Performance of testcrosses of S_1 lines derived from different selection cycles of tropical reciprocal composites

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Introduction

Maize (*Zea mays* L.) is a staple food crops and source of income for farmers in sub-Saharan Africa (Smale *et al*., 2013). The development and accelerated deployment of maize hybrids can allow greater increases in maize yields in the major maize producing countries in Africa. The International Institute of Tropical Agriculture (IITA) started a hybrid breeding program in 1979 to strengthen involvement of the private sector in the production and marketing of hybrid maize in West and Central Africa (WCA). Considering the importance of having hybrid oriented populations and application of selections schemes that maximize expression of heterosis in hybrids, IITA utilized results of diallel studies and promising heterotic patterns of tropical germplasm as the basis to create two late maturing composites (TZL COMP3 and TZL COMP4) that have been subjected to four cycles of reciprocal recurrent selection (RRS) to boost agronomic performance of hybrids involving inbred lines derived from advanced selection cycles of the composites (Hallauer and Eberhart, 1970). The present study was thus conducted to examine the effects of RRS on mean performance, genetic variances, heritability, and relationships among traits in these reciprocal composites.

Materials and methods

Two tropical maize composites, known as TZL COMP3 and TZL COMP4, were developed at IITA using the comprehensive breeding system (CBS) described by Eberhart *et al*. (1967) and were subjected to four cycles of RRS to improve their performance. A total of 100 S_1 each derived from C_0 and C_4 of TZL COMP3 and TZL COMP4 were randomly selected and planted in paired rows to form 200 testcrosses, which were evaluated along with 10 commercial hybrids at four locations in Nigeria for grain yield and other traits. These testcrosses were arranged in 21x10 alpha lattice design with two replications and each testcross was planted in a row 5m long spaced 0.75m apart with 0.50m spacing between plants within a row. Fertilizer and field management practices recommended for optimum maize production were used in all the test locations. Grain yield, foliar diseases and other agronomic traits were recorded in this study.

Combined analysis of variance across locations was computed in SAS version 9.3 to generate entry means adjusted for block effects. Genetic variances for each selection cycles and genetic correlations between grain yield and other traits were estimated using META-R version 5.0. Genetic gains per cycle for each trait were estimated using the t-test.

Table 1. Trait means and response to RRS of two reciprocal composites evaluated across four locations in Nigeria.

Traits	C_0 x C_0	C_4 x C_4	Response cycle^{-1}	% Gain cycle^{-1}	Pr > |t|
Yield (kg ha $^{-1}$)	4855.40	5621.50	191.53	4	<.0001
Days to anthesis	61.40	59.98	-0.35	-1	<.0001
Days to silking	62.99	61.38	-0.40	-1	<.0001
Anthesis-silking interval	1.59	1.40	-0.05	-3	0.0002
Plant height (cm)	219.70	218.20	-0.38	0	0.1276
Ear height (cm)	113.70	113.40	-0.07	0	0.6745
Ear aspect (1-5)	2.13	1.96	-0.04	-2	0.0024
Plant aspect (1-5)	2.18	1.95	-0.06	-3	<.0001
Ears/plant	3.14	2.66	-0.12	-4	0.0002
Leaf rust (1-5)	2.42	2.22	-0.05	-2	<.0001
Leaf blight (1-5)	2.13	1.83	-0.08	-4	<.0001

Table 2. Phenotypic and genotypic correlations between grain yield and other traits of testcrosses of S_1 lined derived from C_0 and C_4 of two reciprocal composites.

