fertilizer K was applied, but increased yields when fertilizer K was applied. This test area is moderate in soil test K and is irrigated so a reason for the negative response to K fertilization is not well understood at this time.

Waseca: Due to the hot, dry growing conditions in 1988 corn grain yields were well below normal at this locations. Final grain yield were significantly different between hybrids, with A632 x LH39 and P-3732 having the lowest yields, P-3475 being intermediate and LH74 x LH51 having the highest overall yields. The P-3475 hybrid tended to have the highest yield when no fertilizer N was applied. Numerous interactions would suggest that not all hybrids responded to the N, K, and nitrification inhibitor treatments in a similar manner. Most of the positive response to K fertilization could be attributed to P-3732 and A632 x LH39. A yield response to increasing N rate was observed through the highest rate of N, but LH74 x LH51 was the most responsive hybrid in the experiment. Although the main effect of nitrification inhibitor was not significant, interactions would suggest that N-Serve increased yields when low rates of N were applied (80 lbs/a), but decreased yields at the high fertilizer N rate when no K was applied. The addition of fertilizer K eliminated the yield depression that was obtained with the nitrification inhibitor at the high fertilizer N rate. The information obtained at both locations warrants continued evaluation.

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. Becker, MN 1988.

N-Rate	Hybrid	Inh.	K-Rate	Whole Plant 12 Leaf Stover			Whole Plant Tasseling Stover		
#/A			#/A	T/A	% N	#/A	T/A	% N	#/A
80	Pioneer 3732	---	---	1.18	2.57	60.2	3.74	1.60	120.2
80		NS	---	0.98	2.85	56.2	3.12	1.49	92.6
80		---	100	1.12	2.72	61.0	3.62	1.67	120.1
80		NS	100	1.41	2.44	69.1	3.70	1.69	125.0
80		---	200	1.15	2.47	56.2	3.35	1.40	93.2
80		NS	200	1.14	2.42	55.0	3.28	1.68	109.3
160		---	200	1.17	2.77	64.6	3.66	1.55	113.1
160		NS	200	1.29	2.58	66.3	3.43	1.69	115.9
240		---	---	1.28	2.68	67.9	3.51	1.64	115.5
240		NS	---	1.12	2.59	58.0	3.35	1.60	106.9
240		---	100	1.24	2.32	57.6	3.43	1.66	114.1
240		NS	100	1.23	2.55	62.5	3.98	1.82	144.2
240		---	200	1.02	2.51	50.4	3.12	1.79	111.6
240		NS	200	1.10	2.58	57.1	3.17	1.82	113.6
80	Pioneer 3737	---	---	1.10	2.72	58.9	3.36	1.52	100.1
80		NS	---	1.15	2.96	67.4	3.50	1.70	118.5
80		---	100	1.28	2.53	65.1	3.42	1.73	119.0
80		NS	100	1.23	2.81	68.8	3.63	1.85	133.5
80		---	200	1.31	2.70	70.6	3.60	1.49	108.1
80		NS	200	1.11	2.72	60.2	3.25	2.07	137.7
160		---	200	0.96	3.20	60.0	2.83	1.82	102.7
160		NS	200	1.07	2.71	58.0	3.25	1.72	111.8
240		---	---	1.15	3.03	69.0	3.37	1.90	127.1
240		NS	---	1.25	3.00	75.4	3.31	2.10	139.8
240		---	100	1.14	2.76	62.2	3.53	2.21	157.6
240		NS	100	1.14	2.96	67.1	3.14	1.90	119.3
240		---	200	0.96	2.83	54.2	3.44	1.88	129.0
240		NS	200	1.12	2.88	64.8	2.87	1.79	102.2
80	A632 X LH39	---	---	1.20	2.86	68.6	3.70	1.73	128.6
80		NS	---	1.36	2.62	71.2	3.61	1.93	139.4
80		---	100	1.16	2.71	60.9	3.36	1.43	95.2
80		NS	100	1.08	2.53	53.6	3.03	1.51	91.3
80		---	200	1.21	2.52	60.7	3.60	1.80	129.2
80		NS	200	1.13	2.67	61.1	2.97	1.44	84.4
160		---	200	0.93	2.76	50.6	3.20	1.84	116.9
160		NS	200	0.91	2.77	49.4	3.08	2.07	126.7
240		---	---	1.04	2.77	57.1	3.06	1.72	106.8
240		NS	---	1.17	2.92	67.8	3.65	2.01	148.9
240		---	100	1.09	2.70	58.5	3.18	1.76	110.8
240		NS	100	1.14	2.79	63.6	3.01	1.86	110.6
240		---	200	0.86	2.91	49.6	2.70	1.94	106.8
240		NS	200	0.96	2.65	50.9	3.03	1.67	101.2
80	DeKalb 484	---	---	1.18	2.61	61.4	3.50	1.61	113.0
80		NS	---	1.21	2.56	61.8	3.82	1.79	136.8
80		---	100	1.11	2.67	59.2	3.42	1.70	116.4
80		NS	100	1.10	2.67	58.9	3.24	1.71	110.6
80		---	200	1.03	2.70	55.0	3.42	1.44	98.2
80		NS	200	1.17	2.68	63.1	3.50	1.67	115.3
160		---	200	1.00	2.73	54.0	3.35	1.53	101.1
160		NS	200	0.93	2.85	52.7	3.14	1.79	112.2
240		---	---	1.28	2.74	70.8	3.29	1.72	113.5
240		NS	---	1.03	2.92	59.3	3.68	2.01	147.3
240		---	100	1.15	2.82	64.7	4.11	1.91	157.6
240		NS	100	1.22	2.69	64.6	3.38	1.83	124.1
240		---	200	1.04	2.90	60.4	3.46	1.98	134.5
240		NS	200	1.22	2.54	61.5	3.32	1.89	124.9

Table 2. 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 predent. Becker, MN 1988.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
#/A			#/A	Bu/A	----------T/A----------			
80	Pioneer 3732	---	---	89.7	2.12	3.56	0.72	6.40
80		NS	---	86.4	2.05	3.47	0.71	6.22
80		---	100	91.1	2.16	3.89	0.67	6.72
80		NS	100	95.4	2.26	4.35	0.69	7.29
80		---	200	91.0	2.15	3.63	0.69	6.47
80		NS	200	86.8	2.05	3.62	0.67	6.34
160		---	200	91.1	2.16	3.49	0.66	6.31
160		NS	200	88.2	2.09	3.78	0.71	6.58
240		---	---	104.6	2.48	3.30	0.78	6.56
240		NS	---	90.8	2.15	3.15	0.70	6.00
240		---	100	83.6	1.98	3.53	0.66	6.17
240		NS	100	97.8	2.32	4.35	0.76	7.43
240		---	200	70.7	1.67	3.14	0.58	5.40
240		NS	200	85.3	2.02	3.58	0.73	6.33
80	Pioneer 3737	---	---	99.1	2.35	3.45	0.62	6.41
80		NS	---	104.6	2.47	3.32	0.64	6.42
80		---	100	92.5	2.19	3.53	0.59	6.31
80		NS	100	95.4	2.26	3.40	0.62	6.28
80		---	200	86.4	2.05	2.98	0.52	5.54
80		NS	200	98.8	2.34	3.37	0.61	6.33
160		---	200	86.1	2.04	3.01	0.57	5.62
160		NS	200	95.6	2.26	3.14	0.62	6.03
240		---	---	101.0	2.39	3.44	0.68	6.51
240		NS	---	97.1	2.30	3.65	0.61	6.56
240		---	100	99.5	2.36	3.82	0.69	6.86
240		NS	100	87.5	2.07	3.21	0.55	5.84
240		---	200	109.5	2.59	3.26	0.71	6.57
240		NS	200	94.3	2.23	3.40	0.60	6.23
80	A632 X LH39	---	---	84.1	1.99	3.54	0.77	6.31
80		NS	---	94.0	2.22	3.43	0.72	6.38
80		---	100	85.6	2.03	3.82	0.73	6.58
80		NS	100	75.4	1.78	3.25	0.69	5.72
80		---	200	70.5	1.67	3.42	0.65	5.73
80		NS	200	93.3	2.21	3.94	0.78	6.93
160		---	200	80.2	1.90	3.32	0.77	5.99
160		NS	200	84.4	2.00	3.45	0.79	6.24
240		---	---	95.8	2.27	3.27	0.79	6.32
240		NS	---	89.3	2.13	3.38	0.73	6.24
240		---	100	79.2	1.87	3.39	0.67	5.94
240		NS	100	78.7	1.86	3.21	0.77	5.84
240		---	200	74.5	1.76	2.89	0.73	5.37
240		NS	200	72.2	1.71	3.28	0.62	5.61
80	DeKalb 484	---	---	89.5	2.12	3.60	0.66	6.38
80		NS	---	83.0	1.96	3.44	0.67	6.08
80		---	100	87.3	2.07	3.84	0.81	6.72
80		NS	100	79.4	1.88	3.61	0.72	6.23
80		---	200	79.4	1.88	3.72	0.69	6.29
80		NS	200	70.8	1.68	3.81	0.53	6.01
160		---	200	76.6	1.81	3.67	0.66	6.15
160		NS	200	79.9	1.89	3.11	0.66	5.67
240		---	---	87.5	2.08	3.31	0.73	6.12
240		NS	---	76.2	1.80	3.08	0.65	5.53
240		---	100	90.5	2.14	4.43	0.80	7.37
240		NS	100	82.0	1.94	3.57	0.64	6.15
240		---	200	81.9	1.94	3.37	0.70	6.01
240		NS	200	79.4	1.88	3.27	0.67	5.82

Table 3. Influence of N-rate, K-rate and nitrification inhibitors on grain, stover and cob N content and total N removal on four corn hybrids at predent. Becker, MN 1988.

				N-Concentration			N-Removal			
N-Rate	Hybrid	Inh.	K-Rate	Stover	Grain	Cob	Stover	Grain	Cob	Total
#/A			#/A	----------%----------			----------#/A----------			
80	Pioneer 3732	---	---	1.15	1.45	0.63	91.4	61.5	8.9	151.9
80		NS	---	1.23	1.48	0.64	85.5	60.6	8.9	155.0
80		---	100	0.96	1.49	0.52	73.9	64.2	7.0	145.1
80		NS	100	1.06	1.52	0.55	90.4	68.5	7.5	166.5
80		---	200	1.19	1.48	0.57	85.5	63.7	7.9	157.1
80		NS	200	1.06	1.46	0.55	76.5	59.8	7.4	143.8
160		---	200	1.24	1.55	0.63	87.3	66.6	8.3	162.2
160		NS	200	1.03	1.55	0.62	77.7	64.8	8.7	151.3
240		---	---	1.19	1.50	0.54	79.1	74.3	8.4	161.9
240		NS	---	1.13	1.52	0.54	71.6	65.4	7.5	144.6
240		---	100	1.11	1.51	0.57	79.6	59.5	7.4	146.6
240		NS	100	1.26	1.56	0.55	110.2	72.0	8.4	190.6
240		---	200	1.10	1.60	0.67	67.9	53.3	7.7	129.0
240		NS	200	1.30	1.56	0.58	93.9	63.0	8.3	165.3
80	Pioneer 3737	---	---	1.19	1.53	0.45	82.2	71.6	5.5	159.3
80		NS	---	1.23	1.55	0.47	80.6	76.2	6.0	162.9
80		---	100	1.01	1.51	0.50	71.8	66.2	5.7	143.8
80		NS	100	1.07	1.62	0.43	72.8	72.9	5.3	151.2
80		---	200	1.10	1.55	0.42	64.4	63.3	4.3	132.1
80		NS	200	1.26	1.60	0.48	84.1	74.9	5.8	165.0
160		---	200	1.10	1.67	0.46	65.9	67.4	5.1	138.6
160		NS	200	1.19	1.69	0.49	75.2	76.4	6.1	157.7
240		---	---	1.18	1.72	0.55	80.9	82.0	7.2	170.3
240		NS	---	1.15	1.67	0.44	83.7	76.5	5.3	165.5
240		---	100	1.33	1.67	0.47	100.7	78.3	6.2	185.3
240		NS	100	1.21	1.65	0.49	76.7	68.2	5.4	150.3
240		---	200	1.14	1.65	0.47	75.1	85.4	6.6	167.2
240		NS	200	1.22	1.74	0.44	83.0	77.5	5.3	165.8
80	A632 X LH39	---	---	0.97	1.66	0.42	69.7	66.1	6.4	142.3
80		NS	---	1.13	1.76	0.45	77.6	78.4	6.4	162.6
80		---	100	1.25	1.63	0.45	96.4	65.3	6.5	168.6
80		NS	100	1.13	1.68	0.45	74.8	59.5	6.1	140.5
80		---	200	0.98	1.62	0.41	66.7	53.9	5.2	125.8
80		NS	200	1.10	1.63	0.41	86.6	71.9	6.4	165.0
160		---	200	1.02	1.81	0.48	67.0	68.7	7.4	143.2
160		NS	200	1.35	1.82	0.43	93.2	73.5	6.6	173.4
240		---	---	1.43	1.71	0.42	93.7	77.9	6.6	178.2
240		NS	---	1.08	1.83	0.40	72.8	77.8	5.9	156.7
240		---	100	1.26	1.85	0.44	85.3	69.2	5.8	160.4
240		NS	100	1.34	1.77	0.48	84.8	66.0	7.4	158.2
240		---	200	1.11	1.68	0.45	64.4	59.1	6.4	130.1
240		NS	200	1.40	1.91	0.53	91.6	65.0	6.6	163.3
80	DeKalb 484	---	---	1.19	1.56	0.53	84.9	66.1	6.8	158.0
80		NS	---	1.21	1.73	0.44	83.3	67.9	5.9	157.2
80		---	100	1.03	1.62	0.52	78.9	67.0	8.4	154.4
80		NS	100	1.00	1.60	0.48	71.8	59.8	6.9	138.6
80		---	200	1.26	1.61	0.47	93.8	60.3	6.5	160.7
80		NS	200	1.04	1.66	0.53	79.2	55.4	5.6	140.3
160		---	200	1.29	1.72	0.54	94.9	62.3	7.1	164.4
160		NS	200	1.13	1.77	0.57	69.8	66.8	7.4	144.2
240		---	---	1.35	1.72	0.43	89.3	71.2	6.2	166.8
240		NS	---	1.24	1.78	0.45	76.3	64.1	5.8	146.3
240		---	100	1.35	1.78	0.54	119.6	76.2	8.6	204.4
240		NS	100	0.97	1.73	0.49	68.9	67.1	6.2	142.3
240		---	200	1.18	1.79	0.47	79.5	69.3	6.6	155.5
240		NS	200	1.20	1.82	0.56	78.0	68.3	7.4	153.7

Table 4. 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 physiological maturity. Becker, MN 1988.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Total
#/A			#/A	Bu/A	----------T/A----------		
80	Pioneer 3732	---	---	172.0	4.07	3.25	7.32
80		NS	---	160.4	3.80	3.01	6.80
80		---	100	181.7	4.30	3.63	7.93
80		NS	100	181.3	4.29	3.39	7.69
80		---	200	164.5	3.89	3.33	7.22
80		NS	200	161.7	3.83	3.14	6.97
160		---	200	164.9	3.90	2.98	6.89
160		NS	200	174.2	4.12	3.63	7.76
240		---	---	173.2	4.10	3.36	7.46
240		NS	---	171.7	4.06	3.11	7.17
240		---	100	176.4	4.17	3.45	7.63
240		NS	100	185.9	4.40	3.88	8.28
240		---	200	181.0	4.28	3.28	7.57
240		NS	200	187.7	4.44	3.91	8.35
80	Pioneer 3737	---	---	179.6	4.25	2.75	7.00
80		NS	---	172.1	4.07	3.21	7.28
80		---	100	173.4	4.10	2.70	6.81
80		NS	100	173.0	4.10	2.81	6.91
80		---	200	161.2	3.81	2.57	6.38
80		NS	200	177.7	4.21	3.07	7.28
160		---	200	157.6	3.73	2.33	6.06
160		NS	200	172.6	4.08	2.60	6.68
240		---	---	189.6	4.49	3.07	7.55
240		NS	---	167.2	3.96	2.49	6.45
240		---	100	171.9	4.07	2.75	6.82
240		NS	100	166.6	3.94	2.52	6.46
240		---	200	166.7	3.94	2.61	6.55
240		NS	200	177.5	4.20	2.96	7.16
80	A632 X LH39	---	---	171.9	4.07	3.11	7.18
80		NS	---	186.0	4.40	3.29	7.69
80		---	100	165.7	3.92	2.92	6.84
80		NS	100	163.8	3.88	2.98	6.86
80		---	200	162.9	3.85	2.95	6.80
80		NS	200	166.5	3.94	2.93	6.87
160		---	200	162.2	3.84	2.72	6.56
160		NS	200	167.2	3.96	2.84	6.79
240		---	---	165.1	3.91	2.85	6.76
240		NS	---	151.3	3.58	2.68	6.26
240		---	100	163.6	3.87	3.05	6.92
240		NS	100	151.6	3.59	2.55	6.14
240		---	200	167.2	3.96	2.88	6.84
240		NS	200	169.8	4.02	2.88	6.75
80	DeKalb 484	---	---	178.1	4.22	2.73	6.72
80		NS	---	178.5	4.22	3.51	7.42
80		---	100	178.3	4.22	3.20	7.50
80		NS	100	173.9	4.12	3.28	7.37
80		---	200	159.5	3.78	3.25	6.83
80		NS	200	175.7	4.16	3.05	7.52
160		---	200	180.6	4.27	3.37	7.45
160		NS	200	175.8	4.16	3.18	6.93
240		---	---	201.5	4.77	2.77	8.15
240		NS	---	166.9	3.95	3.38	6.85
240		---	100	164.1	3.88	2.90	6.88
240		NS	100	173.8	4.11	2.99	7.15
240		---	200	173.9	4.12	3.04	7.25
240		NS	200	166.7	3.95	3.13	6.73

Table 5. Influence of N-rate, K-rate and nitrification inhibitors on grain and stover N content and total N removal on four corn hybrids at physiological maturity. Becker, MN 1988.

