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Combining ability analysis for yield and quality traits in ridge gourd (*Luffa acutangula* L. Roxb.)

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Abstract

The investigation was carried out to study combining ability in ridge gourd through line × tester analysis in which 11 lines were crossed with 3 testers to get 33 F_1 hybrids. These 33 F_1s along with 14 parents were evaluated in Randomized Block Design with three replications under four environments consisting of two locations and two seasons during 2016-17. The parents DRG-3, DRG-5, DRG-15 and Konkan Harita were good general combiners for fruit yield, fruit quality and yield attributing traits and therefore, these are proposed for their further utilization in hybrid breeding programme. Hybrids DRG-15 × Konkan Harita and DRG-3 × Konkan Harita exhibited good specific combining ability for yield per plant and yield contributing characters like number of fruits per plant, fruit weight and fruit diameter. These superior combinations can be further promoted to be utilized as hybrids.

Key words: Combining ability, GCA, SCA, Ridge gourd, Yield

Introduction

Ridge gourd (*Luffa acutangula* L. Roxb.) is an important cucurbitaceous vegetable crop of tropical and subtropical parts of the world. It belongs to genus *Luffa* of Cucurbitaceae family and has chromosome number 2n = 26 and is native to India. It is popularly known as Kalitori in hindi and also called as angled gourd, angled loofah, Chinese okra, silky gourd and ribbed gourd. Tender green fruits are used in soups and curries or cooked as vegetable. It contains a gelatinous compound called 'luffein'' which has medicinal importance (Swarup 2005). The cultivated species of ridge gourd are monoecious in nature but different sex forms *viz.,* androecious, gynoecious, gynomonoecious, andromonoecious and hermaphrodite plants are also reported. Apart from possessing a wide range of genetic variability in terms of growth and yield characters, it is a cross-pollinated crop which envisages its improvement through heterosis breeding. But in hybrid breeding programme the breeder often faces the problem of selecting parents and crosses. At this juncture information on combining ability may be of great value to the breeder.

Combining ability analysis is one of the powerful tools available in crop breeding to identify the best combiners and utilize them in hybridization, either to exploit for heterosis or to combine favourable fixable genes. The concept of combining ability in terms of genetic variation was first given by Sprague and Tatum (1942) using single crosses in maize. Combining ability of inbred lines is the ultimate factor determining the future usefulness of the lines for hybrids. The common approach of selecting parents on the basis of *per se* performance does not necessarily lead to fruitful results since phenotypically superior lines may not lead to expected degree of heterosis. Thus selection of the best parents for hybridization has to be based on the complete genetic information. Sprague and Tatum (1942) defined the term 'general combining ability' (GCA) as the average performance of a strain or genotype in a series of hybrid combinations and 'specific combining ability' (SCA) as the performance of a parent in a specific cross which indicates the deviation of a particular cross from the general combining ability. The estimation of GCA helps the breeders to select suitable parents for hybridization whereas SCA aids in the identification of superior cross combinations. Griffing (1956) elaborated the hypothesis of Sprague and Tatum (1942) and developed the technique to work out GCA and SCA effects along with their variances. General combining ability is due to additive genetic variance and additive x additive epistasis whereas specific combining ability is due to dominance genetic variance and all the three types of epistasis (additive × additive, additive × dominance and dominance × dominance). The knowledge of types of

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gene action controlling various traits is important in deciding a proper breeding programme. Thus, proper understanding of combining ability of the parents and nature of gene effects governing yield and their component traits could be of great help in selecting parents for the hybridization programme and formulating suitable breeding method for improvement of the crop. Keeping these points in mind, present investigation was carried out to obtain information about the GCA and SCA of parents and hybrids, respectively in ridge gourd.

