 (24.41%) recorded the maximum significant positive heterosis over better parent. However, in standard heterosis F_1 hybrid namely BG-65 x PN (22.94%), followed by RBG x PN (20.70%) and NJ x PN, BG-23 x BG-21-2 (17.19%) showed maximum standard heterosis over check (Kashi Ganga). In environment II, recorded that among the thirty F_1 hybrids, fourteen hybrids over mid parent, ten hybrids over better parent and only twelve hybrids over check expressed significant positive heterosis. Hybrids PN x NJ (49.82% and 45.77%) followed by PN x BG-65 and BG-21-2 x NJ over mid parent (46.53%, 37.81%) and better parent (42.19%, 31.63%), respectively. Whereas, in standard heterosis F1 hybrid namely, PN x NJ (40.26%) followed by PN x BG-65 (36.81%) and BG-21-2 x NJ (31.61%) showed the highest significant positive heterosis over the standard check (Kashi Ganga). Among the thirty F_1 hybrids, fifteen hybrids over mid parent, seven hybrids over better parent and only eleven hybrids over check expressed significant positive heterosis for these traits in environment III, F_1 hybrids RBG x BG-23 (26.06%), followed by BG-23 x NJ and BG-23 x RBG (25.22%, 24.69%) recorded maximum significant positive heterosis over mid parent. F_1 hybrids, BG-23 x NJ (24.64%), RBG x BG-23 (24.04%) and NJ x BG-23 (24.03%) showed maximum positive significant heterosis over the better parent. However, in standard heterosis F_1 hybrid namely NJ x BG-21-2 (24.05%), followed by RBG x BG-23 (21.49%) and BG-21-2 x BG-23 (21.46%) showed maximum positive significant over standard check (Kashi Ganga) Similar result conformed with *Khot et al.* (2018), Sanjivani *et al.* (2020) presented in Table 6.

Inter-nodal length (cm)

In environment I, observed that none of the crosses recorded maximum positive significant over mid parent. Whereas F_1 hybrid namely RBG x BG-65 (-30.68), followed by PN x BG-65 and BG-65 x PN (-24.77%, -24.37%) indicated maximum negative significant heterosis over mid parent. In case of better parent heterosis none of the hybrid recorded the maximum positive significant heterosis over the better parent, whereas, F_1 hybrid namely RBG x BG-65 (-32.94) followed by PN x BG-65 and BG-65 x PN (-30.20%, -29.84%) showed maximum negative heterosis over better parent. In standard heterosis F_1 hybrid namely BG-65 x NJ recorded the highest inter-nodal length (27.82%) over standard check (Kashi Ganga). In environment II, recorded that the none of the F_1 hybrids had positively significant over mid and better parent heterosis. F_1 hybrid namely BG-21-2 x BG-65 (-39.17, -41.24) followed by BG-65 x BG-21-2 and BG-21-2 x PN (-34.64%, -36.86 and -27.70%, -30.69) over mid and better parent respectively indicated the maximum negative significant heterosis. Among the F_1 hybrid namely BG-65 x PN and RBG x BG-21-2 (28.21%) had the highest inter-nodal length over standard check (Kashi Ganga). In environment III, revealed that the one hybrids NJ x BG-23 (12.56%) recorded maximum significant positive heterosis over mid parent whereas F_1 hybrid namely BG-21-2 x BG-65 (-35.86%) and BG-65 x BG-21-2 (-34.91) showed negatively significant heterosis. However, in better parent heterosis none of the F1 hybrid recorded

Table 1 : Days to first male flower opening.

	Heterosis (%) (Days to first male flower opening)									
		E1			E2			E3		
F1	**Cross**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
1*2	NJ x BG-23	-16.06**	-16.67**	-15.44**	-14.69**	-15.28**	-14.08**	-17.15**	-17.95**	-16.34**
1*3	NJ x BG-65	1.46	0.72	2.21	-8.33**	-8.33*	-7.04	0.95	0.00	3.92
1*4	NJ x PN	-15.11**	-15.71**	-13.24**	-18.47**	-18.75**	-17.61**	-21.54**	-21.79**	-20.26**
1*5	NJ x BG-21-2	2.16	1.43	4.41	-7.69*	-8.33*	-7.04	-6.11	-6.41	-4.58
1*6	NJ x RBG	-15.13**	-16.67**	-15.44**	-3.52	-4.86	-3.52	-7.64*	-10.90**	-9.15*
2*1	BG-23 x NJ	1.46	0.72	2.21	-2.10	-2.78	-1.41	-3.56	-4.49	-2.61
2*3	BG -23 x BG-65	-1.47	-1.47	-1.47	-14.69**	-15.28**	-14.08**	-10.26**	-11.95**	-8.50*
2*4	BG-23 x PN	1.45	0.00	2.94	-7.37*	-7.69*	-7.04	3.25	2.58	3.92
2*5	BG-23 x BG-21-2	-7.25	-8.57*	-5.88	-7.75*	-7.75*	-7.75*	-3.25	-3.87	-2.61
2*6	BG-23 x RBG	-12.27**	-13.24**	-13.24**	-14.18**	-14.79**	-14.79**	-14.77**	-16.99**	-16.99**
3*1	BG-65 x NJ	-1.46	-2.17	-0.74	-9.03**	-9.03*	-7.75*	-7.94*	-8.81*	-5.23
3*2	BG-65 x BG-23	2.94	2.94	2.94	-4.20	-4.86	-3.52	3.21	1.26	5.23
3*4	BG-65 x PN	-1.45	-2.86	0.00	-8.71**	-9.03*	-7.75*	-7.01	-8.18*	-4.58
3*5	BG-65 x BG-21-2	1.45	0.00	2.94	-4.90	-5.56	-4.23	1.27	0.00	3.92
3*6	BG-65 x RBG	-1.12	-2.21	-2.21	-7.04*	-8.33*	-7.04	-3.29	-7.55	-3.92
4*1	PN x NJ	-16.55**	-17.14**	-14.71**	-17.77**	-18.06**	-16.90**	-20.90**	-21.15**	-19.61**
4*2	PN x BG-23	-3.62	-5.00	-2.21	-6.67*	-6.99	-6.34	-1.95	-2.58	-1.31
4*3	PN x BG-65	1.45	0.00	2.94	-1.74	-2.08	-0.70	-7.64*	-8.81*	-5.23
4*5	PN x BG-21-2	-14.29**	-14.29**	-11.76**	-8.07*	-8.39*	-7.75*	-8.39*	-8.39*	-7.19
4*6	PN x RBG	1.83	-0.71	2.21	-7.42*	-8.39*	-7.75*	-3.33	-6.45	-5.23
5*1	BG-21-2 x NJ	-6.47	-7.14	-4.41	-5.59	-6.25	-4.93	-2.25	-2.56	-0.65
5*2	BG-21-2 x BG-23	-7.25	-8.57*	-5.88	-14.79**	-14.79**	-14.79**	0.00	-0.65	0.65
5*3	BG-21-2 x BG-65	-5.80	-7.14	-4.41	-4.90	-5.56	-4.23	-5.73	-6.92	-3.27
5*4	BG -21-2 x PN	-12.86**	-12.86**	-10.29*	-4.56	-4.90	-4.23	-3.87	-3.87	-2.61
5*6	BG-21-2 x RBG	-6.96	-9.29*	-6.62	-2.84	-3.52	-3.52	-2.67	-5.81	-4.58
6*1	RBG x NJ	-12.92**	-14.49**	-13.24**	-16.20**	-17.36**	-16.20**	-9.63**	-12.82**	-11.11**
6*2	RBG x BG-23	-3.35	-4.41	-4.41	-5.67	-6.34	-6.34	1.34	-1.31	-1.31
6*3	RBG x BG-65	-9.29**	-10.29*	-10.29*	-7.75*	-9.03*	-7.75*	-7.24	-11.32**	-7.84
6*4	RBG x PN	-15.02**	-17.14**	-14.71**	-4.59	-5.59	-4.93	-18.00**	-20.65**	-19.61**
6*5	RBG x BG-21-2	-6.96	-9.29*	-6.62	-13.48**	-14.08**	-14.08**	2.67	-0.65	0.65
	S.Ed (±)	1.56	1.80	1.80	1.46	1.68	1.68	1.75	2.02	2.02
	CD 5%	3.34	3.86	3.86	3.13	3.61	3.61	3.75	4.33	4.33

