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Studies on gene action for growth and yield attributing traits in ridge gourd (*Luffa acutangula* (L.) Roxb.)

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Abstract
Selection of suitable breeding methodologies in bringing desirable improvement in crop plant require the complete knowledge about the nature of gene action involved in the inheritance of quantitative and quality traits. Gene action of growth and yield attributing traits in ridge gourd (*Luffa acutangula* (L.) Roxb.) Were studied through half diallel analysis of 45 F_1 hybrids derived by crossing 10 parental lines (VRG-11, VRG-23, VRG-24, VRG-25, Swarna Manjari, Arka Prasan, VRG-13, VRG-14, VRG-15 and VRG-16). The ratio of *gca* to *sca* variances revealed that non-additive gene action was predominant over additive gene action in the inheritance of all the characters studied except for internodal length. Hence, heterosis breeding is required to be followed for exploitation of these traits.

Keywords: Gene action, ridge gourd, variance, half diallel, fruit yield

Introduction
Ridge gourd (*Luffa acutangula* (L.) Roxb.) belongs to the family Cucurbitaceae and genus *Luffa*. It is widely grown in tropical and subtropical parts of the country. Its chromosome number is 2n=2x=26. It is also called as angled gourd, angled loofah, Chinese okra, silky gourd and ribbed gourd (Muthaiah *et al*., 2017a) [7]. The genus *Luffa* derives its name from the product 'loofah' which is used in bathing sponges, door mats, pillows and also for cleaning utensils. It is one of the important cucurbitaceous vegetable grown throughout India. It is considered to be the old world species and is native of tropical Africa and South-East Asian region including India.
For developing promising hybrids through hybridizations, the choice of parents is a matter of great concern to the plant breeder. A high yielding genotype may or maynot tranmit its superiority to its progenies. Therefore, the success of a breeding programme is determined by useful gene combinations in the form of high combined inbred. The knowledge of nature of gene action governing the expression of various traits could be helpful in predicting the effectiveness of selection. The efficient partitioning of genetic variance into its components *viz.*, additive, dominance and epistasis will help in formulating an effective and sound breeding programme.
The success of a breeding programme is determined by useful gene combinations in the form of high combining inbred.The knowledge of the relative importance of additive and non-additive gene action is essential to a plant breeder for the development of an efficient hybridization programme (Dudley and Moll, 1969) [3]. The present investigation was therefore, undertaken with a set of half diallel crosses to elicit information about the nature and magnitude of gene action for yield and its components in yardlong bean so as to formulate suitable breeding strategy.

Material and Methods
Ten ridge gourd genotypes *viz.*, VRG-11, VRG-23, VRG-24, VRG-25, Swarna Manjari, Arka Prasan, VRG-13, VRG-14, VRG-15 and VRG-16 were chosen in this study to represent substantial amount of genetic diversity for different quantitative traits and were maintained through selfing during 2018. These ten genotypes were involved in 10 × 10 half-diallel combinations to develop 45 F_1 hybrids during *Rabi*, 2018. All the F_1's along with their parents were evaluated in a Randomized Block Design with two replications during *Summer*, 2019. The crop was raised in row and plant spacing of 1 and 1 m, respectively. All recommended package of practices were followed to raise a successful crop.

Five randomly selected plants from each entry were tagged in each replication for recording observations on different characters *viz.*, days to first male and female flower appearance, node number at which first male and female flower appear, sex ratio, intermodal length (cm), days to first fruit harvest, number of fruits per vine, fruit diameter (cm), fruit length (cm), fruit flesh thickness (mm), average fruit weight (g), number of seeds per fruit, fruit yield per vine (kg), number of fruits per vine, fruit diameter (cm), fruit length (cm), fruit flesh thickness (mm), average fruit weight (g), number of seeds per fruit and fruit yield per vine (kg). The data recorded on five plants per treatment was averaged for use in statistical analysis. Data were analyzed according to ANOVA techniques, as outlined by Panse and Sukhatme (1978) [12], to determine the significant differences among genotypes for all the characters. Components of genetic variance were estimated from the data obtained on the diallel crosses by the method given by Griffing's Method-II and Model-I (Griffing, 1956) [4] as outlined by Singh and Chaudhary (1979) [13].

