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Research Article

COMBINING ABILITY STUDIES FOR EARLY AND YIELD TRAITS IN RIDGE GOURD [*Luffa acutangula* L. Roxb.]

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Abstract- An experiment was conducted during 2013-15 at Department of Vegetable Science, Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi (Karnataka), to study combining ability in eight different lines of ridge gourd. They were mated in half diallel fashion and their twenty eight crosses were evaluated along with parents in Randomized block design (RBD). Significant differences of analysis of variances due to SCA and GCA were observed for all the characters, it indicates predominance of non additive and additive gene action, that provides ample scope for heterosis breeding or direct selection. Out of eight parents DMRG-36 and DMRG-25 were found to be best general combiners as they have made significant contribution towards yield and yield contributing traits. The cross DMRG-36 x Arka Sumeet exhibited high SCA effect for number of fruit yield per vine, average fruit weight and sex ratio. The cross DMRG-25 × DMRG-1 for per cent fruit set and average fruit weight. The cross DMRG-25 × Arka Sumeet for average fruit weight, number of fruit per vine and fruit diameter. The knowledge of combining ability helps in identifying suitable parents or best combiners for hybridization.

Keywords- Combining ability, Ridge Gourd, Half diallel, *SCA*, *GCA*, Gene action.

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Introduction

Ridge gourd [*Luffa acutangula* (L.) Roxb.], popularly known as Kalitori and also called as angled gourd, angled loofah, Chinese okra, silky gourd and ribbed gourd. Ridge gourd belongs to genus *Luffa* of Cucurbitaceae family and has chromosome number 2n = 26, and is native to India. The genus derives its name from the product "loofah' which is used in bathing sponges, scrubber pads, door mats, pillows and also for cleaning utensils. It contains a gelatinous compound called 'luffein'' and has medicinal importance. Tender fruits are green in colour, which are used in soups and curries or as a cooked vegetable. It is one of the important tropical cucurbitaceous vegetable grown throughout India and South-East Asia. Though cultivated species are monoecious in nature, different sex forms *viz.,* androecious, gynoecious, gynomonoecious, andromonoecious and hermaphrodite plants are also reported [1]. The staminate flowers with five stamens (synandry) are borne in 10-20 flowered racemes while pistillate flowers are solitary, short or long pedunculate and fragrant. The concept of combining ability for the evaluation of parents in a crossing programme is of immense importance. It has been originated through intensive hybridization work in maize, for breaking yield barriers through hybridization, it is the most potential method and evolving varieties having high yielding potential. The selection of suitable parents is one of the most important steps in heterosis breeding. Selection of parents on the basis of phenotypic performance alone is not a sound procedure, since phenotypically superior lines may not lead to expected degree of heterosis. Thus, one of the potential tools for identifying prospective parents for hybridization and shifting productive hybrids from a set of crosses in F_1 generation is the analysis of combining ability [2]. Therefore, the present investigation was undertaken in ridge gourd to obtain information about estimates of general combining ability and specific combining ability. The combining ability estimates were calculated accordingly [3].

Material and Methods

An experiment was carried out at Department of Vegetable Science, K.R.C. College of Horticulture, Arabhavi, University of Horticultural Sciences, Bagalkot during *kharif* and *rabi*, 2014. The experimental material consisted of eight parental lines *viz.,* DMRG-36, DMRG-25, KRCCH-1, DMRG-22, Arka Sumeet, DMRG-1, DMRG-15 and DMRG-44 of these were crossed in a half diallel fashion excluding reciprocals during *Kharif,* 2014. The resultant 28 F_1 hybrids along with eight parents were evaluated in randomized block design with two replication with spacing of 1.2 x 0.9 m. Observations were recorded on five randomly selected plants from each plot for early and yield parameters.

Results and Discussion

Analysis of variance for combining ability revealed that mean squares due to *gca* and sca were highly significant for all the traits, indicated the importance of both additive and non-additive genetic components for most of the traits. Similar results were reported [4,5] in ridge gourd. Mean squares due to interactions of gca and *sca* were also significant for all the traits. Further, the estimated components of variances for *sca* were larger than gca variance component for all the traits [Table-1], indicating the predominance of non-additive gene action for most of the characters. Similar results were also obtained for fruit yield and its component traits [4].