the maximum positive significant heterosis, whereas two F_1 hybrids namely BG-21-2 x BG-65 (-37.92%) and BG-65 x BG-21-2 (-37.00%) had maximum negatively significant for this trait. Among the F_1 crosses, BG-65 x NJ was the highest in inter-node length (28.14%) followed by RBG x BG-21-2 (24.29) over standard check result conformed by Sanjivani *et al.* (2020) presented in Table 7.

Peduncle length (cm)

In environment I, observed that the hybrids NJ x BG-21-2 (27.68%, 20.94%) followed by PN x BG-21-2 (26.08%) over mid-parent, RBG x NJ (13.03%) over better parent and RBG x NJ (73.82%) followed by NJ x BG-21-2 (63.60%) over standard check (Kashi Ganga) had maximum positive heterosis. In environment II, recorded that the F_1 hybrids BG-23 x PN (24.83%) followed by BG-65 x RBG (24.07%) and BG-65 x BG-23 (19.31%) exhibited maximum positive significant heterosis over mid-parent, BG-23 x PN (21.65%) followed by NJ x PN (17.29%) and PN x BG-23 (16.10%) over better parent and BG-65 x RBG (42.10%) followed by BG-65 x BG-23 (39.59%) and BG-65 x BG-21-2 (36.06%) over check (Kashi Ganga). In environment III, observed that eleven hybrids over mid-parent, eight hybrids

Table 2 : Estimation of heterosis for days to first female flower opening.

	Heterosis (%) (Days to first female flower opening)									
		E1			E2			E3		
F1	Cross	MP	BP	SH	MP	BP	SH	MP	BP	SH
1*2	NJ x BG-23	-7.99*	-9.43*	-7.69	-16.93**	-17.20**	-16.13**	-17.71**	-18.64**	-12.73**
1*3	NJ x BG-65	-8.75**	-9.32*	-6.41	-6.96	-7.55	-5.16	1.12	0.00	9.70*
1*4	NJ x PN	-7.26*	-7.55	-5.77	-19.75**	-19.75**	-18.71**	-26.65**	-27.68**	-22.42**
1*5	NJ x BG-21-2	-5.40	-6.29	-4.49	-8.41*	-10.37*	-5.16	-7.08	-7.34	-0.61
1*6	NJ x RBG	-16.17**	-20.13**	-18.59**	-3.21	-3.82	-2.58	-8.50*	-11.86**	-5.45
2*1	BG-23 x NJ	-6.71	-8.18*	-6.41	-3.51	-3.82	-2.58	-10.29**	-11.30**	-4.85
2*3	BG -23 x BG-65	-5.40	-7.45	-4.49	-16.83**	-17.61**	-15.48**	-12.99**	-14.92**	-6.67
2*4	BG-23 x PN	-4.49	-5.70	-4.49	-8.63*	-8.92	-7.74	0.87	0.58	5.45
2*5	BG-23 x BG-21-2	-7.10*	-7.69	-7.69	-6.88	-9.15*	-3.87	-3.15	-3.98	2.42
2*6	BG-23 x RBG	-12.75**	-15.58**	-16.67**	-15.11**	-15.38**	-14.84**	-21.07**	-23.12**	-19.39**
3*1	BG-65 x NJ	-8.75**	-9.32*	-6.41	-6.96	-7.55	-5.16	-8.38*	-9.39*	-0.61
3*2	BG-65 x BG-23	-7.30*	-9.32*	-6.41	-6.03	-6.92	-4.52	-0.56	-2.76	6.67
3*4	BG-65 x PN	-9.72**	-10.56**	-7.69	-13.29**	-13.84**	-11.61**	-11.61**	-13.81**	-5.45
3*5	BG-65 x BG-21-2	-2.21	-3.73	-0.64	-5.26	-6.71	-1.29	-4.76	-6.08	3.03
3*6	BG-65 x RBG	-5.57	-10.56**	-7.69	-5.73	-6.92	-4.52	-7.25	-11.60**	-3.03
4*1	PN x NJ	-19.24**	-19.50**	-17.95**	-19.11**	-19.11**	-18.06**	-25.50**	-26.55**	-21.21**
4*2	PN x BG-23	-1.28	-2.53	-1.28	-3.51	-3.82	-2.58	-7.25	-7.51	-3.03
4*3	PN x BG-65	-9.09**	-9.94**	-7.05	-3.80	-4.40	-1.94	-11.05**	-13.26**	-4.85
4*5	PN x BG-21-2	-14.65**	-15.19**	-14.10**	-11.53**	-13.41**	-8.39	-9.77**	-10.80*	-4.85
4*6	PN x RBG	-4.64	-8.86*	-7.69	-7.05	-7.64	-6.45	-4.76	-6.98	-3.03
5*1	BG-21-2 x NJ	-11.75**	-12.58**	-10.90**	-9.66**	-11.59**	-6.45	-7.08	-7.34	-0.61
5*2	BG-21-2 x BG-23	-14.84**	-15.38**	-15.38**	-18.13**	-20.12**	-15.48**	-1.43	-2.27	4.24
5*3	BG-21-2 x BG-65	-14.20**	-15.53**	-12.82**	-5.88	-7.32	-1.94	-5.32	-6.63	2.42
5*4	BG -21-2 x PN	-8.28*	-8.86*	-7.69	-8.41*	-10.37*	-5.16	-4.02	-5.11	1.21
5*6	BG-21-2 x RBG	-4.67	-8.33*	-8.33*	-6.58	-9.15*	-3.87	-2.35	-5.68	0.61
6*1	RBG x NJ	-12.21**	-16.35**	-14.74**	-19.87**	-20.38**	-19.35**	-16.72**	-19.77**	-13.94**
6*2	RBG x BG-23	-2.01	-5.19	-6.41	-8.68*	-8.97	-8.39	-2.67	-5.20	-0.61
6*3	RBG x BG-65	-14.75**	-19.25**	16.67**	-7.64	-8.81	-6.45	-10.72**	-14.92**	-6.67
6*4	RBG x PN	-15.23**	-18.99**	17.95**	-2.56	-3.18	-1.94	-20.83**	-22.67**	-19.39**
6*5	RBG x BG-21-2	-2.67	-6.41	-6.41	-17.24**	-19.51**	-14.84**	-3.53	-6.82	-0.61
	S.Ed (±)	1.71	1.97	1.97	1.89	2.18	2.18	2.14	2.47	2.47
	CD 5%	3.66	4.23	4.23	4.05	4.67	4.67	4.59	5.30	5.30

