



E-ISSN: 2278-4136

P-ISSN: 2349-8234

www.phytojournal.com

JPP 2021; 10(2): 679-681

Received: 10-01-2021

Accepted: 12-02-2021

M Banoth

Department of Genetics and Plant Breeding, Professor Jayashankar Telangana State Agricultural University (PJTSAU), College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

K Prabhavathi

Seed Research and Technology Centre, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

D Bhadru

Agricultural Research Institute, Maize Research Centre, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

B Mallaiah

Agricultural Research Institute, Maize Research Centre, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

Corresponding Author:**K Prabhavathi**

Seed Research and Technology Centre, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

Heterotic grouping of maize inbred lines on the yield basis of combining ability: Efficiencies and prospects

M Banoth, K Prabhavathi, D Bhadru and B Mallaiah

DOI: <https://doi.org/10.22271/phyto.2021.v10.i2i.13873>

Abstract

Founding the perfect fit of inbreds into heterotic groups is a pivotal to the development of triumphant maize hybrids. Here the objective of this study were to (i) classifying inbred line(s) into known heterotic groups with unknown testers, HGCAMT, SCA-GY and HSGCA methods (ii) analyze breeding efficiencies of this method(s) and (iii) future prospects of heterotic grouping research. These results demonstrate the usefulness of combining ability in classifying inbreds into useful heterotic group(s) for further studies.

Keywords: maize genotypes, heterotic groups, combing ability, line × tester mating design, grain yield

Introduction

In general, as we all know that maize (*Zea mays* L.) is a miracle crop and queen of cereals, because of its highest genetic yield potential among the cereals. The global maize production is about 1.09 billion metric tonnes from 153.0 million hectares and USA has highest productivity (10.57 t ha⁻¹), which is double than the global average (4.92 t ha⁻¹). Whereas, the average productivity in India is about 2.68 t ha⁻¹ with production of 24.26 million tonnes from 9.3 million hectares, the country lags far behind in productivity against world average. However, in Telangana State maize is grown in almost all the districts in an area of 0.64 million hectares, with a production of about 2.60 million tonnes [1].

Is that heterotic grouping is desirable? because of highly declining in yield reduction and increasing of population growth, we have to boost the grain yield production, considering the above points we have to select the best combination of inbreds in breeding programs for desired traits. Strength of a breeding program depends on the genetic variability in the base populations and development of superior inbreds, fur that 'n' numbers of breeding methods are available, but they are time consuming. Hence, heterotic grouping is the best way to select the desired combination of inbreds in a short period of time and by using these researchers have great influence on how a maize inbred line is assigned to a heterotic group.

Heterosis and combining ability plays a significant role in crop improvement, as it helps the breeder to study and compare the performance of the new lines in hybrid combinations. It provides the basis for selecting good combiners and also for understanding the nature of gene action. Apart from selection of superior lines and analysis of their combining ability, placing them in well-defined heterotic groups is essential to increase the probability of success in heterosis breeding. Identification and utilization of heterotic groups and their patterns is essential in maize heterosis breeding [2]. A heterotic group is a group of related or unrelated genotypes displaying similar combining ability and giving a heterotic response when crossed to opposite or other genetically distinct germplasm group and establishment of the best combination of inbreds among the heterotic groups is crucial to the development of successful maize hybrids [3, 4, 5, 6].

Classification of inbreds into heterotic groups based on sca effects of grain yield is influenced by interaction between two inbred lines, hybrids and environment, which leads to classification of same inbred into different groups in different studies. This issue can be resolved by using heterotic group's specific and general combining ability (HSGCA) method of heterotic grouping [7, 8, 9]. Here we classify inbreds into heterotic groups with unidentified testers on combining ability yield basis by studying their interactions in all way in line × tester mating fashion.

Materials and Methods

Genetic materials

The study material involved seeds of 20 maize inbred lines collected from the Maize Research Center (MRC), Hyderabad. Among this 15 lines different heterotic pattern are identified with five testers based on combining ability grain yield in a line \times tester (L \times T) mating fashion. The pedigree and genetic background of the inbred lines used for this study are listed in table 1.

Experimental Design

Heterotic groupings GCA effects for grain yield of all the five testers were evaluated to identify a pair of testers with significantly highly divergent GCA to allocate the inbred lines and to commence heterotic groups (Legesse). Moreover, three presumed heterotic groups were also commenced among the rest of the testers which were not identified on the bases of their GCA values. In all circumstances, the inbred lines based on the SCA values enumerate from their crossing performance with the testers in line \times tester mating design

were allocated toward any one or both of the heterotic tester groups. An inbred line which possessed negative SCA with any one of a heterotic tester was grouped with the tester with which it revealed negative effects. Another inbred line revealing positive SCA with both testers was assigned towards both groups and, the one which revealed negative SCA with the two testers was discarded (vasal *et al.*, 1992; Parentoni *et al.*, 2001).