Traits	Phenotypic correlation		Genotypic correlation	
	C_0 x C_0	C_4 x C_4	C_0 x C_0	C_4 x C_4
Days to anthesis vs yield	-0.21*	0.05	-0.17	0.28**
Days to silk vs yield	-0.34***	-0.01	-0.32***	0.20*
Anthesis-silking interval vs yield	-0.45***	-0.20*	-0.66***	-0.23**
Plant height vs yield	0.06	0.20*	0.01	0.26**
Ear height vs yield	0.14	0.29**	0.10	0.45***
Ear aspect vs yield	-0.25**	-0.49***	0.08	-0.70***
Husk cover vs yield	0.22*	0.03	0.39	0.05
Ears/plant vs yield	0.20*	0.39***	0.59***	0.63***
Plant aspect vs yield	-0.33***	-0.28**	-0.21*	0.29**
Leaf rust vs yield	-0.11	-0.09	-0.03	-0.12
Leaf blight vs yield	-0.35***	-0.25**	-0.54***	-0.49***

*, **, *** Significant at the 0.05, 0.01 and 0.001 probability levels, respectively.

Results and discussion

RRS was effective in making significant genetic gain of 4% cycle^{-1} for grain yield. These improvements in grain yield were associated with a significant reduction of -1% in days to anthesis, -1% in days to silking, -3% in anthesis-silking interval, -2% in ear aspect, -3% in plant aspect, -2% in southern leaf rust and -4% in southern leaf blight. These results indicate that the frequency of favorable alleles for grain yield and other traits have been shifted in the desired directions (Table 1).

The genetic correlation showed that selection for increased grain yield was accompanied by increased days to anthesis and silking, plant height, ear placement, and ears per plant and a short anthesis-silking interval, resistance to southern leaf blight and better ear and plant aspect scores (Table 2). Heritability estimates decreased from C_0 to C_4 for grain yield, anthesis-silking interval, plant aspect, ear per plant and southern leaf blight and increased for days to anthesis, days to silking, plant height, ear height and ear aspect (Table 3). However, significant variability was still found in C_4 for further genetic improvement in subsequent generations.

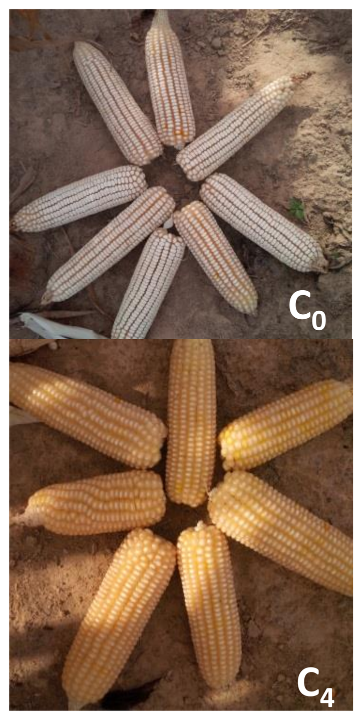

Table 3. Estimates of genetic variances and heritability for various traits measured in testcrosses from two selection cycles of TZL COMP3 and TZL COMP4.

	δ_g		H^2 (%)	
Traits	C_0 x C_0	C_4 x C_4	C_0 x C_0	C_4 x C_4
Yield (kg ha $^{-1}$)	177683***	92753**	53.20	37.08
Days to anthesis	1.00***	1.16***	76.38	81.46
Days to silking	1.48***	1.43***	80.21	81.91
Anthesis-silking interval	0.20***	0.01	44.49	10.13
Plant height (cm)	37.59***	55.52***	59.65	71.37
Ear height (cm)	17.14***	41.89***	55.81	70.96
Ear aspect (1-5)	0.01*	0.02**	32.29	34.97
Plant aspect (1-5)	0.02	0.02*	26.80	15.40
Ears/plant	0.002**	0.001*	38.74	29.24
Leaf rust (1-5)	0.05***	0.03***	47.07	47.37
Leaf blight (1-5)	0.13***	0.03*	61.99	32.52

*, **, *** Significant at the 0.05, 0.01 and 0.001 probability levels, respectively.

Conclusions

- Our results indicate that RRS was effective for improving grain yield and other important agronomic traits in the tropical reciprocal composites without loss in genetic variance.
- The two tropical composites have the potential to generate inbred lines which can be used in the production of superior maize hybrids suitable for production and deployment.

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