over better parent and sixteen hybrids over standard check expressed positive significant heterosis with the maximum in BG-23 x PN (31.67%) followed by NJ x PN (27.30%) and BG-23 x BG-21-2 (23.83%) over mid-parent, BG-23 x PN (26.67%) followed by NJ x PN (23.35%) over better parent and BG-23 x PN (36.71%) followed by BG-65 x RBG (33.85%) over check (Kashi Ganag) were found by Sanjavani *et al.* (2020) presented in Table 8.

Number of primary branches per plant

Estimates of relative heterosis among the crosses for the number of primary branches per plant under environment I, it was observed that the mid-parent heterosis ranged from -22.43% (NJ x RBG) to 32.56% (BG-65 x BG-21-2) with maximum in BG-65 x BG-21-2 (32.56%), BG-23 x BG-21-2 (31.03%) and BG-23 x RBG (30.93%) over relative heterosis. Heterobeltiosis ranged from -26.11% (NJ x RBG) to 27.58% (BG-23 x RBG) with maximum in BG-23 x RBG (27.58%), BG-65 x BG-21-2 (25.56%) and BG-23 x BG-21-2 (25.34%).. Standard heterosis ranged from -19.73 (NJ x RBG) to 25.46% (BG-23 x RBG) with the maximum in BG-23 x RBG (25.46%), NJ x PN (25.01%) and PN x NJ (22.01%). In environment II, recorded that the mid parent heterosis ranged from -17.95% (NJ x BG-65) to 38.66% (BG-23

Table 3 : Estimation of heterosis for days to first harvest.

	Heterosis (%) (Days to first Harvesting)									
		E1			E2			E3		
F1	**Cross**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
1*2	NJ x BG-23	-10.76**	-13.27**	-7.61	-14.05**	-14.52**	-14.05**	-18.43**	-20.57**	-14.43**
1*3	NJ x BG-65	-17.65**	-17.86**	-12.50**	-7.57*	-8.06	-7.57	0.96	0.48	8.25
1*4	NJ x PN	-10.36**	-11.73**	-5.98	-18.92**	-19.35**	-18.92**	-25.55**	-26.79**	-21.13**
1*5	NJ x BG-21-2	-7.09	-9.69*	-3.80	-9.92**	-11.11**	-9.19*	-6.57	-8.13	-1.03
1*6	NJ x RBG	-17.77**	-20.92**	-15.76**	0.00	-0.54	-1.08	-6.27	-10.53*	-3.61
2*1	BG-23 x NJ	-8.66*	-11.22**	-5.43	-1.08	-1.61	-1.08	-7.62	-10.05*	-3.09
2*3	BG -23 x BG-65	-4.74	-7.18	-1.63	-15.59**	-15.59**	-15.14**	-10.62**	-12.56**	-6.70
2*4	BG-23 x PN	-6.67	-7.89	-4.89	-8.06*	-8.06	-7.57	1.50	0.50	4.64
2*5	BG-23 x BG-21-2	-5.41	-5.41	-4.89	-7.20	-7.94	-5.95	2.50	1.49	5.67
2*6	BG-23 x RBG	-16.39**	-17.30**	-16.85**	-15.22**	-16.13**	-15.68**	-18.04**	-19.70**	-18.04**
3*1	BG-65 x NJ	-11.00**	-11.22**	-5.43	-7.57*	-8.06	-7.57	-10.10**	-10.53*	-3.61
3*2	BG-65 x BG-23	-9.47**	-11.79**	-6.52	-5.38	-5.38	-4.86	1.73	-0.48	6.19
3*4	BG-65 x PN	-11.69**	-12.82**	-7.61	-13.44**	-13.44**	-12.97**	-12.47**	-13.53**	-7.73
3*5	BG-65 x BG-21-2	-5.26	-7.69	-2.17	1.87	1.06	3.24	-2.69	-3.86	2.58
3*6	BG-65 x RBG	-8.51*	-11.79**	-6.52	-5.43	-6.45	-5.95	-8.31	-12.08**	-6.19
4*1	PN x NJ	-21.24**	-22.45**	-17.39**	-18.38**	-18.82**	-18.38**	-24.57**	-25.84**	-20.10**
4*2	PN x BG-23	-3.47	-4.74	-1.63	0.00	0.00	0.54	-6.00	-6.93	-3.09
4*3	PN x BG-65	-8.57*	-9.74*	-4.35	-1.08	-1.08	-0.54	-8.56*	-9.66*	-3.61
4*5	PN x BG-21-2	-15.20**	-16.32**	-13.59**	-10.40**	-11.11**	-9.19*	-10.40**	-10.40*	-6.70
4*6	PN x RBG	-9.43*	-11.58**	-8.70	-8.15*	-9.14*	-8.65*	-6.12	-8.91	-5.15
5*1	BG-21-2 x NJ	-14.44**	-16.84**	-11.41**	-6.70	-7.94	-5.95	-7.54	-9.09	-2.06
5*2	BG-21-2 x BG-23	-14.59**	-14.59**	-14.13**	-16.80**	-17.46**	-15.68**	2.00	0.99	5.15
5*3	BG-21-2 x BG-65	-16.32**	-18.46**	-13.59**	1.87	1.06	3.24	-4.16	-5.31	1.03
5*4	BG -21-2 x PN	-1.33	-2.63	0.54	-6.67	-7.41	-5.41	-2.97	-2.97	1.03
5*6	BG-21-2 x RBG	-1.64	-2.70	-2.17	-5.12	-6.88	-4.86	-2.55	-5.45	-1.55
6*1	RBG x NJ	-10.34**	-13.78**	-8.15	-18.58**	-19.02**	-19.46**	-18.30**	-22.01**	-15.98**
6*2	RBG x BG-23	-4.37	-5.41	-4.89	-8.70*	-9.68*	-9.19*	-3.61	-5.56	-3.61
6*3	RBG x BG-65	-17.55**	-20.51**	-15.76**	-5.98	-6.99	-6.49	-9.32*	-13.04**	-7.22
6*4	RBG x PN	-17.52**	-19.47**	-16.85**	-2.17	-3.23	-2.70	-21.43**	-23.76**	-20.62**
6*5	RBG x BG-21-2	-1.64	-2.70	-2.17	-16.98**	-18.52**	-16.76**	-4.08	-6.93	-3.09
	S.Ed (±)	2.22	2.56	2.56	2.15	2.48	2.48	2.62	3.03	3.03
	CD 5%	4.75	5.49	5.49	4.60	5.31	5.31	5.63	6.50	6.50

Table 4 : Estimation of heterosis for number of nodes to first male flower appearance.