Materials and Methods

The present investigation was carried out in four environments comprising of two locations *viz.*, Horticulture farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) and Krishi Vigyan Kendra, Chittorgarh (Rajasthan) and two seasons *viz.*, summer-2017 and *kharif*- 2017. The experimental material used for the study comprised of eleven genetically diverse inbred lines *viz.,* VRS-7 (L_1), VRS-24-2 (L_2), VRS-27 (L_3), VRS-25/10 (L_4), VRS-2/10 (L_5), VRS-7/10 (L_6), IC-571716 (L_7), DRG-3 (L_8), DRG-4 (L_9), DRG-5 (L_{10}), DRG-15 (L_{11}), three testers *viz.*, Swarna Manjiri (T_1), Arka Sujath (T_2), Konkan Harita (T_3), 33 F_1 hybrids and 3 checks *viz.*, Pusa Nutan, Pusa Nasdar and Kaveri (total entries 50). These 33 F_1 hybrids were obtained by crossing 11 inbred lines and 3 testers in line × tester mating fashion during *kharif*- 2016. All genotypes were evaluated in randomized block design (RBD) with three replications in four above mentioned environments. The experimental material was planted in rows of 2.0 m apart with a spacing of 0.5 m between plants. All cultural practices were followed as per the recommended package of practices. Observations were recorded from five randomly selected plants in each replication on twenty growth, yield and quality traits *viz.,* days to anthesis of first male flower, days to anthesis of first female flower, node to first female flower, days to first harvest, number of branches per vine, internodal length (cm), vine length (cm), number of male flowers per vine, number of female flowers per vine, number of fruits per vine, fruit length (cm), fruit diameter (cm), fruit weight (g), rind thickness (cm), flesh thickness (cm), number of seeds per fruit, fruit yield per vine (g), TSS (%), ascorbic acid (mg/100g) and total sugar (%). The pooled data of all four environments for above characters were subjected to statistical analysis for estimation of general and specific combining ability effects according to the model suggested by Kempthrone (1957).

Results and Discussion

Results revealed that the mean squares due to lines, testers and line × tester were significant for all the characters under study (data not shown) which indicated the importance of both additive and non-additive genetic components. Similar results were also reported by Niyaria and Bhalala (2001), Lodam et al. (2009) and Muthaiah et al. (2017). The estimates of negative significant GCA effects for days to anthesis of first male flower and days to anthesis of first female flower were exhibited by parents L_{11} (-3.72 and -3.61), L_8 (-1.90 and -2.13) and T_2 (-0.70 and -0.69) indicating their good general combining ability for these traits. The parental lines L_{11} (-2.80), L_8 (-1.22) and L_1 (-0.87) were recorded to be good general combiners for node to first female flower. L_{11} (-3.91), L_8 (-2.06) and T_2 (-0.87) were good general combiners for days to first harvest (Table 1) which indicated their superiority in transmitting desirable genes for earliness. Significant GCA effects in negative direction for earliness were also reported by Ahmed et al. (2006) in ridge gourd and Naliyadhara et al. (2010) in sponge gourd.

The study revealed that four lines *viz.,* L_{11} (2.36), L_8 (1.38), L_4 (0.62) and L_{10} (0.52) and one tester *viz.,* T_3 (0.61) exhibited positive significant GCA effects for number of fruits per vine (Table 1). Similarly, four lines *viz.,* L_{11} (3.24), L_{10} (2.65), L_8 (2.47) and L_5 (2.04) and one tester *viz.,* T_3 (1.55) exhibited positive significant GCA effects for fruit length (Table 2). For fruit diameter, L_{11} (0.81), L_4 (0.37) and L_{10} (0.32) and T_3 (0.24) were good general combiners. For fruit weight and fruit yield per vine, three lines *viz.,* L_{11} (13.66 and 471.52), L_8 (7.09 and 266.59) and L_{10} (7.03 and 137.47) and one tester *viz.,* T_3 (3.81 and 126.55) exhibited significant positive GCA effects (Table 2) which showed their genetic worth in using them as general combiners for these important traits. These findings are in agreement with the findings of Hedau and Sirohi (2004), Purohit et al. (2007) and Lodam et al. (2009) in ridge gourd. Number of parental lines *viz.,* $L_{5,}$ $L_{7,}$ $L_{8,}$ L_{10} and L_{11} were good general combiners for number of branches per vine while $L_{4,}$ $L_{6,}$ $L_{8,}$ L_{11} and T_3 were good general combiners for vine length. For internodal length, $L_{1,}$ L_8 and L_{11} exhibited negative significant estimates of GCA effects (Table 1). Narasannavar et al. (2015) also reported positive significant GCA effects for number of branches per vine and vine length. The estimate of negative significant GCA effect for number of male flowers per vine was exhibited by parental line L_{11} only while for number of female flowers per vine positive significant estimates of GCA effects were exhibited by $L_{3,}$ L_8, L_{11} and T_3. Similar findings for sex ratio have also been reported by Tyagi et al. (2010) in ridge gourd. Parents $L_{7,}$ L_8, L_{11} and T_3 were good general combiners for rind thickness and flesh thickness while $L_{1,}$ $L_{9,}$ L_{11}

