Table 1. Influence of N-rate, K-rate and nitrification inhibitors on stover N content, total N removal and dry matter production on four corn hybrids at silking. Becker, MN 1989.

N-Rate	Hybrid	Inh.	K-Rate	Whole Plant Silking Stover		
#/A			#/A	T/A	% N	#/A
80	Pioneer 3615	---	---	3.68	1.42	104.5
80		NS	---	3.74	1.73	129.2
80		---	100	3.47	1.89	131.2
80		NS	100	3.66	1.43	104.1
80		---	200	3.50	1.79	125.6
80		NS	200	3.78	1.64	123.3
160		---	200	3.45	1.67	114.2
160		NS	200	3.85	1.55	118.5
240		---	---	3.65	1.95	142.4
240		NS	---	3.38	1.90	128.9
240		---	100	3.62	1.94	140.5
240		NS	100	4.02	2.06	165.8
240		---	200	3.34	1.98	132.4
240		NS	200	3.58	1.85	132.7
80	Pioneer 3737	---	---	3.74	1.94	143.1
80		NS	---	3.81	1.75	132.5
80		---	100	3.68	1.75	129.0
80		NS	100	3.41	1.70	115.3
80		---	200	3.84	1.57	120.1
80		NS	200	3.65	1.40	101.6
160		---	200	3.79	2.10	159.4
160		NS	200	4.07	2.11	173.1
240		---	---	3.57	2.09	148.2
240		NS	---	3.80	2.12	159.6
240		---	100	4.09	1.95	159.3
240		NS	100	3.48	2.17	150.9
240		---	200	3.31	2.16	140.7
240		NS	200	3.88	1.89	144.9
80	LH74 X LH85	---	---	3.46	1.65	112.9
80		NS	---	3.60	1.55	110.7
80		---	100	3.65	1.64	117.1
80		NS	100	3.68	1.68	122.5
80		---	200	3.81	1.64	125.1
80		NS	200	3.37	1.64	110.4
160		---	200	3.72	1.78	130.8
160		NS	200	3.77	1.71	128.9
240		---	---	4.02	2.16	172.0
240		NS	---	3.86	1.93	149.0
240		---	100	3.91	2.14	166.5
240		NS	100	3.64	1.86	133.7
240		---	200	3.92	2.07	162.0
240		NS	200	3.90	1.93	150.6
80	DeKalb 485	---	---	3.68	1.76	129.3
80		NS	---	3.77	1.76	132.2
80		---	100	3.89	1.72	133.6
80		NS	100	3.97	1.97	156.2
80		---	200	3.64	1.75	127.5
80		NS	200	3.87	1.72	133.3
160		---	200	4.05	1.71	138.6
160		NS	200	3.45	1.87	128.8
240		---	---	3.83	1.86	142.1
240		NS	---	4.01	1.65	132.1
240		---	100	3.60	2.04	146.5
240		NS	100	3.75	1.94	145.5
240		---	200	3.98	1.82	145.1
240		NS	200	3.44	1.98	135.6

Table 2. Influence of N-rate, K-rate and nitrification inhibitors on grain yields and dry matter production on four corn hybrids at **milk stage R3**. Becker, MN 1989.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
#/A			#/A	Bu/A	----------T/A----------			
80	Pioneer 3615	---	---	35.7	0.84	4.29	0.63	5.76
80		NS	---	46.9	1.11	4.25	0.68	6.04
80		---	100	42.8	1.01	4.60	0.65	6.26
80		NS	100	32.4	0.77	4.27	0.56	5.60
80		---	200	30.6	0.72	4.44	0.57	5.74
80		NS	200	43.3	1.02	4.65	0.60	6.27
160		---	200	42.6	1.01	4.46	0.73	6.20
160		NS	200	41.1	0.97	5.12	0.76	6.85
240		---	---	46.1	1.09	4.06	0.70	5.84
240		NS	---	50.9	1.20	4.50	0.74	6.44
240		---	100	33.5	0.79	4.08	0.69	5.57
240		NS	100	41.4	0.98	4.55	0.72	6.25
240		---	200	42.0	0.99	4.63	0.69	6.31
240		NS	200	34.0	0.80	4.15	0.64	5.59
80	Pioneer 3737	---	---	62.9	1.49	4.20	0.65	6.34
80		NS	---	68.9	1.63	4.44	0.64	6.71
80		---	100	55.4	1.31	3.73	0.55	5.60
80		NS	100	52.6	1.25	4.18	0.70	6.13
80		---	200	66.7	1.58	4.32	0.65	6.55
80		NS	200	57.6	1.36	3.78	0.53	5.67
160		---	200	61.9	1.46	3.55	0.67	5.68
160		NS	200	65.5	1.55	4.05	0.64	6.24
240		---	---	52.6	1.24	3.58	0.58	5.40
240		NS	---	67.2	1.59	4.30	0.77	6.66
240		---	100	64.5	1.53	4.22	0.69	6.44
240		NS	100	58.2	1.38	4.08	0.76	6.22
240		---	200	55.6	1.32	3.83	0.68	5.83
240		NS	200	65.8	1.56	4.24	0.68	6.48
80	LH74 X LH85	---	---	72.7	1.72	4.36	0.75	6.83
80		NS	---	61.8	1.46	3.68	0.67	5.81
80		---	100	57.9	1.37	4.01	0.76	6.14
80		NS	100	67.7	1.60	4.05	0.73	6.38
80		---	200	70.4	1.66	4.09	0.71	6.47
80		NS	200	57.6	1.36	4.02	0.64	6.03
160		---	200	73.9	1.75	4.18	0.76	6.69
160		NS	200	67.1	1.59	4.13	0.77	6.49
240		---	---	72.6	1.72	4.38	0.73	6.83
240		NS	---	69.3	1.64	4.05	0.72	6.42
240		---	100	72.8	1.72	4.18	0.75	6.65
240		NS	100	66.6	1.58	4.27	0.73	6.58
240		---	200	72.5	1.72	4.39	0.80	6.91
240		NS	200	75.0	1.77	4.39	0.75	6.92
80	DeKalb 485	---	---	66.4	1.57	4.58	0.75	6.90
80		NS	---	64.1	1.52	4.27	0.69	6.47
80		---	100	64.2	1.52	4.39	0.71	6.62
80		NS	100	64.1	1.52	4.42	0.70	6.64
80		---	200	52.9	1.25	4.36	0.65	6.27
80		NS	200	61.9	1.47	4.30	0.75	6.51
160		---	200	68.2	1.61	4.41	0.74	6.77
160		NS	200	64.1	1.52	4.64	0.75	6.92
240		---	---	69.9	1.65	4.35	0.74	6.74
240		NS	---	72.6	1.72	4.53	0.76	7.01
240		---	100	57.1	1.35	3.99	0.78	6.12
240		NS	100	61.9	1.47	4.29	0.80	6.55
240		---	200	58.2	1.38	4.18	0.60	6.16
240		NS	200	68.0	1.61	4.47	0.79	6.87

Table 3. Influence of N-rate, K-rate and nitrification inhibitors on N content and total N removal on four corn hybrids at **milk stage R3**. Becker, MN 1989.

				N-Concentration			N-Removal			
N-Rate	Hybrid	Inh.	K-Rate	Stover	Grain	Cob	Stover	Grain	Cob	Total
#/A			#/A	----------%----------			----------#/A----------			
80	Pioneer 3615	---	---	0.92	1.96	1.01	79.3	32.6	12.6	124.5
80		NS	---	1.11	1.85	1.04	94.5	39.9	14.1	148.5
80		---	100	0.92	1.89	1.07	83.3	38.3	13.9	135.5
80		NS	100	0.99	1.84	1.03	84.0	28.3	11.6	123.9
80		---	200	0.87	1.88	1.06	77.2	27.1	12.1	116.3
80		NS	200	0.88	1.79	1.04	81.7	36.7	12.4	130.8
160		---	200	1.11	1.88	1.03	98.2	38.4	14.9	151.5
160		NS	200	1.18	1.87	1.08	120.5	35.8	16.4	172.6
240		---	---	1.31	1.93	1.03	106.3	41.5	14.2	162.1
240		NS	---	1.35	2.02	0.98	120.9	47.9	14.5	183.2
240		---	100	1.34	2.02	0.99	109.6	31.9	13.7	155.2
240		NS	100	1.39	1.93	1.04	125.5	37.3	15.0	177.8
240		---	200	1.36	1.93	1.06	125.4	38.0	14.6	177.9
240		NS	200	1.62	1.98	1.04	133.5	31.7	13.3	178.5
80	Pioneer 3737	---	---	0.94	1.62	0.83	78.6	48.2	10.7	137.5
80		NS	---	1.27	1.63	0.86	108.2	52.8	10.8	171.7
80		---	100	1.23	1.65	0.95	92.1	43.1	10.5	145.7
80		NS	100	1.12	1.66	0.82	94.3	41.0	11.8	147.2
80		---	200	1.01	1.58	0.85	86.8	49.5	11.1	147.5
80		NS	200	0.97	1.55	0.77	72.1	42.5	8.2	122.8
160		---	200	1.34	1.82	0.95	95.5	53.2	12.6	161.3
160		NS	200	1.57	1.66	0.89	127.0	51.3	11.4	189.7
240		---	---	1.39	1.82	0.85	98.9	44.6	9.9	153.4
240		NS	---	1.49	1.75	0.91	126.4	54.9	14.0	195.3
240		---	100	1.49	1.71	0.86	125.2	52.1	11.8	189.1
240		NS	100	1.40	1.77	0.86	114.2	48.5	13.2	175.8
240		---	200	1.63	1.77	0.89	125.2	46.5	12.1	183.9
240		NS	200	1.67	1.76	0.82	141.5	54.6	11.1	207.2
80	LH74 X LH85	---	---	1.05	1.70	0.78	90.8	58.5	11.7	161.0
80		NS	---	1.09	1.76	0.71	79.9	51.3	9.5	140.6
80		---	100	1.51	1.71	0.71	121.5	46.1	10.6	178.2
80		NS	100	0.93	1.68	0.75	75.4	54.1	10.8	140.2
80		---	200	1.06	1.64	0.70	86.4	54.7	9.9	151.0
80		NS	200	1.08	1.65	0.83	86.0	44.5	10.6	141.2
160		---	200	1.30	1.84	0.70	109.4	64.3	10.6	184.3
160		NS	200	1.34	1.76	0.80	110.7	55.9	12.2	178.8
240		---	---	1.38	1.74	0.80	120.9	59.5	11.7	192.1
240		NS	---	1.38	1.73	0.76	113.0	56.5	10.9	180.4
240		---	100	1.55	1.84	0.81	131.1	63.3	12.1	206.4
240		NS	100	1.37	1.81	0.76	116.9	56.9	11.0	184.8
240		---	200	1.33	1.81	0.83	118.0	62.2	13.3	193.6
240		NS	200	1.48	1.84	0.80	129.0	65.5	12.0	206.5
80	DeKalb 485	---	---	1.03	1.59	0.75	94.2	49.7	11.2	155.0
80		NS	---	1.26	1.62	0.79	109.1	49.0	10.8	168.9
80		---	100	0.93	1.48	0.85	81.4	45.6	11.9	138.9
80		NS	100	1.42	1.50	0.80	126.3	45.4	11.2	182.8
80		---	200	1.26	1.59	0.84	109.4	39.2	10.9	159.5
80		NS	200	1.16	1.61	0.80	99.7	47.2	12.1	159.0
160		---	200	1.42	1.65	0.80	125.8	53.5	11.9	191.1
160		NS	200	1.52	1.68	0.81	141.4	50.9	12.2	204.6
240		---	---	1.17	1.70	0.74	100.2	56.3	10.8	167.3
240		NS	---	1.37	1.76	0.76	124.2	60.5	11.5	196.2
240		---	100	1.22	1.71	0.79	96.6	46.2	12.0	154.8
240		NS	100	1.37	1.75	0.83	117.6	51.3	13.3	182.3
240		---	200	1.53	1.69	0.86	126.8	46.5	9.9	183.2
240		NS	200	1.60	1.76	0.82	142.8	56.7	12.9	212.4

Table 4. Influence of N-rate, K-rate and nitrification inhibitors on grain yields and dry matter production on four corn hybrids at **dent stage R5**. Becker, MN 1989.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
#/A			#/A	Bu/A	T/A			
80	Pioneer 3615	---	---	113.5	2.69	3.73	0.68	7.09
80		NS	---	120.2	2.84	4.15	0.89	7.88
80		---	100	99.3	2.35	3.71	0.63	6.69
80		NS	100	108.1	2.56	4.03	0.69	7.28
80		---	200	98.6	2.33	3.94	0.63	6.91
80		NS	200	114.3	2.70	3.86	0.64	7.20
160		---	200	122.4	2.89	4.47	0.80	8.17
160		NS	200	117.7	2.78	4.30	0.78	7.86
240		---	---	129.5	3.06	4.00	0.78	7.85
240		NS	---	114.9	2.72	3.95	0.76	7.43
240		---	100	123.0	2.91	4.39	0.81	8.12
240		NS	100	118.1	2.80	4.30	0.81	7.91
240		---	200	120.2	2.84	4.25	0.78	7.87
240		NS	200	121.2	2.87	4.40	0.82	8.09
80	Pioneer 3737	---	---	142.0	3.36	3.81	0.58	7.75
80		NS	---	158.9	3.76	3.98	0.67	8.42
80		---	100	137.1	3.24	3.63	0.54	7.41
80		NS	100	139.2	3.29	3.60	0.55	7.44
80		---	200	136.2	3.22	3.66	0.47	7.36
80		NS	200	162.1	3.84	3.92	0.55	8.31
160		---	200	140.4	3.32	3.71	0.61	7.64
160		NS	200	159.2	3.77	3.98	0.62	8.37
240		---	---	150.4	3.56	4.15	0.62	8.32
240		NS	---	156.4	3.70	4.29	0.64	8.63
240		---	100	134.9	3.19	3.38	0.53	7.10
240		NS	100	136.9	3.24	3.68	0.56	7.48
240		---	200	149.3	3.53	3.95	0.64	8.13
240		NS	200	153.6	3.63	3.77	0.61	8.01
80	LH74 X LH85	---	---	143.0	3.38	4.06	0.68	8.12
80		NS	---	143.0	3.38	4.03	0.75	8.17
80		---	100	131.5	3.11	3.51	0.70	7.32
80		NS	100	140.9	3.33	3.93	0.70	7.96
80		---	200	134.1	3.17	4.02	0.73	7.93
80		NS	200	137.7	3.26	3.56	0.69	7.50
160		---	200	144.1	3.41	3.89	0.80	8.09
160		NS	200	141.7	3.35	3.90	0.75	8.00
240		---	---	140.8	3.33	4.10	0.83	8.26
240		NS	---	143.4	3.39	3.95	0.73	8.08
240		---	100	149.7	3.54	4.27	0.81	8.62
240		NS	100	149.2	3.53	3.85	0.75	8.13
240		---	200	142.7	3.38	4.07	0.71	8.15
240		NS	200	149.2	3.53	3.90	0.73	8.16
80	DeKalb 485	---	---	160.9	3.81	4.12	0.79	8.72
80		NS	---	140.6	3.33	3.78	0.72	7.83
80		---	100	161.2	3.81	3.97	0.73	8.51
80		NS	100	136.7	3.24	4.06	0.63	7.92
80		---	200	127.3	3.01	3.54	0.59	7.14
80		NS	200	150.5	3.56	4.03	0.68	8.27
160		---	200	156.8	3.71	4.40	0.72	8.84
160		NS	200	149.1	3.53	3.95	0.69	8.17
240		---	---	166.3	3.93	4.24	0.76	8.93
240		NS	---	159.1	3.76	4.36	0.72	8.84
240		---	100	142.4	3.37	3.67	0.66	7.70
240		NS	100	149.1	3.53	4.12	0.71	8.36
240		---	200	149.9	3.55	3.98	0.72	8.24
240		NS	200	155.6	3.68	4.10	0.76	8.55

Table 5. Influence of N-rate, K-rate and nitrification inhibitors on N content and total N removal on four corn hybrids at dent stage R5. Becker, MN 1989.

				N-Concentration			N-Removal			
N-Rate	Hybrid	Inh.	K-Rate	Stover	Grain	Cob	Stover	Grain	Cob	Total
#/A			#/A	----------%----------			----------#/A----------			
80	Pioneer 3615	---	---	1.13	1.30	0.78	84.1	69.4	10.5	164.0
80		NS	---	1.06	1.40	0.76	88.2	79.9	13.4	181.5
80		---	100	0.94	1.32	0.87	69.4	61.8	10.9	142.1
80		NS	100	1.02	1.40	0.75	82.9	71.0	10.3	164.3
80		---	200	0.94	1.31	0.75	74.7	61.1	9.4	145.2
80		NS	200	1.16	1.32	0.80	89.1	71.5	10.3	170.8
160		---	200	0.97	1.46	0.82	86.0	83.8	13.1	182.9
160		NS	200	1.52	1.52	0.82	131.0	84.6	12.8	228.5
240		---	---	1.06	1.43	0.72	84.1	87.0	11.2	182.3
240		NS	---	1.39	1.50	0.70	108.8	81.4	10.5	200.7
240		---	100	1.15	1.54	0.83	100.9	89.8	13.5	204.3
240		NS	100	1.33	1.44	0.86	114.6	80.6	13.9	209.1
240		---	200	1.34	1.54	0.75	113.7	86.4	11.6	211.8
240		NS	200	1.28	1.48	0.82	112.6	84.6	13.4	210.6
80	Pioneer 3737	---	---	1.15	1.32	0.55	89.3	88.4	6.5	184.3
80		NS	---	1.14	1.37	0.54	91.0	102.9	7.3	201.3
80		---	100	0.87	1.31	0.54	62.0	84.8	5.8	152.5
80		NS	100	1.13	1.29	0.56	81.9	84.4	6.2	172.5
80		---	200	1.20	1.33	0.54	86.8	85.6	5.1	177.5
80		NS	200	1.21	1.21	0.56	95.4	92.4	6.1	193.9
160		---	200	1.22	1.41	0.61	89.4	93.4	7.4	190.1
160		NS	200	1.40	1.36	0.63	111.1	101.8	7.8	220.7
240		---	---	1.38	1.38	0.65	113.2	98.2	7.9	219.3
240		NS	---	1.49	1.44	0.62	127.9	106.6	8.0	242.5
240		---	100	0.99	1.44	0.54	67.2	91.2	5.7	164.1
240		NS	100	1.67	1.39	0.65	122.7	89.4	7.3	219.5
240		---	200	1.34	1.48	0.60	106.0	103.8	7.6	217.4
240		NS	200	1.15	1.37	0.59	86.5	98.9	7.1	192.5
80	LH74 X LH85	---	---	1.03	1.42	0.64	83.6	95.6	8.6	187.7
80		NS	---	1.20	1.41	0.61	96.8	94.9	9.2	200.8
80		---	100	0.86	1.31	0.64	60.5	81.1	8.9	150.4
80		NS	100	0.96	1.37	0.56	74.4	91.6	7.8	173.8
80		---	200	1.04	1.33	0.66	83.4	85.2	9.7	178.3
80		NS	200	0.86	1.30	0.66	60.0	85.0	9.1	154.2
160		---	200	1.10	1.46	0.56	85.3	99.4	9.0	193.8
160		NS	200	1.23	1.51	0.56	95.7	101.4	8.4	205.5
240		---	---	1.08	1.39	0.64	88.3	92.3	10.5	191.0
240		NS	---	0.95	1.52	0.62	75.3	103.3	9.1	187.6
240		---	100	1.19	1.54	0.58	101.5	107.9	9.4	218.8
240		NS	100	1.05	1.49	0.66	80.7	104.6	9.9	195.2
240		---	200	1.33	1.48	0.57	107.2	100.2	8.1	215.5
240		NS	200	1.37	1.49	0.69	106.0	105.3	10.1	221.4
80	DeKalb 485	---	---	1.14	1.21	0.63	94.5	91.7	9.8	196.0
80		NS	---	1.48	1.20	0.63	111.8	80.6	9.0	201.4
80		---	100	1.08	1.14	0.62	86.3	87.2	8.9	182.4
80		NS	100	1.26	1.20	0.65	101.2	77.5	8.1	186.8
80		---	200	0.93	1.06	0.51	66.0	64.4	6.0	136.4
80		NS	200	1.41	1.20	0.62	112.5	85.5	8.4	206.4
160		---	200	1.52	1.30	0.60	133.8	96.4	8.7	238.9
160		NS	200	1.44	1.29	0.64	113.4	91.0	8.8	213.2
240		---	---	1.24	1.34	0.61	105.3	105.2	9.3	219.8
240		NS	---	1.22	1.33	0.64	105.9	100.2	9.2	215.3
240		---	100	1.11	1.30	0.62	81.0	87.2	8.1	176.3
240		NS	100	1.50	1.33	0.58	122.9	93.5	8.1	224.5
240		---	200	1.44	1.36	0.57	114.8	96.1	8.2	219.0
240		NS	200	1.27	1.32	0.65	104.1	97.4	9.9	211.4

