International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 10 Issue 12 Series I || December 2021 || PP 70-72

Estimates of Heterosis for Horticultural Traits in Bittergourd

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ABSTRACT
Fifteen non reciprocal F_1 hybrids derived from six diverse genotypes of bittergourd were evaluated in randomized block design (RBD) with three replications during summer 2019 to study heterosis over better parents and the check cultivar, Kalyanpur Barahmasi. Summing up the results on earliness, vegetative characters and yield and its components, the hybrids PBIG-2 X PBIG-1, PBIG-2 X Priya White and PBIG-1 X Kalyanpur Sona were found to be the most promising. Heterosis to the tune of 82.86 %, 77.57 % and 50.02 % over the check were evidenced by these three hybrids for yield per plant, respectively. Therefore, these three hybrids deserve further evaluations at multilocation and commercial exploitation.

I. INTRODUCTION

Bittergourd is one of the most nutritive and important cucurbitaceous vegetables grown throughout India as well as in Southeast Asian countries. The fruits are rich in several minerals and vitamins and have got medicinal properties too (Whitaker and Davis, 1962). Being monoecious in sex expression, it is highly cross-pollinated, which has resulted in variations in several qualitative and quantitative traits like fruit size, shape, number, weight and total yield in India. It is a well-known fact that heterosis breeding is a quick, cheap and easy method of crop improvement in case of cross pollinated crops, one like bittergourd (Kolhe, 1972 and Whitaker and Davis, 1962). As mentioned above, a wide range of genetic variability is available in our country, which envisages ample scope of its improvement through heterosis breeding (Ram *et al*., 1997). Although, early workers have reported heterosis for yield and yield attributing characters in bittergourd, very few commercial F_1hybrid have been released from public sector so far. It was therefore, felt necessary to make a beginning in this direction with a view to evolving high yielding quality F_1 hybrids through heterosis breeding.

II. MATERIALS AND METHODS

The materials comprised of 15 F_1 hybrids developed throughhalf diallel mating system from six geographically diverse parental lines of bittergourd. The parental lines used were PBIG-2, PBIG-4, PBIG-1, Kalyanpur Sona, Kalyanpur Barahmasi andPriya White. All the 21 genotypes were evaluated in summer 2019 following randomized blockdesign (RBD) with three replications. The seeds were sown in polythene bags, in February, 2019 and were kept under plastic house. Transplanting in the field was done in April, 2019, maintaining a spacing of 2.0 X 0.75 m. Care was taken to do the gap filling within seven days of transplanting. Data were taken on five random plants excluding the border plants on individual plant basis. The nine traits studied were days to first female flowering, nodal position of first female flower, main vine length (m), number of primary branches per plant, fruit length (cm), fruit diameter (cm), fruit weight (g), number of fruits per plant and fruit yield per plant (g). Heterosis was estimated as percentage deviation of the F_1 mean over better parent (heterobeltiosis) and the check cultivar, Kalyanpur Barahmasi (standard heterosis) for each cross for all the traits and their significance was tested by 't-test'.

III. RESULTS AND DISCUSSION

The mean square estimates were significant for all the characters studied, indicating sufficient genetic diversity among the genotypes (Table 1). The mean values for different horticultural traits studied were calculated and presented in Table 2. Estimates of heterosis of the hybrids were calculated over their respective better parent and the standard check, Kalyanpur Barahmasi and presented in Table 3. In cucurbits, including bittergourd, days to first female flower anthesis and its nodal position are indices of earliness (Acharya*et al*., 2019; Rao*et al*., 2017). Importance of earliness is well recognized keeping in view of high market prices. Several crosses such as PBIG-2 X Kalyanpur Sona (-29.5 %), Kalyanpur Sona X Priya White (-16.2 %) and PBIG-4 X Priya White(-14.1 %) showed highly significant negative heterosis for number of days to first female flower anthesis. The crosses PBIG-2 X Kalyanpur Sona (-17.6 %) and PBIG-4 X Priya White (-11.8 %) also showed significant negative heterosis over their better parents for

this trait.Fornodal position of first female flower PBIG-4 X PBIG-1 (-63.6 %), Kalyanpur Sona X Kalyanpur Barahmasi (-43.4 %) and PBIG-2 X Kalyanpur Sona (-41.0. %) exhibited significant negative standard heterosis. It is noteworthy here that the negative values for the above two characters are an indication of earliness. The best hybrids for yield per plant *viz.* PBIG-2 X PBIG-1, PBIG-2 X Priya White and PBIG-1 X Kalyanpur Sona also showed earliness for days to first female flower anthesis and its nodal position, satisfying the basic assumption of production of hybrids.