	Heterosis (%) (No.of nodes to first male flower appearance)									
		E1			E2			E3		
F1	**Cross**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
1*2	NJ x BG-23	-10.53*	-10.53	-5.56	-29.87**	-32.50**	-15.63**	-11.63*	-13.64**	-9.52
1*3	NJ x BG-65	-13.51**	-15.79**	-11.11	-15.38**	-17.50**	3.12	-16.28**	-18.18**	-14.29**
1*4	NJ x PN	-40.00**	-42.86**	-33.33**	-21.05**	-25.00**	-6.25	-22.73**	-26.09**	-19.05**
1*5	NJ x BG-21-2	-21.05**	-21.05**	-16.67**	-15.38**	-17.50**	3.12	-20.00**	-25.00**	-14.29**
1*6	NJ x RBG	-14.29**	-21.05**	-16.67**	13.51**	5.00	31.25**	-9.52	-9.52	-9.52
2*1	BG-23 x NJ	-26.32**	-26.32**	-22.22**	-22.08**	-25.00**	-6.25	-11.63*	-13.64**	-9.52
2*3	BG -23 x BG-65	-18.92**	-21.05**	-16.67**	-25.33**	-26.32**	-12.50*	-22.73**	-22.73**	-19.05**

Table 4 continued...

Table 4 continued...

2*4	BG-23 x PN	-20.00**	-23.81**	-11.11	-20.55**	-21.62**	-9.38	-11.11*	-13.04**	-4.76
2*5	BG-23 x BG-21-2	-21.05**	-21.05**	-16.67**	4.00	2.63	21.88**	0.00	-4.17	9.52
2*6	BG-23 x RBG	-31.43**	-36.84**	-33.33**	-15.49**	-18.92**	-6.25	-6.98	-9.09	-4.76
3*1	BG-65 x NJ	-2.70	-5.26	0.00	0.00	-2.50	21.88**	-16.28**	-18.18**	-14.29**
3*2	BG-65 x BG-23	-18.92**	-21.05**	-16.67**	-4.00	-5.26	12.50*	-22.73**	-22.73**	-19.05**
3*4	BG-65 x PN	-7.69	-14.29**	0.00	-10.81**	-13.16**	3.12	-11.11*	-13.04**	-4.76
3*5	BG-65 x BG-21-2	-35.14**	-36.84**	-33.33**	-23.68**	-23.68**	-9.38	-34.78**	-37.50**	-28.57**
3*6	BG-65 x RBG	0.00	-5.56	-5.56	-2.78	-7.89	9.38	-16.28**	-18.18**	-14.29**
4*1	PN x NJ	-20.00**	-23.81**	-11.11	-21.05**	-25.00**	-6.25	-9.09	-13.04**	-4.76
4*2	PN x BG-23	-30.00**	-33.33**	-22.22**	-26.03**	-27.03**	-15.63**	-15.56**	-17.39**	-9.52
4*3	PN x BG-65	-33.33**	-38.10**	-27.78**	0.00	-2.63	15.62**	-6.67	-8.70	0.00
4*5	PN x BG-21-2	-15.00**	-19.05**	-5.56	-27.03**	-28.95**	-15.63**	-31.91**	-33.33**	-23.81**
4*6	PN x RBG	-13.51**	-23.81**	-11.11	-14.29**	-16.67**	-6.25	-22.73**	-26.09**	-19.05**
5*1	BG-21-2 x NJ	-10.53*	-10.53	-5.56	-5.13	-7.50	15.62**	-20.00**	-25.00**	-14.29**
5*2	BG-21-2 x BG-23	-10.53*	-10.53	-5.56	-20.00**	-21.05**	-6.25	-21.74**	-25.00**	-14.29**
5*3	BG-21-2 x BG-65	-35.14**	-36.84**	-33.33**	-23.68**	-23.68**	-9.38	0.00	-4.17	9.52
5*4	BG -21-2 x PN	-15.00**	-19.05**	-5.56	-18.92**	-21.05**	-6.25	-23.40**	-25.00**	-14.29**
5*6	BG-21-2 x RBG	-2.86	-10.53	-5.56	-8.33	-13.16**	3.12	-20.00**	-25.00**	-14.29**
6*1	RBG x NJ	-14.29**	-21.05**	-16.67**	-24.32**	-30.00**	-12.50*	-4.76	-4.76	-4.76
6*2	RBG x BG-23	-31.43**	-36.84**	-33.33**	-4.23	-8.11	6.25	-2.33	-4.55	0.00
6*3	RBG x BG-65	-11.76*	-16.67**	-16.67**	-5.56	-10.53*	6.25	-20.93**	-22.73**	-19.05**
6*4	RBG x PN	-24.32**	-33.33**	-22.22**	-22.86**	-25.00**	-15.63**	-18.18**	-21.74**	-14.29**
6*5	RBG x BG-21-2	-14.29**	-21.05**	-16.67**	-16.67**	-21.05**	-6.25	-11.11*	-16.67**	-4.76
	S.Ed (±)	0.30	0.34	0.34	0.48	0.56	0.56	0.33	0.38	0.38
	CD 5%	0.63	0.73	0.73	1.03	1.19	1.19	0.70	0.81	0.81

Table 5 : Estimation of heterosis for number of nodes to first female flower appearance.