Table 6. Influence of N-rate, K-rate and nitrification inhibitors on grain yields and dry matter production on four corn hybrids at **physiological maturity**. Becker, MN 1989.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Total
#/A			#/A	Bu/A	----------T/A----------		
80	Pioneer 3615	---	---	195.2	4.62	4.28	8.90
80		NS	---	203.0	4.80	4.45	9.25
80		---	100	177.7	4.21	4.27	8.47
80		NS	100	187.2	4.43	4.29	8.71
80		---	200	174.5	4.13	4.03	8.15
80		NS	200	184.9	4.37	4.24	8.61
160		---	200	202.1	4.78	4.23	9.01
160		NS	200	204.3	4.83	4.48	9.31
240		---	---	221.7	5.25	4.55	9.80
240		NS	---	206.4	4.88	4.50	9.38
240		---	100	208.8	4.94	4.47	9.41
240		NS	100	212.1	5.02	4.66	9.68
240		---	200	205.2	4.86	4.43	9.29
240		NS	200	207.3	4.91	4.54	9.44
80	Pioneer 3737	---	---	207.9	4.92	4.19	9.11
80		NS	---	219.9	5.20	4.33	9.53
80		---	100	199.1	4.71	3.57	8.28
80		NS	100	200.7	4.75	3.91	8.66
80		---	200	199.5	4.72	4.03	8.75
80		NS	200	193.2	4.57	3.83	8.40
160		---	200	206.2	4.88	3.89	8.77
160		NS	200	216.2	5.12	3.94	9.05
240		---	---	214.0	5.06	4.17	9.23
240		NS	---	205.4	4.86	3.87	8.73
240		---	100	210.2	4.97	3.90	8.87
240		NS	100	206.9	4.90	3.94	8.84
240		---	200	214.1	5.07	3.93	8.99
240		NS	200	203.1	4.81	4.00	8.80
80	LH74 X LH85	---	---	195.3	4.62	4.30	8.92
80		NS	---	197.7	4.68	4.20	8.87
80		---	100	178.5	4.22	3.91	8.13
80		NS	100	183.6	4.34	4.19	8.54
80		---	200	194.4	4.60	4.16	8.76
80		NS	200	178.3	4.22	3.93	8.15
160		---	200	202.1	4.78	4.24	9.02
160		NS	200	195.2	4.62	4.43	9.05
240		---	---	197.2	4.67	4.34	9.01
240		NS	---	195.0	4.61	4.25	8.86
240		---	100	191.2	4.52	4.22	8.74
240		NS	100	194.5	4.60	4.22	8.82
240		---	200	199.8	4.73	4.52	9.25
240		NS	200	207.2	4.90	4.31	9.22
80	DeKalb 485	---	---	201.8	4.78	4.25	9.03
80		NS	---	206.1	4.88	4.24	9.12
80		---	100	203.4	4.81	4.21	9.02
80		NS	100	205.2	4.85	4.11	8.97
80		---	200	189.3	4.48	3.83	8.31
80		NS	200	205.2	4.86	4.26	9.11
160		---	200	226.8	5.37	4.33	9.70
160		NS	200	215.5	5.10	4.38	9.48
240		---	---	223.3	5.28	4.44	9.72
240		NS	---	226.7	5.36	4.70	10.06
240		---	100	220.4	5.22	4.29	9.50
240		NS	100	222.1	5.25	4.20	9.45
240		---	200	212.4	5.03	4.15	9.18
240		NS	200	219.0	5.18	4.35	9.53

Table 7. Influence of N-rate, K-rate and nitrification inhibitors on stover and grain N content and total N removal on four corn hybrids at **physiological maturity**. Becker, MN 1989.

N-Rate	Hybrid	Inh.	K-Rate	N-Concentration Stover	N-Concentration Grain	N-Removal Stover	N-Removal Grain	N-Removal Total
#/A			#/A	-------%--------		----------#/A---------		
80	Pioneer 3615	---	---	0.61	1.25	52.2	115.4	167.5
80		NS	---	0.65	1.38	57.6	133.0	190.6
80		---	100	0.68	1.20	58.2	100.6	158.8
80		NS	100	0.63	1.20	53.6	106.6	160.2
80		---	200	0.56	1.26	45.4	103.6	149.0
80		NS	200	0.68	1.32	57.7	115.5	173.3
160		---	200	0.77	1.44	64.8	137.8	202.7
160		NS	200	0.83	1.48	74.5	142.8	217.4
240		---	---	0.82	1.43	74.9	149.7	224.6
240		NS	---	0.80	1.49	71.4	144.7	216.0
240		---	100	0.84	1.38	74.6	135.8	210.4
240		NS	100	0.90	1.46	83.6	145.5	229.1
240		---	200	0.80	1.45	70.5	139.9	210.4
240		NS	200	0.85	1.51	76.9	148.0	224.9
80	Pioneer 3737	---	---	0.70	1.24	58.3	122.4	180.6
80		NS	---	0.75	1.39	65.3	144.5	209.8
80		---	100	0.67	1.19	47.3	112.0	159.3
80		NS	100	0.76	1.26	58.5	119.8	178.3
80		---	200	0.75	1.32	60.4	124.8	185.1
80		NS	200	0.67	1.32	50.5	121.0	171.5
160		---	200	0.88	1.39	68.7	135.8	204.5
160		NS	200	0.86	1.48	67.4	150.7	218.1
240		---	---	0.93	1.42	77.9	143.3	221.2
240		NS	---	0.87	1.44	67.2	139.7	206.9
240		---	100	0.88	1.35	68.6	134.0	202.6
240		NS	100	1.06	1.48	83.0	144.9	227.9
240		---	200	0.87	1.44	68.3	146.1	214.4
240		NS	200	0.93	1.51	73.7	145.4	219.1
80	LH74 X LH85	---	---	0.66	1.30	56.5	119.7	176.2
80		NS	---	0.78	1.31	65.8	122.5	188.3
80		---	100	0.74	1.33	58.0	112.2	170.2
80		NS	100	0.72	1.31	60.8	114.0	174.8
80		---	200	0.73	1.34	60.7	123.7	184.4
80		NS	200	0.71	1.30	55.1	109.5	164.6
160		---	200	0.87	1.57	73.4	150.0	223.4
160		NS	200	0.89	1.42	79.2	131.1	210.3
240		---	---	0.95	1.45	82.1	135.3	217.4
240		NS	---	0.87	1.43	74.1	131.6	205.7
240		---	100	0.95	1.43	80.4	128.9	209.3
240		NS	100	0.97	1.44	81.5	132.8	214.3
240		---	200	0.88	1.44	79.8	136.1	215.9
240		NS	200	0.99	1.49	85.5	145.6	231.1
80	DeKalb 485	---	---	0.74	1.13	62.5	107.7	170.3
80		NS	---	0.70	1.17	59.0	114.0	173.0
80		---	100	0.66	1.14	55.4	109.9	165.2
80		NS	100	0.73	1.17	59.9	113.7	173.6
80		---	200	0.60	1.07	45.9	95.4	141.3
80		NS	200	0.67	1.19	56.6	115.9	172.5
160		---	200	0.78	1.30	68.0	139.4	207.3
160		NS	200	0.86	1.39	75.0	142.0	217.0
240		---	---	0.95	1.30	83.2	137.7	220.9
240		NS	---	0.93	1.46	87.3	156.9	244.2
240		---	100	0.93	1.29	79.7	134.2	213.9
240		NS	100	0.91	1.28	76.0	134.4	210.4
240		---	200	0.87	1.44	72.5	144.3	216.8
240		NS	200	0.97	1.37	84.1	141.9	226.0

Table 8. Continued from table 1.

200 # K-Rate only (Hybrid X N-Rate X Inhibitor)	Whole Plant Silking Stover		
Hybrids	T/A	% N	#/A
Pioneer 3615	3.58	1.74	124.4
Pioneer 3737	3.75	1.87	139.9
LH74 X LH85	3.75	1.79	134.6
DeKalb 485	3.74	1.81	134.8
P-Value	73	78	95
BLSD (.05)			12.5
N-Rate			
80	3.68	1.64	120.8
160	3.77	1.81	136.5
240	3.67	1.95	142.9
P-Value	52	99	99
BLSD (.05)		0.09	9.0
Inhibitor			
None	3.69	1.83	135.1
N-Serve	3.71	1.77	131.8
P-Value	24	85	60
Hybrid X N-Rate	65	99	99
Hybrid X Inhibitor	99	82	21
N-Rate X Inhibitor	14	34	36
Hybrid X N-Rate X Inh.	95	13	26
Split Plot without the 160# N-Rate			
K-Rate			
0	3.72	1.84	135.5
100	3.71	1.86	138.6
200	3.67	1.80	131.9
P-Value	8	73	69
BLSD(.05)			
Hybrid X N-Rate X Inhibitor			
Hybrid			
Pioneer 3615	3.61	1.79	130.0
Pioneer 3737	3.68	1.87	137.1
LH74 X LH85	3.73	1.82	136.0
DeKalb 485	3.78	1.83	138.2
P-Value	11	79	92
BLSD(.05)			
N-Rate			
80	3.68	1.68	123.7
240	3.73	1.97	146.9
P-Value	63	99	99
Inhibitor			
None	3.70	1.85	137.3
N-Serve	3.71	1.79	133.3
P-Value	8	98	90
Hybrid X N-Rate	76	30	99
Hybrid X Inhibitor	60	63	90
N-Rate X Inhibitor	32	36	52
Hybrid X N-Rate X Inhibitor	33	92	98
Hybrid X N-Rate X Inhibitor X K-Rate			
Hybrid X K-Rate	3	99	94
N-Rate X K-Rate	28	99	13
Hybrid X N-Rate X K-Rate	81	83	89
Inhibitor X K-Rate	17	34	14
Hybrid X Inhibitor X K-Rate	89	97	17
N-Rate X Inhibitor X K-Rate	27	61	61
Hybrid X N-Rate X Inhibitor X K-Rate	84	99	62

Table 9. Continued from table 2. **Milk Stage R3**

200 # K-Rate only RCB (Hybrid X N-Rate X Inh.)	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
Hybrids	Bu/A	----------T/A----------			
Pioneer 3615	38.9	0.92	4.57	0.66	6.15
Pioneer 3737	62.2	1.47	3.96	0.64	6.07
LH74 X LH85	69.4	1.64	4.20	0.74	6.58
DeKalb 485	62.2	1.47	4.39	0.71	6.58
P-Value	99	99	99	99	99
BLSD (.05)	4.6	0.11	0.24	0.05	0.36
N-Rate					
80	55.1	1.30	4.24	0.63	6.18
160	60.5	1.43	4.31	0.72	6.47
240	58.8	1.39	4.28	0.70	6.38
P-Value	95	95	19	99	84
BLSD (.05)	4.8	0.11		0.04	
Inhibitor					
None	57.9	1.37	4.23	0.68	6.29
N-Serve	58.4	1.38	4.32	0.69	6.40
P-Value	22	22	68	7	60
Hybrid X N-Rate	76	76	12	96	56
Hybrid X Inhibitor	57	57	87	27	62
N-Rate X Inhibitor	95	95	84	58	95
Hybrid X N-Rate X Inh.					
Split Plot without the 160# N-Rate					
K-Rate					
0	61.2	1.45	4.23	0.69	6.38
100	55.8	1.32	4.20	0.70	6.23
200	57.0	1.34	4.26	0.67	6.28
P-Value	34	34	8	59	13
BLSD(.05)					
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3615	39.9	0.94	4.37	0.65	5.97
Pioneer 3737	60.6	1.43	4.07	0.65	6.16
LH74 X LH85	68.0	1.61	4.15	0.72	6.49
DeKalb 485	63.4	1.50	4.34	0.72	6.57
P-Value	99	99	99	99	99
BLSD(.05)	3.0	0.07	0.18	0.03	0.22
N-Rate					
80	56.5	1.33	4.23	0.66	6.23
240	59.5	1.40	4.23	0.72	6.36
P-Value	99	99	2	99	86
Inhibitor					
None	57.3	1.35	4.21	0.68	6.26
N-Serve	58.7	1.39	4.25	0.69	6.34
P-Value	76	76	43	56	66
Hybrid X N-Rate	75	75	80	42	79
Hybrid X Inhibitor	86	86	69	91	91
N-Rate X Inhibitor	75	75	95	90	97
Hybrid X N-Rate X Inhibitor	56	56	6	18	22
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	55	55	19	14	12
N-Rate X K-Rate	11	11	12	35	18
Hybrid X N-Rate X K-Rate	93	93	41	34	73
Inhibitor X K-Rate	49	49	34	14	14
Hybrid X Inhibitor X K-Rate	95	95	72	97	93
N-Rate X Inhibitor X K-Rate	13	13	47	35	45
Hybrid X N-Rate X Inhibitor X K-Rate	99	99	92	49	99

Table 10. Continued from table 3. **Milk Stage R3**

	N-Contration			N-Removal			
	Stover	Grain	Cob	Stover	Grain	Cob	Total
	---------%---------			----------#/A----------			
200 # K-Rate only RCB (Hybrid X N-Rate X Inh.)							
Hybrids							
Pioneer 3615	1.17	1.88	1.05	106.0	34.5	13.9	154.5
Pioneer 3737	1.36	1.68	0.86	108.0	49.6	11.0	168.7
LH74 X LH85	1.26	1.75	0.77	106.5	57.8	11.4	175.8
DeKalb 485	1.41	1.66	0.82	124.3	49.0	11.6	184.9
P-Value	99	99	99	99	99	99	99
BLSD (.05)	0.09	0.05	0.05	9.2	3.9	1.1	10.9
N-Rate							
80	1.03	1.65	0.86	87.4	42.6	10.9	140.9
160	1.34	1.76	0.88	116.0	50.4	12.7	179.2
240	1.52	1.81	0.89	130.2	50.2	12.3	192.8
P-Value	99	99	51	99	99	99	99
BLSD (.05)	0.07	0.04		7.3	3.5	0.9	8.9
Inhibitor							
None	1.26	1.75	0.87	107.0	47.7	11.9	166.7
N-Serve	1.33	1.74	0.87	115.4	47.7	12.0	175.3
P-Value	96	45	19	99	2	11	96
Hybrid X N-Rate	98	43	56	62	49	77	26
Hybrid X Inhibitor	17	63	87	16	85	95	41
N-Rate X Inhibitor	88	81	60	99	86	29	94
Hybrid X N-Rate X Inh.	36	16	12	42	91	57	71
Split Plot without the 160# N-Rate							
K-Rate							
0	1.21	1.75	0.84	102.8	50.2	11.8	164.8
100	1.26	1.74	0.86	105.9	45.5	12.1	163.6
200	1.28	1.73	0.87	108.8	46.4	11.6	166.9
P-Value	54	19	52	40	42	20	6
BLSD(.05)							
Hybrid X N-Rate X Inhibitor							
Hybrid							
Pioneer 3615	1.17	1.91	1.03	101.7	35.9	13.4	151.1
Pioneer 3737	1.29	1.68	0.85	105.2	48.2	11.2	164.7
LH74 X LH85	1.26	1.74	0.77	105.7	56.0	11.1	172.9
DeKalb 485	1.27	1.64	0.80	110.6	49.4	11.5	171.6
P-Value	99	99	99	92	99	99	99
BLSD(.05)	0.07	0.78	0.03		2.3	0.7	7.3
N-Rate							
80	1.08	1.68	0.86	91.3	44.3	11.2	147.0
240	1.42	1.81	0.86	120.3	50.4	12.4	183.2
P-Value	99	99	49	99	99	99	99
Inhibitor							
None	1.22	1.74	0.87	102.7	46.7	11.8	161.2
N-Serve	1.28	1.74	0.85	109.0	48.1	11.9	169.0
P-Value	98	12	59	99	87	33	99
Hybrid X N-Rate	99	62	59	99	82	45	97
Hybrid X Inhibitor	99	56	10	99	93	62	99
N-Rate X Inhibitor	28	67	2	88	86	83	95
Hybrid X N-Rate X Inhibitor	60	45	55	18	43	60	8
Hybrid X N-Rate X Inhibitor X K-Rate							
Hybrid X K-Rate	89	39	54	65	75	37	57
N-Rate X K-Rate	99	82	40	99	48	37	99
Hybrid X N-Rate X K-Rate	48	76	1	29	95	8	21
Inhibitor X K-Rate	98	10	23	88	65	28	92
Hybrid X Inhibitor X K-Rate	99	7	62	99	93	93	99
N-Rate X Inhibitor X K-Rate	92	17	58	68	17	36	58
Hybrid X N-Rate X Inhibitor X K-Rate	68	20	17	76	99	59	87

