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COMBINING ABILITY ANALYSIS FOR YIELD AND YIELD CONTRIBUTING TRAITS IN MAIZE (*Zea Mays* L.)

H. Z. RAIHAN[1], S. SULTANA[2] AND M. HOQUE[3]

Abstract

An experiment on combining ability was carried out with 21 crosses produced from 7×7 diallel cross without reciprocal for grain yield and yield contributing characters in maize. Analysis of variance for combining ability showed that mean square (MS) due to GCA & SCA were highly significant for all characters except GCA in plant height, cob length and 1000 grain weight and SCA in maturity and row/cob indicated that all but mentioned traits were governed by both additive and non-additive gene action. Variances due to GCA were higher for all characters except thousand grain weight revealed that the predominance of additive gene action for all characters except thousand grain weight. Parent CML 487 and Ki 21 were the best general combiner for yield and most of the yield contributing characters. Parent BMZ 57 & BMZ 15 were the best general combiner for dwarf & earliness in plant. Among all the crosses CML 473 × Ki 21, CML 487 × Ki 21 and CML 429 × BIL 182 exhibited significant positive SCA effect for grain yield. The cross CML 429 × BIL 182 may be considered as the best cross with recorded significant mean value and desired SCA for traits like 1000 grain weight, yield (t/ha), days to 50% pollen shedding, days to 50% silking, plant height, ear height and days to maturity. The promising single crosses with significant and positive SCA could be used for variety development after verifying them across locations.

Keywords: General Combining Ability (GCA), Specific Combining Ability (SCA), Maize

Introduction

Maize is the third most important cereal crop after rice and wheat contributing to agricultural economy of Bangladesh in various ways. Maize is gaining importance in recent years as a promising crop aimed in boosting agricultural growth in Bangladesh. The area and production of maize in 2017-18 was 4.4 lac hectares and 3.3 million tons, respectively (USDA, 2018). Therefore, keeping in mind the future demand of maize as a food for human and as a feed for livestock, there is a continuous need to develop new hybrids with higher and sustainable yield potential than the existing hybrids. It is a fact that selection of parents on the basis of their mean performance does not necessarily lead to desired results (Rai and Asati, 2011). Therefore, to achieve this target, yield improvement

[1]Scientific Officer, Plant Breeding Division, Bangladesh Agricultural Research Institute (BARI), Gazipur, [2]Scientific Officer, Tuber Crops Research Centre, BARI, Gazipur, [3]Senior Scientific Officer, Plant Breeding Division, BARI, Gazipur, Bangladesh.

through genetic approaches which determines the gene action would become highly essential and moreover formulation of comprehensive breeding strategies is to be done for the yield improvement of any crop which depends mostly on understanding the nature of gene action involved for a specific trait to be improved. Combining ability analysis helps breeders in choosing suitable genotypes as parents for hybridization and superior cross combinations through general combining ability and specific combining ability studies. At the same time, it also elucidates the nature and magnitude of different types of gene action involved, which is essential for an effective breeding program. Hence, this investigation was undertaken to study the estimates of general and specific combining ability and gene action in maize for yield and yield components.

