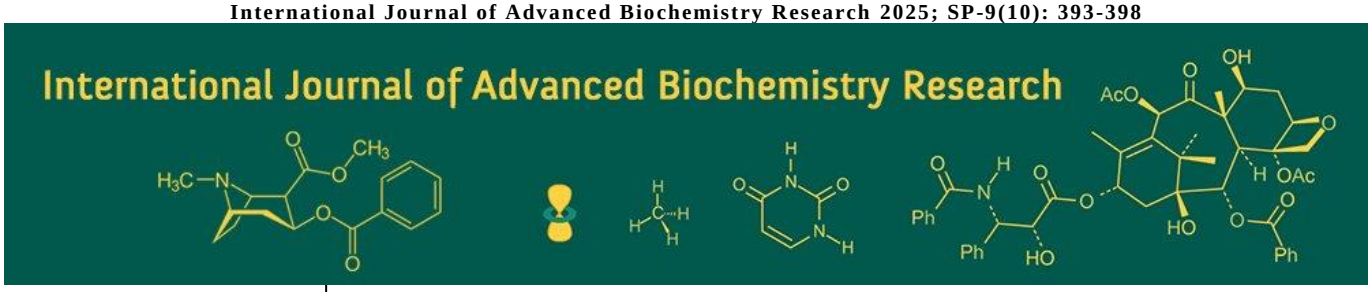

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Development of F_1 hybrids in bitter gourd (*Momordica charantia* Linn.) for hill zone of Karnataka

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Abstract
The present investigation entitled "Development of F_1 Hybrids in Bitter Gourd (*Momordica charantia* Linn.) for Hill Zone of Karnataka" was conducted during 2024-25 at the College of Horticulture, Mudigere. Twenty one F_1 hybrids were developed by crossing seven lines with three testers in a Line × Tester mating design and evaluated along with their parents and standard check (Phule Green Gold) in a Randomized Complete Block Design with three replications. Analysis of variance revealed significant differences among genotypes for most traits, confirming adequate genetic variability. Considerable standard heterosis was observed for yield and quality traits. Positive and significant heterosis was recorded for vine length at 60 DAS (49.15%), number of primary branches per vine at 60 DAS (35.29%), number of fruits per vine (55.62%), fruit yield per vine (80.00%) and ascorbic acid content (25.50%). Earliness was associated with significant negative heterosis for node at first female flower appearance (-35.99%). The hybrid Kashi Urvashi × Pusa Aushadhi was most promising, showing the highest heterosis for yield (80.00%). Among parents, Kashi Urvashi, Arka Harit and Pusa Aushadhi were good general combiners, while Kashi Urvashi × Pusa Aushadhi and Arka Harit × Pusa Aushadhi were superior specific combiners. Predominance of additive gene action, indicated by higher general combining ability variance over specific combining ability, suggested that these promising hybrids can be effectively utilized for genetic improvement of bitter gourd for yield, earliness and quality trait.

Keywords: Heterosis, combining ability, hybrids, lines × tester, ANOVA, GCA, SCA

Introduction
Bitter gourd (*Momordica charantia* Linn.) is an important nutritive and commercial cucurbit belonging to the family Cucurbitaceae with chromosome number 2n=22. The family comprises eight tribes, two subfamilies, 118 genera and 825 species distributed in warmer regions of the world. In India, seven species of *Momordica* are reported while 60 species occur globally (Singh *et al*., 2018) [8]. Bitter gourd, native to Tropical Asia and particularly the Indo-Burma region, is widely cultivated in South-East Asia, Africa, South America, China, Malaysia, Singapore, India, Indonesia and Japan. In India, it occupies 114.77 thousand hectares with a production of 1429 thousand MT with Karnataka, Kerala, Maharashtra, Andhra Pradesh, Tamil Nadu and Chhattisgarh as leading states (Anon, 2024).
The crop is highly nutritive and ranks first among cucurbits for its medicinal value. Every 100 g of fruit contains 2.1 g protein, 4.2 g carbohydrates, 88 mg ascorbic acid, 210 IU vitamin A and essential minerals (Sathishkumar *et al*., 2020) [7]. The bitter taste is due to the alkaloid momordicin. Bioactive compounds such as charantin, triterpenes, proteins and steroids provide anti-diabetic, digestive and therapeutic properties. Fruits and plant parts are consumed as vegetables, juice, chips, pickles or used in pharmaceuticals.
Bitter gourd is a monoecious and highly cross-pollinated crop with a male to female flower ratio of 20:1 primarily pollinated by bees (Behera *et al*., 2009) [2]. Its fast-growing vines bear yellow flowers and ridged green fruits that turn orange on ripening. Owing to cross-pollination and heterozygosity, breeding methods like mass selection, recurrent selection and particularly heterosis breeding are effective. Heterosis breeding enhances yield, quality, earliness and resistance though only specific parental combinations produce superior hybrids. Combining ability analysis introduced by Sprague and Tatum (1942) [9] helps identify such parents.

