ND245, NDSA and NDSB: A New Inbred Line and Two Germplasm Sources for Producing Early Corn Hybrids

H. Z. Cross

ND245 is a yellow dent corn (*Zea mays* L.) inbred line developed at the Agricultural Experiment Station, North Dakota State University. This line was evaluated for yield and agronomic performance and in hybrid combinations. ND245 is released because it appears to have potential for producing early maturing hybrids with good yields, high test weights and good lodging resistance. NDSA and NDSB are early synthetic varieties developed as potential sources of high yielding, early inbreds. They are released for use in other corn breeding programs directed at developing new early maturing corn hybrids.

Dr. Cross examines an ear of the new inbred, ND245.

Introduction

The average planted corn acreage for North Dakota for the five year period 1973-1977 was 541,000 acres. The average grain yield for this period was 52.8 bushels per acre. Average corn grain yields for North Dakota for the period 1955-1977 increased at an average rate of 6.8% per year. The 1978 state average of 79 bushels/acre is approaching the average yields reported by traditional corn belt areas only a few years ago.

The production and marketing of early maturing hybrids with high yield potential by commercial seedsmen has undoubtedly contributed to this increase in productivity. Inbred lines produced by plant breeders employed at public institutions have traditionally served as a major source of breeding material and as parental lines for commercial hybrids. The major objective of the corn breeding program at the North Dakota Agricultural Experiment Station is developing early maturing corn inbreds for producing corn hybrids adapted to short growing seasons such as in North Dakota.

Historically, corn inbred line development has gone through three phases. The first phase involved development of inbreds from open pollinated varieties which were widely grown in the early 1900's. The second phase involved improving the many deficiencies of early inbreds. This was usually accomplished by intercrossing inbreds and self pollinating the resultant hybrids while selecting for desired combinations of traits. Recently plant breeders have recognized the advantages of developing improved base populations to serve as sources of improved inbreds rather than relying on the same old sources which have been widely sampled in the past. Many of the most successful inbreds developed in the last decade were derived from improved synthetic varieties.

There are relatively few improved synthetic varieties in the very early maturity groups. Therefore, in order to have good sources of future inbreds, a number of synthetic varieties are being developed in the corn breeding program at the North Dakota Agricultural Experiment Station. NDSA and NDSB are the first of these varieties to be released for use in corn breeding programs aimed at developing hybrids for extremely short season corn growing areas such as North Dakota.

ND245 is a yellow dent, inbred line developed in the corn breeding program. The effective use of this inbred and these germplasm sources requires some knowledge of their ancestry and breeding behavior when crossed to other inbreds or synthetics. While many of the experimental hybrids tested and reported herein are not suitable for economical commercial production, their breeding behavior may suggest ways to best utilize these genetic materials in a breeding program.

Dr. Cross is associate professor, Department of Agronomy.

Breeding History

ND245 tested as ND76-3 was selected from a cross of (CK98 x ND12Rf). It was self-pollinated for six generations with selection for plant and ear traits.

NDSA was developed by intercrossing eight elite lines of approximate AES300 maturity (90-95 Relative Maturity). The lines were chosen for good general combining ability for yield and are not closely related. This population was then random mated for two generations and mass selected for prolificacy for one generation. The eight parental lines were ND478, ND474, W153R, SD10, ND376, NDB8, A90 and MS1334.

NDSB was developed concurrently with NDSA from an intercross of six inbreds and one open pollinated variety. These parents were generally about AES200 maturity (85-90 Relative Maturity) and were not related to the lines used in developing NDSA. This synthetic was random mated for two generations and then mass selected for prolificacy for one cycle. Parents included ND363, MS142, ND405, ND33, CO303, CV3 and Zapalote Chico.

Agronomic Description

ND245 typically produces a medium tall plant with ears borne on the lower third of the stalk. Plants have narrow, stiff leaves of intermediate length with long, slender ears borne singly on a short shank. Ears produce 10 to 14 rows of rather shallow kernels. In NCR-2 tests in 1978 ND245 (ND76-3) was rated susceptible to Northern leaf blight (*Helminthosporium turcicum*), Southern leaf blight (*Helminthosporium maydis*), Anthracnose leaf blight (*Collectotrichum graminicola*), Stewart's wilt (*Xanthomonas stewartii*) and second brood of European corn borer (*Ostrinia nubilalis*). It was rated intermediate in resistance to Diploida stalk rot (*Diplodia maydis*), first brood of European corn borer, Maize Dwarf Mosaic virus (MDMV), Maize Chlorotic Dwarf virus (MCDV), and downy mildew (*Sclerophthora macrospora*). ND245 was resistant to Wheat Streak Mosaic virus (WSMV) and had a good root pulling resistance. ND245 would be rated about AES200 maturity in terms of the North Central Corn Breeding Research Committee classification system.

