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Assessment of General and Specific Combining abilities for Yield-related Traits in Bitter Gourd (*Momordica charantia* L.)

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ABSTRACT: Eight diverse genotypes of bitter gourd (*Momordica charantia* L.) *viz.* PBIG-1, PBIG-2, PBIG-4, PBIG-12, PBIG-15, PBIG-17, PBIG-19 and PBIG-21, were crossed using a diallel design (excluding reciprocals). The resulting, 28 F_1 hybrids, along with the parents, were evaluated in a randomized complete block design with three replications during the summer seasons of 2022 at the Vegetable Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, (India). Under given agro-climatic conditions, it is important to study the performance of genotypes and hybrids and to identify the superior performing genotypes and hybrids of bitter gourd with desirable features for this zone. The analysis of variance for the experimental design revealed the presence of sufficient genetic variability within the experimental material for all the traits. Combining ability analysis has revealed the importance of both additive and non-additive gene actions. Among the parents PBIG-4, PBIG-1 and PBIG-21 showed superior combiner for earliness and yield-related traits, PBIG-12 for vine length and number of secondary branches per plant and root diameter, while PBIG-15 observed good general combiner for number of primary branches per plant. Based on their overall performance, the following superior crosses PBIG-1 × PBIG-19, PBIG-17 × PBIG-2, were desirable for days to anthesis of first male flower and number of nodes to first male flower. The cross PBIG-21 × PBIG-12 was superior in terms of **days to anthesis of first female flower, number of nodes to first female flower, number of primary branches, root length (cm), fruit yield per plant (g) and fruit yield (q/ha). While, PBIG-1 × PBIG-2 was good for vine length (m) at harvest and root diameter (mm), respectively. The cross combinations PBIG-21 × PBIG-2 was superior in terms of days to the first fruit harvest, while PBIG-4 × PBIG-19 superior for number of secondary branches per plant consistently during summer season 2022. Consequently, these aforementioned crosses could undergo further assessment in future breeding programs for more extensive testing.**

Keywords: Bitter gourd (*Momordica charantia* L.), Parents, GCA, SCA.

INTRODUCTION

Bitter gourd (*Momordica charantia* L., 2n=2x=22) is a tropical and subtropical vine crop belongs to the cucurbitaceae family. The primary centre of diversity of bitter gourd is Tropical Asia, specifically Eastern India (which includes the states of Odisha, West Bengal, Assam, Jharkhand, and Bihar). Southern China considered as the secondary centre of diversity (Zeven and Zhukovsky 1975). In India, it has accumulated a wide range of variability with respect to different quantitative and qualitative traits. Bitter gourd grown in different parts of the tropics varies widely in fruit colour, seed colour, fruit size etc. (Behera *et al.,* 2008a).

Bitter gaurd fruit contains in 92 ml water, 25 calories, 1.2 g protein, 0.2 g fat, 5 g carbohydrate, 1.0 g fiber, 13 mg calcium, 32 mg phosphorus, 0.2 mg iron, 0.02 mg thiamine and 0.07 mg riboflavin in 100 g of an edible portion (Rose *et al.,* 2014). Bitter gourd is considered a valuable nutritional resource due to its high levels of iron and ascorbic acid, along with its well-documented properties for managing diabetes and obesity. Furthermore, it serves as a substantial reservoir of antioxidants, flavonoids, and various polyphenolic compounds (Alam *et al.,* 2015**).** The concept of combining abilities indicates that choosing parents solely based on them per se performance may not always result in identifying desirable genotypes **(Allard 1960)**. Conducting combining ability studies is considered more dependable because they furnish valuable insights into the choice of parental plants based on the performance of their hybrid offspring. Additionally, they shed light on the characteristics and extent of different types of gene action that play a role in determining the expression of quantitative traits.