General Combining Ability (GCA) measures average parental performance while Specific Combining Ability (SCA) evaluates individual cross performance. Line × Tester analysis provides insights into gene action and helps identify heterotic hybrids. Keeping these points in view, the present investigation was undertaken to estimate the magnitude and direction of heterosis for growth and yield traits, assess the general combining ability of parents and evaluate the specific combining ability of crosses to identify superior hybrid combinations in bitter gourd.

Materials and Methods

The experiemental study was carried out using 10 parental lines, which included seven lines (Arka Harit, CO-1, Kashi Urvashi, Mysore Local, NDBT-9, Dasavara Local and Priyanka) and three testers (Preethi, Pusa Do Mausami and Pusa Aushadhi). From these, 21 F_1 hybrids were generated during 2025 through a Line × Tester mating design. The hybrids together with their parents were evaluated for yield and related traits in a randomized block design with three replications at the College of Horticulture, Mudigere during the *Kharif* and *Summer* seasons of 2024-2025. The crop was raised at a spacing of 0.5 m between plants and 1.5 m between rows. Data were collected from five randomly chosen plants in each entry (parents and hybrids) for seven characters, namely vine length (m) at 60 days, number of primary branches per vine at 60 days, node of first female flower appearance, number of fruits per vine, fruit length, fruit yield per vine and ascorbic acid content. Heterosis was worked out over better parent and standard check.

Results and Discussion

Per se performance

The mean values of parents and hybrids for different traits are presented in Table 1, while the analysis of variance for seven traits is given in Table 2. The results revealed highly significant differences among treatments or genotypes for all characters, confirming the presence of wide genetic variability and prospects for improvement through selection. The evaluated traits included vine length at 60 DAS, number of primary branches per vine at 60 DAS, node of first female flower appearance, number of fruits per vine, fruit length, fruit yield per vine and ascorbic acid content. Parents differed significantly for most traits, except for number of fruits per vine among testers, where the difference was non-significant. This indicates adequate variability among the parents for the studied traits.

Line × tester interaction effects were significant for all characters, while parents vs. hybrids and crosses also exhibited significant variation, with none of the traits showing non-significant effects (Dey *et al*., 2008) [3]. The partitioning of parental variance showed that female lines contributed more strongly to genetic divergence compared to male testers, particularly for vine length at 60 DAS, fruit length and fruit yield per vine. On the other hand, characters such as number of primary branches per vine at 60 DAS displayed relatively lower variation, suggesting limited scope for improvement through conventional selection. These findings align with earlier reports in bitter gourd breeding (Kumar *et al*., 2020) [4], which also emphasized the greater role of female lines in enhancing yield and quality attributes.

Heterosis

Out of 21 crosses, 15 exhibited significant positive heterosis over the better parent for vine length at 60 DAS. For number of primary branches per vine at 60 DAS, six crosses recorded significant positive heterosis, whereas three showed significant negative heterosis, which is in agreement with findings of Kumari *et al*. (2021) [5]. In the case of node of first female flower appearance, 19 crosses displayed significant negative heterosis, supporting the reports of Srinivasulu *et al*. (2024) [10]. Significant positive heterosis was noted in 18 crosses for number of fruits per vine, similar to the observations of Naik *et al*. (2020) [6]. For fruit length, only four crosses showed significant positive heterosis while ten recorded significant negative values, consistent with Zehra *et al*. (2023) [13]. For fruit yield per vine, 18 crosses showed significant positive heterosis, as also reported by Tejaswini *et al*. (2024) [11]. For ascorbic acid content, only eight crosses expressed significant positive heterosis, aligning with the findings of Vidya *et al*. (2024) [12] (Table 3).

