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IDENTIFICATION OF BEST GENERAL COMBINERS FOR YIELD AND YIELD RELATED TRAITS IN MAIZE (*Zea Mays* L.) THROUGH POOLED SCORE TECHNIQUES

B. C. CHANDANA AND S. K. DESHPANDE*
Dept of Genetics and Plant Breeding,
College of Agriculture, Dharwad - 580 005, INDIA
e-mail: sanjeevgpb@gmail.com

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***Corresponding author**

ABSTRACT

The study comprised of 12 lines, six testers, 72 derived hybrids and three checks, these entries were evaluated for *perse* during *kharif* -2012. The data on yield related parameters were considered for estimation of combining abilities using WINDOSTAT v8.1 software. Identification of best general combiners based on pooled score technique is advantageous than simple gca values because it imply erroneous results that is, *gca* effects alone influenced by, unit of measurement of traits, higher and lower values of *gca*. To identify the best combiners we followed different methods and based on which, lines BM254 and BM24 were identified as excellent combiners for yield and yield related traits. Testers, BM59 and BM258 were assessed to be best general combiners, indicating their ability in transmitting additive genes in the desirable direction to their progenies. Similarly, among the hybrids, the cross BM52 x BM258 was found to be best specific combination for yield and yield related traits. Thus, we recommend the lines BM254, BM24, BM59 and BM258 as best general combiners and thus they may be used in development of synthetic population or may be pooled to derive superior inbreds and intern can be used as breeding material for improvement of grain yield.

INTRODUCTION

Maize (*Zea mays* L.) as the third most important cereal crop, has made a considerable contribution in feeding animals as fodder and grain, and is also an important source of the human diet worldwide. Maize grain yield is a complex trait and the most important aim of breeders is to develop varieties and hybrids of high yield genetic potential. Increasing efforts have been focusing on evaluating maize genetic resources for combining ability and heterotic grouping. Combining ability estimates are important genetic attributes to maize breeders in anticipating improvement via hybridization and selection.

The concept of combining ability was introduced by Sprague and Tatum (1942). Combining ability has a prime importance in plant breeding since it provides information for the selection of parents and also provides information regarding the nature and magnitude of gene action. The knowledge of genetic structure and mode of inheritance of different characters helps breeders to employ suitable breeding methodology for their improvement (Kiani *et al.,* 2007). Combining ability analysis is considered a very useful technique in classifying parental lines according to their potential to yield good hybrids and to aid in selecting parents which when crossed could give rise to better segregants in later generations.

Since, yield being a complex trait which is dependent on interaction effect of various component traits, it is necessary to bring improvement in the yield influencing traits. It is not possible to assess the true genetic potential existing among the genotypes only by knowing the actual *gca* effects of the parental genotypes and actual *sca* of hybrids. Therefore, it becomes very important to develop a system of working out pooled scores of *gca* and *sca* by utilizing the actual *gca* and *sca* values and also ensuring quantification of differences in *gca* effects among parental genotypes and *sca* effects among the hybrids.

Singh *et al*. (2012) estimated the general and specific combining ability for quality protein maize traits using diallele design and concluded the best general combiners on the basis of gca values alone and best cross combinations on the basis of per se performance, SCA effect and standard heterosis. Similarly, Krupakar *et al*. (2013) considered the gca values alone to determine the best general combiners for yield and its associated traits and ratio of gca and sca to assess the nature inheritance of trait.

Dar *et al*. (2015) evaluated 28 QPM maize inbreds in terms of general and specific combining ability to determine the best combiners based on simple and pooled score analysis and thus classified, lines KDQPM-60 as a good general combiner for grain yield per plant followed by KDQPM-21 and KDQPM-50 and they also concluded that the crosses having high SCA effects for grain yield plant-1and their parents with high GCA can be used directly as donors and exploited for future hybrid breeding programmes. Mani and Deshpande (2016) followed a new approach called, weighted *gca* method and identified top five best general combiners such as, L-11 (PDM 6518), L-12 (PDM6528), L-13 (PDM6529), L-14 (PDM6541), and L-

31(HKI163) as best combiners for yield and its associated traits

The method of identification of best general combiners by various authors differs but it is known that gca values alone lead spurious estimation thus we followed polled score techniques with the breeding lines known for superior per se based on last few years evaluation studies with a objective, to identify of best general combiners among these breeding material for higher grain yield and its related traits.