Table 1: GCA and SCA effects for different traits in ridge gourd

S. No.	Genotype	Days to anthesis of first male flower	Days to anthesis of first female flower	Node to first female flower	Days to first harvest	Number of branches per vine	Internodal length	Vine length	Number of male flowers per vine	Number of female flowers per vine	Number of fruits per vine
1	T1	0.76**	0.89**	0.59**	1.22**	-0.04	0.25*	-6.68	3.35*	-0.49*	-0.40**
2	T2	-0.70**	-0.69**	-0.32	-0.87**	-0.03	-0.22	-1.86	-0.49	0.03	-0.21
3	T3	-0.06	-0.20	-0.27	-0.36	0.06	-0.03	8.55*	-2.86	0.46*	0.61**
4	L1	-0.32	-0.38	-0.87**	-0.54	-0.61**	-1.05**	-37.43**	1.41	0.21	-1.22**
5	L2	0.72*	0.98*	1.29**	1.22**	-0.70**	0.10	-31.97**	4.52	-0.41	-1.10**
6	L3	1.01**	0.84*	1.11**	1.59**	-0.41**	0.49*	6.70	9.87**	1.44**	-1.28**
7	L4	-0.18	-0.10	-0.07	0.16	-0.05	0.61**	16.56**	-3.61	-1.25**	0.62**
8	L5	1.10**	1.08**	-0.47	1.35**	0.45**	0.55*	-26.91**	1.21	-1.73**	0
9	L6	1.05**	0.88*	0.36	0.55	0.17**	0.80**	18.27**	5.74*	-0.53	-0.32
10	L7	1.10**	1.20**	0.90**	0.73	0.66**	-0.31	-1.03	3.88	-1.14**	-0.69**
11	L8	-1.90**	-2.13**	-1.22**	-2.06**	0.32**	-0.71**	26.71**	-4.08	1.55**	1.38**
12	L9	1.64**	1.61**	1.25**	1.56**	-0.18**	0.02	-17.81**	-0.91	-0.23	-0.27
13	L10	-0.52	-0.37	0.53	-0.66	0.22**	0.60**	-11.67	-1.67	-0.20	0.52*
14	L11	-3.72**	-3.61**	-2.80**	-3.91**	0.13*	-1.09**	58.58**	-16.37**	2.31**	2.36**
15	L1 × T1	0.47	0.43	-0.30	0.41	-0.37**	-0.48	1.20	-5.29	-1.01	-0.15
16	L2 × T1	-0.93	-0.85	-0.10	-0.75	0.42**	-0.24	-2.59	-3.69	1.75*	0.17
17	L3 × T1	-0.98	-0.88	-0.83	-1.08	-0.02	0.14	-1.42	-4.56	1.54*	0.87
18	L4 × T1	-0.49	-0.33	-0.50	-0.58	-0.32**	0.43	-10.41	4.05	-0.46	-0.52
19	L5 × T1	-0.50	-0.55	0.03	-0.69	0.60**	-0.68	-8.13	1.49	0.29	-0.08
20	L6 × T1	-0.18	0.03	1.06	0.59	-0.19	-0.41	-28.59*	-5.37	-0.06	0.05
21	L7 × T1	-0.03	-0.25	-1.02	-0.23	0.22	-0.25	50.34**	6.30	0.34	1.18*
22	L8 × T1	1.76*	1.90*	0.98	1.77	-0.02	1.16**	12.2	10.02	-2.22**	-1.48**
23	L9 × T1	-0.70	-0.69	-0.40	-0.86	0.33**	0.15	7.55	4.04	0.64	1.37**
24	L10 × T1	0.69	0.47	-0.34	0.51	0.01	-0.59	-2.40	-8.35	-0.01	-0.62
25	L11 × T1	0.89	0.72	1.41*	0.92	-0.67**	0.76	-17.74	1.35	-0.79	-0.78
26	L1 × T2	-1.48*	-1.75*	-1.06	-3.00**	0.41**	0.10	-2.24	0.88	0.34	0.58
27	L2 × T2	0.73	0.67	0.30	0.86	-0.10	0.19	14.51	7.13	-1.57*	-0.10
28	L3 × T2	0.35	0.18	-0.50	0.39	-0.03	-0.56	6.59	4.30	-0.37	-0.19
29	L4 × T2	-1.12	-1.48	-0.42	-1.46	0.35**	-0.33	28.59*	-3.20	1.86*	1.57**
30	L5 × T2	0.90	0.94	0.22	0.88	-0.32**	0.84	16.06	-8.49	-1.19	0.21
31	L6 × T2	0.14	-0.22	-1.31*	-0.01	0.11	-0.34	-22.80	-2.01	0.67	-0.39
32	L7 × T2	0.46	0.54	1.25*	0.16	0.30*	0.28	-21.85	-8.85	0.13	-0.95*
33	L8 × T2	1.01	1.19	0.44	1.73	-0.44**	0.26	-68.45**	1.98	0.83	-0.19
34	L9 × T2	1.27	1.07	1.04	1.80	-0.51**	-0.85*	27.23*	3.42	-0.64	-0.54
35	L10 × T2	-1.75*	-0.94	0.33	-1.03	-0.13	0.31	28.12*	4.35	0.67	0.58
36	L11 × T2	-0.52	-0.20	-0.28	-0.32	0.36**	0.11	-5.77	0.49	-0.73	-0.59
37	L1 × T3	1.01	1.32	1.36*	2.59**	-0.04	0.38	1.04	4.40	0.66	-0.43
38	L2 × T3	0.20	0.18	-0.21	-0.11	-0.32**	0.05	-11.91	-3.44	-0.18	-0.07
39	L3 × T3	0.62	0.70	1.34*	0.69	0.05	0.42	-5.17	0.26	-1.17	-0.68
40	L4 × T3	1.61*	1.81*	0.92	2.04*	-0.04	-0.10	-18.18	-0.85	-1.40	-1.04*
41	L5 × T3	-0.40	-0.39	-0.25	-0.19	-0.29*	-0.16	-7.93	7.00	0.90	-0.14
42	L6 × T3	0.04	0.18	0.26	-0.58	0.08	0.75	51.40**	7.38	-0.60	0.34
43	L7 × T3	-0.44	-0.29	-0.23	0.07	-0.52**	-0.02	-28.49*	2.55	-0.47	-0.23
44	L8 × T3	-2.77**	-3.09**	-1.41*	-3.49**	0.46**	-1.42**	56.25**	-11.99*	1.40	1.68**
45	L9 × T3	-0.57	-0.38	-0.64	-0.95	0.18	0.70	-34.78**	-7.47	0	-0.83
46	L10 × T3	1.07	0.48	0.01	0.52	0.13	0.29	-25.72*	4.00	-0.65	0.04
47	L11 × T3	-0.36	-0.51	-1.14	-0.60	0.31*	-0.88*	23.50	-1.84	1.52*	1.36**

