Indian J. Agric. Res., **44** (1) : 62 - 65, 2010

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com / indianjournals.com

HETEROSIS AND COMBINING ABILITY STUDIES FOR GRAIN YIELD AND GROWTH CHARACTERS IN MAIZE (*ZEA MAYS* L.)

M.Premlatha and A.Kalamani

Centre for Plant Breeding and Genetics
Tamil Nadu Agricultural University, Coimbatore – 641 003, India.

ABSTRACT

Combining ability and heterosis for grain yield and growth characters was studied in maize through line x tester mating design using nine lines and four testers along with check COH(M)4. Combining ability analysis showed the predominant role of non-additive gene action for all the characters studied. The lines UMI 199 and UMI 278 and the testers UMI 217 and UMI 314 had recorded high *per se* and *gca* for yield and majority of the characters studied. The hybrid UMI 278 ´ UMI 217 and UMI 334 ´ UMI 217 had significant and superior *per se* performances for grain yield per plant. The hybrid UMI 348 ´ UMI 330 exhibited high *sca* effect for plant height. Growth influencing characters positively influenced hybrid performance in grain yield. The hybrid UMI 278 ´ UMI 217 was observed as best and followed by UMI 334 ´ UMI 217 are potential hybrids for exploitation of yield heterosis.

Key words: Combing ability, Heterosis, Maize

INTRODUCTION

Maize is one of the most important cereals of the world. Exploitation of hybrid vigour in maize has gained much significance in view of its tremendous yield increase. There is a continuous need to evolve new hybrids, which should exceed the existing hybrids in yield and quality. Maize is a highly cross pollinated crop and the scope for the exploitation of hybrid vigor will depend on the direction and magnitude of heterosis, biological feasibility and the type of gene action involved. Combining ability analysis is usually employed to understand the nature of gene action of different yield contributing characters and to identify desirable parents in order to exploit heterosis following appropriate recombination breeding. In recent time, more emphasis has been made for the development of superior single cross hybrids.

MATERIAL AND METHODS

Nine inbred lines were crossed with four inbred testers in a line x tester mating design in *kharif* 2005 to generate hybrids for this study. All the thirteen parents (9 lines and 4 testers) together with 36 crosses and a standard check COH(M)4 were evaluated during *rabi* 2005. Each genotype was grown in two rows of four meters length adopting randomized block design and replicated thrice. The trial was conducted in black loamy soil. The recommended fertilizer dose of 132.5:62.5:50 kg NPK/ha was applied. The row-to-row and plant to plant distance was 60 and 25 cm respectively. The data were recorded recorded on days to 50 percent tasseling, days to 50 percent silking, plant height, ear height, number of leaves per plant, leaf length, leaf breadth, leaf area per plant, stem girth, grain yield per plant and plant dry weight on five randomly selected plants. The combining ability analysis was done according to Kempthorne (1957). The magnitude of heterosis was estimated over the standard check (COH(M)4)

RESULTS AND DISCUSSION

The analysis of variance for all the traits studied was highly significant, indicating the existence of sufficient variation in the materials studied. The analysis of variance revealed significant differences among the parents for all the traits under consideration. It expressed the presence of significant variability in the parents. Among the crosses, significant differences were observed for all the traits. Presence of significant differences among parents and crosses revealed the choice of exploitation of heterosis for all the characters studied. Higher level of significance in the variance of parents vs hybrids for all the twenty one characters clearly indicate the

Table 1: Analysis of variance for combining ability

Characters	Replicationdf = 2	Linesdf = 8	Testersdf = 3	Line Vs testerdf = 24	Errordf = 72
Days to 50 percent tasseling	0.176	17.398	37.071	15.625**	0.459
Days to 50 percent silking	0.732	22.037	44.803	18.969**	0.732
Plant height	6.001	763.467	4680.821**	1222.263**	4.112
Ear height	15.528	212.704	2075.457**	294.945**	5.342
Number of leaves per plant	1.083	3.625	14.877*	5.085**	0.483
Leaf length	1.035	176.651	339.058*	124.810**	0.612
Leaf breadth	0.012	0.677	1.067	0.427**	0.004
Leaf area per plant	0.002	1.102	0.193*	0.063**	0.003
Stem girth	0.004	0.143	0.327*	0.107**	0.003
Grain yield per plant	8.037	1010.836	4256.172**	627.555**	4.675
Dry matter yield per plant	45.861	7065.833*	24822.256**	3068.895**	16.080

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

existence of significant level of average heterosis in the hybrids.