Table 11. Continued from table 4. **Dent Stage R5**

	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
	Bu/A	----------T/A----------			
200 # K-Rate only RCB (Hybrid X N-Rate X Inh.)					
Hybrids					
Pioneer 3615	115.6	2.73	4.20	0.74	7.68
Pioneer 3737	150.1	3.55	3.83	0.58	7.96
LH74 X LH85	141.5	3.34	3.88	0.73	7.97
DeKalb 485	148.2	3.50	3.99	0.69	8.20
P-Value	99	99	96	99	79
BLSD (.05)	8.2	0.19	0.30	0.04	
N-Rate					
80	132.5	3.13	3.81	0.62	7.57
160	141.4	3.34	4.07	0.72	8.14
240	142.6	3.37	4.05	0.72	8.14
P-Value	98	98	95	99	99
BLSD (.05)	8.1	0.19	0.25	0.03	0.41
Iinhibitor					
None	135.1	3.19	3.98	0.68	7.87
N-Serve	142.6	3.37	3.97	0.69	8.04
P-Value	98	98	16	50	68
Hybrid X N-Rate	12	12	17	78	16
Hybrid X Inhibitor	57	57	35	35	47
N-Rate X Inhibitor	90	90	15	60	62
Hybrid X N-Rate X Inh.	23	23	61	27	49
Split Plot without the 160# N-Rate					
K-Rate					
0	142.6	3.37	4.04	0.72	8.14
100	134.8	3.19	3.88	0.67	7.74
200	137.6	3.25	3.96	0.67	7.86
P-Value	36	36	44	80	44
BLSD(.05)					
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3615	115.0	2.72	4.05	0.74	7.52
Pioneer 3737	146.4	3.46	3.81	0.58	7.86
LH74 X LH85	142.0	3.36	3.96	0.73	8.03
DeKalb 485	149.9	3.54	3.99	0.70	8.24
P-Value	99	99	95	99	99
BLSD(.05)	5.0	0.11	0.20	0.02	1.87
N-Rate					
80	134.8	3.19	3.85	0.66	7.71
240	141.8	3.35	4.04	0.71	8.12
P-Value	99	99	99	99	99
Inhibitor					
None	136.8	3.23	3.92	0.68	7.84
N-Serve	139.9	3.31	3.98	0.69	7.99
P-Value	88	88	66	84	84
Hybrid X N-Rate	72	72	30	88	62
Hybrid X Inhibitor	80	80	63	90	46
N-Rate X Inhibitor	79	79	48	92	73
Hybrid X N-Rate X Inhibitor	87	87	31	81	67
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	81	81	85	44	78
N-Rate X K-Rate	44	44	15	99	45
Hybrid X N-Rate X K-Rate	61	61	72	99	77
Inhibitor X K-Rate	97	97	27	47	40
Hybrid X Inhibitor X K-Rate	54	54	21	69	42
N-Rate X Inhibitor X K-Rate	67	67	6	96	15
Hybrid X N-Rate X Inhibitor X K-Rate	56	56	78	88	82

Table 12. Continued from table 5. **Dent Stage R5**

	N-Concentration			N-Removal			
	Stover	Grain	Cob	Stover	Grain	Cob	Total
	---------%---------			----------#/A----------			
200 # K-Rate only RCB (Hybrid X N-Rate X Inh.)							
Hybrid							
Pioneer3615	1.25	1.35	0.79	101.1	78.6	11.7	191.6
Pioneer 3737	1.25	1.35	0.58	95.8	95.9	6.8	198.7
LH74 X LH85	1.15	1.42	0.61	89.6	96.0	9.0	194.7
DeKalb 485	1.33	1.25	0.59	107.4	88.4	8.3	204.2
P-Value	99	99	99	99	99	99	81
BLSD (.05)	0.08	0.04	0.03	7.9	5.6	0.7	
N-Rate							
80	1.09	1.25	0.63	83.4	78.8	8.0	170.3
160	1.30	1.41	0.65	105.7	93.9	9.5	209.2
240	1.31	1.43	0.65	106.3	96.5	9.4	212.4
P-Value	99	99	50	99	99	99	99
BLSD (.05)	0.7	0.04		6.4	4.7	0.6	9.3
Inhibitor							
None	1.19	1.37	0.62	95.6	87.9	8.6	192.2
N-Serve	1.27	1.36	0.66	101.4	91.6	9.3	202.4
P-Value	99	49	99	96	90	98	98
Hybrid X N-Rate	98	6	98	99	16	98	92
Hybrid X Inhibitor	97	91	53	97	5	46	79
N-Rate X Inhibitor	99	59	68	99	84	82	99
Hybrid X N-Rate X Inh.	99	44	38	99	72	99	99
Split Plot without the 160# N-Rate							
K-Rate							
0	1.19	1.37	0.64	96.7	92.3	9.3	198.4
100	1.13	1.36	0.65	88.1	86.4	8.9	183.5
200	1.20	1.34	0.64	94.9	87.7	8.7	191.3
P-Value	92	41	13	81	46	73	64
BLSD(.05)							
Hybrid X N-Rate X Inhibitor							
Hybrid							
Pioneer 3615	1.14	1.41	0.78	93.5	77.0	11.5	182.2
Pioneer 3737	1.22	1.35	0.57	94.1	93.8	6.7	194.7
LH74 X LH85	1.07	1.41	0.62	84.8	95.5	9.1	189.5
DeKalb 485	1.25	1.24	0.61	100.5	88.8	8.5	197.9
P-Value	99	99	99	99	99	99	99
BLSD(.05)	0.05	0.03	0.02	5.7	3.5	0.4	8.3
N-Rate							
80	1.09	1.29	0.64	84.4	82.2	8.5	175.1
240	1.26	1.42	0.65	102.1	95.4	9.4	207.0
P-Value	99	99	80	99	99	99	99
Inhibitor							
None	1.12	1.35	0.64	88.4	87.5	8.8	184.8
N-Serve	1.23	1.36	0.65	98.0	90.1	9.2	197.4
P-Value	99	51	85	99	93	97	99
Hybrid X N-Rate	91	43	84	85	78	84	73
Hybrid X Inhibitor	99	69	25	99	17	44	94
N-Rate X Inhibitor	72	83	91	75	92	7	91
Hybrid X N-Rate X Inhibitor	99	68	77	81	87	40	20
Hybrid X N-Rate X Inhibitor X K-Rate							
Hybrid X K-Rate	45	7	97	94	79	94	96
N-Rate X K-Rate	99	99	12	99	96	92	99
Hybrid X N-Rate X K-Rate	99	11	74	99	77	99	99
Inhibitor X K-Rate	99	95	96	99	57	94	75
Hybrid X Inhibitor X K-Rate	99	76	63	92	88	76	92
N-Rate X Inhibitor X K-Rate	99	84	63	96	53	97	93
Hybrid X N-Rate X Inh. X K-Rate 99	47	34	99	86	84	99	

Table 13. Continued from table 6. **Physiological Maturity**

	Grain Yields	Dry Matter Production Grain	Stover	Total
	Bu/A	----------T/A----------		
200 # K-Rate only RCB (Hybrid X N-Rate X Inh)				
Hybrids				
Pioneer 3615	196.4	4.64	4.32	8.96
Pioneer 3737	205.3	4.86	3.93	8.79
LH74 X LH85	196.1	4.64	4.26	8.90
DeKalb 485	211.3	5.00	4.21	9.21
P-Value	99	99	99	99
BLSD (.05)	6.1	0.14	0.12	0.26
N-Rate				
80	189.9	4.49	4.03	8.53
160	208.5	4.93	4.23	9.17
240	208.5	4.93	4.27	4.93
P-Value	99	99	99	99
BLSD (.05)	5.1	0.12	0.10	0.19
Inhibitor				
None	202.2	4.78	4.14	8.92
N-Serve	202.4	4.79	4.22	9.01
P-Value	9	9	89	65
Hybrid X N-Rate	55	55	76	67
Hybrid X Inhibitor	65	65	94	91
N-Rate X Inhibitor	12	12	29	1
Hybrid X N-Rate X Inh.	97	97	76	97
Split Plot without the 160# N-Rate				
K-Rate				
0	207.2	4.90	4.31	9.22
100	200.1	4.73	4.14	8.88
200	199.2	4.71	4.15	8.87
P-Value	91	91	80	88
BLSD(.05)				
Hybrid X N-Rate X Inhibitor				
Hybrid				
Pioneer 3615	198.6	4.70	4.39	9.09
Pioneer 3737	206.1	4.87	3.97	8.84
LH74 X LH85	192.7	4.56	4.21	8.77
DeKalb 485	211.2	4.99	4.25	9.24
P-Value	99	99	99	99
BLSD(.05)	4.0	0.09	0.09	0.17
N-Rate				
80	195.0	4.61	4.12	8.73
240	209.3	4.92	4.28	9.24
P-Value	99	99	99	99
Inhibitor				
None	201.4	4.76	4.18	8.94
N-Serve	202.9	4.80	4.23	9.03
P-Value	65	65	77	77
Hybrid X N-Rate	99	99	93	99
Hybrid X Inhibitor	71	71	66	73
N-Rate X Inhibitor	89	89	60	89
Hybrid X N-Rate X Inhibitor	82	82	11	41
Hybrid X N-Rate X Inhibitor X K-Rate				
Hybrid X K-Rate	88	88	74	71
N-Rate X K-Rate	99	99	80	97
Hybrid X N-Rate X K-Rate	50	50	70	70
Inhibitor X K-Rate	19	19	35	32
Hybrid X Inhibitor X K-Rate	64	64	87	80
N-Rate X Inhibitor X K-Rate	76	76	14	48
Hybrid X N-Rate X Inhibitor X K-Rate	37	37	73	58

Table 14. Continued from table 7. **Physiological Maturity**

	N-Concentration		N-Removal		
	Stover	Grain	Stover	Grain	Total
	-------%-------		----------#/A----------		
200 # K-Rate only RCB (Hybrid X N-Rate X Inh.)					
Hybrids					
Pioneer 3615	0.74	1.40	65.0	131.3	196.2
Pioneer 3737	0.82	1.40	64.8	137.3	202.1
LH74 X LH85	0.84	1.42	72.2	132.6	204.9
DeKalb 485	0.79	1.29	67.0	129.8	196.8
P-Value	99	99	99	85	78
BLSD (.05)	0.04	0.04	4.7		
N-Rate					
80	0.69	1.26	54.0	113.6	167.7
160	0.84	1.43	71.3	141.2	212.5
240	0.89	1.45	76.4	143.4	219.8
P-Value	99	99	99	99	99
BLSD (.05)	0.03	0.03	3.6	5.2	7.5
Inhibitor					
None	0.77	1.37	64.8	131.4	196.2
N-Serve	0.82	1.39	69.6	134.1	203.8
P-Value	99	85	99	74	97
Hybrid X N-Rate	31	65	42	52	57
Hybrid X Inhibitor	85	87	97	92	96
N-Rate X Inhibitor	65	12	60	13	22
Hybrid X N-Rate X Inh.	37	90	49	96	85
Split Plot without the 160# N-Rate					
K-Rate					
0	0.79	1.34	68.4	132.3	200.8
100	0.81	1.30	67.4	123.7	191.1
200	0.78	1.35	65.2	128.5	193.7
P-Value	11	93	58	86	86
BLSD(.05)					
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3615	0.73	1.35	64.7	128.2	192.9
Pioneer 3737	0.81	1.36	64.9	133.1	198.0
LH74 X LH85	0.82	1.37	70.0	125.9	196.0
DeKalb 485	0.80	1.25	68.5	125.4	194.0
P-Value	99	99	99	99	78
BLSD(.05)	0.02	0.02	2.7	4.0	
N-Rate					
80	0.68	1.25	56.7	115.7	172.4
240	0.90	1.42	77.3	140.7	218.0
P-Value	99	99	99	99	99
Inhibitor					
None	0.78	1.31	65.5	125.5	191.0
N-Serve	0.81	1.36	68.5	130.8	199.4
P-Value	99	99	99	99	99
Hybrid X N-Rate	93	49	92	99	99
Hybrid X Inhibitor	7	92	33	82	84
N-Rate X Inhibitor	3	8	25	70	65
Hybrid X N-Rate X Inhibitor	17	21	5	70	27
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	35	57	89	57	57
N-Rate X K-Rate	67	55	89	98	99
Hybrid X N-Rate X K-Rate	15	84	65	90	96
Inhibitor X K-Rate	82	66	87	35	17
Hybrid X Inhibitor X K-Rate	94	27	99	54	95
N-Rate X Inhibitor X K-Rate	99	48	99	80	98
Hybrid X N-Rate X Inhibitor X K-Rate	92	54	99	99	99

Table 15. Influence of N-rate, K-rate and nitrification on stover dry matter production, N content and total N removal on four corn hybrids at silking. Waseca 1989.

N-Rate	Hybrid	Inh.	K-Rate	Whole Plant Silking Stover		
#/A			#/A	T/A	% N	#/A
0	Pioneer 3615	---	---	4.07	1.37	111.4
0		---	100	3.75	1.01	74.6
80		---	---	4.12	1.50	123.3
80		NS	---	3.82	1.56	119.6
80		---	100	4.16	1.49	123.7
80		NS	100	4.13	1.50	122.6
160		---	---	3.67	1.53	112.0
160		NS	---	3.90	1.64	128.1
160		---	100	3.98	1.55	123.1
160		NS	100	4.03	1.54	123.8
0	Pioneer 3475	---	---	3.82	1.15	87.5
0		---	100	4.36	0.87	75.2
80		---	---	4.55	1.45	132.0
80		NS	---	4.19	1.55	129.8
80		---	100	4.44	1.55	136.6
80		NS	100	4.33	1.44	125.0
160		---	---	4.54	1.73	157.1
160		NS	---	4.44	1.44	127.9
160		---	100	4.37	1.65	144.3
160		NS	100	3.98	1.44	114.8
0	LH74 X LH51	---	---	4.32	1.37	117.9
0		---	100	3.89	1.29	100.3
80		---	---	4.65	1.63	151.5
80		NS	---	4.29	1.56	134.0
80		---	100	4.26	1.64	138.1
80		NS	100	4.02	1.56	124.8
160		---	---	4.35	1.84	160.2
160		NS	---	4.16	1.60	132.7
160		---	100	4.61	1.59	146.6
160		NS	100	4.44	1.67	146.4
0	LH74 X LH82	---	---	3.33	1.18	78.2
0		---	100	4.04	1.31	104.7
80		---	---	3.61	1.65	119.0
80		NS	---	4.23	1.77	149.6
80		---	100	4.20	1.64	137.6
80		NS	100	4.31	1.59	136.6
160		---	---	4.02	1.80	144.6
160		NS	---	4.23	1.69	142.9
160		---	100	4.18	1.65	136.9
160		NS	100	4.79	1.74	165.2

Table 16. Influence of N-rate, K-rate and nitrification on grain yields and dry matter production on four corn hybrids at the **milk stage R3**. Waseca 1989.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
#/A			#/A	Bu/A	----------T/A----------			
0	Pioneer 3615	---	---	66.2	1.57	4.41	0.68	6.65
0		---	100	43.9	1.04	4.47	0.54	6.05
80		---	---	74.8	1.77	4.46	0.79	7.02
80		NS	---	65.4	1.55	4.34	0.77	6.66
80		---	100	63.3	1.50	4.64	0.73	6.87
80		NS	100	54.6	1.29	4.43	0.66	6.38
160		---	---	65.7	1.55	4.27	0.75	6.57
160		NS	---	66.9	1.58	4.28	0.77	6.63
160		---	100	57.0	1.35	4.47	0.72	6.54
160		NS	100	60.9	1.44	4.89	0.73	7.06
0	Pioneer 3475	---	---	48.9	1.16	4.12	0.57	5.85
0		---	100	37.8	0.89	4.67	0.57	6.13
80		---	---	69.5	1.64	4.96	0.84	7.45
80		NS	---	66.7	1.58	4.70	0.77	7.05
80		---	100	54.6	1.29	4.52	0.67	6.48
80		NS	100	51.7	1.22	4.49	0.64	6.36
160		---	---	66.4	1.57	5.01	0.80	7.38
160		NS	---	60.6	1.43	4.48	0.76	6.68
160		---	100	59.8	1.41	5.24	0.75	7.41
160		NS	100	53.7	1.27	4.89	0.70	6.86
0	LH74 X LH51	---	---	42.2	1.00	5.01	0.59	6.60
0		---	100	30.5	0.72	5.26	0.47	6.45
80		---	---	55.5	1.31	5.42	0.72	7.46
80		NS	---	49.2	1.16	5.17	0.63	6.96
80		---	100	44.5	1.05	5.31	0.65	7.02
80		NS	100	48.8	1.15	5.71	0.70	7.56
160		---	---	44.6	1.05	4.52	0.59	6.16
160		NS	---	50.9	1.20	5.01	0.64	6.85
160		---	100	43.2	1.02	5.56	0.66	7.24
160		NS	100	47.6	1.13	5.75	0.67	7.54
0	LH74 X LH82	---	---	59.7	1.41	3.61	0.50	5.52
0		---	100	51.9	1.23	4.04	0.51	5.77
80		---	---	76.3	1.80	3.78	0.67	6.25
80		NS	---	89.2	2.11	4.50	0.70	7.30
80		---	100	69.9	1.65	4.20	0.64	6.49
80		NS	100	71.7	1.70	4.68	0.72	7.10
160		---	---	80.9	1.92	3.98	0.68	6.58
160		NS	---	80.3	1.90	4.33	0.72	6.96
160		---	100	70.6	1.67	4.29	0.66	6.62
160		NS	100	76.8	1.82	4.60	0.72	7.14

Table 17. Influence of N-rate, K-rate and nitrification on N content and total N removal on four corn hybrids at the **milk stage R3**. Waseca 1989.