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

and T_1 were good general combiners for number of seeds per fruit (Table 2). For TSS content, three parents *viz.*, L_8, L_{11} and T_3 had good range of positive GCA effects. L_7, L_8, L_{11} and T_3 were good general combiners for ascorbic acid content while L_8, L_{11} and T_3 were good general combiners for total sugar content (Table 2). Karmakar et al. (2013) also reported significant GCA effects for ascorbic acid content in ridge gourd.

A perusal of SCA effects with regard to days to flowering revealed that three hybrids *viz.*, $L_8 \times T_3$ (-

Table 2: GCA and SCA effects for different traits in ridge gourd

S. No.	Genotype	Fruit length	Fruit diameter	Fruit weight	Rind thickness	Flesh thickness	Number of seeds per fruit	Fruit yield per vine	TSS	Ascorbic acid	Total sugar
1	T1	-1.65**	-0.35**	-4.31**	-0.05**	-0.06**	-6.41**	-101.52**	-0.07**	-0.25	-0.04
2	T2	0.10	0.10	0.50	0.01	0.02	3.59*	-25.03	-0.03	-0.06	-0.06*
3	T3	1.55**	0.24**	3.81**	0.04*	0.04*	2.82	126.55**	0.10**	0.31*	0.10**
4	L1	-4.86**	-1.32**	-18.21**	-0.21**	-0.24**	-27.72**	-338.98**	-0.38**	-1.51**	-0.23**
5	L2	-1.16*	-0.21	-4.75**	-0.03	-0.01	-0.40	-186.79**	-0.12**	-0.18	-0.04
6	L3	-0.15	0.10	-2.01	-0.05	-0.07*	2.80	-185.45**	-0.51**	-0.74**	-0.31**
7	L4	-1.00*	0.37*	-1.04	-0.02	-0.08*	9.04**	51.79	0.02	0.41	0.08
8	L5	2.04**	-0.10	0.56	-0.03	-0.03	18.07**	-3.26	-0.08	-0.02	-0.18**
9	L6	-0.41	-0.22	-3.18*	0.01	-0.01	2.54	-85.79**	-0.17**	-0.43	-0.23**
10	L7	-0.37	0.02	1.15	0.08*	0.08*	12.89**	-79.89*	-0.06	0.61*	-0.08
11	L8	2.47**	0.27	7.09**	0.12**	0.14**	8.55**	266.59**	0.43**	1.85**	0.28**
12	L9	-2.44**	-0.04	-0.29	-0.02	0.04	-16.91**	-47.22	-0.02	-1.03**	-0.03
13	L10	2.65**	0.32*	7.03**	0.03	0.04	8.45**	137.47**	-0.05	-1.40**	-0.02
14	L11	3.24**	0.81**	13.66**	0.12**	0.15**	-17.32**	471.52**	0.94**	2.42**	0.76**
15	L1 × T1	0.61	0.35	1.23	0.03	0	5.01	13.63	-0.14	-0.63	-0.13
16	L2 × T1	0.48	-0.19	-1.61	-0.02	-0.06	-0.44	14.27	0.12	0.07	-0.07
17	L3 × T1	1.00	-0.29	0.98	0.05	0.05	-7.48	124.46	0.08	1.04*	0.03
