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Combining Ability in Quality Protein Maize Using Diallele Crosses Among Five Inbred Lines

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ABSTRACT
A study was conducted to assess the magnitude of combining ability in a half diallel cross. Materials involving 10 hybrids and 5 parents of quality protein maize (QPM) were evaluated in 2013/2014 at the Institute for Agricultural Research farms, IAR. Ahmadu Bello University, Zaria. The analysis of variance for the seven agronomic traits viz: days to 50% tasseling days to 50% silking, plant height, ear weight, ear height, ears per plant and grain yield indicated significant ($p \leq 0.05$) amount of variability among the genotypes for all the seven traits studied, variances for general combining ability (GCA) were highly significant for all traits except ear height and ear weight. Variance for specific combining ability (SCA) were highly significant for days to 50% tasseling, plant height, ear height, ears per plant and ear weight. Among the parents sammaz 17 was the best general combiner with high GCA effects for grain yield, as well as negative GCA value for days to 50% tasseling and days to 50% silking. Among the hybrids Sammaz 14 x Sammaz 32 and Sammaz 37 x Sammaz 36 showed significant SCA effect in the desired direction. The hybrid with the best yielding quality and earliness to tasseling and silking was sammaz 14 x Sammaz 32 followed by sammaz 37 x Sammaz 36.
Key Words: Combining ability, quality protein maize, diallel.

1.0 Introduction

Botanically maize (*Zea mays.* L) belongs to the grass family (*Gramineae*) and it is a tall annual plant with an extensive fibrous root system. It is a cross pollinating species, with the female (ear) and male (tassel) flowers in separate place on the plant (Cross et al, 2000). Maize (*Zea mays* L) is a major staple food and an important source of protein accounting for up to 60% of the daily human protein supply (Lamkey, 1995; Sofi and Rather, 2006). Its worldwide economic importance is due to its trade as a food, feed and an industrial grain crop. Unfortunately, maize protein is of poor nutritional quality as it is deficient in two essential amino acids lysine and tryptophan which the human body cannot synthesize and has to be supplemented. Improving the nutritional quality of staple food crops including maize is therefore a noble goal. This strategy is particularly important for cereal crops as benefits can reach hundreds or millions of people rapidly without changing the food habits of the consumer (Ito, 1998)

The modified opaque 2 maize with hard endosperm and vitreous kernels is termed quality protein maize (QPM) (zelleke, 2000). Metrz et al., 1964 first reported that the lysine content in opaque -2 (O2) was 3.3 to 4.0g per 100g of endosperm protein, which was more than twice that of normal maize endosperm (1.3g lysine per 100g endosperm protein). Several researchers later demonstrated the superior maize (QMP) over normal maize (Bressani, 1995; Graham et al 1980; Paes et al., 1995)

When the same parents are used as females and males in breeding the mating design is called diallele (Paul and Debnath, 1999). The diallele mating design has been used extensively for developing breeding population for recurrent selection.

2.0 MATERIALS AND METHOD

The plant materials for this study comprise of five open pollinated varieties (OPV) of quality protein maize (QPM) used as inbred parents viz Sammaz 32, Sammaz 36, Sammaz 37, Sammaz 17 and Sammaz 14 each of which was used as both male and female parents, the open pollinated varieties were obtained from maize and sorghum improvement unit of Institute for Agricultural Research (IAR) Samaru Zaria.

After thorough land preparation, sowing was done by hand dibbling of seeds with three seeds per hole and the plot was irrigated. The plants were thinned to two plants per hill two weeks after planting to maintain two seedlings per hole. The plants were planted using a staggered planting pattern of one week interval in order to synchronize the flowering and subsequent pollination. Selected female parents were pollinated with pollen from selected male parents to produce crosses and pollination is controlled to ensure progenies of known parentage.

10 single cross hybrids, were generated using five quality protein maize inbred parents in a 5x5 half diallel mating design. The five parents together with 10 F_1 hybrids (15 entries) were evaluated for days to 50% tasseling, days to 50% silking, plant height, ear weight, ear height, ear per plant and grain yield at instituted for agricultural research, Samaru irrigation filed at Samaru Zaria.