Table 1: Analysis of variance for different horticultural traits in bittergourd

Source of variation	Degree of freedom	Days to anthesis of first female flower	Nodal position of first female flower	Vine length (m)	Number of primary branches per plant	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Number of fruits per plant	Fruit yield per plant
Replication	2	5.58	2.35	0.06	0.95	1.95	0.07	8.86	20.70	628.44
Genotype	21	46.54*	12.39*	0.46*	30.59*	36.84*	0.72*	263.41*	18.16*	979.20*
Error	40	4.38	1.53	0.03	1.91	0.89	0.02	8.32	9.82	443.82
CV (0.5)		4.65	14.25	5.21	6.38	5.3	3.9	4.9	13.38	14.93

* : Significant at 0.05 level of significance

Table 2: Mean values of parents and crosses for different horticultural traits in bittergourd

Genotypes	Days to anthesis of first female flower	Nodal position of first female flower	Vine length (m)	Number of primary branches per plant	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Number of fruits per plant	Fruit yield per plant
PBIG-2	42.40	7.82	3.08	3.27	14.12	3.27	46.92	14.11	662.04
PBIG-4	48.28	5.58	3.27	3.32	15.63	3.32	72.93	31.33	2284.90
PBIG-1	42.91	8.23	3.45	3.19	16.32	3.9	56.21	29.27	1645.27
K. S.	42.90	7.45	2.22	2.97	11.15	2.97	53.38	16.97	905.86
K. B.	49.54	12.50	3.27	2.36	17.16	2.36	50.10	20.33	1018.53
P. W.	53.75	11.91	3.48	3.76	18.98	3.76	69.39	23.01	1596.66
PBIG-2 X PBIG-4	46.57	8.94	3.16	4.22	19.26	4.22	74.06	20.38	1509.34
PBIG-2 X PBIG-1	42.63	7.93	3.14	3.91	16.81	3.91	74.92	34.16	2559.27
PBIG-2 X K. S.	34.92	7.44	2.27	3.60	13.50	3.60	50.27	28.18	1416.61
PBIG-2 X K. B.	50.28	11.09	3.83	3.15	17.11	3.15	66.17	29.88	1977.16
PBIG-2 X P. W.	52.78	9.76	3.10	3.71	18.16	3.71	72.39	34.30	2482.98
PBIG-4 X PBIG-1	45.16	4.58	3.38	3.92	18.26	3.92	66.57	13.05	868.74
PBIG-4 X K. S.	44.64	10.20	3.17	3.17	18.54	3.17	52.69	29.57	1558.04
PBIG-4 X K. B.	45.64	8.15	3.31	4.38	17.76	4.38	63.03	23.16	1459.77
PBIG-4 X P. W.	42.58	8.53	3.55	3.29	16.16	3.29	64.29	31.58	2030.28
PBIG-1 X K. S.	44.09	7.57	3.19	3.07	18.65	3.07	71.20	29.50	2100.40
PBIG-1 X K. B.	43.46	7.50	3.75	4.24	23.32	4.24	54.23	14.65	794.47
PBIG-1 X P. W.	49.10	8.27	3.39	3.40	18.57	3.40	50.61	11.86	600.23
K. S. X K. B.	46.67	7.13	3.43	3.07	19.43	3.07	66.43	19.69	1308.01
K. S. X P. W.	41.49	9.05	3.24	3.43	18.22	3.43	49.06	11.77	577.44
K. B. X P. W.	44.18	9.34	3.54	3.75	15.16	3.75	59.95	17.21	1031.74