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 3732	---	---	0.49	1.28	31.4	104.0	135.4
80		NS	---	0.48	1.38	29.2	104.5	133.7
80		---	100	0.55	1.50	39.7	128.9	168.6
80		NS	100	0.52	1.35	35.4	115.8	151.2
80		---	200	0.50	1.38	33.2	107.2	140.4
80		NS	200	0.50	1.40	31.1	106.7	138.0
160		---	200	0.51	1.43	30.5	111.3	141.8
160		NS	200	0.55	1.47	39.7	121.1	160.8
240		---	---	0.55	1.31	37.0	106.8	143.8
240		NS	---	0.61	1.39	38.0	112.9	151.0
240		---	100	0.55	1.49	38.2	124.3	162.5
240		NS	100	0.63	1.46	48.7	128.3	177.1
240		---	200	0.54	1.40	35.2	119.9	155.2
240		NS	200	0.59	1.48	46.2	131.4	177.7
80	Pioneer 3737	---	---	0.45	1.35	24.6	114.1	138.7
80		NS	---	0.43	1.33	27.6	108.4	136.1
80		---	100	0.44	1.34	23.9	109.5	133.4
80		NS	100	0.41	1.42	22.9	116.2	139.1
80		---	200	0.44	1.39	22.0	105.3	127.4
80		NS	200	0.42	1.31	25.3	109.8	135.2
160		---	200	0.54	1.43	25.2	107.1	132.4
160		NS	200	0.56	1.46	29.2	118.8	148.0
240		---	---	0.57	1.50	34.8	134.0	168.9
240		NS	---	0.61	1.54	30.1	121.7	151.8
240		---	100	0.67	1.49	37.2	121.4	158.7
240		NS	100	0.66	1.53	32.8	120.4	153.2
240		---	200	0.53	1.50	27.1	118.0	145.2
240		NS	200	0.60	1.54	35.9	129.3	165.2
80	A632 X LH39	---	---	0.49	1.39	30.7	112.7	143.4
80		NS	---	0.43	1.45	28.3	127.4	155.6
80		---	100	0.50	1.45	29.2	113.5	142.8
80		NS	100	0.41	1.33	24.7	103.7	128.5
80		---	200	0.40	1.48	23.5	113.7	137.3
80		NS	200	0.37	1.45	21.8	114.0	135.9
160		---	200	0.50	1.52	26.8	116.7	143.6
160		NS	200	0.56	1.48	31.7	116.8	148.6
240		---	---	0.57	1.56	31.7	121.1	152.9
240		NS	---	0.52	1.59	27.5	114.4	141.9
240		---	100	0.52	1.62	31.5	125.1	156.7
240		NS	100	0.54	1.54	27.2	110.1	137.4
240		---	200	0.49	1.62	28.1	128.1	156.3
240		NS	200	0.52	1.64	27.8	131.6	159.4
80	DeKalb 484	---	---	0.39	1.42	27.0	119.4	146.5
80		NS	---	0.49	1.46	30.7	123.8	154.6
80		---	100	0.46	1.43	29.9	120.6	150.5
80		NS	100	0.46	1.38	29.6	113.7	143.4
80		---	200	0.39	1.37	23.5	103.0	126.5
80		NS	200	0.44	1.34	29.5	111.0	140.6
160		---	200	0.53	1.49	33.5	127.1	160.6
160		NS	200	0.49	1.57	26.9	130.4	157.3
240		---	---	0.52	1.63	35.5	155.4	190.6
240		NS	---	0.58	1.56	33.4	123.4	156.8
240		---	100	0.55	1.55	32.7	119.8	152.6
240		NS	100	0.52	1.52	31.6	125.4	157.0
240		---	200	0.49	1.47	30.4	120.7	151.2
240		NS	200	0.44	1.62	24.8	127.8	152.7

Table 6. Continued from table 1.	Whole Plant			Whole Plant		
200 # K-Rate only RCB (Hybrid X N-Rate)	12 Leaf Stover			Tasseling Stover		
Hybrids	T/A	% N	#/A	T/A	% N	#/A
Pioneer 3732	1.14	2.55	58.3	3.33	1.65	109.4
Pioneer 3737	1.09	2.83	61.3	3.20	1.79	115.3
632 X LH39	0.99	2.71	53.7	3.09	1.79	110.9
DeKalb 484	1.06	2.73	57.8	3.36	1.85	114.4
P-Value	83	99	77	81	89	20
BLSD (.05)		0.12				
N-Rate						
80	1.15	2.61	60.2	3.36	1.62	109.4
160	1.03	2.79	56.9	3.24	1.75	112.5
240	1.03	2.72	56.1	3.13	1.84	115.5
P-Value	99	96	61	85	99	41
BLSD (.05)	0.11	0.10			0.11	
Inhibitor						
None	1.05	2.74	57.2	3.30	1.70	112.0
N-Serve	1.09	2.67	58.3	3.19	1.77	112.9
P-Value	67	92	35	78	85	16
Hybrid X N-Rate	79	10	81	55	87	85
Hybrid X Inhibitor	7	15	5	2	86	61
N-Rate X Inhibitor	66	72	42	35	96	73
Hybrid X N-Rate X Inh.	22	98	18	80	97	89
Split Plot without the 160# N-Rate						
K-Rate						
0	1.16	2.77	64.4	3.47	1.75	122.2
100	1.17	2.66	62.3	3.44	1.76	121.8
200	1.09	2.66	58.2	3.25	1.73	112.5
P-Value	40	90	63	61	18	78
BLSD(.05)						
Hybrid X N-Rate X Inhibitor						
Hybrid						
Pioneer 3732	1.16	2.55	59.3	3.44	1.65	113.9
Pioneer 3737	1.16	2.82	65.3	3.36	1.84	124.3
A632 X LH39	1.11	2.72	60.3	3.24	1.73	112.8
DeKalb 484	1.14	2.70	61.7	3.51	1.77	124.3
P-Value	27	99	87	92	99	94
BLSD(.05)		0.8			0.08	
N-Rate						
80	1.17	2.65	61.8	3.44	1.65	114.0
240	1.12	2.74	61.5	3.33	1.84	123.7
P-Value	84	99	17	85	99	99
Inhibitor						
None	1.13	2.69	60.8	3.42	1.71	117.8
N-Serve	1.15	2.70	62.5	3.35	1.78	119.8
P-Value	49	24	61	66	96	42
Hybrid X N-Rate	71	89	53	58	38	45
Hybrid X Inhibitor	5	84	14	10	34	2
N-Rate X Inhibitor	36	4	37	47	89	45
Hybrid X N-Rate X Inhibitor	42	39	46	91	89	97
Hybrid X N-Rate X Inhibitor X K-Rate						
Hybrid X K-Rate	40	23	23	64	94	98
N-Rate X K-Rate	79	18	71	68	23	51
Hybird X N-Rate X K-Rate	59	27	51	8	94	50
Inhibitor X K-Rate	37	55	12	57	80	89
Hybrid X Inhibitor X K-Rate	84	14	51	89	99	99
N-Rate X Inhibitor X K-Rate	73	74	41	45	92	78
Hybrid X N-Rate X Inhibitor X K-Rate	26	50	17	4	25	22

Table 7. Continued from table 2. Predent 200 # K-Rate only RCB (Hybrid X N-Rate)	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
Hybrids	Bu/A	----------T/A----------			
Pioneer 3732	85.5	2.02	3.54	0.67	6.23
Pioneer 3737	95.1	2.25	3.19	0.60	6.05
A632 X LH39	79.2	1.87	3.38	0.72	5.97
DeKalb 484	78.0	1.84	3.49	0.65	5.99
P-Value	99	99	99	99	69
BLSD (.05)	3.9	0.09	0.22	0.03	
N-Rate					
80	84.6	2.00	3.56	0.64	6.20
160	85.3	2.01	3.37	0.68	6.07
240	83.5	1.97	3.27	0.66	5.91
P-Value	27	27	99	92	91
BLSD (.05)			0.18		
Inhibitor					
None	83.1	1.98	3.32	0.66	5.95
N-Serve	85.7	2.02	3.48	0.66	6.17
P-Value	90	90	96	25	96
Hybrid X N-Rate	99	99	92	98	99
Hybrid X Inhibitor	88	88	94	97	97
N-Rate X Inhibitor	82	82	66	69	47
Hybrid X N-Rate X Inh.	99	99	26	99	93
Split Plot without the 160# N-Rate					
K-Rate					
0	92.1	2.17	3.39	0.69	6.27
100	87.6	2.07	3.70	0.69	6.46
200	84.0	1.98	3.41	0.65	6.06
P-Value	99	99	62	92	62
BLSD(.05)	2.5	0.06			
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3732	89.4	2.11	3.63	0.69	6.44
Pioneer 3737	97.1	2.29	3.40	0.61	6.31
A632 X LH39	82.8	1.95	3.40	0.72	6.08
DeKalb 484	82.3	1.94	3.58	0.68	6.22
P-Value	99	99	99	99	99
BLSD(.05)	2.5	0.06	0.17	0.03	0.22
N-Rate					
80	87.9	2.08	3.58	0.69	6.33
240	87.9	2.08	3.42	0.68	6.19
P-Value	2	2	99	82	93
Inhibitor					
None	88.5	2.09	3.50	0.69	6.29
N-Serve	87.2	2.09	3.50	0.66	6.24
P-Value	80	80	2	95	51
Hybrid X N-Rate	61	61	94	43	96
Hybrid X Inhibitor	99	99	96	99	99
N-Rate X Inhibitor	99	99	4	89	73
Hybrid X N-Rate X Inhibitor	99	99	66	98	93
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	99	99	95	98	96
N-Rate X K-Rate	41	41	71	32	51
Hybird X N-Rate X K-Rate	99	99	44	93	61
Inhibitor X K-Rate	90	90	95	58	95
Hybrid X Inhibitor X K-Rate	98	98	92	94	96
N-Rate X Inhibitor X K-Rate	87	87	18	52	7
Hybrid X N-Rate X Inhibitor X K-Rate	99	99	24	99	80

Table 8. Continued from table 3. Predent 200 # K-Rate only RCB (Hybrid X N-Rate)	N-Concentration Stover	Grain	Cob	N-Removal Stover	Grain	Cob	Total
Hybrids	---------%---------			----------#/A----------			
Pioneer 3732	1.15	1.53	0.60	81.4	61.9	8.0	151.4
Pioneer 3737	1.16	1.64	0.45	74.6	74.2	5.5	154.4
A632 X LH39	1.15	1.74	0.45	78.2	65.3	6.4	150.1
DeKalb 484	1.18	1.72	0.52	82.6	63.7	6.7	153.1
P-Value	15	99	99	86	99	99	19
BLSD (.05)		0.04	0.03		3.5	0.62	
N-Rate							
80	1.21	1.57	0.47	79.6	62.9	6.1	148.7
160	1.16	1.69	0.52	78.9	68.3	7.1	154.4
240	1.20	1.71	0.52	79.2	67.6	6.8	153.7
P-Value	96	99	98	3	99	99	68
BLSD (.05)	0.06	0.03	0.03		3.3	0.58	
Inhibitor							
None	1.14	1.64	0.50	76.0	64.4	6.6	147.1
N-Serve	1.18	1.68	0.51	82.4	68.1	6.8	157.4
P-Value	93	99	67	99	99	62	99
Hybrid X N-Rate	69	52	35	27	99	8	82
Hybrid X Inhibitor	99	84	85	99	94	2	99
N-Rate X Inhibitor	97	68	17	94	43	10	66
Hybrid X N-Rate X Inh.	90	75	65	83	99	93	98
Split Plot without the 160# N-Rate							
K-Rate							
0	1.18	1.63	0.48	80.8	71.1	6.7	158.7
100	1.14	1.63	0.49	84.8	67.5	6.8	159.2
200	1.16	1.64	0.49	79.4	65.3	6.5	151.2
P-Value	68	78	61	36	98	60	50
BLSD(.05)							
Hybrid X N-Rate X Inhibitor							
Hybrid							
Pioneer 3732	1.14	1.50	0.57	82.9	63.8	7.9	154.8
Pioneer 3737	1.17	1.61	0.46	79.7	74.4	5.7	159.9
A632 X LH39	1.18	1.72	0.44	80.3	67.5	6.3	154.3
DeKalb 484	1.16	1.69	0.49	83.6	66.1	6.7	156.5
P-Value	46	99	99	61	99	99	70
BLSD(.05)		0.02	0.02		2.2	0.4	
N-Rate							
80	1.11	1.58	0.48	79.7	65.6	6.5	152.0
240	1.21	1.69	0.49	83.6	70.3	6.8	160.8
P-Value	99	99	71	96	99	84	99
Inhibitor							
None	1.16	1.61	0.49	81.9	67.7	6.8	156.4
N-Serve	1.16	1.65	0.49	81.4	68.2	6.6	156.3
P-Value	1	99	14	19	42	77	6
Hybrid X N-Rate	85	95	48	26	92	33	69
Hybrid X Inhibitor	99	77	73	99	99	93	99
N-Rate X Inhibitor	74	56	20	58	99	60	93
Hybrid X N-Rate X Inhibitor	70	54	87	93	99	94	99
Hybrid X N-Rate X Inhibitor X K-Rate							
Hybrid X K-Rate	98	57	84	19	99	99	38
N-Rate X K-Rate	93	87	98	97	9	95	84
Hybird X N-Rate X K-Rate	87	71	74	73	99	32	47
Inhibitor X K-Rate	93	90	63	73	99	32	47
Hybrid X Inhibitor X K-Rate	92	99	70	99	99	70	99
N-Rate X Inhibitor X K-Rate	99	95	29	94	80	60	81
Hybrid X N-Rate X Inhibitor X K-Rate	99	84	70	98	81	81	99

Table 9. Continued from table 4.	Grain	Dry Matter Production		
200 # K-Rate only RCB (Hybrid X N-Rate)	Yields	Grain	Stover	Total
Hybrids Physiological Maturity	Bu/A	---------T/A----------		
Pioneer 3732	172.3	4.07	3.37	7.45
Pioneer 3737	168.9	3.99	2.69	6.68
A632 X LH39	165.9	3.92	2.84	6.76
DeKalb 484	172.0	4.07	3.04	7.11
P-Value	99	99	99	99
BLSD (.05)	6.8	0.16	0.15	0.25
N-Rate				
80	166.2	3.93	3.05	6.98
160	169.4	4.00	2.88	6.89
240	173.8	4.11	3.03	7.14
P-Value	99	99	95	91
BLSD (.05)	5.0	0.11	0.16	
Inhibitor				
None	166.8	3.94	2.91	6.86
N-Serve	172.8	3.06	3.06	7.15
P-Value	99	99	98	99
Hybrid X N-Rate	99	99	92	98
Hybrid X Inhibitor	87	87	99	99
N-Rate X Inhibitor	41	41	5	20
Hybrid X N-Rate X Inh.	72	72	99	98
Split Plot without the 160# N-Rate				
K-Rate				
0	174.1	4.11	3.07	7.19
100	171.6	4.06	3.07	7.13
200	170.0	4.02	3.04	7.06
P-Value	48	48	9	26
BLSD(.05)				
Hybrid X N-Rate X Inhibitor				
Hybrid				
Pioneer 3732	174.8	4.13	3.39	7.53
Pioneer 3737	173.0	4.09	2.79	6.88
A632 X LH39	165.4	3.91	2.91	6.82
DeKalb 484	174.2	4.12	3.15	7.28
P-Value	99	99	99	99
BLSD(.05)	4.5	0.10	0.12	0.20
N-Rate				
80	171.6	4.06	3.11	7.17
240	172.1	4.07	3.01	7.08
P-Value	23	23	96	73
Inhibitor				
None	172.6	4.08	3.07	7.16
N-Serve	171.1	4.04	3.05	7.10
P-Value	54	54	43	57
Hybrid X N-Rate	99	99	99	99
Hybrid X Inhibitor	9	9	71	45
N-Rate X Inhibitor	96	96	89	95
Hybrid X N-Rate X Inhibitor	96	96	99	99
Hybrid X N-Rate X Inhibitor X K-Rate				
Hybrid X K-Rate	99	99	99	99
N-Rate X K-Rate	99	99	70	94
Hybird X N-Rate X K-Rate	90	90	10	60
Inhibitor X K-Rate	99	99	98	99
Hybrid X Inhibitor X K-Rate	90	90	80	89
N-Rate X Inhibitor X K-Rate	95	95	82	93

Table 10. Continued from table 5.

200 # 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 3732	0.52	1.42	36.0	116.3	152.3
Pioneer 3737	0.51	1.43	27.5	114.7	142.2
A632 X LH39	0.47	1.52	26.6	120.2	146.8
DeKalb 484	0.46	1.47	28.1	120.0	148.1
P-Value	99	99	99	87	95
BLSD (.05)	0.03	0.04	2.8		8.0
N-Rate					
80	0.42	1.38	26.3	108.9	135.2
160	0.52	1.47	30.4	118.7	149.2
240	0.52	1.53	31.9	125.8	157.8
P-Value	99	99	99	99	99
BLSD (.05)	0.03	0.03	2.5	4.3	5.5
Inhibitor					
None	0.48	1.45	28.3	114.9	143.2
N-Serve	0.50	1.47	30.8	120.7	151.6
P-Value	73	81	98	99	99
Hybrid X N-Rate	79	96	77	92	85
Hybrid X Inhibitor	27	76	97	46	78
N-Rate X Inhibitor	22	96	26	46	51
Hybrid X N-Rate X Inh.	62	13	98	7	65
Split Plot without the 160# N-Rate					
K-Rate					
0	0.50	1.44	31.1	119.0	150.1
100	0.52	1.46	32.2	118.5	150.8
200	0.47	1.45	29.1	117.4	146.5
P-Value	99	92	89	19	53
BLSD(.05)	0.02				
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3732	0.54	1.40	36.9	115.9	152.9
Pioneer 3737	0.51	1.43	28.7	117.3	146.1
A632 X LH39	0.47	1.50	27.7	117.9	145.7
DeKalb 484	0.47	1.47	29.9	122.0	151.9
P-Value	99	99	99	98	99
BLSD(.05)	0.02	0.03	1.7	4.3	4.9
N-Rate					
80	0.45	1.38	28.1	112.8	140.9
240	0.55	1.52	33.5	123.8	157.3
P-Value	99	99	99	99	99
Inhibitor					
None	0.50	1.45	30.7	118.6	149.4
N-Serve	0.50	1.45	30.8	118.0	148.9
P-Value	53	33	11	35	25
Hybrid X N-Rate	99	99	99	65	88
Hybrid X Inhibitor	93	27	94	29	72
N-Rate X Inhibitor	96	84	32	46	27
Hybrid X N-Rate X Inhibitor	98	3	99	95	99
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	55	99	98	99	99
N-Rate X K-Rate	40	28	13	98	93
Hybird X N-Rate X K-Rate	92	14	54	71	69
Inhibitor X K-Rate	73	99	91	99	99
Hybrid X Inhibitor X K-Rate	69	99	38	94	66
N-Rate X Inhibitor X K-Rate	30	95	77	99	99
Hybrid X N-Rate X Inhibitor X K-Rate	18	60	53	66	44

Table 11. Influence of N-rate, K-rate and nitrification inhibitors on stover N content, total N removal and dry matter production on four corn hybrids. Waseca, MN 1988.