The gca effects of parents were significant for most of the characters studied which indicated the existence of variability among the parents selected for hybridization [Table-2]. Comprehensive assessment of parents by considering gca effects of characters studied has resulted into identification of parents, *viz.*, DMRG-36 and DMRG-25 as good combiners for the most of traits. Information regarding gca effect of the parent is of prime importance as it helps in successful prediction of genetic potentiality of crosses. The parent DMRG-25 had highest mean values for days to first male flowering, days to first female flowering, nodes to first female flowering, per cent fruit set, fruit diameter and average fruit weight. Hence, DMRG-25 can be used in ridge gourd breeding programme. These parents with good gca for the traits also exhibited good *per se* performance. Similar results for some of the traits were reported [6] in bitter gourd, [7] in pumpkin and [8] in sponge gourd. So, the lines DMRG-36 and DMRG-25 were the best general combiner for most of the early and yield traits. The parent KRCCH-1 had high *per se* performance for number of fruits per vine and but has low gca. Hence, it can be concluded that combining ability of parents can't always be judged by their *per se* performance. Similar results were obtained [9] in bottle gourd.

Table-1 *Analysis of variance due to general combining ability and specific combining ability for different parameters in ridge gourd.*

Source of variation	Mean sum of squares			σ^2_g	σ^2_s	σ^2_g: σ^2_s
	GCA	SCA	Error			
Degree of freedom	7	28	35			
Characters						
Early parameters						
Days to first male flowering	1.77**	1.91**	0.29	0.14	1.61	0.09
Days to first female flowering	4.28**	2.26**	0.75	0.35	1.51	0.23
Nodes to first male flowering	0.43**	0.46**	0.09	0.03	0.37	0.09
Nodes to first female flowering	0.46*	0.39*	0.18	0.02	0.21	0.13
Yield parameters						
Sex Ratio (Male : Female)	16.55**	7.35**	2.76	1.37	4.58	0.30
Per cent fruit set	170.76**	70.27**	13.90	15.68	56.37	0.27
Number of fruit per vine	1.24**	1.79**	0.20	0.10	1.58	0.06
Fruit diameter	13.76**	9.74**	1.29	1.24	8.44	0.14
Average fruit weight	304.20**	171.49**	62.94	24.12	108.55	0.22

* And ** indicates significance of value at p= 0.05 and p=0.01, respectively.

GCA - General combining ability SCA - Specific combining ability

σ^2_g - Variance due to GCA=GA σ^2_s - Variance due to SCA=VD

Table-2 *General combining ability effects for early and yield parameters in ridge gourd*

Parent	Early parameters				Yield parameters				
	Days to first male flowering	Days to first female flowering	Nodes to first male flowering	Nodes to first female flowering	Sex Ratio	Per cent fruit set	Number of fruit per vine	Fruit diameter	Average fruit weight
DMRG-36	-0.14	-0.47	-0.35**	-0.09	1.31 *	2.53 *	-0.40 **	0.00	3.53
DMRG-25	-0.40*	-0.86*	-0.23*	-0.25	0.37	2.54 *	0.06	1.35 **	6.09 *
KRCCH-1	0.66**	0.47	-0.17	0.42*	-0.74	-3.42 **	-0.28 *	-0.62	-6.35 *
DMRG-22	-0.30	-0.78*	-0.09	-0.21	2.10 **	5.32 **	0.66 **	1.59 **	6.70 **
Arka Sumeet	-0.18	0.07	0.13	0.08	-0.29	2.00	0.29 *	0.34	3.03
DMRG-1	-0.31	0.10	0.11	0.10	0.26	1.77	0.03	-0.03	-4.05
DMRG-15	0.03	0.57	0.03	-0.07	-1.49 **	-4.51 **	-0.11	-0.52	-2.00
DMRG-44	0.64**	0.91**	0.22*	0.04	-1.53 **	-6.24 **	-0.27	-2.11 **	-6.95 **
S. E. M	0.24	0.38	0.13	0.19	0.74	1.66	0.20	0.50	3.54
CD at 5 (%)	0.37	0.60	0.21	0.30	1.16	2.60	0.31	0.79	5.54
CD at 1 (%)	0.56	0.89	0.31	0.44	1.72	3.85	0.47	1.17	8.21