18	L4 × T1	-0.21	-0.08	4.31	0.01	0.03	-6.68	-10.89	-0.10	0.08	-0.07
19	L5 × T1	1.25	0.40	4.18	0.15*	0.17*	1.16	48.00	0.10	-0.39	0.24**
20	L6 × T1	-1.32	0.27	2.08	0.06	-0.02	-5.36	36.27	-0.34**	-0.48	-0.23**
21	L7 × T1	0.90	-0.19	0.67	-0.05	-0.08	2.49	159.28*	-0.13	-0.78	-0.24**
22	L8 × T1	1.44	-0.17	-4.56	-0.08	0.06	11.13*	-253.51**	-0.12	-0.29	0.01
23	L9 × T1	0.21	0.39	-1.38	0	-0.02	-8.68	146.57*	0.01	1.27*	0.01
24	L10 × T1	-2.59*	-0.28	-3.19	-0.07	-0.06	9.87	-121.46	0.08	-0.23	0.18*
25	L11 × T1	-1.78	-0.21	-2.71	-0.09	-0.08	-1.02	-156.61*	0.43**	0.34	0.27**
26	L1 × T2	0.52	0.25	2.70	0	-0.05	-3.55	98.38	0.27**	0.81	0.32**
27	L2 × T2	0.38	-0.08	-0.96	0.01	0.01	-1.59	-21.10	-0.19*	-0.41	-0.03
28	L3 × T2	1.04	0.83**	5.27*	0.08	0.07	8.87	32.10	0.05	0	0.04
29	L4 × T2	-0.63	-0.56	-4.01	0	0.08	-5.43	136.56*	0.03	0.42	0.06
30	L5 × T2	-0.48	0	-0.52	-0.05	-0.04	-1.12	23.16	0.56**	0.31	0.19*
31	L6 × T2	-0.33	-0.71*	-1.81	-0.06	-0.02	-3.91	-59.49	0.08	0.28	0.09
32	L7 × T2	-1.36	0.58	-3.31	0.04	0.05	-7.33	-152.32*	-0.22*	-0.28	-0.06
33	L8 × T2	-1.99*	-0.41	-0.68	-0.01	-0.13*	12.96*	-35.95	-0.16	-0.07	-0.16
34	L9 × T2	0.72	-0.08	1.03	0.02	0.02	17.85**	-40.55	0.22*	0.20	0.15
35	L10 × T2	1.91	0.36	2.73	0.01	0.01	-17.69**	107.65	-0.07	-0.18	-0.23**
36	L11 × T2	0.22	-0.19	-0.44	-0.04	0	0.93	-88.44	-0.56**	-1.07*	-0.37**
37	L1 × T3	-1.14	-0.59	-3.92	-0.04	0.05	-1.46	-112.01	-0.13	-0.19	-0.19*
38	L2 × T3	-0.86	0.27	2.58	0.01	0.05	2.03	6.83	0.08	0.35	0.10
39	L3 × T3	-2.04*	-0.53	-6.25*	-0.13*	-0.11	-1.39	-156.57*	-0.13	-1.04*	-0.07
40	L4 × T3	0.84	0.63*	-0.30	-0.01	-0.11	12.11*	-125.67	0.07	-0.50	0
41	L5 × T3	-0.77	-0.40	-3.66	-0.10	-0.13	-0.03	-71.16	-0.67**	0.09	-0.43**
42	L6 × T3	1.65	0.43	-0.27	-0.01	0.03	9.27	23.22	0.26**	0.21	0.15
43	L7 × T3	0.46	-0.40	2.63	0.01	0.03	4.84	-6.96	0.35**	1.06*	0.30**
44	L8 × T3	0.54	0.58	5.24*	0.09	0.07	-24.09**	289.46**	0.28**	0.35	0.15
45	L9 × T3	-0.93	-0.31	0.36	-0.02	0	-9.17	-106.02	-0.23*	-1.48**	-0.16
46	L10 × T3	0.68	-0.08	0.45	0.06	0.04	7.82	13.81	-0.02	0.41	0.05
47	L11 × T3	1.56	0.39	3.15	0.13*	0.08	0.09	245.05**	0.13	0.73	0.10