Analysis of variance for combining ability revealed that the mean squares due to lines were significant for dry matter yield per plant. The testers showed significant differences for plant height, ear height, grain yield per plant, dry matter yield per plant and significant differences for number of leaves per plant, leaf length, leaf area per plant and stem girth. This indicated that there was a good level of genetic difference brought out by the testers. The variance due to line x tester interaction was significant for all the characters studied (Table 1). Non-additive gene action was reported for all the characters studied. These results support the findings of Kalla *et al.* (2001), Prasad and Pramod Kumar (2003), Kumar and Gupta (2004) and Aydin Unay *et al.* (2004).

The line UMI 235 recorded high *gca* effect for leaf length, leaf breadth and leaf area per plant. The line UMI 348 showed high *gca* for plant height, ear height, grain yield per plant and dry matter yield per plant, while UMI 199 showed superior *gca* for number of leaves per plant. In case of testers UMI 217 was identified for high *gca* effects for ear height, number of leaves per plant, leaf breadth, leaf area per plant, stem girth, grain yield per plant and dry matter yield per plant. The tester UMI 314 had the best *gca* for plant height and leaf length (Table 2). The parents with high *gca* could produce superior segregants in the F_2 as well as in later generations. The lines UMI 199, UMI 278 and the testers UMI 217 and UMI 314 had recorded high *per se* and *gca* for most of the yield contributing characters studied. Therefore, these parents may be utilized in the hybridization programme for selecting superior recombinants. Kalla *et al.* (2001), Pramod Kumar *et al.* (2003), Kabdal *et al.* (2003), Kumar and Gupta (2004) and Katna *et al.* (2005) also identified good general combiners and superior hybrids in maize.

The hybrids UMI 199 x UMI 330, UMI 240 x UMI 217x, and UMI 350 x UMI 330 exhibited high *sca* for earliness. The hybrids UMI 240 x UMI 217, UMI 350 x UMI 330 and UMI 370 x UMI 330 exhibited high *sca* for plant height and ear height. The hybrid UMI 334 x UMI 217 possessed high *sca* effect for number of leaves per plant, leaf length, leaf breadth, leaf area per plant, stem girth, grain yield per plant and dry matter yield per plant. The hybrid UMI 348 x UMI 330 exhibited high *sca* effect for plant height.

Combination of favorable genes from the parents for the corresponding traits might have resulted in high *sca* effects. In the present study, hybrids were identified with significant and high *sca* effects for different characters. Many of these hybrids were from either one of the parents with high *gca* or parents with low x low general combiners. Hence, it presents the evidence that the parents with either high *gca* or low *gca* would have greater probability to have good complimentarity with other parents. Similar results in maize have been reported by Kalla *et al.* (2001), Prasad and Pramod Kumar (2003), Promod Kumar *et al.* (2003) and Katna *et al.* (2005)

The commercial hybrid COH(M)4 was used as a standard check. Negative heterosis was considered desirable for days to 50 per cent tasseling and days to 50 percent silking. The hybrids UMI 199 x UMI 217, UMI 199 x UMI 330, UMI 240 x UMI 217, and UMI 300 x UMI 314 showed negative heterosis for days to 50 per cent tasseling. The hybrids