Materials and Methods

Seven inbred lines of maize viz. BMZ 57, BMZ 15, CML 473, CML 487, CML 429, BIL 182, and Ki 21 were crossed in all possible combinations excluding reciprocals in rabi 2015-16 at the experimental field of Plant Breeding division, BARI, Gazipur. During rabi 2016-17, the 21 F_1s (produced from those 7 parents) viz. BMZ 57×BMZ 15, BMZ 57×CML 473, BMZ 57× CML 487, BMZ 57× CML 429, BMZ 57×BIL 182, BMZ 57 × Ki 21, BMZ 15 ×CML 473, BMZ 15 ×CML 487, BMZ 15 ×CML 429, BMZ 15 × BIL 182, BMZ 15 × Ki 21, CML 473× CML 487, CML 473× CML 429, CML 473× BIL 182, CML 473× Ki 21, CML 487× CML 429, CML 487× BIL 182, CML 487× Ki 21, CML 429× BIL 182, CML 429× Ki 21, BIL 182×Ki 21 were planted following randomized complete block design with three replications on 29 November 2016 where the plot size was 4m × 1.2m . Spacing adopted was 60×25 cm between rows and hills, respectively. One healthy seedling per hill was kept after proper thinning. Different dose of fertilizers was applied for parents or inbred line and for hybrids or the crosses or F_1s as hybrids need more fertilizer to grow. Fertilizer dose was @ 250, 55, 110, 40, 5 and 1.5 kg of N, P, K, S, Zn and B, respectively for the crosses or F_1s, and for parents or inbred lines the dose was @ 120, 35, 70, 40, 5, 1.5kg of N, P, K, S, Zn and B, respectively. Standard agronomic practices were followed and plant protection measures were taken when required. Observations were recorded on ten randomly selected plants from each replication for the characters viz., plant height (PH), ear height (EH), cob length (CL), cob girth (CG), whereas days to 50 per cent pollen shedding (DPS), days to 50 per cent silking (DS), 1000 grain weight (TGW) and Grain yield (Yi) was calculated on whole plot basis which was then converted to tons per hectare. Mean data was subjected for analysis of general combining ability (GCA), specific combining ability (SCA) as per method given by Griffing (1956) (method II and model IV).

Results and discussions

Analysis of variance for combining ability (Table 1) revealed that mean square (MS) due to GCA and SCA were highly significant for all the characters except plant height, cob length and 1000 grain weight for GCA; and maturity and row/cob for SCA indicated that all but mentioned traits might be governed by both additive & non-additive gene action.

Highly significant differences for most of the sources of variation were also reported by Narro *et al*., (2003). Cob length, plant height, and TGW might be governed by only non-additive gene action but maturity and row/cob could be controlled by only additive gene action. Variances due to GCA were much higher in magnitude than SCA for all characters except 1000- grain weight. This indicated preponderance of additive gene action for all characters except thousand grain weight which seemed to be controlled by non-additive gene action. Predominance of additive gene action for various quantitative traits in maize was also reported by Muraya *et al*. (2006), Ahmed *et al*. (2008), Alam *et al*. (2008), and Amiruzzaman (2010). The current result was in contrast with Abdel- Moneam *et al*. (2009) who observed higher SCA in seed/ row, 1000 - grain weight and yield, indicating non- additive gene action in controlling those traits.

General combining ability effects

The GCA effects of the parents for different characters are presented in Table 2. A wide range of variability for GCA effects was observed among the parents for different traits. The parent CML 487 and Ki 21 showed highly significant and positive GCA effects for yield, cob girth and cob length. Parent BMZ 57 and CML 429 showed significant negative GCA for yield indicated that these two parents were not good combiner for yield. Significant and positive GCA was observed in Ki 21 for seed/ row. So, parent CML 487 and Ki 21 could be used to develop high yielding maize hybrid. Sharma *et al*. (1982) reported that parents with good general combiner for grain yield generally shows good performance for various yield components. Similar views were also reported by Malik *et al*. (2004), Uddin *et al*. (2006), Ahmed *et al*. (2008), and Abdel-Moneam *et al*. (2009). For maturity and growth parameters, significant negative GCA effect is desirable for dwarf and earliness in plant. Highly significant and negative GCA effects for days to pollen shedding, days to 50% silking, and days to maturity were observed in BMZ 57, and for days to pollen shedding, days to 50% silking, days to maturity and ear height in BMZ 15. Therefore, the parent BMZ 57 and BMZ 15 could be used to develop early maturing dwarf hybrid.

Specific combining ability effects

The specific combining ability for different characters is presented in Table 3. For yield & yield component, significant and positive SCA is desirable. Three crosses (CML 473 × Ki 21, CML 487 × Ki 21 and CML 429 × BIL 182) exhibited significant and positive SCA effect for grain yield. High estimates of SCA effects of these crosses indicated the preponderance of non additive gene action revealing their potential for commercial exploitation in terms of grain yield

Table 1. Analysis of variances for combining ability for yield and yield contributing traits in maize