Diallel cross analysis gives the genetic parameters related to combining ability and offers a quick and comprehensive overview of the dominance relationships among the studied parent plants, utilizing the first-generation hybrids (F_1), without reciprocals. When parents are involved in diallel analysis, it provides further details such as the presence or absence of epistasis, the average degree of dominance, and the distribution of dominant and recessive genes within the parent plants (Zongo *et al.*, 2019). Mishra and Singh (2018) noted that the enhanced performance observed in F_1 hybrids with substantial Specific Combining Ability (SCA) was primarily attributed to the influence of epistatic interactions**.** Behera *et al.* (2020) revealed from his study that F_1 hybrid was derived from the crosses between pure-line of bitter gourd having superior specific combiners for yield and its components. With this purpose in mind, the current experiment was conducted to elucidate both the general and specific combining abilities in bitter gourd, with the ultimate goal of creating a high-yielding variety.

MATERIAL AND METHODS

The present experiment was conducted with eight diverse parental lines that were combined in all possible combinations using a half-diallel mating design (excluding reciprocals), resulting in the development of twenty-eight F_1 hybrids. During the summer seasons of 2022, all twenty-eight F_1 hybrids, along with their parents, were evaluated using a Randomized Block Design at the Vegetable Research Centre, Department of Vegetable Science, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (India). Seeds were sown in the centre of the pit in each replication duly maintaining the spacing of 150 cm × 75 cm between and within the rows respectively. A space of 30 cm was uniformly left from the borders of the plot. The observations were recorded in each genotype from five randomly tagged plants. The mean of five plants were taken for analysis. The data were recorded for days to anthesis of first male flower, number of nodes to first male flower, days to anthesis of first female flower, number of nodes to first female flower, days to first fruit harvest, vine length (m) at harvest, number of primary branches, number of secondary branches, root length (cm), root diameter (cm), fruit yield per plant (g) and fruit yield (q/ha). Combining ability was calculated in accordance with Method II Model I of Griffing (1956).

RESULT AND DISCUSSIONS

Combining ability analysis is one the most effective tool which provides estimates of mean squares due to GCA, SCA, and combining ability effects and assists in choosing superior parents and crosses for further exploitation. According to the analysis of variance for combining ability, all genotypes showed an appropriate level of variation. The higher magnitude of SCA variance than that of GCA variance for only two traits out of twelve traits studied which indicated the predominance of the non-additive gene effects for that trait. Jasim and Esho (2021) concluded that vine length was primarily influenced by additive genetic variation, while non-additive genetic factors played a more significant role in yield for summer squash. Similar findings were observed in bitter gourd (Talukder *et al.,* 2018), cucumber (Golabadi *et al.,* 2017), and bottle gourd, as reported by Quamruzzaman *et al.* (2020).

This suggests that the influence of additive gene action is prominent in the manifestation of these traits. As a result, a combination of selection and heterosis breeding holds potential for enhancing the genetic attributes of these quantitative characteristics in bitter gourd.

The GCA mean squares were larger in magnitude than mean SCA squares for days to anthesis of first male flower, days to anthesis of first female flower, vine length at (m) harvest, number of secondary branches, root length, root diameter, fruit yield per plant and for days to first fruit harvest, root diameter, for number of primary branches showed higher. The general combining ability is primarily a function of additive and additive × additive gene action. High GCA effect of a parent is a function of breeding value and hence due to additive gene action effect and /or additive × additive interaction effect which represents the fixable component of genetic variation (Griffting, 1956) (Tables 2 and 3).

