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EFFECTIVENESS OF CLASSES OF TESTERS FOR EVALUATION OF LINES AS POTENTIAL PARENTS FOR GRAIN SORGHUM [*Sorghum bicolor* (L.) Moench] HYBRIDS

by

JEUTONG FABIEN

A DISSERTATION

Presented to the Faculty of

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In Partial Fulfillment of Requirements

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Under the Supervision of Professor David Andrews

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DISSERTATION TITLE

Effectiveness of Classes of Testers for Evaluation of Lines as Potential Parents for Grain Sorghum [Sorghum bicolor (L.) Moench] Hybrids

BY

Jeutong Fabien

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EFFECTIVENESS OF CLASSES OF TESTERS FOR EVALUATION OF LINES AS POTENTIAL PARENTS FOR GRAIN SORGHUM [*Sorghum bicolor* (L.) Moench] HYBRIDS

Jeutong Fabien, Ph.D.

University of Nebraska-Lincoln, 1996

Advisor: David Andrews

The choice of appropriate testers, which are still not well defined in sorghum, for initial evaluation of sorghum lines as potential parents for hybrids determine the success of hybrid breeding programs. In two experiments over 2 to 3 locations in 2 to 3 years, effectiveness of inbreds, F1's or double cross was compared, and a population (KP9B) as testers in determining general combining abilities (GCA) of new inbred lines as parents for sorghum grain hybrids in the Milo-Kafir cytoplasmic male sterility system. Effectiveness was based on higher GCA's of testers, consistency in classifying lines across environments, simplicity in use, and higher dispersion ability in testcrosses.

Trials in experiments one and two included testcross hybrids involving a maximum of twelve male sterilized restorers and sixteen male sterilized maintainers used as testers to evaluate fourteen heterotic maintainer and fifteen restorer lines respectively and the corresponding inbred parental lines. Experiment one was conducted at Mead, Nebraska, and Hesston Kansas, in 1993-1994 and experiment two at Mead, 1992-1994.

Regardless of tester types, GCA's were more important than specific combining abilities. GCA's of some high yielding inbreds were greater than or equal to GCA's of related F1 testers. The latter were greater than or equal to GCA's of F1's related to low yielding inbred testers and were in general greater than or equal to GCA of low yielding testers of any kind.

Rank correlations for similarity of testers in classifying lines within environments or between testcross yields and yields of parental lines, and for consistency of any tester in ranking lines across environments were low. However consistency in identifying the majority of the best 45% lines across environments was slightly in favor of the F1 and low yielding inbred testers. Few high yielding inbred testers tended to discriminate among lines more effectively than other testers.

When considering all attributes, no single tester was effective. These results suggest that one more dispersive inbred and one more consistent and less biased F1 tester used simultaneously may effectively identify new B and R hybrid parental lines with good combining abilities before extensive hybrid testing.

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INTRODUCTION

The discovery of cytoplasmic male sterility in sorghum by Stephens and Holland (1954) led to large scale exploitation of heterosis in sorghum through use of hybrids. The authors found that cytoplasmic male sterility was a trait resulting from the interaction between the female milo cytoplasm and the male nuclear kafir genome. Since the discovery, experimental and commercial sorghum hybrids have been easily made by crossing sterile versions, *A*-lines, of male fertile lines, *B*-lines, in the milo cytoplasm with pollinator lines, *R*-lines known to restore male fertility of the resulting F_1 hybrid progenies.

Although this sterility system ease in making hybrids, evaluation of large number of experimental lines is not practical due to large amounts of resources needed for sterilizing and testing new lines, and the usual and limited resources of most breeding programs. Methods developed by maize breeders or geneticists to alleviate this problem will be reviewed later with some details. Basically, the methods consist of using testers to identify potentialy superior lines prior to extensive testing in hybrid combinations. The choice of appropriate testers, whether narrow or broad genetic base types used in the early or late stage of line development process, relies in the concept that the identification of good combining lines best come from testing in combination using testers from a contrasting or heterotic group. Such heterotic groups were previously determined empirically. This methology is also consistent with the theory of reciprocal recurrent selection where gain from

selection is increased by using progeny resulting from crosses made between two populations. This approach in reducing the number of new lines to only those showing good potential as parents for hybrids has readily been adopted by sorghum breeders.

A summary of alternate male sterile cytoplasms found in sorghum was given by Shertz (1983). The sorghum heterotic groups used for line evaluation were rather established by classifying lines to groups based on their similarities in their sterility/fertility relationships with the milo cytoplasm (A_1), as well as four other major sterile cytoplasms designated A_2, A_3, A_4 and 9E by Shertz and Richey (1978), Quinby (1980) and Shertz (1983), Worstell *et al.* (1984), and Webster (1980).

A survey of sorghum germplasm base in the USA by Harvey (1977) revealed that 97.1% of the total sorghum production used the cytoplasmic male sterility system (CMS) of milo-kafir origin. The other CMS were used for breeding purposes.

Evaluations of the A_1 CMS R-lines in testcrosses have been conducted easily by making direct crosses with A_1 CMS tester seed parents. The screening of the A_1 CMS *B*-lines has been more difficult due to the sterilization requirement prior to making crosses with *R*-lines. Lee *et al.* (1992) suggested a relatively simple method to overcome this problem by evaluating the A_1 CMS *B*-lines (pollinators) with A_3 CMS seed parent versions of the A_1 CMS *R*-lines used as testers. Grain yields of the resulting hybrids were equivalent to that of the reciprocal hybrids made in alternate cytoplasms. However the technique requires additional rows of male

fertile plants as the experimental hybrids being evaluated are male sterile. This result suggested that both A_1 and A_3 CMS can be used simultaneously as breeding tools for making CMS testers to evaluate A_1 CMS *R*-lines and *B*-lines respectively on equal basis, in conformity with the concept of testing with representatives of appropriate heterotic groups.

Chungu (1993) using three female testers, an inbred tester, an F_1 tester both sterilized versions of A_1 CMS restorers in A_3 CMS, and sterile plants from the KP9B ms, did not arrive at a clear conclusion about which tester or tester type best identified the potentially superior *B*-lines. The tester abilities to seperate the lines were also confounded with the tester types.

The present study, using the previous relevant strategies in choosing appropriate testers, re-examines the effectiveness of testers and tester types by comparing inbred, their related or unrelated F_1's and the KP9B population testers in their abilities to properly and efficiently identify potential A_1 CMS heterotic *B*-lines and *R*-lines as parents for grain sorghum hybrids.

The main features considered for effective testers were:

- Larger general combining ability (GCA) versus specific combining ability (SCA) with the lines as defined by Sprague and Tatum (1942). Viewed as the main effect of a tester resulting from its additive gene actions, one may expect that the higher the GCA compared to SCA, the better the tester predictive value in determining potential good lines.