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Combining Ability Analysis in Ridge Gourd [*Luffa acutangula* (L.) Roxb.]

D. Nandhini*, M. Ananthan, V. Krishnamoorthy and G. Anand

Department of Horticulture, AC&RI, TNAU, Madurai-625 104, India
Department of Vegetable Crops, HC&RI, TNAU, Coimbatore-641 003, India

**Corresponding author*

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A B S T R A C T

The present study was carried out at Department of Horticulture, Agricultural College and Research Institute, Madurai during 2015-2016 to study the Combining ability estimates for growth, earliness, yield and quality parameters. Sixteen crosses obtained on Line × Tester approach were evaluated for fifteen traits. The variance due to *sca* was higher than the *gca* for all the characters, indicating the importance of non-additive gene action. Maximum and positively significant *sca* effects was observed in the cross $L_3 \times T_1$ (0.36) followed by $L_1 \times T_4$ (0.33) for fruit yield per vine as well as fruit yield per hectare. $L_4 \times T_4$ showed significant *sca* effects for earliness characters like days to first female flower appearance (-2.75) and days to first harvest (-8.74).

Introduction

Ridge gourd is popularly known as kalitori and also called as angled gourd, angled loofah, Chinese okra, silky gourd and ribbed gourd. Ridge gourd [*Luffa acutangula* (L).Roxb] or Ribbed gourd is an underexploited vegetable crop and it is an important Cucurbitaceous vegetable crop. It is grown as mixed crop in the river bed areas and as monocrop in the garden lands. It is widely grown in tropical and subtropical parts of the world. Ridge gourd belongs to genus *Luffa* of Cucurbitaceae and has a chromosome no. 2n=2x= 26. The genus derives its name from product "Loofah" which is used in bathing sponge, doormats, pillows and cleaning utensils. Ridge gourd, being predominantly monoecious, is a cross pollinated crop and provides ample scope for utilization of the hybrid vigour. During recent years, the exploitation of hybrid vigour and selection of parents on the basis of combining ability have expanded a new alley in crop improvement. These studies are generally used to assess the performance of lines in hybridization programme and to understand the gene action involved in different characters.

Materials and Methods

An experiment was carried out at Department of Horticulture, Agricultural College and Research Institute, Madurai during *rabi* 2015. The experimental material consists of eight parents viz. PKM-1 (L_1), CO-1 (L_2), LA 12 (L_3), LA 19 (L_4) used as lines and four testers namely LA 7 (T_1), LA 16 (T_2), LA17 (T_3) and

LA 20 (T_4) and one standard check CO-1. The experiment consists of eight parents and 16 hybrids and was evaluated in randomized block design with three replications. A inter row spacing of 2 m and intra row spacing of 2 m was followed and other cultural practices were followed as per the production guidelines of Tamilnadu Agricultural University. Observations on five randomly selected plants were recorded for various growth, earliness, yield and quality parameters. The Line × Tester analysis is one of the most appropriate methods in preliminary screening of the breeding material for combining ability and data was analyzed as per the Kempthorne to determine general and specific combining ability.

Results and Discussion

The analysis of variance (Table 1) for genotypes showed significant differences for all the characters. The estimates of mean sum of squares due to parents showed significant differences for all the characters except node to first female flower, per cent fruit set, number of fruits per vine and fruit yield per vine indicating the presence of sufficient variability among the parents studied. The magnitude of variance due to *sca* was greater than *gca* for all the characters and *gca: sca* less than unity also confirmed the preponderance of non-additive gene action for all the traits. This result is expected as ridge gourd as cross pollinated crop thus exhibiting predominance of dominance genetic variance in comparison to additive component. These results are close conformity with Purohit (2007) and Neeraja (2008).

The estimates of *gca* effects of each parents are presented in Table 2. Among the four testers, T_2 (0.69) showed highly significant and positive *gca* effects for fruit yield per vine, the highest was observed in the line L_3 (0.52). The parent L_3 was found to be good general combiner for number of fruits per vine and estimated fruit yield per hectare these results are in agreement with Shahe and Kale (2003).