Over the standard check, 17 crosses showed significant positive heterosis for vine length at 60 DAS, 18 for number of primary branches at 60 DAS and 16 for earliness in node of first female flower appearance. Likewise, 18 crosses expressed significant positive heterosis for number of fruits per vine, 11 for fruit length, 18 for fruit yield per vine and eight for ascorbic acid content. The hybrid Kashi Urvashi × Pusa Aushadhi emerged as the best, recording significant heterosis over the standard check for vine length at 60 DAS (49.15%), number of primary branches per vine (35.29%), node of first female flower appearance (-35.99%), number of fruits per vine (55.62%), fruit yield per vine (80.00%) and ascorbic acid content (25.50%). Another promising cross, CO-1 × Pusa Aushadhi, registered the highest heterosis (74.79%) for fruit length over the standard check. These results are in agreement with earlier reports of Zehra *et al*. (2023) [13] and Kumari *et al*. (2020) [5] in bitter gourd (Table 4).

Combining ability

For vine length at 60 DAS, Kashi Urvashi (0.17) and Arka Harit (0.16) showed positive and significant GCA effects due to favorable additive genes for vigorous growth, whereas Dasavara Local (-0.33) and NDBT-9 (-0.23) were negative. Among testers, Pusa Aushadhi (0.15) contributed positively, while Preethi (-0.10) and Pusa Do Mausami (-0.04) were negative. Positive SCA in Dasavara Local × Pusa Aushadhi (0.18) and NDBT-9 × Pusa Aushadhi (0.14) resulted from complementary non-additive gene interactions. For the number of primary branches per vine, Arka Harit (0.44), Kashi Urvashi (0.39) and Priyanka (0.26) had positive GCA, indicating additive potential for branching, whereas Dasavara Local (-0.93) and NDBT-9 (-0.58) were negative. Pusa Aushadhi (0.26) was the only positive tester. Favorable SCA was observed in Dasavara Local × Pusa Aushadhi (0.57) and NDBT-9 × Pusa Do Mausami (0.32), reflecting heterotic effects, supporting the reports of Srinivasulu *et al*. (2024) [10]. Regarding earliness, Kashi Urvashi (-1.05), Arka Harit (-1.03) and Priyanka (-0.71) had desirable negative GCA, while Dasavara Local (2.25) and NDBT-9 (0.77) were positive. Pusa Aushadhi (-1.32) was the best tester for earliness. Negative SCA in NDBT-9 × Pusa Do Mausami (-2.11) and Priyanka × Pusa Aushadhi (-0.71) indicated that non-additive interactions promoted early flowering despite one late parent.

For number of fruits per vine, Arka Harit (1.95) and Kashi Urvashi (1.46) showed positive GCA due to additive genes promoting higher fruit set, while Dasavara Local (-3.51) and

NDBT-9 were negative. Among testers, Pusa Aushadhi (1.42) contributed positively, whereas Preethi (-0.97) reduced fruit number. Favorable SCA in NDBT-9 × Pusa Do Mausami (1.44), Mysore Local × Preethi (0.72) and Kashi Urvashi × Pusa Aushadhi (0.93) reflected beneficial non-additive interactions enhancing fruit production. For fruit length, CO-1 (3.89) and Kashi Urvashi (2.66) had positive GCA due to additive genes for longer fruits, while Dasavara Local (-3.46) and NDBT-9 were negative; SCA was highest in Kashi Urvashi × Pusa Aushadhi (1.16), showing complementary gene action, similar to the observations of Naik *et al*. (2020) [6]. Fruit yield per vine was positively influenced by Kashi Urvashi, Arka Harit (0.11) and CO-1 (0.07) due to additive effects, while Dasavara Local (-0.24) and NDBT-9 (-0.16) were negative; crosses like NDBT-9 × Pusa Do Mausami (0.09) exhibited favorable SCA, similar results reported by Tejaswini *et al*. (2024) [11]. For ascorbic acid, Kashi Urvashi (5.50), Arka Harit (3.34) and Pusa Aushadhi (6.07) had positive GCA, whereas Dasavara Local (-3.95) and Mysore Local (-3.00) were negative; highest SCA in Kashi Urvashi × Pusa Aushadhi (8.13) reflected strong non-additive gene contribution.