				N-Concentration			N-Removal			
N-Rate	Hybrid	Inh.	K-Rate	Stover	Grain	Cob	Stover	Grain	Cob	Total
#/A			#/A	----------%----------			----------#/A----------			
0	Pioneer 3615	---	---	0.90	1.54	0.76	79.1	48.0	10.3	137.4
0		---	100	0.62	1.65	0.86	55.7	34.4	9.1	99.2
80		---	---	1.07	1.78	0.76	95.9	62.6	12.0	170.5
80		NS	---	0.97	1.73	0.82	84.3	53.4	12.6	150.3
80		---	100	1.19	1.81	0.78	110.2	54.0	11.5	175.7
80		NS	100	1.04	1.81	0.84	91.7	46.8	11.2	149.7
160		---	---	1.05	1.80	0.80	89.8	55.7	12.0	157.5
160		NS	---	1.28	1.65	0.78	109.4	51.9	12.1	173.4
160		---	100	1.30	1.83	0.86	115.5	49.4	12.3	177.3
160		NS	100	1.25	1.79	0.81	122.5	51.5	11.7	185.8
0	Pioneer 3475	---	---	0.70	1.60	0.77	58.1	36.8	8.8	103.6
0		---	100	0.74	1.67	0.82	69.0	29.8	9.3	108.1
80		---	---	1.13	1.50	0.77	111.0	49.1	12.9	173.0
80		NS	---	1.03	1.57	0.83	95.8	49.2	12.7	157.8
80		---	100	1.24	1.61	0.85	111.7	41.5	11.4	164.5
80		NS	100	1.05	1.74	0.90	93.3	42.5	11.6	147.4
160		---	---	1.13	1.67	0.88	112.2	52.6	14.1	178.9
160		NS	---	1.06	1.64	0.88	95.1	47.1	13.4	155.6
160		---	100	1.28	1.57	0.92	135.1	44.5	13.7	193.4
160		NS	100	1.22	1.81	0.95	119.7	45.8	13.3	178.8
0	LH74 X LH51	---	---	0.84	1.71	0.68	85.6	34.1	7.9	127.5
0		---	100	0.70	1.74	0.75	73.7	25.2	7.0	105.9
80		---	---	1.34	1.93	0.75	144.5	50.0	10.8	205.2
80		NS	---	1.11	1.92	0.74	114.5	44.5	9.3	168.3
80		---	100	1.04	2.00	0.78	110.8	41.9	10.2	162.9
80		NS	100	1.13	1.85	0.80	129.3	42.8	11.2	183.2
160		---	---	1.26	1.95	0.76	113.4	41.2	9.0	163.6
160		NS	---	1.20	1.91	0.75	119.4	46.0	9.5	174.8
160		---	100	1.23	2.03	0.80	136.9	41.5	10.5	188.9
160		NS	100	1.17	2.00	0.83	135.5	44.7	11.0	191.1
0	LH74 X LH82	---	---	0.83	1.40	0.61	59.8	39.6	6.0	105.4
0		---	100	0.71	1.43	0.72	58.1	34.9	7.2	100.2
80		---	---	1.17	1.61	0.68	88.2	58.1	9.1	155.4
80		NS	---	1.25	1.60	0.70	112.0	67.4	9.7	189.0
80		---	100	1.09	1.64	0.75	90.9	54.1	9.6	154.5
80		NS	100	1.02	1.76	0.76	95.9	59.5	11.0	166.4
160		---	---	1.21	1.68	0.72	95.8	64.0	9.8	169.6
160		NS	---	1.15	1.63	0.68	99.6	61.8	9.8	171.2
160		---	100	1.23	1.70	0.71	105.5	56.6	9.3	171.3
160		NS	100	1.15	1.73	0.77	106.0	62.5	10.9	179.4

Table 18. Influence of N-rate, K-rate and nitrification on grain yield and dry matter production on four corn hybrids at the dent stage R5. Waseca 1989.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
#/A			#/A	Bu/A	----------T/A----------			
0	Pioneer 3615	---	---	135.8	3.21	3.52	0.66	7.39
0		---	100	104.5	2.47	3.34	0.56	6.37
80		---	---	156.5	3.70	3.89	0.76	8.36
80		NS	---	150.7	3.57	3.62	0.78	7.97
80		---	100	141.3	3.34	3.87	0.73	7.94
80		NS	100	134.8	3.19	3.63	0.71	7.53
160		---	---	139.4	3.30	3.19	0.65	7.14
160		NS	---	147.6	3.49	3.49	0.75	7.73
160		---	100	138.6	3.28	3.59	0.74	7.61
160		NS	100	138.3	3.27	3.79	0.72	7.79
0	Pioneer 3475	---	---	111.1	2.63	3.47	0.54	6.65
0		---	100	98.8	2.34	3.83	0.53	6.70
80		---	---	152.9	3.62	4.08	0.77	8.46
80		NS	---	148.4	3.51	3.84	0.71	8.07
80		---	100	126.5	2.99	4.03	0.60	7.63
80		NS	100	126.4	2.99	3.73	0.62	7.34
160		---	---	144.5	3.42	4.09	0.70	8.21
160		NS	---	139.7	3.31	3.27	0.66	7.24
160		---	100	127.6	3.02	3.70	0.67	7.39
160		NS	100	140.8	3.33	4.17	0.69	8.20
0	LH74 X LH51	---	---	114.1	2.70	4.24	0.57	7.51
0		---	100	103.5	2.45	4.78	0.53	7.75
80		---	---	131.2	3.10	4.23	0.63	7.97
80		NS	---	129.7	3.07	4.40	0.62	8.09
80		---	100	118.4	2.80	4.26	0.62	7.68
80		NS	100	120.0	2.84	4.37	0.62	7.83
160		---	---	131.4	3.11	4.11	0.59	7.81
160		NS	---	116.2	2.75	3.86	0.57	7.18
160		---	100	113.7	2.69	4.38	0.60	7.68
160		NS	100	132.2	3.13	5.15	0.68	8.96
0	LH74 X LH82	---	---	106.9	2.53	3.03	0.54	6.10
0		---	100	100.2	2.37	3.38	0.51	6.26
80		---	---	135.9	3.22	3.17	0.61	6.99
80		NS	---	148.0	3.50	3.47	0.65	7.62
80		---	100	137.7	3.26	3.92	0.66	7.83
80		NS	100	137.2	3.25	3.65	0.65	7.54
160		---	---	141.7	3.35	3.47	0.65	7.48
160		NS	---	142.9	3.38	3.35	0.65	7.38
160		---	100	144.8	3.43	3.97	0.69	8.09
160		NS	100	143.0	3.38	3.61	0.69	7.69

Table 19. Influence of N-rate, K-rate and nitrification on N content, and total N removal on four corn hybrids at the **dent stage R5**. Waseca 1989.

				N-Concentration			N-Removal			
N-Rate	Hybrid	Inh.	K-Rate	Stover	Grain	Cob	Stover	Grain	Cob	Total
#/A			#/A	----------%----------			----------#/A----------			
0	Pioneer 3615	---	---	0.77	1.29	0.58	54.6	82.8	7.6	144.9
0		---	100	0.72	1.26	0.63	48.1	62.2	6.9	117.2
80		---	---	1.01	1.49	0.54	78.6	110.3	8.1	196.9
80		NS	---	0.94	1.46	0.60	68.0	103.6	9.4	181.0
80		---	100	0.84	1.40	0.56	64.8	93.6	8.1	166.5
80		NS	100	0.92	1.47	0.60	66.6	93.8	8.4	168.9
160		---	---	0.97	1.46	0.58	61.7	95.9	7.5	165.1
160		NS	---	1.03	1.54	0.56	72.1	107.6	8.4	188.1
160		---	100	0.96	1.53	0.57	68.6	99.8	8.5	176.9
160		NS	100	0.87	1.54	0.62	65.7	100.8	8.8	175.3
0	Pioneer 3475	---	---	0.63	1.14	0.58	43.5	59.8	6.2	109.5
0		---	100	0.58	1.18	0.56	44.2	55.4	5.9	105.5
80		---	---	1.00	1.42	0.61	80.2	102.0	9.2	191.4
80		NS	---	0.87	1.39	0.60	67.3	97.8	8.5	173.6
80		---	100	1.01	1.37	0.70	81.5	82.5	8.3	172.3
80		NS	100	0.89	1.46	0.64	66.7	87.0	7.9	161.6
160		---	---	0.95	1.47	0.62	77.5	100.7	8.7	186.9
160		NS	---	0.92	1.41	0.61	60.4	92.9	8.0	161.3
160		---	100	0.93	1.42	0.63	68.8	85.3	8.4	162.5
160		NS	100	0.92	1.44	0.65	76.2	95.7	8.9	180.8
0	LH74 X LH51	---	---	0.72	1.26	0.48	61.6	68.1	5.4	135.1
0		---	100	0.55	1.10	0.52	53.0	53.8	5.5	112.2
80		---	---	1.15	1.59	0.50	97.0	98.7	6.4	202.1
80		NS	---	1.00	1.43	0.55	88.2	87.6	6.8	182.6
80		---	100	0.91	1.44	0.53	78.0	80.6	6.5	165.1
80		NS	100	1.03	1.41	0.52	90.6	79.7	6.4	176.7
160		---	---	1.19	1.44	0.53	98.1	89.5	6.2	193.8
160		NS	---	1.14	1.51	0.61	88.3	82.8	6.9	178.0
160		---	100	1.01	1.53	0.57	88.5	82.4	6.9	177.8
160		NS	100	1.13	1.51	0.53	116.4	93.5	7.2	217.1
0	LH74 X LH82	---	---	0.63	1.18	0.58	38.1	59.6	6.3	104.0
0		---	100	0.54	1.16	0.64	36.7	55.2	6.4	98.3
80		---	---	0.90	1.45	0.59	57.0	93.6	7.2	157.8
80		NS	---	0.96	1.54	0.53	66.1	107.6	6.9	180.6
80		---	100	0.94	1.40	0.61	74.0	91.2	8.0	173.3
80		NS	100	1.00	1.41	0.50	72.1	90.8	6.5	169.4
160		---	---	0.97	1.55	0.65	67.8	103.6	8.4	179.9
160		NS	---	0.96	1.49	0.51	64.1	101.0	6.6	171.7
160		---	100	1.07	1.50	0.59	84.6	102.6	8.1	195.3
160		NS	100	1.04	1.43	0.66	75.4	96.5	9.1	181.0

Table 20. Influence of N-rate, K-rate and nitrification on grain yields and dry matter production on four corn hybrids at **physiological maturity**. Waseca 1989.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Total
#/A			#/A	Bu/A	----------T/A---------		
0	Pioneer 3615	---	---	166.9	3.95	3.76	7.71
0		---	100	134.1	3.17	3.74	6.91
80		---	---	185.3	4.38	3.88	8.26
80		NS	---	174.3	4.12	3.69	7.82
80		---	100	180.7	4.27	3.91	8.18
80		NS	100	171.4	4.05	3.88	7.93
160		---	---	185.6	4.39	3.74	8.13
160		NS	---	191.2	4.52	4.01	8.53
160		---	100	188.1	4.45	3.93	8.38
160		NS	100	184.5	4.37	3.92	8.29
0	Pioneer 3475	---	---	132.8	3.14	3.92	7.07
0		---	100	135.4	3.20	4.47	7.68
80		---	---	193.8	4.59	4.12	8.71
80		NS	---	185.2	4.38	4.20	8.58
80		---	100	175.5	4.15	4.35	8.51
80		NS	100	167.6	3.96	4.19	8.16
160		---	---	178.9	4.23	4.05	8.29
160		NS	---	180.8	4.28	4.11	8.39
160		---	100	177.3	4.20	4.16	8.36
160		NS	100	184.7	4.37	4.50	8.87
0	LH74 X LH51	---	---	165.2	3.91	4.35	8.26
0		---	100	133.5	3.16	4.36	7.51
80		---	---	185.6	4.39	4.35	8.74
80		NS	---	183.1	4.33	4.55	8.89
80		---	100	184.2	4.36	4.54	8.89
80		NS	100	166.4	3.94	4.23	8.16
160		---	---	180.3	4.27	4.51	8.77
160		NS	---	171.3	4.05	4.29	8.35
160		---	100	183.0	4.33	4.63	8.96
160		NS	100	174.2	4.12	4.55	8.67
0	LH74 X LH82	---	---	136.7	3.24	3.55	6.78
0		---	100	125.5	2.97	3.77	6.74
80		---	---	168.3	3.98	3.85	7.83
80		NS	---	173.6	4.11	3.98	8.08
80		---	100	175.5	4.15	4.26	8.41
80		NS	100	172.5	4.08	4.10	8.18
160		---	---	174.8	4.14	3.85	7.98
160		NS	---	175.5	4.15	4.04	8.19
160		---	100	179.3	4.24	4.02	8.26
160		NS	100	175.1	4.14	4.28	8.42

Table 21. Influence of N-rate, K-rate and nitrification on N content and total N removal on four corn hybrids at **physiological maturity**. Waseca 1989.

N-Rate	Hybrid	Inh.	K-Rate	N-Concentration Stover	N-Concentration Grain	N-Removal Stover	N-Removal Grain	N-Removal Total
#/A			#/A	------%-------		----------#/A----------		
0	Pioneer 3615	---	---	0.39	1.21	29.4	96.1	125.5
0		---	100	0.32	1.26	24.1	79.7	103.8
80		---	---	0.47	1.39	36.6	122.0	158.6
80		NS	---	0.41	1.38	30.2	113.9	144.1
80		---	100	0.41	1.38	31.8	117.9	149.7
80		NS	100	0.47	1.41	36.2	113.8	150.0
160		---	---	0.49	1.41	36.6	124.2	160.8
160		NS	---	0.48	1.50	38.2	135.5	173.7
160		---	100	0.50	1.45	38.8	128.9	167.8
160		NS	100	0.46	1.48	36.0	129.1	165.1
0	Pioneer 3475	---	---	0.33	1.15	25.7	72.4	98.1
0		---	100	0.34	1.13	30.5	72.1	102.6
80		---	---	0.44	1.43	36.5	131.2	167.7
80		NS	---	0.46	1.47	38.6	127.8	166.4
80		---	100	0.47	1.38	41.0	114.1	155.1
80		NS	100	0.38	1.44	31.7	113.8	145.6
160		---	---	0.48	1.46	38.8	123.6	162.4
160		NS	---	0.50	1.37	40.7	116.9	157.6
160		---	100	0.49	1.41	40.4	117.9	158.4
160		NS	100	0.52	1.46	46.9	126.9	173.8
0	LH74 X LH51	---	---	0.39	1.17	33.8	91.3	125.1
0		---	100	0.31	1.10	26.9	69.1	95.9
80		---	---	0.49	1.28	42.2	112.3	154.5
80		NS	---	0.47	1.41	42.7	122.5	165.2
80		---	100	0.45	1.35	41.0	117.5	158.5
80		NS	100	0.38	1.34	32.1	105.2	137.3
160		---	---	0.52	1.36	47.1	115.5	162.6
160		NS	---	0.54	1.35	46.3	109.3	155.6
160		---	100	0.54	1.47	49.7	126.7	176.4
160		NS	100	0.53	1.38	48.3	113.2	161.5
0	LH74 X LH82	---	---	0.37	1.18	26.7	77.0	103.7
0		---	100	0.33	1.11	25.0	65.2	90.1
80		---	---	0.53	1.39	40.7	110.9	151.7
80		NS	---	0.54	1.46	42.6	119.3	162.0
80		---	100	0.48	1.37	41.2	113.5	154.7
80		NS	100	0.50	1.44	41.1	117.4	158.5
160		---	---	0.56	1.51	42.9	125.0	167.8
160		NS	---	0.54	1.53	43.3	127.2	170.5
160		---	100	0.56	1.58	44.8	133.5	178.4
160		NS	100	0.53	1.57	45.7	130.2	175.9

Table 22. Waseca 1989

0 # K-Rate only RCB (Hybrid X N-Rate)	Whole Plant Tassling % N	Stover T/A	N-Removal #/A
Hybrids			
Pioneer 3615	1.46	3.95	115.6
Pioneer 3475	1.44	4.30	125.5
LH74 X LH51	1.61	4.43	143.1
LH74 X LH82	1.54	3.65	113.9
P-Value	99	99	99
BLSD (.05)	0.09	0.24	10.2
N-Rate			
0	1.26	3.88	98.7
80	1.55	4.23	131.4
160	1.72	4.14	143.4
P-Value	99	99	99
BLSD (.05)	0.07	0.02	8.5
Hybrid X N-Rate	99	99	99
100 # K-Rate only RCB			
Pioneer 3615	1.35	3.96	107.1
Pioneer 3475	1.35	4.39	118.7
LH74 X LH 51	1.50	4.25	128.3
LH74 X LH82	1.53	4.14	126.3
P-Value	99	84	99
BLSD (.05)	0.10		11.6
N-Rate			
0	1.11	4.01	88.6
80	1.57	4.02	133.9
160	1.61	4.28	137.7
P-Value	99	80	99
BLSD (.05)	0.08		9.0
Hybrid X N-Rate	99	22	77
Split Plot without the 0 # N-Rate			
K-Rate			
0	1.62	4.26	135.2
100	1.57	4.26	134.1
P-Value	60	55	47
Hybrid X N-Rate X Inhibitor			
Hybrid			
Pioneer 3615	1.53	3.97	122.0
Pioneer 3475	1.53	4.35	133.4
LH74 X LH51	1.63	4.34	141.7
LH74 X LH82	1.68	4.19	141.5
P-Value	99	99	99
BLSD (.05)	0.05	0.21	6.9
N-Rate			
80	1.56	4.20	131.4
160	1.63	4.23	137.9
P-Value	99	23	99
Inhibitor			
None	1.61	4.23	136.6
N-Serve	1.58	4.20	132.7
P-Value	91	25	86
Hybrid X N-Rate	3	66	62
Hybrid X Inhibitor	98	99	99
N-Rate X Inhibitor	91	54	42
Hybrid X N-Rate X Inhibitor	88	11	84
Hybrid X N-Rate X Inhibtor X K-Rate			
Hybrid X K-Rate	16	90	68
N-Rate X K-Rate	38	43	18
Hybrid X N-Rate X K-Rate	32	80	56
Inhibitor X K-Rate	10	4	15
Hybrid X Inhibitor X K-Rate	82	1	56
N-Rate X Inhibitor X K-Rate	99	10	93
Hybrid X N-Rate X Inhibitor X K-Rate	77	67	93

Table 23 Waseca 1989

Milk Stage R3	Dry Matter Production				Grain
0 # K-Rate only RCB	Cob	Stover	Grain	Total	Yields
Hybrid (Hybrid X N-Rate)	----------T/A----------				Bu/A
Pioneer 3615	0.74	4.37	1.63	6.74	68.8
Pioneer 3475	0.74	4.69	1.45	6.88	61.5
LH74 X LH51	0.63	4.98	1.12	6.73	47.4
LH74 X LH82	0.61	3.79	1.70	6.11	72.2
P-Value	99	99	99	99	99
BLSD (.05)	0.05	0.30	0.12	0.51	5.1
N-Rate					
0	0.58	4.28	1.28	6.15	54.2
80	0.75	4.65	1.63	7.04	69.0
160	0.70	4.44	1.52	6.67	64.4
P-Value	99	96	99	99	99
BLSD (.05)	0.04	0.30	0.10	0.40	4.5
Hybrid X N-Rate	98	98	98	99	98
100 # K-Rate only RCB					
Hybrids					
Pioneer 3615	0.66	4.52	1.29	6.48	54.7
Pioneer 3475	0.66	4.81	1.19	6.67	50.7
LH74 X LH51	0.59	5.37	0.93	6.90	39.3
LH74 X LH82	0.60	4.17	1.51	6.29	64.1
P-Value	99	99	99	97	99
BLSD (.05)	0.05	0.25	0.10	0.45	4.0
N-Rate					
0	0.52	4.61	0.96	6.10	41.6
80	0.67	4.66	1.37	6.71	58.9
160	0.69	4.89	1.36	6.95	57.6
P-Value	99	94	99	99	99
BLSD (.05)	0.04		0.09	0.33	
Hybrid X N-Rate	28	68	46	63	46
Split Plot without the 0 # N-Rate					
K-Rate					
0	0.72	4.57	1.57	6.87	66.4
100	0.68	4.85	1.37	6.91	58.0
P-Value	73	77	94	12	94
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3615	0.74	4.47	1.50	6.71	63.5
Pioneer 3475	0.74	4.78	1.42	6.95	60.3
LH74 X LH51	0.65	5.30	1.13	7.09	48.0
LH74 X LH82	0.68	4.29	1.82	6.80	76.9
P-Value	99	99	99	99	99
BLSD(.05)	0.03	0.18	0.06	0.32	2.8
N-Rate					
80	0.70	4.70	1.48	6.90	62.8
160	0.70	4.72	1.45	6.88	61.6
P-Value	6	19	70	10	70
Inhibitor					
None	0.70	4.66	1.47	6.84	62.2
N-Serve	0.70	1.47	1.47	6.94	62.1
P-Value	12	84	7	66	7
Hybrid X N-Rate	74	77	25	70	25
Hybrid X Inhibitor	98	99	99	99	99
N-Rate X Inhibitor	78	11	72	41	72
Hybrid X N-Rate X Inhibitor	37	78	96	97	96
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	99	93	83	94	83
N-Rate X K-Rate	94	99	98	99	98
Hybrid X N-Rate X K-Rate	43	72	12	54	12
Inhibitor X K-Rate	60	52	32	51	32
Hybrid X Inhibitor X K-Rate	35	18	23	15	23
N-Rate X Inhibitor X K-Rate	80	21	34	19	34
Hybrid X N-Rate X Inh. X K-Rate	54	68	86	73	86

