NDSCD, NDSK(FS)C1, and NDSL(FS)C1: Improved Germplasm Sources for Early Corn

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The success of any corn (*Zea mays* L.) breeding program depends greatly on the source of germplasm used in the breeding program. If genes for traits desired in the hybrid do not exist in the source populations and they can't be easily introduced from some outside source, the breeding program cannot be successful.

Corn breeders in the U.S. Corn Belt have had a wealth of germplasm to work with, but a very small percentage of the total germplasm has produced the vast majority of today's hybrids. Brown (1975) has stated that in the U.S. more than 90 percent of the maize breeding effort is devoted to germplasm whose origin traces to not more than three of the 130 existing races of maize. Experienced plant breeders realize that some source populations produce many successful varieties while other populations are unproductive. Just as a few races of corn have produced most of the modern hybrids, a few breeding populations have yielded a much greater frequency of usable inbred parents than other source populations. As Hallauer and Miranda (1981) have pointed out, in the U.S. Corn Belt, Lancaster, Midland, and Stiff Stalk Synthetic have been very productive source populations while potential sources such as Hickory King, Krug, and Corn Borer Synthetic have produced a disappointingly low frequency of usable parent lines.

Corn breeders in the central Corn Belt have an abundance of breeding populations to use in developing new parent lines, but only a very small fraction of these germplasm sources are early enough to mature in the extreme northern Great Plains. Breeders in these northern areas have much less choice in selecting source populations. In the past decade the North Dakota Experiment Station has released 11 synthetic varieties as sources of new parental lines for these extreme northern areas. Of the 23 inbred lines released since 1975 by the NDSU program, 12 inbreds were developed from synthetic varieties. Seven different synthetics have been sources of releasable inbreds, but selections initiated in dozens of other source populations have not produced inbreds capable of passing inbred release standards of the NDSU breeding program. Of the seven synthetic varieties which have been productive North Dakota breeding sources, four are synthetics produced at NDSU.

Some of these breeding sources which have produced releasable inbreds should be even more productive if the frequency of favorable genes could be increased. Various recurrent selection methods have been applied to several of these synthetics to improve their potential as sources of new inbred parental lines for producing early hybrids. NDSCD, NDSK(FS)C1, and NDSL(FS)C1 are the newest synthetic varieties released by the North Dakota Agricultural Experiment Station as a result of this effort.

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Breeding History

NDSCD was developed by one cycle of full-sib family selection among 78 full-sib families between NDSC(FS)C1, and NDSD(FS)C1 (Cross, 1984). NDSC(FS)C1 and NDSD(FS)C1 were produced by one cycle of reciprocal full-sib selection from NDSC and NDSD (Cross, 1982). The 78 full-sib families were evaluated in three environments, and 20 superior famillies were identified based on a rank-summation index which weighted yield at 40 percent and 20 percent each for low grain moisture, stalk lodging and root lodging percentages. These 20 families were intercrossed by making sib matings and bulking seed. An additional generation of random mating was practiced to produce NDSCD.

NDSK(FS)C1 and NDSL(FS)C1 were developed by one cycle of reciprocal full-sib selection among full-sib families between NDSA and NDSB synthetics released earlier (Cross, 1980). Among approximately 400 sets of attempted crosses, 41 successful full-sib families with corresponding selfed ears were obtained. These were tested at three locations and 15 superior families were identified based on the same rank-summation index listed above. Remnant seed from selfed ears on plants that produced superior full-sib families were planted and intercrossed within both NDSA and NDSB by making full-sib matings. Seed was composited within each for the improved synthetics, NDSD(FS)C1 and NDSL(FS)C1, respectively.

Agronomic Description and Performance

NDSCD averaged almost 24 percent higher grain yield and had lower stalk lodging and root lodging percentages than the midparental values for NDSC and NDSD in 1986 tests (Table 1). When averaged over 13 environments, NDSCD had improved test weight and tended to have higher stalk lodging resistance than NDSAB. NDSCD had only slightly lower yield than NDSAB, which has been the most consistently high yielding synthetic in previous tests. NDSCD should be classified AES300 maturity, because it had higher ear moisture at harvest than NDSAB.