A randomized complete block design with three replications was used for each experiment. The plot size was 0.5m x 0.75m, each plot consist of one row of 5m length. Spacing between rows is 75cm and spacing between plants within the row is 50cm.

Statistical analysis
The data collected was statistically analysed using analysis of variance (ANOVA) appropriate for Randomized complete block design (RCBD) and combined analysis was done with SAS version 9.1.

3.0 Result and Discussion
The results of the analysis of variance for seven agronomic traits are presented in table 1. The result of the entries were highly significant (P<0.01) for all traits studied. The mean sum of square for general combining ability (GCA) was highly significant for all the traits except ear height and ear weight. Days to 50% silking and grain yield showed non-significant difference for specific combining ability among the traits.

Table 1: Analysis of variance in respect of 7 agronomic traits

SOURCE OF VARIATION	D. F	DYTS	DYSK	PHT	EHT	EPP	EWT	GY
ENTRY/GENOTYPE	14	38.14**	52.02**	393.36**	618.03**	0.14**	1334857.14**	2860905.22
G C A	4	53.36**	78.14**	712.10**	1195.11	0.12**	2368583.33	1102339.54
S C A	10	25.13**	32.00	205.85**	285.80**	0.14**	1176666.67**	3579696.37
REP	2	12.16	10.69	0.16	269.42	0.02	1152000**	816249.14
ERROR	28	4.44	6.88	74.66	123.66	0.01	366285.71**	2119444.90
C.V		2.92	3.48	4.40	11.80	8.65	19.69**	29.23

*Significant difference
**= Highly significant difference.
df = Degrees of freedom
DYTS= Days to 50% Tasseling DYSK= Days to 50% Silking PLHT= Plant height EHT = Ear height
EWT= Ear weight EPP=Ears per plant GY=Grain yield

Days to 50% Tasseling
The general combining ability (GCA) effects study suggested that Sammaz 37 were good combiner for earliness in developing tassels table 2. The two parents showed significant GCA effect in the negative direction. Days from planting to pollen shedding are one of the important maturity character. (Surya and Granguli, 2006). The crosses showed significant SCA effects in both positive and negative direction. Among the hybrids, Sammaz 14 x Sammaz 37, Sammaz 37 x Sammaz 17 and Sammaz 36 showed significant SCA effect in the desired positive direction.

Days to 50% silking
Studies on general combining ability effects revealed that none of the parents showed significant GCA effect in desired direction except Sammaz 17. While two hybrids Sammaz 36 x Sammaz 37 and Sammaz 14 x Sammaz 32 showed significant SCA effect in the desired direction. These crosses can be used as specific combiners for this trait.
Days to 50% silking is another maturity character often used and more reliable to predict maturity (Ling et al., 1996)

Table 2: General Combining Ability Effects for 7 Agronomic Traits

PARENTS	DYTS	DYSK	PLHT	EHT	EPP	EWT	GY
SAMMAZ 14	2.20	3.00	19.53**	28.60**	-0.33**	1420.00*	2062.22
SAMMAZ 37	-3.47*	-3.20	1.13	2.47	-0.36**	13.33	-131.78
SAMMAZ 17	-6.27**	-8.53**	13.13	-0.73	-0.27**	760.00	3601.56**
SAMMAZ 36	1.00	1.67	3.27	6.20	0.46**	286.67	-391.11
SAMMAZ 32	6.53**	7.07*	-37.07**	-36.53**	0.57**	-248.00**	-5140.89**

*=significant p≤0.05

**=highly significant p≥0.01
DYTS= Days to 50% Tasseling DYSK= Days to 50% Silking PLHT= Plant height EHT = Ear height
EWT= Ear weight EPP=Ears per plant GY=Grain yield