Table 24. Waseca 1989	N-Concentration			N-Removal			
0 # K-Rate only RCB (Hybrid X N-Rate)	Cob	Stover	Grain	Cob	Stover	Grain	Total
Hybrids Milk Stage R3	----------%---------			----------#/A----------			
Pioneer 3615	0.77	1.00	1.70	55.4	88.2	55.4	155.1
Pioneer 3475	0.80	0.98	1.58	11.9	93.7	46.1	151.8
LH74 X LH51	0.73	1.14	1.86	9.2	114.4	41.7	165.4
LH74 X LH82	0.67	1.06	1.56	8.3	81.2	53.9	143.4
P-Value	99	97	99	99	99	99	97
BLSD (.05)	0.03	0.12	0.07	0.7	12.0	3.8	16.2
N-Rate							
0	0.70	0.81	1.56	8.2	70.6	39.6	118.4
80	0.74	1.17	1.70	11.1	109.9	54.9	176.3
160	0.79	1.16	1.77	11.2	102.8	53.3	167.4
P-Value	99	99	99	99	99	99	99
BLSD (.05)	0.03	0.09	0.06	0.6	10.0	3.3	11.4
Hybrid X N-Rate	72	75	99	99	98	99	99
100 # K-Rate only RCB							
Hybrid							
Pioneer 3615	0.83	1.03	1.76	10.9	93.7	45.9	150.7
Pioneer 3475	0.86	1.08	1.61	11.4	105.2	38.5	155.3
LH74 X LH51	0.77	0.99	1.92	9.2	107.1	36.2	152.5
LH74 X LH82	0.72	1.00	1.58	8.6	84.8	48.5	142.0
P-Value	99	93	99	99	99	99	81
BLSD (.05)	0.05	0.08	0.07	0.9	9.1	3.9	
N-Rate							
0	0.78	0.69	1.62	8.1	64.1	31.0	103.3
80	0.79	1.13	1.76	10.6	105.8	47.8	164.4
160	0.81	1.25	1.78	11.2	123.2	48.0	182.7
P-Value	67	99	99	99	99	99	99
BLSD (.05)		0.05	0.06	0.7	7.4	3.2	9.8
Hybrid X N-Rate	69	86	99	67	67	52	45
Split Plot without the 0 # N-Rate							
K-Rate							
0	0.76	1.15	1.72	11.7	105.0	53.4	169.6
100	0.81	1.16	1.79	11.2	113.1	48.7	173.1
P-Value	99	93	89	25	85	92	41
Hybrid X N-Rate X Inhibitor							
Hybrid							
Pioneer 3615	0.80	1.14	1.77	11.9	102.4	53.1	167.5
Pioneer 3475	0.87	1.14	1.63	12.8	109.2	46.5	168.6
LH74 X LH51	0.77	1.18	1.94	10.1	125.5	44.0	179.7
LH74 X LH82	0.72	1.15	1.66	9.8	99.2	60.5	169.5
P-Value	99	75	99	99	99	99	99
BLSD(.05)	0.02		0.04	0.5	5.6	2.3	8.2
N-Rate							
80	0.78	1.11	1.73	11.0	104.9	51.0	167.1
160	0.80	1.19	1.77	11.4	113.2	51.0	175.6
P-Value	97	99	94	90	99	4	99
Inhibitor							
None	0.78	1.18	1.75	11.1	110.4	51.0	172.6
N-Serve	0.80	1.12	1.75	11.3	107.7	51.0	170.1
P-Value	87	99	7	60	78	3	63
Hybrid X N-Rate	92	87	69	98	85	67	80
Hybrid X Inhibitor	26	76	99	71	99	99	99
N-Rate X Inhibitor	85	93	50	21	83	53	81
Hybrid X N-Rate X Inhibitor	62	98	42	29	99	97	99
Hybrid X N-Rate X Inhibitor X K-Rate							
Hybrid X K-Rate	25	99	20	99	90	37	53
N-Rate X K-Rate	23	99	13	79	99	93	99
Hybrid X N-Rate X K-Rate	17	57	82	54	66	3	48
Inhibitor X K-Rate	69	63	97	72	4	90	55
Hybrid X Inhibitor X K-Rate	31	99	87	71	95	3	83
N-Rate X Inhibitor X K-Rate	57	77	80	39	76	64	48
Hybrid X N-Rate X Inhibitor X K-Rate	28	95	49	46	98	70	98

Table 25 Waseca 1989

Dent Stage R3	Dry Matter Production				Grain
0 # K-Rate only RCB	Cob	Stover	Grain	Total	Yields
Hybrid	----------T/A----------				Bu/A
Pioneer 3615	0.69	3.53	3.40	7.62	143.8
Pioneer 3475	0.67	3.87	3.22	7.77	136.1
LH74 X LH51	0.59	4.19	2.97	7.76	125.5
LH74 X LH82	0.60	3.22	3.03	6.85	128.1
P-Value	99	99	97	98	97
BLSD (.05)	0.06	0.29	0.35	0.71	14.9
N-Rate					
0	0.57	3.56	2.76	6.91	116.9
80	0.69	3.84	3.41	7.94	144.1
160	0.64	3.71	3.29	7.65	139.2
P-Value	99	86	99	99	99
BLSD (.05)	0.05		0.25	0.56	10.9
Hybrid X N-Rate	92	91	62	83	62
100 # K-Rate only RCB					
Hybrid					
Pioneer 3615	0.67	3.60	3.03	7.30	128.1
Pioneer 3475	0.60	3.85	2.78	7.24	117.6
LH74 X LH51	0.58	4.47	2.64	7.70	111.8
LH74 X LH82	0.61	3.75	3.01	7.39	127.5
P-Value	99	99	99	69	99
BLSD (.05)	0.05	0.27	0.25		10.9
N-Rate					
0	0.53	3.83	2.40	6.77	101.7
80	0.65	4.01	3.09	7.77	130.9
160	0.67	3.91	3.10	7.69	131.1
P-Value	99	66	99	99	99
BLSD (.05)	0.04		0.19	0.43	8.3
Hybrid X N-Rate	50	97	76	93	76
Split Plot without the 0 # N-Rate					
K-Rate					
0	0.67	3.72	3.33	7.73	141.0
100	0.66	3.98	3.13	7.79	132.5
P-Value	13	87	95	92	95
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3615	0.73	3.63	3.39	7.75	143.3
Pioneer 3475	0.67	3.86	3.27	7.81	138.3
LH74 X LH51	0.61	4.34	2.93	7.89	124.1
LH74 X LH82	0.65	3.57	3.34	7.57	141.4
P-Value	99	99	99	61	99
BLSD(.05)	0.03	0.19	0.14		6.2
N-Rate					
80	0.67	3.88	3.24	7.80	137.2
160	0.66	3.82	3.22	7.72	136.3
P-Value	20	56	28	45	28
Inhibitor					
None	0.66	3.87	3.22	7.76	136.3
N-Serve	0.67	3.83	3.24	7.75	137.2
P-Value	37	33	28	4	28
Hybrid X N-Rate	69	53	32	47	32
Hybrid X Inhibitor	32	73	5	28	5
N-Rate X Inhibitor	55	55	47	55	47
Hybrid X N-Rate X Inhibitor	14	62	34	52	34
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	98	66	82	82	82
N-Rate X K-Rate	99	98	98	99	98
Hybrid X N-Rate X K-Rate	63	72	10	42	10
Inhibitor X K-Rate	10	71	62	68	62
Hybrid X Inhibitor X K-Rate	89	92	83	91	83
N-Rate X Inhibitor X K-Rate	20	97	27	92	27
Hybrid X N-Rate X Inh. X K-Rate	40	68	42	57	42

Table 26. Waseca 1989	N-Concentration			N-Removal			
0 # K-Rate only RCB (Hybrid X N-Rate)	Cob	Stover	Grain	Cob	Stover	Grain	Total
Hybrids Dent Stage R3	----------%---------			----------#/A----------			
Pioneer 3615	0.56	0.91	1.41	7.7	64.9	96.3	168.9
Pioneer 3475	0.60	0.85	1.34	8.0	67.0	87.4	162.5
LH74 X LH51	0.50	1.01	1.42	5.9	85.6	85.4	177.0
LH74 X LH82	0.60	0.83	1.39	7.3	54.3	85.6	147.2
P-Value	99	99	92	99	99	89	99
BLSD (.05)	0.04	0.08	0.07	0.7	8.5		18.7
N-Rate							
0	0.55	0.68	1.21	6.3	49.4	67.5	123.3
80	0.55	1.01	1.48	7.7	78.2	101.1	187.0
160	0.59	1.01	1.47	7.7	76.2	97.4	181.4
P-Value	84	99	99	99	99	99	99
BLSD (.05)		0.06	0.05	0.6	7.2	7.9	13.9
Hybrid X N-Rate	16	78	96	96	92	85	91
100 # K-Rate only RCB							
Hybrid							
Pioneer 3615	0.58	0.83	1.39	7.7	60.5	85.1	153.5
Pioneer 3475	0.62	0.83	1.32	7.5	64.8	74.3	146.7
LH74 X LH51	0.53	0.82	1.35	6.3	73.1	72.2	151.7
LH74 X LH82	0.61	0.85	1.35	7.5	65.1	83.0	155.6
P-Value	99	11	87	99	96	99	35
BLSD (.05)	0.05			0.7	9.7	6.9	
N-Rate							
0	0.58	0.59	1.17	6.1	45.4	56.6	108.2
80	0.59	0.92	1.40	7.7	74.5	86.9	169.2
160	0.59	0.99	1.49	7.9	77.6	92.5	178.1
P-Value	12	99	99	99	99	99	99
BLSD (.05)		0.05	0.04	0.6	6.8	5.4	11.4
Hybrid X N-Rate	92	99	93	18	94	58	77
Split Plot without the 0 # N-Rate							
K-Rate							
0	0.57	0.99	1.47	7.6	74.5	98.4	180.6
100	0.59	0.96	1.45	7.8	77.4	90.9	176.2
P-Value	49	82	77	51	66	99	68
Hybrid X N-Rate X Inhibitor							
Hybrid							
Pioneer 3615	0.57	0.94	1.48	8.3	68.2	100.6	177.3
Pioneer 3475	0.63	0.93	1.42	8.5	72.3	92.9	173.8
LH74 X LH51	0.54	1.06	1.48	6.6	93.1	86.8	186.6
LH74 X LH82	0.58	0.97	1.46	7.6	70.1	98.3	176.1
P-Value	99	99	99	99	99	99	95
BLSD(.05)	0.02	0.04	0.03	0.4	5.4	4.3	11.0
N-Rate							
80	0.57	0.95	1.44	7.6	74.8	93.7	176.2
160	0.59	1.00	1.48	7.9	77.1	95.6	180.7
P-Value	95	99	99	89	73	74	81
Inhibitor							
None	0.58	0.98	1.46	7.7	76.6	94.5	178.9
N-Serve	0.58	0.97	1.46	7.7	75.2	94.9	177.9
P-Value	35	49	10	4	49	20	23
Hybrid X N-Rate	70	87	21	90	90	27	67
Hybrid X Inhibitor	99	77	72	99	89	12	42
N-Rate X Inhibitor	39	34	6	61	60	43	60
Hybrid X N-Rate X Inhibitor	61	76	98	12	66	88	82
Hybrid X N-Rate X Inhibitor X K-Rate							
Hybrid X K-Rate	69	99	86	65	95	30	75
N-Rate X K-Rate	26	81	94	99	93	99	99
Hybrid X N-Rate X K-Rate	60	14	78	6	42	16	35
Inhibitor X K-Rate	7	90	57	21	94	78	92
Hybrid X Inhibitor X K-Rate	97	95	67	78	99	96	99
N-Rate X Inhibitor X K-Rate	97	88	91	96	50	30	52
Hybrid X N-Rate X Inhibitor X K-Rate	96	69	81	88	84	60	82

Table 27 Waseca 1989

Physiological Maturity	Dry Matter Production				Grain
0 # K-Rate only RCB	Cob	Stover	Grain	Total	Yields
Hybrid	----------T/a----------				Bu/A
Pioneer 3615	---	3.79	4.24	8.03	179.2
Pioneer 3475	---	4.03	3.98	8.02	168.5
LH74 X LH51	---	4.40	4.18	8.59	177.0
LH74 X LH82	---	3.74	3.78	7.53	159.9
P-Value		99	99	99	99
BLSD (.05)		0.20	0.29	0.41	12.3
N-Rate					
0	---	3.89	3.55	7.45	150.4
80	---	4.05	4.33	8.38	183.2
160	---	4.03	4.25	8.29	179.9
P-Value		79	99	99	99
BLSD (.05)			0.22	0.34	9.4
Hybrid X N-Rate					
100 # K-Rate only RCB					
Hybrid					
Pioneer 3615	---	3.85	3.96	7.82	167.5
Pioneer 3475	---	4.32	3.85	8.18	162.7
LH74 X LH51	---	4.50	3.94	8.45	166.8
LH74 X LH82	---	4.01	3.78	7.80	160.0
P-Value		99	51	99	51
BLSD (.05)		0.20		0.40	
N-Rate					
0	---	4.08	3.12	7.21	132.1
80	---	4.26	4.23	8.49	178.9
160	---	4.18	4.30	8.49	181.9
P-Value		81	99	99	99
BLSD (.05)			0.20	0.30	8.8
Hybrid X N-Rate		80	5	50	5
Split Plot without the 0 # N-Rate					
K-Rate					
0	---	4.07	4.27	8.34	180.4
100	---	4.21	4.19	8.41	177.4
P-Value		80	47	26	47
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3615	---	3.86	4.32	8.18	182.6
Pioneer 3475	---	4.21	4.27	8.48	180.4
LH74 X LH51	---	4.45	4.22	8.68	178.5
LH74 X LH82	---	4.04	4.12	8.16	174.3
P-Value		99	98	99	98
BLSD(.05)		0.10	0.14	0.20	6.1
N-Rate					
80	---	4.13	4.20	8.33	177.6
160	---	4.16	4.26	8.42	180.2
P-Value		53	81	77	81
Inhibitor					
None	---	4.13	4.28	8.41	181.0
N-Serve	---	4.15	4.18	8.34	176.9
P-Value		41	96	64	96
Hybrid X N-Rate		14	83	47	83
Hybrid X Inhibitor		66	62	77	62
N-Rate X Inhibitor		93	84	94	84
Hybrid X N-Rate X Inhibitor		57	64	54	64
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate		56	70	57	70
N-Rate X K-Rate		58	95	90	95
Hybrid X N-Rate X K-Rate		51	73	73	73
Inhibitor X K-Rate		66	65	73	65
Hybrid X Inhibitor X K-Rate		14	22	25	22
N-Rate X Inhibitor X K-Rate		87	31	73	31
Hybrid X N-Rate X Inhibitor X K-Rate		88	29	75	29

Table 28. Waseca 1989

0 # K-Rate only RCB (Hybrid X N-Rate)	N-Concentration Stover	N-Concentration Grain	N-Removal Stover	N-Removal Grain	N-Removal Total
Hybrids Physiological Maturity	------%---------		---------#/A--------		
Pioneer 3615	0.45	1.33	34.2	114.1	148.2
Pioneer 3475	0.41	1.34	33.6	109.0	142.7
LH74 X LH51	0.46	1.26	41.0	106.3	147.3
LH74 X LH82	0.48	1.36	36.7	104.3	141.0
P-Value	99	94	99	72	44
BLSD (.05)	0.03	0.08	3.7		
N-Rate					
0	0.36	1.17	28.8	84.2	113.0
80	0.48	1.37	39.0	119.1	158.1
160	0.51	1.43	41.3	122.0	163.3
P-Value	99	99	99	99	99
BLSD (.05)	0.02	0.05	2.9	8.2	9.4
Hybrid X N-Rate	57	58	48	94	92
100 # K-Rate only RCB					
Hybrid					
Pioneer 3615	0.40	1.36	31.5	108.8	140.4
Pioneer 3475	0.43	1.30	37.2	101.3	138.6
LH74 X LH51	0.43	1.30	39.1	104.4	143.6
LH74 X LH82	0.45	1.35	37.0	104.0	141.0
P-Value	93	89	99	76	28
BLSD (.05)			3.9		
N-Rate					
0	0.32	1.14	26.6	71.5	98.1
80	0.45	1.36	38.7	115.7	154.5
160	0.51	1.47	43.4	126.7	170.2
P-Value	99	99	99	99	99
BLSD (.05)	0.02	0.04	3.0	5.6	6.7
Hybrid X N-Rate	74	99	89	79	94
Split Plot without the 0 # N-Rate					
K-Rate					
0	0.49	1.41	40.2	121.0	161.3
100	0.47	1.43	40.4	119.9	160.4
P-Value	52	32	7	34	14
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3615	0.45	1.42	35.5	123.1	158.7
Pioneer 3475	0.46	1.42	39.3	121.5	160.8
LH74 X LH51	0.48	1.36	43.6	115.2	158.9
LH74 X LH82	0.52	1.48	42.7	122.1	164.9
P-Value	99	99	99	99	90
BLSD(.05)	0.01	0.03	2.0	4.8	
N-Rate					
80	0.45	1.39	37.8	117.0	154.9
160	0.51	1.45	42.7	123.9	166.7
P-Value	99	99	99	99	99
Inhibitor					
None	0.49	1.41	40.6	120.9	161.5
N-Serve	0.48	1.43	40.4	120.1	160.1
P-Value	88	87	54	37	52
Hybrid X N-Rate	96	99	93	99	90
Hybrid X Inhibitor	12	17	56	63	79
N-Rate X Inhibitor	65	92	92	5	49
Hybrid X N-Rate X Inhibitor	98	76	72	88	83
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	51	30	48	79	57
N-Rate X K-Rate	99	92	99	99	99
Hybrid X N-Rate X K-Rate	60	19	74	70	86
Inhibitor X K-Rate	43	30	65	71	80
Hybrid X Inhibitor X K-Rate	96	89	72	91	88
N-Rate X Inhibitor X K-Rate	6	21	65	33	54
Hybrid X N-Rate X Inhibitor X K-Rate	99	49	99	64	97

EVALUATION OF THE EFFECT OF POTASH FERTILIZER APPLIED IN RIDGES ON THE EARLY GROWTH AND YIELD OF CORN

George Rehm, Andy Scobbie, Greg Cremers, and Gyles Randall[1/]

ABSTRACT: Farmers who grow corn in ridge-till planting systems wish to place all of the phosphate and potash fertilizer in the ridge during late fall. This study was conducted to determine if practical rates of potash would have any negative impact on yield. High rates of potash applied in the center of the ridge in the preceeding fall had no negative effect on corn emergence, early growth, and yield.

Introduction:

Many farmers who have switched to ridge-till planting systems have complained about problems associated with using starter fertilizers and they seek alternatives. There is equipment available which allows for placement of either liquid or dry fertilizer in a band in existing ridges. This equipment can be used to apply needed phosphate and potash in the ridge in the late fall. There is reason to believe that the use of this practice could substitute for the use of a starter fertilizer at planting.

Objective:

This study was planned and conducted to evaluate the effect of rate of potash fertilizer applied in a band in the center of an existing ridge on the early growth and yield of corn.

