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Estimating Combining Ability for Yield and Yield Contributing Traits in Snake Gourd (*Trichosanthes cucumerina* L.)

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A B S T R A C T

Line x Tester analysis was carried out for thirteen diversified parents at the department of Horticulture, Agricultural College and Research Institute, Madurai, Tamil Nadu, to study the combining ability for yield and yield contributing characters in snake gourd. The analysis for combining ability revealed significant mean sum of squares of both general combining ability (GCA) and specific combining ability (SCA) for all the characters which indicate that the presence of both additive and non-additive gene actions. The line IC 284753 (L_5) and IC333314 (L_2) were found to be best general combiners, for majority of the yield and yield contributing characters. Among the testers Kumbakonam Local (T_3), Kulithalai Local (T_1) and Jeyamkondam Local (T_2) were found to be good general combiner for yield contributing characters *viz*., vine length, fruit length, fruit girth, average fruit weight, number of fruits per vine, number of seeds per fruit and yield per vine. Among the hybrids L_2xT_3, L_7xT_2, L_2xT_4, L_5xT_1 and L_8xT_4 were found to be the good specific combiners (*gca*) for most of the yield and yield contributing characters. These cross combinations can be utilized for further breeding programme for crop improvement in snake gourd.

Introduction

Snake gourd (*Trichosanthes cucumerina* L.) belongs to the family Cucurbitaceae and it's an important summer vegetable but it can be grown throughout the year except extreme winter. It is important as a good sources of minerals, fiber and nutrients to make the food wholesome and healthy (Ahmed *et al.*, 2004). It is also one of the important vegetables which fetch more yields per unit area but the average yield of the crop is low. In addition it has got tremendous export potential because of its excellent keeping quality and shelf life. There are a number of cultivars with wide range of variability in size, shape and color of fruits available in this country. A large number of local lines are cultivated in the country but there is no recommended cultivar so far. There is no serious attempts have been made to upgrade the productivity of snake gourd. For developing superior varieties, it is necessary to improve the yield and its components in snake gourd. Yield is a complex character and is associated with some yield contributing characters, which are simple inherited (Rao *et al.*, 2004). This can be achieved through effective utilization of germplasm resources and integration of genomic tools to impart efficiency and pace of breeding processes (Banga, 2012). Combining ability analysis has greater importance in crop improvement to identification of best combiners and utilize them in hybridization programme to produce superior hybrids, either to exploit for heterosis or to combine favourable genes (Meena *et al.*, 2015). This technique was developed by Kempthorne in 1957. In addition, the information on nature of gene action will be helpful to develop efficient crop improvement programme. General combining ability is due to additive and additive × additive gene action and is fixable in nature while specific combining ability is due to non-additive gene action which may be due to dominance or epistasis or both and is non-fixable. The presence of non-additive genetic variance is the primary justification for initiating the hybrid breeding programme (Pali and Mehta, 2014). Keeping these points in view, the present investigation was undertaken to determine general combining ability and specific combining ability in snake gourd.

Materials and Methods

The present investigation was conducted in the Department of Horticulture, Agricultural College and Research Institute, Madurai, Tamil Nadu, during the period 2012-13. Study comprise of thirteen parents (nine lines and four testers) and these lines and testers (Table1) were crossed in LxT (Line x Tester) design to generate 36 F_1 hybrids (crosses). These 36 F_1 hybrids along with 13 parents were evaluated in randomized block design with three replications. These parents and hybrid seeds were sown at a spacing of 2m x 2m with recommended package of practices followed as per the state of Tamil Nadu. Observations were recorded on five randomly tagged plants in each entry on vine length, fruit length, fruit girth, average fruit weight, number of fruits per vine, number of seeds per fruit and yield per vine. The data were analyzed for combining ability model of Kempthorne (1957).

Results and Discussion

The results revealed that significant differences existed among the genotypes and the parents for all the characters. The variance due to the lines was significant for all the traits under the study, indicating that the existence of enormous amount of genetic variability for growth, earliness and yield traits among the lines (female), Similarly, testers (male) and interaction between lines x testers exhibited significant differences for all the traits.