NDSA plants are tall with high ear placement (Table 1). Ears average 17.5 rows of average depth kernels. Under favorable growing conditions NDSA plants will average slightly more than one ear per plant.

An ear of the new inbred, ND245.

NDSB plants are shorter than NDSA plants and have a lower ear placement. Ears average about 16.2 rows of kernels which are slightly smaller than those of NDSA. NDSB appears to be slightly more prolific than NDSA.

Performance of ND245 as an Inbred

ND245 was evaluated for yield and agronomic characters in 1978 at Fargo (Table 2). ND245 had near average yield, below average ear moisture at harvest and no root or stalk lodging. Evaluations of ear charcters (Table 3) indicated ND245 had about average shelling percentages.

Table 1. Comparisons of NDSA and NDSB with a check hybrid averaged over three locations in 1978.

	Plant ht. cm	Ear ht. cm	Ear moist. %	Ear length cm	Kernel rows	Ears/ 100 plants	Test wt. lb/bu	Kernel depth cm
NDSA	194	100	36.8	16.4	17.5	109.9	59.0	0.79
NDSB	185	86	33.8	16.0	16.2	112.2	58.7	0.74
Sokota TS-28	170	75	36.5	16.9	17.7	112.1	59.1	0.88
LSD(0.05)[1]	18	18	2.9	1.2	1.2	-ns-[2]	1.3	0.08

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

2/ -ns- Differences among entries were not large and could be explained by random environmental effects which could be expected more than once in 20 repetitions of the experiment.

Table 2. Summary of yield and plant characteristics for 10 standard and one new inbred grown at Fargo in 1978.

Inbred line	Yield bu/A	Ear moist. %	Plant ht. cm	Ear ht. cm	Stalk[1] lodging %	Root[2] lodging %	Leaf length cm	Leaf width cm	Ears/ plant	Shank length cm	Tassel branch	Leaves
ND474	36.6	23.5	113	47	9.2	0.0	64	7.2	0.97	10	8	12.0
NDB8	19.4	30.9	133	67	0.0	0.0	62	8.0	1.00	9	18	13.0
ND363	28.3	17.3	122	37	0.0	0.0	67	8.2	1.00	15	14	12.0
ND405	25.9	33.5	123	66	5.6	5.6	69	9.0	0.97	13	15	12.0
ND376	51.6	35.7	133	58	0.0	7.1	65	7.8	1.08	6	22	12.0
ND240	38.9	23.9	114	61	3.6	3.3	57	8.0	1.28	11	19	11.5
ND241	21.9	18.1	116	44	0.0	0.0	56	9.4	1.35	20	16	12.0
ND100	24.5	25.0	108	53	0.0	0.0	64	9.5	1.04	13	13	10.5
ND300	40.1	28.7	113	50	0.0	3.1	74	9.4	1.00	11	12	14.0
ND245	26.0	31.9	124	52	0.0	0.0	61	8.5	0.96	8	16	11.5
LSD (0.05)[3]	14.8	10.5	18	21	10.1	12,2	11	1.8	0.29	3	9	1.6

1/ % of plants broken below the ear at harvest.

2/ % of plants lodged 30 degrees or more from vertical at harvest.

3/ Inbred differences larger than this value would be expected due to random environmental effects only one year in 20.

Table 3. Summary of ear characters for 10 standard and one new corn inbred grown at Fargo in 1978.

Inbred line	Shelling %	Kernel rows	Ear length cm	Ear diameter cm	Cob diameter cm	Kernel depth cm
ND474	73.7	15.4	11.2	3.6	3.3	0.62
NDB8	71.7	16.4	11.4	3.7	2.2	0.74
ND363	73.0	13.8	13.1	3.6	2.5	0.56
ND405	69.5	14.6	11.3	3.3	2.3	0.51
ND376	76.9	16.2	13.1	3.9	2.6	0.67
ND240	79.5	16.6	10.9	3.8	2.5	0.65
ND241	76.3	16.2	9.7	3.4	2.4	0.51
ND100	70.4	14.0	10.3	3.0	2.2	0.39
ND300	78.7	15.2	14.1	3.3	2.2	0.58
ND245	75.0	11.8	11.7	2.8	2.0	0.37
LSD (0.05)[1]	6.3	2.0	2.0	0.3	0.4	0.19

1/ See Table 2.

Performance of ND245 in Hybrids

ND245 was tested in 10 single cross hybrids in six environments in 1978. Yields and agronomic performance of hybrids including ND245 as a parent are included in Table 4. This inbred appeared to combine well with two Wf9 related lines, ND474 and A509, which may indicate good specific combining ability with other Wf9 related inbreds. The performance index (P.I.) values indicate that ND245 hybrids yielded more than other hybrids in the test with equal ear moisture at harvest.