Experimental Procedures:

This study was conducted at the Southern Experiment Station at Waseca. The soil pH was 6.1. The phosphorus level was high (28 ppm) and the soil test value for potassium was in the medium range (117 ppm).

The experimental area was planted to soybeans in 1988 and ridges were established at that time. Four rates of K_2O, (20, 40, 80, 160 lb./acre) were knifed into the center of the ridges in late October of 1988. The potash bands were at a depth of 3 to 3.5 inches. Adequate N as 82-0-0 was also applied in the fall. Corn was planted in early May of 1989. Recommended practices to assure good corn yields were used throughout the growing season.

Whole plant samples were collected from each plot at approximately 4 weeks after emergence. These plants were dried, weighed, ground, and analyzed for K. Stand counts were also taken at this time. Grain yields were measured in mid-October and corrected to 15.5% moisture.

Results and Discussion:

The data that were collected in this study are summarized in Table 1.

Table 1. The effect of rate of potash fertilizer applied in the center of existing ridges on the growth and yield of corn. Waseca, 1989.

	K_2O Applied (lb./acre)				
Variable	0	20	40	80	160
Stand (plants/20ft.)	34	34	34	35	34
Weight of 6 Young Plants (gm)	26.5	31.0	29.8	29.3	30.0
K Concentration Young Plants (%)	2.69	3.10	3.14	2.92	3.12
K Uptake by 6 Young Plants (mg)	736	961	934	851	936
Grain Yield lb./acre	160.1	166.9	161.8	161.6	162.3

Statistical analysis shows that the rate of potash applied had no significant effect on any of the variables that were measured. There was no negative effect on corn emergence and early growth. The K concentration in young plants, K uptake by young plants, and grain yield were not affected. With soil test values for K in the medium to high range, these results could be anticipated.

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BANDED APPLICATION OF POTASH FERTILIZER FOR CORN IN A RIDGE-TILL PRODUCTION SYSTEM

George Rehm, Greg Cremers, Andy Scobbie[1/]

ABSTRACT: In recent years, potassium deficiency symptoms have appeared in corn planted in a ridge-till system even though soil test values for potassium are in the high range. In this trial, the application of K_2O in a band in the center of the ridge increased corn grain yield. Uptake of potassium was also enhanced by the banded application of K_2O. This study will be continued to monitor effects on yield and growth of soybeans.

Introduction:

In recent years, there have been numerous reports of corn which exhibits potassium (K) deficiency symptoms when grown in ridge-till production systems. These symptoms occurred even though soil test K values were considered to be in the high or very high range. The severity of the symptoms were thought to be related to hybrid. The problem was not confined to specific soils or specific environments. Reports of the problem have come from a diversity of corn producing regions in Minnesota.

Banded application of essential plant nutrients has proven to be an effective practice for supplying nutrients in a fertilizer program for corn. With equipment which is currently available, it is possible to place fertilizer bands at various positions in relation to the seed. this is especially true for ridge-till planting systems.

The problem described above had not been addressed in previous research programs. Therefore, the study described in the sections that follow was designed to develop an answer to this widespread problem.

Objectives:

Recognizing the needs just cited, this study was conducted to:

1. Measure the effect of K_2O applied in a band on corn yield in a ridge-till planting system where soil test levels for K are high.
2. Determine if the response, if any, to applied potash is related to variety.
3. Measure the effect of rate of applied potash on K uptake by corn in these planting systems.

Experimental Procedure:

This study was initiated in a farmer's field in Murray County in the fall of 1988. Soybeans were grown on ridges in 1988. After soybean harvest, various rates of K_2O (0, 40, 80, 160 lb./acre), supplied as 0-0-60 were knifed into the center of the existing ridges. With the equipment available, the K_2O was placed at a depth of 3 to 3 1/2 inches below the soil surface.

The existing ridges were intensively sampled in the fall of 1988 to monitor the variability of pH, P, and K. To complete this sampling, cores were taken from the center of the ridge then at 3, 6, 9, 12 and 15 inches from the center. Each core was then sectioned into depths of 0-3, 3-6, 6-9, and 9-12 inches. This intensive sampling was conducted at 16 locations in the plot area and the soil composited for analysis. Results of these analyses are summarized in Tables 1, 2, and 3.

Corn was planted on April 24 at a population of 28,112 plants per acre. Three hybrids (Pioneer 3902, Pioneer 3732, Pioneer 3737) were combined with the applied rates of K_2O in a complete factorial design arranged in a randomized complete block design with 4 replications in the field. Weed control was achieved by banding Lasso over the row at planting.

Plant samples were collected from all plots at 3 times during the growing season. These samples were dried, weighed, ground, and analyzed for K. The first sample consisted of 10 plants/plot and was taken on June 7. Six plants were taken from each plot on June 21 for the 2nd sampling. Ear leaf samples were collected at silking.

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Whole plants from selected treatments were excavated on June 20 in order to measure the effect of both hybrid and applied K_2O on early root growth. To do this, a steel box (6 in. x 15 in. x 18 in.) was pushed into the soil so that the box surrounded on plant and its root system. The box was pushed into the soil to a depth of about 12 inches. The box was then pulled from the soil and soaked in water over night. Soil was carefully washed away from the root system with a fine spray of water. The resulting root samples were dried, weighed, ground, and analyzed for K. Uptake of K by the young root systems was also computed. For the root investigation, plants of each variety were taken from plots which received no K_2O as well as the plots which had been fertilized with 80 lb. K_2O/acre. Only 2 replications were sampled because of a shortage of equipment.

Grain yields were measured in late September and corrected to 15.5% moisture. Selected treatments were applied in the fall of 1989 and soybeans will be planted in the experimental area in 1990.

Results and Discussion

Soil Test Values

In general, the pH values increased with depth regardless of the position from the center of the ridge (Table 1). Values were neutral to slightly acid.

Table 1. Soil pH in a ridge-till planting system. Fall 1988

	Distance From the Row (in.)					
Depth	0	3	6	9	12	15
in.	pH					
0-3	6.2	6.3	6.2	6.2	6.1	6.1
3-6	6.3	6.2	6.2	6.3	6.2	6.5
6-9	6.4	6.4	6.5	6.7	6.8	6.9
9-12	6.8	6.8	6.8	7.0	7.1	7.1

Soil test values for P were very high close to the soil surface (0-3 in.). The soil test P values also decreased with depth and distance from the row.

Table 2. Soil test values for P in a ridge-till planting system. Fall 1988.

	Distance From the Row (in.)					
Depth	0	3	6	9	12	15
in.	ppm P*					
0-3	44	43	49	55	50	48
3-6	36	41	42	43	26	22
6-9	30	31	27	20	12	17
9-12	15	12	13	9	7	7

* Soil test P measured by the Bray and Kurtz #1 procedure.

Soil test values for K are listed in Table 3. As was the case with P, soil test values were high close to the soil surface and decreased with depth and distance from the row. The average for the 0-9 inch depth to a distance of 15 inches from the row was 145 ppm. This is considered to be a high soil test value by current standards.

Table 3. Soil test values for K in a ridge-till planting system. Fall, 1988.

Depth	Distance From the Row (in.) 0	3	6	9	12	15
in.	ppm K*					
0-3	173	157	166	187	194	179
3-6	141	138	146	139	125	118
6-9	138	132	126	113	101	128
9-12	111	107	105	103	105	107

* Soil test K measured by the ammonium acetate procedure

Early Growth and Yield

Rate of K_2O applied had a significant effect on the early growth of corn and grain yield. Early growth measured at the first sampling and yield were also significantly affected by hybrid. Plant growth measured at the second sampling was not affected by hybrid. There was no significant interaction between rate of applied K_2O and hybrid for any of the growth measurements. Therefore, the effects of K_2O rate and hybrid are summarized in Tables 4 and 5, respectively.

Table 4. Effect of rate of K_2O applied on early growth and grain yield.

K_2O Applied	Early Growth 1st Sample	2nd Sample	Grain Yield
lb./acre	wt. of 10 plants,g	wt. of 6 plants,g	bu./acre
0	6.8 c*	28.9 c	150.9 b
40	9.4 b	41.6 b	164.2 a
80	10.2 a b	43.6 a b	163.1 a
160	10.9 a	45.9 a	162.9 a

* Treatment means in any column followed by the same letter are not significantly different at the .05 confidence level.

Table 5. The effect of corn hybrid on early growth and grain yield.

Hybrid	Early Growth 1st Sample	2nd Sample	Grain Yield
	wt. of 10 plants,g	wt. of 6 plants,g	bu./acre
Pioneer 3902	8.2 b*	40.5 a	150.3 c
Pioneer 3732	9.8 a	38.8 a	158.1 b
Pioneer 3737	10.0 a	40.7 a	172.5 a

* Treatment means in any column followed by the same letter are not significantly different at the .05 confidence level.

When averaged over the 3 hybrids used, early growth increased curvilinearly with rate of K_2O applied. The response was similar for both the first and second sampling. Grain yield did not show the curvilinear response. The use of 40 lb. K_2O per acre was adequate for optimum yield. Although the early growth may have been affected by the ability of corn to take up K early in the season, root development was apparently adequate to absorb some K supplied by the soil. Consequently, the use of 40 lb. K_2O per acre was adequate for optimum yield of all hybrids. Even though the soil test value for K was high, there was still a response to K_2O. As yet, there is no explanation for this.

When averaged over the rate of K_2O applied, hybrid had as significant effect on the growth measured at the first sampling and yield (Table 5). The early growth of Pioneer 3902 was significantly less than growth of Pioneer 3732 and Pioneer 3737 which were not significantly different from each other. This is probably due to the fact that the Pioneer 3902 is a short-season hybrid.

The Pioneer 3902 also produced the lowest yield. The Pioneer 3737 produced the highest yield with the yield of Pioneer 3732 being intermediate.

Potassium Concentration and Uptake

Both rate of applied K_2O and hybrid had a significant effect on the K concentration in plant tissue and subsequent uptake. When averaged over the 3 hybrids used, the K concentration in both the young plants and ear leaf tissue increased with rate of K_2O applied (Table 6). The uptake of K computed from K concentration and plant weight data also increased with each rate of applied K_2O. The concept of luxury consumption of K has been well documented and is illustrated in this study by the K uptake data.

Table 6. The effect of rate of applied K_2O on K concentration in corn tissue and K uptake by young plants.

K_2O	1st Sampling		2nd Sampling		Ear Leaf
Applied	K Conc.	K Uptake	K Conc.	K Uptake	K Conc.
lb./acre	%	mg in 10 plants	%	mg in 6 plants	%
0	.91 d*	63 d	1.08 d	321 d	.95 d
40	2.18 c	204 c	1.49 c	621 c	1.21 c
80	2.57 b	258 b	1.75 b	763 b	1.37 b
160	3.06 a	335 a	2.08 a	950 a	1.46 a

* Treatment means in any column followed by the same letter are not significantly different at the .05 confidence level.

When averaged over rates of applied K_2O, the hybrid had a significant effect on concentration of K in plant tissue and K uptake (Table 7). The K concentration in the tissue of each hybrid was significantly different from the K concentration of the other two. The ranking was the sampling was the same for all stages. The concentration was lowest in Pioneer 3732 and highest in Pioneer 3737. This could be due to a fixed trait or the result of a more poorly developed root system. The data collected do not provide for an explanation of this observation.

Potassium uptake by young plants was lowest for the Pioneer 3732 hybrid. This is the result of reduced weight and a lower concentration of K in the plant tissue.

Table 7. The effect of corn hybrid on K concentration in corn tissue and K uptake by young plants.

	1st Sampling		2nd Sampling		Ear
Hybrid	K Conc.	K Uptake	K Conc.	K Uptake	Leaf
	%	mg in 10 plants	%	mg in 6 plants	%
Pioneer 3902	2.23 b*	193 b	1.71 b	715 a	1.23 b
Pioneer 3732	1.92 c	200 b	1.28 c	524 b	1.15 c
Pioneer 3737	2.40 c	252 a	1.80 a	753 a	1.36 a

* Treatment means in same column followed by the same letters are not significantly different at the .05 confidence level.

Root Growth and K Uptake

Because of a limited amount of equipment, root samples were only taken from each variety where the K_2O rates were 0 and 80 lb./acre. Two of the four replications were sampled. Therefore, there was no statistical analysis of the data. The data collected are summarized in Table 8.

Table 8. The effect of K_2O applied and corn hybrid on root growth, K concentration in the root tissue, and K uptake by the roots of a young corn plant.

Hybrid	K_2O Applied	Root Weight	K Conc.	K Uptake
	lb./acre	gm	%	mg
Pioneer 3902	0	4.5	.189	8.5
	80	5.5	.197	10.8
Pioneer 3732	0	3.0	.239	7.2
	80	5.0	.215	10.8
Pioneer 3737	0	4.5	.213	9.6
	80	5.0	.187	9.4

The root weight of all hybrids appeared to be increased by the application of K_2O. The concentration of K in the root tissue was variable. The lowest concentrations were associated with the highest weights which is a result of plant dilution. The concentration of K in the root system was not as high as in the plant tissue. Uptake of K seemed to be higher for the 80 lb./acre K_2O rate. This is a reflection of K_2O on early plant growth. Much more research is needed to study the effect of potash fertilizer and corn hybrid on the growth of roots of young corn plants.

Summary

The application of potash fertilizer to the center of the existing ridge certainly had a positive effect on corn production. A substantial yield increase for three hybrids was measured even though the soil test value for K was in the high range.

The data collected in this study do not provide evidence for the cause of the problem. Much more research is needed before the cause can be identified and corrected.

FIELD EVALUATION TO DETERMINE BEST FLUID STARTER RATIOS FOR CORN

George Rehm, Greg Cremers, and Andy Scobbie[1/]

ABSTRACT: Starter fertilizers have been important to corn growers in Minnesota for many years. This study was conducted to evaluate the effect of rate of N applied in a starter and the $N:P_2O_5$ ratio of a starter on early growth and yield of corn. The $N:P_2O_5$ ratios used had no effect on early growth, nutrient uptake by young plants and grain yield. Grain yield increased with rate of applied P_2O_5 at 1 of 2 sites. The rate of N applied in a starter had no effect on emergence, early growth, and grain yield.

Background:

Use of a starter fertilizer is a key management tool for corn production in Minnesota. Although it is possible to formulate liquid starters having several grades, a few grades have become very popular for use in corn production. They have been effective. However, with the emphasis on efficiency of nutrient use, several questions revolving around the analysis of liquid starters have been raised.

Recent research from Alabama has questioned the agronomic value of the conventional 1:3 $N:P_2O_5$ ratio for starter fertilizers used for corn production. There is also some question about the importance of various nutrients that can be supplied in a starter fertilizer. There is some argument that a starter containing N, P, K, S, and Zn may be superior to a starter which contains only N and P. This contention must be tested with field research trials.

Growers are also concerned about the rate of N and P_2O_5 that can be applied in a starter fertilizer. There is a small possibility that high rates of N applied in this way could cause problems. These concerns also need to be addressed in field research trials.

Objective:

Recognizing the research needs just cited, this study was planned and initiated to:

1. Measure the impact of the $N:P_2O_5$ ratio in a liquid starter fertilizer on corn production.

2. Determine the effect of the nutrients which may be supplied in a starter fertilizer on corn production.

3. Evaluate the rate of N and/or P_2O_5 applied in a starter fertilizer on corn growth and yield.

Experimental Procedure:

This study was conducted at two locations in Minnesota in 1989. The relative soil test level for P was used as a major deciding factor in site selection. Soil samples were collected from each site prior to treatment application for the purpose of site characterization. By current Minnesota standards, the P level at the Renville County site was considered to be medium to high (Table 1) while the P level at the McLeod County site was in the low range (Table 2).

Table 1. Relevant soil properties at the Renville County site

	Depth (in.)					
Measurement	0-6	6-12	12-24	24-36	36-48	48-60
pH	7.8	7.8	7.8	7.7	7.8	7.8
P (Bray #1), ppm	13.5	11.5	5.5	7.5	9.5	8.5
P (Olsen), ppm	9.5	5.5	1.5	2.5	4.0	4.5
K, ppm	115	-	-	-	-	-
O.M., %	6.4	-	-	-	-	-
Zn, ppm	.9	-	-	-	-	-
NO_3-N, lb./acre	34	32	17	13	12	32
soil texture:	silty clay loam					

[1/] Extension Soil Scientist, Assistant Scientist, and Junior Scientist, Soil Science Department, respectively.

The soil test values for P decrease with depth. This is typical of soils in western Minnesota. The Zn test is in the medium range.

Table 2. Relevant soil properties at the McLeod County site

Measurement	Depth (in.) 0-6	6-12	12-24	24-36	36-48	48-60
pH	7.8	7.7	7.9	8.0	8.0	8.0
P (Bray #1), ppm	5.3	3.5	2.4	1.8	1.8	1.7
P (Olsen), ppm	7.4	2.8	1.4	.9	1.2	1.2
K, ppm	115	-	-	-	-	-
O.M., %	6.4	-	-	-	-	-
Zn, ppm	.8	-	-	-	-	-
NO_3-N, lb./acre	38	57	82	33	22	27
soil texture:	silty clay loam					

Soil test values for P are in the low range and, in agreement with the Renville County site, decrease with depth. The Zn test is also in the medium range.

Although the amount of N applied in a starter fertilizer varied with treatment, the total amount applied to all treatments was constant at 180 lb./acre for both sites. This N (supplied as 46-0-0) was broadcast and incorporated before planting.

The management practices used at each site are outlined below:

	Renville County	McLeod County
previous crop:	soybeans	soybeans
primary tillage:	fall chisel	fall chisel
planting date:	5/10/89	5/3/89
variety:	Pioneer 3737	Pioneer 3737
planted population:	27,000	27,000
herbicide:	Lasso (incorporated) 2, 4-D (post emergence)	Lasso (incorporated) 2, 4-D (post emergence)

Fluid fertilizers formulated by Nutra-Flo Chemical, Sioux City, Iowa were used to supply the needed nutrients. This assistance is gratefully acknowledged.

Stand counts were taken from all plots at about 4 weeks after emergence. Six whole plants were also taken from each plot at this time. These plants were dried, weighed, ground, and analyzed for N, P, K, S, and Zn. Uptake of these nutrients was computed from plant weight and nutrient concentration data.

Grain yields were measured in mid-October and corrected to 15.5% moisture.

At each site, treatments were placed in the field in a randomized complete block design with 4 replications. Several statistical procedures were used in the analysis of the data. These procedures will be briefly described in the Results and Discussion section.

Results and Discussion:
The 18 treatments that were applied in the field were used to complete several small studies. Each of these studies will be discussed separately in the sections that follow.

N:P_2O_5 Ratio

Three ratios were evaluated at 2 rates of P_2O_5 (20, 40 lb./acre). Yield, early growth, and stand count data are summarized in Table 3. The impact of these ratios on the nutrient concentration in young corn plants is summarized in Table 4, and uptake values are provided in Table 5.

Table 3. The effect of $N:P_2O_5$ ratio on corn grain yield, early growth and emerged stand measured at 4 weeks after emergence.