N-Rate	Hybrid	Inh.	K-Rate	Whole Plant 12 Leaf Stover			Whole Plant Tasseling Stover		
#/A			#/A	T/A	% N	#/A	T/A	% N	#/A
0	Pioneer 3732	---	---	1.08	1.96	42.1	2.91	1.04	60.6
0		---	100	1.21	2.02	48.8	2.86	1.04	56.6
80		---	---	1.04	2.23	46.4	3.28	1.29	83.8
80		NS	---	1.17	2.18	51.0	3.14	1.33	83.3
80		---	100	0.86	2.38	41.6	3.42	1.46	100.2
80		NS	100	1.10	2.34	51.4	3.54	1.29	91.0
160		---	---	1.17	2.31	53.9	3.60	1.46	105.2
160		NS	---	1.12	2.58	57.8	3.33	1.45	96.0
160		---	100	1.11	2.06	45.6	3.01	1.43	85.9
160		NS	100	1.06	2.26	47.5	3.68	1.44	105.8
0	Pioneer 3475	---	---	1.02	1.88	38.5	3.08	1.00	61.4
0		---	100	1.14	1.93	43.8	3.11	0.91	56.6
80		---	---	1.16	2.20	50.9	3.38	1.40	94.6
80		NS	---	1.02	2.08	42.2	3.12	1.27	79.2
80		---	100	1.02	2.17	44.3	2.99	1.39	83.3
80		NS	100	1.05	2.33	49.3	3.24	1.31	85.3
160		---	---	1.08	2.29	49.3	3.28	1.31	86.0
160		NS	---	1.01	2.27	46.0	3.27	1.39	90.5
160		---	100	1.00	2.26	45.2	3.26	1.56	101.5
160		NS	100	1.05	2.37	49.5	3.00	1.46	87.3
0	LH74 X LH51	---	---	0.91	1.92	34.8	2.89	1.13	65.2
0		---	100	0.88	1.85	32.6	3.10	1.13	70.2
80		---	---	0.85	2.33	39.2	3.09	1.33	82.6
80		NS	---	0.90	2.20	39.8	2.90	1.42	82.7
80		---	100	0.94	2.36	44.3	3.30	1.54	101.9
80		NS	100	0.82	2.40	39.5	3.00	1.51	90.6
160		---	---	0.97	2.49	48.2	3.04	1.50	91.2
160		NS	---	0.87	2.41	42.1	3.12	1.55	96.0
160		---	100	0.92	2.38	43.5	3.25	1.53	99.4
160		NS	100	0.89	2.36	41.6	3.10	1.53	94.9
0	A632 X LH38	---	---	0.80	2.15	34.2	2.50	1.04	51.6
0		---	100	0.74	2.32	34.1	2.49	1.28	64.4
80		---	---	0.93	2.46	45.6	3.28	1.54	100.5
80		NS	---	0.97	2.25	43.3	2.81	1.49	83.8
80		---	100	0.91	2.34	42.5	3.25	1.40	90.5
80		NS	100	0.96	2.53	48.1	2.55	1.51	76.5
160		---	---	1.09	2.34	51.2	3.15	1.48	93.1
160		NS	---	0.88	2.67	46.9	3.24	1.55	100.7
160		---	100	1.07	2.48	53.0	2.84	1.62	91.6
160		NS	100	0.87	2.28	39.6	2.72	1.56	84.5

Table 12. 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 predent. Waseca, MN 1988.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
#/A			#/A	Bu/A	----------T/A----------			
0	Pioneer 3732	---	---	67.5	1.60	2.39	0.43	4.41
0		---	100	65.3	1.55	2.90	0.44	4.89
80		---	---	73.6	1.74	2.66	0.45	4.85
80		NS	---	77.8	1.84	2.65	0.50	4.99
80		---	100	83.6	1.98	3.38	0.55	5.90
80		NS	100	84.2	1.99	3.19	0.59	5.78
160		---	---	89.0	2.11	2.92	0.57	5.60
160		NS	---	85.4	2.03	2.88	0.53	5.44
160		---	100	74.7	1.77	3.04	0.53	5.33
160		NS	100	81.1	1.92	3.12	0.54	5.58
0	Pioneer 3475	---	---	61.1	1.45	3.12	0.58	5.15
0		---	100	57.3	1.36	3.06	0.49	4.91
80		---	---	57.6	1.36	3.19	0.56	5.12
80		NS	---	65.5	1.55	3.14	0.62	5.31
80		---	100	67.3	1.59	3.09	0.68	5.36
80		NS	100	67.8	1.61	3.65	0.65	5.90
160		---	---	76.2	1.80	3.59	0.67	6.07
160		NS	---	69.8	1.65	3.06	0.58	5.29
160		---	100	60.3	1.43	3.43	0.61	5.46
160		NS	100	79.0	1.87	3.60	0.74	6.21
0	LH74 X LH51	---	---	41.9	0.99	3.13	0.41	4.53
0		---	100	32.2	0.76	3.05	0.31	4.17
80		---	---	48.8	1.16	3.75	0.47	5.38
80		NS	---	55.1	1.31	3.88	0.54	5.72
80		---	100	40.2	0.95	3.81	0.44	5.21
80		NS	100	49.2	1.17	3.80	0.54	5.50
160		---	---	59.7	1.41	3.82	0.56	5.79
160		NS	---	51.2	1.21	3.46	0.48	5.15
160		---	100	49.7	1.18	3.77	0.53	5.47
160		NS	100	47.1	1.11	3.44	0.54	5.10
0	A632 X LH38	---	---	46.5	1.10	2.27	0.35	3.72
0		---	100	47.5	1.12	2.69	0.43	4.24
80		---	---	70.6	1.67	3.10	0.53	5.30
80		NS	---	59.8	1.42	2.53	0.49	4.43
80		---	100	66.6	1.58	3.29	0.57	5.44
80		NS	100	52.8	1.25	2.75	0.46	4.46
160		---	---	61.6	1.46	2.73	0.48	4.66
160		NS	---	57.9	1.37	2.83	0.44	4.64
160		---	100	62.9	1.49	3.05	0.58	5.12
160		NS	100	59.1	1.40	2.90	0.53	4.83

Table 13. Influence of N-rate, K-rate and nitrification inhibitors on grain, stover and cob N content and total N removal on four corn hybrids at predent. Waseca, MN 1988.

				N-Concentration			N-Removal			
N-Rate	Hybrid	Inh.	K-Rate	Stover	Grain	Cob	Stover	Grain	Cob	Total
#/A			#/A	----------%----------			----------#/A----------			
0	Pioneer 3732	---	---	0.73	1.38	0.56	35.0	44.0	4.7	83.7
0		---	100	0.81	1.43	0.57	46.6	44.0	5.1	95.7
80		---	---	1.06	1.63	0.62	56.2	56.5	5.6	118.3
80		NS	---	0.97	1.56	0.49	51.6	57.2	5.0	113.7
80		---	100	1.14	1.67	0.63	76.0	65.7	6.8	148.4
80		NS	100	0.99	1.61	0.58	63.1	64.0	6.9	134.0
160		---	---	1.08	1.63	0.59	62.9	68.5	6.7	138.1
160		NS	---	1.04	1.62	0.59	59.6	65.7	6.2	131.5
160		---	100	1.13	1.56	0.64	68.4	55.1	6.7	130.2
160		NS	100	1.07	1.74	0.67	66.7	66.7	7.2	140.7
0	Pioneer 3475	---	---	0.71	1.51	0.60	44.1	43.6	6.9	94.6
0		---	100	0.76	1.54	0.66	46.2	41.5	6.4	94.1
80		---	---	0.99	1.78	0.71	63.1	48.6	7.9	119.6
80		NS	---	0.88	1.70	0.61	55.1	52.5	7.4	115.1
80		---	100	1.17	1.67	0.67	72.4	53.2	9.0	134.6
80		NS	100	0.95	1.68	0.70	68.9	53.7	9.1	131.7
160		---	---	1.04	1.61	0.70	74.9	58.0	9.4	142.3
160		NS	---	1.04	1.76	0.69	63.9	57.9	7.9	129.7
160		---	100	1.23	1.71	0.78	83.7	48.3	9.5	141.5
160		NS	100	1.06	1.58	0.61	76.1	58.5	8.9	143.5
0	LH74 X LH51	---	---	0.95	1.67	0.54	59.7	33.0	4.4	97.1
0		---	100	0.73	1.68	0.66	44.2	25.5	4.7	74.4
80		---	---	1.11	1.86	0.64	82.7	42.7	5.9	131.3
80		NS	---	1.12	1.79	0.61	87.2	46.3	6.6	140.1
80		---	100	1.01	1.95	0.74	77.2	36.9	6.5	120.6
80		NS	100	1.03	1.83	0.72	77.7	42.6	7.7	128.0
160		---	---	1.19	1.88	0.64	90.9	53.3	7.1	151.3
160		NS	---	1.02	1.85	0.67	70.3	45.1	6.5	121.9
160		---	100	1.18	1.83	0.66	88.2	42.9	6.8	137.9
160		NS	100	1.29	1.94	0.74	89.2	43.1	8.0	140.3
0	A632 X LH38	---	---	0.84	1.64	0.54	38.0	36.0	3.8	77.8
0		---	100	0.85	1.73	0.55	45.9	39.1	4.8	89.7
80		---	---	1.10	1.97	0.54	68.0	65.6	5.8	139.4
80		NS	---	1.04	2.08	0.58	52.3	58.7	5.6	116.7
80		---	100	0.98	1.83	0.60	64.7	57.4	6.8	128.9
80		NS	100	1.16	1.93	0.65	63.9	48.3	5.9	118.1
160		---	---	1.15	2.01	0.51	62.4	58.3	4.8	125.5
160		NS	---	1.11	2.02	0.58	62.9	55.4	5.0	123.3
160		---	100	1.32	2.17	0.61	79.9	64.5	7.1	151.5
160		NS	100	1.24	1.99	0.54	72.0	55.6	5.7	133.3

Table 14. 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 physiological maturity. Waseca, MN 1988.

N-Rate	Hybrid	Inh.	K-Rate	Grain Yields	Dry Matter Production Grain	Stover	Total
#/A			#/A	Bu/A	---------T/A----------		
0	Pioneer 3732	---	---	93.3	2.21	3.30	5.51
0		---	100	111.2	2.63	3.67	6.33
80		---	---	105.1	2.49	3.54	6.03
80		NS	---	113.0	2.67	3.69	6.36
80		---	100	121.6	2.88	4.08	6.96
80		NS	100	137.0	3.24	3.87	7.11
160		---	---	129.1	3.05	3.95	7.00
160		NS	---	116.1	2.75	3.79	6.53
160		---	100	126.4	2.99	3.85	6.84
160		NS	100	115.5	2.73	3.90	6.64
0	Pioneer 3475	---	---	128.9	3.05	3.87	6.92
0		---	100	115.8	2.74	3.98	6.72
80		---	---	113.2	2.68	4.15	6.83
80		NS	---	115.4	2.73	3.89	6.63
80		---	100	116.1	2.75	4.15	6.90
80		NS	100	113.9	2.69	4.14	6.83
160		---	---	140.8	3.33	4.32	7.66
160		NS	---	121.9	2.88	4.20	7.08
160		---	100	120.4	2.85	3.82	6.67
160		NS	100	136.2	3.22	4.44	7.66
0	LH74 X LH51	---	---	106.1	2.51	3.77	6.28
0		---	100	96.0	2.27	3.82	6.09
80		---	---	120.5	2.85	4.12	6.98
80		NS	---	142.9	3.38	4.22	7.60
80		---	100	130.3	3.08	4.31	7.40
80		NS	100	152.9	3.62	4.51	8.13
160		---	---	141.0	3.33	4.09	7.43
160		NS	---	131.9	3.12	4.05	7.17
160		---	100	124.8	2.95	3.98	6.93
160		NS	100	141.2	3.34	4.28	7.63
0	A632 X LH38	---	---	89.6	2.12	3.09	5.21
0		---	100	102.5	2.42	3.47	5.89
80		---	---	97.8	2.31	3.33	5.64
80		NS	---	120.4	2.85	3.66	6.51
80		---	100	111.9	2.65	3.54	6.19
80		NS	100	105.1	2.49	3.59	6.08
160		---	---	121.1	2.87	3.69	6.56
160		NS	---	101.7	2.41	3.20	5.61
160		---	100	130.8	3.09	4.03	7.12
160		NS	100	119.4	2.82	3.80	6.62

Table 15. Influence of N-rate, K-rate and nitrification inhibitors on grain and stover N content and total N removal on four corn hybrids at physiological maturity. Waseca, MN 1988.

				N-Concentration		N-Removal		
N-Rate	Hybrid	Inh.	K-Rate	Stover	Grain	Stover	Grain	Total
#/A			#/A	-------%-------		----------#/A----------		
0	Pioneer 3732	---	---	0.58	1.41	38.2	62.1	100.4
0		---	100	0.54	1.48	39.7	77.3	117.0
80		---	---	0.70	1.70	49.6	84.1	133.7
80		NS	---	0.62	1.65	45.4	88.2	133.6
80		---	100	0.69	1.55	56.6	88.9	145.5
80		NS	100	0.65	1.59	50.3	103.2	153.4
160		---	---	0.67	1.58	52.7	96.8	149.5
160		NS	---	0.66	1.76	49.5	96.9	146.3
160		---	100	0.71	1.66	54.5	98.9	153.3
160		NS	100	0.73	1.63	57.2	88.6	145.8
0	Pioneer 3475	---	---	0.53	1.27	41.2	77.3	118.4
0		---	100	0.54	1.44	42.7	78.5	121.1
80		---	---	0.69	1.65	56.8	88.4	145.2
80		NS	---	0.64	1.55	49.4	84.5	133.9
80		---	100	0.67	1.55	56.0	82.3	138.4
80		NS	100	0.64	1.51	52.3	81.7	134.0
160		---	---	0.69	1.49	59.1	99.1	158.2
160		NS	---	0.70	1.56	58.6	89.6	148.2
160		---	100	0.85	1.51	64.2	85.6	149.7
160		NS	100	0.70	1.50	62.1	95.9	158.1
0	LH74 X LH51	---	---	0.48	1.38	36.1	68.7	104.8
0		---	100	0.49	1.37	37.1	62.4	99.5
80		---	---	0.65	1.55	53.5	88.0	141.5
80		NS	---	0.66	1.60	54.9	107.4	162.3
80		---	100	0.72	1.60	61.8	98.7	160.5
80		NS	100	0.63	1.64	57.7	118.8	176.5
160		---	---	0.69	1.62	56.4	107.7	164.1
160		NS	---	0.73	1.63	59.1	101.9	161.0
160		---	100	0.78	1.65	61.1	97.3	158.4
160		NS	100	0.73	1.63	62.1	108.1	170.2
0	A632 X LH38	---	---	0.58	1.56	35.6	65.9	101.5
0		---	100	0.60	1.76	41.4	85.4	126.8
80		---	---	0.74	1.83	48.9	84.2	133.2
80		NS	---	0.72	1.91	52.2	108.1	160.3
80		---	100	0.68	1.84	47.8	97.0	144.8
80		NS	100	0.62	1.64	44.7	81.5	126.2
160		---	---	0.70	1.91	51.9	108.8	160.7
160		NS	---	0.83	1.94	53.0	93.3	146.3
160		---	100	0.83	1.99	66.6	123.2	189.7
160		NS	100	0.78	1.95	59.1	109.8	168.9

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Table 16. Continued from table 1 and 2.
0 # K-Rate only RCB (Hybrid X N-Rate)

	Whole Plant 12 Leaf Stover			Whole Plant Tasseling Stover		
Hybrids	T/A	% N	#/A	T/A	% N	#/A
Pioneer 3732	1.09	2.16	47.5	3.26	1.26	83.5
Pioneer 3475	1.08	2.12	46.2	3.24	1.23	80.7
LH74 X LH51	0.90	2.24	40.7	3.00	1.31	79.6
A632 X LH38	0.93	2.31	43.7	2.97	1.35	81.7
P-Value	99	99	99	97	98	23
BLSD (.05)	0.07	0.11	3.8	0.27	0.06	
N-Rate						
0	0.95	1.97	37.4	2.48	1.05	59.7
80	0.99	2.30	45.5	3.25	1.38	90.4
160	1.07	2.35	50.6	3.26	1.43	93.9
P-Value	99	99	99	99	99	99
BLSD (.05)	0.06	0.08	2.9	0.20	0.05	5.5
Hybrid X N-Rate	97	78	80	77	99	99

Predent
0 # K-Rate only RCB

	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
Hybrid	Bu/A	----------T/A----------			
Pioneer 3732	76.7	1.81	2.65	0.48	4.95
Pioneer 3475	65.0	1.53	3.30	0.60	5.44
LH74 X LH51	50.1	1.18	3.56	0.47	5.23
A632 X LH38	59.6	1.41	2.69	0.45	4.56
P-Value	99	99	99	99	99
BLSD (.05)	5.7	0.13	0.02	0.04	0.34
N-Rate					
0	54.3	1.28	2.72	0.44	4.45
80	62.7	1.48	3.17	0.50	5.16
160	71.6	1.69	3.26	0.57	5.53
P-Value	99	99	99	99	99
BLSD (.05)	4.9	0.11	0.18	0.03	0.28
Hybrid X N-Rate	99	99	99	99	99

Physiological Maturity
0 # K-Rate only RCB

Hybrid					
Pioneer 3732	109.1	2.58	3.59	---	6.18
Pioneer 3475	127.6	3.02	4.11	---	7.13
LH74 X LH51	122.5	2.89	3.99	---	6.89
A632 X LH38	102.8	2.43	3.37	---	5.80
P-Value	99	99	99	---	99
BLSD (.05)	11.6	0.27	0.14		0.36
N-Rate					
0	104.4	2.47	3.51	---	5.98
80	109.1	2.58	3.78	---	6.37
160	132.9	3.14	4.01	---	7.16
P-Value	99	99	99		99
BLSD (.05)	9.4	0.22	0.13		0.31
Hybrid X N-Rate	61	61	63		42

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Table 17. Continued from table 1 and 2.