	Heterosis (%) (No. of nodes to first female flower appearance)									
		E1			E2			E3		
F1	**Cross**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
1*2	NJ x BG-23	-23.94**	-25.00**	-22.86**	-19.27**	-20.00**	-13.73**	-17.14**	-19.44**	-14.71**
1*3	NJ x BG-65	-12.33**	-15.79**	-8.57	-17.12**	-19.30**	-9.80	-12.33**	-17.95**	-5.88
1*4	NJ x PN	-18.31**	-19.44**	-17.14**	-18.87**	-20.37**	-15.69**	-11.43**	-13.89**	-8.82
1*5	NJ x BG-21-2	-13.89**	-16.22**	-11.43**	-15.89**	-16.67**	-11.76*	-10.81**	-17.50**	-2.94
1*6	NJ x RBG	-11.43**	-11.43**	-11.43**	8.57*	5.56	11.76*	-13.04**	-14.29**	-11.76*
2*1	BG-23 x NJ	-9.86**	-11.11**	-8.57	-11.93**	-12.73**	-5.88	-5.71	-8.33	-2.94
2*3	BG -23 x BG-65	-18.92**	-21.05**	-14.29**	-30.36**	-31.58**	-23.53**	-20.00**	-23.08**	-11.76*
2*4	BG-23 x PN	-19.44**	-19.44**	-17.14**	-19.63**	-21.82**	-15.69**	8.33	8.33	14.71**
2*5	BG-23 x BG-21-2	-28.77**	-29.73**	-25.71**	7.41	5.45	13.73**	-7.89	-12.50**	2.94
2*6	BG-23 x RBG	-23.94**	-25.00**	-22.86**	-11.32**	-14.55**	-7.84	-7.04	-8.33	-2.94
3*1	BG-65 x NJ	-23.29**	-26.32**	-20.00**	-13.51**	-15.79**	-5.88	-1.37	-7.69	5.88
3*2	BG-65 x BG-23	-27.03**	-28.95**	-22.86**	12.50**	10.53*	23.53**	-4.00	-7.69	5.88
3*4	BG-65 x PN	-24.32**	-26.32**	-20.00**	-15.60**	-19.30**	-9.80	-6.67	-10.26*	2.94
3*5	BG-65 x BG-21-2	-14.67**	-15.79**	-8.57	-10.91**	-14.04**	-3.92	-31.65**	-32.50**	-20.59**
3*6	BG-65 x RBG	-28.77**	-31.58**	-25.71**	11.11**	5.26	17.65**	-5.41	-10.26*	2.94
4*1	PN x NJ	-12.68**	-13.89**	-11.43**	-16.98**	-18.52**	-13.73**	-5.71	-8.33	-2.94
4*2	PN x BG-23	-19.44**	-19.44**	-17.14**	-17.76**	-20.00**	-13.73**	-11.11**	-11.11*	-5.88

Table 5 continued...

Table 5 continued...

4*3	PN x BG-65	-24.32**	-26.32**	-20.00**	-11.93**	-15.79**	-5.88	-12.00**	-15.38**	-2.94
4*5	PN x BG-21-2	-20.55**	-21.62**	-17.14**	-29.52**	-30.19**	-27.45**	-23.68**	-27.50**	-14.71**
4*6	PN x RBG	-23.94**	-25.00**	-22.86**	-26.21**	-26.92**	-25.49**	-7.04	-8.33	-2.94
5*1	BG-21-2 x NJ	-25.00**	-27.03**	-22.86**	-19.63**	-20.37**	-15.69**	0.00	-7.50	8.82
5*2	BG-21-2 x BG-23	-23.29**	-24.32**	-20.00**	-12.96**	-14.55**	-7.84	-13.16**	-17.50**	-2.94
5*3	BG-21-2 x BG-65	-22.67**	-23.68**	-17.14**	-18.18**	-21.05**	-11.76*	-8.86*	-10.00*	5.88
5*4	BG -21-2 x PN	-15.07**	-16.22**	-11.43**	-20.00**	-20.75**	-17.65**	-2.63	-7.50	8.82
5*6	BG-21-2 x RBG	-25.00**	-27.03**	-22.86**	-15.38**	-16.98**	-13.73**	-12.00**	-17.50**	-2.94
6*1	RBG x NJ	-11.43**	-11.43**	-11.43**	-18.10**	-20.37**	-15.69**	-7.25	-8.57	-5.88
6*2	RBG x BG-23	-21.13**	-22.22**	-20.00**	-11.32**	-14.55**	-7.84	-23.94**	-25.00**	-20.59**
6*3	RBG x BG-65	-12.33**	-15.79**	-8.57	-18.52**	-22.81**	-13.73**	-27.03**	-30.77**	-20.59**
6*4	RBG x PN	-23.94**	-25.00**	-22.86**	-16.50**	-17.31**	-15.69**	-7.04	-8.33	-2.94
6*5	RBG x BG-21-2	-19.44**	-21.62**	-17.14**	-19.23**	-20.75**	-17.65**	-12.00**	-17.50**	-2.94
	S.Ed (±)	0.42	0.49	0.49	0.68	0.79	0.79	0.50	0.58	0.58
	CD 5%	0.90	1.04	1.04	1.46	1.69	1.69	1.07	1.24	1.24

Table 6 : Estimation of heterosis for vine length at the time final harvesting (m).

