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Original Research Article

Heterosis Study in Bitter Gourd for Earliness and Qualitative Traits

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Keywords

Hybrids, parents, better parent and standard parent and heterosis

A B S T R A C T

Investigation was carried out to bitter gourd (*Momordica charantia* L.) to develop potential F_1 hybrids with quality and quantity parameters. The random crosses were made and total of six F_1 crosses were obtained and evaluated with their parents for various quantitative and qualitative traits. The *per se* performance of the parents and hybrids for both morphological and biochemical traits indicated highly significant variation among the parents and hybrids. *Per se* performance revealed few crosses had shown significant heterotic effects for most of the traits in terms of better parent and standard parent. Heterotic vigour over standard parent was shown by the cross BRBBTL × Pusa Aushadhi and BRBTL × Gangajalee hybrid for earliness, quantitative and qualitative traits. Thus, Heterosis breeding method and gene action may be more rewarding for improvement in bitter gourd.

Introduction

Bitter gourd is an important cucurbitaceous crop having chromosome number (2n=26) grown near the bank of river of sub- tropical belts (Behera, 2010). It has rich nutritional and medicinal value and ranks first among cucurbits due to high value of flavonoids, antioxidants, vitamins and minerals (Verma & Singh, 2014). It is highly cross pollinated and has possess high levels of heterozygosity in bitter gourd (Singh *et al.*, 2013). The efforts of the many vegetable breeders has marked improvement in yield and good number of new varieties and hybrids have been developed (Laxuman *et al.*, 2012). Crop improvement involves the strategies to enhance the yield potentiality and quality components. Any breeding strategy aiming to develop improved varieties with required merits in productivity, market preference, and nutrition should target those major constraints. The success of breeding programs is intimately related to the appropriate choice of divergent parents which, when crossed, must provide wide genetic variability to be used for selection. The systematic approach for the detection of appropriate parents for crossing allows estimation of different genetic parameters including heterotic expression in early generations. Selection of parents for hybridization programme has based on the complete genetic information and prepotency of the potential parents. Heterosis breeding is a potential tool to achieve improvement in quantity and quality of bitter gourd, which cannot be done through traditional methods. Though many reports on heterosis breeding are available in bitter gourd like 79.58 % (Singh *et al.,* 2013), 73.51 % (Laxuman *et al.*, 2013) for yield information on identification of better parents for F_1 production is lacking (Singh *et al.,* 2013; Yadav *et al.,* 2009). Commercialization of hybrids in bitter gourd are easy due to its high seed content and easy seed extraction technique. Variability found in quality, quantity and fruits of bitter gourd is most conspicuous which offers tremendous scope for heterosis breeding for yield enhancement. Crossing nature and heterosis in this crops has long been known to offer good potentialities for increased yield.

Materials and Methods

The study was conducted at Vegetable Science Farm at Bihar Agricultural University, Sabour. Six parents and their 6 F_1 random crosses were studied in three replication of randomized complete block design. The crops were sown at spacing of 120 × 90 cm at depth of 10 cm. with all the recommended cultural practices were followed for good cultivation of crops. Five plants in each entry were selected randomly and tagged. These tagged plants were used for taking observations for the following characters like days to 1^{st} fruit harvest, vine length (m), fruit length (cm), fruit diameter (cm), inter nodal length (cm), number of fruits/vine, fruit weight (g), fruit yield/plant (kg), iron, ß-carotenoid (µg/g), total Phenol (µg/100g), acidity, total sugar (mg/ 100 g), flavonoids (mg/g), ascorbic acid (mg/100g) and total chlorophyll (%).

The present study was conducted to estimate the level of per cent better parent heterosis and economic heterosis among random crosses F_1 hybrids of six varieties. This information would be useful to investigate the performance and relationship of F_1 hybrids and parents and to select suitable parents and population for designing an effective breeding programme. The magnitude of heterosis was calculated as per cent increase or decrease of F_1 values over the better parent (BP) and the standard variety.

