Electronic Journal of Plant Breeding (2009) 1: 24-27

Research Article

Studies on relationship between *gca* and *sca* effects in maize (*Zea mays* L.)

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Abstract

An investigation was carried out with five lines and three testers of maize genotypes to assess combining ability. The resultant fifteen hybrids were evaluated for nine characters viz., plant height, days to 50 per cent tasseling, days to 50 per cent silking, cob length, cob girth, number of grain rows per cob, number of grains per row, 100 grain weight, and grain yield per plant. The results revealed that the hybrids L1/T3 and L4/T2 were the best for exploitation of heterosis. It also revealed that there is inconsistent relationship between *gca* and *sca* effects.

Key words : Combining ability, Maize *(Zea mays* L.)

Introduction:

Maize is a highly cross pollinated crop and there is a wide scope for exploitation of hybrid vigour. Already this phenomenon has been successfully exploited and still there is tremendous potential to develop several high yielding hybrids and composites. An understanding of the genetic architecture of parent, their mode of inheritance will greatly aid the breeder to device appropriate breeding methodology to incorporate the traits in question. Line x Tester analysis is one of the methods employed by which the genetic architecture of a given character, the combing ability and heterosis could be understood.

Materials and Methods:

The present investigation was carried at plant breeding farm, Faculty of Agriculture, Annamalai University in two seasons (April – July 2006 and January – April 2007). The experimental materials consisted of five lines viz., ML – 47(L1), SW – 98-D-1062-7 (L2), SW – 99-D-1005-128(L3), SW – 99-L-3001-21 (L4) and SW – 99-L-8001-24 (L5) and three testers viz., African tall (T1), Chidambaram local (T2) and Attur local (T3) collected from Department of Agricultural Botany, Annamalai University. The fifteen hybrids were evaluated for 9 characters *viz*., plant height, days to 50 per cent tasseling, days to 50 per cent silking, cob length, cob girth, number of grain rows per cob, number of grains per row, 100 grain weight, and grain yield per plant. The observations taken for the hybrids and the parents were subjected to L x T analysis and the general combining ability effects of parents and specific combining ability effects of different crosses were worked out. The combining ability variance analysis was based on the method developed by Kempthorne (1957).

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Results and Discussion:

In the present investigation, the *gca* effects of lines indicated that the line L_1 was a good general combiner for days to 50 per cent tasseling, cob girth, cob length and number of grains per row. The other good general combiner was L_2 for cob girth, number of grain rows per cob and 100 grain weight. Among the testers, T_3 possessed desirable *gca* effects for plant height, cob length, number of grain rows per cob, number of grains per row, 100 grain weight and grain yield per plant. The next best tester, T_2 possessed desirable *gca* effects for number of grain rows per cob and 100 grain weight (Table 1). Dhillon (1975) reported that combining ability of parents give useful information on the choice of parents in terms of expected performance of the hybrids and their progenies. A number of workers had advocated *gca* effects to critically analyse the parents for their ability to transmit superior performance to their progenies.

The *gca* effects is a value derived from the general mean of hybrid involving all parents. The *gca* effects of parents may be positive or negative. Simmonds (1979) pointed out that the *gca* values were relative and dependent upon the mean of the chosen material. It is better to choose parents possessing significant *gca* effects or merely based on mean performance. This assumption is based on the principle that *gca* effect reflects additive gene action. Sometimes, the immediate hybrid may not perform well despite both the parents possessing high *gca* effects for a trait, due to interaction of the parental *gca* effects which may cause distortions on expectations. The reverse trend may also happen with low performing parents showing high hybrid values than expected. This interaction is measured by the *sca* effects of the hybrids. It is to be remembered that interaction effects are not fixable. The point for consideration here is to identify the hybrids which could be forwarded further for selection in the segregating generation and hybrids suitable for heterosis breeding. The specific combining ability is the deviation from the performance predicted on the basis of *gca* (Allard, 1960). According to Sprague and Tatum (1942) the specific combining ability is controlled by non-additive gene action. The *sca* effect is an important criterion for the evaluation of hybrids.