	Heterosis (%) (Vine length at the time of final harvesting (m))									
		E1			E2			E3		
F1	**Cross**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
1*2	NJ x BG-23	10.48	10.17	3.78	8.64	3.39	4.17	24.61**	24.03**	18.69**
1*3	NJ x BG-65	10.53	9.99	3.03	35.21**	34.85**	22.73**	7.19	0.11	10.38
1*4	NJ x PN	21.81**	18.69**	17.19**	7.22	4.32	0.37	7.76	7.25	3.61
1*5	NJ x BG-21-2	16.18**	14.20*	6.97	34.88**	28.83**	28.81**	24.37**	19.51**	24.05**
1*6	NJ x RBG	19.04**	17.05**	9.63	23.21**	18.87*	16.38*	15.05*	13.72	11.39
2*1	BG-23 x NJ	11.50*	11.19	4.74	16.35*	10.72	11.56	25.22**	24.64**	19.27**
2*3	BG -23 x BG-65	15.80**	14.92*	8.25	3.08	-2.15	-1.42	16.94**	8.75	19.90**
2*4	BG-23 x PN	17.51**	14.80*	13.36*	8.67	6.22	7.02	9.10	8.09	4.42
2*5	BG-23 x BG-21-2	26.92**	24.41**	17.19**	12.39	11.96	12.80	7.07	2.44	6.33
2*6	BG-23 x RBG	15.39**	13.15*	6.58	-0.47	-1.88	-1.14	24.69**	22.69**	20.18**
3*1	BG-65 x NJ	23.84**	23.24**	15.43**	13.49	13.19	3.02	8.42	1.26	11.65
3*2	BG-65 x BG-23	17.34**	16.44**	9.69	14.69*	8.87	9.69	-1.85	-8.73	0.63
3*4	BG-65 x PN	28.39**	24.51**	22.94**	32.24**	28.33**	23.47**	16.74**	9.51	20.74**
3*5	BG-65 x BG-21-2	20.24**	18.76**	10.16	13.75	8.37	8.36	5.26	2.18	12.66
3*6	BG-65 x RBG	26.60**	25.07**	16.02**	34.36**	29.29**	26.59**	3.36	-2.41	7.59
4*1	PN x NJ	21.70**	18.58**	17.08**	49.82**	45.77**	40.26**	7.95	7.45	3.80
4*2	PN x BG-23	12.75*	10.16	8.77	10.02	7.55	8.36	16.39*	15.31*	11.39
4*3	PN x BG-65	21.72**	18.04**	16.55**	46.53**	42.19**	36.81**	15.99**	8.81	19.96**
4*5	PN x BG-21-2	12.23*	7.53	6.17	1.40	-0.51	-0.53	4.85	1.22	5.06
4*6	PN x RBG	23.50**	18.36**	16.87**	10.26	9.31	7.02	8.00	7.26	5.06
5*1	BG-21-2 x NJ	26.01**	23.86**	16.02**	37.81**	31.63**	31.61**	14.21*	9.76	13.92
5*2	BG-21-2 x BG-23	26.80**	24.29**	17.08**	9.73	9.31	10.13	22.31**	17.02*	21.46**
5*3	BG-21-2 x BG-65	15.60**	14.17*	5.91	7.66	2.57	2.55	12.95*	9.64	20.89**
5*4	BG -21-2 x PN	8.44	3.90	2.59	11.82	9.71	9.69	13.70*	9.76	13.92
5*6	BG-21-2 x RBG	19.38**	19.34**	8.04	4.12	3.04	3.02	10.43	7.32	11.39
6*1	RBG x NJ	11.82*	9.94	2.98	6.25	2.51	0.37	10.47	9.20	6.96
6*2	RBG x BG-23	14.09**	11.86	5.38	18.04**	16.37*	17.25*	26.06**	24.04**	21.49**
6*3	RBG x BG-65	18.47**	17.04**	8.57	19.73**	15.21	12.80	16.12**	9.64	20.89**
6*4	RBG x PN	27.55**	22.24**	20.70**	21.71**	20.66**	18.14*	5.40	4.68	2.53
6*5	RBG x BG-21-2	13.79*	13.76*	2.98	14.90*	13.71	13.69	-1.49	-4.27	-0.63
	S.Ed (±)	0.30	0.35	0.35	0.47	0.54	0.54	0.31	0.36	0.36
	CD 5%	0.65	0.75	0.75	1.01	1.17	1.17	0.67	0.78	0.78

Table 7 : Estimation of heterosis for inter-nodal length (cm).

	Heterosis (%) (Inter-nodal Length (cm))									
		E1			E2			E3		
F1	**Cross**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
1*2	NJ x BG-23	-9.46*	-14.96**	9.27	-2.10	-11.03*	17.71**	12.56**	5.36	22.86**
1*3	NJ x BG-65	-7.48	-15.67**	15.68**	-20.82**	-22.73**	7.42	-19.18**	-24.83**	1.92
1*4	NJ x PN	0.26	-1.64	15.41**	-23.75**	-27.62**	-4.24	-20.67**	-21.51**	-8.47
1*5	NJ x BG-21-2	-12.38**	-12.86*	-1.63	-9.22	-10.16	18.87**	-1.60	-5.59	19.80**
1*6	NJ x RBG	-14.23**	-19.35**	3.39	-24.34**	-26.03**	-2.14	-19.90**	-20.25**	-7.01
2*1	BG-23 x NJ	-5.66	-11.39*	13.86*	-1.84	-10.80*	18.02**	7.01	0.17	16.81**
2*3	BG -23 x BG-65	-13.96**	-16.68**	14.29*	-13.25**	-22.89**	7.21	-13.33**	-24.17**	2.82
2*4	BG-23 x PN	-14.87**	-18.57**	4.64	-13.80**	-17.68**	-2.15	-13.82**	-18.51**	-7.01
2*5	BG-23 x BG-21-2	-23.61**	-28.61**	-8.27	-9.81	-17.26**	7.21	-8.95*	-17.99**	4.07
2*6	BG-23 x RBG	-18.57**	-18.67**	4.51	-25.23**	-30.62**	-12.32	-25.74**	-30.21**	-19.32**
3*1	BG-65 x NJ	2.24	-6.82	27.82**	-5.50	-7.78	28.21**	1.61	-5.50	28.14**
3*2	BG-65 x BG-23	-14.15**	-16.86**	14.04*	-20.79**	-29.59**	-2.11	-20.76**	-30.67**	-5.99
3*4	BG-65 x PN	-24.37**	-29.84**	-3.76	-0.57	-7.78	28.21**	1.45	-6.58	26.67**
3*5	BG-65 x BG-21-2	-18.21**	-25.82**	1.75	-34.64**	-36.86**	-12.22	-34.91**	-37.00**	-14.58**
3*6	BG-65 x RBG	-22.08**	-24.63**	3.38	-10.90*	-14.95**	18.24**	-4.98	-11.99**	19.33**
4*1	PN x NJ	-0.72	-2.61	14.29*	-22.14**	-26.09**	-2.21	-20.67**	-21.51**	-8.47
4*2	PN x BG-23	-16.30**	-19.93**	2.88	0.74	-3.80	14.35*	2.20	-3.37	10.28
4*3	PN x BG-65	-24.77**	-30.20**	-4.26	-8.71	-15.33**	17.71**	-3.62	-11.25**	20.34**
4*5	PN x BG-21-2	-9.38*	-11.58*	3.76	-17.33**	-20.75**	2.70	-19.64**	-23.69**	-3.16
4*6	PN x RBG	-4.97	-8.99	16.67**	-2.90	-5.79	19.07**	0.64	0.00	15.59**
5*1	BG-21-2 x NJ	-16.84**	-17.30**	-6.64	-24.94**	-25.71**	-1.72	-22.60**	-25.73**	-5.76
5*2	BG-21-2 x BG-23	-15.26**	-20.81**	1.75	0.18	-8.10	19.08**	4.95	-5.47	19.95**
5*3	BG-21-2 x BG-65	-22.95**	-30.11**	-4.14	-39.17**	-41.24**	-18.31**	-35.86**	-37.92**	-15.82**
5*4	BG -21-2 x PN	-11.13*	-13.28**	1.75	-27.70**	-30.69**	-10.19	-6.24	-10.95*	12.99*
5*6	BG-21-2 x RBG	-19.85**	-25.02**	-3.88	-7.61	-8.75	18.24**	-0.55	-4.98	20.57**
6*1	RBG x NJ	-14.65**	-19.75**	2.88	-18.82**	-20.63**	5.01	-27.49**	-27.81**	-15.82**
6*2	RBG x BG-23	-11.64**	-11.75**	13.40*	-8.58	-15.17**	7.21	4.00	-2.25	12.99*
6*3	RBG x BG-65	-30.68**	-32.94**	-8.02	-10.27*	-14.35**	19.08**	-7.15	-14.00**	16.61**
6*4	RBG x PN	1.77	-2.54	24.94**	-22.88**	-25.18**	-5.44	-24.74**	-25.22**	-13.56*
6*5	RBG x BG-21-2	-12.85**	-18.48**	4.51	0.18	-1.05	28.21**	2.52	-2.05	24.29**
	S.Ed (±)	0.39	0.45	0.45	0.54	0.62	0.62	0.41	0.48	0.48
	CD 5%	0.83	0.96	0.96	1.15	1.33	1.33	0.88	1.02	1.02

Table 8 : Estimation of heterosis for peduncle length (cm).