Evidently, parents exhibiting favorable General Combining Ability (GCA) effects can be assumed to carry more favourable genes for the concerned traits. Among the parents PBIG-4 and PBIG-1 showed superior combiner for days to anthesis of first male flower, number of nodes to first male flower and number of nodes to first female flower. Similarly, PBIG-12 showed superior combiner for vine length, number of secondary branches per plant and root diameter while, PBIG-21 for days to anthesis of first female flower, days to first fruit harvest, root length, yield per plant and yield per hectare. PBIG-15 showed good general combiner for number of primary branches per plant. In the majority of cases, it was found that individual performances of parents' provided a clear indication of their respective GCA effects, with the parents who had the highest GCA effects for a given character also being found to have a high mean with regard to that character. Balat *et al.* (2021) conveyed findings from a combining ability analysis involving long-fruited bottle gourd, which identified the most significant General Combining Ability (GCA) effects for traits such as the time it takes to open the first male and female flowers, days to the first harvest number of fruits produced per plant, and the total yield per plant. Mishra and Singh (2018) observed that within a five-line and two-tester cross in bitter gourd, US-33 exhibited the highest general combining ability for traits related to yield, fruit weight, and fruit size. The similar results was also recorded by Cerutti *et al.* (2020); Tamilselvi *et al.* (2015); Bhatt *et al.* (2017).

The crosses exhibiting significant and favorable specific combining ability (SCA) effects for economically significant traits were PBIG-1 × PBIG-19, PBIG-2 × PBIG-15, PBIG-21 × PBIG-12 to anthesis of first male flower, PBIG-17 × PBIG-2, PBIG-1 × PBIG-21, PBIG-1 × PBIG-2, number of nodes to first male flower, PBIG-21 × PBIG-12, PBIG-21 × PBIG-2, PBIG-4 × PBIG-2, days to anthesis of first female flower, PBIG-21 × PBIG-12, PBIG-4 × PBIG-19 number of nodes to first female flower, PBIG-21 × PBIG-2, PBIG-4 × PBIG-19, PBIG-1 × PBIG-19 days to first fruit harvest, PBIG-1 × PBIG-2,, PBIG-1 × PBIG-19, PBIG-21 × PBIG-12 vine length at harvest, PBIG-21 × PBIG-12, PBIG-4 × PBIG-1, PBIG-1 × PBIG-19 number of primary branches per plant, PBIG-4 × PBIG-19, PBIG-21 × PBIG-12, PBIG-1 × PBIG-19 number of secondary branches per plant, PBIG-21 × PBIG-12, PBIG PBIG-17 × PBIG-2, PBIG-21 × PBIG-15 root length, PBIG-1 × PBIG-2, PBIG PBIG-4 × PBIG-1, PBIG-17 × PBIG-12 root diameter, PBIG-21 × PBIG-12, PBIG-1 × PBIG-21, PBIG-21 × PBIG-2 and fruit yield per plant (g), PBIG-21 × PBIG-17, PBIG-1 × PBIG-19, PBIG-21 × PBIG-2 fruit yield (q/ha) consistently during summer season 2022 respectively.

Another noteworthy point to highlight is that the aforementioned hybrids, in addition to displaying significant Specific Combining Ability (SCA) effects, also showed a notable degree of hybrid vigor over their superior parents in terms of economically important traits such as earliness and the number of fruits per plant (Tables 4 and 5). The average performance of these hybrids followed a fairly similar pattern to their SCA effects for the mentioned traits. Hybrids that demonstrated strong individual performance also exhibited favorable and substantial SCA effects. This indicates that the *per se* performance of hybrids was indicative of their respective SCA effects. It's important to note that crosses exhibiting higher SCA effects in a desirable direction also showed favorable and substantial hybrid vigor compared to the superior parent. As a result, the average performance of hybrids could be considered as an indicator of SCA effects and selecting crosses based on individual performance would be a practical approach. Rani and Reddy (2017) observed that, vine length, days to the first appearance of male and female flowers, fruit length, and girth in bottle gourd, the most effective specific combiners were Arka Bahar × Pusa Summer Prolific Long, Arka Bahar × IC-92330, Arka Bahar × Tirupati local, Pusa Summer Prolific Long × Pratik, Pratik × IC-92330, and Pratik × Tirupati local, respectively. Napolitano *et al.* (2020) indicated that either the combination PI414723 × PI161375 exhibited superior specific combining ability for yield per plot in melon. A similar result was also reported by Thakur and Kumar (2020); Alhariri *et al.*, (2020); Cerutti *et al.* (2020); Bairagi *et al.* (2013).