$N:P_2O_5$ Ratio	County and P_2O_5 Rate (lb./acre) Renville 20	Renville 40	McLeod 20	McLeod 40
Grain Yield: (bu./acre)				
.4 : 1.0	164 a*	157 a	153 a	176 a
1.0 : 1.0	161 a	161 a	147 a	174 a
2.0 : 1.0	162 a	162 a	147 a	177 a
Early Growth : (weight of 6 plants, gm)				
.4 : 1.0	14.3 a	13.0 a	14.8 a	18.5 a
1.0 : 1.0	13.5 a	13.0 a	12.8 b	15.0 b
2.0 : 1.0	13.5 a	13.5 a	10.0 c	11.5 c
Emerged Stand: (plants/20 ft.)				
.4 : 1.0	28 a	25 a	29 a	30 a
1.0 : 1.0	27 a	27 a	28 a	29 a
2.0 : 1.0	26 a	26 a	30 a	29 a

*Treatment means in any column at each site are not significantly different at the .05 confidence level.

At the Renville County site, the $N:P_2O_5$ ratio had no significant effect on any of these variables measured. This was true for both rates of applied phosphate indicating no response to the rate of P_2O_5 used. Considering the medium to high soil test for P, this would be expected.

The $N:P_2O_5$ ratio had no significant effect on grain yield at the McLeod County site. Yields, however, did increase as the phosphate rate increased from 20 to 40 lb./acre. With the low soil test values for P, this yield increase would be expected.

The weight of the young corn plants decreased as the $N:P_2O_5$ ratio increased at the McLeod County site. This observation was consistent for both rates of applied phosphate. This decrease was not expected and cannot be readily explained by the data collected in this study. This decreased early growth, however, was not reflected in yield and the importance of this observation is, therefore, questioned.

Table 4. The effect of $N:P_2O_5$ ratio on the nutrient concentration in young corn plants.

County	P_2O_5 Rate	$N:P_2O_5$ Ratio	Nutrient N	P	K	S	Zn
	lb./acre		- - - - - - % - - - - - - -				ppm
Renville	20	.4:1.0	4.16	.420	3.22	.260	28.6
	20	1.0:1.0	4.22	.407	3.35	.263	28.7
	20	2.0:1.0	4.18	.392	3.03	.257	27.9
Renville	40	.4:1.0	4.18	.396	3.17	.257	28.7
	40	1.0:1.0	4.23	.407	2.90	.257	29.7
	40	2.0:1.0	4.20	.390	3.11	.256	28.6
McLeod	20	.4:1.0	3.96	.318	2.69	.279	27.0
	20	1.0:1.0	4.08	.326	2.65	.283	29.1
	20	2.0:1.0	3.88	.289	2.39	.274	29.2
McLeod	40	.4:1.0	4.09	.332	2.04	.288	28.1
	40	1.0:1.0	4.05	.341	2.11	.288	29.9
	40	2.0:1.0	3.97	.317	2.28	.277	29.2

Except for the P concentration at the Renville County site when the applied phosphate was 20 lb./acre, the $N;P_2O_5$ ratio had no significant effect on the concentration of N, P, K, S, and Zn in the whole plant tissue. The P concentration decreased linearly with an increase in the $N:P_2O_5$ ratio at the Renville County site. There, as yet, is no apparent explanation for this observation. There was also no significant increase in P concentration as the rate of applied phosphate was increased from 20 to 40 lb./acre. The 20 lb./acre rate was apparently adequate for growth of the young plants.

Table 5. The effect of $N:P_2O_5$ ratio on the nutrient uptake by young corn plants.

County	P_2O_5 Rate	$N:P_2O_5$ Ratio	Nutrient N	P	K	S	Zn
	lb./acre		- - - - - - mg in 6 plants - - - - - -				
Renville	20	.4:1.0	594	60	476	37	.4
	20	1.0:1.0	572	55	450	35	.4
	20	2.0:1.0	564	53	409	35	.4
Renville	40	.4:1.0	545	52	417	33	.4
	40	1.0:1.0	551	53	383	33	.4
	40	2.0:1.0	567	53	426	34	.4
McLeod	20	.4:1.0	584	47	393	41	.4
	20	1.0:1.0	521	42	330	36	.4
	20	2.0:1.0	388	29	245	28	.3
McLeod	40	.4:1.0	758	62	373	53	.5
	40	1.0:1.0	612	53	307	44	.5
	40	2.0:1.0	457	37	259	32	.3

Nutrient uptake by the young plants was not affected by the $N:P_2O_5$ ratio at the Renville County site. For both rates of applied phosphate, uptake at the McLeod County site decreased as the $N;P_2O_5$ ratio increased. This is mainly due to the decrease in plant growth (Table 3).

N Rate in a Starter

No phosphate was used in the starter fertilizer for this study. This would allow for a true measurement of the effect of N rate. The rates of K_2O, S, and Zn were held constant at 5, 4, and .8 lb./acre respectively. The N was applied at rates of 8, 16, 20, 40, and 80 lb./acre.
Grain yields, whole plant weights and stand counts are summarized in Table 6. The plant weight listed is the total weight of 6 corn plants. Regression analysis was used to determine the effect of the rate of N applied in the starter fertilizer band.

Table 6. The effect of N rate in a starter fertilizer on grain yield, weights of young corn plants, and stand counts at about 4 weeks after emergence.

	County					
	Renville			McLeod		
N Rate	Grain Yield	Weight of 6 Plants	Corn Plants	Grain Yield	Weight of 6 Plants	Corn Plants
lb./acre	bu/acre	gm	#/20 ft.	bu/acre	gm	#/20 ft.
0	159	13.5	26	134	11.0	31
8	148	12.8	26	149	11.0	29
16	152	12.8	27	144	12.0	27
20	156	11.8	27	141	12.0	28
40	149	11.8	26	159	11.5	27
80	160	12.8	27	140	12.5	27
CV, %	9.9	18.6	5.1	20.1	25.0	6.0

The rate of fertilizer N in the starter band had no significant effect on grain yield, early growth of young plants as measured by plant weight and corn emergence at both sites. There are substantial differences in treatment averages for yield at the McLeod County site. Because of variability in the data (CV = 20.1%), these differences are not statistically significant.

Table 7. The effect of N rate in a starter fertilizer on the concentration of nutrients in young corn plants.

N Rate	Nutrient N	P	K	S	Zn
lb./acre	%				ppm
Renville Co.:					
0	4.13	.395	3.48	.252	28.1
8	4.11	.386	3.31	.262	28.9
16	4.22	.395	2.97	.259	28.8
20	4.29	.400	3.04	.261	28.3
40	4.25	.400	3.13	.268	28.2
80	4.13	.394	3.33	.254	27.4
CV: %	2.80	5.83	21.20	4.37	16.00
McLeod Co.:					
0	3.82	.294	2.54	.270	28.4
8	3.91	.299	2.53	.274	29.6
16	4.01	.301	2.71	.281	28.1
20	3.93	.311	2.82	.276	29.5
40	3.95	.297	2.19	.273	29.2
80	3.86	.290	2.64	.269	29.9
CV: %	5.36	13.47	17.07	4.50	7.73

The effect of rate of N applied in a starter band on the nutrient concentration in young corn plants is summarized in Table 7. At the Renville County site, the concentration of both N and S increased curvilinearly with rate of applied N. The concentrations of P, K, and Zn were not affected. Since increases in concentrations were not reflected in yield, the practical significance of these increases in concentration are not well defined at this time.

In contrast to the Renville County site, rate of N in the starter band had no significant effect on the nutrient concentration in young corn plants at the McLeod County site.

Nutrient uptake was computed by multiplying plant weight by concentration. These values are summarized in Table 8.

Table 8. The effect of rate of N in a starter fertilizer on uptake of selected nutrients in young corn plants.

N Rate	Nutrient N	P	K	S	Zn
lb./acre	mg in 6 plants				
Renville Co.:					
0	558	53.5	476	33.9	.4
8	526	49.1	427	33.3	.4
16	539	50.2	382	32.9	.4
20	503	47.1	365	30.6	.3
40	500	47.4	383	31.2	.3
80	529	50.4	438	32.4	.3
CV: %	19.8	20.7	34.80	18.0	10.3
McLeod Co.:					
0	426	34.2	264	29.7	.3
8	429	33.0	274	30.1	.3
16	486	37.0	319	33.8	.3
20	472	37.4	340	33.0	.4
40	463	35.8	251	31.9	.3
80	487	37.1	328	33.9	.4
CV: %	5.36	13.47	17.07	4.50	7.73

Uptake of N, P, K, S, and Zn was not affected by rate of N applied in a starter band at both sites. All plots received ample N that was broadcast and incorporated before planting. So, all plants had access to ample amounts of N and major effects resulting from the rate of N applied in a starter should not be anticipated.

Impact of K, S, and Zn

The objective of this study was to measure the effect of each nutrient, applied in a starter band, on grain yield, early growth of corn, and the emerged stand. The results of this study are summarized in Table 9. Except for the control, the rate of N and P_2O_5 was held constant at 20 lb./acre. The Duncan's Multiple Range Test was used for mean separation.

Table 9. The effect of K, S, and Zn applied in a starter fertilizer band on grain yield, early growth, and emergence.

Nutrient Applied					Grain	Weight of	Emerged
N	P_2O_5	K_2O	S	Zn	Yield	6 plants	Stand
- - - - lb./acre - - - -					bu./acre	gm	plants/20 ft.
Renville Co:							
0	0	0	0	0	159 a*	13.5 a	26 a
20	20	5	4	0	161 a	12.0 a	26 a
20	20	5	0	.8	167 a	14.3 a	27 a
20	20	0	4	.8	165 a	13.0 a	26 a
20	20	0	0	0	162 a	15.0 a	27 a
20	20	5	4	.8	161 a	13.5 a	27 a
20	0	5	4	.8	156 a	11.8 a	27 a
				CV:	3.7	14.3	9.4
McLeod Co:							
0	0	0	0	0	117 a	12.3 a	28 a b
20	20	5	4	0	170 c	15.5 a	30 a
20	20	5	0	.8	163 b c	16.0 a	27 b
20	20	0	4	.8	152 b c	12.3 a	29 a b
20	20	0	0	0	146 b	12.3 a	28 a b
20	20	5	4	.8	147 b	12.8 a	28 a b
20	0	5	4	.8	140 a b	12.0 a	28 a b
				CV:	13.7	22.0 a	5.9

* Treatment means in any one column at each site which are followed by the same letter are not significantly different at the .05 confidence level.

Corn yield and early growth at the Renville County site were not affected by any nutrient applied in the starter band. There was no yield increase when the starter was used. The soil test level for both P and Zn was in the medium to high range and a response to the use of a starter fertilizer could be expected in some years. Spring soil conditions were warm and moist. This reduces the possibility that a starter fertilizer might increase yield at these soil test levels.

The starter usage had no damaging effect on the emerged stand. This would be expected for this soil type.

In contrast to Renville County, use of a starter fertilizer produced a substantial improvement in yield at the McLeod County site. There was a substantial amount of variability in yields and this may have masked other treatment effects. The use of the starter fertilizer had no significant effect on the weight of young plants (weight of 6 plants, gm). With a low soil test for P, a response to applied phosphate would be expected. The soil test level for Zn was marginal and there was no significant yield increase when Zn was added to the starter.

Summary and Conclusions

It's not possible to make broad and sweeping conclusions after one year of study at only two sites. Yet, there were some effects that were observed. These are summarized below.

- The $N:P_2O_5$ ratio in the starter fertilizer did not affect grain yield. This was true for both rates of applied phosphate at each site.

- Grain yield increased as the rate of applied phosphate was increased from 20 to 40 lb./acre at the McLeod County site where the soil test for P was low.

- The early plant growth was inversely related to the $N:P_2O_5$ ratio at the McLeod County site.

- Emerged stand was not affected by the $N:P_2O_5$ ratio.

- In general, nutrient uptake by young plants was not affected by the $N:P_2O_5$ ratio. Nutrient uptake paralleled the effects on early growth.

- The rate of N applied in a starter fertilizer had no significant effect on grain yield, early growth, and emergence.

- Use of the starter fertilizer increased grain yield at one of the two sites. At the responsive site, soil test P was low. The yield increase was attributed to the N and P_2O_5 in the starter. There was no benefit from the addition of K, S, and Zn.

Acknowledgement

The assistance of Nutra Flo Chemical of Sioux City, Iowa was vital for the success of this study. Their cooperation in the preparation of the various materials saved considerable amounts of time and eliminated the potential for many frustrations.

PRECISION PLACEMENT FOR IMPROVED EFFICIENCY OF PHOSPHATE USE WHEN GROWING CORN WITH A RIDGE-TILL PLANTING SYSTEM

George Rehm, Greg Cremers, Andy Scobbie, Sam Evans, and Wally Nelson[1/]

ABSTRACT: Use of a starter fertilizer is a good management practice for corn production in a ridge-till planting system. Yet, this can be a problem in years when it is wet at planting time. This study was conducted to evaluate the effect of banded phosphate fertilizer on the growth and yield of corn. Use of 69 lb. P_2O_5 per acre produced optimum yield. Placement had no significant effect on yield. The application of phosphate in a band in the center of the ridge in the previous fall appears to be a promising alternative to a starter fertilizer in a ridge-till planting system.

Introduction:

Users of conventional tillage systems can broadcast and incorporate the P before planting, apply it to the side of and below the seed at planting (starter placement) or use a combination of both of these placement methods. However, there are no major tillage operations used in the ridge-till planting system prior to the building of the ridge with a cultivator during the growing season. The lack of an opportunity to incorporate immobile nutrients, that are broadcast on the soil surface, leads to stratification of P and/or K where highest concentrations persist near the soil surface. This stratification could be a major problem if the soil is dry at planting time or if moisture is limited during the growing season.

Past research has shown that rates of fertilizer P needed for maximum economic production can be reduced substantially if banded rather than broadcast applications of phosphate fertilizer are used. The lower rates needed to achieve the same yield translate into reduced costs which, in turn, improves the potential for increased farm profitability. In addition to providing for increased efficiency of P use, placement of phosphate fertilizer in a band can reduce concerns for environmental quality which center on the movement of broadcast phosphate attached to soil particles which might reach surface waters via erosion.

The effect of distance between the corn seed and the rate of band applied P needed for optimum production has not been addressed. The root growth model of Dr. Barber focuses more on the volume of soil that needs to be fertilized to produce maximum efficiency of fertilizer use. Since root surface area and concentration of P and/or K near the root are important components of this model, one can speculate that the rate of phosphate fertilizer needed for most efficient production could vary with the distance between the seed and the fertilizer. This speculation needs to be verified in field trials.

Objectives:

In an attempt to improve the efficiency of P use by corn planted in a ridge-till planting system, this study is being conducted to:

1. Measure the effect of distance between seed and phosphate fertilizer on the early growth of corn and subsequent grain yield.

2. Determine if repeated application of banded P in a localized area will improve the efficiency of P use by corn.

3. Monitor uptake of P by corn during the growing season as influenced by distance between the seed and phosphate fertilizer applied at several rates.

4. Determine the effect of initial soil test level for P and environmental conditions on the efficiency of use of fertilizer P applied in bands.

Experimental Procedure:

In 1989, this study was conducted at the West-Central Experiment Station at Morris and the Southwest Experiment Station at Lamberton. At Morris, treatments were reapplied to the treatments established for the 1988 growing season. Two sites were used at Lamberton. At one site, treatments were reapplied to the treatments established for the 1988 growing season. The same treatments were applied to a second site which had not received P fertilizers for a number of years.

At each site, 0-46-0 was used to supply 23, 46, and 69 lb P_2O_5 per acre. Four methods of phosphate placement were compared at each experimental site. These were:

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1. Broadcast

2. Starter (a band below and to the side of the seed at planting)

3. Subsurface band at a depth of 3.5 to 5.0 inches placed in the center of the existing ridge. This application of phosphate was made in the fall. This is identified as the ridge center treatment.

4. Subsurface band at a depth of 3 to 4 inches at a distance of 10-12 inches from the row. This band was placed to one side of the existing ridge. This application of phosphate was also completed each fall. This is identified as the ridge shoulder treatment.

The treatments used were arranged in a complete factorial design placed in the field in a randomized complete block arrangement with 4 replications. A control (non-fertilized) treatment was included, but was not part of the complete factorial design for purposes of statistical analysis. In addition to the treatments in the factorial design, various combinations of phosphate placement were compared. For these combinations, the phosphate rate was held constant at 46 lb. P_2O_5 per acre with 23 lb. P_2O_5 per acre applied in each portion of the combination.

Soil samples from the added site at Lamberton were collected in 1-foot intervals to a depth of 5 feet prior to fertilizer application. The results of the analysis of soil samples from all sites are summarized in Table 1.

The ridges constructed in the fall of 1987 , for the 1988 and 1989 growing seasons, were maintained. Corn was planted in late April or early May at all sites. Management practices, such as plant population, hybrid, and nitrogen rate, were selected to provide for high yields. Nitrogen rate was 120 lb./acre at all sites and a uniform application was made to all plots.

Whole plant samples were collected from each plot at approximately 4 weeks after emergence. Six plants were taken from the center rows. The plot size was 10 ft. x 55 ft. These samples were dried, weighed, ground, and analyzed for P. Uptake of P by the young corn plants was computed from these measurements. Ear leaf samples were collected at silking, dried, ground, and analyzed for P. Grain yields were measured in mid-October and corrected to the 15.5% moisture base.

Table 1. Relevant soil properties for the experimental sites.

Soil Property	Depth	Site* Morris	Lamberton (88)	Lamberton (89)
pH	0-6	8.1	6.4	6.5
	6-12	8.1	6.5	6.4
	12-24	8.2	7.3	7.2
	24-36	8.2	7.8	8.0
	36-48	8.4	8.1	8.1
	48-60	8.3	8.2	8.1
P**, ppm	0-6	5.5	5.1	2.7
	6-12	6.9	4.1	1.3
	12-24	3.8	2.8	.8
	24-36	.6	3.1	1.8
	36-48	.5	3.5	2.8
	48-60	.5	3.4	3.0
K, ppm	0-6	111	188	137
	6-12	155	147	117
	12-24	118	103	93
	24-36	72	92	67
	36-48	67	90	80
	48-60	93	98	97
Zn, ppm	0-6	2.2	1.0	.6
O.M., %	0-6	4.7	4.3	4.0

* Lamberton (88) = site established for 1988; treatments repeated for 1989
Lamberton (89) = site established for 1989
** Bray and Kurtz #1 procedure used for soil samples from Lamberton;
Olsen procedure used for soil samples from Morris

Results and Discussion:

Yield

In 1989, grain yield was increased by rate of P applied at all sites (Table 2). Placement had no significant effect on yield and there was no significant rate x placement interaction. When averaged over placement,

Table 2. Effect of rate and placement of phosphate fertilizer on corn yield.