100 # K-Rate only RCB (Hybrid X N-Rate)	Whole Plant 12 Leaf Stover			Whole Plant Tasseling Stover		
Hybrids	T/A	% N	#/A	T/A	% N	#/A
Pioneer 3732	1.05	2.15	45.3	3.09	1.30	81.9
Pioneer 3475	1.05	2.12	44.4	3.11	1.28	80.5
LH74 X LH51	0.91	2.19	40.1	3.21	1.39	90.5
A632 X LH38	0.90	2.37	43.2	2.86	1.43	82.2
P-Value	99	99	92	97	99	96
BLSD (.05)	0.06	0.10		0.27	0.06	8.2
N-Rate						
0	0.99	2.02	39.8	2.88	1.09	62.7
80	0.93	2.31	43.2	3.24	1.44	94.0
160	1.02	2.29	46.8	3.08	1.53	94.6
P-Value	99	99	99	99	99	99
BLSD (.05)	0.06	0.08	3.4	0.21	0.05	5.7
Hybrid X N-Rate	99	99	99	92	99	96

Predent 100 # K-Rate only RCB	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
Hybrid	Bu/A	----------T/A----------			
Pioneer 3732	74.5	1.76	3.10	0.50	5.37
Pioneer 3475	61.6	1.46	3.19	0.59	5.24
LH74 X LH51	40.7	0.96	3.54	0.44	4.94
A632 X LH38	59.0	1.39	3.00	0.52	4.93
P-Value	99	99	99	99	95
BLSD (.05)	5.6	0.13	0.24	0.05	0.42
N-Rate					
0	50.6	1.19	2.92	0.43	4.55
80	64.4	1.52	3.39	0.56	5.47
160	61.9	1.46	3.31	0.55	5.34
P-Value	99	99	99	99	99
BLSD (.05)	4.9	0.11	0.20	0.11	0.29
Hybrid X N-Rate	86	86	88	53	72

Physiological Maturity 100 # K-Rate only RCB					
Hybrid					
Pioneer 3732	119.7	2.83	3.86	---	6.69
Pioneer 3475	117.4	2.78	3.98	---	6.76
LH74 X LH51	117.0	2.76	4.03	---	6.80
A632 X LH38	115.0	2.72	3.67	---	6.39
P-Value	20	20	97		95
BLSD (.05)			0.27		0.35
N-Rate					
0	106.3	2.51	3.73	---	6.24
80	120.0	2.83	4.02	---	6.86
160	125.5	2.97	3.91	---	6.89
P-Value	99	99	97		99
BLSD (.05)	7.9	0.18	0.22		0.25
Hybrid X N-Rate	93	93	93		99

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Table 18. Continued from table 3 and 4.

0 # K-Rate only RCB (Hybrid X N-Rate)	N-Concentration Stover	Cob	Grain	N-Removal Stover	Cob	Grain	Total
Hybrids **Predent**	----------%---------			----------#/A----------			
Pioneer 3732	0.95	0.58	1.54	51.3	5.6	56.3	113.3
Pioneer 3475	0.91	0.66	1.63	60.7	8.0	50.0	118.8
LH74 X LH51	1.08	0.60	1.80	77.7	5.7	42.9	126.5
A632 X LH38	1.03	0.53	1.86	56.1	4.7	53.3	114.2
P-Value	99	99	99	99	99	99	97
BLSD (.05)	0.09	0.07	0.05	6.3	0.6	4.6	10.8
N-Rate							
0	0.80	0.55	1.54	44.1	4.9	39.1	88.3
80	1.06	0.62	1.80	67.5	6.2	53.3	127.1
160	1.11	0.60	1.78	72.2	6.9	59.5	139.2
P-Value	99	92	99	99	99	99	99
Hybrid X N-Rate	15	29	98	46	82	99	97
0 # K-Rate only RCB **Physiological Maturity**							
Hybrid							
Pioneer 3732	0.64	---	1.56	46.8	---	80.9	127.8
Pioneer 3475	0.63	---	1.47	52.3	---	88.2	140.6
LH74 X LH51	0.60	---	1.51	48.6	---	88.1	136.7
A632 X LH38	0.67	---	1.76	45.4	---	86.3	131.7
P-Value	91		99	99		75	95
BLSD (.05)			0.05	4.6			10.9
N-Rate							
0	0.54	---	1.40	37.7	---	68.5	106.2
80	0.69	---	1.68	52.2	---	86.1	138.3
160	0.68	---	1.64	55.0	---	103.0	158.1
P-Value	99		99	99		99	99
Hybrid X N-Rate	37		99	9		56	37
100 # K-Rate only RCB **Predent**							
Hybrid							
Pioneer 3732	1.02	0.61	1.55	63.6	6.1	54.9	124.7
Pioneer 3475	1.04	0.70	1.63	67.4	8.3	47.6	123.3
LH74 X LH51	0.97	0.68	1.81	69.8	5.9	35.1	110.9
A632 X LH38	1.05	0.58	1.90	63.5	6.2	53.6	123.3
P-Value	73	99	99	84	99	99	99
BLSD (.05)		0.04	0.07		0.70	3.8	10.0
N-Rate							
0	0.78	0.61	1.59	45.7	5.2	37.5	88.4
80	1.07	0.65	1.78	72.5	7.2	53.3	133.1
160	1.21	0.67	1.81	80.0	7.5	52.6	140.2
P-Value	99	98	99	99	99	99	99
Hybrid X N-Rate	95	85	99	95	16	99	98
100 # K-Rate only RCB **Physiological Maturity**							
Hybrid							
Pioneer 3732	0.64	---	1.55	50.2	---	88.3	138.6
Pioneer 3475	0.68	---	1.48	54.3	---	82.1	136.4
LH74 X LH51	0.66	---	1.54	53.3	---	86.1	139.4
A632 X LH38	0.70	---	1.86	51.9	---	101.8	153.7
P-Value	75		99	50		99	99
BLSD (.05)			0.04			6.2	7.5
N-Rate							
0	0.54	---	1.51	40.2	---	75.9	116.1
80	0.68	---	1.62	55.5	---	91.7	147.3
160	0.78	---	1.70	61.5	---	101.2	162.8
P-Value	99		99	99		99	99
Hybrid X N-Rate	90		97	97		99	99

Table 19 Waseca 1988 Continued from table 1 and 2.

Split Plot without the 0 # N-Rate	Whole Plant 12 Leaf Stover			Whole Plant Tasseling Stover		
	T/A	% N	#/A	T/A	% N	#/A
K-Rate						
0	1.01	2.33	47.1	3.18	1.42	90.6
100	0.97	2.33	45.4	3.13	1.46	91.9
P-Value	52	2	59	86	86	43
Hybrid X N-Rate X Inhibitor						
Hybrid						
Pioneer 3732	1.08	2.29	49.4	3.37	1.39	93.9
Pioneer 3475	1.04	2.24	47.1	3.19	1.38	88.4
LH74 X LH51	0.89	2.36	42.3	3.10	1.48	92.4
A632 X LH39	0.96	2.41	46.3	2.97	1.51	90.1
P-Value	99	99	99	99	99	91
BLSD(.05)	0.04	0.07	2.6	0.13	0.03	
N-Rate						
80	0.96	2.29	45.0	3.14	1.40	88.1
160	1.01	2.36	47.5	3.18	1.48	94.3
P-Value	90	98	99	54	99	99
Inhibitor						
None	1.00	2.31	46.5	3.21	1.45	93.2
N-Serve	0.98	2.34	46.0	3.10	1.43	89.2
P-Value	78	68	44	96	51	99
Hybrid X N-Rate	73	36	24	2	11	17
Hybrid X Inhibitor	98	67	99	93	79	66
N-Rate X Inhibitor	99	92	93	97	66	99
Hybrid X N-Rate X Inhibitor	99	78	86	87	49	52
Hybrid X N-Rate X Inhibitor X K-Rate						
Hybrid X K-Rate	76	65	92	97	91	99
N-Rate X K-Rate	38	99	98	91	31	81
Hybird X N-Rate X K-Rate	26	86	37	46	99	94
Inhibitor X K-Rate	77	71	88	57	96	38
Hybrid X Inhibitor X K-Rate	79	69	91	97	52	80
N-Rate X Inhibitor X K-Rate	9	99	85	15	58	37
Hybrid X N-Rate X Inhibitor X K-Rate	74	98	92	85	99	99

Table 20 Predent Waseca 1988

Split Plot without the 0 # N-Rate	Grain Yields	Dry Matter Production Grain	Stover	Cob	Total
	Bu/A	----------T/A----------			
K-Rate					
0	66.2	1.56	3.13	0.52	5.23
100	64.1	1.51	3.33	0.56	5.41
P-Value	63	63	99	95	99
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3732	81.2	1.92	2.97	0.53	5.43
Pioneer 3475	67.9	1.60	3.34	0.63	5.59
LH74 X LH51	50.1	1.18	3.71	0.51	5.41
A632 X LH39	61.4	1.45	2.89	0.51	4.86
P-Value	99	99	99	99	99
BLSD(.05)	3.0	0.07	0.11	0.03	0.19
N-Rate					
80	63.8	1.51	3.24	0.53	5.29
160	66.6	1.57	3.22	0.55	5.36
P-Value	98	98	23	83	65
Inhibitor					
None	65.1	1.54	3.28	0.54	5.37
N-Serve	65.2	1.54	3.18	0.54	5.27
P-Value	6	6	98	3	84
Hybrid X N-Rate	92	92	92	31	84
Hybrid X Inhibitor	99	99	92	95	99
N-Rate X Inhibitor	29	29	37	84	49
Hybrid X N-Rate X Inhibitor	98	98	99	88	98
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	72	72	97	53	91
N-Rate X K-Rate	87	87	79	6	83
Hybird X N-Rate X K-Rate	95	95	68	92	91
Inhibitor X K-Rate	74	74	77	70	82
Hybrid X Inhibitor X K-Rate	29	29	98	54	86
N-Rate X Inhibitor X K-Rate	96	96	30	98	85
Hybrid X N-Rate X Inhibitor X K-Rate	66	66	23	69	40

Table 21 Predent Waseca 1988

Split Plot without the 0 # N-Rate	N-Concentration Stover	Cob	Grain	N-Removal Stover	Cob	Grain	Total
	----------%---------			----------#/A----------			
K-Rate							
0	1.05	0.60	1.79	66.5	6.4	55.6	128.6
100	1.12	0.65	1.79	74.2	7.4	53.5	135.2
P-Value	89	99	11	98	99	77	95
Hybrid X N-Rate X Inhibitor							
Hybrid							
Pioneer 3732	1.05	0.59	1.62	63.0	6.3	62.4	131.8
Pioneer 3475	1.04	0.68	1.68	69.7	8.6	53.8	132.2
LH74 X LH51	1.11	0.67	1.86	82.9	6.8	44.1	133.9
A632 X LH39	1.13	0.57	1.99	65.7	5.8	57.9	129.5
P-Value	99	99	99	99	99	99	38
BLSD(.05)	0.05	0.04	0.03	4.4	0.4	2.4	
N-Rate							
80	1.04	0.62	1.78	67.5	6.7	53.1	127.4
160	1.13	0.63	1.80	73.2	7.0	56.0	136.4
P-Value	99	42	89	99	92	99	99
Inhibitor							
None	1.11	0.64	1.79	73.2	7.0	54.7	134.9
N-Serve	1.06	0.62	1.79	67.5	6.8	54.4	128.8
P-Value	99	67	24	99	60	22	99
Hybrid X N-Rate	54	61	98	56	80	33	34
Hybrid X Inhibitor	90	83	31	12	92	99	67
N-Rate X Inhibitor	6	46	79	30	65	15	22
Hybrid X N-Rate X Inhibitor	73	86	99	79	36	93	93
Hybrid X N-Rate X Inhibitor X K-Rate							
Hybrid X K-Rate	56	62	91	94	8	77	95
N-Rate X K-Rate	95	68	75	75	55	75	12
Hybird X N-Rate X K-Rate	87	35	96	97	59	99	99
Inhibitor X K-Rate	31	3	32	69	67	76	81
Hybrid X Inhibitor X K-Rate	91	59	89	41	82	62	38
N-Rate X Inhibitor X K-Rate	3	98	46	35	28	93	77
Hybrid X N-Rate X Inhibitor X K-Rate	86	89	99	95	17	60	90

Table 22 Physiological Maturity Waseca 1988

Split Plot without the 0 # N-Rate	Grain Yields	Dry Matter Production Grain	Stover	Total
	Bu/A	----------T/A---------		
K-Rate				
0	120.7	2.85	3.86	6.72
100	125.2	2.96	4.01	6.98
P-Value	73	73	68	71
Hybrid X N-Rate X Inhibitor				
Hybrid				
Pioneer 3732	120.4	2.85	3.83	6.68
Pioneer 3475	122.2	2.89	4.13	7.03
LH74 X LH51	135.6	3.21	4.19	7.40
A632 X LH39	113.5	2.68	3.06	6.29
P-Value	99	99	99	99
BLSD(.05)	6.7	0.15	0.15	0.23
N-Rate				
80	119.8	2.83	3.92	6.75
160	126.1	2.98	3.96	6.94
P-Value	99	99	48	96
Inhibitor				
None	121.9	3.93	2.88	6.82
N-Serve	124.3	3.95	2.93	6.88
P-Value	59	59	22	52
Hybrid X N-Rate	90	90	84	96
Hybrid X Inhibitor	90	90	48	90
N-Rate X Inhibitor	99	99	34	99
Hybrid X N-Rate X Inhibitor	62	62	95	94
Hybrid X N-Rate X Inhibitor X K-Rate				
Hybrid X K-Rate	61	61	72	79
N-Rate X K-Rate	83	83	67	85
Hybird X N-Rate X K-Rate	96	96	95	99
Inhibitor X K-Rate	78	78	89	91
Hybrid X Inhibitor X K-Rate	92	92	81	90
N-Rate X Inhibitor X K-Rate	99	99	98	99
Hybrid X N-Rate X Inhibitor X K-Rate	72	72	7	32

Table 23 **Physiological Maturity Waseca 1988**

Split Plot without the 0 # N-Rate	N-Concentration Stover	N-Concentration Grain	N-Removal Stover	N-Removal Grain	Total
	-------%---------		--------#/A----------		
K-Rate					
0	0.69	1.68	53.1	95.4	148.6
100	0.71	1.64	57.1	97.4	154.5
P-Value	72	76	84	55	76
Hybrid X N-Rate X Inhibitor					
Hybrid					
Pioneer 3732	0.67	1.63	51.9	93.1	145.1
Pioneer 3475	0.69	1.53	57.3	88.3	145.7
LH74 X LH51	0.69	1.61	58.3	103.4	161.8
A632 X LH39	0.73	1.87	53.0	100.7	153.7
P-Value	99	99	99	99	99
BLSD(.05)	0.03	0.03	3.3	5.4	6.3
N-Rate					
80	0.66	1.64	52.3	98.2	145.1
160	0.73	1.68	57.9	100.0	158.0
P-Value	99	99	99	99	99
Inhibitor					
None	0.71	1.66	56.0	95.5	151.6
N-Serve	0.68	1.66	54.2	97.3	151.5
P-Value	97	28	87	62	4
Hybrid X N-Rate	78	99	84	95	99
Hybrid X Inhibitor	56	79	28	96	96
N-Rate X Inhibitor	88	87	66	99	95
Hybrid X N-Rate X Inhibitor	50	75	39	77	81
Hybrid X N-Rate X Inhibitor X K-Rate					
Hybrid X K-Rate	66	90	17	82	84
N-Rate X K-Rate	99	99	88	19	58
Hybird X N-Rate X K-Rate	48	90	94	99	99
Inhibitor X K-Rate	98	95	61	9	35
Hybrid X Inhibitor X K-Rate	78	87	53	99	99
N-Rate X Inhibitor X K-Rate	85	81	18	97	95
Hybrid X N-Rate X Inhibitor X K-Rate	44	97	24	99	89

PRECISION FERTILIZER PLACEMENT FOR MOST PROFITABLE YIELD OF CORN GROWN IN A RIDGE-TILL MANAGEMENT SYSTEM

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

ABSTRACT: As ridge-till planting systems become more popular, several questions arise that pertain to fertilizer placement. This study was established to evaluate methods of placement of N, P_2O_5 and K_2O in ridges on corn production. The 1988 drought hindered the collection of much meaningful data. Nevertheless, the results from 1988 did show that substantial amounts of N as urea and K_2O could be applied in the fall without causing any damage to germination or early growth.

Background and Justification:

Several research studies conducted throughout the northern Corn Belt have shown that the ridge-till management system has several advantages for corn production. Use of this planting system reduces surface runoff thus diminishing soil erosion. Because of the recent concern for soil erosion and farm profitability, the farmer adoption of this planting system has accelerated rapidly in recent years. As adoption progresses, several unanswered questions surface each year. Many of these questions deal with fertilizer placement.

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

Past research has also shown that rates of fertilizer P needed for maximum economic corn production can be reduced somewhat if banded rather than broadcast applications of phosphate fertilizer are used. The lower rate requirements with banded placement translate into reduced costs which, in turn, improves the potential for farm profitability. In addition to increasing the efficiency of P use, banded application of P fertilizers, when compared to broadcast usage, can reduce concerns for environmental quality which arise because of movement of surface applied P to lakes, rivers, and streams.

In conventional tillage systems, the placement of banded fertilizer is usually limited to some position near the seed at planting. With the ridge-till management system, however, there are several alternatives for banded application of fertilizer. It is also widely known that high amounts of N and/or K_2O can cause damage to germinating corn if applied too close to the seed. Yet, many growers are searching for a placement of fertilizer that will provide for maximum efficiency of fertilizer use while, at the same time, eliminating the potential for seedling damage.

By using equipment that is currently available, it is possible to place fertilizer, with precision, at several distances from the seed in a ridge-till system. If a grower using a ridge-till management system could apply all of the needed fertilizer in a band in the fall before planting, he would be able to take advantage of traditionally lower prices and eliminate some time involved with planting in the spring.

If a system for banded application of fertilizer is to be developed, there are several important questions that must be answered. The interactions between rate of N and/or K_2O and distance between seed and fertilizer must be comprehensively evaluated. We need to determine if all of the needed N and K_2O can be applied in a band in the fall before planting without causing germination problems in the following

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spring. Likewise, the effect of distance between seed and fertilizer on corn growth and development must be measured if high amounts of N and/or K_2O are to be applied in bands.

The effect of distance between the corn seed and the P in a fertilizer band on the optimum rate of phosphate fertilizer needed for corn production has not been addressed in any research program. The root growth model of Dr. Barber at Purdue University focuses on the effect of volume of soil fertilized on fertilizer use efficiency. Since root surface area and concentration of P and K near the root are important components of the model, one can speculate that the rate of phosphate fertilizer needed for most efficient production will vary with the distance between the seed and the phosphate fertilizer. This speculation needs to be verified in field research trials.