Table 1: Analysis of variance for combining ability of parents and crosses for various traits in bitter gourd.

S.V./parameter	Mean squares		
	GCA (General Combining Ability)	SCA (Specific Combining Ability)	Error
D.F.	7	28	70
Days to anthesis of first male flower	21.657**	17.834**	0.86
No. of nodes to first male flower	0.982**	1.663**	0.154
Days to anthesis of first female flower	39.870**	19.041**	1.572
No. of nodes to first female flower	8.412**	9.940**	0.18
Days to first fruit harvest	110.883**	30.316**	6.302
Vine length (m) at harvest	0.415**	0.144 **	0.04
Number of primary branches	22.238**	46.501**	1.29
Number of secondary branches	37.651**	142.604**	3.11
Root length (cm)	17.379**	14.747**	0.23
Root diameter (cm)	7.915**	7.430**	0.13
Fruit yield per plant (g)	326114.90**	312379.25 **	8811.37
Fruit yield (q/ha)	2566.792**	2522.010 **	75.82

Table 2: Estimates of general combining ability effect of parents for days to anthesis of first male flower, no. of nodes to first male flower, days to anthesis of first female flower, no. of nodes to first female flower, days to first fruit harvest and vine length (m) at harvest.

Sr. No.	Parents	Days to anthesis of first male flower	No. of nodes to first male flower	Days to anthesis of first female flower	No. of nodes to first female flower	Days to first fruit harvest	Vine length (m) at harvest
1.	PBIG-4	-1.94 **	-0.56 **	-1.50 **	-0.69 **	-2.28 **	-0.36 **
2.	PBIG-1	-1.75 **	0.52 **	-1.78 **	-1.05 **	-3.43 **	-0.12 *
3.	PBIG-21	-1.15 **	-0.25 *	-2.09 **	0.63 **	-3.76 **	0.17 **
4.	PBIG-19	1.91 **	-0.02	1.02 **	1.91 **	0.65	0.14 *
5.	PBIG-17	0.97 **	0.18	0.7	0.04	2.14 **	0.11
6.	PBIG-2	-0.18	-0.01	3.88 **	-0.12	6.11 **	-0.03
7.	PBIG-15	1.25 **	0.08	0.75 *	-0.30 *	1.69 *	-0.15 *
8.	PBIG-12	0.89 **	0.07	-0.98 **	-0.42 **	-1.13	0.25 **
	S.E. (gi)	0.27	0.12	0.37	0.13	0.74	0.06
	S.E. (gi-gj)	0.41	0.18	0.56	0.19	1.12	0.09

*, ** Significant at 5% and 1 % level, respectively

Table 3: Estimates of general combining ability effect of parents for number of primary branches, number of secondary branches, root length (cm), root diameter (cm), fruit yield per plant (g) and fruit yield (q/ha).

Sr. No.	Parents	Number of primary branches	Number of secondary branches	Root length (cm)	Root diameter (cm)	Yield per plant (g)	Yield (q/ha)
1.	PBIG-4	-1.33 **	1.45 **	-1.39 **	1.11 **	71.73 *	7.23 **
2.	PBIG-1	0.52	-1.47 **	-1.57 **	0.82 **	114.99 **	10.06 **
3.	PBIG-21	-1.81 **	-0.21	1.82 **	-0.08	178.60 **	18.06 **
4.	PBIG-19	-1.44 **	-1.76 **	-0.05	-0.72 **	-199.41 **	-15.86 **
5.	PBIG-17	-0.38	-3.05 **	-1.05 **	-1.03 **	23.58	2.08
6.	PBIG-2	1.17 **	1.50 **	-0.00	-0.73 **	-331.00 **	-29.59 **
7.	PBIG-15	2.46 **	1.00	1.32 **	-0.51 **	-24.43	-4.76
8.	PBIG-12	0.79 *	2.53 **	1.22 **	1.12 **	165.95 **	12.78 **
	S.E. (gi)	0.34	0.52	0.14	0.11	27.77	2.58
	S.E. (gi-gj)	0.51	0.79	0.21	0.16	41.98	3.89

*, ** Significant at 5% and 1 % level, respectively

Table 4: Estimates of specific combing ability effect of crosses for days to anthesis of first male flower, no. of nodes to first male flower, days to anthesis of first female flower, no. of nodes to first female flower, days to first fruit harvest and vine length (m) at harvest.