The line L_3 (-1.56) and tester T_1 (-1.25) exhibited negative and significant *gca* effects for days to first female flower appearance. Highest significant *gca* effects for days to first harvest was observed in the parent L_3 (-9.54) and T_2 (-4.51). The parents *viz.*, L_3 and T_2 exhibited the significant and negative *gca* effects for both days to first female flower appearance and days to first harvest so, these parents may be used in breeding programme for earliness. These results are in agreement with Ahmed *et al.*, 2006.

The female parent L_3 (1.64) and tester T_2 (1.61) and T_3 (1.23) had positive significant *gca* effects for number of leaves at 90 DAS and the line L_1 (0.30) and tester T_2 (0.34) showed positive significant *gca* effects for number of branches at 90 DAS. The average fruit weight in the line L_2 (0.73) exhibited maximum and significant *gca* effects whereas, L_2 (2.58) exhibited significant and maximum *gca* effects for fruit length. The line L_3 was the good general combiner for number of fruits per vine (0.52), fruit length (0.91), fruit yield per vine (0.10), estimated fruit yield per hectare (0.72) whereas, L_2 (0.15) exhibited the positive and significant *gca* effects for flesh thickness and L_3 (0.36) showed positive significant *gca* effects for rind thickness. Positive and significant *gca* effect was observed in the tester T_3 (0.03) for total crude fibre content. This indicating that there was strong tendency of transmission of higher gain from the parents to the off springs. The present findings corroborated the earlier work of Rao *et al.*, (2000).

However parents $L_{1,}$ $L_{2,}$ L_3 and $T_{1,}$ T_2 exhibited significant *gca* effects for the most of the traits.

Table.1 Analysis of variance for combining ability of ridge gourd (*Luffa acutangula* L.)

SI. No.	Character	Replications	Genotypes	Crosses	Lines	Testers	Line x Tester	Error
	Degree of freedom	2	23	15	3	3	9	30
1	Number of leaves on 90 DAS	17.01	46.79*	25.49*	30.26*	37.92*	19.76*	3.22
2	Number of branches at 90 DAS	0.01	0.63*	0.59*	1.13*	0.73*	0.35*	0.06
3	Days to first female flower	7.31	18.25*	16.53*	21.95*	30.99*	9.91*	3.50
4	Node to first female flower	2.45	2.42*	2.33*	2.42	1.69	2.52*	0.84
5	Days to first harvest	143.27	266.88*	264.42*	540.30*	135.76*	215.35*	15.82
6	Sex ratio	0.04	2.20*	2.65*	2.17*	3.34*	2.58*	0.15
7	Number of fruits per vine	0.69	5.35*	3.70*	1.62	2.84	4.68*	**1.29**
8	Average fruit weight	168.06	349.52*	380.77*	1034.49*	154.12	238.42*	89.04
9	Fruit length	23.37	34.21*	39.19*	57.91*	18.49*	39.86*	**2.51**
10	Fruit diameter	0.58	5.01*	2.61*	1.17	4.03*	2.61*	0.58
11	Fruit yield per vine	0.02	0.25*	0.19*	0.20*	0.00	0.25*	0.05
12	Estimated fruit yield per hectare	3.58	14.28*	10.76*	10.93*	0.19	14.22*	1.25
13	Rind thickness	0.01	0.71*	0.45*	1.77*	0.01	0.16*	0.02
14	Flesh thickness	0.01	0.14*	0.11*	0.19*	0.01	0.12*	0.05
15	Total crude fibre content	0.01	0.01*	0.01*	0.01	0.01*	0.01	0.01

* Significant at 5% level

Table.2 General combining ability effects of parents for growth, earliness, yield and quality parameters in ridge gourd

