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# Comparison of Two Breeding Methods in Corn. III. Yield of Selected Fourth-Cycle Lines from Each Population and Method[1]

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ABSTRACT

To compare the two breeding methods, a mix of fourth-cycle lines from each population and method were tested at two locations. The overall yield performance was better with the $S_2$ progeny method than with the testcross method. These results suggest that the two methods emphasize different types of gene action and that overdominant gene action may exist at some loci.

COMPENDIO

Para comparar los dos métodos de mejoramiento, una mezcla de líneas seleccionadas del cuarto ciclo procedente de cada población y método fueron probadas en dos localidades. El comportamiento en rendimiento total fue mejor con el método de líneas autofecundadas que con el método de cruza de prueba. Esos resultados, sugieren que los dos métodos enfatizan diferentes tipos de acción de genes y que genes overdominantes pueden existir en algunos loci.

## INTRODUCTION

The objective of this paper is to report additional information on the value of $S_2$ progeny selection in comparison with selection based on testcross performance. One method is based on performance of $S_2$ lines since selfed progeny evaluation avoids the masking effect of testers (resulting in higher heritability estimates). The second method is based on the performance of testcrosses involving $S_2$ lines crossed with an inbred tester.

Reports from Genter and Alexander (2) and Burton *et al.* (1) indicated that dominant genes of the tester may mask genetic differences between lines. $S_1$ line selection has been suggested to solve this difficulty. However, increases in the frequencies of favorable alleles at those loci affecting grain yield should be greater with $S_2$ selection than with $S_1$ line selection since, at $p = 0.5$, additive variance among $S_2$ lines is 1.5 times as large as among $S_1$ lines (3).

Horner *et al.* (4) evaluated five cycles of recurrent selection using an inbred line and the parental popula-

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tion as testers, and $S_2$ progeny performance They reported a 4.4% yield gain per cycle from the inbred tester method compared with a 2.4% and 2.0% yield for the parental tester and $S_2$ progeny methods, respectively. They indicated that the inbred tester method was evidently more effective for improving breeding populations and developing elite single crosses In a later experiment, using a different base population, Horner (5) reported no significant difference between methods for combining ability improvement However, in the case of grain yield of inbred generations, $S_2$ selection was clearly superior to the test cross method. This was expected because, based on genetic theory (3), the $S_2$ progeny method places relatively more emphasis on contributions of homozygous loci than of heterozygous loci.

## MATERIALS AND METHODS

To determine the effect of breeding methods on the vigor of selected inbred lines derived from fourth cycle populations, four composites were obtained by bulking equal amounts of seed from the selected fourth-cycle $S_2$ lines of each population and method The four composites were evaluated in one-row plots in 1986 at two locations near Gainesville, Florida A randomized complete block design with ten replications was used at each location Row spacing was 91 cm and plant distance in the rows was 30 5 cm. Two seeds were planted per hill and the plants were thinned to one per hill when they had reached a height of 15 cm

Data on grain yield per plot, ear height, husk score, and percentage of erect plants at harvest were taken prior to harvesting The plots were harvested by hand, and the total number of ears and field weight per plot were registered Representative ears from four replications were saved, dried, and shelled for dry matter calculations. The field weight of each plot was adjusted to Mg/ha shelled grain at 15% moisture and full stand The analysis of variance was performed for adjusted grain yield, ear height, ears per plant, husk score, ear weight, and percentage of erect plants at harvest.

To estimate method and population effects, the sums of squares for composites were partitioned into sources of variation attributed to methods, populations, and the interaction between methods (M) and populations (P) Similarly, the sums of squares for composites (C) and locations (L) were partitioned into L x M, L x P, and (M x P) x L sources

## RESULTS AND DISCUSSION

Variation among the four composites was significant at the 0 01 probability level for all traits studied except erect plants (Table 1) Interaction between composites and locations was significant at the 0 01 level only for grain yield. There were statistically significant differences between methods for all traits analyzed except erect plants (Table 1). Populations were also significantly different at the 0 01 level for

Table 1. Mean squares from the analyses of variance for several traits for comparison of $S_2$ progeny and testcross methods of fourth-cycle populations.

| Source of variation | df | Trait | | | | | |
|---|---|---|---|---|---|---|---|
| | | Grain yield | Ear weight | Ear height | Ears/plant | Erect plant | Husk score+ |
| | | Mg/ha | g | cm | no | % | |
| Locations (L) | 1 | 4.02** | 1 757.81* | 0.001 | 0.36* | 0 10** | 3.61 |
| Reps/L | 18 | 0.37 | 303 70 | 0.07 | 0.05 | 0 01 | 1.39 |
| Composites (C) | 3 | 3.60** | 2 497 75** | 0 50** | 0 17** | 0.02 | 10 75** |
| Methods (M) | 1 | 6.11** | 7 353 61** | 0.70** | 0 22** | 0 02 | 15 31** |
| Populations (P) | 1 | 1.67** | 99 02 | 0.33* | 0 25** | 0.00 | 9 11* |
| M X P | 1 | 3.03** | 40 61 | 0.46* | 0 04 | 0 04 | 7.82* |
| L X C | 3 | 0 82** | 68.21 | 0.06 | 0.02 | 0.03 | 0 81 |
| L X M | 1 | 0 00 | 0.61 | 0 01 | 0.00 | 0.00 | 0.01 |
| L X P | 1 | 2.46** | 183.01 | 0.10 | 0 06 | 0.04 | 0.11 |
| L X (M X P) | 1 | 0.00 | 21 01 | 0.08 | 0.00 | 0.04 | 2.33 |
| Error | 54 | 0.13 | 121.44 | 0 08 | 0 02 | 0 01 | 1.48 |
| Total | 79 | | | | | | |