Objectives:

Based on the needs outlined in the previous paragraphs, the study described in the following sections is designed to meet 3 objectives. These are:

1. Measure the effect of distance between seed and fertilizer and phosphate applied on growth and yield of corn grown in a ridge-till management system.
2. Determine the effect of rate of urea-N applied in a band in the ridge in the fall on germination, early growth and yield of corn.
3. Determine the effect of rate of K_2O applied in the ridge in the fall on germination, early growth, and yield of corn.

Experimental Procedure:

Three separate studies were used to meet the stated objectives. Each study will be described separately.

Study #1: Rate Of Applied P_2O_5 And Distance From The Seed.

This study was conducted at the West-Central Experiment Station at Morris and the Southwest Experiment Station at Lamberton. At each site, 0-46-0 was used to supply 23,46, and 69 lb. P_2O_5/acre. Four methods of phosphate placement were compared. These were: 1) broadcast, 2) below and to the side of the seed at planting (starter), 3) a subsurface band in the center of the ridge in the fall at a depth of approximately 5 inches, and 4) a subsurface band 12 inches to the side of the row in the fall at a depth of approximately 3 inches. Four placement combinations were used (see Table 3) and all treatments were compared to a control which received no P_2O_5. Each treatment was replicated 4 times in a randomized complete block design.

Soil samples were collected at 1 foot intervals to a depth of 5 feet prior to fertilizer application. Results are summarized in Table 1. Ridges were constructed during the 1987 growing season. Except for the starter placement, all treatments were applied in the fall of 1987.

Corn was planted in late April at both sites. Management practices conducive to high yields were used at both sites.

Stand counts were taken at approximately 4 weeks after emergence and whole plant samples were collected at this time. These samples were dried, weighed, ground and analyzed for P. Plant uptake of P was calculated from these measurements. Grain yields were measured in the fall and corrected to the 15.5% moisture base.

Study #2: Nitrogen Rate And Placement For Corn Grown In A Ridge-Till System.

This study was conducted at the West-Central Experiment Station at Morris and the Southern Experiment

Station at Waseca. The soil property data listed in Table 1 are appropriate for this study at the Morris location. The soil property data for the Waseca site are summarized in Table 2.

Three rates of N (45, 90, 135 lb./acre) were used at the Morris site.. The N rates were 50, 100, and 150 lb./acre at the Waseca site. At Morris, urea (46-0-0) was applied: 1) in a band in the center of the ridge at a depth of 3 to 5 inches, 2) in a band at a depth of 3 to 5 inches 12 inches from the row, 3) broadcast in the fall and 4) broadcast in the spring. These various applications of 46-0-0 were also compared to a fall application of anhydrous ammonia (82-0-0).

Nitrogen placement was changed for the Waseca site. The urea was applied in the bands in the center of the ridge and at 12 inches from the ridge and a fall application of anhydrous ammonia was also a part of the study. An additional placement consisted of the application of N as 28-0-0 with a spoke injector at planting time. A control treatment (no N applied) was incorporated into the study at both locations. Recommended management inputs such as plant population and herbicide selection were used at both locations.

Stand counts were taken at 4 to 5 weeks after emergence. Whole plant samples were also taken at this time and were dried and weighed. Grain yields were measured in the fall and corrected to the 15.5% moisture base.

Table 1. Relevant soil properties for the experimental sites used in study #1.

Soil Property	Depth	Site: Morris	Site: Lamberton
pH	0- 6	8.1	6.4
	6-12	8.1	6.5
	12-24	8.2	7.3
	24-36	8.2	7.8
	36-48	8.4	8.1
	48-60	8.3	8.2
P*, ppm	0- 6	5.5	5.1
	6-12	6.9	4.1
	12-24	3.8	2.8
	24-36	.6	3.1
	36-48	.5	3.5
	48-60	.5	3.4
K, ppm	0- 6	111	188
	6-12	155	147
	12-24	118	103
	24-36	72	92
	36-48	67	90
	48-60	93	98
Zn, ppm	0- 6	2.2	1.0
Organic Matter, %	0- 6	4.7	4.3

*Bray and Kurtz #1 procedure used for soil samples from Lamberton; Olsen procedure used for soil samples from Morris.

Table 2. Relevant soil properties for the experimental sites at Waseca, 1988.

pH	7.9
P (Olsen), ppm	13.5
K, ppm	120

Study #3: Band Placement of K_2O In The Center Of The Ridge.

This study was conducted at the Southern Experiment Station at Waseca. Soil test properties listed in Table 2 are appropriate for this site.

Four rates of K_2O (20, 40, 80, 160 lb./acre) supplied as 0-0-60 were applied in the center of an existing ridge at a depth of 3 to 5 inches in the fall of 1987. A control (no K_2O) was also included. Recommended management practices such as selection of plant population and herbicide were used. The N (supplied as 82-0-0) was constant for all treatments.

Stand counts were taken at 4 to 5 weeks after emergence. Whole plant samples were also taken at this time. These samples were dried and weighed. Grain yields were measured in the fall and corrected to the 15.5% moisture base.

Results and Discussion:

Study #1

The effects of rate and placement of applied phosphate on grain yield, weight of young corn plant, phosphorus concentration in young corn plants, and phosphorus uptake by young corn plants are summarized in Tables 3, 4, 5, and 6. Whole plant samples were collected from the Lamberton location and weighed. However, they were discarded by mistake before analysis. Therefore, concentration and uptake data are not available from this location.

In 1988, grain yield as well as early growth and nutrient uptake by young plants was not influenced by either rate of P_2O_5 applied or the placement of the phosphate fertilizer. This lack of treatment response can be attributed to the drought throughout the growing season at both locations.

Grain yields were in the range of 50-60 bu./acre. Even though soil test levels for phosphorus were low, a response to phosphorus in a fertilizer program would not be expected. The dry weather during the early part of the growing season also limited growth and root development of young plants. Consequently, the treatments used had no significant effect on early plant growth and nutrient absorption by these young plants.

Table 3. The effect of rate of applied phosphate and placement of phosphate fertilizer on corn yield. 1988

		P_2O_5 rate (lb./acre)		
Placement		23	46	69
	- - - - - - - - - - bu./acre - - - - - - - -			
Morris:				
control	51.4			
center of ridge		48.4	51.9	51.8
starter		54.2	43.6	57.1
12 in. from ridge center		56.7	47.2	48.2
broadcast		58.1	45.7	52.1
	Ave:	54.4	47.1	52.3
Lamberton:				
control	56.3			
center of ridge		47.5	60.4	64.3
starter		54.0	69.7	58.0
12 in. from ridge center		60.2	51.6	60.3
broadcast		60.0	62.2	48.4
	Ave:	55.4	61.0	57.8

Table 4. The effect of rate and placement of applied phosphate on the weight of young corn plants, 1988.

Placement		P_2O_5 rate (lb./acre) 23	46	69
		- - - - - - - - gm/6 plants - - - - - - - -		
Morris:				
control	32.3			
center of ridge		39.0	32.3	33.0
starter		29.3	33.0	29.8
12 in. from ridge center		33.3	37.0	39.0
broadcast		33.0	36.8	36.5
	Ave:	33.7	34.8	34.6
Lamberton:				
control	36.0			
center of ridge		46.5	45.0	55.8
starter		43.0	44.0	49.3
12 in. from ridge center		38.8	40.5	47.3
broadcast		46.8	35.5	43.3
	Ave:	43.8	41.3	48.9

Table 5. Effect of rate and placement of applied phosphate on the phosphorus content of young corn plants, Morris, 1988.

Placement		P_2O_5 rate (lb./acre) 23	46	69
		- - - - - - - - - - - - - % P - - - - - - - - -		
control	.374			
center of ridge		.375	.375	.368
starter		.371	.373	.390
12 in. from ridge center		.412	.363	.379
broadcast		.358	.360	.380
	Ave:	.379	.368	.379

Table 6. The effect of rate and placement of applied phosphate on phosphorus uptake by young corn plants. Morris, 1988.

Placement		P_2O_5 rate (lb./acre) 23	46	69
		- - - - - - - - g P/6 plants - - - - - - - -		
control	.121			
center of ridge		.146	.121	.122
starter		.110	.124	.115
12 in. from ridge center		.138	.135	.148
broadcast		.118	.131	.138
	Ave:	.128	.128	.131

Study #2

The primary purpose of this study was to evaluate the effect of placement of 46-0-0, applied at 3 rates, on corn emergence, early growth of corn, and corn yield. At Morris, these placements were compared to the standard fall application of 82-0-0. At Waseca, these placements were compared with the fall application

of 82-0-0 as well as the application of 28-0-0 with a spoke injector into the ridge at planting time.

The effect of the placement of 46-0-0 at a depth of 5 inches in the center of the ridge was of special interest. If this placement had no harmful effect on production, it would be possible for farmers to apply all of the fertilizer needs in the ridge in the fall thereby saving time during the busy planting season.

At Morris, neither N rate nor placement had a significant effect on grain yield, weight of young corn plants, and emergence (Tables 7, 8, 9). Yields were reduced by the dry weather. Therefore, no response to fertilizer N was expected. With a corn/soybean rotation, this soil is capable of supplying the N requirements for 50-60 bu./acre corn.

The fall application of high rates of 46-0-0 in the center of the ridge did not reduce the weight of young corn plants or hinder emergence (Tables 8, 9). If negative effects were not recorded in a dry year with a calcareous soil, it is doubtful if the use of 46-0-0 in this way would be harmful to early corn growth in other years.

Table 7. The effect of nitrogen rate and management on corn yield in 1988 at Morris.

N Management		N rate (lb./acre) 45	90	135
	- - - - - bu./acre - - - - - - -			
control	56.6			
46-0-0, center of ridge		56.2	60.2	50.9
46-0-0, 12 in. from ridge center		56.4	48.2	47.7
46-0-0, fall broadcast		50.8	65.2	52.0
82-0-0, fall applied		58.7	52.6	53.3
46-0-0, spring broadcast		66.3	58.7	55.3

Table 8. The effect of nitrogen rate and management on the weight of young corn plants at Morris.

N Management		N rate (lb./acre) 45	90	135
	- - - - - - gm/6 plants - - - - - -			
control	38.6			
46-0-0, center of ridge		42.0	33.8	33.0
46-0-0, 12 in. from ridge center		36.3	39.5	41.3
46-0-0, fall broadcast		36.5	31.8	35.3
82-0-0, fall applied		34.8	41.3	41.0
46-0-0, spring broadcast		41.5	44.3	44.8

Table 9. The effect of nitrogen rate and management on the emergence of corn at 5 weeks after planting at Morris.

N Management		N rate (lb./acre) 45	90	135
	- - - - plants/20 ft. of row - - - -			
control	29			
46-0-0, center of ridge		28	26	28
46-0-0, 12 in. from ridge center		29	28	28
46-0-0, fall broadcast		27	26	27
82-0-0, fall applied		29	29	28
46-0-0, spring broadcast		27	27	29

Data from the Waseca site are summarized in Tables 10, 11, and 12. Grain yield was not significantly affected by the placement of the nitrogen fertilizer (Table 10). When averaged over all rates of applied N, the 46-0-0 and the 28-0-0 applied in the ridge were as effective as the band of 46-0-0 to the side of the ridge and the fall applied 82-0-0.

Grain yields did increase with the rate of N used. These increases, however, were small. The major increase occurred when the control is compared to the 50 lb./acre N rate. Yield increases from applied N were expected to be small because of the low yields.

Nitrogen placement had no significant effect on the weight of young corn plants (Table 11). However, early growth increased with rate of applied N. Again, increases were small.

Neither N placement nor rate of N used had a significant effect on emergence (Table 12). This is encouraging for those growers who would like to place all of the fertilizer in the ridge in the fall. The potential damaging effect of urea applied at high rates in a band directly below the seed should be most obvious in a dry year.

Study #3

This study was conducted to evaluate the effects of rate of K_2O fall applied at a depth of 5 inches in the center of the ridge on corn emergence, early growth, and subsequent grain yields. Results are summarized in Table 13. The rate of applied K_2O had no significant effect on any of the variables measured.

The soil test value for K was in the very high range. Therefore, a yield response to rate of applied K_2O would not be expected.

High rates of K_2O applied near the seed at planting have been known to reduce corn emergence and reduce early growth. These reductions were not noted in this study. Apparently, the K_2O applied in the fall dissolves in soil moisture in late fall and early spring and has no damaging impact on corn emergence.

Table 10. The effect of nitrogen rate and management on corn yield in 1988 at Waseca.

N Management		N rate (lb./acre) 50	100	150
	- - - - - - - bu./acre - - - - - - -			
control	77.4			
46-0-0, center of ridge		86.9	90.3	93.8
28-0-0, spoke injector		86.3	85.7	89.6
46-0-0, 12 in. from ridge center		89.3	81.4	88.3
82-0-0, fall applied		81.7	83.0	88.0

Table 11. The effect of nitrogen rate and management on the weight of young corn plants at Waseca in 1988.

N Management		N rate (lb./acre) 50	100	150
	- - - - - - gm/6 plants - - - - - -			
control	26.4			
46-0-0, center of ridge		32.8	32.8	31.5
28-0-0, spoke injector		28.0	30.3	28.0
46-0-0, 12 in. from ridge center		28.9	30.8	31.3
82-0-0, fall applied		27.5	27.8	34.3

Table 12. The influence of nitrogen rate and management on the emergence of corn measured 5 weeks after planting at Waseca in 1988.

N Management		N rate (lb./acre) 50	100	150
	- - - - - - plants/20 ft - - - - - -			
control	34			
46-0-0, center of ridge		34	33	34
28-0-0, spoke injector		33	34	32
46-0-0, 12 in. from ridge center		32	33	34
82-0-0, fall applied		33	34	34

Table 13. The effect of rate of K_2O applied in the center of the ridge at a depth of 5 inches on corn yield, early growth and emergence at Waseca, 1988.

K_2O Applied	Yield	Growth	Emergence
lb./acre	bu./acre	gm/6 plants	plants/20 ft.
0	84.4	29	33
20	81.7	31	33
40	78.4	29	33
80	86.3	35	34
160	83.6	31	34

SULFUR FOR CORN PRODUCTION IN SWIFT COUNTY

Pat Maher and George Rehm[1/]

ABSTRACT: This study was conducted to demonstrate the importance of soil texture in determining a need for fertilizer S. One rate of S (25 lb./acre) was broadcast and incorporated before planting for corn grown on an irrigated sand and corn grown on a non-irrigated fine textured soil. Sulfur increased grain yield by about 11 bu./acre on the sandy soil only. There was no response to S on the fine textured soil.

Past research in Minnesota has shown that the addition of sulfur (S) to a fertilizer program will increase the yield of corn grown on sandy soils. Responses to S fertilization have not been measured for fine textured soils with an organic matter content in excess of 1.8%. Yet, we continue to get questions about the need for sulfur. So, this trial was conducted in Swift County to demonstrate the importance of soil texture in determining the need for S in a fertilizer program for corn.

EXPERIMENTAL PROCEDURE:

Two sites were selected. Irrigated corn was grown on a sandy soil at one site while a non-irrigated fine-textured soil was chosen for the second site. Selected soil properties are summarized in Table 1.

Granular gypsum was used to supply S at a rate of 25 lb./acre at each site. This gypsum was broadcast and incorporated before planting. One variety was used at the sandy site while two were planted at the fine-textured site. Appropriate management practices for profitable corn production were used at each site. Grain yields were measured in mid-October and corrected to 15.5% moisture.

Table 1. Relevant soil properties for the soils used in this trial.

Site Description	pH	P Bray	P Olsen	K	S	Zn	O.M.
		- - lb./acre - - -			- - ppm - -		%
Irrigated	6.8	53	-	310	1	.9	1.9
Dryland	8.2	3	10	259	19	.5	6.5

RESULTS AND DISCUSSION:

Grain yields are summarized in Table 2. As expected, there was a yield increase when S was applied to the sandy soil. The low organic matter content (1.9%) and low soil test for S (1 ppm) are soil properties where responses to fertilizer S Can be expected.

Use of fertilizer S did not increase the yield of either variety at the dryland site. This was to be expected because of the high organic matter content (6.5%) and high soil test for S (19 ppm). The results obtained in this trial are consistent with other trials involving the application of S for corn production in Minnesota.

Table 2. The effect of S application on the yield of corn in Swift County.

Site	Hybrid	Without S	With S
		- - - - - - bu./acre	- - - - - -
Irrigated	Pioneer 3737	168	177
Dryland	Pioneer 3737	138	127
Dryland	Northrup King EX99	125	129

1/ County Extension Agent, Swift County and Extension Specialist, respectively.

THE IMPACT OF LASSO COMBINED WITH UAN ON EARLY SEASON WEED CONTROL AND YIELD OF CORN

Jeff Gonsulus, Doug Miller, Greg Cremers, Andy Scobbie, and George Rehm[1/]

ABSTRACT: The practice of combining some herbicides with liquid nitrogen fertilizer (UAN) instead of water has been widely promoted in the absence of verification of supposed benefits through research. This study was conducted at 3 locations in 1988 to measure the impact of Lasso-liquid N combinations on weed control and corn yield. The use of split applications of N was also evaluated. Weed control was not improved when Lasso was combined with UAN instead of water and this herbicide-N combination had no positive effect on yield. Split applications of N also had no positive effect on yield.

In recent years, there has been widespread promotion via testimonials of the practice of applying some herbicide with liquid N (UAN) instead of water. The practice has not been adequately evaluated in research trials. Consideration of the basic principles of weed control and soil fertility would indicate that there should be no positive effects noted from these combinations. Therefore, this study was conducted to: 1) evaluate the impact of the Lasso-UAN combination on foxtail control and corn yield, 2) measure the effect of split applications of N as UAN on corn yield, and 3) determine if the use of UAN as a carrier would allow for the use of reduced rates of Lasso.

EXPERIMENTAL PROCEDURE:

This study was conducted at 3 sites (Benton, Renville, Winona Counties) in 1988. Corn was grown on an irrigated sand in Benton County. In Renville County, the soil was a silty clay loam with a calcareous pH. A silt loam soil with an acid pH was selected in Winona County. Relevant soil properties are listed in Table 1.

Three rates of Lasso, plus a control, were combined with 4 nitrogen management plans in a complete factorial with 4 replications. A randomized complete block design was used at each site.

Corn was planted with accepted management practices by the cooperating farmer at each location. Treatments were applied within one week of planting. Lasso rates were .83, 1.66, and 2.50 lb. a.i./acre at the Benton County site. In Renville County, the rates were 1.17, 2.33, and 3.50 lb. a.i./acre. For Winona County, the selected rates were 1.00, 2.00, and 3.00 lb. a.i./acre.