Placement	P_2O_5 Applied	Site Morris	Lamberton(88)	Lamberton(89)
	lb./acre	bu./acre		
None	0	145.9	114.3	98.7
Broadcast	23	147.9	110.2	117.4
	46	145.5	119.8	110.8
	69	155.9	117.0	120.2
Starter	23	148.3	113.4	112.8
	46	148.2	117.0	114.0
	69	153.7	115.8	123.4
Ridge Center	23	150.5	114.5	108.1
	46	150.6	115.6	111.7
	69	156.8	121.1	121.9
Ridge Shoulder	23	154.1	116.5	116.8
	46	137.0	119.1	121.2
	69	153.4	124.0	126.9
CV, %	-	6.1	6.8	8.4
Main Effects:				
Rate	0	145.9	114.3	98.7
	23	150.2	113.7	113.7
	46	145.4	117.9	114.4
	69	155.0	119.5	123.1
Placement				
	Broadcast	149.8	115.7	116.1
	Starter	150.1	115.4	116.7
	Ridge Center	152.6	117.1	113.9
	Ridge Shoulder	148.2	119.9	121.6

grain yields were not increased by the application of either 23 or 46 lb. P_2O_5 per acre at the sites where trials were initiated in 1988 and treatments repeated for 1989 (Morris, Lamberton-88). The application of 69 lb. P_2O_5 per acre did, however, increase yields at these two sites. Compared to the control, all rates of applied phosphate increased yields at the second Lamberton site where the study was initiated in 1989. Yields were equal when the phosphate rate was 23 and 46 lb. per acre. Yields increased when the rate was increased to 69 lb. P_2O_5 per acre.

The various combinations of phosphate placement that were used had a significant effect on yield at the Morris location only (Table 3). Dry weather limited yields at the Lamberton location. Some differences among yields may have been observed if yields had been higher.

Table 3. The effect of phosphate placement combination on corn yield. Total rate of applied phosphate was 46 lb./acre for each combination.

Combination	Site Morris	Lamberton(88)	Lamberton(89)
	bu./acre		
None	145.8 b	114.3 a	98.7 b
Ridge Center + Broadcast	160.7 a	115.4 a	121.9 a
Ridge Center + Ridge Shoulder	154.5 a b	121.0 a	122.7 a
Starter + Broadcast	150.3 b	114.9 a	113.0 a b
Starter + Ridge Shoulder	150.5 b	118.6 a	121.4 a

At Morris, the highest yields were measured when some of the phosphate was applied in the band in the center of the ridge. Yields were not significantly different from the control when the starter + broadcast and starter + ridge shoulder placements were used.

Except for the starter + broadcast combination, all placement combinations increased yields when compared to the control at the Lamberton (89) site. The combination used had no effect on yield at the Lamberton (88) site. This lack of a significant yield increase is attributed to variability caused, in part, by the dry weather.

Soil test values for P were low at all sites (Table 1) and a response to applied phosphate would be expected. The absence of a larger response to applied P at sites where treatments were repeated is somewhat surprising but cannot be explained at this time.

Weight of Young Plants

The effects of rate and placement on the weight of young corn plants sampled approximately 4 weeks after planting were quite varied and inconsistent (Table 4).

Lower weights were recorded at the Morris site because plants were sampled at an earlier growth stage. Both rate and placement of phosphate affected early growth at this site. The use of 46 and 69 lb. P_2O_5 per acre increased growth when compared to the check and the 23 lb. P_2O_5 per acre treatments. Considering placement, the best growth was measured when the P_2O_5 was placed in the center of the ridge. The lowest early growth occurred when the phosphate was applied on the shoulder of the ridge. The effects of broadcast and starter placements were intermediate.

Neither rate of applied phosphate nor placement had a significant effect on early growth at the Lamberton (88) site. The extremely dry weather early in the season caused a great deal of variability and this variability may have masked treatment effects.

Phosphate placement, but not rate, affected early growth at the Lamberton (89) site. Lowest plant weights were associated with the broadcast and starter placements. The best early growth was produced by the ridge center and ridge shoulder placements.

The effects of combinations of phosphate placement were also quite varied (Table 5). Using the Duncan's Multiple Range Test for mean separation, placement combination had no significant effect on early growth at Morris. At both Lamberton sites, the best early growth occurred where some of the phosphate was applied in the center of the ridge.

Table 4. Effect of rate and placement of phosphate fertilizer on the weight of young corn plants.

Placement	P_2O_5 Applied	Site: Morris	Lamberton (88)	Lamberton (89)
	lb./acre	- - - - - - - weight of 6 plants, gm - - - - - - -		
None	0	9	65	56
Broadcast	23	8	92	55
	46	10	71	59
	69	12	72	48
Starter	23	9	76	53
	46	13	82	59
	69	10	84	58
Ridge Center	23	11	68	61
	46	12	91	63
	69	12	91	68
Ridge Shoulder	23	9	72	62
	46	9	78	61
	69	9	97	63
CV, %	-	14.2	15.5	12.9
Main Effects:				
Rate	0	9	65	56
	23	9	77	58
	46	11	81	61
	69	11	86	59
Placement				
Broadcast		10	78	54
Starter		11	81	57
Ridge Center		12	83	64
Ridge Shoulder		9	82	62

Table 5. The effect of phosphate placement combination on the weight of young corn plants. The rate of applied phosphate was 46 lb./acre for each combination.

Combination	Site: Morris	Site: Lamberton (88)	Site: Lamberton (89)
	- - - - - - - - weight of 6 plants, gm - - - - - - - -		
None	9 a	65 b	56 b
Ridge Center + Broadcast	12 a	85 a	69 a b
Ridge Center + Ridge Shoulder	11 a	79 a b	77 a
Starter + Broadcast	9 a	84 a	58 b
Starter + Ridge Shoulder	9 a	72 a b	63 b

P Concentration in Young Plants

The effect of rate and placement of phosphate fertilizer is summarized in Table 6. Concentrations at Morris are higher because plants were sampled at a younger growth stage. At Morris, P concentration was affected by both rate and placement. Compared to the check, all P_2O_5 applications increased the P concentration in young plants. There were, however, no differences among rates. Considering placement, the highest concentration was produced by the starter placement. All other placements had an equal effect.

Rate and placement of phosphate also affected the P concentration at the Lamberton (88) site. Increases in concentration as affected by rate were small. The 23 lb./acre rate did not produce a significant increase. The 46 and 69 lb./acre rates produced equal increases. Lowest P concentrations were associated with the starter and broadcast placements. The band on the ridge shoulder produced the highest concentration with the ridge center band being intermediate. These data show that the roots of young corn plants are able to reach the phosphate band placed on the shoulder of the ridge. It's notable, also, that this occurred with extremely dry soil conditions.

Table 6. The influence of rate and placement of phosphate fertilizer on the phosphorus concentration in young corn plants.

Placement	P_2O_5 Applied	Site: Morris	Site: Lamberton (88)	Site: Lamberton (89)
	lb./acre	- - - - - - - - - - - - - - % - - - - - - - - - - - -		
None	0	.391	.291	.231
Broadcast	23	.419	.265	.237
	46	.420	.299	.266
	69	.425	.304	.264
Starter	23	.432	.282	.276
	46	.438	.269	.263
	69	.470	.294	.297
Ridge Center	23	.421	.301	.261
	46	.422	.313	.273
	69	.433	.300	.301
Ridge Shoulder	23	.426	.307	.310
	46	.401	.340	.314
	69	.411	.331	.299
CV, %	-	5.5	8.0	11.0
Main Effects:				
Rate	0	.391	.291	.231
	23	.425	.289	.271
	46	.420	.305	.279
	69	.435	.307	.290
Placement				
	Broadcast	.421	.289	.256
	Starter	.447	.282	.279
	Ridge Center	.425	.305	.278
	Ridge Shoulder	.413	.326	.308

At the Lamberton (89) site, all rates of applied phosphate increased the P concentration when compared to the check. Concentration, however, did not increase as rate increased. Consistent with data from the

Lamberton (88) site, highest p concentrations were associated with the band on the shoulder of the ridge. When averaged over rate, all other placements had an equal effect.

The influence of placement combinations on P concentration is summarized in Table 7. Except for the improvement over the check treatment, no distinct effects emerged from this measurement. Plant dilution could account for much of the variability.

Table 7. The effect of phosphate placement combinations on the P concentration in young corn plants. The rate of applied phosphate was 46 lbs/acre for each combination.

Combination	Site: Morris	Lamberton (88)	Lamberton (89)
	% P		
None	.391 b	.291 b	.231 c
Ridge Center + Broadcast	.427 a	.305 a b	.255 b c
Ridge Center + Ridge Shoulder	.425 a	.312 a	.287 a
Starter + Broadcast	.431 a	.301 b	.243 c
Starter + Ridge Shoulder	.423 a	.318 a	.276 a b

Phosphorus Uptake by Young Plants

Phosphorus uptake by young corn plants is probably the best measure of the effect of placement on the early growth of the crop. Calculated from plant weight and concentration measurements, this measure overcomes problems caused by plant dilution.

At Morris, uptake at this stage of growth was affected by both rate and placement and the rate x placement interaction was significant. When averaged over all placements, P uptake increased curvilinearly with rate with maximum uptake occurring with the application of 46 lb. P_2O_5 per acre. Considering placement, P uptake was lower when the phosphate fertilizer was either broadcast or placed in a band on the ridge shoulder.

Table 8. The influence of rate and placement of phosphate on phosphorus uptake by young corn plants.

Placement	P_2O_5 Applied	Site: Morris	Lamberton (88)	Lamberton (89)
	lb./acre	mg P/6 plants		
None	0	35.3	185	130
Broadcast	23	34.5	235	130
	46	43.3	200	159
	69	49.5	211	127
Starter	23	40.5	212	147
	46	58.0	210	154
	69	46.7	243	170
Ridge Center	23	44.5	194	159
	46	49.7	279	170
	69	52.5	265	206
Ridge Shoulder	23	39.5	213	188
	46	35.8	268	189
	69	37.3	315	186
CV, %	-	15.5	15.6	15.0
Main Effects:				
Rate	0	35.3	185	130
	23	39.8	214	156
	46	46.7	239	168
	69	46.5	259	172
Placement				
	Broadcast	42.4	215	139
	Starter	48.4	222	157
	Ridge Center	48.9	246	178
	Ridge Shoulder	37.5	265	188

Both rate and placement had a significant effect on P uptake at both Lamberton sites. Uptake continued to increase with rate at Lamberton (88) site. At the Lamberton (89) site, this increase was not measured. Compared to the control, however, all rates of applied P_2O_5 increased P uptake.

The application of phosphate in a band in either the center of the ridge or on the shoulder of the ridge produced the highest uptake at the Lamberton (88) site. Both broadcast and starter placement produced lower uptake by the young plants. This same observation holds true for the Lamberton (89) site.

The combinations of placements also affected P uptake (Table 9). In general, uptake was higher at all locations when the phosphate fertilizer or a portion of the total amount applied was placed in a band either in the center of the ridge or on the shoulder of the ridge. These results are consistent with those obtained from the other phase of the study.

Table 9. The effect of phosphate placement combinations on the P uptake by young corn plants. The rate of applied phosphate was 46 lb./acre for each combination.

Combination	Site: Morris	Site: Lamberton (88)	Site: Lamberton (89)
	mg P/6 plants		
None	35.3 b	185 b	130 c
Ridge Center + Broadcast	51.5 a	254 a	178 b
Ridge Center + Ridge Shoulder	47.8 a b	245 a	222 a
Starter + Broadcast	38.0 a b	248 a	142 b c
Starter + Ridge Shoulder	47.3 a b	228 a b	175 b

Phosphorus Concentration in Ear Leaf Tissue

Ear leaf samples collected at silking were analyzed for P in an attempt to monitor the effects of rate and placement at a later point in the growing season. At all sites, P concentration increased with rate of applied phosphate, but placement had no significant effect on this value (Table 10). The response to rate was linear at all sites. Root development later in the growing season is apparently extensive enough to take up the P regardless of placement.

Table 10. The effect of rate and placement of phosphate fertilizer on the P concentration in ear leaf tissue of corn.

Placement	P_2O_5 Applied	Site: Morris	Site: Lamberton (88)	Site: Lamberton (89)
	lb./acre	% P		
None	0	.256	.255	.193
Broadcast	23	.254	.273	.220
	46	.265	.266	.244
	69	.274	.296	.250
Starter	23	.246	.243	.239
	46	.254	.269	.248
	69	.290	.279	.263
Ridge Center	23	.272	.261	.217
	46	.268	.279	.231
	69	.275	.286	.267
Ridge Shoulder	23	.264	.263	.241
	46	.254	.274	.259
	69	.255	.289	.253
CV, %	-	7.0	5.9	7.4
Main Effects:				
Rate	0	.256	.255	.193
	23	.259	.260	.229
	46	.260	.272	.246
	69	.274	.288	.258
Placement				
Broadcast		.264	.278	.238
Starter		.263	.264	.250
Ridge Center		.272	.275	.238
Ridge Shoulder		.258	.275	.251

The P concentration in the ear leaf tissue was also not affected by combinations of phosphate placement (Table 11). The P concentration was increased by P application, regardless of placement combination.

Table 11. The effect of phosphate placement combinations on the P concentration in the ear leaf collected at silking. The rate of applied phosphate was 46 lb./acre for each combination.

Combination	Site		
	Morris	Lamberton (88)	Lamberton (89)
	% P		
None	.256 b	.255 b	.193 b
Ridge Center + Broadcast	.266 a	.278 a	.250 a
Ridge Center + Ridge Shoulder	.270 a	.279 a	.252 a
Starter + Broadcast	.273 a	.278 a	.223 a
Starter + Ridge Shoulder	.272 a	.275 a	.246 a

Summary

After evaluating the data collected from three experimental sites in 1989, there are some limited statements that can be made. These are listed below.

- With low soil test values for P at all sites, the use of phosphate fertilizer increased grain yield at all sites. The rate of 69 lb. P_2O_5 per acre was necessary for maximum yield. This response was noted even though dry weather limited yields at the Lamberton sites.

- Placement of phosphate had no significant effect on grain yield.

- In general, uptake of phosphorus by young corn plants was higher when phosphate fertilizer was applied in a band in the center of the ridge in the previous fall.

- As would be expected, phosphorus uptake by young plants increased with the rate of phosphate applied.

- The application of phosphate in a band in the center of the ridge appears to be a promising alternative to placement in a starter fertilizer band.

EVALUATION OF THE BRAY AND OLSEN SOIL TEST PROCEDURES FOR PREDICTING PHOSPHATE FERTILIZER NEEDS FOR CORN

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ABSTRACT: Traditionally, the Bray and Kurtz #1 procedure has been used to predict phosphate requirements when the soil pH is 7.3 or less. The Olsen procedure is recognized for use when the soil pH is 7.4 or higher. This study was conducted to evaluate these procedures for situations where P extracted by the Bray procedure exceeds P values when the Olsen procedure is used if the soil pH is high.

Introduction:

There is general agreement that the Bray and Kurtz #1 procedure should be used to predict phosphate fertilizer needs for corn when the soil pH is 7.3 or less. Likewise, the Olsen procedure is widely used to predict these needs when the soil pH is 7.4 or higher. The concentration of P measured by the Bray procedure is usually too low to accurately reflect the P status of soils when the soil pH is 7.4 or higher.

Recently, there have been numerous situations in highly calcareous soils where the P extracted by the Bray and Kurtz #1 procedure is higher than the amount of P extracted by the Olsen procedure. There is no apparent explanation for these observations. Therefore, there was a need to determine which procedure was accurately describing the P status of soils in these situations.

Objective:

This study was conducted to determine which P extraction procedure would accurately predict the P status of highly calcareous soils that would be planted to corn.

Experimental Procedure:

This study was conducted at two locations in Renville County (Moritz, Hillman). Soil samples were collected to 5 feet prior to treatment application. The soil properties at the Moritz site are summarized in Table 1, while those from the Hillman site are listed in Table 2.

Both sites were calcareous. For the Moritz location, the P measured by the Bray and Kurtz #1 procedure (0-6 inches) was higher than the procedure measured by the Olsen procedure. The reverse was true at the Hillman site. There was also interest in measuring P by a universal extractant. Therefore, the Soltanpour procedure was also used to measure P in these soils.

Six rates of P_2O_5 (20, 40, 60, 80, 100, 300 lb./acre) supplied as 0-46-0, were broadcast and incorporated before corn was planted. The appropriate control was used. Management practices appropriate for high yields of corn were used at both sites.

Phosphorus uptake was monitored by collecting leaf samples from opposite and below the primary ear at silking. At physiological maturity, whole plant samples were taken from each plot. These samples were dried, weighed, ground, and analyzed for P. Phosphorus uptake was computed by combining P concentration, plant weight, and plant population data.

Grain yields were measured in October and corrected to 15.5% moisture. Following harvest, soil samples (0-6 inches) were collected from all plots to measure changes in soil test P. Both Bray and Kurtz #1 and Olsen procedures were used for these samples.

Results and Discussion:

At the Moritz location, soil test P as measured by the Bray and Kurtz #1 procedure in the initial sample (0-6 inches) was considered to be high. Using the Olsen procedure, the soil test P is considered to be in the medium range. There was a significant curvilinear increase in yield with rate of applied P_2O_5 (Table 3). The rate of 60 lb. P_2O_5 per acre was adequate for optimum yield. This type of yield response to broadcast phosphate would not be expected if soil test P values were in the high range. Apparently, the Olsen procedure, showing soil test P to be in the low to medium range, was more accurate at this site.

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As would be expected, soil test P, as measured by both the Bray and Kurtz #1 procedure and the Olsen procedure, increased with rate of applied phosphate. The increase was linear for both measurements.

The grain yield at the Hillman location also increased with the rate of applied phosphate. The relationship was curvilinear with the broadcast application of 100 lb. P_2O_5 per acre producing optimum yields (Table 4). The effect of applied phosphate on dry matter yield was also significant. The relationship was curvilinear with the rate of 100 lb. P_2O_5 per acre producing maximum dry matter. The soil test P level at this site is considered to be low by both measurements and a response to applied phosphate would be expected.

The soil test value for P also increased linearly with rate of applied phosphate at this site. Again, this relationship was observed for both methods used.

The problem that is addressed by this study cannot be solved by collecting data from only 2 sites. This study must be conducted at numerous sites in the years ahead before an answer can be found.

Table 1. Soil test values for the Moritz experimental site.

	Depth (in)					
Property	0-6	6-12	12-24	24-36	36-48	48-60
pH	7.7	7.7	7.9	8.1	8.1	8.0
organic matter, %	6.8	-	-	-	-	-
K (1N $NH_4C_2H_3O_2$), ppm	167	-	-	-	-	-
Zn, ppm	.6	-	-	-	-	-
NO_3-N, lb./acre	42.5	33.4	30.0	18.0	17.2	24.8
Bray P, ppm	16.2	2.8	1.4	1.7	1.5	1.5
Olsen P, ppm (organic)	7.8	5.2	2.3	1.0	.3	.2
Olsen P, ppm (inorganic)	12.3	2.8	1.5	1.5	.8	1.0
Soltanpour P, ppm	10.2	3.5	1.7	.9	.5	.7

Table 2. Soil test values for the Hillman experimental site.

	Depth (in)					
Property	0-6	6-12	12-24	24-36	36-48	48-60
pH	7.7	7.7	7.9	8.1	8.1	8.1
organic matter, %	6.3	-	-	-	-	-
K (1N $NH_4C_2H_3O_2$), ppm	100	-	-	-	-	-
Zn, ppm	.6	-	-	-	-	-
NO_3-N, lb./acre	37.8	52.6	77.3	30.8	16.0	20.4
Bray P, ppm	5.8	2.7	1.8	1.3	1.2	1.5
Olsen P, ppm (organic)	9.2	7.5	2.6	.9	.3	.3
Olsen P, ppm (inorganic)	5.8	2.8	1.0	.5	.5	.5
Soltanpour P, ppm	7.0	4.0	1.9	.8	.4	.5