Heterosis measures better parent heterosis (BPH) and economic heterosis (SH) in per cent, both having commercial breeding implication. These were calculated for those characters which showed significant difference between genotypes (crosses plus parents) following the method suggested by Falconer and Mackay (1996):

BPH (%) = ((F1 –BP)/ BP) × 100; SH (%) = ((F1 –SH)/SH) × 100

Where, F_1 = Mean value of the F_1 cross BP = Mean value of the better parent SH = Mean value of the standard check or economic variety to the study area. Tests for significance of heterosis were made using t-test standard error of the differences between heterosis was calculated as follows:

SE (d) for BP or SH = r Me/2± Where, SE (d) is standard error, Me is error mean square and r is the number of replications and the t obtained was tested against the tabular t-value at error degree of freedom. t (better parent) = BPH/SE (d), and t (economic) = SH/SE(d)

Results and Discussion

The *per se* performance of the parents and hybrids for both morphological and biochemical traits were given in Table 1.2. The range of mean values of parents and hybrids, mean values over parents and hybrids and grand mean over parents and hybrids has been presented in Table 1.2. Among the parental lines and hybrids, days to 1st fruit harvest was recorded earliest in BRBTL × Pusa Aushadhi (41.48) followed by parents Pusa Aushadhi (42.79) and BRBTL × Gangajalee Small (50.39). Vine length were observed lowest in the hybrids i.e. BRBTL x Pusa Aushadhi (233.00). Fruit diameter was observed highest among parents and hybrids in BRBTL × Gangajalee Small (15.63).Internodal length was observed highest in Konkan Tara × Pusa Rasdar (5.72). Numbers of fruits/vines were observed highest in Konkan Tara × Pusa Rasdar (45.18). The fruit weight was highest in BRBTL × Gangajalee Small (143.88). The fruit yield was observed maximum in BRBTL × BRBTW (5.63).

For bio-chemical traits like iron, ß-carotenoid, total phenol and charantin content was observed highest in BRBTL × Gangajalee Small (Table.1.2). Total sugar, flavonoids ascorbic acid and total chlorophyll was observed highest in Konkan Tara × Gangajalee Small.

Heterosis over better parent

The extents of Heterosis (heterobeltiosis) for better parent were presented (Table 1.3). There were six hybrids which showed significant heterotic effect. For morphological traits days to 1st fruit harvest two F_1s showed significant negative of positive heterotic effect. The superior significant cross combinations for this trait were BRBTL × Pusa Aushadhi (- 4.73). For vine length the superior significant cross combinations for this trait were Konkan Tara × Pusa Rasdar (4.51). For fruit length the superior significant cross combinations for this trait were Konkan Tara × Gangajalee Small (87.06). The heterosis for fruit diameter superior significant cross combinations for this trait was BRBTL × BRBTW (10.22). The heterosis for internodal length the superior significant cross combinations for this trait were BRBTL × Gangajalee Small (27.87). The heterosis for number of fruits/vine the superior significant cross combinations for this trait were Pusa Aushadhi × Pusa Rasdar (31.03). The heterosis for fruit weight the superior significant cross combinations were Konkan Tara × Gangajalee Small (17.01). The heterosis for fruit yield the superior significant cross combinations were BRBTL × Pusa Aushadhi (64.36).

The extent of heterbeltiosis for biochemical trait was presented Table 1.5. The heterosis for iron content ranged from -2.28 to 54.23. The superior significant cross combinations for this trait were BRBTL × Pusa Aushadhi (54.23). For ß-carotenoid the superior significant cross combinations for this trait were BRBTL × BRBTW (23.97). For total phenol content the superior significant cross combinations for this trait were BRBTL × Gangajalee small (34.20). For acidity the superior significant cross combinations for this trait were Pusa Aushadhi × Pusa Rasdar (190.16). For total sugar content the superior significant cross combinations for this trait were BRBTL × BRBTW (14.63). For flavonoids content the superior significant cross combinations for this trait were Konkan Tara × Gangajalee Small (26.80). For ascorbic acid the superior significant cross combinations for this trait were Pusa Aushadhi × Pusa Rasdar (59.08). For total chlorophyll the superior significant cross combinations were Pusa Aushadhi × Pusa Rasdar (67.17).

Heterosis over standard parent

The extents of standard heterosis for morphological traits were presented in Table 1.4. Among six hybrids two show significant negative heterosis 3 showed significant positive heterosis for days to first fruit harvest. The entire cross combinations were having negative and significant heterosis ranged from -20.02 to 0.19. The superior significant cross combinations for this trait was BRBTL × Gangajalee Small (-20.02) followed by BRBTL × Pusa Aushadhi (-18.65). For vine length it was ranged from Pusa Aushadhi × Pusa Rasdar (-8.84) to BRBTL × Gangajalee Small (32.41). The superior significant cross combinations for this trait was BRBTL × Gangajalee Small (32.41) followed by BRBTL × Pusa Aushadhi (24.89).