MATERIALS AND METHODS

The present investigation was carried out at College of Agriculture, Dharwad. The experimental hybrids were generated according to 12 x 6 Line x Tester design. The 12 lines were sown in six sets of one row each, while five rows of each tester were sown separately. The crossing programme was carried out during *rabi- summer* 2012. Further evaluation for *per se* was conducted in *kharif* 2012. Observations were recorded from the five randomly selected plants of each entry for the parameters such as, plant height, plant girth, ear weight, ear length, ear diameter, number of rows per ear, number of seeds per row, 100-seed weight, shelling percentage and grain yield per plant.

Identification of best combiner lines is prime requirement of varietal improvement programme. Usually breeders consider a best combiner is the one, which has significant and positive *gca* effects for the traits, which are directly correlated with yield. But, it may miss lead us, since, *gca* effects are influenced by the different units of measurements of different traits, affected by very high and very low values of gca effects and the character with higher *per se* effect influence the most as against the character with low *per se gca* values. To avoid such wrong interpretations, Arunachalam and Bandopadhyay (1979) proposed, simple pooled *gca* score method. In this approach, significant *gca* effect in desirable direction is given positive weightge (+1) and negative weighatge (-1) is given for *gca* effect in undesirable direction These values are added to arrive pooled score of *gca* effects. But, in this approach it is not possible to quantify the magnitude of difference existing among the genotypes of this group which get a positive score.

Later on, Deshpande (2005) and Hosmani (2005) recommended, per cent *gca* method to overcome the disadvantages of earlier methods. In per cent *gca* method, raw *gca* values have to be converted into per cent *gca* values by dividing the gca effects with cross mean and the ratio multiplied with 100. Thus, by working out per cent *gca* values, the minute differences in *gca* values can be focused and the possible problem arising out of the differences in unit of measurement, high and lower *per se gca* values associated with the type of character concerned could be avoided Patil (1995). But, Rama Krishna (2008) identified weighted per cent *gca* method which is, better than earlier two techniques. In weighted *gca* method, individual trait is taken in to consideration and equal weight age given to estimate their contribution towards yield.

In weighted gca method, the experience of the crop scientists concerned is important to attach weightages to each quantitative trait. In the present study, weightages were worked out by consulting three senior crop scientists in Maize, Dr. S. K. Deshpande, Dr. G. Shanthakumar and Dr. B. B. Chennappa Goudar, University of Agricultural Sciences, Dharwad. These values were further multiplied with the respective per cent *gca* values, worked out for each trait and then added to obtain pooled weighted *gca* score for each parent.

RESULTS AND DISCUSSION

Among lines differences were found in the group of top five lines between simple method and other two improved methods of evaluation of pooled scores for yield and related traits. The results obtained in three methods were compared and discussed below.

Simple pooled gca method: In this method (Table 1), the ranking of first four lines in descending order were BM254, BM24, BM423 and BM8. These lines were found to be top four best combiners. Among testers, two testers *viz.*, BM59, BM258 are the top two best combiners in decreasing order.

Per cent gca method: In per cent *gca* method (Table 2), the

Table 1 : Simple pooled gca score for yield and important yield attributing traits

Parents Females (Lines)	Plant height (cm)	Plant girth (cm)	Ear weight (g)	Ear length (cm)	Ear diameter (cm)	Number of rows per ear head	Number of seeds per row	100-seed weight (g)	Shelling percen tage	Grain yield per plant (g)	Pooled score	GCA status	Overall ranking
BM259	-1	1	0	0	0	0	0	-1	0	0	-1	Low	11
BM127	-1	0	0	-1	0	1	0	0	0	0	-1	Low	9
BM136	-1	1	0	0	0	-1	1	0	0	0	0	Low	7
BM24	1	0	0	0	0	0	0	1	0	0	2	High	3
BM423	1	0	0	0	0	0	0	1	0	0	2	High	2
BM8	1	-1	0	0	0	0	0	1	0	0	1	High	4
BM60	1	-1	0	0	0	0	0	0	0	0	0	Low	5
BM51	-1	0	0	-1	1	1	-1	1	0	0	0	Low	8
BM52	-1	1	-1	0	-1	-1	0	-1	-1	-1	-6	Low	12
BM254	1	1	1	1	1	1	0	1	1	1	9	High	1
BM36	0	-1	0	-1	0	-1	0	-1	0	0	-4	Low	10
BM83	1	0	0	-1	0	0	0	0	0	0	0	Low	6
Males (Testers)													
BM59	1	1	1	1	1	0	-1	1	1	1	7	High	1
BM258	0	0	1	0	0	0	0	0	0	1	2	High	2
BM32	-1	-1	0	-1	0	0	0	-1	-1	-1	-6	Low	6
RNBL4611	-1	0	0	0	0	0	0	0	0	-1	-2	Low	5
RNBL 4711	0	0	0	0	0	0	0	-1	0	0	-1	Low	3
BM1	1	0	0	0	-1	0	0	-1	0	0	-1	Low	4