In the present study, the line L_5 was adjudged as the best general combiner, since it expressed significant gca effects for four characters *viz.*, fruit length, average fruit weight, number of fruits per vine and fruit yield per vine. The next best general combiner was L_2 with high *gca* for two characters *viz.*, fruit length and number of fruits per vine. This was followed by L_1 (average fruit weight), L_4 (yield per vine), L_8 (fruit girth) which showed good general combining ability for different traits. Among the lines, IC 284753 (L_5) and IC 333314 (L_2) were also considered as good general combiners, because of high *gca* values for most of the yield and yield contributing characters. Among the testers, T_2 was adjudged to be the good general combiner, as it showed significantly favourable *gca* effect for traits such as vine length, average fruit weight and number of fruits per vine. The next best was T_3 with good general combining ability for two traits *viz.*, number of seeds per fruit and fruit yield per vine and T_1 for average fruit weight and number of fruits per vine.

Table.1 Details of the parents used in the present study

S. No.	Name of the parents	Source	Symbol
Lines			
1.	IC413017	NBPGR, New Delhi	L_1
2.	IC333314	NBPGR, New Delhi	L_2
3.	IC433526	NBPGR, New Delhi	L_3
4.	IC308557	NBPGR, New Delhi	L_4
5.	IC284753	NBPGR, New Delhi	L_5
6.	IC546083	NBPGR, New Delhi	L_6
7.	IC410160	NBPGR, New Delhi	L_7
8.	IC202159	NBPGR, New Delhi	L_8
9.	IC212527	NBPGR, New Delhi	L_9
Tester			
1.	Kulithalai Local	Tamil Nadu	T_1
2.	Jeyamkondam Local	Tamil Nadu	T_2
3.	Kumbakonam local	Tamil Nadu	T_3
4.	Palayajeyankondam Local	Tamil Nadu	T_4

Table.2 General combining ability effects of parents

Parents	Vine length (cm)	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	Number of fruits per vine	Number of seeds per fruit	Yield per vine (kg)
Line							
L_1	0.50 *	0.26 **	-0.77 **	-61.67 **	-1.44 **	12.56 **	-5.49 **
L_2	5.19 **	-4.04 **	0.58 **	25.58 *	4.30 **	3.11 **	-2.35 **
L_3	-1.16 **	-2.41 **	-2.71 **	69.33 **	0.62	-10.82 **	-3.10 **
L_4	4.78 **	-1.85 **	0.78 **	21.83 NS	-4.10 **	1.76 **	3.37 **
L_5	-1.91 **	-9.71 **	-0.44	-124.67 **	4.56 **	0.12 NS	3.52 **
L_6	-2.41 **	6.89 **	-0.16	6.83 NS	0.54	-0.77 **	2.68 **
L_7	1.34 **	-1.41 **	0.52 **	-8.42 NS	-3.44 **	-13.85 **	2.46 **
L_8	-0.41	14.63 **	0.87 **	86.58 **	-1.26 **	10.31 **	-0.04 NS
L_9	-5.91 **	-2.35 **	1.32 **	-15.42 NS	0.22	-2.42 **	-1.03 **
SE	**0.2329**	**0.0932**	**0.0777**	**11.1816**	**0.4425**	**0.0834**	**0.0861**
Tester							
T_1	-1.31 **	0.18 **	-0.34	-33.33 **	1.15 **	2.92 **	-0.63 **
T_2	-0.12	-4.95 **	0.93 **	-26.11 **	0.29	1.36 **	-0.50 **
T_3	-0.92**	1.50 **	0.82 **	42.33 **	-0.81 **	-6.56 **	0.68 **
T_4	2.36**	3.27 **	-1.41 **	17.11 *	-0.64 *	2.27 **	0.46 **
SE	**0.1553**	**0.0621**	**0.0518**	**7.4544**	**0.2950**	**0.0556**	**0.0574**