For fruit length it was ranged from Konkan Tara × Gangajalee Small (-38.08) to BRBTL × Gangajalee Small (2.01). The superior significant cross combinations for this trait were BRBTL × Gangajalee Small (2.01). For fruit diameter it was ranged from Konkan Tara × Gangajalee Small (-40.79) to BRBTL × BRBTW (27.10). The superior significant cross combinations for this trait was BRBTL × BRBTW (27.10) followed by BRBTL × Pusa Aushadhi (17.75) and BRBTL × Gangajalee Small (14.77). The heterosis for internodal length ranged from BRBTL × Pusa Aushadhi (-33.59) to BRBTL × Gangajalee Small (21.79). The superior significant cross combinations for this trait was BRBTL × Gangajalee Small (21.79) followed by Konkan Tara × Pusa Rasdar (19.51) and Konkan Tara × Gangajalee Small (15.51). For number of fruits/vine heterosis was ranged from Konkan Tara × Gangajalee Small (-31.25) to BRBTL × BRBTW (132.67). The superior significant cross combinations BRBTL × BRBTW (132.67) followed by BRBTL × Pusa Aushadhi (121.98). For fruit weight it was ranged from Konkan Tara × Pusa Rasdar (7.91) to BRBTL × Gangajalee Small (65.03). The superior combination BRBTL × Gangajalee Small (65.03) followed by BRBTL × BRBTW (55.37). For fruit yield/plant it was ranged from Konkan Tara × Pusa Rasdar (-36.64) to Konkan Tara × Gangajalee Small (69.33). The superior combination for these traits BRBTL × BRBTW (69.33) followed by Konkan Tara × Gangajalee Small (5.49), BRBTL × Pusa Aushadhi (4.24) and BRBTL × Gangajalee Small (1.43).

Table.1 Details of Parents and their source

Parents	Morphological characteristics	Source
BRBTL	Light green	Local collection, Bhagalpur
Gangajalee Small	Small Light green	Nalanda collection, Bihar
Pusa Aushadhi	Medium green	IARI, New Delhi
Konkan Tara	Medium green	BSKV Dapoli, Bihar
Pusa Rasdar	Light green	IARI, New Delhi
BRBTW	Milky white	Local collection, Bhagalpur

The extents of standard Heterosis for biochemical traits were presented Table 1.6. The heterosis for iron content ranged from 7.91 to 65.03. The superior combinations for these traits were BRBTL × Gangajalee Small (65.03), BRBTL × BRBTW (55.37) and BRBTL × Pusa Aushadhi (48.13). For ß-carotenoid it was ranged from 4.93 to 69.33. The superior combinations for these traits were Konkan Tara × Gangajalee Small (5.49), BRBTL × Pusa Aushadhi (4.24) and BRBTL × Gangajalee Small l (1.43). The Heterosis for Total Phenol content ranged from 64.152 to 154.907. The superior combinations for these traits were BRBTL × Gangajalee Small (154.907), BRBTL × Pusa Aushadhi (120.114), BRBTL × BRBTW (110.381) and Pusa Aushadhi × Pusa Rasdar

(105.596). The Heterosis for acidity content range from 27.45 to 290.20. The superior combination for this traits were BRBTL × Pusa Aushadhi (290.26) followed by Pusa Aushadhi × Pusa Rasdar (247.06), Konkan Tara × Gangajalee Small (150.98), BRBTL × Gangajalee Small (119.61). The Heterosis for total Sugar ranged from 1.0 to 168.0. The superior heterotic combinations for this trait were BRBTL × Gangajalee Small (161.0) and Konkan Tara × Gangajalee Small (137.0). The Heterosis for Flavonoids content ranged from -16.54 to 1.31. The superior heterotic combinations for this trait were Konkan Tara x Gangajalee Small (1.31). The Heterosis for ascorbic acid content ranged from -47.71 to 223.84. The superior heterotic combinations for this trait were Konkan Tara × Gangajalee Small (223.84), BRBTL × Pusa Aushadhi (182.18) and BRBTL × Gangajalee Small (75.86). The Heterosis for total chlorophyll content ranged -51.49 to 20.30. The superior heterotic combinations for this trait were Konkan Tara x Gangajalee Small (20.30). The Heterosis for charantin content ranged from -21.75 to 45.27. The superior heterotic combination for this trait were Konkan Tara × Pusa Rasdar (45.27) followed by Konkan Tara × Gangajalee Small (40.09), BRBTL × Gangajalee Small (15.87) and BRBTL × Pusa Aushadhi (9.48).