SI. NO.	Parent	Number of leaves on 90 DAS	Number of branches at 90 DAS	Days to first female flower	Node to first female flower	Days to first harvest	Sex ratio	Number of fruits per vine	Average fruit weight	Fruit length	Fruit diameter	Fruit yield per vine	Estimated fruit yield per hectare	Rind thick ness	Flesh thick ness	Total crude fibre content
1.	L_1	0.14	0.30 **	1.74 **	-0.38	1.26	-0.20	-0.04	-10.97**	-1.10 *	-0.06	-0.19 *	-1.38 **	-0.29 **	-0.14 *	-0.00
2.	L_2	-2.17 **	-0.35 **	-0.01	0.51	6.16 **	-0.43**	-0.34	10.73 **	2.58 **	0.17	0.07	0.56	-0.37 **	0.15 *	0.02
3.	L_3	1.64 **	0.21 **	-1.56**	0.24	-9.54**	0.07	0.52	-3.28	0.91	-0.41	0.10 *	0.72 *	0.36 **	-0.07	-0.01
4.	L_4	0.38	-0.16 *	-0.17	-0.38	2.12	0.56 **	-0.14	3.52	-2.40**	0.30	0.01	0.11	0.31 **	0.05	-0.01
5.	T_1	-2.24 **	-0.08	-1.25 *	0.50	2.13	-0.75**	-0.11	-2.85	0.95 *	0.71 **	-0.02	-0.11	0.05	-0.02	-0.04 **
6.	T_2	1.61 **	0.34 **	-1.06	-0.31	-4.51**	0.46 **	0.69 *	-2.69	-1.66 **	-0.15	0.03	0.16	-0.00	-0.01	0.00
7.	T_3	1.23 *	-0.01	0.06	-0.27	-0.58	0.03	-0.46	4.75	0.96 *	0.12	0.01	0.05	-0.04	-0.02	0.01
8.	T_4	-0.61	-0.25 **	2.25 **	0.08	2.96 *	0.25 *	-0.12	0.78	-0.25	-0.68 **	-0.02	-0.10	-0.00	0.05	0.03 **
	SEd	0.73	0.10	0.76	0.37	1.62	0.16	0.46	3.85	0.64	0.31	0.09	0.45	0.05	0.09	0.01

* Significant at 5 % level ** Significant at 1 % level

Table.3 Specific combining ability effects of hybrids for growth, earliness yield and quality parameters in ridge gourd

SI. NO.	Crosses	Number of leaves on 90 DAS	Number of branches at 90 DAS	Days to first female flower	Node to first female flower	Days to first harvest	Sex ratio	Number of fruits per vine	Average fruit weight	Fruit length	Fruit diameter	Fruit yield/vine	Estimated fruit yield/ha	Rind thick ness	Flesh thick ness	Total crude fibre content
1	L_1 x T_1	-1.28	0.41**	-2.06	-0.89	-14.44**	0.66**	-1.36*	-4.35	-2.21*	0.42	-0.36*	-2.71**	0.08	-0.16	-0.02
2	L_1 x T_2	1.34	0.19	0.55	-0.28	-0.74	0.17	-0.40	-3.30	-1.60	0.46	-0.08	-0.53	-0.24**	0.27	0.03
3	L_1 x T_3	0.12	-0.09	-1.04	1.14*	9.92**	-0.21	0.29	3.49	-2.25*	-1.28**	0.11	0.77	0.27**	-0.09	0.01
4	L_1 x T_4	-0.18	-0.51**	2.54*	0.03	5.25*	-0.62*	1.46*	4.16	6.07**	0.39	0.33*	2.47**	-0.11	-0.02	-0.02
5	L_2 x T_1	-1.70	-0.51**	-0.64	-0.11	5.46*	0.62*	0.62	-0.51	-4.06*	-1.17*	0.12	0.88	-0.03	0.08	-0.00
6	L_2 x T_2	0.56	0.01	1.18	-0.37	-4.97*	-0.61*	1.02	2.53	2.26*	0.88	0.14	1.14	0.03	0.07	0.02
7	L_2 x T_3	2.50*	0.09	-0.66	0.02	-1.38	0.27	-1.63*	8.69	2.96**	0.07	-0.13	-1.04	-0.05	0.01	-0.02
8	L_2 x T_4	-2.93**	0.40**	0.19	0.47	0.89	-0.28	-0.00	-10.70	-1.16	0.23	-0.13	-0.99	0.05	-0.16	0.01
9	L_3 x T_1	2.12*	0.26	1.10	-0.11	-1.58	-0.70**	1.06	5.36	3.94**	0.35	0.36*	2.77**	-0.05	-0.13	0.02
10	L_3 x T_2	-2.83*	-0.22	-1.31	0.20	2.12	1.43**	0.16	9.30	0.44	0.00	0.17	1.08	0.14	-0.19	-0.05*
11	L_3 x T_3	-1.58	-0.01	0.13	0.53	-3.14	-0.30	0.47	-14.97*	-0.57	0.38	-0.20	-1.42*	-0.38**	0.02	0.01
12	L_3 x T_4	3.85**	-0.03	0.01	-0.62	2.59	-0.43	-1.69*	0.30	-3.81**	-0.73	-0.33*	-2.43**	0.29**	0.30*	0.01
13	L_4 x T_1	2.42*	-0.16	1.52	1.11*	10.56**	-0.59*	-0.32	-0.50	2.34*	0.40	-0.12	-0.95	0.00	0.21	0.00
14	L_4 x T_2	-0.62	0.02	-0.34	0.45	3.59	-0.99**	-0.78	-8.53	-1.10	-1.34**	-0.24	-1.69*	0.07	-0.15	0.00
15	L_4 x T_3	-1.05	0.00	1.57	-1.69**	-5.41*	0.25	0.87	2.80	-0.14	0.83	0.23	1.69*	0.15	0.07	-0.00
16	L_4 x T_4	-0.75	0.14	-2.75*	0.13	-8.74**	1.33**	0.23	6.24	-1.10	0.11	0.13	0.95	-0.23*	-0.12	-0.00

