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Gamete Selection with an Inbred Tester[1]

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Summary. A common inbred tester was used to evaluate gametes selected from three complex hybrid populations using two different inbreds as elite lines. The results support STADLER's contention that gamete selection is an efficient method for extracting superior gene combinations from hybrid populations. The inbred tester increases the resolving power of the method by eliminating extraneous genetic variability and by providing a homogeneous check population for comparative purposes.

Introduction

The initial successes of hybrid corn breeding were obtained with inbred lines that were isolated directly from open-pollinated varieties. As the hybrid corn program developed emphasis was shifted from the isolation of new inbreds to the improvement of existing inbreds.

STADLER (1945a, b) proposed a modification of early testing, which he called gamete selection, as a method of obtaining improved inbred lines. The scheme involves crossing, a genetically variable population with an 'elite' inbred line and subsequently crossing individual F_1 plants to a common tester. If an inbred tester is used, as is suggested in this paper, all test-cross progenies receive essentially identical genetic contributions from the tester and from the elite inbred. Thus, genetic differences among test-cross progenies result only from differences among the gametes sampled from the variable gametic source. This allows recognition of the better gametes, but it does not permit their intact recovery. However, if the test-cross progenies are compared with the elite inbred by tester hybrid, those which are superior to this check hybrid are presumed to have received a gamete from the variable source which was superior to the gamete contributed by the elite inbred. Inbreeding these F_1 plants would produce modifications of the elite line which would be superior to the original inbred. STADLER suggested that gametic sampling offers a more efficient means of sampling open-pollinated varieties.

PINNELL et al. (1952) used gamete selection in improving inbreds and used single crosses as specific combining ability testers. The agreement for combining ability of S_0 and S_1 lines was very good indicating gamete selection was an effective breeding method.

LONNQUIST and MCGILL (1954) studied gametic sampling as a means of obtaining better inbred lines for specific combinations. They concluded from the S_0 and S_1 test-cross results that selection of better varietal plants as sources of germplasm to improve the inbred lines effectively increased the probability of isolation of the superior gamete combination.

GIESBRECHT (1964) pointed out in his study of gametic selection that superior gametes existed in open-pollinated varieties. But he failed to observe a relationship between the yields of the F_1 plants and those of their respective F_2 and F_4 progenies. He used a single cross ($WD \times ND255$) as a tester for his study.

This paper summarizes the effectiveness of gamete selection, using an inbred line as tester, in two related experiments with two different elite lines using the same sources of gametes.

Materials and Methods

The following complex hybrid populations were used as sources of superior gametes:

A. (FYD-2 × YS-2) × Indian Chief
B. (FYD-2 × YS-2) × (Jarvis × Indian Chief)
C. (FYD-2 × YS-2) × Jarvis

Ferguson's Yellow Dent (FYD) and Yellow Surcropper (YS) are open-pollinated Texas varieties. The FYD-2 and YS-2 parental materials are from a second cycle reciprocal recurrent selection program. Jarvis and Indian Chief are open-pollinated varieties from North Carolina.

The inbred lines *Tx*403 and *Tx*127*C* were used as elite lines. *Tx*403 is an inbred selected from the backcross (*Tx*203 × *WF*9) × *Tx*203. The inbred line *Tx*127*C* was developed from Mosshart Yellow Dent in Texas, and it has good combining ability. However, it also has numerous agronomic defects.

The inbred line *Tx*508, a selection from *Tx*325 × *B*37, was used as a tester for both elite lines. This tester possesses good agronomic characters and combining ability.

Bulked pollen samples were collected from each of the complex hybrid populations and used to pollinate the elite lines *Tx*403 and *Tx*127*C*. Thus, individual F_1 plants would differ according to the genetic complement of the gamete they received from the variable gametic sources.

Visually selected F_1 plants were selfed, backcrossed to four inbred parent plants and test-crossed to four tester plants. The numbers of test-crossed selections from populations A, B and C were 278, 178 and 195, and 271, 284 and 179 for the elite lines *Tx*403 and *Tx*127*C*, respectively.

In 1967 the evaluation tests for the gametic sampling using *Tx*403 were separated from those using *Tx*127*C*. However, both were grown in the same field. A "restricted" randomized block design having a nested subclassi-

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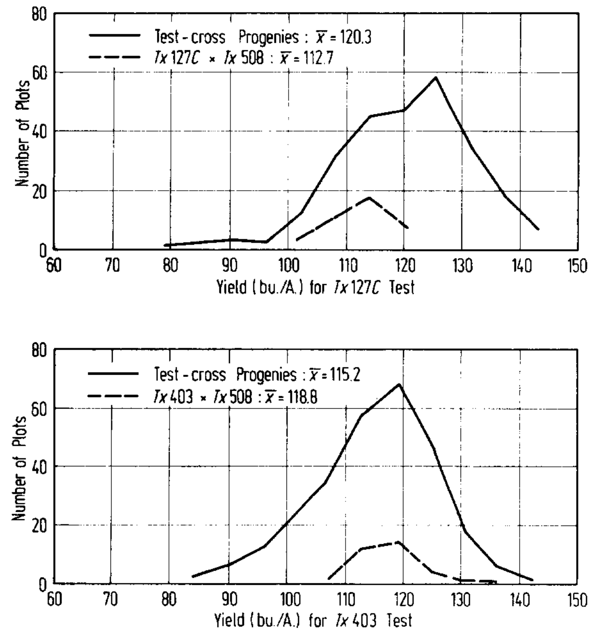