NDSK(FS)C1 has similar yield and stalk lodging as its parent, NDSA, but it is significantly earlier as indicated by lower ear moisture at harvest, and tends to have better root lodging resistance and higher test weight (Table 1). NDSL(FS)C1 is significantly higher yielding and has higher test weight and lower root and stalk lodging percentages than its parent, NDSB. NDSK(FS)C1 and NDSL(FS)C1 are AES200 maturity.

Conclusions

NDSC and NDSD have proven to be productive source populations [ND257 and ND261 were selected from NDSC and NDSD, respectively (Cross, 1986; Cross, 1987b)]. Because NDSCD seems to be equal to or better than NDSC or NDSD for yield, ear moisture content, root and stalk lodging resistance, and test weight, it seems to be a promising source population for developing early inbreds. NDSB also is a proven source population [ND260 was developed from NDSB (Cross, 1987a)]. Because NDSK(FS)C1 and NDSL(FS)C1 were developed by interpopulation improvement designed to increase both specific and general combining abilities, and each population has demonstrated improvements over the parent synthetics, they should be more productive source populations for future early corn inbreds.

References

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Table 1. Agronomic performance of NDSCD, NDSK(FS)C1, and NDSL(FS)C1, grown over three years in North Dakota.

Entry	Ear moist.	Grain yield	Root lodg.	Stalk lodg.	Test wt.
	%	bu/A	---------%	---------	lb/bu
1984 - 4 locations					
NDSA	28.46	85.61	6.73	9.41	58.03
NDSB	24.78	42.96	6.76	9.55	51.69
NDSK(FS)C1	24.28	91.21	1.04	14.62	58.84
NDSL(FS)C1	22.38	83.37	2.33	6.79	58.33
NDSAB	23.42	91.64	2.32	8.37	57.90
NDSCD	28.04	105.29	0.65	9.54	59.19
Pioneer Brand 3978	25.66	110.54	1.95	6.61	58.79
LSD (0.05)[1]	4.17	27.33	NS	NS	NS
1985 - 5 locations					
NDSA	46.08	83.11	1.51	8.78	51.87
NDSB	43.45	66.74	4.40	7.46	52.51
NDSK(FS)C1	43.43	86.45	0.85	6.14	52.55
NDSL(FS)C1	40.50	87.70	0.39	2.04	53.10
NDSAB	39.58	98.35	1.73	7.70	53.21
NDSCD	46.08	83.95	1.98	4.17	55.31
Pioneer Brand 3978	40.34	105.66	0.03	0.14	53.23
LSD (0.05)[1]	5.57	26.84	NS	NS	2.48
1986 - 4 locations					
NDSB	37.22	97.75	2.14	10.03	58.82
NDSAB	38.00	123.63	1.96	5.38	58.30
NDSCD	39.81	114.17	2.25	3.31	58.56
NDSC	40.50	83.30	2.64	4.14	57.38
NDSD	38.24	100.91	3.32	5.19	58.27
Pioneer Brand 3978	38.12	149.12	0.55	2.33	58.94
LSD (0.05)[1]	2.25	17.18	4.90	5.61	1.07
1984-85 - 9 environments					
NDSA	38.25	84.22	3.83	9.06	54.61
NDSB	35.15	56.17	5.45	8.39	52.15
NDSK(FS)C1	34.92	88.57	0.93	9.91	55.35
NDSL(FS)C1	32.45	85.78	1.25	4.15	55.42
NDSAB	32.40	95.37	1.99	8.00	55.29
NDSCD	38.06	93.43	1.39	6.56	57.03
Pioneer Brand 3978	33.82	107.83	0.88	3.02	55.70
LSD (0.05)[1]	2.61	14.92	3.51	3.87	1.74
1984-86 - 13 environments					
NDSB	35.79	68.97	4.43	8.89	54.20
NDSAB	34.12	104.06	1.98	7.19	56.22
NDSCD	37.18	99.81	1.65	5.56	57.50
Pioneer Brand 3978	35.14	120.53	0.78	2.80	56.70
LSD (0.05)[1]	1.81	10.64	2.50	3.36	1.12

[1]Average differences among hybrids of this amount could be explained by random environmental effects only once in 20 repetitions of this experiment.