Table 2: Specific Combining Ability Effects for 7 Agronomic Traits

CROSSES	DYTS	DYSK	PLHT	ERHT	EPP	EWT	GY
SAMMAZ14X37	0.09**	0.05	-10.12*	-17.49**	0.37**	-864.00**	-1620.71*
SAMMAZ 14X17	0.09	0.06	-2.39	1.97	0.03	276.00	128.84
SAMMAZ 14X36	0.23	-0.41	-2.72	-6.83	-0.15**	-270.67	-48.93
SAMMAZ 14X32	-2.71**	-3.28**	5.81	11.24*	-0.29**	302.67	1099.29
SAMMAZ 37X17	4.09**	3.45**	1.01	-1.89	0.19**	-317.33	-166.04
SAMMAZ 37X36	-3.44**	-4.21**	3.68	2.97	-0.06	502.67	508.40
SAMMAZ 37X32	-1.37	-0.08	-4.45	-3.63	0.01	-157.33	-173.38
SAMMAZ 17X36	4.69**	6.45**	-6.65	4.84	0.19**	-944.00**	-2210.49**
SAMMAZ 17X32	0.09	0.25	-0.79	-5.09	0.12*	896.00**	359.96
SAMMAZ 36X32	1.49	0.72	-1.92	-4.36	-0.15*	-664.00*	-447.38

*=Significant P ≥ 0.01 **=highly significant P ≤0.01 DYTS= Days to 50% Tasseling DYSK= Days to 50% Silking PLHT= Plant height EHT = Ear height
EWT= Ear weight EPP=Ears per plant GY=Grain y

Plant height
Sammaz 14 was found to be good general combining followed by Sammaz 17. Plant height is of major concern to plant breeders since yield has positive correlation with plant height (Rupak et al, 1979).
Among the hybrids only Sammaz 14 x Sammaz 37 showed significant positive SCA effect among the crosses. This was in accordance to the findings of surya and Gangwi 2006) who observed light and positive heterosis effects for plant height and grain yield.

Ear height
The general combining ability studies revealed that only one of the parents Sammaz 14 expressed significant GCA effect. Ear height has less effect on grain yield and it is the only component which affects the ear traits like kernel number and to lesser degree the kernel weight (Herezecjji, 1970). Among the hybrids Sammaz 14 x Sammaz 32 and Sammaz 14 x Sammaz 37 showed significant SCA effects in both positive and negative direction respectively. This finding is in line with that of Mohammad (1993), xingming et al., (2002), Sedhom, (1994) and sinobas and monteagudo (1994).

Ear weight
From general combining ability study, it was found that three parents Sammaz 14x Sammaz 32 and Sammaz 17 were found to be good general combiner for this trait. While among the hybrids only Sammaz 17 x Sammaz 32 showed significant SCA effect for the crosses such findings are reported by Mohammad (1993), El, Hosary et al., 2006) and sinnobas and Montaegudo (1994). The above cross involved high x high and low x high combining parents this was supported by xingming et al., (2002) who reported the involvement of good parents in high yielding crosses.

Ears per plant
Sammaz17 was found to be the best general combiner for ears per plant as it showed high positive GCA effects. Among the hybrids Sammaz 14 x Sammaz 37 Sammaz 14 x Sammaz 17, Sammaz 37 x Sammaz Sammaz 17 x Sammaz 36 and Sammaz 17 x Sammaz 32 showed positive SCA effects for ears per plant this result is in agreement with the earlier works of Turgut et al (1995) who found similar results.

Grain yield
From the GCA effect studies two parents were found to have high GCA effects. Those parents were Sammaz 14 and Sammaz 17. Among the crosses only Sammaz 14 x Sammaz 32 showed high significant SCA effect among all the crosses. The hybrid with best yielding quality and earliness in Tasseling and Silking was Sammaz 14XSammaz 32, Followed by Sammaz 37 x Sammaz 36.

CONCLUSION
The performance of parents may be used to predict the performance of the crosses it was observed that parents with high and positive GCA values were good combiners for grain yield such as Sammaz 14 ,except for days to

50% tasseling, days to 50% silking and ear height which showed negative value being of economic importance for earliness and short plants which is not susceptible to stalk lodging.

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