Among the hybrids, L_1/T_3 recorded desirable *sca* effect for plant height, days to 50 per cent tasseling, cob length, number of grains per row, 100 grain weight and grain yield per plant. L_4/T_2 recorded significant and positive *sca* effect for cob length, number of grain rows per cob, number of grains per row, 100 grain weight and grain yield per plant. So, from the foregoing discussion it may be concluded that the hybrids L_1/T_3 and $L4/T_2$ were adjudged as the best for exploitation of heterosis (Table 2**).**

Diwakar and Singh (1993) and Amarnath and Subramaniam (1992) suggested that the crosses with high *gca* effects generally gave high *sca* effects. In the present study L_1/T_3 was outstanding performance for cob length. Number of grains per row and 100 grain weight. The next best hybrid L_1/T_2 showed outstanding performance for cob girth. These hybrids showed superior *sca* effect since their parents possessed high x high combination of *gca* effect.

High *sca* effects were not only produced by high x high but also with high x low (or) low x high combination of *gca* effects as observed in most of the hybrids like L_4/T_2 for number of grain rows per cob, number of grains per row, 100 grain weight and grain yield per plant. The next best hybrids like L_3/T_1 and L_5/T_1 showed outstanding performance for number of grain rows per cob and grain yield per plant. Such potential crosses from high x low combinations have attributed to interaction between dominant alleles from good combiner and recessive alleles from poor combiner (Dubey, 1975). The hybrid L_2/T_1 showed superior *sca* effect for plant height, cob length and number of grains per row but their parents possessed low x low combination of *gca* effect.

The inconsistent relationship between *gca* and *sca* effects might be due to complex interaction of genes as suggested by Matzinger and Kempthorne (1956) and Hayman (1958). The superior specific hybrids were obtained from parents involving all kinds of combinations (high x high, high x low (or) low x high, low x low) (Table 3).

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Table 1. General Combining Ability of Parents

Parents	Plant height	Days to 50 per cent tasseling,	Days to 50 per cent silking	Cob length	Cob Girth	Number of grain rows per cob	Number of grains per row	100 grain weight	Grain yield per plant
L_1	-12.28**	-0.93*	-1.07	3.13**	1.47**	-0.59**	7.25**	3.02**	-4.61**
L_2	-16.08**	-0.60	-0.23	0.02	0.48**	0.75**	-3.21**	3.02**	-8.4**
L_3	-9.58**	1.07*	1.10	-0.05	-0.15	0.15	-3.21**	3.67**	3.76**
L_4	9.49**	1.40**	0.43	-0.05	-0.05	-0.52**	0.19	-1.27**	1.11**
L_5	28.45**	-0.93*	-0.23	-2.05**	-0.64**	0.21	-1.95**	-4.75**	8.15**
T_1	-0.27	0.63	0.20	-1.11**	-0.20	-0.76**	-1.07**	-3.03**	-9.45**
T_2	-4.73**	-0.17	0.10	-0.36	0.20	0.40**	-1.13**	2.22**	-2.01**
T_3	4.99**	-0.47	-0.30	1.47**	0.01	0.36**	2.21**	0.80**	11.46**

