Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP2: 262-265

Gokulakrishnan Jayabalan
Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

Priya Balasubramaniam
Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

Kavitha Ravi
Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

Correspondence
Gokulakrishnan Jayabalan
Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

Studies on combining ability through line × tester analysis in maize (*Zea Mays* L.)

Gokulakrishnan Jayabalan, Priya Balasubramaniam and Kavitha Ravi

Abstract
An investigation was carried out in maize involving seven lines (AU121, AU161, AU183, AU562, AU617, AU720 and AU530), three testers (AU21, AU44 and AU51) and standard check as dragon to identify the best combining parents, nature of gene action with yield and yield component traits. The parents were mated in a L × T design. The resultant twenty one hybrids were evaluated for ten characters *viz.,* plant height, days to 50% silking, days to maturity, cob weight, ear length, ear girth, number of grain rows per ear, number of grains per row, 100 grain weight and grain yield per plant. Based on per se performance, the line AU161, AU183 and AU720 and the testers AU44 and AU51 were adjusted as the best for most of traits and for *gca* effects the line AU61 and tester AU44 exhibited as the best for most of the traits studied. Among hybrids, AU720/AUP44, AU161/AU44 and AU183/AU51 exhibited high per se performance and AU720/AUP44, AU183/AU44 exhibited high *sca* effects for all the economic traits. Study of combining ability variance revealed that the σ^2 *sca* were greater in magnitude than the σ^2 *gca* indicating the preponderance of non-additive gene action for all the ten traits. The hybrids AU720/AU44, AU161/AU51 and AU121/AU21 showed desirable performance based on per se performance, *sca* for most of the economic traits and so those hybrids can be exploited for further crop improvement.

Keywords: Maize, combining ability, *gca, sca,* heterosis, nature of gene action

Introduction

Maize (*Zea mays* L.) is the world's widely grown cereal and is the primary staple food in many developing countries (Morries *et al.*, 1999) [6]. It possesses one of the most well studied genetic system among cereals which have motivated a rich history of research into the genetics of various traits in maize (Hallauer and Miranda, 1988) [4]. It is a highly allogamous crop and there is a wide scope for exploitation of hybrid vigour, hence it has been successfully exploited for the production of hybrids. Parental selection is very important in hybrid development. In this context, L×T analysis (Kempthorne, 1957) [5] has widely been used for the evaluation of inbred lines by crossing them with testers. The value of any inbred line in hybrid breeding ultimately depends on its ability to combine very well with other lines to produce superior hybrids. Hence, combining ability analysis is an important tool to identify parents with better potential to transmit desirable characteristics to the progenies and to identify the best specific crosses for yield. The commercial production of hybrids however, depends upon two factors *viz.,* the behaviour of the line itself and the behaviour of line in hybrid combination. The behaviour of a line in hybrid combination is assessed through the estimation of general combining ability (gca) and specific combining ability (sca) effects.

The exploitation of heterosis in maize (*Zea mays* L.) can be accomplished through the development and identification of high *per se* performance vigorous parental lines and their subsequent evaluation for combining ability in cross combinations. The information about the combining ability of the parents and crosses facilitate the breeders in the selection and development of the single cross hybrids.

Materials and Methods

The experiment was conducted at Plant breeding farm, Department of Genetics and
Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University. The materials for the present study consisted of seven lines (AU121, AU161, AU183, AU562, AU617, AU720, AU530) and three testers (AU21, AU44, AU51) were selected on the basis of morphological difference. The experiments were laid out in a RBD with three replications. Three seeds per hill were dibbled at a spacing of 60 cm with in rows and 10 cm between plants in a row. Recommended cultural practices and plant protection measures were adopted. The selected seven inbreds were grown along with three testers for effecting crosses in a separate crossing block.

Seven lines, three testers and twenty one were raised in RBD with three replications. Twenty five plants were maintained in each replication for each cross with parents. Ten randomly selected plants in each replication were used for recording the biometrical observations on plant height, days to 50 percent silking, days to maturity, cob weight, ear length, ear girth, number of grain rows per ear, number of grains per row, hundred grain weight, grain yield per plant.

Results and Discussion

Analysis of variance for combining ability (Table 1) revealed that the mean squares due to females (lines) were differed significantly for all characters. The mean squares due to males (testers) were found non-significant for plant height characters. Thus suggesting the importance of heterosis breeding for improvement of maize. Combining ability analysis revealed that *gca* and *sca* variances were important for inheritance of various traits studied. The Analysis of variance for combining ability revealed that all the character showed greater magnitude of SCA variance than the GCA variance thus indicating the role of non-additive gene action.