Thereafter allocating the inbred lines, the SCA values of all the four heterotic groups were determined separately by adding the values of all the crosses brought together to initiate a heterotic group and then compared in pair using t-test statistics (Parentoni *et al.*, 2001). Similarly, grain yield mid-parent heterosis was computed for all crosses with respect to each tester and then the average value determined and compared likewise in order to verify the appropriateness of the testers (Ordas, 1991) which have identified based on contrasting GCA effects and to which assigning of the inbred lines have been suggested to initiate the heterotic group bases on SCA.

Table 1: List of maize inbred lines used in this study for heterotic grouping

Genotypes	Pedigree	Source	Grain texture	Silking Colour
MGC-6	(CML451-B*7/((CML451/CL-RCY016)-B-18-1-1-1-BBB)-B-11-BB	MRC, ARI(R)	Flint	Yellow
MGC-9	((CML161 \times CML451)-B18-1-BBB/CML161-B)-B13-BB(NonQ)-BBB/CML395/MBRC5BcF114-1-2-3-B-4-2-B) DH-3007-B*4)-B-8-BB	MRC, ARI(R)	Flint	Yellow
MGC-15	(AMDROUTI (DT-Tester)C1f2-36-b*5/(POP502C5#18/GEMN-0145)-B-21-2-1-1-B)-B-3-BB	MRC, ARI(R)	Semi-flint	Orange
MGC-32	AMDROUT(5 \times 6)C3F2-B2-15-1-BB	MRC, ARI(R)	Flint	Yellow
sMGC-92	PT9633301-1-B*4-1-B*6-1-BBB-#-BB	MRC, ARI(R)	Flint	Yellow
MGC-137	(MARSSYN-155)-4-1-1-BB	MRC, ARI(R)	Dent	Orange
MGC-230	CML452=Ac8328BNC6-166-1-1-1-B*15-#-BB	MRC, ARI(R)	Flint	Yellow with cap
MGC-237	(POP501C5#8/GEMS-0039)-B-10-1-1--1-BBB	MRC, ARI(R)	Flint	Yellow
MGC-238	(CML451/CA00360/P3011F2-3-5-6-1-B*10)-B-4	MRC, ARI(R)	Flint	Orange
MGC-239	(CML161 \times CLQ-RCYQ49=(CML176/CL-G2501)-B-55-2-1-B)-B-19-1-B*11	MRC, ARI(R)	Flint	Orange
MGC-242	CML227-B*12	MRC, ARI(R)	Flint	Yellow
MGC-248	DTPYC9-F46-3-6-1-2-2-1-2-B*7-B-B	MRC, ARI(R)	Flint	Pinkish orange
MGC-252	NEI9008-B*9	MRC, ARI(R)	Flint	Yellow with cap
MGC-254	CLQ-RCYQ36-B-1-B*8-B-B	MRC, ARI(R)	Semi-dent	Yellow
MGC-256	CA00360/P3011F2-3-5-6-1-B*12	MRC, ARI(R)	Flint	Yellow with cap
BML-6	BML-6(SRRL65-b96-1-1-2-#-2-1-1-1-1	MRC, ARI(R)	Semi-flint	Yellow
BML-7	BML-7(X2 y pool \times CML226-B98R-1-1-1-xb-xb-xb	MRC, ARI(R)	Flint	Orange
BML-14	BML-14(COIB96 K-1-#-1-2-xb-xb-1-2-xb-xb-2-xb-xb-xb	MRC, ARI(R)	Semi-dent	Pinkish orange
GP-170	Selected from CIMMYT lines	CIMMYT	Dent	Yellow with cap
GP-311	Selected from CIMMYT lines	CIMMYT	Dent	Yellow with cap

ARI(R), Agricultural Research Institute (Rajendranagar); BML, Code for Hyderabad Maize Line; CIMMYT, International Maize and Wheat Improvement Center; GP, Germplasm; MGC, Maize Germplasm selected from CIMMYT; MRC, Maize Research Center.

Abbreviations: ARI(R), Agricultural Research Institute (Rajendranagar); BML, Code for Hyderabad Maize Line; CIMMYT, International Maize and Wheat Improvement Center; GCA, General Combining Ability; GP, Germplasm; HSGCA, Heterotic group's Specific and General Combining Ability; MGC, Maize Germplasm selected from CIMMYT; MRC, Maize Research Center; SCA, Specific Combining Ability; SCA_GY, Specific Combining Ability and Grain Yield; USA, United States of America.