The nitrogen rates selected for sites in Benton and Winona Counties were based on yield goal, cropping history, and the soil organic matter content. In Renville County, the selected nitrogen rate was based on yield goal in combination with the results of the soil nitrate test. The selected rates were 220, 170, and 170 lb./acre for Benton, Renville, and Winona County respectively.

All rates of Lasso were applied preemergence with either 10 gallons of water or 10 gallons of 28-0-0 (UAN) per acre. When Lasso was applied with the UAN, the remainder of the N needed to attain the desired rate was applied as a sidedress treatment.

In the second nitrogen management strategy, all of the N was applied as a sidedress treatment and Lasso was applied with water. In a third management strategy, Lasso was applied with water, UAN was applied in a separate operation at the same time and the remainder of the needed N was applied as a sidedress treatment.

Plots were visually evaluated for weed control in early June and cultivated after evaluation. The UAN was sprayed on the soil surface for the sidedress treatment and incorporated with cultivation.

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

1/ Extension specialist, junior scientist, assistant scientist, junior scientist and extension specialist, respectively.

Table 1. Relevant soil properties for the 1988 experimental sites.

Soil Property	County Location Benton	Renville	Winona
pH	5.3	7.8	-
P, lb./acre	110	48	81
K, lb./acre	268	382	193
O.M., %	3.9	6.8	2.4
NO_3-N, lb./acre	-	61	36
Texture	sandy loam	silty clay loam	silt loam

RESULTS AND DISCUSSION:

Control of giant foxtail at all locations was affected by rate of Lasso applied. The full rate of Lasso was needed for the best control at the Benton and Renville County sites (Tables 2 and 3). In Winona County, the 2 lb. rate of Lasso was adequate for optimum control (Table 4). A heavy snow immediately after herbicide application probably improved the control of the giant foxtail.

The effectiveness of Lasso was not improved by mixing with 28-0-0 instead of water and there was no significant interaction between the rate of Lasso used and the N management system. There was also no indication that the rate of Lasso needed for optimum control could be reduced if it was mixed with 28-0-0 instead of water.

Table 2. Effect of N management system and Lasso rate on control of giant foxtail - Benton County.

N Management Preemerge	Sidedress	Lasso Carrier	Lasso Rate (lb. a.i./acre) .83	1.66	2.50	Ave.
lb./acre			- - - - - - % control - - - - - -			
-	-	water	72.0	89.5	93.8	85.1
-	220	water	76.2	90.5	96.5	87.8
30	190	water	74.5	94.8	95.2	88.2
30	190	28-0-0	78.0	87.0	95.0	86.7
		Ave.	75.2	90.4	95.1	

LSD for Lasso Rate = 4.3; LSD for N Management - NS

Table 3. Effect of N management system and Lasso rate on control of giant foxtail. Renville County.

N Management Preemerge	Sidedress	Lasso Carrier	Lasso Rate (lb. a.i./acre) 1.17	2.33	3.50	Ave.
lb./acre			- - - - - % control - - - - -			
-	-	water	58.8	77.8	89.2	75.2
-	170	water	52.5	77.8	89.5	73.2
30	140	water	51.2	77.0	89.2	72.5
30	140	28-0-0	52.5	73.8	85.5	70.6
		Ave.	53.8	76.6	88.4	

LSD for Lasso Rate -=6.5; LSD for N Management = NS

Table 4. Effect of N management system and Lasso rate on control of giant foxtail, Winona County.

N Management Preemerge	N Management Sidedress	Lasso Carrier	Lasso Rate (lb. a.i./acre) 1.0	2.0	3.0	Ave.
- - - - lb./acre - - -			- - - - - - % control - - - - -			
-	-	water	92.2	95.5	99.5	95.8
0	170	water	93.2	96.2	99.0	96.2
30	140	water	92.0	97.0	100.0	96.3
30	140	28-0-0	90.8	99.0	98.5	96.1
		Ave.	92.1	96.9	99.2	

LSD for Lasso Rate = 2.6; LSD for N Management = NS

Grain yield was affected by both Lasso rate and N management systems. In Benton County, there was no yield response from the application of fertilizer N (Table 5). However, yields did increase with the rate of Lasso applied. The application of .83 lb. a.i. per acre was adequate for optimum yield.

The lack of a response to N at this sandy site was surprising. Traditionally, sandy soils have relatively low levels of NO_3-N in the root zone at the beginning of the growing season. This site had received heavy applications of manure in the past. Apparently, ample N was released from the manure and the soil organic matter.

The yield goal for this site was 190 bu./acre. The drought, however, had a negative impact on yield. There was also a large amount of variability in yields which is attributable to the dry weather.

Table 5. Effect of N management system and Lasso rate on corn yield, Benton County.

N Management Preemerge	N Management Sidedress	Lasso Carrier	Lasso Rate (lb. a.i./acre) 0	.83	1.66	2.50	Ave.
- - - - lb./acre - - - -			- - - - - - - - - - bu/acre - - - - - - - - - -				
-	-	water	116.5	163.6	159.0	148.6	146.9
-	220	water	96.9	145.2	161.2	175.7	144.7
30	190	water	109.0	161.3	168.5	166.8	151.4
30	190	28-0-0	110.1	165.7	156.4	157.2	147.3
		Ave.	108.1	158.9	161.3	162.1	

LSD for Lasso Rate = 16.5; LSD for N Management = NS

The N management system as well as the rate of Lasso used had a significant effect on yield at the Renville County site (Table 6). There was, however, no significant interaction between these two factors.

The highest yield was associated with the highest rate of Lasso used (3.5 lb. a.i./acre). Therefore, the highest yield was associated with the lowest weed pressure. Since weeds compete with corn for moisture, this observation would be expected in a dry year.

Yields were also substantially improved by the use of fertilizer N. The use of split applications of N, however, had no effect on yield. When averaged over all rates of Lasso, the yield was 81.6 bu./acre when all of the N was applied as a sidedress treatment. With water as a carrier and a split application of N, the yield was 85.1 bu./acre when averaged over all rates of Lasso applied. Again, the dry weather caused a large amount of variability in measured yields.

Table 6. Effect of N management system and Lasso rate on corn yield, Renville County.

N Management		Lasso	Lasso Rate (lb. a.i./acre)				
Preemerge	Sidedress	Carrier	0	1.17	2.33	3.50	Ave.
- - - - lb./acre - - - -			- - - - - - - - - - bu./acre - - - - - - - -				
-	-	water	18.8	60.4	72.0	76.5	56.9
-	170	water	30.4	84.7	77.5	113.8	81.6
30	140	water	29.5	87.1	106.8	116.8	85.1
30	140	28-0-0	26.5	84.8	91.7	99.4	75.6
		Ave.	26.3	79.3	92.0	101.6	

LSD for Lasso Rate = 8.6; LSD for N Management = 8.6

Grain yields at the Winona County site were affected by both the N management system and the rate of Lasso used (Table 7). The application of fertilizer N increased yields, but method of application had no significant effect. The split application was not superior to a single application of N.

The use of Lasso at 2 lb. a.i. per acre produced the optimum yield of corn. Yield was not affected by the carrier used for the Lasso herbicide.

Table 7. Effect of N management system and Lasso rate on corn yield, Winona County.

N Management		Lasso	Lasso Rate (lb. a.i./acre)				
Preemerge	Sidedress	Carrier	0	1.0	2.0	3.0	Ave.
- - - - lb./acre - - - -			- - - - - - - - - bu./acre - - - - - - - -				
-	-	water	61.9	102.0	102.4	108.7	93.7
-	170	water	61.8	106.3	121.5	130.8	105.1
30	140	water	72.9	110.5	128.2	129.3	110.2
30	140	28-0-0	86.2	116.0	129.5	132.2	116.0
		Ave.	70.7	108.7	120.4	125.2	

SUMMARY AND CONCLUSIONS:

This study has been conducted at several locations over a period of 2 years (1987, 1988). Based on the information collected at this time, it is possible to draw the following conclusions:

1. Lasso applied with 28-0-0 instead of water does not improve the control of giant foxtail.

2. The mixture of Lasso and 28-0-0 does not allow for a reduction in the rate of Lasso that is recommended.

3. Split applications of N did not increase grain yield when compared to a single sidedress treatment.

4. There's a reason for using recommended rates of herbicide and nitrogen -- it's called profit.

SURVEY OF EMERGENCY CORN FORAGE FOR NITRATE CONTENT, FEED VALUE, AND YIELD

Mike Schmitt, Neal Martin, and George Rehm[1/]

ABSTRACT: The drought experienced by many livestock producers in 1988 created situations where emergency forages were needed in the middle of the summer. One possible source of emergency forage was corn. In many cases, the corn was looking very stressed and the thought that the crop would not produce any significant grain stimulated the idea to chop the forage for feed during July and August. The nitrate levels in the plants and the expected yields were of primary concern to producers.

PROCEDURE:

In the middle of August, samples were collected from Goodhue and Rice Counties and two areas of Stearns County. At each field site, six plants were measured for height and weight, and a sample of the plant material was collected for moisture, nitrates and NIRS analyses. A general observation of the field was made for overall color of the plants and notes were taken as to the development of ears.

RESULTS AND DISCUSSION:

Data from all of the fields that were sampled are listed in Table 1. Independent variables that a producer might use to evaluate the crop would include the plant height, color of the foliage, and the presence of ears. The dependent variables--those items a producer would want to predict from an independent variable--include the nitrate contents, feed quality, and yields. Data is sorted by plant height at the bottom portion of Table 1.

Yield

Yields from these fields ranged from 1.2 to 4.6 tons of dry matter per acre. Plants that were less than three feet tall had the lowest yields; however, there was no correlation between plant height and forage yield for plants taller than three feet. Numerous publications make a generalized statement that drought-stressed corn will yield approximately one ton of dry matter for each foot of height. This approximation was made for corn that grew somewhat normally until stress during the reproductive period caused little or no ear formation. This generalization does not apply to the 1988 case because stress occurred early in the season as well as during the reproductive stages.

Nitrates

Nitrate analyses were run on a portion of the sampled fields and the quantities ranged from 690 to 3383 parts per million nitrate nitrogen. The higher quantities were in the range that feeding restrictions should apply. Nitrate concentrations were not correlated to plant height. Although there were only 13 samples run for nitrates, there was a slight pattern of the nitrates being high when no ears were developing on shorter stature plants that were turning brown. This would be expected since these plants do not have an active sink for the nitrogen to be translocated to.

Forage Quality

As might be expected, crude protein amounts were inversely correlated to the height of the plants--as the height increased, the protein concentrations decreased. This effect is mainly a dilution function since the dry weights did increase somewhat as the height increased. The acid detergent fiber (ADF) and neutral detergent fiber (NDF) contents had great variation within each height interval and did not have any general trends.

1/ Extension Specialist, Soil Fertility; Extension Specialist, Forage Crops; Extension Specialist, Soil Fertility, respectively.

Summary

The severity, longevity, and timing of high temperature and low moisture stress greatly affects corn quality, quantity, and potential toxicity. In 1988, there were no general guidelines to predict some of these parameters and the best advice for all livestock/crop producers was to test their corn forage for nitrates, moisture, quality, etc.

Table 1. Data of several characteristics from corn plants sampled in Minnesota, 1988.

Sample I.D.[1]	Ear Present	Plant Color[2]	Plant Height	Dry Matter	Yield (D.M.)	Nitrate-N	Crude Protein	ADF	NDF
			in.	%	T/A	ppm	%	%	%
A1	Y	G	68	20	4.4	3241	9.3	30.8	39.6
A2	N	GB	38	58	4	3383	11.0	36.7	48.0
A3	N	G	43	28	2.3	1949	9.9	33.3	44.3
A4	Y	G	41	30	3.4		10.0	29.9	43.2
A5	Y	G	41	30	3.4	1559	10.9	28.1	40.5
A6	N	G	21	21	1.2		12.1	35.1	43.9
A7	Y	G	46	35	3.7		9.2	36.3	41.6
A8	Y	G	41	33	4.6		7.9	32.4	49.1
A9	Y	G	34	32	2.2		8.5	35.0	49.7
B1	Y	G	26	26	1.7	1004	11.3	32.4	44.1
B2	Y	G	52	32	3.5		8.2	34.4	49.3
B3	Y	G	36	29	1.9		9.2	28.5	40.0
B4	Y	G	32	29	2.6		10.4	31.5	44.4
B5	Y	G	31	22	1.6		11.4	34.7	45.3
B6	Y	GB	39	38	3.2		8.5	30.7	45.8
B7	Y	G	27	30	2.3		9.7	36.5	49.9
B8	Y	G	35	25	1.9	690	10.5	32.7	44.0
B9	Y	GB	53	43	4.2	338	6.2	37.8	56.9
B10	Y	G	45	32	2.8		7.3	34.8	54.2
B11	Y	G	48	29	4		9.8	35.4	49.4
B12	Y	G	34	29	2.2		9.4	34.4	48.0
B13	Y	G	39	32	2.1		8.5	33.3	48.2
C1	N	B	56	29	2.8	1539	9.5	40.0	55.1
C2	Y	G	65	27	3.2		8.6	31.2	42.4
C3	Y	G	66	37	3.7	1360	8.4	35.9	51.1
C4	Y	G	63	33	2.5		8.4	31.8	43.8
C5	Y	GB	58	30	4	1802	9.6	30.1	39.9
C6	Y	B	60	42	3.4	1181	10.1	30.8	45.5
C7	Y	GB	57	34	4.5		8.6	30.7	43.6
C8	Y	B	50	43	3.2		9.4	32.4	48.6
C9	Y	GB	64	36	3.3		8.5	33.1	46.8
C10	Y	GB	48	44	3.2	791	7.4	38.3	54.5
C11	N	B	36	35	1.6	2438	10.4	41.2	57.9
Mean Heights									
1-3 feet			31	27.8	1.9	1377	10.3	34.2	46.7
3-4 feet			43	35.4	3.4	1921	9.1	33.6	47.1
4-5 feet			55	36.1	3.7	1373	8.8	33.7	48.4
5-6 feet			65	30.6	3.4	2301	8.6	32.6	44.7
ALL			45	32.5	3.0	1685	9.3	33.6	46.9

[1] Samples designated A were from Stearns County taken on Aug. 12, 1988, B samples were from Stearns County taken Aug. 23, 1988 and C samples were from Goodhue and Rice Counties taken Aug. 16, 1988.

[2] Color was abbreviated G for green, B for brown, and GB for plants that were turning brown.

INFLUENCE OF EXPERIMENTAL DESIGNS ON ON-FARM TRIAL INTERPRETATIONS

M.A. Schmitt and S.J. Openshaw[1]

ABSTRACT: Experimental designs used in on-farm research trials are largely responsible for the precision of the research results. Three experimental designs (unreplicated strip, unreplicated strip with "tester", and randomized complete block (RCB)) were compared from modeled uniformity trial data from four uniformity trial experiments in the Upper Midwest and from seven field trials conducted in Minnesota (Schmitt and Openshaw, 1988). True error variances were 20-45% less for the RCB (3 reps) compared to the strip design. The strip with "tester" design's true error was highest. Treatment mean differentiation based on either a set confidence interval or least significant differences (LSD) was directly correlated to the relative size of the error terms. Field results from 1988 indicate that the RCB (2 reps) estimated error was 25-50% less than the strip design. There were no differences between the strip and strip with "tester" design errors in the field trials conducted at University of Minnesota Agricultural Experiment Stations at Waseca and Lamberton and five on-farm trials.

INTRODUCTION

On-farm research trials provide information used to make decisions affecting the productivity and profitability of a farming operation. Virtually all practices and products warrant on-farm trials because their effects depend heavily on the management and environment of each farm. Because these two components are unique to each farm, research results conducted by neighbors, local farm groups, private companies, and university research are not always directly transferable.

As the trend develops to place increasing emphasis on on-farm trials, the validity of these trial results must be emphasized. The role of experimental design and statistics in determining trial validity is often neglected, yet without validity, interpretation of results have little impact. In conducting on-farm large-plot research trials, the experimental design is often determined by logistical convenience rather than by statistical desirability.

On-farm trials cannot be expected to involve intricate experimental designs that researchers may use under controlled station plots. Those designs are impractical and probably unnecessary in order to provide useful, interpretive results. Although many basic designs have been suggested for on-farm trials, no data has compared designs with respect to their error terms or final interpretations.

The objectives of this project are two-fold. First, we want to compare the precision of three experimental designs used in large-plot research. Second, we want to investigate how experimental design might affect interpretation of the results.

MATERIALS AND METHODS

Two sources of data were used. One set of data is from four uniformity trials previously conducted by other researchers at land grant universities in the Upper Midwest. The second pool of data--which will be reported here--was collected from a series of field trials established for the purpose of this project.

Three basic experimental designs commonly used in large plot, on-farm trials were compared. These three designs are: 1) a nonreplicated strip (strip), in which the number of plots equals the number of treatments, 2) a nonreplicated strip that has a common treatment placed in every second or third plot (strip with "tester"), in which the number of plots equals the number of treatments times (2 or 1.5) plus 1, and 3) a randomized complete block (RCB), in which the number of plots equals the number of treatments times the number of replications.

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The experimental design used in the field trials (Figure 1) incorporated each of the three experimental designs investigated in this study. Five of the locations in Minnesota were on farmers' fields, with each plot having a width of 30 feet and a length from 330 to 1320 feet. Two sites were at University of Minnesota experiment stations, the width was 10-15 feet and the length between 100 and 200 feet. All of the sites were selected based on visual uniformity of the soil.

Management practices were followed at each site that were parallel to that practiced by top corn producers. There were five treatments at each location, consisting of different hybrids: Pioneer brands 3737, 3751, 3732, 3585, and XC272. Pioneer brand 3737 was used as the "tester" in the strip with "tester" design. Grain yields were measured after physiological maturity using a combine and weigh wagons, and grain yields were adjusted to 15.5% moisture.

Approximate errors associated with the three experimental designs were estimated. One main assumption of the analysis is that the size and number of plots do not change depending on the experimental design used. So for the design in Figure 2, assume there are 18 plots (rather than 19 for mathematical logistics), providing the space for 18 treatments in a strip design, 12 treatments in a strip with "tester" design using a "tester" in every third plot, and 9 treatments in an RCB with the minimum of 2 replications.