Gca effects

Dhillon (1975) [3] 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.

In the present investigation, the *gca* effects of lines indicated that the line NM720 was a good general combiner for days to maturity, cob weight, ear length, number of grain rows per ear, number of kernels per row, 100 grain weight and grain yield per plant. The other good general combiner was NM161, NM183 for plant height, cob weight, days to 50 percent silking, ear length, number of grain rows per ear and grain yield per plant.

Among the testers, NTP21, NTP44 and NTP51 possessed desirable *gca* effects for plant height, days to maturity, days to 50 percent silking, cob weight, ear length, ear girth, number of grains per row, number of grains per row, 100 grain weight and grain yield per plant.

Sca effects

The specific combining ability is the deviation from the performance predicted on the basis of *gca* (Allard 1960) [1]. According to Sprague and Tatum (1942) [7], the specific combining ability is controlled by dominance and non-additive gene action. The *sca* effect is an important criterion for the evaluation of hybrids.

Among the hybrids, L_3/T_3 recorded desirable *sca* effect for plant height, cob weight,

ear length, number of grain row per ear, number of grains per row, 100 grain weight and grain yield per plant. L_2/T_2 recorded significant and positive *sca* effect for cob weight,

ear length, number of grains per row, 100 grain weight and grain yield per plant.

Gene action

A sound planning of any breeding programme for the improvement of quantitative characters rest upon the knowledge of their gene action. Tai (1979) [8] suggested that the success of any plant breeding programme depends to a greater extent on the knowledge of the genetic architecture of the population handled by the breeder. For such information acknowledge on the relative importance of the GCA and SCA variance is more useful. In such situation, line x tester analysis is one which provides information on the nature of gene action expressed as the ratio of GCA and SCA variance. If GCA variance is greater, it implies the preponderance of additive gene action and if SCA variance is greater the particular character is under the control of additive and non-additive gene action.

In the present studies, the SCA variance was higher than GCA variance for all the characters *viz.*, plant height, days to 50 per cent silking, days to maturity, cob weight, ear length, ear girth, number of grain row per ear, number of grain per row, 100 grain weight, grain yield per plant indicating the importance of the non- additive gene action

This study revealed the importance of non-additive gene effects for most of the characters. This would mean that the heterosis observed in maize is due to genetic interaction and dominance. Dominance is non fixable in advanced generations. Hence, the development of hybrid is the best way to exploit the again observed in the F_1 generation, but in the absence of many prerequisites, it is not possible at present to develop hybrid. Therefore, recurrent selection as suggested by Andrus (1963) [2], although very cumbersome and time consuming, may be the most effective way to handle the breeding material. Despite the disadvantages, this procedure may give high yielding segregates. It has often been observed that high yield progenies, occur due to recombination even through the prominent gene action may be dominance and epistasis. Therefore, to obtain high yielding segregates, it is suggested that both pedigree breeding and recurrent selection be followed simultaneously.

Table 1: Analysis of combining ability variance for seven characters in rice

Source	Days to first flowering	Plant height	No. of. productive tillers/plant	Panicle length	No. of. grains/ panicle	1000 grain weight	Grain yield/ plant
GCA variance	1.67	0.01	0.25	0.07	4.46	-0.0005	0.41
SCA variance	59.82	-19.05	4.17	0.71	156.84	1.97	29.60
GCA:SCA	0.027	0.0005	0.059	0.098	0.028	0.002	0.013

Table 2: General combining ability effects of the parents

Parents	Days to first flowering	Plant height	No. of. productive tillers/plant	Panicle length	No. of. grains/ panicle	1000 grain weight	Grain yield/ plant
L_1	7.22	-0.26	0.06	0.83**	9.57**	0.51**	2.77**
L_2	-1.88**	-3.20**	-1.94*	-0,97**	-0.73	-0.63**	-3.58
L_3	-5.33**	3.40**	1.88**	0.14	-8.83	0.12	0.87*
T_1	-1.38	2.03*	2.68*	0.34	7.27**	0.09	5.92**
T_2	-2.22*	2.02*	-1.37**	1.19**	-6.57**	-0.37	2.67**
T_3	4.62**	0.20	1.94**	1.22**	1.93**	0.52	1.85**