Due to monoecious, highly cross-pollinated nature of crop creates large amount of variation had observed for both quantitative and qualitative characters. The exploitation of hybrid vigour in any crop depends on substantial heterosis for yield coupled with an economical method of producing hybrid seed. The heterosis helps in the selection of suitable breeding methodology and parameters, which are to be employed in crop improvement. The manifestation of heterosis over better parent and standard parent was studied among the six cross combinations. Negative heterosis over better parent and standard parent had desirable attribute for some of the characters especially those concerned with crop maturity such as node number to 1st staminate flower, days to 1st staminate flower, node number to 1st pistillate flower, days to 1st pistillate flower anthesis, days to 1st fruit harvest and days to 50% flowering. The superior significant cross combinations for these trait were BRBTL × Pusa Aushadhi (-4.73) and BRBTL × Gangajalee Small (-8.88). Similar finding of negative and high Heterosis were reported by Yadav *et al.,* 2009 for crosses MC-84 × JMC- 22 and MC-84 × VRBT-89, Bhatt *et al.,* 2017 reported for crosses Arka Harit × Panipat Local, Pusa Do Mausami × Kalyanpur Barahamasi and Bhatt *et al.,* 2017 reported for Kalyanpur Sona × Pant Karela-1 and Punjab-14 × Pant Karela-1 for days taken to opening of 1st female flower. These traits were desirable for earliness. The superior significant cross combinations were Konkan Tara × Pusa Rasdar for vine length and fruit length, for fruit diameter it was BRBTL × BRBTW, for internodal length it was BRBTL × G Small, for number of fruits/vine it was Pusa Aushadhi × Pusa Rasdar, for Konkan Tara × Gangajalee Smalland for fruit yield it was BRBTL × Pusa Aushadhi. Similar finding was reported by Kadansamy (2017) for cross MC-13 × Arka Harit for fruit length, VK-1 Priya × Arka Harit for fruit girth, Panruti local × Arka Harit for fruit weight, Panruti local × VK-1 Priya for fruit yield/vine. Similar finding was observed by Thangamani and Pugalnedhi, 2009; Al-Mamun *et al.,* 2015; Bhatt *et al.,* 2017 and Talekar *et al.,* 2013.

The positive and high Heterosis over better parent and standard parent for biochemical traits was desirable for exploitation of biochemical traits. The superior significant cross combinations for iron content were

BRBTL × Pusa Aushadhi, BRBTL × Gangajalee Small. For ß-carotenoid it was Konkan Tara × BRBTW, BRBTL × Pusa Aushadhi and BRBTL × Gangajalee small. For total phenol content it was BRBTL × Gangajalee Small, BRBTL × Pusa Aushadhi, BRBTL × BRBTW and Pusa Aushadhi × Pusa Rasdar. For acidity it was Pusa Aushadhi × Pusa Rasdar, BRBTL × Pusa Aushadhi, BRBTL × Gangajalee Small. For total sugar content it was BRBTL × BRBTW and BRBTL × Gangajalee Small. For flavonoids content was Konkan Tara × Gangajalee Small, BRBTL × Gangajalee Small, Pusa Aushadhi × Pusa Rasdar. For ascorbic acid it was Pusa Aushadhi × Pusa Rasdar, BRBTL × Pusa Aushadhi and Konkan Tara × Gangajalee Small. For total chlorophyll it was Pusa Aushadhi × Pusa Rasdar, BRBTL × BRBTW and Konkan Tara × Gangajalee Small. For charantin content Heterosis was Pusa Aushadhi × Pusa Rasdar, RBTL × Pusa Aushadhi and BRBTL × Gangajalee Small. Similar finding was reported by Thangamani and Pugalendhi (2013) cross MC-105 × MC-10 (48.30 %) for iron content. Similar finding was reported by Mamun *et al.*, 2015 for ß-carotenoid, total soluble solid, acidity and phenol content. Similar finding was reported by Behera *et al.*, 2010 for ascorbic acid, ß-carotene in bitter gourd; Pandey *et al.*, 2010 in snake melon. This increase or decrease in performance of F_1 hybrids for both morphological and biochemical traits due to the selection of diverse inbreds. These findings were in consonance of Chaubey and Ram, 2004; Behera *et al.*, 2010; Aruna and Swaminathan, 2012; Mulung *et al.*, 2013; Thangamani and Puglanedhi, 2013 and Mamun *et al.*, 2016.

Economic point of view, it is useful to select hybrids having one or more important characters like earliness, higher fruit number, higher yield and quality parameters in order to achieve higher gains in the F_1 hybrids through heterosis breeding. Among six hybrids only two hybrids i.e. BRBTL × Pusa Aushadhi and BRBTL × Gangajalee Small were found significant heterotic combinations for both morphological and biochemical traits. These two hybrids can be well exploited through heterosis breeding for both morphological and biochemical traits. Moreover, these hybrids could be better utilized for the improvement of the characters concerned and intermating among superior segregants resulting from these heterotic hybrids, is likely to throw desirable progenies in the subsequent later generations.

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