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

Table.3 Specific combining ability effects of hybrids

Hybrids	Vine length (cm)	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	Number of fruits per vine	Number of seeds per fruit	Yield per vine (kg)
$L_1 \times T_1$	2.35	-12.16 **	2.28 **	45.33*	2.48 **	-1.59 **	-0.08 NS
$L_1 \times T_2$	-7.39**	19.43**	-2.64 **	14.11	0.26 NS	5.14 **	0.12 NS
$L_1 \times T_3$	3.41**	-7.18 **	0.17 NS	-80.33**	3.31 **	0.95 **	-2.49**
$L_1 \times T_4$	1.63	-0.09 NS	0.19 NS	20.89	3.13 **	-4.50 **	-2.96 **
$L_2 \times T_1$	2.16	11.34**	3.18 **	-15.92	2.49**	6.02 **	0.10 NS
$L_2 \times T_2$	2.47	9.88 **	-2.14 **	-24.14	1.08 NS	-4.50 **	2.04 **
$L_2 \times T_3$	4.82 **	-11.18 **	1.67 **	82.42**	2.58**	3.39 **	-2.19 **
$L_2 \times T_4$	-9.46 **	-10.04 **	-2.71 **	-42.36	-1.77 NS	-5.16 **	0.05 NS
$L_3 \times T_1$	-1.44	-14.13 **	-3.43 **	4.33	3.13 **	-6.01 **	-2.96 **
$L_3 \times T_2$	2.37	-4.75 **	1.90 **	7.11	3.32 **	7.78 **	-2.50 **
$L_3 \times T_3$	1.17	1.50 **	1.11 **	14.67	-2.81 **	-4.50 **	1.67 **
$L_3 \times T_4$	-2.11	17.38 **	0.43 **	-26.11	-3.64 **	-4.83 **	3.78 **
$L_4 \times T_1$	3.62 **	8.36 **	-1.07 **	111.83 **	-3.05**	5.08 **	-0.95 **
$L_4 \times T_2$	4.18 **	-13.31 **	0.66 **	4.61 NS	-2.95 **	4.85 **	0.77 **
$L_4 \times T_3$	2.23	-1.27 **	0.77 **	-37.83 NS	-2.03**	2.94 **	-1.15 **
$L_4 \times T_4$	-10.04 **	6.22 **	-0.36 *	-78.61 **	0.75 NS	-2.07 **	1.33 **
$L_5 \times T_1$	-7.69 **	8.07 **	0.90 **	-16.67 NS	5.03 **	10.57 **	1.18 **
$L_5 \times T_2$	5.12 **	-2.55 **	-2.07 **	51.11 *	-2.28 *	15.46 **	1.61 **
$L_5 \times T_3$	3.92 **	-8.40 **	-0.06 NS	7.67 NS	-2.17 *	-26.56 **	-0.57 **
$L_5 \times T_4$	-1.36	2.88 **	1.22 **	-42.11 NS	2.70**	0.53 **	-2.22 **
$L_6 \times T_1$	-1.19	6.92 **	-2.28 **	-23.17 NS	2.27 **	1.37 **	-1.43 **
$L_6 \times T_2$	-12.38 **	-12.35 **	4.70 **	19.61 NS	0.34 NS	-6.81 **	1.52 **
$L_6 \times T_3$	7.42 **	17.00 **	-2.39 **	-22.83NS	0.60 NS	5.96 **	2.48 **
$L_6 \times T_4$	6.14 **	-11.57 **	-0.02 NS	26.39NS	-0.68NS	-0.52 **	-2.57 **
$L_7 \times T_1$	2.06	-3.23 **	-0.06 NS	72.08 **	0.29NS	-9.27 **	4.26 **
$L_7 \times T_2$	3.87 **	13.75 **	0.06 NS	34.86NS	3.66**	-3.61 **	-2.49 **
$L_7 \times T_3$	-4.33 **	-1.20 **	-2.13 **	-58.58 *	0.14NS	13.29 **	-1.52 **
$L_7 \times T_4$	-1.61	-9.32 **	2.13 **	-48.36 *	-0.48NS	-0.41 *	-0.25 NS
$L_8 \times T_1$	-5.19 **	0.83 **	0.94 **	-102.92 **	-5.73 **	-9.27 **	-3.25 **
$L_8 \times T_2$	6.62 **	-2.04 **	-1.48 **	-160.14 **	-1.49NS	-3.61 **	-1.83 **
$L_8 \times T_3$	-7.58 **	-8.64 **	2.78 **	121.42 **	3.46 **	13.29 **	2.99 **
$L_8 \times T_4$	6.14 **	9.85 **	-2.24 **	141.64 **	3.76 **	-0.41 *	2.09 **
$L_9 \times T_1$	5.31 **	-5.99 **	-0.46 **	-74.92 **	3.23**	-0.26 NS	3.12 **
$L_9 \times T_2$	-4.88 **	-8.06 **	1.02 **	52.86 *	1.67 NS	-0.54 **	0.76 **
$L_9 \times T_3$	-11.08 **	19.38 **	-1.92 **	-26.58 NS	0.22 NS	2.60 **	-1.47 **
$L_9 \times T_4$	10.64 **	-5.33 **	1.36 **	48.64 *	-2.88 **	-1.79 **	-2.42 **
SEd	0.4658	0.1864	0.1554	22.3632	0.8850	0.1667	0.1723

