ND262, ND263, and ND264: New Parental Lines of Corn

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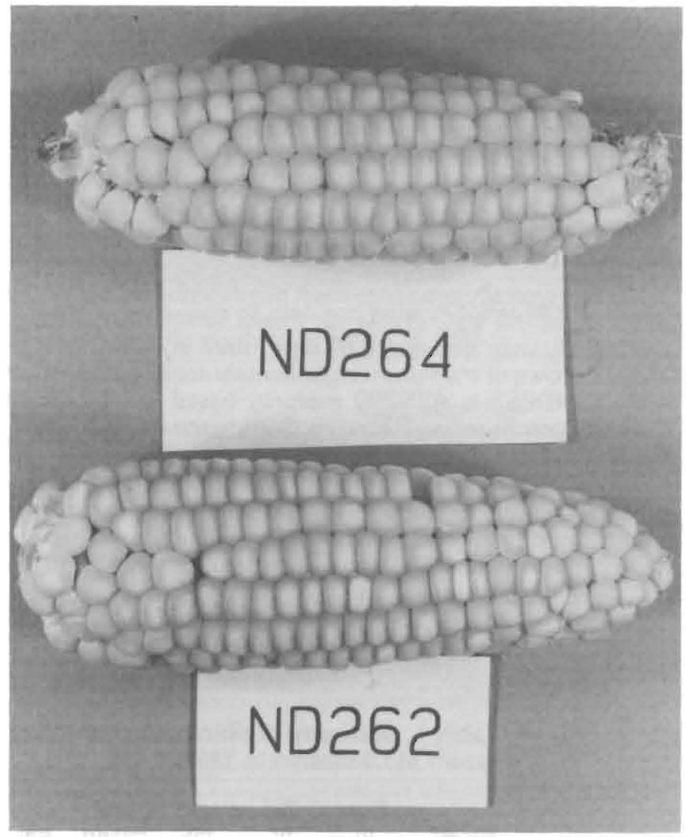
Corn *(Zea mays L.)* yields are lower in North Dakota than in the U.S. Corn Belt due to a combination of factors including lower temperatures, a shorter growing season, irregular precipitation, and soil moisture deficiencies during the growing season. Profitable corn production requires that growers apply the most advanced management practices and select hybrids best suited to the environment and management practices. Much of the improvement in corn yields in the U.S. Corn Belt has been attributed to the increased use of nitrogen fertilizer and higher planting densities (Sundquist et al., 1983). These modern corn production practices may require a different plant type to maximize any advantage associated with these practices in the Northern Great Plains.

Several studies conducted in the Northern Great Plains and northern Corn Belt have confirmed the importance of maturity and plant density for maximizing grain yields. As early as 1930, Olson (1930) reported that an early flint varieity gave increased yields when planting rates were increased from 8,000 to 20,000 plants per acre in an experiment conducted at Fargo. Wiidakas (1958) found that early maturing varieties planted at 20,000 plants per acre at Fargo produced higher grain yields than late maturing varieties. Carson et al. (1966) evaluated the grain yield responses of three northern Corn Belt hybrids (early, medium, and late) at three plant densities (20,000, 30,000, and 40,000 plants per acre) for two planting dates (early May and late June) at Brookings, South Dakota. Their results seemed to indicate that early maturing hybrids display a greater yield response to increased planting rates, and that the earlier hybrids are higher yielding at high plant densities. Troyer (1968) observed that earlier maturing corn varieties with their smaller plant sizes tend to withstand crowding better than larger, later maturing varieties. High plant density and uniform plant distribution within the row tend to compensate for the smaller plant size and lower yield per plant of early maturing varieties.



Ears of ND262 and ND264.

Merely increasing plant density does not always result in increased corn yields. Kanter (1969) evaluted several corn hybrids in North Dakota in the mid-1960's and found that some hybrids did not respond favorably to plant populations greater than 18,000 plants per acre. Troyer and Rosenbrook (1983) reported that corn breeders have been testing hybrids at higher plant densities in recent years, and many of the newer hybrids are more tolerant to higher planting rates. One factor which has been associated with plant density responses in the Corn Belt is production of more than one ear per plant or prolificacy. Zuber et al. (1960) reported that prolific maize hybrids, which produce more than one ear per plant, had more consistent yields that nonprolific types in Missouri regardless of planting rate. Russell (1968) compared one-eared and two-eared hybrids in Iowa and concluded that prolific types would reduce barrenness at high plant densities.