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

2.77), $L_{10} \times T_2$ (-1.75) and $L_1 \times T_2$ (-1.48) exhibited the negative significant SCA effects for days to anthesis of first male flower while two hybrids *viz.*, $L_8 \times T_3$ (-3.09) and $L_1 \times T_2$ (-1.75) exhibited the negative significant SCA effects for days to anthesis of first female flower. For node to first female flower, two hybrids *viz.*, $L_8 \times T_3$ (-1.41) and $L_6 \times T_2$ (-1.31) were good specific combiners. Out of 33 hybrids, only two hybrids *viz.*, $L_8 \times T_3$ (-3.49) and $L_1 \times T_2$ (-3.00) exhibited the negative significant SCA effects for days to first harvest (Table 1) which indicated that these crosses were good specific combiners for earliness. These results are in agreement with those of Ahmed et al. (2006) and Muthaiah et al. (2017) in ridge gourd and Naliyadhara et al. (2010) in sponge gourd. The estimates of significant positive SCA effects for number of fruits per vine were observed in five hybrids (Table 1) with minimum value in $L_7 \times T_1$ (1.18) and maximum value in $L_8 \times T_3$ (1.68). Significant positive SCA effects for fruit diameter were observed in two hybrids *viz*., $L_3 \times T_2$ (0.83) and $L_4 \times T_3$ (0.63) while $L_3 \times T_2$ (5.27) and $L_8 \times T_3$ (5.24) exhibited the significant positive SCA effects for fruit weight. For fruit yield per vine, five hybrids exhibited the positive significant SCA effects (Table 2) with minimum value in $L_4 \times T_2$ (136.56) and maximum value in $L_8 \times T_3$ (289.46). Similar findings have been reported by Mole et al. (2001), Ahmed et al. (2006), Purohit et al. (2007) and Narasannavar et al. (2015) in ridge gourd and Ram et al. (2007) in sponge gourd.