Table 1: *Per se* performance of parents, their hybrids for yield and yield related traits

Parents/Hybrids	Vine length (m) at 60 DAS	Number of primary branches per vine at 60 DAS	Node at which first female flower appears	Number of fruits per vine	Fruit length (cm)	Fruit yield per vine (kg)	Ascorbic acid (mg/100 g)
NDBT-9	1.36	3.99	14.36	13.50	4.36	0.53	90.60
Kashi Urvashi	2.10	5.29	11.25	16.75	11.26	0.92	105.35
Priyanka	1.76	4.82	13.79	14.64	8.79	0.64	92.29
Arka Harit	2.08	5.02	11.85	16.58	8.85	0.84	100.42
Mysore Local	1.50	4.37	13.96	14.88	4.45	0.59	88.50
Dasavara Local	1.45	3.91	15.45	13.15	3.65	0.52	87.94
CO-1	2.01	4.95	12.78	15.26	10.20	0.80	90.70
Preethi	1.36	4.65	14.36	19.35	9.36	0.71	92.60
Pusa Aushadhi	1.95	5.02	13.55	20.55	10.55	0.79	99.20
Pusa Do Mausami	1.55	4.53	13.95	19.75	9.55	0.74	94.90
NDBT-9 × Preethi	1.65	3.95	13.75	14.35	8.35	0.72	92.05
NDBT-9 × Pusa Aushadhi	2.27	4.89	11.67	17.50	8.56	0.95	95.12
NDBT-9 × Pusa Do Mausami	1.99	4.79	10.50	17.42	7.47	0.93	92.43
Kashi Urvashi × Preethi	2.23	5.45	11.25	18.80	11.56	1.05	94.42
Kashi Urvashi × Pusa Aushadhi	2.62	5.75	8.50	22.56	14.65	1.32	115.35
Kashi Urvashi × Pusa Do Mausami	2.29	5.37	10.70	19.25	11.36	1.07	93.65
Priyanka × Preethi	2.24	5.31	11.20	19.26	9.70	1.03	92.37
Priyanka × Pusa Aushadhi	2.31	5.49	8.45	19.49	10.75	1.16	100.42
Priyanka × Pusa Do Mausami	2.29	5.39	11.80	19.25	9.80	1.08	92.54
Arka Harit × Preethi	2.30	5.53	10.05	19.51	9.75	1.07	92.95
Arka Harit × Pusa Aushadhi	2.50	5.68	8.95	21.87	10.95	1.25	110.75
Arka Harit × Pusa Do Mausami	2.31	5.52	11.50	20.49	8.66	1.11	93.24
Mysore Local × Preethi	2.22	5.25	11.25	18.75	8.67	1.04	91.50
Mysore Local × Pusa Aushadhi	2.25	5.36	9.90	19.95	8.51	1.11	93.98
Mysore Local × Pusa Do Mausami	2.26	5.28	11.85	18.29	7.85	1.02	92.42
Dasavara Local × Preethi	1.75	3.80	13.95	14.26	5.25	0.71	91.97
Dasavara Local × Pusa Aushadhi	2.21	5.03	12.25	17.23	7.38	0.93	92.82
Dasavara Local × Pusa Do Mausami	1.64	3.75	14.16	14.18	6.56	0.70	90.24
CO-1 × Preethi	2.31	5.29	11.70	19.21	13.72	1.04	93.78
CO-1 × Pusa Aushadhi	2.39	5.55	9.45	21.50	14.95	1.23	103.50
CO-1 × Pusa Do Mausami	2.32	5.27	12.40	19.18	12.60	1.05	92.80

Table 2: ANOVA for seven various characters in bitter gourd

Character	Replication	Treatments (genotypes)	Parents	Lines	Tester	Line × Tester	Parents vs Cross	Crosses	Error
Degrees of freedom	2	30	9	6	2	1	1	20	60
Vine length (m) at 60 DAS	0.04	0.37**	0.27**	0.30**	0.26**	0.11**	4.98**	0.18**	0.02
No. of primary branches per vine at 60 DAS	0.19	1.03**	0.62**	0.86**	0.19**	0.07**	4.52**	1.04**	0.09
Node at which first female flower appears	0.66	10.42**	4.69**	6.49**	0.48**	2.29**	110.08**	8.01**	0.69
No. of fruits per vine	0.19	21.75**	4.05**	5.70**	1.12**	0.04**	292.98**	16.15**	0.17
Fruit length (cm)	0.06	22.82**	24.08**	29.39**	1.22**	37.96**	62.79**	20.25**	0.06
Fruit yield per vine (kg)	0.00	0.14**	0.05**	0.07**	0.00NS	0.01*	2.09**	0.08**	0.00
Ascorbic acid (mg/100 g)	15.30	116.06**	97.21*	130.87**	33.70**	22.22*	38.89**	128.40**	41.15