Results and Discussion

The analysis of variance carried out for different traits of ridge gourd are presented in table 1. The analysis of variance revealed that the variances for general combining ability are highly significant for the characters like node number at which first male flower appear, node number at which first female flower appear, sex ratio, internodal length, number of fruits per vine, fruit length, fruit flesh thickness, average fruit weight, number of seeds per fruit, fruit yield per vine. The variance for specific combining ability are highly significant for all the characters, except for days to first male flower appearance, days to first female appearance, internodal length and days to first fruit harvest.

This indicates the existence of wide variability in the material studied and there is a good scope for identifying promising parents and hybrid combinations, and improving the yield through its components. These results are in accordance with the earlier findings of Laxuman *et al*., (2012) [5] in bitter gourd and Naliyadhara *et al*., (2007) [8] in sponge gourd.

The estimates of *gca* and *sca* variances, their ratios and gene action are presented in table 2. General combining ability is genetically associated with additive gene action while specific combining ability is due to dominance and epistasis. The ratio of $\sigma^2 gca$ and $\sigma^2 sca$ is an index of additive and non-additive gene action. The ratio of *gca* and *sca* variance if less than unity, predominance of non-additive gene action is indicated whereas the ratio of more than unity indicates predominance of additive gene action. In the present investigation, the magnitude of *sca* variance was greater than that of *gca* variance and suggests the predominance of the non-additive gene action for majority of the traits. However, for intermodal length, the greater magnitude of *gca* variance than that of *sca* variance suggests the predominance of additive gene action.

The results for this kind of gene action are in conformity with earlier findings of Narasannavar *et al*., (2014) [9], Narasannavar *et al*., (2015) [10], Neeraja (2008) [11], Bairwa *et al.*, (2015) [1], Muthaiah *et al*., (2017b) [6], Divya *et al.*, (2018) [2] in ridge gourd.

Table 1: Analysis of variance for combining ability analysis for growth and yield characters in 10x10 half diallel of ridge gourd

Source	Df	Days to first male flower appearance	Days to first female flower appearance	Node number at which first male flower appear	Node number at which first female flower appear	Sex ratio	Internodal length (cm)	Days to first fruit harvest
Gca	09.00	0.70	2.20	0.14 **	2.03 **	9.47 **	6.47 *	0.57
Sca	45.00	0.78	5.39	0.17 **	1.78 **	12.83 **	2.95	0.76
Error	54.00	0.58	6.68	0.02	0.72	2.53	3.02	1.74

Source	Df	Number of fruits per vine	Fruit diameter (cm)	Fruit length (cm)	Fruit flesh thickness (mm)	Average fruit weight (g)	Number of seeds per fruit	Fruit yield per vine (kg)
Gca	09.00	3.84 **	1.70	31.33 **	2.74 **	2365.52 **	1648.19 **	0.55 **
Sca	45.00	5.04 **	1.94 *	17.10 **	6.45 **	2113.89 **	1357.53 **	0.45 **
Error	54.00	1.28	1.14	4.77	0.00	149.80	24.03	0.04

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

Table 2: Combining ability variances and gene action for growth and yield characters in 10x10 half diallel of ridge gourd

Source	Days to first male flower appearance	Days to first female flower appearance	Node number at which first male flower appear	Node number at which first female flower appear	Sex ratio	Internodal length (cm)	Days to first fruit harvest
$\sigma^2 gca$	-0.00	-0.26	-0.00	0.02	-0.27	0.29	-0.01
$\sigma^2 sca$	0.20	-1.29	0.14	1.05	10.29	-0.06	-0.98
gca/*sca*	-0.03	0.20	-0.01	0.01	-0.02	-4.64	0.01

Source	Number of fruits per vine	Fruit diameter (cm)	Fruit length (cm)	Fruit flesh thickness (mm)	Average fruit weight (g)	Number of seeds per fruit	Fruit yield per vine (kg)
$\sigma^2 gca$	-0.10	-0.01	1.18	-0.30	20.96	24.22	0.00
$\sigma^2 sca$	3.76	0.79	12.32	6.44	1964.09	1333.50	0.40
gca/*sca*	-0.02	-0.02	0.09	-0.04	0.01	0.01	0.02

* and ** significance at 5% and 1% respectively

Conclusion

The presence of non-additive gene action and additive gene action revealed that heterosis breeding and simple selection is required to be followed for further improvement of ridge gourd respectively. Sufficient genetic variability was generated for yield and related traits after crossing ten diverse genotypes of ridge gourd in a diallel mating design (excluding reciprocals).

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