The estimates of significant positive SCA effects for number of branches per vine were observed in nine hybrids with minimum value in $L_7 \times T_2$ and maximum value in $L_5 \times T_1$. For vine length, six crosses were observed to be good specific combiners while three hybrids were good specific combiners for internodal length (Table 1). Narasannavar et al. (2015) also reported similar results for these traits. The study revealed that only one hybrid $L_8 \times T_3$ exhibited significant negative SCA effect for number of male flowers per vine while four hybrids *viz*., $L_4 \times T_2$, $L_2 \times T_1$, $L_3 \times T_1$ and $L_{11} \times T_3$ exhibited the positive significant SCA effects for number of female flowers per vine (Table 1). Similarly, Tyagi et al. (2010) and Muthaiah et al. (2017) also recorded significant SCA effects for sex ratio in ridge gourd. Two hybrids *viz.,* $L_5 \times T_1$ and $L_{11} \times T_3$ were good specific combiners for rind thickness while only one hybrid $L_5 \times T_1$ was noted to be good specific combiner for flesh thickness (Table 2). For number of seeds per fruit, two hybrids *viz.,* $L_8 \times T_3$ and $L_{10} \times T_2$ exhibited the negative significant SCA effects. Among 33 crosses, seven crosses exhibited the positive significant SCA effects for TSS with the highest value in $L_{11} \times T_1$. However, three hybrids *viz*., $L_3 \times T_1$, $L_9 \times T_1$ and $L_7 \times T_3$ exhibited the positive significant SCA effects for ascorbic acid while six hybrids exhibited the positive significant SCA effects for total sugar (Table 2). Karmakar et al. (2013) also recorded positive significant SCA effects for ascorbic acid content in ridge gourd.

The results indicated that the GCA effects were mostly reflected in the SCA effects of the cross combinations as it is obvious that in almost all the hybrids which showed the best SCA effects, the parents involved were either one or both of the parents with good GCA effect for the particular trait. This indicated that there was strong tendency of transmitting the favourable alleles from parents to off-springs. However, the crosses exhibiting high SCA effects did not always involve parents with high GCA effects, there by suggesting the presence of interallelic gene interactions. These results are in conformity with the result of Narasannavar et al. (2015). However, good general combiners could not always produce best specific combiners for all the traits. Better performance of hybrids involving poor × poor or average × poor general combiners indicated dominance × dominance (epistasis) type of gene action. The crosses involving both parents with good general combining ability effects can be exploited effectively by conventional breeding procedure like pedigree method. However, the crosses with one good combiner and other average or poor combiner could produce desirable transgressive segregators in subsequent generations if additive genetic system was operative in good combining parents and epistatic effects also act in the same direction (Narasannavar et al. 2015).

Overall, combining ability revealed that the parents L_8 (DRG-3), L_{10} (DRG-5), L_{11} (DRG-15) and T_3 (Konkan Harita) were good general combiners for fruit yield and most of them were also good or average general combiners for other component characters like number of fruits per plant, number of branches per vine, fruit weight, fruit diameter and fruit length. These parents could be included in hybrid breeding programme of ridge gourd for developing promising hybrids. Similarly, the best performing hybrids $L_{11} \times T_3$ (DRG-15 × Konkan Harita) and $L_8 \times T_3$ (DRG-3 × Konkan Harita) for total yield per plant also exhibited significantly higher SCA effects for yield contributing characters like number of fruits per plant, fruit weight and fruit diameter which culminated into higher total yield. These superior combinations can be tested for promotion of F_1 hybrids in ridge gourd.

सारांश

प्रस्तुत अन्वेषण नसदार तुरई में वंशक्रम ग परीक्षक विश्लेषण द्वारा संयोजन क्षमता का अध्ययन करने के लिए किया गया जिसमें 11 वंशक्रमों का 3 परीक्षकों के साथ संकरण करके 33 संकर प्राप्त किये गये। इन 33 संकरों का उनके 14 पैतष्कों के साथ वर्ष 2016—17 के दौरान यादषच्छिक खण्ड अभिकल्पना के अंतर्गत तीन पुनरावषत्तियों में चार वातावरणों के अंतर्गत जिनमें दो मौसम और दो स्थान सम्मिलित थे, का विश्लेषण किया गया। पितष डीआरजी—3, डीआरजी—5, डीआरजी—15 और कोंकण हरिता वांछित फल उपज, फल गुणवत्ता व

उपज में सहायक गुणों के लिए अच्छे संयोजक पाए गये, अतः इन्हें भविष्य की संकर प्रजनन योजना में उपयोग हेतु प्रस्तावित किया गया। संकर डीआरजी–15 ग कोंकण हरिता तथा डीआरजी–3 ग कोंकण हरिता ने उपज प्रति पौध तथा उपज में सहायक लक्षणों जैसे फल संख्या प्रति पौध, फल भार व फल व्यास के लिए अच्छी संयोजन क्षमता का प्रदर्शन किया। इन उच्च संयोजनों को संकर के रूप में उपयोग के लिए आगे बढ़ाया जा सकता है।

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