Heterotic group's specific and general combining ability computation

Heterotic group's specific and general combining ability

(HSGCA) method proposed by Fan *et al.* (2009) was computed as follows:

$$\text{SCA} = \text{Cross mean } (X_{ij}) - \text{Line mean } (X_{.j}) - \text{Tester mean } (X_{i.}) + \text{Overall mean } (X_{..})$$

$$\text{GCA} = \text{Line mean } (X_{.j}) - \text{Overall mean } (X_{..})$$

$$\text{HSGCA} = \text{Cross mean } (X_{ij}) - \text{Tester mean } (X_{i.}) = \text{GCA} + \text{SCA}$$

Where,

X_{ij} = mean yield of the cross between i^{th} tester and j^{th} line

$X_{i.}$ = mean yield of the i^{th} tester

$X_{.j}$ = mean yield of j^{th} line

Identification of testers: The key for HSGCA method is to identify representative tester lines (Fan *et al.* 2009). Grain yield GCA effects of all the testers are to be estimated to identify a pair of testers with significantly contrasting GCA to

assign the inbred lines and to initiate heterotic groups (Legesse *et al.* 2009) [7].

Formation of heterotic groups: With the representative testers identified based on the GCA effects and divergence, heterotic grouping was done following the HSGCA method developed by Fan *et al.* (2009). The following steps were followed for heterotic grouping of the inbred lines.

Step 1: Placed all inbred lines with negative HSGCA effects into the same heterotic groups as their tester. At this step, a line might be assigned to more than one heterotic group.

Step 2: If an inbred line was assigned to more than one heterotic group in Step 1, we kept the line in the heterotic group if its HSGCA had the smallest value (or largest negative value) and removed it from other heterotic groups.

Step 3: If a line had positive HSGCA effect with all representative testers, we must be cautious to assign that line to any heterotic group because the line might belong to a heterotic group different from all the tester. In conclusion, In order to classify inbred lines into heterotic grouping, evaluated the 15 maize inbred lines with two highly divergent testers out of five testers and assigned the 13 lines into two heterotic groups A and B. Eight and five lines were belonged to tester group BML-7 (Group-A) and GP-311 (Group-B) respectively. This study demonstrates the usefulness of combining ability effects in classifying inbred lines into useful heterotic groups for further studies.

Acknowledgement

Authors are thankful to the Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad for providing maize inbred lines.

References

1. Akinwale RO, Badu-Apraku B, Fakorede MAB, Vroh-Bi I. Heterotic grouping of tropical early maturing maize inbred lines based on combining ability in striga infested and striga free environments and use of SSR markers for genotyping. *Field crop research* 2014;156:48-62.
2. Badu-Apraku B, Oyekunle M, Akinwale O, Aderounmu M. Combining ability and genetic diversity of extra-early white maize inbreds under stress and non-stress environments. *Crop Sciences* 2015;53:9-26.
3. Barata C, Carena M. Classification of North Dakota maize inbred lines into heterotic groups based on molecular and testcross data. *Euphytica* 2006;151:339-349.
4. Fan XM, Zhan YM, Hao WH, Chen HM, Tan J, Xu CX, *et al.* Classifying maize inbred lines into heterotic groups using a factorial mating design. *Agronomy journal* 2009;101:106-112.
5. Hallaur AR, Miranda JB. Quantitative genetics in maize breeding 1988. Iowa state university, Ames, Iowa, USA.
6. India stat 2018-19. <https://www.indiastat.com/maize/production/area>.
7. Legesse BW, Pixley KV, Botha AM. Combining ability and heterotic grouping of highland transition maize inbred lines. *Maydica* 2009;54:1-9.
8. Meena AK, Gurjar D, Patil SS, Kumhar BL. Concept of heterotic group and its exploitation in hybrid breeding. *International Journal of Current Microbiology and Applied Sciences* 2017;6(6):61-73.
9. Melchinger AE, Gumber RK. Over view of heterosis and heterotic groups in agronomic crops. In: Lamkey KR,

- Staub JE, editors. *Concepts and Breeding of Heterosis in Crop Plants*. Madison, WI, USA: CSSA 1998, 29-44.
10. Melchinger AE. Genetic diversity and heterosis. In Coors, J, G., Pandel, S. (eds). *The genetics and exploitation of heterosis in crops*. CSSA-SP. Madison. Wis 1999, 99-118.