The error variance for a strip design having as many treatments as there are strips can be approximated by calculating the residual mean square from a completely random design (CRD) analysis (Eq. 1) that used the unadjusted yields of the nontester plots. By using a CRD, only the treatment effects are partitioned from the trial variance--not any block effects.

$$\text{Eq. 1:}\quad S^2 = \sum_{1}^{n}\sum_{1}^{r} (X_{ij} - \overline{X}_{i.})^2/n(r-1)$$

The strip with "tester" design's error variance is approximated in a similar manner as the strip design's error. First, however, the yields are adjusted according to Eq. 2. The adjusted yields for the nontester hybrids are then used in a CRD analysis, partitioning out the treatment effect, resulting in the error variance associated with the total plot area as if a strip with "tester" design were used (Eq. 3).

$$\text{Eq. 2:}\quad X^{l} = X - ((.667)t_{left} + (.333)t_{right}) + t_{..},$$ when the tester to the left is adjacent to the treatment

$$X - ((.333)t_{left} + (.667)t_{right}) + t_{..},$$ when the tester to the right is adjacent to the treatment

$$\text{Eq. 3:}\quad S^2 = \sum_{1}^{n}\sum_{1}^{r} (X^{l}_{ij} - X^{l}_{i.})^2/n(r-1)$$

The estimated experimental error for a RCB design can only be given as a range based on the assumption that there can be 2 replicates of 9 treatments in the given plot area. The error variance associated with the 1 block of 9 plots is the experimental error of a treatment mean for those 9 plots. By analyzing the unadjusted treatment means as an RCB (with 3 blocks, as the design is laid out), the residual mean square is actually the error associated with 6 plots of a strip design. The estimated error variance for 9 plots will lie between the estimates for 6 and 18 plots. With 2 replicates, the error variances are divided by 2 to obtain the error associated with a treatment mean.

RESULTS AND DISCUSSION

The measurement that is used to evaluate the precision of the different experimental designs is the error variance. The relative size of the error variance is inversely related to the degree of precision of the design. The larger the error variance, the less precision the experiment possesses. The precision of an experiment is directly related to the confidence one can give to the data.

For example, a large relative error variance results in larger differences between treatment means in order for the treatments to be significantly different. A 10 bushel per acre difference in two corn treatment means might be significantly different if relatively low error variance was measured, but would not necessarily be different if a relatively high error variance was measured.

Calculated error variances from the 7 field locations are reported in Table 1. When the analysis was made without adjustmeant for the "testers", simulating a strip design, the range of the unreplicated error variance of a treatment mean was 18.6-91.3. If the treatment means were adjusted for the "tester", the error variance of a treatment mean ranged from 3.2-110.8. The mean of the error variances were almost identical (51.2, 51.0) when combined over locations. There was a wide range of error variances between locations while the relative relationship between the two analyses was similar. The severe drought throughout Minnesota created large variations in yields among locations.

Table 1. Treatment mean error variances as affected by experimental design, 1988.

Location	Strip	Strip w/"Tester"	R.C.B.
			--range--
Woodlake	18.7	3.2	3.3- 9.3
Litchfield	22.0	64.9	11.0-12.2
Utica	30.6	35.9	14.0-15.3
Hector	59.4	51.5	15.0-29.7
Sleepy Eye	59.5	11.4	4.8-29.7
Waseca-AES	91.3	110.8	8.0-45.6
Lamberton-AES	76.9	79.2	30.4-38.4

The error variance of a treatment mean for an RCB design with 2 replicates were estimated to average between 12.5 and 25.6 (Table 2). This represents a reduction in the error variance of 50-75% as compared to the strip design. While the treatment mean error variance is greatly reduced in the RCB design compared to the two strip designs, the compromising factor is that for the given amount of plots, fewer treatments can be evaluated.

Table 2. Mean and range of treatment mean error variances from 7 Minnesota locations as affected by experimental design, 1988.

Design	Plots	Trt	Mean Error Variance
Strip	18	18	51.2
Strip w/"Tester"	18	12	51.0
R.C.B.	18	9	25.6>E>12.5

SUMMARY

Results from the field data provide similar conclusions as those from previous uniformity trial data. In terms of precision, error variances were consistently smaller for the RCB design than for the strip or strip with "tester" designs. The strip with "tester" design did not provide any more precision than the strip design. This means that greater confidence or better interpretation of treatment mean differences are not achieved by using a "tester" design in 1988.

The results of this study favor the practice of replication. The precision of error and the resulting interpretations are all enhanced using a replicated design. Although the logistical argument of increased plotwork is generally presented, the confidence in the results should provide the incentive. The amount of time and effort necessary to lay out an on-farm trial using an RCB or strip with "tester" design are not very different, yet the use of the strip with "tester" (or control) design is greater than for the replicated design.

Note: This is the first year data of a multi-year study.

References:

Schmitt, M.A. and S. J. Openshaw. 1988. Influence of experimental designs on on-farm trial interpretations. Paper presented at 1988 American Society of Agronomy meetings, Anaheim, CA.

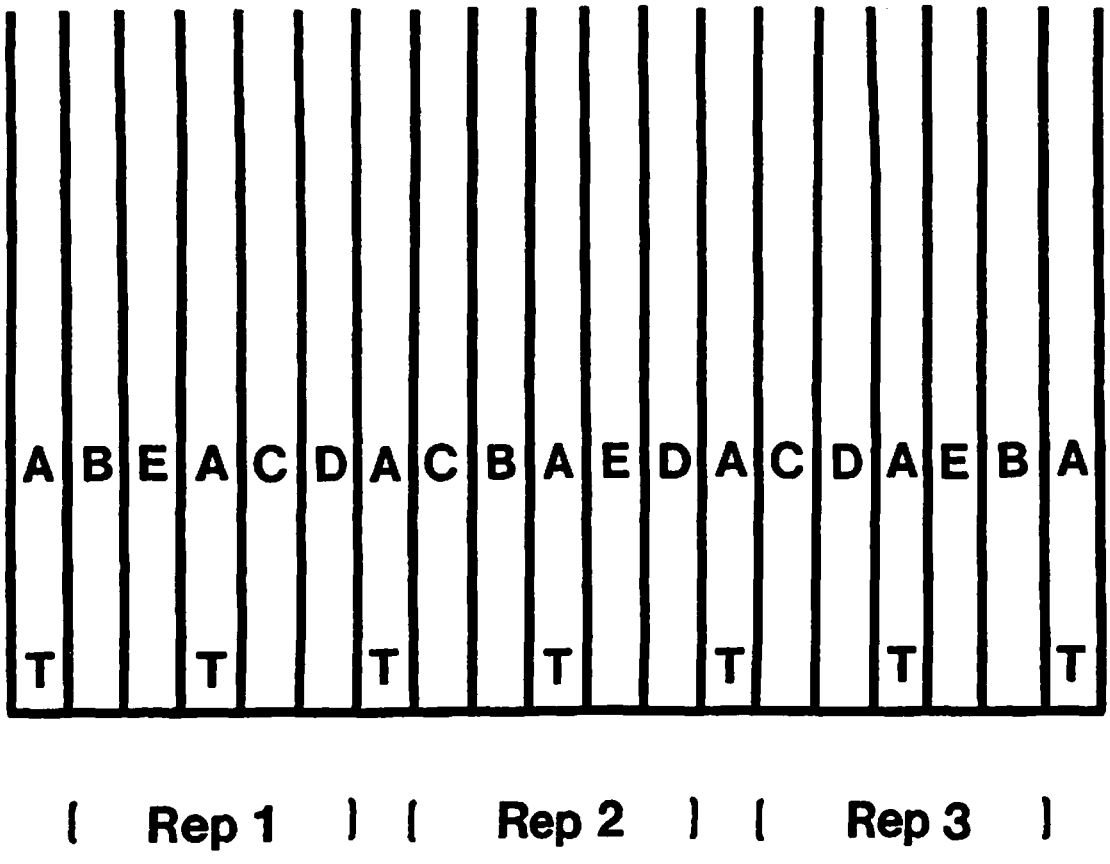

Figure 1. Experimental design used in field trials.

EVALUATION OF COMBINATIONS OF POTASSIUM FERTILIZER, VARIETY, AND FUNGICIDE USE ON PRODUCTION OF HIGH YIELDING SOYBEANS IN MINNESOTA

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ABSTRACT: Potassium fertilization has frequently been associated with the ability of crops to tolerate pressure from some disease organisms. This study was conducted to evaluate the effect of potassium fertilization and the fungicide, Ridomil, on soybean production where phytophthora root rot was known to be a problem. Three sites were selected in Dodge and Mower Counties. Use of K had no effect on yield (soil test K values were in excess of 200 lb./acre). The use of Ridomil produced substantial increases in yield with the greatest increase associated with the most susceptible variety. This study will be conducted in 1989 with special emphasis on location of sites having low soil test values for K.

Background and Scope:

The corn-soybean rotation is a dominant crop production system in Minnesota. The management of crop inputs in this rotation system has been dominated by the corn crop. Fertilizer management practices for many growers include extra phosphate and/or potash when fertilizing the corn crop with the expectation that the soybean crop will use the carryover. This practice may be questioned in view of: 1) documented fixation reactions of P and K in the soil, 2) environmental concerns caused by use of extra inputs, and 3) emphasis on efficient use of inputs to achieve high yields and increased profitability.

Researchers throughout the United States have demonstrated that soybeans respond to applications of phosphate fertilizer when soil test levels for P are low. In Minnesota, this response to P was first reported by Ham and co-workers. The response of soybeans in Minnesota to fertilizer K has been conflicting. No response was measured when soybeans were grown on a sandy soil with a low K test. Yet, there has been some indication of a positive response to K when soil test levels were in the medium to high range. Clearly, more information is needed to improve K fertilizer recommendations for soybean production in Minnesota.

Phytophthora root rot (PRR) is a serious and growing problem in Minnesota. The application of a fungicide in the furrow at planting is available and will reduce the damage caused by this disease. Soil moisture is a critical factor affecting the severity of PRR. The disease is usually not a problem in well drained soils unless the soil becomes saturated in the area of seedling development. A perched water table, heavy rainfall during the week after planting, or drought stress may allow expression of this disease in areas not expected to be prime sites for PRR. The disease is not limited to heavy soils with poor internal drainage. It can and does occur in soils that require irrigation.

The influence of fertilizer management and use on the incidence and severity of PRR is not clear. There are reports that the amount of PRR in Harsoy soybeans increased as the level of soil fertility increased. There was no attempt to identify the specific nutrient responsible for this increase. Another report has stated that chloride salts increased the severity of damage caused by PRR. Since KCl (0-0-60) is the dominant source of fertilizer K in Minnesota, this use may enhance the damage and yield reduction caused by PRR. Therefore, this study was conducted to evaluate the effects of: 1) rate of fertilizer K, 2) soybean variety, and 3) fungicide use on production of soybeans in a high yield environment in Minnesota.

Experimental Procedure:

This study was conducted at 3 locations in southeast Minnesota in 1988. All sites had a known history of soybean damage caused by PRR. It was also hoped that the sites would have a wide range of soil test K values representative of the soils in the region.

1/ Extension Plant Pathologist, Assistant Scientist, Junior Scientist and Extension Specialist, respectively.

Three factors (K rate, variety, fungicide use) were combined into a complete factorial with a split, split plot design. Four replications of each treatment were used. Rates of applied K (0, 40, 80, 160 lb./acre) were the main plots. Soybean varieties (54-254, BSR-101, Corsoy 79) were the sub plots. Fungicide use (with and without) were the sub-sub plots.

Soil samples from 0-6, 6-12, 12-24, 24-36, 36-48, and 48-60 inches were collected at the initiation of the study. The results of the analyses of these samples are summarized in Table 1. As would be expected, soil test values for K decreased substantially with depth at all locations. The soil test value for K (0-6 in.) at the Ruhter site is considered to be in the medium range. The soil test K values at the Meyer and Hortop locations are considered to be in the high or very high range.

Table 1. Relevant soil test values for the experimental sites used in the study.

Property	Depth	Site		
		Ruhter	Meyer	Hortop
	in			
pH	0- 6	5.9	7.9	6.6
P (Bray & Kurtz), lb./acre	0- 6	39	75	88
K (1 N $NH_4C_2H_3O_2$), lb./acre	0- 6	214	320	250
	6-12	133	219	188
	12-24	78	180	195
	24-36	80	72	91
	36-48	139	202	92
	48-60	169	203	90
Organic Matter, %	0- 6	2.1	6.6	6.3

The fertilizer K was broadcast and incorporated before planting. The fungicide treatment consisted of the application of Ridomil in the seed furrow at planting at a rate of approximately 6 lb./acre. Seeding rate was approximately 10 seeds per foot of row. Row spacing was 30 inches at all sites. Appropriate herbicides were used for weed control.

During the growing season, plant stands were determined by counting the number of plants in 5 feet of row. Plant height was also measured. The most recently matured leaflet was collected at early bloom, dried, ground, and analyzed for K. Grain yields were measured in early October.

The effect of fertilizer K applied in a starter was also measured at the Ruhter and Meyer locations. For this study, K (supplied as 0-0-60) was applied at planting at rates of 0, 20, 40, and 80 lb./acre. The Corsoy 79 variety was used and Ridomil was also applied. Soybean management practices were consistent with those used in the other phase of the study.

Results and Discussion:

Yield

The broadcast applications of K had no significant effect on yield throughout the study (Table 2). There was also no significant interaction between K rate and variety or K rate and fungicide use. Values reported, therefore, are averaged over variety and fungicide use.

Table 2. The influence of rate of broadcast K on soybean yield, Mower and Dodge Counties, 1988.

K Applied	Site Ruhter	Meyer	Hortop
lb./acre	- - - - - - - - bu./acre - - - - - - -		
0	31.2	42.8	46.2
40	29.6	44.5	46.9
80	29.8	44.0	43.8
160	28.4	44.5	41.6

The use of K in a starter fertilizer had no effect on soybean yield at the Ruhter and Meyer locations (Table 3).

Table 3. The effect of rate of K applied in a starter fertilizer on soybean yield. Mower and Dodge Counties, 1988.

K Applied	Site Ruhter	Meyer
lb./acre	- - - - - bu./acre - - - -	
0	33.7	50.5
20	35.7	52.3
40	33.4	50.9
80	31.1	51.6

Because of the high soil test values for K at the Meyer and Hortop locations, the lack of response to both broadcast and starter applied K would be expected. The soil test K value at the Ruhter location is considered to be in the medium range. Apparently the soil at this site was capable of supplying the K needed for the soybean crop.

Soybean yield at all locations was affected by both variety and fungicide use. There was also an interaction between these two inputs (Table 4). Values reported are averaged over all K rates used.

Table 4. Soybean yield as affected by variety and fungicide use, Mower and Dodge Counties, 1988.

Site	Fungicide Used	Variety 54-254	BSR-101	Corsoy 79
		- - - - - - - - bu./acre - - - - - - - -		
Ruhter	no	8.9	34.9	33.0
	yes	24.4	41.1	36.3
Meyer	no	15.7	51.4	50.1
	yes	42.0	52.4	52.1
Hortop	no	33.7	51.4	44.3
	yes	40.8	51.9	45.6

Use of Ridomil increased the yield of the 54-254 variety at all sites. The disease pressure from PRR was considered to be high at the Ruhter site, intermediate at the Meyer site, and low at the Hortop site. The 54-254 variety is susceptible to PRR.

The BSR-101 variety is resistant to most races of PRR. Use of Ridomil increased the yield of this variety where disease pressure was high (Ruhter location) but not at the other two sites. There was also a small increase in the yield of the Corsoy 79 variety when Ridomil was used at the Ruhter site. The Corsoy 79 variety was considered to be most resistant to PRR.

Considering variety, yields were generally lower with the 54-254 soybeans with the yield from the BSR-101 and Corsoy-79 varieties being nearly equal (Table 4).

K Concentration in Plant Tissue

The most recently matured trifoliate leaves were sampled at early to mid-bloom to provide an indication of K uptake by the soybean crop. The effect of K rate, variety and fungicide on the K concentration in the soybean tissue varied with location. The K concentration increased with rate of applied K at the Ruhter, but not at the Meyer and Hortop locations (Table 5). Values listed are averaged over variety and fungicide treatment.

Table 5. Effect of rate of broadcast K on the K concentration in soybean leaves at early to mid-bloom. Mower and Dodge Counties, 1988.

K Applied	Site		
	Ruhter	Meyer	Hortop
lb./acre	- - - - - - - - - -	% K	- - - - - - - - - -
0	1.76	1.92	1.96
40	1.90	2.00	1.99
80	1.96	2.03	1.99
160	2.03	2.07	1.99

Use of 80 lb. K/acre was needed to increase the K concentration of the soybean tissue to near the 2.00% value which is generally considered to be the critical concentration for K in soybean leaves. This is probably a reflection of the overall damage to the root system caused by the PRR when disease pressure is high.

Use of K in a starter fertilizer had no significant effect on the K concentration in soybean tissue of the Corsoy 79 variety at both the Ruhter and the Meyer locations (Table 6). This is further evidence that the soils at these sites were able to supply the K needed for soybean production.

Table 6. Effect of rate of K applied in a starter fertilizer on the K concentration in soybean tissue. Mower and Dodge Counties, 1988.

K Applied	Site	
	Ruhter	Meyer
lb./acre	- - - - - % K	- - - - - -
0	1.93	1.93
20	2.00	1.98
40	2.10	1.95
80	2.02	2.03

The K concentration in the soybean tissue was affected by both variety and use of the Ridomil (Table 7).

Table 7. The influence of variety and fungicide use on the K concentration in soybean leaf tissue. Mower and Dodge Counties, 1988.

Site	Fungicide Used	Variety 54-254	BSR-101	Corsoy-79
		- - - - - - - - - % K - - - - - - - - -		
Ruhter	no	1.65	2.02	1.98
	yes	1.75	2.07	2.01
Meyer	no	1.87	2.16	1.97
	yes	1.89	2.16	1.99
Hortop	no	1.86	2.09	1.98
	yes	1.91	2.09	1.98

The K concentration was lowest in the 54-254 variety at all sites. Highest concentrations were recorded with the BSR-101 variety.

The use of Ridomil produced a significant increase in the K concentration of all varieties at the Ruhter site. The impact of the heavy disease pressure on the root system was apparently limiting K uptake at this site. There was no significant fungicide treatment x variety interaction. The fungicide application had no effect on the K concentration at the Meyer and Hortop sites.

Soybean Stand

For soybeans, final yield is not necessarily related to stand. Therefore, stand counts were used to provide an additional evaluation of the variables used in this study. The rate of K broadcast and incorporated before planting had no significant effect on the number of plants counted in a 5 foot section of row at all sites (Table 8).

Table 8. The influence of rate of broadcast K on the stand of soybeans. Mower and Dodge Counties, 1988.

K Applied	Site Ruhter	Meyer	Hortop
lb./acre	- - - - - - - - - plants/5 ft. - - - - - - - - -		
0	34	30	33
40	34	33	33
80	36	32	32
160	36	33	33

Both variety and fungicide use had a significant effect on stand at all locations. There was also a highly significant variety x fungicide interaction at each site (Table 9). Since PRR has a major impact on the health and persistence of the soybean plant, this type of observation can be expected.