*Significant at 5% level

**Significant at 1% level

From the above points, it could be inferred that IC 284753 (L_5), IC 333314 (L_2), Jeyamkondam Local (T_2), Kumbakonam Local (T_3) and Kulithalai Local (T_1) were the best general combiners, since they expressed good gca effects for majority of the yield and yield contributing characters.

These parents could be used in the breeding programme to improve yield along with yield contributing characters. It may be inferred that the yield contributing genotypes can maintain their superiority in combining ability effects. The ratio of GCA and SCA exhibited non-additive gene action for vine length, fruit length, fruit girth, average fruit weight, number of fruits per vine, number of seeds per fruit and yield per vine. This was also reported by Dubey and Maurya (2007) and Suganthi (2008) in bottle gourd, Sarkar and Sirohi (2010) in cucumber, Podder (2010) in snake gourd, Vegad *et al.*, (2011) in bottle gourd, Alli Rani (2013) in ridge gourd, Singh *et al.*, (2013) in bitter gourd and Narasannavar (2014) in ridge gourd, and Bairwa *et al.*, (2015) in ridge gourd. Such an absence of parallelism may be due to epistatic interactions.

Among the hybrid L_2xT_3 and L_7xT_2 excelled with superior *sca* effects for five characters *viz.*, vine length, fruit length, fruit girth, number of seeds per fruit and number of fruits per vine. The crosses L_2xT_4, L_5xT_1 and L_8xT_4 were identified as the next best specific combiners for most of the yield contributing characters. The *sca* effects of hybrids have been attributed to the combination of positive favourable genes from different parents or might be due to the presence of linkage in repulsion phase (Sarsar *et al.*, 1986). Hence, selection of hybrids based on *sca* effects would excel in their heterotic effect. Similar results were obtained by Dubey and Maurya (2007) and Suganthi (2008) in bottle gourd, Sarkar and Sirohi (2010) in cucumber, Podder (2010) in snake gourd, Vegad *et al.*, (2011) in bottle gourd, Alli Rani (2013) and Narasannavar (2014) in ridge gourd and Meena (2015) in Indian Mustard found that these yield and yield contributing trait was under the control of non-additive gene action.

Hence, this cross can be utilized for breeding programme to evolve high yielding varieties. The crosses, L_2xT_3, L_7xT_2, L_2xT_4, L_5xT_1, and L_8xT_4 recorded significant sca effects and the gene action might be of additive type of epistasis. These crosses also can be utilized for breeding programme. However, selection should be postponed to later generation due to the presence of additive type of epistatic gene action.

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