Source	d.f	Mean Square										
		DPS	DS	PH (cm)	EH (cm)	DM	CL (cm)	CG (cm)	Row /cob	Seed/ row	1000 GW (g)	Yield (t/ha)
Crosses	20	50.2**	59.6**	471.3**	480.7**	16.3**	10.1**	4.36**	4.17**	32.6**	2585**	7.91**
GCA	6	46.5**	52.1**	223.9	294.15*	11.98**	5.62	3.20**	3.36**	22.2**	706	6.92**
SCA	14	3.9**	6.08**	128**	102.8**	2.66	2.42**	0.70**	0.54	6.01*	928**	0.80**
Error	40	1.39	1.46	21.94	14.15	1.78	0.64	0.27	0.44	3.09	126	0.3
GCA/ SCA		11.7	8.56	1.74	2.85	4.5	2.32	4.57	6.22	3.7	0.76	8.65

* Significant at 5% level; ** Significant at 1% level.

DPS=days to 50% pollen shedding, DS=Days to 50% silkng, PH=Plant height, DM=Days to maturity, EH=Ear height, CL=Cob length, CG=Cob grith, 1000GW=1000 Grain weight.

Table 2. General Combining Ability (GCA) effects for yield and yield contributing traits in maize

SL	Entry	Days to 50% Pollen Shedding	Days to 50% Silking	Plant Height (cm)	Ear Height (cm)	Days to Maturity	Cob length (cm)	Cob girth (cm)	Row/ Cob	Seed/ Row	1000-grain weight	Yield (t/ha)
1	BMZ 57	-3.07**	-3.50**	-0.31	0.12	-1.87*	-0.90*	-0.44	-0.78*	-2.69**	-3.9	-1.29**
2	BMZ 15	-3.07**	-3.44**	-4.38	-8.81**	-1.87*	0.5	-1.44**	-0.65	0.71	-22.57**	-0.54*
3	CML 473	-1	-0.9	2.42	-2.21	0.73	-0.44	0.16	-0.91*	-0.35	10.76	-0.53
4	CML 487	3.87**	4.23**	5.62*	6.12**	2.40**	1.16*	0.96**	1.09**	1.25	8.76	1.45**
5	CML 429	-1.60*	-1.57*	-1.51	0.92	-0.6	-1.57**	-0.17	-0.11	-0.69	-3.9	-1.21**
6	BIL 182	0.6	1.23*	-11.11**	-8.68**	0.47	-0.04	0.16	0.82*	-1.89*	10.76	0.70*
7	Ki 21	4.27**	3.96**	9.29**	12.52**	0.73	1.30**	0.76*	0.55	3.65**	0.1	1.42**
	SE(gi)	0.48	0.5	1.93	1.55	0.55	0.33	0.21	0.27	0.72	4.65	0.22
	LSD (5%)	1.5	1.54	5.98	4.8	1.7	1.02	0.67	0.85	2.24	14.35	0.7

* Significant at 5% level; ** Significant at 1% level.

Table 3. Specific Combining Ability (SCA) effects for yield and yield contributing traits in maize