T_4	5.12**	-8.13**	-2.27**	-1.72**	-3.73**	0.24	-4.24**
T_5	3.12**	-4.99**	1.58**	-0.66**	-2.07**	-0.28	-1.77**
T_6	3.28**	0.87	0.36	-0.66**	6.93**	-0.70*	-2.09**
T_7	-6.22**	-8.30	-2.83**	-0.19	-13.90**	-1.02**	-2.09**
T_8	-9.88**	8.37*	-2.17**	-1.34**	-10.07**	1.63**	-2.34**
T_9	4.78**	5.70	1.78**	0.84**	17.77**	0.16	5.01**
T_{10}	-1.22*	2.03	0.33	0.98**	2.43**	-0.27	-2.92**

*,** significant at P= 0.05 and P= 0.01 level, respectively

Table 3: Specific combining ability effects of the hybrids

Parents	Days to first flowering	Plant height	No. of. productive tillers/plant	Panicle length	No. of. grains/ panicle	1000 grain weight	Grain yield/ plant
L_1x T_1	-1.72	-2.13	2.24**	-0.11	2.93*	-0.23	0.13
L_1x T_2	-5.88**	-3.80**	-1.24*	-0.38	-3.73**	-0.28	-0.13
L_1x T_3	4.28**	2.20	0.13	-0.11	-1.73	0.27	3.72
L_1x T_4	5.78**	-1.47	-0.04	-0.31	-2.07	-0.03	-1.30
L_1x T_5	-1.22	-0.13	-0.59	-0.47	0.27	-0.41	1.51
L_1x T_6	9.22**	-2.47*	1.67*	0.61	-9.73**	1.88**	-0.46
L_1x T_7	1.12	13.70**	0.67	0.63	21.60**	-1.17	-0.57
L_1xT_8	-16.22**	0.53	-3.06**	-0.71*	-15.73**	0.03	-6.41**
L_1x T_9	5.12*	-5.30*	0.60	0.58	4.93**	1.30**	2.41*
L_1x $T_1$0	-0.38	-1.13	-0.33	0.29	3.27**	-1.37**	1.10
L_2x T_1	1.88	-1.13	1.15	0.53	-0.27	-0.07	-0.08
L_2x T_2	3.72*	-1.80	0.40	0.23	-2.93*	-0.15	-0.64
L_2x T_3	-3.62*	-3.80**	-1.11	-0.16	2.57*	-0.94*	4.58*
L_2x T_4	-2.62	-4.47**	0.22	0.09	-1.27	0.06	1.09
L_2x T_5	1.38	-0.63	-0.06	0.36	1.07	-0.11	0.96
L_2x T_6	-5.28**	4.03**	-3.30**	-0.87*	1.07	-1.87**	-5.16**
L_2x T_7	-6.78**	16.20	-0.75	-1.82**	-15.60**	2.56**	-6.71**
L_2x T_8	17.88**	-6.97*	4.97**	1.76**	32.57**	-0.66	12.30**
L_2x T_9	-10.28**	3.20**	-1.90**	0.60	-9.77**	-1.86**	-5.79**
L_2x T_{10}	3.72*	-4.63**	0.38	-0.71*	-7.43**	3.02**	-0.55
L_3x T_1	-0.17	3.27**	-3.38**	-0.41	-2.67*	0.29	-0.05
L_3x T_2	2.17	5.60*	0.84	0.15	6.67**	0.42	0.77
L_3x T_3	-0.67	1.60	0.98	0.28	-0.83	0.67	-8.31**
L_3x T_4	-3.17*	5.93*	-0.12*	0.23	3.33**	-0.03	0.21
L_3x T_5	-0.17	0.77	0.65	0.11	-1.33	0.52	-2.46**
L_3x T_6	-3.83*	-1.57	1.63*	0.27	8.67**	-0.02	5.62**
L_3x T_7	5.67**	-29.92*	0.07	1.19**	-6.00**	-1.39**	7.27**
L_3x T_8	-1.67	6.43*	-1.90**	-1.04**	-16.83**	0.63	-5.88**
L_3x T_9	5.77**	2.10	1.29	-1.18**	4.83**	0.56	3.38**
L_3x T_{10}	-3.33*	5.77*	-0.06	0.41	4.17**	-1.65**	-0.55