Note: * and ** indicates significant at 5% and 1% respectively. DAS-days after sowing

Table 3: Heterobeltiosis of the promising crosses in bitter gourd

Crosses	Vine length (m) at 60 DAS	Number of primary branches per vine at 60 DAS	Node at which first female flower appears	Number of fruits per vine	Fruit length (cm)	Fruit yield per vine (kg)	Ascorbic acid (mg/100 g)
NDBT-9 × Preethi	21.32 *	-15.05 **	-4.25	0.00	-10.79 **	1.89	-0.59
NDBT-9 × Pusa Aushadhi	16.61 *	-2.52	-18.73 **	12.52 **	-18.86 **	20.76	-4.11
NDBT-9 × Pusa Do Mausami	28.60 **	5.74	-26.86 **	18.11 **	-21.82 **	26.24 *	-2.60
Kashi Urvashi × Preethi	6.19	3.02	-21.64 **	12.28 **	2.72	14.18	-10.38 *
Kashi Urvashi × Pusa Aushadhi	24.76 **	8.70	-37.27 **	34.71 **	30.12 **	44.00 **	9.49 *
Kashi Urvashi × Pusa Do Mausami	8.89	1.51	-23.30 **	14.95 **	0.95	16.73	-11.11 *
Priyanka × Preethi	27.27 **	10.09	-21.96 **	31.50 **	3.67	45.75 **	-0.24
Priyanka × Pusa Aushadhi	18.66 *	9.36	-38.72 **	31.77 **	1.86	47.03 **	1.23
Priyanka × Pusa Do Mausami	30.11 **	11.68 *	-15.41 **	30.54 **	2.65	46.61 **	-2.48
Arka Harit × Preethi	10.42	10.02 *	-30.00 **	18.90 **	4.17	26.98 **	-7.44
Arka Harit × Pusa Aushadhi	20.19 **	13.01 *	-33.95 **	31.93 **	3.79	49.21 **	10.29 *
Arka Harit × Pusa Do Mausami	10.90	9.89	-17.56 **	23.61 **	-9.32 **	32.54 **	-7.15
Mysore Local × Preethi	47.45 **	12.83 *	-21.64 **	25.96 **	-7.37 **	46.70 **	-1.18
Mysore Local × Pusa Aushadhi	15.41 *	6.77	-29.06 **	28.32 **	-19.37 **	41.53 **	-5.27
Mysore Local × Pusa Do Mausami	46.02 **	16.48 **	-15.11 **	22.89 **	-17.80 **	38.91 **	-2.61
Dasavara Local × Preethi	20.97 *	-18.28 **	-9.71 *	-0.63	-43.91 **	0.47	-0.68
Dasavara Local × Pusa Aushadhi	13.36	0.13	-20.71 **	10.80 **	-30.02 **	18.64	-6.43
Dasavara Local × Pusa Do Mausami	6.67	-17.22 **	-8.35	-3.84	-31.27 **	-4.52	-4.91
CO-1 × Preethi	14.76 *	6.87	-18.53 **	25.88 **	34.43 **	30.42 **	1.28
CO-1 × Pusa Aushadhi	18.91 *	10.56 *	-30.26 **	38.26 **	41.71 **	53.75 **	4.33
CO-1 × Pusa Do Mausami	15.42 *	6.46	-11.09 *	25.67 **	23.46 **	30.83 **	-2.21