	Heterosis (%) (Peduncle length (cm))									
		E1			E2			E3		
F1	**Cross**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
1*2	NJ x BG-23	-3.81	-4.26	29.52**	10.53	7.35	16.19*	6.04	5.25	13.60*
1*3	NJ x BG-65	6.95	3.33	39.78**	-6.93	-15.82**	6.15	-5.50	-8.96	4.44
1*4	NJ x PN	18.27**	0.78	36.33**	17.69**	17.29**	20.47**	27.30**	23.35**	31.15**
1*5	NJ x BG-21-2	27.68**	20.94**	63.60**	-10.65	-15.02*	-3.92	3.25	0.46	6.81
1*6	NJ x RBG	6.12	-0.27	53.37**	-18.97**	-19.35**	-16.96*	-13.34**	-17.95**	-2.37
2*1	BG-23 x NJ	13.91**	13.38**	53.37**	8.30	5.19	13.85	13.85**	13.01*	21.97**
2*3	BG -23 x BG-65	-8.28	-10.99*	19.29**	1.04	-6.12	18.39**	16.78**	13.33*	30.01**

Table 8 continued...

Table 8 continued...

2*4	BG-23 x PN	7.03	-8.44	22.70**	24.83**	21.65**	31.67**	31.67**	26.67**	36.71**
2*5	BG-23 x BG-21-2	12.27**	6.82	43.15**	6.30	4.03	17.62*	23.83**	19.62**	29.11**
2*6	BG-23 x RBG	-0.52	-6.91	43.15**	15.02**	12.22	21.46**	6.49	1.54	20.82**
3*1	BG-65 x NJ	-8.72	-11.82*	19.29**	4.37	-5.60	19.03**	-4.56	-8.05	5.48
3*2	BG-65 x BG-23	-8.28	-10.99*	19.29**	19.31**	10.86	39.79**	12.72**	9.38	25.48**
3*4	BG-65 x PN	-7.62	-18.92**	2.25	16.09**	5.33	32.82**	17.03**	9.38	25.48**
3*5	BG-65 x BG-21-2	-15.75**	-17.46**	4.09	13.78**	7.90	36.06**	20.44**	13.02*	29.65**
3*6	BG-65 x RBG	-29.37**	-35.73**	-1.16	24.07**	12.69*	42.10**	14.55**	12.49*	33.85**
4*1	PN x NJ	15.32**	-1.74	32.92**	11.21	10.83	13.84	3.44	0.23	6.57
4*2	PN x BG-23	4.06	-10.99*	19.29**	19.14**	16.10*	25.66**	4.40	0.43	8.39
4*3	PN x BG-65	1.62	-10.81*	12.47	4.73	-4.98	19.81**	-7.83	-13.85**	-1.17
4*5	PN x BG-21-2	26.08**	12.68*	36.33**	-3.89	-8.29	3.69	-3.15	-3.57	-3.00
4*6	PN x RBG	-15.15**	-31.29**	5.66	4.95	4.82	7.93	-6.31	-13.90**	2.45
5*1	BG-21-2 x NJ	-25.52**	-29.45**	-4.57	-14.30**	-18.50**	-7.85	-17.83**	-20.05**	-14.99*
5*2	BG-21-2 x BG-23	-19.81**	-23.70**	2.25	-9.55	-11.48	0.08	-11.01*	-14.04*	-7.22
5*3	BG-21-2 x BG-65	-0.69	-2.70	22.70**	-12.01*	-16.56**	5.21	7.30	0.69	15.51*
5*4	BG -21-2 x PN	-2.29	-12.68*	5.66	-13.82*	-17.77**	-7.03	3.11	2.67	3.27
5*6	BG-21-2 x RBG	-28.06**	-35.73**	-1.16	-6.68	-10.85	0.80	-12.71**	-19.46**	-4.17
6*1	RBG x NJ	20.27**	13.03**	73.82**	16.03**	15.49*	18.91**	-3.40	-8.54	8.83
6*2	RBG x BG-23	-0.52	-6.91	43.15**	18.76**	15.87*	25.41**	7.31	2.32	21.75**
6*3	RBG x BG-65	-0.15	-9.13*	39.74**	14.03**	3.57	30.60**	6.20	4.29	24.09**
6*4	RBG x PN	4.01	-15.78**	29.52**	15.65**	15.51*	18.94**	20.75**	10.98*	32.05**
6*5	RBG x BG-21-2	4.19	-6.91	43.15**	18.01**	12.74*	27.47**	16.38**	7.38	27.77**
	S.Ed (±)	0.54	0.62	0.62	0.70	0.81	0.81	0.62	0.72	0.72
	CD 5%	1.15	1.33	1.33	1.50	1.74	1.74	1.34	1.55	1.55

Table 9 : Estimation of heterosis for number of primary branches.

	Heterosis (%) (Number of primary branches per plant)									
		E1			**E2**			**E3**		
F1	**Cross**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
1*2	NJ x BG-23	-2.68	-9.55	-1.74	-1.59	-11.04	6.51	6.89	6.10	6.10
1*3	NJ x BG-65	-18.05**	-23.10**	-16.46**	-17.95**	-24.96**	-10.15	4.82	3.30	1.76
1*4	NJ x PN	20.46**	15.08**	25.01**	27.99**	17.44**	40.61**	26.25**	25.70**	23.83**
1*5	NJ x BG-21-2	1.24	-9.68	-1.88	4.98	-2.08	17.24*	7.59	3.49	10.35
1*6	NJ x RBG	-22.43**	-26.11**	-19.73**	-13.53*	-16.64**	-0.19	-0.49	-0.87	-2.34
2*1	BG-23 x NJ	16.40**	8.19	17.53**	7.96	-2.40	16.86*	11.57	10.74	10.74
2*3	BG -23 x BG-65	-8.68	-9.61	-13.90*	1.83	0.53	-0.19	23.99**	21.29**	21.29**
2*4	BG-23 x PN	26.63**	23.04**	21.71**	38.66**	36.40**	36.40**	20.95**	19.53**	19.53**
2*5	BG-23 x BG-21-2	31.03**	25.34**	16.95**	17.03**	13.14	17.24*	7.19	3.86	10.74
2*6	BG-23 x RBG	30.93**	27.58**	25.46**	35.85**	27.07**	41.19**	22.66**	21.29**	21.29**
3*1	BG-65 x NJ	-11.95*	-17.38**	-10.25	8.64	-0.64	18.97**	18.10**	16.38*	14.65
3*2	BG-65 x BG-23	-8.52	-9.45	-13.75*	2.22	0.92	0.19	15.41*	12.89	12.89
3*4	BG-65 x PN	13.29**	11.19	9.99	21.89**	21.46**	21.46**	7.51	6.40	3.91
3*5	BG-65 x BG-21-2	32.56**	25.56**	19.59**	28.40**	25.71**	30.27**	-3.83	-8.78	-2.73
3*6	BG-65 x RBG	-3.60	-5.12	-6.69	13.82*	7.76	19.73**	25.83**	24.47**	21.68**
4*1	PN x NJ	17.57**	12.31*	22.01**	24.50**	14.24*	36.78**	17.29**	16.78*	15.04
4*2	PN x BG-23	-11.36*	-13.87*	-14.81**	3.99	2.30	2.30	1.19	0.00	0.00

Table 9 continued...