In recent North Dakota tests, Cross et al. (1987) compared prolific with nonprolific hybrids of both early and late maturity, at plant densities of 10,000, 20,000 and 30,000 plants per acre in four environments. They found that the early hybrids yielded more than late hybrids and prolific hybrids yielded more than nonprolific hybrids. Over the four environments, the highest yields were obtained at the highest plant density. The data supported the use of early, prolific hybrids at medium to high plant densities.

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In order to provide a germplasm source for parental lines to produce very early, prolific hybrids, the corn improvement project at North Dakota State University developed a synthetic, NDSF, by intercrossing approximately 65 very early maturing prolific inbreds (Cross, 1983). The first parental inbred lines developed from that new germplasm source are ND262, ND263, and ND264.

BREEDING HISTORY

ND262, ND263, and ND264 (tested as ND84-4, ND84-9, and ND84-11, respectively) were selected from NDSF(FS)C1, an improved version of NDSF. NDSF(FS)C1 was developed by one cycle of reciprocal full-sib selection with NDSB as a reciprocal tester population (for a description of NDSB see Cross, 1980). The S1 parents of these inbreds were selected on the basis of their full-sib family performance. ND262 and ND264 are sister lines derived from the same S3 plant, but ND263 was derived from a different S1 plant from that used to derive ND262 and ND264. All three inbreds were self-pollinated for eight generations with selection for desired plant and ear traits.

AGRONOMIC DESCRIPTION

ND262 typically produces short plants with ears below the midpoint of the stalk (Table 1). Plants have medium-long, moderately wide leaves and medium-sized tassels. Ears with 14 to 16 rows of medium-weight kernels are borne on short shanks. ND262 is AES200 maturity based on the North Central Corn Breeding Research Committee (NCR-2) classification system.

ND263 produces medium-height plants with ears below the midpoint of the stalk. Plants have medium-long, narrow leaves and small tassels. Short, slender ears with 12 to 14 rows of small, shallow kernels are borne on medium-length shanks. ND263 also is AES200 maturity.

ND264 usually produces medium-height plants with ears well below the midpoint of the stalk. Plants have medium-long, wide leaves and large tassels. Ears with 14 to 18 rows of medium weight, deep kernels are borne on medium-long shanks. ND262 also is AES200 maturity.

INBRED PERFORMANCE

ND262, ND263, and ND264 were evaluted for yield and agronomic characters in 1987 at Casselton (Table 2). ND262 and ND264 had above average grain yields and near average ear moisture at harvest. ND263 had low grain yields, high ear moisture at harvest, and tended to tiller, indicating that it would not make a suitable female parent for single cross hybrids.

HYBRID PERFORMANCE

ND262, ND263, and ND264 were tested in four hybrid combinations in three locations in 1985 and 10 hybrid combinations at five environments in 1987 (Table 3). ND262 produced high yields in crosses with ND301 and CM105 in 1985 and with ND256, A654, ND259, and CM105 in 1987. ND263 produced good overall performance in hybrids with ND246, CM105, ND250, ND257, and ND256. ND264 displayed good overall performance in crosses to ND301, ND246, ND256, CM105, A654, and ND257.

Estimates of general combining ability (GCA) over five environments in 1987 (Table 4) indicated that ND262, ND263, and ND264 each had significantly better GCA effects for grain yield than ND240, ND246, ND257, and

Table 1. Summary of plant characteristics in ND262, ND263, ND264, and 14 standard inbreds grown at Casselton in 1987.