Note: DAS-days after sowing

Table 4: Standard heterosis of the promising crosses in bitter gourd

Crosses	Vine length (m) at 60 DAS	Number of primary branches per vine at 60 DAS	Node at which first female flower appears	Number of fruits per vine	Fruit length (cm)	Fruit yield per vine (kg)	Ascorbic acid (mg/100 g)
NDBT-9 × Preethi	-6.07	-7.06	3.54	-1.01	-2.38	-1.82	0.15
NDBT-9 × Pusa Aushadhi	29.22 **	15.14 *	-12.12 *	20.69 **	0.08	29.55 *	3.49
NDBT-9 × Pusa Do Mausami	13.47	12.71 *	-20.91 **	20.14 **	-12.70 **	26.82 *	0.56
Kashi Urvashi × Preethi	26.94 **	28.24 **	-15.29 **	29.71 **	35.19 **	42.73 **	2.73
Kashi Urvashi × Pusa Aushadhi	49.15 **	35.29 **	-35.99 **	55.62 **	71.24 **	80.00 **	25.50 **
Kashi Urvashi × Pusa Do Mausami	30.17 **	26.35 **	-19.43 **	32.79 **	32.85 **	45.91 **	1.89
Priyanka × Preethi	27.51 **	24.94 **	-15.64 **	32.84 **	13.45 **	40.45 **	0.50
Priyanka × Pusa Aushadhi	31.50 **	29.18 **	-36.37 **	41.34 **	25.64 **	57.73 **	9.26
Priyanka × Pusa Do Mausami	30.36 **	26.75 **	-11.14 *	32.79 **	14.61 **	47.27 **	0.68
Arka Harit × Preethi	30.74 **	30.04 **	-24.32 **	35.96 **	13.99 **	45.45 **	1.13
Arka Harit × Pusa Aushadhi	42.31 **	33.57 **	-32.61 **	50.86 **	28.02 **	70.91 **	20.49 **
Arka Harit × Pusa Do Mausami	31.31 **	29.88 **	-13.40 **	41.34 **	1.25	51.82 **	1.45
Mysore Local × Preethi	26.19 **	23.45 **	-15.29 **	29.32 **	1.36	41.36 **	-0.45
Mysore Local × Pusa Aushadhi	27.89 **	26.12 **	-25.43 **	37.64 **	-0.55	51.82 **	2.24
Mysore Local × Pusa Do Mausami	28.84 **	24.16 **	-10.77 *	26.17 **	-8.22 **	39.55 **	0.55
Dasavara Local × Preethi	-0.38	-10.59	5.05	-1.63	-38.62 **	-3.18	0.06
Dasavara Local × Pusa Aushadhi	25.62 **	18.27 **	-7.76	18.85 **	-13.68 **	27.27 *	0.99
Dasavara Local × Pusa Do Mausami	-5.88	-11.76	6.63	-2.18	-23.27 **	-4.09	-1.82
CO-1 × Preethi	31.31 **	24.47 **	-11.92 *	32.51 **	60.37 **	42.27 **	2.03
CO-1 × Pusa Aushadhi	36.05 **	30.59 **	-28.84 **	48.31 **	74.79 **	67.73 **	12.61 *
CO-1 × Pusa Do Mausami	32.07 **	24.00 **	-6.60	32.28 **	47.27 **	42.73 **	0.96

Note: DAS-days after sowing

Table 5: Estimates of general combining ability effects of ten parents for seven quantitative characters in L × T analysis

Parents	Vine length (m) at 60 DAS	Number of primary branches per vine at 60 DAS	Node at which first female flower appears	Number of fruits per vine	Fruit length (cm)	Fruit yield per vine (kg)	Ascorbic acid (mg/100 g)
Lines							
NDBT-9	-0.23**	-0.58**	0.77**	-2.31**	-1.73**	-0.16**	-2.43
Kashi Urvashi	0.17**	0.39**	-1.05**	1.46**	2.66**	0.11**	5.50**
Priyanka	0.07	0.26*	-0.71**	0.92**	0.22*	0.06	-0.52
Arka Harit	0.16**	0.44**	-1.03**	1.95**	-0.07	0.11**	3.34**
Mysore Local	0.03	0.16	-0.20	0.25	-1.51**	0.03	-3.00
Dasavara Local	-0.33**	-0.93**	2.25**	-3.51**	-3.46**	-0.24**	-3.95
CO-1	0.13*	0.24*	-0.01	1.22**	3.89**	0.07*	1.06**
S.Em±	0.08	0.14	0.37	0.20	0.12	0.04	2.79
CD @ 5%	0.25	0.44	1.12	0.61	0.37	0.12	8.36
Testers							
Preethi	-0.10**	-0.18**	0.67**	-0.97**	-0.28**	-0.07**	-2.91*
Pusa Aushadhi	0.15**	0.26**	-1.32**	1.42**	0.96**	0.10**	6.07**
Pusa Do Mausami	-0.04	-0.07	0.64**	-0.44**	-0.67**	-0.03	-3.16*
S.Em±	0.05	0.09	0.24	0.13	0.08	0.03	1.82
CD @ 5%	0.14	0.28	0.74	0.40	0.22	0.09	5.47