*,** significant at P= 0.05 and P = 001 level, respectively

Table 4: Specific combining ability effects of the single cross hybrids

Source	Plant height	Days to 50% silking	Days to maturity	Cob weight	Ear length	Ear girth	No. of grain rows per ear	No. of grains per row	100 grain weight	Grain yield per plant
NM121×NTP21	-7.35	-0.07	-4.80**	4.11	-0.27	6.97**	-0.98	-0.38	0.34	5.37
NM121×NTP44	10.51*	-1.56*	0.96	2.91	0.13	-4.73*	-1.04	0.67	-0.86	2.96
NM121×NTP51	-3.16	-1.63*	3.85**	-7.02	0.14	2.24	-2.02**	1.54**	0.52	-8.33*
NM161×NTP21	3.98	1.40*	-0.46	5.73	1.51**	1.50	0.50	-1.60	-0.84	8.55*
NM161×NTP44	8.15	-1.91**	3.08**	10.41**	2.08**	-0.05	0.14	-8.56**	-3.01**	14.44**
NM161×NTP51	4.17	-0.51	-2.62**	4.69	0.57	-1.45	-0.64	-0.29	2.64**	5.89
NM183×NTP21	11.76**	-1.19	0.29	8.58*	1.26**	2.14	1.63*	0.51	0.11	6.19
NM183×NTP44	-1.71	0.96	4.91**	7.00	1.80**	-0.12	1.17	6.22**	-3.67**	7.50*
NM183×NTP51	9.03*	0.23	4.62**	15.46**	-3.06**	-2.02	2.80**	-6.73**	3.77**	13.69**
NM562×NTP21	-1.61	2.40**	-3.17**	-7.14	-1.43**	-2.01	-0.25	1.40	0.76	-7.26*
NM562×NTP44	-2.19	2.71**	1.23	15.58**	-2.00**	-3.17	1.57*	-1.22	0.38	-15.61**
NM562×NTP51	3.79	-5.11**	4.40**	8.31*	-0.57	5.18**	-1.33	-0.17	-1.14	-8.35*
NM617×NTP21	-10.68	0.34	0.74	5.23	-1.73**	1.54	-1.51*	-0.71	-1.00	4.70
NM617×NTP44	1.00	-1.13	-7.15**	-14.21**	-0.13	-0.65	-1.62*	0.01	1.60	13.68**
NM617×NTP51	9.67*	0.79	-6.41**	-8.98*	1.86**	-0.88	-1.63**	0.71	-0.60	8.99**
NM720×NTP21	-6.65	-1.03	-3.72**	22.51**	-1.10*	2.42	-0.24	0.06	1.25	22.48**
NM720×NTP44	15.68**	-1.58*	3.35**	30.45**	-2.08**	-1.01*	3.14**	-10.16**	3.85**	29.21**
NM720×NTP51	-10.04*	-0.55	-0.38	7.94*	3.18**	-2.26	1.39*	-1.52	-1.90	6.73**
NM530×NTP21	10.55*	-1.65*	-2.66**	6.01	1.76**	1.38	0.84	0.72	-0.62	4.94
NM530×NTP44	-2.75	0.56	7.16**	7.18	0.36	-0.58	1.19	1.44	2.40*	8.78**
NM121×NTP44	-7.79	1.09	4.50**	13.19**	-2.12**	-0.80	2.03**	-2.17	-3.03**	13.72**

Study of combining ability variance revealed that the SCA variance were greater in magnitude than the GCA variance indicating the preponderance of dominance and non-additive gene interaction for all the economic traits. The parents NM 720, and NM 161, NM121, NM183 were rated as the best since they possessed desirable *per se* and *gca* effects for most of the yield component characters. Hence they can be further utilized for hybridization programme. Thus, it may be concluded that the hybrids NM 161/NTP 44, NM 720/NTP 44 and NM 83/NTP 51 were best since they possessed desirable *per se*, *sca* and standard heterosis for most of the yield attributing characters. Hence, these hybrids can be exploited for further crop improvement.

References

1. Allard RW. Principles of plant breeding. John Wiley and Sons. Inc., New York and London. 1960.
2. Andrus CF. Plant breeding systems. Euphytica. 1963; 12:205-228.
3. Dhillon BS. The application of partial diallel crosses in plant breeding review. Crop Improv. 1975; **2:**1-7.
4. Hallauer AR, Miranda JB. Quantitative Genetics in Maize Breeding 2nd ed. Iowa State University Press Ames USA, 1988, 468.
5. Kempthorne O. An introduction to genetic statistics, 1957.
6. Morries ML, Risopoulos J, Beck D. Genetic changes in farmers recycle maize seed: A review of the evidence, CIMMYT Econ, working paper No. 99-07, Mexico, D. F., CIMMYT. 1999, 1.
7. Sprauge GF, Tatum LA. General *Vs* specific combining ability in single crosses of corn. J. Am. Soc. Agron. 1942; 34:923-932.
8. Tai GCC. An internal estimation of expected response to selection. Theor. Appl. Genet. 1979; 54:273-275.