* And ** indicates significance of value at p= 0.05 and p=0.01, respectively

Estimation of sca effects for 28 crosses has resulted in identification of good specific combiner for various traits as given in [Table-3]. Among crosses, estimates of specific combining ability effects are DMRG-25 × Arka Sumeet, DMRG-36 × Arka Sumeet and DMRG-25 × DMRG-1 were showing significant sca effects for almost all the important yield and yield contributing traits. The cross DMRG-25 × Arka Sumeet exhibited maximum and significant sca effects for nodes to first male flowering, sex ratio, average fruit weight, fruit yield per vine. Similar results were also reported [10] for nodes to first male flowering in ridge gourd, for average fruit weight Neeraja [11] in ridge gourd and for sex ratio Sundaram [12] in bitter gourd. The cross DMRG-36 × Arka Sumeet exhibited maximum and significant sca effects for days to first female flowering, number of fruit per vine. Similar results were also observed [7] for days to first female flowering in pumpkin, [11] for number of fruit per vine in ridge gourd. The cross DMRG-25 × DMRG-1 exhibited maximum and significant sca effects for days to first female flowering, nodes up to first female flowering and number of fruit per vine. [7] made similar observations for days to first female flowering in pumpkin, [11] for number of fruit per vine in ridge gourd . The best crosses showing positive significant sca effects for different characters were DMRG-36 × Arka Sumeet followed DMRG-25 × DMRG-1 and DMRG-25 × Arka Sumeet for number of fruit per vine, DMRG-25 × Arka Sumeet followed by DMRG-25 × DMRG-1 and DMRG-36 × DMRG-22 for fruit diameter, DMRG-25 × Arka Sumeet followed by DMRG-25 × DMRG-1 for average fruit weight. Hence, crosses with higher specific combining ability effects are useful to derive high performing hybrids. These cross combinations involved parents with general combining ability effects like high x high, high x low and low x low which, indicating presence of additive, dominance and epistatic gene actions for controlling these characters. Similar results were also reported [13] in ridge gourd and [6] in bitter gourd. However high x low general combining ability combinations are suitable for heterosis breeding. High x high general combining ability combinations can be considered for developing superior variants through pedigree selection method.

Conclusion

This study indicates that combining ability helps in identifying best combiners and cross combinations for hybridization and to exploit heterosis. Out of eight parents DMRG-36 and DMRG-25 were observed to be best general combiners as they have made significant contribution towards yield contributing characters. The cross DMRG-36 x Arka Sumeet exhibited high SCA effect for number of fruits yield per vine, average fruit weight and sex ratio. The cross DMRG-25 × Arka Sumeet for average fruit weight number of fruits per vine and fruit diameter. The cross DMRG-25 × DMRG-1 for per cent fruit set and average fruit weight. These studies

Table-3 *Specific combining ability effects for early and yield parameters in ridge gourd*

Hybrids	Early parameters				Yield parameters				
	Days to first male flowering	Days to first female flowering	Nodes to first male flowering	Nodes to first female flowering	Sex Ratio	Per cent fruit set	Number of fruit per vine	Fruit diameter	Average fruit weight
DMRG-36 × DMRG-25	-0.76	0.75	-0.19	-0.96 *	0.66	3.14	0.519	2.45 *	9.41
DMRG-36 × KRCCH-1	0.98	1.11	-0.10	-0.44	-3.58 *	-5.49	-2.22 **	-2.16 *	-2.47
DMRG-36 × DMRG-22	-1.76 **	-1.52	-0.43	-0.30	2.97	6.61	1.02 *	3.58 **	14.38
DMRG-36 × Arka Sumeet	-1.68 **	-1.98 *	-0.46	-0.60	3.61*	13.40 **	1.98**	0.41	13.12
DMRG-36 × DMRG-1	1.25*	2.28 **	-0.44	0.17	-1.93	-9.84**	-1.74 **	-4.69 **	-16.97 *
DMRG-36 × DMRG-15	2.01 **	0.81	0.23	1.05 *	-1.43	-3.68	-1.89 **	-1.90	-6.10
DMRG-36 × DMRG-44	1.80 **	-0.82	-0.45	0.93 *	-0.33	-3.75	-1.23 **	-0.14	4.17
DMRG-25 × KRCCH-1	0.84	1.60	0.97 **	0.41	-0.09	-0.78	-2.10 **	-3.48 **	-24.37**
DMRG-25 × DMRG-22	-1.30 *	-0.63	-0.65*	-0.34	2.91	8.39 *	1.14 **	1.53	4.81
DMRG-25 × Arka Sumeet	-1.42 **	-1.99 *	-0.58 *	-0.94 *	4.70 **	11.87 **	1.74 **	7.22 **	32.50 **
DMRG-25 × DMRG-1	-0.49	-2.52 **	-0.76 *	-0.36	-1.35	16.78 **	1.87 **	5.69 **	15.19 *
DMRG-25 × DMRG-15	1.17 *	1.10	0.51	0.71	-1.80	-18.55 **	0.12	-1.17	-13.97
DMRG-25 × DMRG-44	0.36	0.36	0.12	0.49	0.57	-10.02 **	0.98 *	0.48	-7.36
KRCCH-1 × DMRG-22	-0.69 **	0.24	0.72	0.43	-3.56 *	-11.93 **	-0.69	-1.91	-4.27