* Significant at 5 % level ** Significant at 1 % level

Due to predominant role of non-additive gene action for yield and its components, it is difficult to bring together desirable genes by pedigree method. In this situation formation of central gene pool by bringing together the multiple parents having the good *gca* effects suggested by Jensen (1970) might prove to be useful.

The crosses having desired significant specific combining effects are presented in Table 3. Out of 16 crosses, two crosses exhibited positively significant and two crosses exhibited negatively significant *sca* effects for fruit yield per vine. Maximum and positively significant *sca* effects was observed in the cross L_3xT_1 (0.36) followed by L_1xT_4 (0.33).

The highest positive *sca* effects was exhibited (Table 3) by the cross L_3xT_4 (3.85) followed by for number of leaves per vine. Number of branches was maximum and significant *sca* effects were exhibited by L_1xT_1 (0.41) and L_2T_4 (0.40). Days to first female flower appearance, in the cross L_4xT_4 (-2.75) exhibited negative and significant *sca* effects. Among the crosses only cross L_4xT_3 (-1.69) was exhibited negative and significant *sca* effects for node to first female flower appearance which is desirable. These results are in agreement with Prabhakar (2008). A comparison of the *sca* effects of the crosses and *gca* effects of the parents involved indicated that most of the cases *gca* effects were reflected in the *sca* effects of the cross combination.

The cross L_1xT_4 (-0.62) followed by L_2xT_2 (-0.61) exhibited significant in desirable direction (negative) for sex ratio. For fruit length maximum and significant *sca* effects was observed in the cross L_1xT_4 (6.07) followed by L_4xT_1 (2.34). None of the crosses exhibited positive and significant *sca* effects for average fruit weight and fruit diameter. Maximum and significant *sca* effects was observed in the cross L_1xT_3 (0.27) followed by L_3xT_4 (0.29) for rind thickness. Flesh in thickness the cross L_3xT_4 (0.30) showed significant positive *sca* effect. These results are in agreement with Tyagi *et al.,* (2010).

The crosses involving parents with good general combining ability effects can be exploited effectively by conventional breeding procedure like pedigree method. However the crosses one good combiner and other average or poor combiner could produce desirable transgressive segregators if additive genetic system was operative in good combining parents and epistatic effects also act in the same direction. The crosses exploited for hybrid vigour and hybrid derivative is L_3xT_1 and L_1xT_4.

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