Fig. 1. Frequency distributions for grain yield of the check populations and of the test-cross progenies of gametes sampled from the [(FYD-2 × YS-2) × Indian Chief] population using *Tx127C* and *Tx403* as elite lines

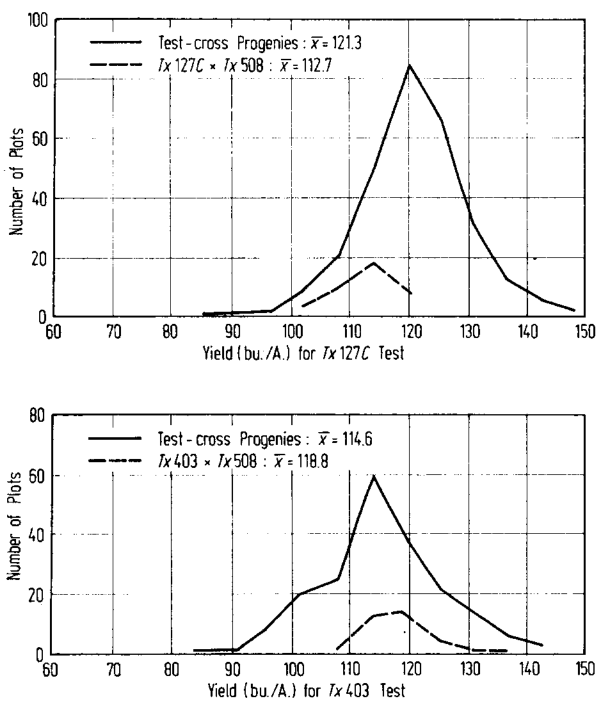

Fig. 2. Frequency distributions for grain yield of the check populations and of the test-cross progenies of gametes sampled from the [(FYD-2) (YS-2) × (Jarvis)(Indian Chief)] population using *Tx127C* and *Tx403* as elite lines

Table 1. *Frequency distributions of superior progenies*[1] *selected from the three variable gametic sources for the elite inbred line Tx403*

Range bu./acre	Population A		Population B		Population C		Total	
	No.	%	No.	%	No.	%	No.	%
128.1—130.0	5	1.80	2	1.01	5	2.56	12	1.79
130.1—132.0	4	1.44	5	2.53	4	2.05	13	1.94
132.1—134.0	3	1.08	1	0.51	3	1.54	7	1.04
134.1—136.0	4	1.44	5	2.53	2	1.03	11	1.64
136.1—138.0	1	0.36	2	1.01	1	0.51	4	0.60
138.1—140.0	0	0.00	0	0.00	0	0.00	0	0.00
140.1—142.0	0	0.00	2	1.01	1	0.51	3	0.45
142.1—144.0	0	0.00	0	0.00	0	0.00	0	0.00
144.1—146.0	1	0.36	0	0.00	0	0.00	1	0.15
Total superior	18		17		16		51	
Total selected	278		189		195		671	
% superior	6.47		8.59		8.21		7.60	

[1] Superior progenies were defined as those which differed significantly from the mean of the *Tx*403 × *Tx*508 check ($\bar{x}$ = 118.8 bu./A.) at the .05 probability level

Table 2. *Frequency distributions of superior progenies*[1] *selected from the three variable gametic sources for the elite inbred line Tx127C*

Range bu./acre	Population A		Population B		Population C		Total	
	No.	%	No.	%	No.	%	No.	%
122.6—125.0	22	8.12	18	6.34	10	5.59	50	6.81
125.1—127.5	9	3.32	14	4.93	8	4.47	31	4.22
127.6—130.0	14	5.17	7	2.46	1	0.56	22	3.00
130.1—132.5	6	2.21	2	0.70	2	1.12	10	1.36
132.6—135.0	7	2.58	5	1.76	2	1.12	14	1.91
135.1—137.5	0	0.00	3	1.06	0	0.00	3	0.41
137.6—140.0	1	0.37	1	0.35	0	0.00	2	0.27
140.1—142.5	0	0.00	1	0.35	0	0.00	1	0.14
142.6—145.0	0	0.00	0	0.00	1	0.56	1	0.14
Total superior	59		51		24		134	
Total selected	271		284		179		734	
% superior	21.77		17.95		13.41		18.25	

[1] Superior progenies were defined as those which differed significantly from the mean of the *Tx*127 × *Tx*508 check ($\bar{x}$ = 112.7 bu./A.) at the .01 probability level.

fication was used for both experiments. It was restricted in the sense that the check (*Tx*403 × *Tx*508) for the *Tx*403 experiment was repeated every 19th plot, and the check (*Tx*127*C* × *Tx*508) for *Tx*127*C* was repeated every 20th plot. The test-crosses were completely randomized in each replication. One row plots 21 feet long having 25 plants were used for both experiments with three replications in each.