Inbred	Plant ht.	Ear ht.	Leaf no.	Leaf length	Leaf wid.	Tassel br.	Shank len.	Ear len.	Ear wid.	Kernel rows	Kernel wt.	Kernel dpth.
	---- Inches ----			---- Inches ----			---------- Inches ----------				g	In
A654	49.1	15.4	11.5	23.0	3.35	7	6.0	5.30	1.51	13.6	0.224	0.29
CM105	55.1	19.5	13.0	27.0	3.35	6	4.5	5.15	1.51	13.8	0.240	0.27
ND240	49.9	22.7	12.5	19.5	3.36	16	6.0	4.00	1.50	18.0	0.189	0.25
ND246	51.7	22.3	12.0	22.0	3.36	18	6.0	5.65	1.20	12.2	0.170	0.18
ND247	64.1	25.0	11.5	27.0	4.13	20	11.0	6.80	1.57	14.8	0.235	0.31
ND248	53.8	21.6	13.0	26.0	3.34	19	6.5	5.65	1.38	14.6	0.208	0.27
ND253	50.0	21.9	12.0	23.0	2.95	18	1.5	5.65	1.52	15.8	0.212	0.29
ND254	30.2	8.9	12.0	18.0	3.54	12	4.0	4.40	1.32	17.1	0.148	0.22
ND256	49.4	25.9	12.0	20.0	3.57	18	1.5	4.30	1.61	18.4	0.212	0.31
ND257	52.3	23.2	11.0	22.0	3.93	16	7.0	5.35	1.50	17.6	0.151	0.27
ND259	52.0	27.9	12.0	26.5	3.55	14	3.0	5.00	1.43	13.2	0.257	0.25
ND260	51.2	21.0	12.5	27.0	2.74	9	6.5	5.30	1.24	11.3	0.244	0.17
ND301	57.6	28.7	18.5	19.5	2.54	18	3.5	5.35	1.50	15.6	0.204	0.29
ND474	57.0	25.1	12.0	29.5	3.55	12	6.5	6.80	1.65	14.4	0.262	0.34
ND262	39.8	15.4	11.5	22.5	3.34	13	3.5	5.00	1.48	14.4	0.223	0.31
ND263	47.0	19.2	12.5	24.5	2.57	10	5.5	4.15	1.00	13.7	0.180	0.13
ND264	47.7	16.9	11.0	21.5	4.14	24	6.5	5.45	1.51	16.0	0.209	0.32
MEAN	50.9	21.7	12.3	23.4	3.43	15	5.1	5.31	1.46	15.0	0.216	0.27
LSD[1]	5.9	6.5	2.9	3.6	0.89	6	2.9	0.57	0.09	2.0	0.025	0.05

[1] Inbred differences larger than this value would be expected due to random environmental effects only once in 20 repetitions of this experiment.

ND474, and each had better than average GCA effects for stalk lodging resistance. ND263 exhibited significantly better GCA effects for low grain moisture at harvest than all inbreds except ND246 and ND257, while only CM105 had better GCA effects for grain yield. ND262 and ND263 also had better than average GCA effects for root lodging resistance.

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Table 2. Summary of yield and agronomic characteristics of ND262, ND263, ND264, and 10 standard inbreds grown at Casselton in 1987.

Inbred	Grain yld.	Ear moist.	Stalk ldg.	Root ldg.	Test wt.	Gen. app.[1]	Uniformity[1]	Tillers	Smut	Ears /plt.	Plant pop.
	bu/A	----------	%	----------	lb/bu			----	% ----		plt/A
A654	57.0	42.2	1.9	3.4	61.8	6.0	9.0	18.0	1.9	0.95	23151
CM105	46.2	40.3	0.0	2.7	61.5	7.5	7.5	15.8	2.2	1.28	17786
ND240	37.9	39.1	5.0	1.4	54.8	6.0	8.0	0.0	0.0	1.41	13838
ND246	37.8	25.2	9.2	6.8	65.7	7.5	7.5	15.8	58.0	1.01	18482
ND248	55.9	33.1	10.0	13.3	63.5	7.0	7.0	25.5	18.0	1.38	16130
ND253	53.9	41.4	0.0	0.1	58.6	5.5	7.5	7.5	7.5	1.31	15128
ND257	43.0	30.4	0.0	0.0	56.2	6.0	8.0	10.5	0.0	1.46	15120
ND259	24.3	46.5	10.5	0.0	60.2	7.0	7.5	15.5	10.5	1.03	15613
ND301	40.1	34.9	13.8	4.9	60.1	8.5	7.0	16.0	20.5	1.17	15910
ND474	75.8	34.8	2.4	0.0	62.5	7.5	7.5	13.8	0.0	1.20	13855
ND262	60.0	40.3	0.0	1.0	61.0	9.0	7.5	21.5	7.2	1.37	19337
ND263	4.2	54.6	3.1	0.0	61.3	5.5	7.0	46.5	0.0	1.32	14132
ND264	72.8	41.2	2.0	15.3	59.7	7.0	7.5	18.0	6.2	1.30	21392
MEAN	44.5	37.3	5.1	5.3	60.2	6.5	7.6	18.4	9.5	1.31	
LSD[2]	24.8	6.0	NS	10.5	1.9	2.0	NS	NS	17.2	0.50	

[1] The scale was 1 to 9 with 9 assigned for the most desirable expression of the trait and 1 for the least desirable expression.

[2] Inbred differences larger than this value would be expected due to random environmental effects only once in 20 repetitions of this experiment.