This inbred was also evaluated for general combining ability (GCA) and compared with five other experimental inbreds (Table 5). General combining ability is the average performance of an inbred in various hybrid combinations. In this trial each experimental inbred was crossed to eight standard inbreds in order to compute GCA effects. No significant differences among either the standard or the experimental inbreds were detected for yield. ND245 generally produced hybrids with high test weights, and below average ear moisture, root lodging and stalk lodging.

Since these investigations represent the performance of these hybrids in only one year, their performance in future years cannot be predicted with certainty. However, six environments with very diverse growing conditions were represented. Averaged yields ranged from 43 to 163 bushels/acre. This inbred was also tested in preliminary screening tests in other years.

Agronomic Performance of Synthetics

A comparison of the synthetics indicated that NDSA is higher yielding than ASA, ASB, ASD and NDSB (Table 6), and has a higher ear moisture at harvest and more root lodging. It also has more stalk lodging than ASD.

NDSB produced intermediate yields, intermediate ear moisture and intermediate lodging. It tended to be more prolific, but differences were small.

Table 4. Average performance of selected single cross hybrids with ND245 tested at six North Dakota environments in 1978.

Hybrid	Pedigree	Yield bu/A	Ear moist. %	Stalk lodging %	Root lodging %	Test weight lb/bu	Shelling %	P.I.[1]
NDC705	ND245 x ND240	84.9	30.1	5.4	0.0	61.2	85.8	106.8
NDC706	ND245 x ND241	85.1	31.1	2.2	0.7	61.4	85.3	103.6
NDC707	ND245 x A509	89.0	26.8	1.6	1.7	61.0	81.8	125.8
NDC708	ND245 x W59E	77.0	28.6	2.4	0.5	63.4	83.2	101.9
NDC709	ND245 x W182B	79.2	33.2	4.1	1.4	63.6	79.1	90.3
NDC710	ND245 x ND474	90.8	30.1	2.8	1.9	62.7	83.9	114.2
NDC711	ND245 x CM182	86.8	27.7	9.5	0.9	62.6	84.0	118.7
NDC712	ND245 x CG10	81.1	33.0	2.0	1.5	61.0	83.8	93.1
NDC713	ND245 x ND8Rf	88.9	35.4	0.4	1.6	61.1	81.1	95.1
NDC714	ND245 x ND302	78.7	33.2	1.7	1.1	63.2	79.2	89.8
MEAN	(ND245 hybrids)	84.1	30.9	3.2	1.1	62.1	82.7	103.9
NDC267	ND240 x ND474	98.6	28.9	12.1	5.6	58.3	85.3	129.2
NDC678	W182B x ND474	86.8	30.2	7.5	5.5	60.6	82.3	108.9
MEAN	(100 hybrids)	84.7	32.1	4.8	2.6	59.5	82.7	100.0
LSD (0.05)[2]		16.0	3.6	6.9	5.4	1.3	2.3	–

1/ P.I. = performance index = (Yield/test mean)/(Ear moisture/test mean) x 100.

2/ See Table 1.

Table 5. Average general combining ability comparisons among six experimental inbreds and among eight standard inbreds grown in six environments in 1978.

	Yield bu/A	Ear moist. %	Stalk lodging %	Root lodging %	Test wt. lb/bu	Shelling %	Plant ht. cm	Ear ht. cm
ND76-1	85.1	29.6	4.3	1.0	61.5	82.4	157	71
ND76-2	85.7	30.9	7.5	4.6	58.5	83.1	154	67
ND76-4	86.3	30.7	3.4	1.1	57.7	84.6	154	74
ND76-6	80.3	34.4	1.8	0.6	61.5	82.0	163	76
ND76-8	87.1	32.5	6.4	4.2	58.8	83.0	161	72
ND245	85.7	30.9	3.5	1.2	61.8	83.1	159	73
LSD (0.05)[1]	-ns-	1.6	3.3	2.5	1.0	1.3	4	3
ND474	82.8	31.2	3.4	4.0	61.4	82.9	159	71
CG10	85.7	33.5	3.5	1.9	58.9	84.7	155	64
W182B	81.7	33.3	3.6	3.3	61.1.	80.4	163	75
ND240	89.5	30.6	6.7	0.8	56.9	86.1	149	69
ND8Rf	85.7	36.1	2.8	3.5	59.8	81.3	165	75
CM182	85.2	27.8	9.0	1.4	60.8	83.7	158	76
A509	87.1	28.6	2.9	1.2	59.5	80.3	155	70
ND241	82.5	31.2	4.1	0.8	59.2	85.0	159	76
MEAN	85.1	31.5	4.5	2.1	60.0	83.0	158	72
LSD (0.05)[1]	-ns-	1.8	3.4	2.1	0.5	1.3	5	4

1/ See Table 1.