Entry	Days to Pollen Shedding	Days to Silking	Plant Height (cm)	Ear Height (cm)	Days to Maturity	Cob length (cm)	Cob girth (cm)	Row/ Cob	Seed/ Row	1000 grain weight	Yield (t/ha)
BMZ 57×BMZ 15	-0.31	-0.31	-3.51	6.18	-0.49	0.93	-0.71	0.01	0.84	-18.44	0.65
BMZ 57×CML 473	-2.38*	-1.84	0.36	2.91	-1.76	-0.13	0.36	0.93	1.58	1.56	0.59
BMZ 57× CML 487	-0.24	-0.98	21.16**	13.24**	-0.76	-1.07	0.22	0.27	-1.02	13.56	-0.09
BMZ 57× CML 429	1.56	2.16*	3.96	-2.89	1.58	1.67*	-0.31	-0.53	0.58	-7.11	0.40
BMZ 57×BIL 182	1.36	0.69	-11.11**	-0.62	1.18	0.80	0.36	0.53	1.11	-1.78	-0.22
BMZ 57 × Ki 21	0.02	0.29	-10.84**	-18.82**	0.24	-2.20**	0.09	-1.20*	-3.09*	12.22	-1.33**
BMZ 15 ×CML 473	-0.04	0.42	2.42	9.18**	-0.76	-0.2	0.02	-0.53	-0.82	10.22	-0.15
BMZ 15 ×CML 487	-0.24	-0.38	-13.44**	-11.16**	-0.42	0.53	0.56	0.80	-0.76	28.89**	-0.34
BMZ 15 ×CML 429	0.56	0.76	3.02	0.71	1.24	-0.07	-0.31	0.01	0.51	-25.11*	0.13
BMZ 15 × BIL 182	0.02	-0.38	8.29*	-0.36	-0.16	-1.27	0.36	-0.27	-1.29	20.22*	0.33
BMZ 15 × Ki 21	0.02	-0.11	3.22	-4.56	0.58	0.07	0.09	0.01	1.51	-15.78	-0.61
CML 473× CML 487	-0.31	-0.91	11.76**	1.58	-0.69	-0.53	-0.38	-0.27	0.98	-4.44	-0.29
CML 473× CML 429	2.82**	3.89**	-17.11**	-17.22**	-0.36	-3.13**	-1.58**	-0.40	-5.76**	-51.78**	-1.53**
CML 473× BIL 182	0.62	-0.58	1.49	-3.96	2.24	2.00**	1.09*	0.67	1.44	20.22*	-0.16
CML 473× Ki 21	-0.71	-0.98	1.09	7.51*	1.31	2.00**	0.49	-0.40	2.58	24.22*	1.54**
CML 487× CML 429	1.62	1.09	-2.64	4.11	2.31*	1.27	0.96*	0.27	2.98*	6.89	0.44
CML 487× BIL 182	-0.58	1.96	-14.71**	-8.62*	0.24	-0.93	-1.04*	-1.33*	-2.49	-21.11*	-0.74
CML 487× Ki 21	-0.24	-0.78	-2.11	0.84	-0.69	0.73	-0.31	0.27	0.31	-23.78*	1.03*
CML 429× BIL 182	-4.44**	-5.58**	10.09*	6.91*	-3.42**	0.13	0.42	-0.13	2.11	28.22**	1.00*
CML 429× Ki 21	-2.11*	-2.31*	2.69	8.38*	-1.36	0.13	0.82	0.80	-0.42	48.89**	-0.44
BIL 182×Ki 21	3.02**	3.89**	5.96	6.64*	-0.09	-0.73	-1.18*	0.53	-0.89	-45.78**	-0.20
SE (gi)	0.96	0.98	3.82	3.07	1.09	0.65	0.42	0.54	1.43	9.17	0.45
LSD(5%)	3.01	3.08	11.97	9.61	3.41	2.04	1.34	1.70	4.49	28.71	1.41

* Significant at 5% level; ** Significant at 1% level.

(Anyanwu, 2013). The cross CML 429 ×BIL 182 considered the best cross as that recorded significant and desired SCA for the traits 1000 - grain weight, yield (t/ha), days to 50% pollen shedding, days to 50% silking, plant height, ear height and days to maturity. For maturity and growth parameters negative SCA effect is desirable for dwarf and earliness in maize plant. Significant and negative SCA effects were observed in CML 429× BIL 182 for days to pollen shedding, days to 50% silking and maturity. Highly significant and negative SCA effects were found in BMZ 57×BIL 182, BMZ 57 × Ki 21, BMZ 15 ×CML 487, CML 473× CML 429 and CML 487× BIL 182 crosses for plant height and for ear height.

Conclusion

Variances due to GCA were much higher in magnitude than SCA for all characters except 1000 - grain weight. This indicated preponderance of additive gene action for all characters except thousand grain weight which seemed to be controlled by non-additive gene action. The parent CML 487 and Ki 21 could be used to develop high yielding maize hybrid. Parent BMZ 57 and BMZ 15 were the good general combiner for both dwarf and earliness in plant. The cross CML 473 × Ki 21, CML 487× Ki 21 and CML 429 × BIL 182 were promising with respect to SCA effects for grain yield and other desirable characters. This study provided combining ability information on tested inbred lines. As a future breeding strategy, the promising lines have to be maintained and used in hybridization program. The promising single crosses could be tested across locations and seasons for further confirmation.

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