K. S. ; Kalyanpur Sona, K. B. : Kalyanpur Barahmasi, P. W. : Priya White

Table 3: Estimates of heterobeltiosis and standard heterosis of bittergourd hybrids for different horticultural traits

Hybrids	Days to anthesis of first female flower		Nodal position of first female flower		Vine length (m)		Number of primary branches per plant		Fruit length (cm)		Fruit diameter (cm)		Fruit weight (g)		Number of fruits per plant		Fruit yield per plant	
	Hetero-beltiosis	Standard Heterosis	Hetero-beltiosis	Standard Heterosis	Hetero-beltiosis	Standard Heterosis	Hetero-beltiosis	Standard Heterosis	Hetero-beltiosis	Standard Heterosis	Hetero-beltiosis	Standard Heterosis	Hetero-beltiosis	Standard Heterosis	Hetero-beltiosis	Standard Heterosis	Hetero-beltiosis	Standard Heterosis
1 X 2	9.8*	-5.9	42.3*	-5.13	-3.5	-3.5	-32.0*	3.9	23.2	-29.1	27.0*	79.0*	1.6	47.8*	-35.0*	0.3	-33.8*	7.7
1 X 3	0.5	-13.9*	1.4	-36.9*	-9.1*	-4.1	-41.1*	-10	3	-38.1*	19.5*	66.0*	33.3*	49.5*	16.7	68.1*	55.5*	82.9*
1 X 4	-17.6*	-29.5*	-0.2	-41.0*	-26.2*	-30.6*	-13.6	32.1*	-4.4	-50.3*	10.1	52.8*	-5.8	0.3	-66.1*	38.6*	55.8*	1.2
1 X 5	18.6*	1.5	41.7*	-11.9	17.0*	17.0*	-30.1*	7	-37.0*	-37.1*	-3.9	33.5	32.1*	32.1*	47.0*	47.0*	41.2*	41.2*
1 X 6	0.9	-13.6*	24.8*	-22.4	-11.1*	-5.4	-28.9*	8.7	-4.3	-33.2	-1.2	57.5*	4.3	44.5*	49.1*	68.7*	55.7*	77.6*
2 X 3	5.4	-8.8	-17.9	-63.6*	-2	3.3	-12.6	-0.8	11.3	-33.2	18.0*	66.2*	-8.7	32.9*	-58.3*	-35.8*	-61.7*	-37.7*
2 X 4	4.1	-9.9	82.8*	-19	-3.1	-3.7	-23.7*	-2.6	18.6*	-31.8	-4.5	34.6	-27.7*	5.1	-6.5	44.0*	-32.3*	10.3
2 X 5	-5.5	-7.9	46.2*	-35.2*	1.2	1.2	-1.9	11.3	-34.6*	-34.7*	31.9*	85.9*	-13.6	25.8*	-26.1*	14	-36.0*	4.2
2 X 6	-11.8*	-14.1*	52.9*	-32.2*	2.1	8.5	-21.0*	-0.4	14.8	-4.5	-1.1	39.4	-29.0*	28.3*	0.8	55.4*	-10.9	45.0*
3 X 4	2.9	-11.0*	1.6	-39.8*	7.4	-2.4	-7.5	18.2*	18.6*	-31.3	4	30.1	4.3	42.1*	0.7	45.1*	27.4	50.0*
3 X 5	1.4	-12.3*	-8.8	-40.4*	8.6*	14.4*	-19.3*	-9.6	-7.2	-7.1	32.6*	79.7*	-3.5	8.3	-50.1*	-28	-51.7*	-43.2*
3 X 6	14.5*	-0.9	0.5	-34.3*	-2.6	3.6	-20.6*	0	-2.2	-31.7	-9.4*	44.4*	-27.1*	1	-59.5*	-41.6*	-63.7*	-57.3*
4 X 5	8.8	-5.8	-4.4	-43.4*	4.8	4.8	-7.5	18.2	28.5*	-24.5	3.4	30.7	24.4*	32.6*	-3.1	-3.2	-7.6	-6
4 X 6	-3.3	-16.2*	21.4	-2.1	-7.1	-1.1	-13.4	9.1	-4	-33.0*	-8.8*	45.3*	-29.3*	-2.1	-48.8*	-42.1*	63.9*	-58.9*
5 X 6	-10.8*	-10.8*	-21.5	-25.7*	1.5	8	14.5	44.3*	-44.2*	-44.2*	0.2	59.1*	-14.1	19.0*	-25.1*	-15.3	-35.6*	-26.5*