*, * significant at 5 and 1 % respectively

Table 2. Specific Combining Ability of Hybrids

Hybrids	Plant height	Days to 50 per cent tasseling,	Days to 50 per cent silking	Cob length	Cob Girth	Number of grain rows per cob	Number of grains per row	100 grain weight	Grain yield per plant
L_1/T_1	2.90*	-1.47	-0.53	-2.52**	-0.98**	-0.77**	-5.09**	-0.07	-9.49**
L_1/T_2	-7.14**	-0.17	-0.43	-1.62**	1.00**	0.47	2.07**	-4.31**	-17.69**
L_1/T_3	4.24**	1.63*	0.97	4.14**	-0.01	0.31	3.03**	4.37**	27.18**
L_2/T_1	17.10**	0.70	1.13	1.02*	0.75*	0.09	3.27**	-4.78**	-8.25**
L_2/T_2	-1.04	0.00	-1.27	-0.44	-0.17	-1.07**	-2.47**	2.37**	7.27**
L_2/T_3	-16.06**	-0.70	0.13	-0.57	-0.57	0.97**	-0.81*	2.41**	0.98**
L_3/T_1	-9.50**	0.03	-1.70	1.73**	0.51	0.89**	-0.16	6.46**	16.15**
L_3/T_2	7.66**	-0.67	1.40	-0.11	-0.40	-0.47	-1.80**	-7.07**	-2.24**
L_3/T_3	1.84	0.63	0.30	-1.61**	-0.12	-0.43	1.96**	0.61**	-14.27**
L_4/T_1	-15.27	0.63	-0.53	-1.70**	0.19	-1.04**	-1.43**	-1.35**	-18.23**
L_4/T_2	0.89	1.00	1.07	1.24*	-0.79*	0.80**	1.43**	5.11**	25.07**
L_4/T_3	14.37	-0.70	-0.53	0.47	0.59	0.24	-0.01	-3.75**	-6.84**
L_5/T_1	4.77**	1.03	1.63	1.48**	-0.48	0.83**	3.41**	-0.25	19.47**
L_5/T_2	-0.37	-0.17	-0.77	0.93*	0.36	0.27	0.77	3.90**	-12.42**
L_5/T_3	-4.39	-0.87	-0.87	-2.42**	0.11	-1.09**	0.77	-3.64**	-7.05**

*, * significant at 5 and 1 % respectively

Table 3. Relationship between *gca* and *sca* effects

Character	*gca*	*sca*	Based on two criteria		
			high x high	**high x low or low x high**	**Low x low**
Plant height	L_5, L_4, T_3	L_1/T_1, L_1/T_3, L_2/T_1, L_3/T_2, L_5/T_1	-	L_1/T_3, L_5/T_1	L_1/T_1, L_2/T_1 L_3/T_2
Days to 50 per cent tasseling	L_1, L_5	L_1/T_3	-	-	L_1/T_3
Days to 50 per cent silking	-	-	-	-	-
Cob length	L_1, T_3	L_1/T_3, L_2/T_1, L_3/T_1, L_4/T_2, L_5/T_1, L_5/T_3	L_1/T_3	-	L_2/T_1, L_3/T_1, L_5/T_1, L_5/T_2, L_4/T_2
Cob girth	L_2, L_1	L_1/T_2, L_2/T_1	L_1/T_2	L_2/T_1	-
Number of grain rows per cob	L_2, T_2, T_3	L_2/T_3, L_3/T_1, L_4/T_2, L_5/T_1	L_2/T_3	L_3/T_1, L_5/T_1, L_4/T_2	-
Number of grains per row	L_1, T_3	L_1/T_2, L_1/T_3, L_2/T_3, L_3/T_3, L_4/T_2, L_5/T_1	L_1/T_3	L_1/T_2, L_3/T_3, L_4/T_2	L_2/T_1, L_5/T_1
100 grain weight	L_3, L_2, T_2, T_3	L_1/T_3, L_2/T_2, L_2/T_3, L_3/T_1, L_3/T_3, L_4/T_2, L_5/T_2	L_1/T_3, L_3/T_3	L_2/T_2, L_2/T_3, L_3/T_1, L_4/T_2, , L_5/T_2	-
Grain yield per plant	L_5, L_3, L_4, T_3	L_1/T_3, L_2/T_2, L_2/T_3, L_3/T_1, L_4/T_2, L_5/T_1	-	L_1/T_3, L_2/T_3, L_3/T_1, L_4/T_2, , L_5/T_1	L_2/T_2