Sr. No.	Parents	Days to anthesis of first male flower	No. of nodes to first male flower	Days to anthesis of first female flower	No. of nodes to first female flower	Days to first fruit harvest	Vine length (m) at harvest
1.	PBIG-4 × PBIG-1	-2.50 **	-0.27	-1.83 **	-0.18	-3.24 **	4.00 **
2.	PBIG-4 × PBIG-21	-1.34 **	-0.09	2.27 **	4.63 **	5.52 **	-3.60 **
3.	PBIG-4 × PBIG-19	2.16 **	-0.11	-1.95 **	-3.38 **	-8.09 **	-3.66 **
4.	PBIG-4 × PBIG-17	5.83 **	0.03	6.36 **	-2.21 **	5.44 **	-2.25 **
5.	PBIG-4 × PBIG-2	-1.01 **	-0.12	-5.16 **	0.25	-2.38 *	-0.12
6.	PBIG-4 × PBIG-15	1.95 **	0.31 *	-0.92	2.67 **	2.83 **	-1.27 **
7.	PBIG-4 × PBIG-12	3.89 **	-0.86 **	-3.36 **	-2.25 **	-6.16 **	1.87 **
8.	PBIG-1 × PBIG-21	4.95 **	-1.25 **	5.02 **	-1.17 **	7.10 **	-1.06 **
9.	PBIG-1 × PBIG-19	-8.14 **	4.36 **	-4.84 **	1.48 **	-7.44 **	1.72 **
10.	PBIG-1 × PBIG-17	-4.89 **	1.63 **	-2.56 **	2.25 **	-3.07 **	-0.31 *
11.	PBIG-1 × PBIG-2	0.06	-0.87 **	1.53 **	-2.07 **	8.39 **	5.35 **
12.	PBIG-1 × PBIG-15	2.65 **	-0.47 **	0.67	-1.23 **	-2.76 **	-0.35 *
13.	PBIG-1 × PBIG-12	4.14 **	-0.43 **	-1.91 **	2.88 **	-2.85 **	-0.04
14.	PBIG-21 × PBIG-19	-4.88 **	-1.20 **	-1.59 **	0.02	-4.07 **	-1.97 **
15.	PBIG-21 × PBIG-17	-1.34 **	1.02 **	0.29	1.04 **	0.76	-2.04 **
16.	PBIG-21 × PBIG-2	4.57 **	-0.09	-8.51 **	0.42 *	-8.67 **	-1.17 **
17.	PBIG-21 × PBIG-15	0.70	-0.23	2.41 **	3.48 **	1.01	-0.74 **
18.	PBIG-21 × PBIG-12	-5.69 **	-0.20	-8.90 **	-4.11 **	-3.09 **	1.20 **
19.	PBIG-19 × PBIG-17	-1.68 **	-0.18	0.49	8.00 **	2.12 *	0.67 **
20.	PBIG-19 × PBIG-2	8.36 **	-0.69 **	0.89	1.29 **	3.46 **	2.22 **
21.	PBIG-19 × PBIG-15	3.76 **	-0.23	0.58	-5.62 **	7.29 **	1.71 **
22.	PBIG-19 × PBIG-12	2.78 **	-0.23	7.35 **	-1.35 **	9.66 **	-3.92 **
23.	PBIG-17× PBIG-2	0.90 *	-1.53 **	-2.88 **	-0.76 **	-0.95	1.22 **
24.	PBIG-17× PBIG-15	5.10 **	-0.31 *	3.74 **	1.65 **	7.10 **	2.27 **
25.	PBIG-17× PBIG-12	-0.76 *	0.54 **	-2.09 **	-3.30 **	-4.60 **	2.56 **
26.	PBIG-2× PBIG-15	-6.10 **	-0.67 **	-0.04	-1.70 **	-4.45 **	1.33 **
27.	PBIG-2× PBIG-12	-1.24 **	2.97 **	-1.73 **	-2.20 **	-1.85	-0.71 **
28.	PBIG-15× PBIG-12	-3.24 **	-0.25	-0.32	4.44 **	-3.05 **	-0.87 **
	SE (gii)	0.83	0.35	1.13	0.38	1.7126	0.07
	SE (gij)	0.72	0.30	0.98	0.33	1.4898	0.28