Table 3. Average performance of selected single cross hybrids with ND262, ND263, ND264, and check hybrids tested at three environments in 1985 and five environments in 1987.

Pedigree	Hybrid	Grain moist.	Grain yield	Root lodg.	Stalk lodg.	Pop.	P.I.[1]
		%	bu/A	---------- %	----------	plts/A	
		Means of 3 locations in 1985					
ND246 X ND262	NDG384	20.35	61.7	0.80	0.00	20994	167.49
ND249 X ND262	NDG385	31.82	63.4	0.00	4.24	17482	108.47
ND301 X ND262	NDG386	36.75	74.8	0.80	2.27	19925	110.74
CM105 X ND262	NDG383	34.33	70.0	0.80	0.28	18749	110.99
ND246 X ND263	NDG403	22.16	55.8	0.70	1.57	21027	137.10
ND249 X ND263	NDG404	27.18	61.1	0.00	3.99	20399	122.30
ND301 X ND263	NDG405	33.29	65.4	1.40	3.33	21462	106.89
CM105 X ND263	NDG402	30.71	62.1	0.00	2.03	21565	110.12
ND246 X ND264	NDG410	25.26	51.0	0.00	2.23	17529	109.85
ND249 X ND264	NDG411	30.64	64.6	0.80	3.79	19553	114.83
ND301 X ND264	NDG412	36.15	73.5	0.00	0.00	19973	108.11
CM105 X ND264	NDG409	33.08	66.7	0.00	3.44	18814	109.79
Pioneer Brand	3901	50.94	54.5	0.00	1.28	23074	58.27
Pioneer Brand	3978	29.95	71.8	0.00	2.59	19832	130.51
Top Farm Brand	TFSX87	32.56	72.1	0.00	0.48	22769	120.47
LSD (0.05)[2]		5.32	17.5	5.18	NS	4987	
		Means of 5 locations in 1987					
ND259 X ND262	NDG680	24.66	100.4	1.40	5.40	20227	80.63
ND260 X ND262	NDG689	20.22	87.7	6.70	18.80	19914	85.89
ND262 X CM105	NDG383	21.27	93.7	0.70	7.00	19698	87.28
ND262 X ND240	NDG645	20.01	97.9	1.60	22.40	19987	96.97
ND262 X ND246	NDG384	15.77	76.4	0.00	2.90	18864	95.98
ND262 X ND250	NDG654	22.46	75.7	8.90	4.40	18202	66.77
ND262 X ND256	NDG705	19.75	102.7	0.00	13.20	20464	102.97
ND262 X ND257	NDG666	11.66	94.9	0.00	18.00	21282	161.24
ND262 X ND474	NDG640	18.08	95.0	3.60	14.80	20866	104.08
A654 X ND262	NDG697	18.20	100.6	0.00	3.70	20725	109.45
A654 X ND263	NDG702	18.41	92.3	4.40	8.70	23728	99.32
CM105 X ND263	NDG402	13.53	92.1	1.50	15.20	20611	134.84
ND240 X ND263	NDG650	15.31	82.8	2.40	26.60	18617	107.17
ND256 X ND263	NDG710	14.03	98.6	2.60	10.40	21227	139.30
ND259 X ND263	NDG685	18.77	83.9	1.90	23.40	19265	88.57
ND260 X ND263	NDG693	17.47	97.1	0.00	23.90	21765	110.09
ND263 X ND246	NDG403	11.81	77.3	2.40	9.30	19753	129.69
ND263 X ND250	NDG659	16.02	101.4	6.70	5.90	20400	125.47
ND263 X ND257	NDG670	12.20	86.5	0.40	9.90	22833	140.55
ND263 X ND474	NDG643	19.13	97.3	14.00	17.80	20935	100.72
A654 X ND264	NDG699	17.51	89.3	3.00	8.50	17556	101.02
CM105 X ND264	NDG409	17.73	83.5	0.00	6.20	17837	93.27
ND240 X ND264	NDG647	19.35	96.2	9.40	36.10	19210	98.49
ND256 X ND264	NDG707	19.80	109.6	12.80	8.20	20180	109.60
ND264 X ND246	NDG410	14.13	79.1	6.30	6.70	18536	110.97
ND264 X ND250	NDG656	21.10	88.6	15.50	10.30	19277	83.24
ND264 X ND257	NDG667	16.40	90.8	1.30	15.70	17567	109.71
ND264 X ND259	NDG682	24.13	106.6	4.00	4.40	20409	87.50
ND264 X ND260	NDG690	18.93	100.2	0.00	18.30	18669	104.89
ND264 X ND474	NDG641	17.90	102.4	21.40	17.40	21068	113.32
Pioneer Brand	3953	13.20	104.3	1.70	2.90	20134	156.61
Pioneer Brand	3978	17.44	97.0	1.30	7.80	20014	110.18
Top Farm Brand	TFSX87	16.40	112.8	0.50	9.60	20981	136.29
LSD (0.05)[2]		1.97	12.2	9.10	10.68	2005	

[1] Performance Index = (Yield/test mean)/(Moisture/test mean) x 100.