Table 2 : Per cent gca method for yield and important yield attributing traits

Parents Females (Lines)	Plant height (cm)	Plant girth (cm)	Ear weight (g)	Ear length (cm)	Ear diameter (cm)	Number of rows per ear head	Number of seeds per row	100-seed weight (g)	Shelling percentage	Grain yield per plant (g)	Pooled score	Overall ranking
BM259	-5.64	2	0.24	0.46	0.92	4.19	1.06	-10.13	-1.08	-8.15	-16.13	9
BM127	-2.42	0.89	-2.14	-5.61	3.53	6.33	-3.82	-1.72	0.56	6.42	2.03	7
BM136	-7.47	2.72	-3.53	3.43	-3.16	-7.21	8.41	0.55	-0.53	-1.6	-8.38	8
BM24	4.71	-0.5	6.06	0.47	-0.53	-3.6	2.04	6.23	1.54	7.81	24.24	2
BM423	3.73	-1.45	4	0.66	-0.2	-3.6	0.37	7.73	1.12	4.4	16.76	3
BM8	3.96	-3.22	-3.54	1.86	1.67	-1.79	-2.19	9.45	0.75	2.9	9.84	5
BM60	2.04	-3.67	3.95	0.49	3	1.59	3.2	-2.2	-0.91	-4.53	2.96	6
BM51	-2.64	-0.78	0.68	-4.68	4.98	8.36	-8.56	6.36	2.13	8.95	14.8	4
BM52	-4.86	2.17	-22.19	-1.44	-12.25	-5.86	-3.36	-16.24	-7.13	-22.49	-93.65	12
BM254	6.23	5.17	22.38	15.05	4.8	9.72	3.81	6.88	4.47	23	101.49	1
BM36	0.59	-3.22	-4	-5.89	-3.2	-5.41	3.57	-7.28	-0.32	-9.2	-34.36	11
BM83	1.78	-0.17	-1.91	-4.8	0.48	-2.7	-4.52	0.37	-0.63	-7.52	-19.62	10
Males (Testers)												
BM59	2.17	3.17	13.42	4.85	7.14	0.24	-4.22	17.79	2.31	17.51	64.39	1
BM258	0.7	0.17	8.96	-0.35	2.48	2.83	1.48	-0.42	1.53	11.83	29.21	2
BM32	-3.67	-2.5	-3.55	-6.04	-1.42	1.93	-0.68	-4.78	-3.46	-9.47	-33.64	6
RNBL4611	-1.43	0.5	-5.61	1.03	-1.99	-1.63	1.9	-3.33	-0.29	-8.92	-19.77	4
RNBL 4711	0.27	-1.17	-5.92	-0.45	-1.07	-0.89	-1.31	-4.24	-1.12	-5.24	-21.14	5
BM1	1.96	-0.17	-7.29	0.95	-5.13	-2.47	2.83	-5.03	1.02	-5.72	-19.04	3
F1 means	224.68	1.8	184.15	17.35	4.56	14.77	35.84	30.47	81.68	154.78	-	-