Note: DAS-days after sowing

Table 6: Estimates of specific combining ability effects of twenty one crosses for seven quantitative characters in L × T analysis

Crosses	Vine length (m) at 60 DAS	Number of primary branches per vine at 60 DAS	Node at which first female flower appears	Number of fruits per vine	Fruit length (cm)	Fruit yield per vine (kg)	Ascorbic acid (mg/100 g)
NDBT-9 × Preethi	-0.21 **	-0.40 **	1.09 **	-1.09 **	0.51 **	-0.07 *	1.76
NDBT-9 × Pusa Aushadhi	0.14 **	0.08	1.01 **	-0.34	-0.52 **	-0.02	-4.15 **
NDBT-9 × Pusa Do Mausami	0.07 *	0.32 **	-2.11 **	1.44 **	0.01	0.09 **	2.39
Kashi Urvashi × Preethi	-0.04	0.11	0.42 *	-0.42	-0.67 **	-0.02	-3.80 **
Kashi Urvashi × Pusa Aushadhi	0.08 *	-0.03	-0.33 *	0.93 **	1.16 **	0.06 *	8.13 ***
Kashi Urvashi × Pusa Do Mausami	-0.04	-0.07	-0.09	-0.51	-0.48 **	-0.04	-4.33 **
Priyanka × Preethi	0.06 *	0.10	0.04	0.56	-0.09	0.01 **	0.17
Priyanka × Pusa Aushadhi	-0.12 **	-0.17 *	-0.71 **	-0.59 *	-0.29 *	-0.04	-0.76
Priyanka × Pusa Do Mausami	0.05	0.06	0.67 **	0.02	0.39 **	0.02 *	0.59
Arka Harit × Preethi	0.03	0.14	-0.79 **	-0.00	0.25	-0.00	-3.11 *
Arka Harit × Pusa Aushadhi	-0.02	-0.16 *	0.10	-0.24	0.20	0.02 *	5.69 **
Arka Harit × Pusa Do Mausami	-0.01	0.02	0.69 **	0.24	-0.45 **	0.00	-2.57
Mysore Local × Preethi	0.08 *	0.14	-0.42 *	0.72 *	0.61 **	0.05 *	1.78
Mysore Local × Pusa Aushadhi	-0.15 **	-0.19 **	0.22	-0.46	-0.79 **	-0.05 *	-4.72 **
Mysore Local × Pusa Do Mausami	0.06 *	0.05	0.20	-0.26	0.18	-0.00	2.94 *
Dasavara Local × Preethi	-0.01	-0.20 **	-0.18	0.01	-0.86 **	0.00 *	3.20 *
Dasavara Local × Pusa Aushadhi	0.18 **	0.57 **	0.11	0.58	0.02	0.04	-4.92 **
Dasavara Local × Pusa Do Mausami	-0.16 **	-0.36 **	0.06	-0.59 *	0.83 **	-0.04	1.72
CO-1 × Preethi	0.07 *	0.10	-0.16	0.22	0.25	0.01 *	-0.00
CO-1 × Pusa Aushadhi	-0.10 **	-0.08	-0.41 *	0.11	0.23	0.01 **	0.73
CO-1 × Pusa Do Mausami	0.02	-0.02	0.57 **	-0.34	-0.48 **	-0.02	-0.73
	0.03	0.06	0.16	0.29	0.12	0.02	1.31
	0.09	0.18	0.49	0.86	0.65	0.07	3.95

Note: DAS-days after sowing

Conclusion

The study confirmed wide genetic variability and significant heterosis in bitter gourd. Kashi Urvashi × Pusa Aushadhi emerged as the best hybrid for yield, earliness and ascorbic acid content, while CO-1 × Pusa Aushadhi was also promising. Kashi Urvashi, Arka Harit and Pusa Aushadhi were good general combiners, with Kashi Urvashi × Pusa Aushadhi and Arka Harit × Pusa Aushadhi as superior specific combiners. Predominance of additive gene action suggests that selection can effectively improve yield and quality in bitter gourd.

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