1 : PBIG-2, 2 : PBIG-4, 3 : PBIG-1, 4 : Kalyanpur Sona 5 : Kalyanpur Barahmasi 6 : Priya White

There has been a positive association between number of branches per plant and number of fruits per plant in all the cucurbits including bittergourd (Naik*et al*., 2020; Rao*et al*., 2017). This implies that more the number of laterals per plant, more would be the yield per plant. In this experiment the most heterotic hybrid for main vine length was PBIG-2 X Kalyanpur Barahmasi (17.0 and 17.0 %) followed by PBIG-1 X Kalyanpur Barahmasi (14.4 and 8.6 %) in terms of standard heterosis and heterobeltiosis, respectively. As regards number of primary branches per plant the best two hybrids were Kalyanpur Barahmasi X Priya White (44.3 %) and PBIG-2 X Kalyanpur Sona (32.1 %).

Fruit appearance, which is largely determined by its length, diameter and colour, has profound effect on total yield as well as consumer acceptance. Out of the15 hybrids, only two *viz*. Kalyanpur Sona XKalyanpur Barahmasi (28.5 %) and PBIG-2 X PBIG-4 (23.2 %) exhibited significantly positive heterosis over their better parents, while none was *at par* than the standard check. For fruit diameter the best hybrid was PBIG-4 X Kalyanpur Barahmasi (85.9 and 31.9 %) followed by PBIG-1 X Kalyanpur Barahmasi (79.7 and 32.6 %) and PBIG-2 X PBIG-4 (79.0 and27.0 %) in terms of standard heterosis and heterobeltiosis, respectively.

Any breeding programme including heterosis breeding would not be regarded as successful unless the developed variety outperforms the existing varieties in terms of yield. Fruit weight and number of fruits per plant determine the yield to a greater extent in bittergourd. PBIG-2 X PBIG-1 came out to be the best performing hybrid, which recorded 82.9 % higher yield over the check Kalyanpur Barahmasi and 55.5 % over the better parent. It also exhibited highest standard heterosis and heterobeltiosis for fruit weight (49.5 and 33.3 %) and number of fruits per plant (68.1 and 16.7 %), respectively. PBIG-2 X Priya White was adjudged as the second best, which recorded 77.6 % standard heterosis and 55.7 % heterobeltiosis for yield per plant, 44.5 % standard heterosis for fruit weight and 68.7 and 49.1 % standard heterosis and heterobeltiosis, respectively for number of fruits per plant. Other hybrids, which showed significant heterosis for yield, were PBIG-1 X Kalyanpur Sona (50.0 % standard heterosis) and PBIG-2 X Kalyanpur Sona (55.8 % heterobeltiosis). Presence of heterosis for yield and yield contributing characters in bittergourd have also been reported by Kumar*et al*., (2000); Mallikarjunarao*et al*., (2000); Kumari*et al*. (2000); Naik*et al*., (2000); Ram *et al*., (1997) and Thangamaniand Pugalendhi (2013).In bittergourd it is the marketable yield rather than total yield, which matters much to fetch a good price in the market. In the present investigation one of the interesting results was that almost all the best performing hybrids produced significantly higher number of fruits per plant with higher average fruit weight accompanied with earliness to flowering, signifying the utility of hybrids from farmer's point of view. Similar kind of results have also been reported by Naik*et al*., (2020); Rao*et al*., (2017) and Talekar*et al*., (2013).

IV. CONCLUSION

In the present investigation three hybrids namely PBIG-2 X PBIG-1, PBIG-2 X Priya White and PBIG-1X Kalyanpur Sona were found to be the best heterotic combinations in terms of yield and most of the other yield attributing traits. Therefore, these three hybrids may be worth exploiting through heterosis breeding and may be subjected to further evaluations at multilocation trials repeated over years.

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