Table 2: Estimates of *gca* effects for different traits in parents

Parent	Days to 50 percent tasseling	Days to 50 percent silking	Plant height	Ear height	Number of leaves per plant	Leaf length	Leaf breadth	Leaf areat per plant	Stem girth	Grain yield per plant	Dry matter yield per plant
UMI 199	-1.71 **	-2.15 **	-8.46 **	-1.99 **	0.72 **	-1.70 **	0.18 **	0.05 **	0.02	7.37 **	9.25 **
UMI 235	-0.55 **	-1.23 **	5.55 **	5.81 **	0.72 **	6.12 **	0.26 **	0.16 **	0.10 **	4.37 **	8.75 **
UMI 240	1.37 **	1.52 **	-14.38 **	-3.68 **	-0.11	-6.28 **	-0.13 **	-0.11 **	-0.09 **	-5.88 **	-15.67 **
UMI 278	1.70 **	1.85 **	3.85 **	2.22 **	-0.69 **	0.91 **	0.20 **	-0.02 ns	0.14 **	0.04	23.42 **
UMI 300	-1.13 **	-0.56 *	3.74 **	0.40	0.47 *	4.01 **	-0.01 ns	0.08 **	-0.03	-3.96 **	-33.17 **
UMI 334	0.37 ns	0.44 ns	0.73 ns	-2.85 **	-0.03	0.76 **	-0.12 **	0.00 ns	0.02	3.20 **	12.33 **
UMI 348	1.04 **	0.94 **	10.78 **	7.16 **	-0.19	1.01 **	0.22 **	0.02 ns	0.12 **	16.29 **	37.00 **
UMI 350	-1.05 **	-1.15 **	-6.03 **	-4.22 **	-0.78 **	-4.39 **	-0.45 **	-0.15 **	-0.19 **	-15.46 **	-32.25 **
UMI 370	-0.05 ns	0.35 ns	4.21 **	-2.85 **	-0.11	-0.44 ns	-0.17 **	-0.03 *	-0.08 **	-5.96 **	-9.67 **
UMI 213	0.25 ns	0.06 ns	-1.59 **	-2.96 **	0.72 **	-1.18 **	-0.10 **	-0.03 **	-0.07 **	-8.41 **	-30.92 **
UMI 217	-1.38 **	-1.35 **	9.41 **	7.23 **	0.72 **	2.29 **	0.24 **	0.12 **	0.15 **	17.11 **	29.64 **
UMI 314	-0.31 *	-0.43 *	10.21 **	6.82 **	0.72 **	3.34 **	0.08 **	-0.02 ns	0.01	1.63 **	22.12 **
UMI 330	1.44 **	1.72 **	-18.02 **	-11.09 **	0.72 **	-4.45 **	-0.21 **	-0.08 **	-0.09 **	-10.33 **	-20.84 **

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

Table 3: Best hybrids – *sca* and Standard heterosis

Characters	Hybrids	*Per se*	sca	Standard heterosis
Days to 50 % tasseling	UMI 240 x UMI 217	53.67	-3.04**	-4.85**
Days to 50 % silking	UMI 240 x UMI 217	58.33	-3.81**	-6.21**
Plant height (cm)	UMI 278 x UMI 217UMI 334 x UMI 217	199.13 203.90	3.02**10.90**	4.08**6.57**
Ear height (cm)	UMI 278 x UMI 217	134.43	13.16**	19.07**
Number of leaves per plant	UMI 334 x UMI 217	18.33	1.55**	10.00**
Leaf length (cm)	UMI 334 x UMI 217	99.07	7.48**	4.83**
Leaf breadth (cm)	UMI 334 x UMI 217	10.88	0.54**	2.35**
Leaf area per plant (m^2)	UMI 334 x UMI 217	1.50	0.28**	17.99**
Stem girth (cm)	UMI 334 x UMI 217UMI 278 x UMI 217	2.972.93	0.36**0.20**	14.10**12.82**
Grain yield per plant (g)	UMI 334 x UMI 217UMI 278 x UMI 217	165.67 165.00	15.39**17.89**	13.99**13.53**
Dry matter yield per plant (g)	UMI 348 x UMI 213UMI 334 x UMI 217	468.33 489.00	41.67**26.44**	6.68**6.68**

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

UMI 199 x UMI 217, UMI 199 x UMI 314, UMI 240 x UMI 217, and UMI 300 x UMI 314 exhibited negative heterosis for days to 50 per cent silking.

In maize tall types are preferred over dwarf types. Hence positive heterosis is considered desirable for plant height. The hybrids UMI 235 x UMI 314, UMI 278 x UMI 213, UMI 278 x UMI 314, UMI 334 x UMI 217, UMI 348 x UMI 330 and UMI 370 x UMI 314 were tall. Significant and positive heterosis over the check COH(M)4 was recorded by UMI 235 x UMI 217, UMI 235 x UMI 314, UMI 240 x UMI 217, UMI 278 x UMI 217, UMI 278 x UMI 314, UMI 348 x UMI 217 and UMI 348 x UMI 314 for ear height.