Table 3 : Weighted gca method for yield and important yield attributing traits

Parents Females (Lines)	Plant height (cm)	Plant girth (cm)	Ear weight (g)	Ear length (cm)	Ear diameter (cm)	Number of rows per ear head	Number of seeds per row	100-seed weight (g)	Shelling percentage	Grain yield per plant (g)	Pooled score	Pooled ranking
BM259	-15.05	10	1.98	3.31	6.44	33.48	8.86	-50.67	-6.47	-81.46	-89.57	9
BM127	-6.44	4.45	-17.5	-40.2	24.7	50.66	-31.83	-8.61	3.37	64.24	42.83	5
BM136	-19.93	13.62	-28.8	24.58	-22.09	-57.7	70.09	2.77	-3.16	-15.99	-36.61	8
BM24	12.55	-2.5	49.49	3.39	-3.68	-28.82	17	31.16	9.26	78.13	165.97	2
BM423	9.96	-7.23	32.67	4.75	-1.38	-28.82	3.05	38.63	6.72	43.99	102.33	4
BM8	10.57	-16.12	-28.88	13.34	11.66	-14.36	-18.28	47.23	4.51	29.02	38.7	6
BM60	5.43	-18.34	32.25	3.51	21.02	12.73	26.67	-11.01	-5.44	-45.28	21.54	7
BM51	-7.03	-3.89	5.58	-33.55	34.83	66.91	-71.37	31.8	12.77	89.54	125.58	3
BM52	-12.97	10.84	-181.23	-10.33	-85.76	-46.87	-27.97	-81.19	-42.75	-224.89	-703.13	12
BM254	16.6	25.85	182.73	107.83	33.6	77.75	31.72	34.41	26.84	229.96	767.29	1
BM36	1.57	-16.12	-32.69	-42.22	-22.4	-43.29	29.79	-36.38	-1.9	-92.02	-255.66	11
BM83	4.74	-0.83	-15.6	-34.41	3.38	-21.62	-37.65	1.85	-3.75	-75.22	-179.12	10
Males (Testers)												
BM59	5.77	15.84	109.6	34.79	50.01	1.9	-35.14	88.95	13.88	175.09	460.69	1
BM258	1.86	0.83	73.18	-2.48	17.34	22.65	12.35	-2.1	9.2	118.35	251.16	2
BM32	-9.77	-12.51	-29.02	-43.3	-9.97	15.44	-5.67	-23.88	-20.78	-94.65	-234.11	6
RNBL4611	-3.82	2.5	-45.82	7.4	-13.96	-13	15.84	-16.67	-1.73	-89.16	-158.44	4
RNBL 4711	0.73	-5.84	-48.38	-3.22	-7.52	-7.15	-10.91	-21.18	-6.69	-52.44	-162.6	5
BM1	5.23	-0.83	-59.55	6.82	-35.9	-19.78	23.58	-25.14	6.13	-57.18	-156.62	3
Weightage	2.67	5	8.17	7.17	7	8	8.33	5	6	10	-	-

ranking of first five lines in descending order were BM254, BM24, BM423, BM51 and BM8. The line BM51 occupied fourth position instead of BM8. BM8 obtained fifth place in this method. Among testers, same two testers BM59, BM258 were the top two best combiners.

Weighted *gca* method: Difference was found in the group of top five lines for yield and related traits in this method (Table 3). The ranking of first five lines in descending order were BM254, BM24, BM51, BM423 and BM127. The line BM51 occupied third position instead of BM423, while BM423 occupied fourth position which occupied third position in per cent *gca* method. BM127 occupied fifth position. BM8 obtained sixth position which occupied fifth position in per cent *gca* method. But the top two best combiners in decreasing order, *viz*. BM254 and BM24 remained same. Among testers same two testers, BM59, BM258 were the top two best combiners, these results are on par with the findings of Mani and Deshpande (2016).

In all the three methods of pooled scoring, the lines BM254 and BM24 were found to be excellent combiners for yield and yield related traits of economic importance. Hence, such lines can be effectively used in hybrid breeding program. Among testers, BM59 and BM258 were found to be best general combiners. The results implied that two lines (BM254 and BM24) and two testers (BM59 and BM258) studied were high combiners across all the traits, indicating their ability in transmitting additive genes in the desirable direction to their progenies. Further, these lines *viz.*, BM254, BM24 and testers *viz.*, BM59, BM258 can be preferentially used as high combiner parents in hybridization programmes to develop potential hybrids in Maize.

The best combiner lines identified through weighted *gca* method are the one which have maximum number of favorable or useful genes and positive allelomorphes for the characters associated with grain yield. Hence we would recommend utilization of these five inbreds in recombination breeding to derive high yielding maize hybrids. It was reported that entries with larger positive GCA estimates with larger and significant additive gene effects could provide desirable genes for the improvement of characters under consideration (Baker, 1978).

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