*, ** Significant at 5% and 1 % level, respectively

Table 5: Estimates of specific combing ability effect of crosses for number primary branches, number of secondary branches, root length (cm), root diameter (cm), fruit yield per plant (g) and fruit yield (q/ha).

Sr. No.	Parents	Number of primary branches	Number of secondary branches	Root length (cm)	Root diameter (cm)	Fruit yield per plant	Fruit yield(q/ha)
1.	PBIG-4 × PBIG-1	8.64 **	-4.25 **	2.66 **	4.00 **	-118.41 **	-30.83 **
2.	PBIG-4 × PBIG-21	1.88 **	-1.60 *	-5.43 **	-3.60 **	-321.54 **	5.36
3.	PBIG-4 × PBIG-19	1.01 *	26.91 **	3.29 **	-3.66 **	161.81 **	18.25 **
4.	PBIG-4 × PBIG-17	-12.64 **	1.27	-6.40 **	-2.25 **	277.39 **	14.49 **
5.	PBIG-4 × PBIG-2	-5.51 **	-5.64 **	5.19 **	-0.12	232.40 **	-3.35
6.	PBIG-4 × PBIG-15	4.06 **	5.78 **	-2.03 **	-1.27 **	-48.21	56.31 **
7.	PBIG-4 × PBIG-12	5.55 **	8.98 **	1.43 **	1.87 **	527.82 **	-51.12 **
8.	PBIG-1 × PBIG-21	-0.84	0.03	1.52 **	-1.06 **	-609.40 **	60.08 **
9.	PBIG-1 × PBIG-19	7.95 **	15.28 **	1.74 **	1.72 **	680.26 **	50.38 **
10.	PBIG-1 × PBIG-17	5.08 **	12.57 **	-2.13 **	-0.31 *	538.38 **	51.45 **
11.	PBIG-1 × PBIG-2	1.59 **	-11.17 **	-1.84 **	5.35 **	635.41 **	-17.17 **
12.	PBIG-1 × PBIG-15	2.98 **	7.44 **	-1.84 **	-0.35 *	-217.06 **	-0.77
13.	PBIG-1 × PBIG-12	1.63 **	1.43 *	-1.01 **	-0.04	-112.95 **	-64.00 **
14.	PBIG-21 × PBIG-19	-10.19 **	-8.81 **	-1.10 **	-1.97 **	-729.61 **	21.06 **
15.	PBIG-21 × PBIG-17	-3.25 **	-10.28 **	-2.41 **	-2.04 **	110.07 **	-43.53 **
16.	PBIG-21 × PBIG-2	5.51 **	14.52 **	0.35	-1.17 **	793.14 **	57.55 **
17.	PBIG-21 × PBIG-15	4.63 **	8.11 **	6.46 **	-0.74 **	525.65 **	46.86 **
18.	PBIG-21 × PBIG-12	13.41 **	19.54 **	8.37 **	1.20 **	1011.75 **	74.82 **
19.	PBIG-19 × PBIG-17	-0.85	12.14 **	0.31	0.67 **	-473.40 **	-47.65 **
20.	PBIG-19 × PBIG-2	-6.37 **	-4.26 **	-2.98 **	2.22 **	-619.38 **	-40.90 **
21.	PBIG-19 × PBIG-15	1.21 **	-13.23 **	-1.69 **	1.71 **	-405.37 **	-65.03 **
22.	PBIG-19 × PBIG-12	-5.12 **	-12.60 **	0.15	-3.92 **	-731.08 **	-0.20
23.	PBIG-17× PBIG-2	2.43 **	15.08 **	7.46 **	1.22 **	-15.25	-50.36 **
24.	PBIG-17× PBIG-15	2.09 **	0.21	-1.88 **	2.27 **	-667.15 **	-7.76 *
25.	PBIG-17× PBIG-12	1.50 **	-12.49 **	3.00 **	2.56 **	243.54 **	41.47 **
26.	PBIG-2× PBIG-15	2.75 **	-1.88 **	-1.78 **	1.33 **	383.36 **	-20.08 **
27.	PBIG-2× PBIG-12	1.66 **	-11.19 **	-4.01 **	-0.71 **	-432.28 **	-8.73 *
28.	PBIG-15× PBIG-12	0.78	4.20 **	-4.60 **	-0.87 **	216.52 **	-6.09
	SE (gii)	1.02	1.59	0.43	0.07	85.12	7.89
	SE (gij)	0.89	1.39	0.37	0.28	74.04	6.86

