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Heterotic Grouping of Selected inbred lines of Maize (*Zea mays L.*) Using two Testers

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Abstract: **The objectives of the present study were to determine heterotic groups of germplasm of the inbred lines and to identify promising hybrid crosses. Twenty-one S_5 lines testcrossed with FS59 and FS57 in Line × Tester design for heterotic grouping. The experiment was planted in an alpha lattice design (22x2) arrangement with two replications of one row plot in 2019/20 rainy season at Kulumsa. All the 21 lines were derived from Ambo Highland Maize Breeding Program. The basis of grouping the germplasm into different heterotic groups was specific combining ability (SCA) effects for grain yield. From twenty-one inbred lines, eight inbred lines viz. L1, L2, L4, L11, L12, L14, L15 and L21 were showing positive SCA effect with FS59, exhibiting negative SCA effect with FS67 and grain yield greater than the mean grain yield when crossed to FS59 and were classified as group "B". On the other hand, eight inbred lines viz. L3, L5, L6, L8, L9, L10, L17 and L18 showed positive SCA effect with FS67, exhibiting negative SCA effect with FS59 and grain yield greater than the mean grain yield when crossed to FS67 and were classified as group "A". The general, specific combining abilities and heterotic groups showed that these genotypes had a potential hybrid for advanced yield testing and subsequent release in the specific locations.**

Keywords: **Grain Yield, Heterotic Grouping, SCA.**

I. INTRODUCTION

Heterotic grouping is a group of related or unrelated genotypes from the same or different population that indicate similar combining ability and heterotic response when crossed with genotype from other genetically diverse germplasm groups. So far, combining ability effects in maize and heterotic classification of inbred lines has been extensively studied in Ethiopia for different sets of new inbred lines developed/introduced and adapted at different times [1]; [2];[3]; and [4]. It is always mandatory for any breeding program to generate such information for any new batch of inbred lines generated or received outside of the program. Understanding the relative importance of general combining and specific combing ability effects for different traits for newly developed inbred lines is of paramount importance to design future breeding strategies for the development of hybrid and/or synthetic varieties. The heterotic classification will also assist in determining the relationship existing among the different inbred lines.

In maize breeding program, two heterotic grouping are mostly use. Group "A" and group "B" dent type and flint type of maize respectively. CIMMYT used three heterotic groups "A"," B" and "AB" but it varies depending on the objective of the breeding program. Accordingly, the mid altitude program of Kenya has six heterotic groups, Embu 11, Embu12, Muguga A, Muguga B,Kakamega pool A, and Kakamega pool B. (KARI, 2000), while the high-altitude program has three heterotic groups; Ecuadar 573 and Kitale Synthetic I and II [5].

[6] grouped 23 inbred lines into different heterotic groups based on SCA effect and test cross into mean grain yield. [6] grouped maize inbred lines in to group A and B based on SCA of grain yield in their study of test cross with proven tester as a main criterion for grouping of lines into dent and flint group.

So, the present study was undertaken to identify best hybrid combination of lines and testers and to group these lines into heterotic groups. The study also looks into heterotic grouping of lines using two diverse testers to find out how the grouping affects the selection and utilization of lines in hybrid breeding program

II. MATERIAL AND METHODS

Description of the study areas

Kulumsa is located 165 km south-east of Addis Ababa in the highlands of Arsi zone. It lies at 8°5'N latitude, 39°10'E longitude with an altitude of 2200 m.a.s.l and is located in a tepid to cool, moist plain agro-ecological zone. Rainfall data for the last 10 years (2006-2016) showed that average total annual rainfall was 830 mm which ranged from 535 to 1018 mm. Average annual maximum temperature was 23.2 °C and minimum temperature was 10 °C. The dominant soil type is luvisol/eutric nitosols with good drainage and (pH =6).

Experimental Materials

Twenty-one S_5 generation elite inbred lines and two locally developed adaptable line testers were used to make the line x tester crosses the previous cropping season (2019). Consequently, 42-line x tester crosses and two commercial checks were made available to evaluate in alpha lattice design with two replications of one row plot in 2020 main season. The testers are line testers of well known heterotic group and checks are three-way cross of normal hybrid maize. Both are used in this study are locally developed by the national highland maize breeding program of Ethiopia.

List and pedigrees of the inbred lines and testers used in the line x tester crosses are given in Table 1.

Table 1: Description of lines, testers and checks used in the study.