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

\+ Scores were on a 1 (good) to 9 (poor) scale

Table 2. Mean performance for several traits of fourth-cycle lines selected by the $S_2$ progeny and testcross methods. Average for two locations (1986).

| | Trait | | | | | |
|---|---|---|---|---|---|---|
| | Grain yield[1] | Ear weight | Ear height[2] | Ears/100 plants | Erect plant[3] | Husk score[4] |
| | Mg/ha | g | cm | no | % | |
| Pop A: | | | | | | |
| $S_2$ | 3.85+ | 116 | 83.4 | 159 | 92 | 6.0 |
| TC | 2.92 | 95 | 73.2 | 159 | 85 | 5.8 |
| Pop B: | | | | | | |
| $S_2$ | 3.00 | 117 | 82.5 | 140 | 91 | 6.0 |
| TC | 3.18 | 99 | 81.6 | 158 | 89 | 4.5 |
| L.S.D. (0.05) | 0.23 | 7 | 3.8 | 11 | ns | 0.8 |

\+ Each mean represents 20 observations
ns nonsignificant.
1 Shelled grain at 15% $H_2O$ in $Mg/ha^{-1}$
2 Measured in cm to the node of top ear attachment
3 Percentage of plants with stalks not broken below the ear at harvest
4 Scores were on a 1 (good) to 5 (poor) scale.

grain yield and number of ears per plant and at 0.05 level for ear height and husk score. No significant difference between populations was found for ear weight or erect plants at harvest. In populations A, the two methods were significantly different for yield, the $S_2$ progeny method being significantly superior at the 0.05 level; whereas in population B there was no significant difference for yield between the two methods (Tables 1 and 2). This resulted in a significant method/population interaction.

The $S_2$ progeny method resulted in significantly heavier ears in both populations than the testcross method (Table 2). The $S_2$ progeny method resulted in significantly higher ears in population A; whereas in population B there was no significant difference between the two methods. The number of ears per 100 plants was higher in population A than in population B. However, in population A no significant difference between the two methods was observed. In population B, the testcross method resulted in significantly more ears per 100 plants at the 0.05 level than the $S_2$ progeny method. The testcross method resulted in significantly better ($P < 0.05$) husk scores (low husk-cover scores are more desirable than high scores) than the $S_2$ progeny method in population B, but no significant difference was found in population A. The larger ears with the $S_2$ progeny method may have resulted in a shorter husk and, therefore, higher husk scores.

In summary, these data (Table 2) show that there was a trend for higher grain yield (population A), higher ear weight, taller (undesirable) ear height, same number of ears per 100 plants in population A but fewer in population B, more erect plants at harvest, and higher (poorer) husk score with the $S_2$ progeny method than with the testcross method.

Effect of methods on vigor of inbred lines derived from third (6) and fourth-cycle populations and on inbreeding depression have produced similar results. The second experiment showed that the $S_2$ progeny method was superior to the testcross method for grain yield of third-cycle populations in the $S_1$ and $S_2$ generations. The third experiment showed (Table 2) that the $S_2$ progeny method was superior to the testcross method for grain yield in population A; however, in population B no significant difference was detected. A possible explanation for the lack of difference between methods in population B is that a more intensive selection for agronomic type and vigor was necessary in this population than in population A, possibly because it contained more tall plants of poor agronomic type. This visual selection may have resulted in equal progress for both methods in population B. The overall yield performance (average of both populations and both experiments) was better with the $S_2$ progeny method than with the testcross method.

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# Comparison of Two Breeding Methods in Corn. IV. Correlation of Inbred Lines ($S_2$ Parents) and Testcross Performance[1] /

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ABSTRACT

The experiment reported in this paper was initiated to obtain information on the relative value of inbred line selection and selection based on testcross performance. To evaluate both methods, fourth cycle inbred lines ($S_2$ parents) and their testcrosses were tested in one and two locations, respectively, over one year. There was a significant positive correlation between the two evaluation methods for all traits studied, except ears per plant in population B. These results suggest that visual selection among lines in one environment may be effective for the elimination of undesirable traits in hybrids, especially for stalk strength, ear height and husk score.

COMPENDIO

El experimento reportado en este artículo fue iniciado para obtener respuesta sobre el valor relativo de selección de líneas *per se* y selección basada en los cruces de prueba. Para evaluar ambos métodos, líneas puras obtenidas del cuarto ciclo y sus respectivos híbridos fueron probados en una y dos localidades, respectivamente durante un año. Hubo una correlación significativa entre los dos métodos de evaluación para todos los tratamientos estudiados, a excepción de número de mazorcas por planta en la Población B. Esos resultados sugieren que selección visual entre líneas *per se* en un ambiente puede ser efectivo para la eliminación de características indeseables en los híbridos, especialmente para resistencia de tallo al acame, altura de mazorca y extensión de la tuza.

## INTRODUCTION

With the advent of single-cross corn hybrids, breeders have become interested in increasing the yield of parental line *per se* and the hybrids developed using these inbred lines.

The first evaluation of $S_1$ and $S_2$ line selection was made by Davis (2) in which lines were selfed for two generations, then crossed with an unrelated open-pollinated variety tester. Davis found that the average yield of $S_1$ and $S_2$ lines was more reliable than that of testcrosses for selection.

Genter and Alexander (4) made comparative performance tests between $S_1$ lines selected on the basis of $S_1$ progeny yield and $S_1$ lines selected on the basis of testcross performance with single-cross testers. They reported more dispersed means (larger variance) and fewer environmental effects from $S_1$ progenies than from testcrosses. After two cycles of selection, Genter and Alexander (5) found that

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