*, ** Significant at 5% and 1 % level, respectively

CONCLUSIONS

Diallel mating design without reciprocal crosses revealed that analysis of variance due to genotypes and crosses showed significant difference for most of the characters indicating the presence of sufficient variation in genetic material. According to combining ability the parents PBIG-4, PBIG-1, PBIG-21, PBIG-12 and PBIG-15 observed superior general combiner for most of the traits and could be used for developing desirable bitter gourd hybrids. The hybrids PBIG-21 × PBIG-2 and PBIG-21 × PBIG-12 Showed significant positive SCA effects indicating good specific combining ability for days to first fruit harvest, number of fruit yield per plant and yield per hectare.

FUTURE SCOPE

From this investigation it is suggested that parental lines PBIG-1 and PBIG-21, can be selected as a parents in future breeding programmes due to high GCA effect in positive direction. The cross PBIG-21 × PBIG-12 showed significant positive SCA effect for most of the characters so this can be considered for further breeding programmes

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Conflict of Interest. None.

REFERENCES

Alam, M. A., Uddin, R., Subhan, N., Rahman, M. M., Jain, P. and Reza, H. M. (2015). Beneficial role of Bitter melon supplementation in obesity and related complications in metabolic syndrome. *Journal of Lipids*, 1-18.

Allard, R. W. (1960). Principles of plant breeding. John Wiley and Sons Inc, New York, USA. 485p.

Alhariri, A., Behera, T. K., Munshi, A. D. and Jat, G. S. (2020). Gene action and combining ability analysis for horticultural traits in bitter gourd. *Indian Journal Horticulture*, *77*(3), 484-490.

Balat, J. R., Patel, J .B., Delvadiya, I. R. and Ginoya, A.V. (2021). Combining ability studies for fruit yield and its components in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Biological Forum – International Journal*, *13*(2), 396-403.

Bairagi, S. K., Ram, H. H. and Singh, D. K. (2013). Analysis of combining ability in cucumber (*Cucumis sativus* L.) through half diallel mating system. *Annals of Horticulture*, 6, 308-314

Behera, T. K., Singh, A. K., and Staub, J. E. (2008). Comparative analysis of genetic diversity in Indian bitter gourd (*Momordica charantia* L.) using RAPD and ISSR markers for developing crop improvement strategies. *Scientia Horticulturae*, *115*(3), 209-217.

Behera, T. K., Dey, S. S., Datta, S. and Kole, C. (2020). Classical genetics and traditional breeding. In: C. Kole, H., Matsumura and T. Behera, eds. The Bitter gourd genome: compendium fo plant genomes. *Springer*, pp. 45-59.