Table 9 continued...

4*3	PN x BG-65	-0.17	-2.03	-3.09	19.78**	19.35**	19.35**	27.72**	26.40**	23.44**
4*5	PN x BG-21-2	19.80**	11.49	10.29	34.16**	31.82**	36.59**	31.75**	26.20**	34.57**
4*6	PN x RBG	-15.30**	-15.54**	-16.46**	12.70*	7.07	18.97**	13.34	13.28	10.74
5*1	BG-21-2 x NJ	3.41	-7.75	0.22	5.33	-1.76	17.62*	14.25*	9.90	17.19*
5*2	BG-21-2 x BG-23	30.69**	25.01**	16.65**	23.72**	19.61**	23.95**	19.85**	16.13*	23.83**
5*3	BG-21-2 x BG-65	12.92*	6.96	1.87	9.52	7.23	11.11	1.00	-4.20	2.15
5*4	BG -21-2 x PN	3.48	-3.70	-4.74	6.69	4.82	8.62	-8.60	-12.45	-6.64
5*6	BG-21-2 x RBG	12.16*	4.66	2.92	4.74	1.21	12.45	8.36	3.86	10.74
6*1	RBG x NJ	8.17	3.04	11.94*	7.39	3.52	23.95**	5.88	5.48	3.91
6*2	RBG x BG-23	-7.64	-10.00	-11.50	-3.59	-9.83	0.19	9.43	8.20	8.20
6*3	RBG x BG-65	21.43**	19.52**	17.53**	15.46**	9.31	21.46**	27.65**	26.27**	23.44**
6*4	RBG x PN	11.82*	11.49	10.29	12.70*	7.07	18.97**	-11.05	-11.09	-13.09
6*5	RBG x BG-21-2	-0.12	-6.80	-8.35	2.42	-1.03	9.96	-17.05**	-20.51**	-15.23
	S.Ed (±)	0.31	0.36	0.36	0.31	0.36	0.36	0.32	0.37	0.37
	CD 5%	0.66	0.77	0.77	0.67	0.77	0.77	0.68	0.79	0.79

x PN), with the maximum in BG-23 x PN (38.66%), BG-23 x RBG (35.85%) and PN x BG-21-2 (34.16%). F_1 hybrid BG-23 x PN (36.40%), PN x BG-21-2 (31.82%) and BG-23 x RBG (27.07%) showed maximum positive heterobeltiosis, while F_1 hybrids BG-23 x RBG (41.19%) followed by NJ x PN (40.61%) recorded the maximum positive significant heterosis over the standard check (Kashi Ganga). In environment III recorded that the mid parent heterosis ranged from -17.05% (RBG x BG-21-2) to 31.75% (PN x BG-21-2), with the maximum in PN x BG-21-2 (31.75%), PN x BG-65 (27.27%) and NJ x PN (26.25%) over mid parent and heterobeltiosis ranged from -17.05% (RBG x BG-21-2) to 26.40% (PN x BG-65) with maximum in PN x BG-65 (26.40%), RBG x BG-65 (26.27%) and PN x BG-21-2 (26.20%), however standard heterosis ranged from -15.22% (RBG x BG-21-2) to 34.57 (PN x BG-21-2) with maximum in PN x BG-21-2 (34.57%), BG-21-2 x BG-23 and NJ x PN (23.83%) showed over check (Kashi Ganga) results conformed with Singh *et al.* (2012), Gaykawad *et al.* (2016) presented in Table 9.

Conclusion

Finally concluded that, on the basis of standard heterosis for earliness trait, the F_1 hybrids *viz.*,NJ x PN, PN x NJ, BG-23 x RBG and RBG x PN exhibited significant and better standard heterosis over check (Kashi Ganga). For growth traits F_1 hybrids NJ x PN for vine length and primary branches and BG-65 x RBG for peduncle length showed significant and better standard heterosis over check (Kashi Ganga).

References

Anupam, A., Randhir K., Amit K. and Singh H.K. (2017). Estimation of gene action and heterosis in bottle gourd (*Lagenaria siceraria* (Mol). Standl.). *Environ. Ecol.*, **35(2A)**, 936-44.

Chandramouli, B., Reddy R.V., Rao M.P., Babu M.R., Jyothi K.U. and Umakrishna K. (2021). Studies on heterosis and inbreeding depression in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.). *J. Pharma Innov.*, **5**, 1501-1506

Gayakawad, P.S., Evoor S., Mulge R., Reshmika P.K. and Nagesh G.C. (2016). Heterosis studies in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] for growth and yield parameters. *Environ. Ecol*., **34(4)**, 1756-1763.

Khot, R.K., Evoor S., Gasti V.D., Koulagi S. and Masuthi D.A. (2018). Estimation of heterosis in the advanced lines of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] for growth, earliness and yield parameters. *Int. J. Curr. Microbiol. Appl. Sci*., **7(9)**, 3375-84.

Kumar, P., Yadav G.C. and Ram C.R. (2021). Study the general and specific combing ability in bottle gourd [*Lagenaria siceraria* (Mol.) Standl]. *The Pharma Innov. J*., **10(8)**, 1400-1411

Panse, V.G. and Sukhatme P.V. (1967). *Statistical Methods for Agricultural Workers*, ICAR, New Delhi, pp. 1-381.

Rambabu, E., Mandal A., Das S., Hazra P. and Thapa U. (2021). Heterosis studies in bottle gourd [*Lagenaria siceraria* (Mol.) Standley.]. *J. Crop Weed*, **17(2)**, 145-151.

Sanjivani, P., Gondane M.N., Bhalekar and Kshirsagar D.B. (2020). Exploitation of heterosis in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) for earliness, yield and yield contributing traits. *Int. J. Pharmacog. Phytochem*., **9(2)**, 777-783.

Singh, S.K., Upadhyay A.K., Pandey J. and Pandey A.K. (2012). Studies on heterosis and combining ability in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) for yield traits. *Annals of Horticulture*, **5(2)**, 246-251.