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

Table 4. Average general combining ability effects for ND262, ND263, and ND264 compared to various sets of standard inbreds.[1]

Inbred	Grain moist.	Grain yield	Root lodg.	Stalk lodg.	Pop.	P.I.
	%	bu/A	---------- %	----------	plts/A	
Design II analysis (two testers) over 3 locations in 1985						
ND262	0.65	3.38	0.10	-1.02	-1687	7.40
ND263	-4.79	-1.72	-0.30	0.34	1179	13.38
ND264	-1.87	2.36	0.10	-0.27	-619	9.81
ND300	7.07	-11.98	0.35	-1.79	233	-32.97
CG10	1.43	3.42	0.05	1.82	741	1.11
ND474	-1.21	4.53	-0.30	0.94	153	11.13
LSD (0.05)[2]	3.76	12.37	3.66	NS	3526	
Diallel analysis over 5 locations in 1987						
ND262						
ND262	1.48	3.95	-2.52	-3.62	880	-2.87
A654	-0.15	5.05	-2.83	-4.30	399	4.35
CM105	-0.09	7.84	-2.63	-0.79	916	8.55
ND240	0.34	-1.82	-0.76	11.53	-1	-5.53
ND246	-3.09	-9.59	-1.02	-7.38	-748	7.51
ND250	0.89	0.05	2.88	-3.07	-244	-4.59
ND256	1.13	2.45	-0.55	-0.57	-73	-4.12
ND257	-4.37	-4.39	0.47	2.34	-231	24.83
ND259	2.90	4.67	0.92	1.67	371	-11.08
ND260	0.01	1.50	0.68	4.46	875	1.05
ND474	0.90	-9.72	5.34	1.75	-2139	-18.22
LSD (0.05)[2]	0.66	4.07	3.03	3.56	668	
ND263						
ND263	-1.46	2.64	-1.38	-0.51	1605	12.41
A654	0.98	5.03	-2.65	-4.57	564	-1.78
CM105	-0.26	7.91	-2.77	-0.91	842	10.14
ND240	0.47	-3.10	-0.90	11.01	-303	-7.67
ND246	-2.89	-9.26	-1.37	-7.68	-824	7.72
ND250	0.85	2.86	2.44	-3.86	-189	-1.88
ND256	1.15	2.28	-0.49	-1.79	-161	-3.65
ND257	-3.72	-5.00	0.48	0.59	-241	19.60
ND259	2.92	3.26	0.75	2.53	110	-13.44
ND260	0.33	2.67	-0.26	4.03	895	0.31
ND474	1.61	-9.26	6.16	1.11	-2297	-21.72
LSD (0.05)[2]	0.66	4.07	3.03	3.56	668	
ND264						
ND264	1.02	5.66	1.56	-2.08	65	-0.99
A654	0.34	4.06	-3.44	-4.23	289	1.36
CM105	-0.39	6.38	-3.60	-1.45	906	8.96
ND240	0.32	-2.43	-0.85	12.32	98	-5.57
ND246	-3.21	-9.75	-1.63	-7.58	-603	8.81
ND250	0.80	0.91	2.67	-3.06	41	-3.13
ND256	1.18	2.70	-0.12	-1.65	76	-3.65
ND257	-3.85	-5.24	-0.08	1.53	-426	19.49
ND259	2.90	4.85	0.31	0.99	566	-10.58
ND260	-0.07	2.32	-1.03	3.83	928	2.76
ND474	0.93	-9.42	6.25	1.43	-1942	-17.49
LSD (0.05)[2]	0.66	4.07	3.03	3.56	668	

[1] General combining ability effects are differences between the mean of all hybrids in the test and all hybrids produced from a particular inbred. Negative values indicate that inbred's hybrids were below average while positive values indicate above average performance.

[2] Average differences among hybrids of this amount could be explained by random environmental effects on once in 20 reptitions of this experiment.