Results and Discussion

Since the selections were to be made on the basis of combining ability, grain yield was the most important character. However, observations were also taken on other characters, including days to silk, root lodging and stalk breaking, number of ears per 100 plants, percentage of diseased ears, and extent of earworm damage.

The frequency distributions of the test-cross progenies from the three gametic populations and the single cross control populations are shown in Figures 1, 2 and 3. Variability within the homogeneous control populations is presumed to represent the effect of environment, while the variation seen in gametic test-cross populations stems from both genetic differences among the gametes sampled and environmental sources. The check population provided a measurement of the combining ability of the elite inbred line with the tester inbred line. This established a

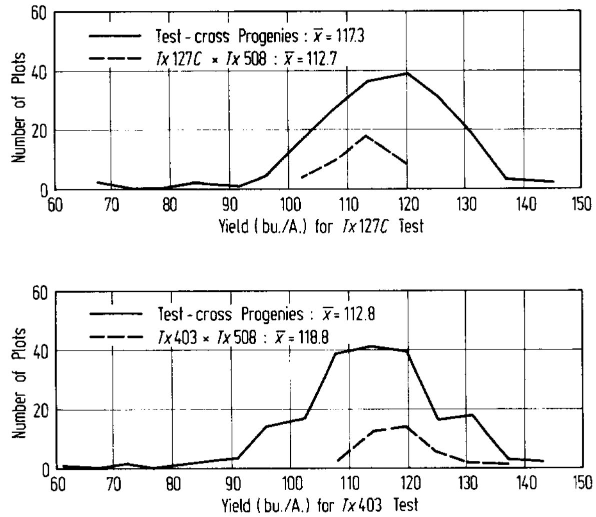

Fig. 3. Frequency distributions for grain yield of the check populations and of the test-cross progenies of gametes sampled from the [(FYD-2) (YS-2) × Jarvis] population using *Tx*127*C* and *Tx*403 as elite lines

base for comparing the relative merits of the gametes sampled from the variable gametic sources. It also provided an estimate of environmental variation.

The check population grain yield data were analyzed separately for each experiment. For the elite line *Tx*403 there were 34 check plots in each replication. Test-crosses whose mean yields exceeded the check mean at the 5% probability level were accepted as superior. Of the 671 selections tested 51 entries qualified as superior. They comprised 7.60% of the gametes sampled from the variable gametic sources. Table 1 shows the percentages of superior gametes in each population and the yield distributions in bu./acre for the superior progenies sampled from the three populations separately and jointly.

Forty check-plots were used in each replication for the elite inbred line *Tx*127*C*. At the 5% level 30.33% of the gametes tested were superior to *Tx*127*C*. Of the 734 selections tested 134 entries qualified as superior at the 1% probability level. These comprised 18.25% of the gametes sampled from the variable gametic sources. The percentages of superior gametes and also the frequency distribution of yield in bu./acre for these selections are shown in Table 2.

This difference in the results may be associated with the choice of elite lines. Although not directly comparable, the two experiments were evaluated in adjacent areas in the same year, and they were extremely similar except for the elite lines used. A comparison of the test-cross distributions (Fig. 1, 2 and 3) indicates rather similar yield distributions were obtained from each of the three variable gametic sources in both experiments. Thus, it would appear that the principal reason for the difference in the frequencies of superior gametes is related to the higher yield and greater variability of the (*Tx*403 × *Tx*508) check population. An obvious conclusion to be drawn from this is that comparisons of the frequencies of superior gametes identified in different experiments are rather meaningless, since the yield level and variability of the check populations influence these frequencies.

The use of an inbred tester provides some very positive advantages for this type of selection. Since the inbred is essentially monogametic, genetic variation among test-crosses can be attributed to differences among the gametes sampled from the original populations. At the same time, the precision of these comparisons is improved by using a single cross check. In the opinion of the authors, these advantages outweigh the disadvantages associated with the use of an inbred tester.

It is apparent that gamete selection should be considered only as a screening procedure to identify those gametes with above average potential. However, this potential can be utilized even though the superior gametes cannot be recovered in the homozygous condition. If the average gametic array of an F_1 plant exhibits significantly greater combining ability than the elite inbred line, then a conventional selfing with selection or backcrossing program should have a high probability of yielding improved forms of the original inbred line. The continued use of gamete selection through the early segregating generations would by expected to increase the probability of success.

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