Line code	Pedigree	Source	
L1	POOL-5/GUAT-1341-2-4-2-2-2	AHMBP	
L2	POOL-5/GUAT-1341-2-2-1-2-1	AHMBP	
L3	POOL-5/GUAT-1341-3-1-2-1-1	AHMBP	
L4	POOL-5/GUAT-1341-4-1-1-1-1	AHMBP	
L5	POOL-5/GUAT-1341-4-1-1-1-2	AHMBP	
L6	POOL-5/GUAT-1341-4-1-1-2-1	AHMBP	
L7	POOL-5/GUAT-1341-4-2-3-1-2	AHMBP	
L8	POOL-5/GUAT-1341-4-2-3-2-2	AHMBP	
L9	POOL-5/GUAT-1341-4-3-3-1-1	AHMBP	
L10	POOL-5/GUAT-1341-4-3-3-2-2	AHMBP	
L11	POOL-5/GUAT-1341-4-3-3-2-3	AHMBP	
L12	POOL-5/GUAT-1487-1-1-1-1-1	AHMBP	
L13	POOL-5/GUAT-1487-1-1-1-1-2	AHMBP	
L14	POOL-5/GUAT-1487-1-1-1-1-3	AHMBP	
L15	POOL-5/GUAT-1487-1-1-1-2-1	AHMBP	
L16	POOL-5/GUAT-1474-1-1-1-3-1	AHMBP	
L17	POOL-5/GUAT-1474-1-1-1-3-2	AHMBP	
L18	POOL-5/GUAT-1474-1-1-3-3-1	AHMBP	
L19	POOL-5/GUAT-1474-2-1-1-1-1	AHMBP	
L20	POOL-5/GUAT-1474-2-1-1-2-1	AHMBP	
L21	POOL-5/GUAT-1474-2-1-1-2-2	AHMBP	
Testers			
T1	FS-59	AHMBP	Line tester (Ecuador group)
T2	FS-67	AHMBP	Line tester (Kitale group)
Checks			
JIBAT		AHMBP	Hybrid normal maize
WONCHI		AHMBP	Hybrid normal maize

Experimental Design

The experiment was planted in an alpha lattice design (22x2) arrangement with two replications of one row plot in 2019/20 rainy season. Each plot had one row of 5.25-meter length (21 plants). Each genotype was planted at 75 cm between rows and 25 cm within row spacing. Two seeds were planted per hill and later thinned to one plant per hill providing a uniform stand of about 53,333 plants ha^{-1}.

Statistical Analysis

Data analysis was performed using Agricolae package of R software version 3.2.2. Grouping of inbred lines was done according to [7] which was based on sign of the SCA effect of crosses and their mean grain yield. Inbred lines having positive SCA effect with tester “A” (FS59) but having negative SCA effect with tester “B” (FS67) and with test cross mean yields equal to or larger than the average of the hybrids of tester were placed into the heterotic group “A” i.e., they nick (combine) well with Tester A (FS59).Similarly, inbred lines displaying positive SCA effect with tester “B” only and having negative SCA effect with tester “A” and with test cross mean yields equal to or larger than the average yield of the hybrid of tester were put into the heterotic group “B” group.

III. RESULT AND DISCUSSION

The heterotic grouping of 21 inbred lines with their SCA effects are presented in (Table 2). The result exhibited that, from twenty-one inbred lines, eight inbred lines *viz.* L1, L2, L4, L11, L12, L14, L15 and L21 were showing positive SCA effect with FS59, exhibiting negative SCA effect with FS67 and grain yield greater than the mean grain yield when crossed to FS59 and were classified as group “B” (Table 9). On the other hand, eight inbred lines

viz. L3, L5, L6, L8, L9, L10, L17 and L18 showed positive SCA effect with FS67, exhibiting negative SCA effect with FS59 and grain yield greater than the mean grain yield when crossed to FS67 and were classified as group “A”.

Table 2: Grain yield mean, SCA effect and heterotic group of 21 maize inbred lines teste crosses to FS-59 and FS-67

	Tester 1 (FS-59) (Group “A”)		Tester 2 (FS-69) (Group “B”)		Heterotic Group
Lines	Grain yield	SCA	Grain Yield	SCA	
1	9.19	1.35**	7.55	-1.35**	B
2	8.20	0.31	8.63	-0.31	B
3	6.20	-1.28*	9.81	1.28*	A
4	8.20	0.26	8.74	-0.26	B
5	6.97	-0.32	8.66	0.32	A
6	7.44	-0.51	9.50	0.51	A
7	6.48	-0.15	7.83	0.15	-
8	7.00	-0.16	9.27	0.61	A
9	7.19	-0.19	8.62	0.19	A
10	6.52	-0.5	8.64	0.53	A
11	7.56	0.11	8.38	-0.11	B
12	7.83	0.07	8.75	-0.07	B
13	6.64	-0.22	8.12	0.22	-
14	7.68	0.56	7.60	-0.56	B
15	7.77	0.51	7.80	-0.51	B
16	7.45	0.14	8.23	-0.14	-
17	6.90	-0.25	8.46	0.25	A
18	7.52	-0.47	9.51	0.47	A
19	7.22	0.37	7.52	-0.37	-
20	7.31	0.22	7.93	-0.22	-
21	7.44	0.62	7.25	-0.62	B
Mean	7.40		8.46		

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In order to maximize genetic diversity and therefore heterosis during hybrid variety development using these inbred lines, one parent should come from the eight inbred lines belonging to heterotic group A while the other parent should be from the eight inbred lines belonging to heterotic group B. In the case of the development of synthetic varieties, inbred lines belonging to the same heterotic group should be used. Likewise, [8] using population and inbred line testers separated inbred lines into different heterotic groups on the basis of grain yield SCA values.

IV. SUMMARY AND CONCLUSION

Heterotic grouping of lines is an important activity in plant breeding. It enables the efficient selection of parents in Inbred-hybrid breeding program. Among them 21 lines showed positive GCA and 8 lines were grouped with group "B" and also 8 lines grouped with "A". This means grouping of lines is based on testers, a line derived has to undergo long process of heterotic grouping. It is better to characterize lines based on agronomic, traits and reaction to pest and diseases so that the worth of the line is assessed comprehensively. Later the lines can be used in crossing or in improvement of traits.

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