Four hybrids namely, UMI 199 x UMI 217, UMI 240 x UMI 213, UMI 300 x UMI 330 and UMI 334 x UMI 217 recorded significant and positive heterosis over the standard check for number of leaves per plant. Seven hybrids *viz*., UMI 235 x UMI 217, UMI 235 x UMI 314, UMI 278 x UMI 217, UMI 278 x UMI 314, UMI 348 x UMI 213 and UMI 348 x UMI 330 exhibited superior performance over the check for leaf length. For leaf breadth significant and positive heterosis over the check was recorded by four hybrids namely, UMI 278 x UMI 217, UMI 278 x UMI 314, UMI 334 x UMI 217 and UMI 348 x UMI 314. Hybrids with high leaf area were desirable for increasing grain yield per plant through higher photosynthetic activities. Only three hybrids namely, UMI 199 x UMI 217, UMI 235 x UMI 217 and UMI 334 x UMI 217 recorded significant and positive heterosis over the standard check for this character. For stem girth, the hybrids UMI 278 x UMI 217, UMI 334 x UMI 217 and UMI 348 x UMI 330 recorded significant and positive heterosis over the standard check. The hybrids UMI 278 x UMI 217, UMI 334 x UMI 217, UMI 348 x UMI 217 and UMI 348 xUMI

314 exhibited superior performance over the check for grain yield per plant. The desirable standard heterosis for dry matter yield per plant was exhibited by UMI 278 x UMI 217, UMI 278 x UMI 314, UMI 334 x UMI 217, UMI 348 x UMI 213, UMI 348 x UMI 217 and UMI 348 x UMI 314. High heterosis values are desirable for grain yield in maize. Similar results have been reported by Mohanraj (2001), Kayalvizhi (2002), Pramod Kumar *et al.* (2003), Marker and Joshi (2005) and Katna *et al.* (2005).

For exploiting hybrid vigor, *per se* performance, *sca* effects and the extent of heterosis of hybrids are important. Selection based on any one of these criteria alone may not be effective. The hybrids with high *per se* performance need not always reveal high *sca* effect and *vice versa*. So selection must be based on all the three parameters. In the present study also, the hybrids were evaluated on the basis of the above said three parameters. Among the thirty six hybrids analyzed UMI 334 ´ UMI 217 was identified as the best hybrid since it possessed desirable *per se* performance, *sca* and heterosis for grain yield per plant, number of leaves per plant, leaf length, leaf breadth, leaf area per plant and stem girth. The hybrid UMI 278 x UMI 217 was the next best hybrid for grain yield per plant, ear height and stem girth. The other hybrid UMI 240 x UMI 217 for days to 50 per cent tasseling and days to 50 per cent silking. UMI 278 x UMI 213 and UMI 348 x UMI 330 for plant height. The hybrid UMI 348 x UMI 213 showed desirable performance for dry matter yield per plant. The results obtained in the present investigation were encouraging and tremendous increase in yield was obtained in most of the hybrids. The increase in the *per se* yield level of the hybrids accompanied with high heterosis over better parent was confirmed. There was a good correspondence between the *per se* performance and *sca* effects in all the characters were seen in general.(Table 3).

REFERENCES

Aydin Unay *et al.* (2004). *Turk. J. Agric. For.,* **28**: 239-244.

Kabdal, M.K. *et al.* (2003). *Agric. Sci. Digest.,* **23**: 137-139.

Kalla,V. *et al.* (2001). *Crop Res.,* **22**: 102-106.

Katna, G. *et al.* (2005). *Crop Res.,* **30**: 221-226.

Kayalvizhi, G. (2002). M.Sc., Thesis. Tamil Nadu Agricultural University, Coimbatore, India.

Kempthorne, O. (1957). An Introduction to Genetic Statistics. John Willy and Sons. Inc. New York, pp. 545.

Kumar, P. and Gupta, S.C. (2004). *Agric. Sci. Digest.*, **24:** 30-32.

Marker, S. and .Joshi, V.N. (2005). Allahabad Farmer, **59**:76-86.

Mohanraj, K. (2001). M.Sc. Thesis**.** Tamil Nadu Agricultural University, Coimbatore, India.

Pramod Kumar *et al.* (2003). *RAU J. Res.*, **13**: 36-38.

Prasad, S.K. and Pramod Kumar. (2003). *RAU J.* ***Res.,*** **13**: 68-72.