Bhatt, L., Singh, S. P., Soni, K. and Samota, M. K. (2017). Combining ability studies in bitter gourd (*Momordica charantia* L.) for quantitative characters. *International Journal of Current*

Microbiology and Applied Sciences, *6*(7), 4471-4478.

Cerutti, P. H., Grigolo, S., Melo, R. C., Fioreze, A. C. C. L., Guidolin, A. F. and Coimbra, J. L. M. (2020). Combining ability between common bean gene groups for root distribution trait. *Ciência e Agrotecnologia*, *44*(17), 1-10.

Golabadi, M., Golkar, P. and Ercisli, S. (2017). Estimation of gene action for fruit yield and morphological traits in greenhouse cucumber by mating designs. *Acta Scientiarum Polonorum*, *16*(4), 3-12.

Griffing, J. B. (1956). Concept of general and specific ability in relation to diallel crossing system. *Australia Journal of Bio Science, 9*, 463-493.

Jasim, E. A. A. and Esho, K. B. (2021). Study the line × tester hybridization, [ii] seeds yield and it's component in Squash (*Cucurbita pepo* L.). *Plant Archives*, *21*(1), 1-5.

Mishra, V. and Singh, D. K. (2018). Combining ability and heterosis studies in Bitter guard (*Momordica charactia* L.). *International Journal of Current Microbiology and Applied Sciences*, *7*(7), 4278-4289.

Napolitano, M., Terzaroli, N., Kashyap, S., Russi, L., Evans, E. and Albertini, E. (2020). Exploring heterosis in melon (*Cucumis melo* L.). *Plants*, *9*(2), 1-19.

Quamruzzaman, A., Salim, M. M. R., Akhter, L., Rahman, M. M. and Chowdhury, M. A. Z. (2020). Gene action for yield contributing character in Bottle Gourd. *European Journal of Agriculture and Food Sciences*, *2*(3), 1-8.

Rani, K. U. and Reddy, E. N. (2017). Combining ability analysis for yield and its components in Bottle Gourd. *International Journal of Pure and Applied Bioscience*, *5*(4), 809-817.

Rose, B., Yadav, F., Parida, P. and Haseena, K. (2014). Study of wild bitter melon species in different geographical area. *Journal of Ethnopharmacology*, *97*(6), 156-167.

Talukder, Z. H., Khan, M. H., Das, A. K. and Uddin, N. (2018). Assessment of genetic variability, heritability and genetic advance in bitter gourd (*Momordica charantia* L) for yield and yield contributing traits in Bangladesh. *Journal of Applied Sciences and Research*, *1*(6), 9-18.

Tamilselvi, N. A., Jansirani, P. and Pugalendhi L. (2015). Estimation of heterosis and combining ability for earliness and yield characters in pumpkin (*Cucurbita moschata* Duch. ex Poir.). *African Journal of Agricultural Research*, *10*(16), 1904-1912.

Thakur, M. and Kumar, R. (2020). Combining ability and gene action studies for different yield contributing traits in cucumber. *Indian Journal Horticulture*, *77*(3), 491-495.

Wu, S. and Ng. L. (2008). Antioxidant and free radical scavenging activities of wild bitter melon (*Momordica charantia* Linn. var. *abbreviata* Ser.) in Taiwan. LWT- *Food Science and Technology*, *41*(9), 323-330.

Zeven, A. C. and Zhukovsky, P. M. (1975). Dictionary of cultivated plants and their centers of diversity- Excluding ornamentals, forest trees and lower plants, Wageningen: Centre for agricultural publishing and documentation. 219p.

Zongo, A., Konate, A. K., Koïta, K., Sawadogo, M., Sankara, P., Ntare, B. R. and Desmae, H. (2019). Diallel analysis of early leaf spot (*Cercospora arachidicola* Hori) disease resistance in groundnut. *Agronomy*, *9*(1), 15.

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