Table 6. Average agronomic performance of five early maize synthetics tested at three plant densities at two eastern North Dakota locations in 1977 and 1978.

Synthetic	Yield bu/A	Ear moist. %	Stalk lodging %	Root lodging %	100 kernel wt. g	Kernels/ ear	Ears/ 100 plants
ASA	63.1	25.1	9.3	6.9	17.3	361	99.1
ASB	65.7	25.9	11.1	3.9	18.5	365	96.4
ASD	55.0	21.7	7.7	2.7	20.3	294	94.1
NDSA	83.2	29.7	12.1	11.8	20.1	406	97.7
NDSB	66.5	25.6	10.4	7.0	19.8	326	105.7
LSD (0.05)[1]	10.8	2.1	3.1	3.4	0.6	37	-ns-

1/ See Table 1.

Combining Abilities of Synthetics

NDSA has demonstrated high general combining ability (GCA) for yield, kernel weight, and kernels/ear in comparison with four other early synthetics (Table 7). It produced above average GCA for stalk and root lodging, ear moisture at harvest, and ears/plant.

NDSB also had high GCA effects for yield and ears/plant. It produced above average GCA for ear moisture and stalk and root lodging.

Specific hybrid performances among the five synthetics are presented in Table 8. Both NDSA and NDSB appeared to combine well with ASD. The heterosis for yield and the performance indexes indicate that ASD should be a good synthetic to use with either NDSA or NDSB in a reciprocal recurrent selection program.

Seed Increase and Distribution

Germplasm quantities of breeder seed of ND245, NDSA and NDSB will be maintained by the Agricultural Experiment Station, North Dakota State University, Fargo. Inbred seed is normally produced by self-pollination in ear-to-row progenies while the synthetic seed is usually grown in isolation and allowed to open pollinate. ND245 is available in normal cytoplasm only and will be distributed in 50-kernel lots to the extent of aviailable supplies. NDSA and NDSB will be distributed in 200-kernel lots to the extent of available supplies. All seed requests should be directed to the author.

Table 7. Average general combining ability effects for a diallel set of crosses among five early synthetics tested at three plant densities at two eastern North Dakota locations in 1977 and 1978[1].

Synthetic	Yield bu/A	Ear moist. %	Stalk lodging %	Root lodging %	100 kernel wt.	Kernels/ ear	Ears/ 100 plants
ASA	-2.32	0.06	-0.23	0.65	-0.65	-5.4	1.22
ASB	-1.27	-0.29	0.19	-0.48	-0.32	4.0	-0.07
ASD	-2.51	-1.49	-1.15	-1.80	0.45	-11.6	-2.97
NDSA	4.32	1.19	0.47	1.15	0.41	8.6	0.89
NDSB	1.78	0.52	0.72	0.48	0.11	4.3	0.93
LSD (0.05)[2]	3.45	0.79	1.21	1.28	0.23	11.7	2.29

1/ Combining abilities are expressed as differences from the overall mean.

2/ See Table 1.

Table 8. Agronomic performance of a diallel set of crosses among five early synthetics grown at three plant densities at two eastern North Dakota locations in 1977 and 1978.

Synthetic	Yield bu/A	Ear moist. %	Stalk lodging %	Root lodging %	100 Kernel wt. g	Kernels/ ear	Ears/ 100 plants	Yield[1] heterosis %	P.I.[2]
ASA x ASB	67.7	25.6	9.7	5.8	18.5	369	98.8	5.2	92.0
ASA x ASD	67.1	24.1	7.7	3.3	19.6	358	95.6	13.6	96.8
ASA x NDSA	78.1	27.0	9.8	8.6	19.6	386	101.5	6.7	100.5
ASA x NDSB	73.5	26.4	10.1	7.5	19.2	376	101.4	14.1	96.7
ASB x ASD	68.4	23.4	8.7	3.8	20.0	362	95.2	13.3	101.6
ASB x NDSA	78.9	27.0	9.5	6.3	20.0	388	98.5	6.0	101.5
ASB x NDSB	75.5	25.8	11.0	4.8	19.6	398	99.6	14.3	101.8
ASD x NDSA	76.2	25.2	9.0	4.2	21.1	376	95.2	10.2	105.1
ASD x NDSB	73.9	24.3	8.2	4.2	20.6	367	94.5	21.7	105.8
NDSA x NDSB	79.8	28.4	11.7	8.1	20.5	386	100.7	6.7	97.7
LSD (0.05)[3]	7.6	1.5	2.2	2.4	0.4	26	-ns-	–	–

1/ (Hybrid yield - midparent yield)/midparent yield x 100. 2/ P.I. = performance index = (Yield/mean)/(Ear moisture/mean) x 100. 3/ See Table 1.