* And ** indicates significance of value at p= 0.05 and p=0.01, respectively.

Table 3 contd...

Hybrids	Early parameters				Yield parameters				
	Days to first male flowering	Days to first female flowering	Nodes to first male flowering	Nodes to first female flowering	Sex Ratio	Per cent fruit set	Number of fruit per vine	Fruit diameter	Average fruit weight
KRCCH-1 × Arka Sumeet	0.92	0.46	0.60 *	-0.12	-3.01	-2.50	-0.33	0.25	-1.29
KRCCH-1 × DMRG-1	0.25	-0.161	-0.47	0.95*	-0.57	-8.37 *	0.43	0.39	9.49
KRCCH-1 × DMRG-15	0.51	0.56	-0.09	0.13	0.59	3.92	0.38	1.65	7.24
KRCCH-1 × DMRG-44	2.30 **	-1.47	-0.28	-0.28	-0.08	5.32	1.24 **	2.34 *	-1.50
DMRG-22 × Arka Sumeet	0.98	2.22 **	-0.02	0.41	-5.41**	-1.85	-1.18 **	-2.82 *	-13.64
DMRG-22 × DMRG-1	-0.19	-2.10 *	-1.00 **	-0.40	2.76	1.33	0.38	1.44	11.33
DMRG-22 × DMRG-15	-1.33 *	-1.07	-0.92 **	-0.32	3.74 *	8.5 *	0.53	2.96**	13.68
DMRG-22 × DMRG-44	0.56	1.18	1.18 **	1.05 *	-2.25	-0.82	-0.10	0.56	-11.66
Arka Sumeet × DMRG-1	0.99	1.23	1.26**	0.79	-1.58	-0.10	-1.55 **	-0.14	3.00
Arka Sumeet × DMRG-15	0.15	0.16	0.14	-0.12	0.18	-2.91	-0.50	-0.04	8.45
Arka Sumeet × DMRG-44	0.34	2.52 **	-0.04	0.15	0.04	-1.30	-0.34	-3.52 **	1.01
DMRG-1 × DMRG-15	0.58	-0.36	0.66 *	-0.24	-2.38	-0.38	0.36	0.25	-5.45
DMRG-1 × DMRG-44	-0.63	0.99	-0.82**	-0.06	1.3	-2.02	0.02	-2.86 **	-7.00
DMRG-15 × DMRG-44	-0.57	0.82	0.15	-0.28	1.12	2.43	0.37	-2.99 **	5.74
S. E .M	0.72	1.16	0.41	0.57	2.23	5.00	0.61	1.52	10.64
CD at 5 (%)	1.01	1.61	0.57	0.80	3.10	6.94	0.85	2.12	14.76
CD at 1 (%)	1.36	2.18	0.77	1.08	4.18	9.37	1.15	2.86	19.93

* And ** indicates significance of value at p= 0.05 and p=0.01, respectively.

are prerequisite for breeding programme.

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Author contributions

K. Muthaiah – Conception and design of the research programme, crossing work, data collection, data analysis and interpretation, drafting the article, critical revision of the article, final approval of the version to be published and acted as corresponding author.
V.D. Gasti – Critical revision of the research article
Sanganamoni Mallesh– Critical revision of the research article
Arindam Das - Critical revision of the research article
Vittal Mangi - Critical revision of the research article.

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