Table 9. The effect of variety and fungicide use on soybean stand. Mower and Dodge Counties. 1988.

Site	Fungicide used	Variety 54-254	BSR-101	Corsoy 79
		- - - - - - - plants/5 ft. - - - - - - -		
Ruhter	no	30	29	33
	yes	47	34	38
Meyer	no	24	30	35
	yes	36	34	35
Hortop	no	33	31	32
	yes	33	31	37

Use of Ridomil improved the stand of all varieties at the Ruhter site. The largest improvement was noted with the 54-254 variety. The same observations were recorded at the Meyer site.

Plant Height

The height of the soybean plants was measured in mid-June at the Ruhter and Meyer sites. Plant height at both locations was not affected by the rate of K broadcast and incorporated before planting (Table 10). These results are consistent with yield, K concentration, and stand density measurements.

Table 10. The effect of rate of broadcast K on plant height of soybeans. Mower and Dodge Counties. 1988.

K Applied	Site Ruhter	Meyer
lb./acre	- - - - - -in. - - - - - -	
0	26.5	26.7
40	26.6	25.6
80	25.8	26.0
160	26.2	26.9

The height of the soybean plants was significantly affected by both variety and fungicide use at both locations. There was also a significant variety x fungicide interaction at the Meyer location (Table 11.)

Table 11. The influence of variety and fungicide use on the height of soybean plants. Mower and Dodge Counties. 1988.

Site	Fungicide used	Variety 54-254	BSR-101	Corsoy 79
		- - - - - - - - - - in - - - - - - - - - -		
Ruhter	no	21.5	23.5	28.8
	yes	25.2	26.4	32.2
Meyer	no	21.0	25.6	28.6
	yes	25.4	27.1	30.0

These observations are consistent with the other measurements taken in the study.

Soil Test K

Soil samples (0-6 in.) were collected at the end of the growing season to measure the effect of broadcast K on changes in the soil test K values. Results are summarized in Table 12. As would be expected, soil test K values increased as rate of broadcast K increased. The increase was linear at all locations. It's also important to note that there were no major decreases in soil test values when no fertilizer K was applied even though a respectable yield of soybeans was produced in 1988.

Table 12. The effect of rate of broadcast K on soil test K values at the end of the growing season. Mower and Dodge Counties. 1988.

K Applied	Site: Ruhter	Site: Meyer	Site: Hortop
lb./acre	- - - - - - - - - -	lb. k/acre	- - - - - - - - -
0	204	316	262
40	240	326	290
80	234	350	290
160	264	368	306

Summary and Conclusions:

It is not practical to make broad and sweeping conclusions from data collected from only one year. Nevertheless, there are some summary statements that can be made. These are:

1) Use of fertilizer K had no effect on soybean yield at sites with medium to high soil test levels for K. This indicates that the soils chosen were able to supply adequate K for soybean production.

2) Soybean yield was affected by variety. The 54-254 variety produced the lowest yield. Yields from the BSR-101 and Corsoy 79 varieties were nearly equal at all sites.

3) The use of the fungicide, Ridomil, had a positive effect on soybean yield. Substantial increases were observed with the 54-254 variety at all locations. This treatment also increased the yield of the BSR-101 variety at 2 locations.

4) The results of measurements of stand persistence and plant height parallel the observations made for yield.

5) Soil test values for K measured at the end of the growing season increased linearly with rate of K broadcast and incorporated before planting.

NITRATE AND AMMONIUM MONITORING IN IRRIGATED SOILS USED FOR POTATO PRODUCTION[1]

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ABSTRACT: Soil samples from six irrigated commercial potato fields were collected to a depth of three feet during the 1988 growing season. Nitrate and ammonium-N were extracted from each sample using 2 N KCl. Concentrations of nitrate-N and ammonium-N in rows were nearly double those between rows. In general, levels of nitrate-N at the end of the growing season were related to N fertilizer application rates. Only background levels of ammonium-N were detected at the end of the season. Highest N fertilizer rates were not associated with highest yields. The results of this study in a dry season show that if nitrogen is managed carefully leaching losses can be kept to a minimum.

The irrigated soils of Sherburne and Pope counties have been identified as soils susceptible to nitrate leaching. Excessive applications of nitrogen could potentially contaminate the ground water. Few studies could be found which actually monitored how nitrates might be moving in these soils used for potato production. This monitoring is essential to determine the extent of the problem and to improve upon nitrogen management practices for potato production on irrigated soils. The objective of this study, therefore, was to monitor nitrate and ammonium through the growing season under various potato grower production practices.

Procedures

Five potato fields (fields A - E) in Sherburne county and one field (field F) in Pope county were selected for monitoring. All soils in Sherburne county were characterized as Hubbard loamy sands and the soil in Pope county was characterized as an Esterville sandy loam. The cultivar grown was 'Russet Burbank' except in Field E which was in 'Norchip'. The previous crop in all cases was corn. All fields were sampled to a depth of 3 feet at one foot increments. Samples were collected from 4 locations in each field and each sample depth was made up of 3 cores. The first sampling date was in April prior to planting. Fields were sampled again in the same approximate locations in July during tuber enlargement. At this time samples were collected both between rows and within rows. A final sampling date was in September prior to or within one week after harvest. Samples were again collected between and within rows.

Fertilizer rate, timing, and method of application were recorded, but actual practices were left up to each grower. Approximate yields were recorded by harvesting two, 20 ft rows. All soil samples were placed in plastic bags and kept moist at 40°F until analyzed. Nitrate and ammonium were extracted with 2 N KCl using a 5 g moist sample to 25 ml extractant ratio. Percent moisture was determined in each sample and ppm nitrate-N or ammonium-N was calculated on a dry weight basis. All results are expressed as pounds of nitrate-N or ammonium-N per acre using the convention ppm X 2 = lb/A for a 6" acre furrow slice. Bulk density of each sampling depth was not determined so that lb/A values should be considered as approximate. For the July and September samples, total nitrate-N and ammonium-N in the 3 foot profile were calculated by assuming that half the field was 'within row' and the remainder was 'between row'.

Results and Discussion

During the season little rainfall occurred until August. Although these conditions are not that normal, interpretation of the results is made easier. Since the July samples were collected before any leaching events took place, it is assumed that this mode of N loss was minimal. Yields varied from approximately

[1] Support for this project was provided by the Minnesota Agricultural Experiment Station and Minnesota Extension Service.

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200 cwt/A to 450 cwt/A and N fertilizer rates varied from 160 - 380 lb N/A. There was little relationship, however, between total N applied and yield.

Nitrate-N levels through the growing season are presented in Tables 1a - 6a and a summary providing means and ranges over all fields is presented in Table 7. The practice of hilling and placing fertilizer N in the row greatly affects N distribution in the field. Concentrations of nitrate-N and ammonium-N in rows were nearly double those between rows. In general, higher N fertilizer rates were associated with higher residual nitrates in September than lower N fertilizer rates. An exception to this observation was field B where highest rates of fertilizer N were used, but levels of nitrate-N in July and September were near the average. Ammonium-N levels are presented in Tables 1b - 6b and a summary providing means and ranges over all fields is presented in Table 8. In general, ammonium-N levels were greatest in July and lowest in September. Nitrification obviously played a major role in the conversion of ammonium-N to nitrate-N.

Residual nitrate-N in the top three feet ranged from 20 lb/A to 102 lb N/A with an average of 61 lb/A. With sufficient rainfall during the fall and winter, substantial leaching of the high residual nitrate might occur. This study will be continued to determine nitrate status in the spring of 1989. A good example of how nitrogen can be managed with minimal nitrate residual or leaching can be found in field C. In this field, 166 lb N/A was applied and a yield of 456 cwt/A was obtained. Residual nitrate-N in September was 20 lbs/A in the top three feet; only three lbs more than what was found in April before planting. Of course had heavy rains occurred during the season additional N would probably have been necessary; however the results do show that if nitrogen is managed carefully leaching losses can be kept to a minimum.

Field A

Initial Soil pH 0-12" - 5.4
N Fertilizer Management: 60 lbs N/A. starter
190 lbs N/A. irrigation
Total 250 lb. N/A
Estimated Yield - 210 cwt/A

Table 1a. Nitrate-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NO_3-N/A				
0-1	9.6 ± 1.6	10.0 ± 4.0	7.0 ± 3.0	11.6 ± 4.1	3.2 ± 0.2
1-2	8.4 ± 2.4	14.2 ± 9.0	4.0 ± 1.2	21.6 ± 13.8	3.0 ± 1.6
2-3	14.0 ± 3.2	9.8 ± 5.4	3.4 ± 1.6	15.4 ± 5.6	7.0 ± 2.4
Total	32.0 ± 5.0	34.0 ± 18.0	14.4 ± 5.5	48.6 ± 21.4	13.2 ± 4.0
Total in row + between row		48.4 ± 22.4		61.8 ± 22.3	

Table 1b. Ammonium-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NH_4-N/A				
0-1	3.1 ± 1.6	9.1 ± 4.6	8.1 ± 3.4	14.8 ± 11.0	1.8 ± 0.2
1-2	4.0 ± 1.2	4.6 ± 2.0	2.6 ± 1.4	1.8 ± 0.4	1.2 ± 0.4
2-3	3.6 ± 1.2	3.2 ± 1.8	1.4 ± 0.6	2.1 ± 1.6	0.8 ± 0.1
Total	10.7 ± 1.8	16.9 ± 6.1	12.1 ± 4.6	18.7 ± 12.7	3.8 ± 0.5
Total in row + between row		29.0 ± 10.0		22.5 ± 12.6	

[z] April = prior to planting and fertilizer application
July = during tuber enlargement
Sept. = 10 days prior to vine kill

Field B

Initial Soil pH 0-12" - 5.6
N Fertilizer Management: 70 lbs. N/A starter
160 lbs. N/A as 82-0-0 pre emergence
150 lbs. N/A at hilling
Total 380 lbs. N/A
Estimated Yield - 309 cwt/A

Table 2a. Nitrate-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NO_3-N/A				
0-1	2.5 ± 0.4	38.8 ± 12.2	5.0 ± 2.8	10.4 ± 1.2	12.0 ± 7.8
1-2	2.4 ± 0.4	44.4 ± 22.6	7.6 ± 7.0	9.0 ± 2.2	6.8 ± 3.8
2-3	6.7 ± 1.6	10.4 ± 4.4	7.2 ± 4.4	7.2 ± 2.0	4.1 ± 3.4
Total	11.6 ± 1.1	93.6 ± 27.8	19.8 ± 11.8	26.6 ± 2.2	23.0 ± 14.0
Total in row + between row		113.4 ± 35.4		49.6 ± 14.7	

Table 2b. Ammonium-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NH_4-N/A				
0-1	10.6 ± 2.3	13.5 ± 20.5	3.7 ± 2.2	1.5 ± 0.6	1.1 ± 0.2
1-2	10.9 ± 5.5	5.9 ± 5.6	1.7 ± 0.6	1.6 ± 1.2	1.1 ± 0.2
2-3	7.9 ± 3.4	1.7 ± 0.7	1.4 ± 0.3	2.0 ± 1.8	0.8 ± 0.4
Total	29.4 ± 10.6	21.1 ± 19.8	6.8 ± 3.0	5.1 ± 3.6	3.0 ± 0.6
Total in row + between row		28.0 ± 18.9		8.1 ± 4.2	

[z] April = prior to planting and fertilizer application.
July = during tuber enlargement.
Sept. = after vines were killed but before harvest.

Field C

Initial Soil pH 0-12" - 5.3
N Fertilizer Management: 70 lbs. N/A starter
30 lbs. N/A.irrigation
66 lbs. N/A hilling
Total 166 lbs. N/A
Estimated Yield - 456 cwt/A

Table 3a. Nitrate-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NO_3-N/A				
0-1	9.6 ± 1.2	8.4 ± 6.0	6.2 ± 4.2	5.4 ± 1.2	5.0 ± 1.0
1-2	4.8 ± 1.2	3.2 ± 1.0	2.8 ± 1.4	3.0 ± 0.6	2.2 ± 0.4
2-3	3.2 ± 0.8	1.2 ± 0.4	1.4 ± 1.6	2.4 ± 0.4	2.4 ± 2.4
Total	17.6 ± 2.8	12.8 ± 7.3	10.4 ± 4.8	10.8 ± 1.8	9.6 ± 1.9
Total in row + between row		23.2 ± 10.6		20.4 ± 3.2	

Table 3b. Ammonium-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NH_4-N/A				
0-1	5.1 ± 2.6	5.5 ± 3.2	3.3 ± 1.4	1.2 ± 0.3	1.2 ± 0.3
1-2	6.5 ± 1.2	2.2 ± 1.2	1.6 ± 0.2	1.2 ± 0.4	1.4 ± 0.2
2-3	4.4 ± 1.1	1.9 ± 0.7	1.4 ± 0.1	1.1 ± 0.2	1.2 ± 0.2
Total	16.0 ± 4.1	9.6 ± 3.8	6.3 ± 1.2	5.1 ± 3.6	3.0 ± 0.6
Total in row + between row		15.9 ± 4.8		7.3 ± 1.2	

[z] April = prior to planting and fertilizer application.
July = during tuber enlargement.
Sept. = after vines were killed but before harvest.

Field D

Initial Soil pH 0-12" - 5.4
N Fertilizer Management: 45 lbs. N/A starter
120 lbs. N/A emergence
120 lbs. N/A hilling
Total 285 lbs. N/A
Estimated Yield - 446 cwt/A

Table 4a. Nitrate-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NO_3-N/A				
0-1	32.8 ± 30.4	73.8 ± 20.4	12.4 ± 7.4	31.2 ± 6.0	16.4 ± 1.8
1-2	30.0 ± 18.0	18.6 ± 6.4	13.6 ± 7.8	29.8 ± 9.8	7.4 ± 2.2
2-3	16.8 ± 7.2	8.0 ± 4.6	8.0 ± 5.4	13.2 ± 3.8	4.0 ± 0.4
Total	79.6 ± 54.0	100.4 ± 28.4	34.0 ± 13.5	74.2 ± 16.6	27.8 ± 3.4
Total in row + between row		134.4 ± 22.2		102.0 ± 3.4	

Table 4b. Ammonium-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NH_4-N/A				
0-1	5.1 ± 2.6	41.4 ± 9.4	1.1 ± 1.1	1.8 ± 0.1	1.0 ± 0.1
1-2	4.4 ± 1.5	4.2 ± 4.4	0.6 ± 0.8	1.2 ± 0.2	0.8 ± 0.1
2-3	4.4 ± 4.1	2.6 ± 1.4	0.9 ± 0.9	0.9 ± 0.1	0.8 ± 0.1
Total	13.9 ± 4.9	48.2 ± 13.6	2.6 ± 2.8	3.9 ± 0.5	2.6 ± 0.1
Total in row + between row		50.8 ± 15.2		6.5 ± 0.4	

[z] April = prior to planting and fertilizer application.
July = during tuber enlargement.
Sept. = after vines were killed but before harvest.

Field E

Initial Soil pH 0-12" - 5.4
N Fertilizer Management: 75 lbs. N/A starter
100 lbs. N/A broadcast late May
Total 175 lbs. N/A
Estimated Yield - 440 cwt/A

Table 5a. Nitrate-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NO_3-N/A				
0-1	4.8 ± 0.8	11.6 ± 7.2	8.2 ± 2.6	22.0 ± 9.8	16.8 ± 2.4
1-2	12.0 ± 13.6	3.2 ± 2.4	0.8 ± 0.4	7.6 ± 0.8	3.6 ± 1.4
2-3	7.2 ± 6.4	1.4 ± 1.4	0.8 ± 0.8	3.2 ± 0.4	4.6 ± 4.0
Total	24.0 ± 18.8	16.2 ± 9.6	9.8 ± 2.2	32.8 ± 9.9	25.0 ± 3.8
Total in row + between row		26.0 ± 9.8		57.8 ± 13.2	

Table 5b. Ammonium-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NH_4-N/A				
0-1	1.5 ± 0.4	42.0 ± 44.0	7.0 ± 3.8	1.8 ± 1.1	1.0 ± 0.2
1-2	3.3 ± 1.2	3.9 ± 2.8	1.6 ± 0.4	1.0 ± 0.1	0.8 ± 0.1
2-3	1.3 ± 1.0	1.7 ± 0.1	2.6 ± 0.8	0.8 ± 0.1	1.0 ± 0.1
Total	6.1 ± 1.1	47.6 ± 45.0	11.2 ± 3.4	3.6 ± 1.1	2.8 ± 0.3
Total in row + between row		58.8 ± 46.2		6.4 ± 1.0	

[z] April = prior to planting and fertilizer application
July = during tuber enlargement
Sept. = after harvest; in row and between row are therefore approximate

Field F

Initial Soil pH 0-12" - 5.8
N Fertilizer Management: 15 lbs. N/A broadcast
50 lbs. N/A starter
200 lbs. N/A hilling
Total 265 lbs. N/A
Estimated yield - 243 cwt/A

Table 6a. Nitrate-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NO_3-N/A				
0-1	36.0 ± 11.6	161.4 ± 67.6	80.4 ± 42.4	18.0 ± 9.8	14.2 ± 2.0
1-2	9.6 ± 4.8	17.4 ± 6.8	10.6 ± 5.6	16.8 ± 12.6	8.8 ± 5.6
2-3	6.0 ± 1.5	6.2 ± 1.6	3.0 ± 0.5	9.6 ± 6.6	7.0 ± 4.4
Total	51.6 ± 15.2	185.0 ± 63.0	94.0 ± 45.0	44.4 ± 27.4	30.0 ± 8.0
Total in row + between row		279.0 ± 49.1		74.0 ± 23.2	

Table 6b. Ammonium-N levels in sandy soils used for potato production (means of 4 samples per field).

	Sampling Date[z]				
	April	July		September	
		in row	betn. row	in row	betn. row
Depth	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.	mean ± s.d.
ft.	lb NH_4-N/A				
0-1	4.4 ± 1.8	39.8 ± 27.0	56.4 ± 82.0	0.8 ± 0.1	3.0 ± 3.9
1-2	1.9 ± 1.7	6.2 ± 4.4	7.4 ± 7.6	1.0 ± 0.2	2.0 ± 2.6
2-3	1.2 ± 1.0	2.5 ± 0.7	2.2 ± 0.1	1.0 ± 0.4	1.0 ± 0.3
Total	7.5 ± 3.0	48.5 ± 24.3	66.0 ± 90.0	2.8 ± 0.8	6.0 ± 6.7
Total in row + between row		114.5 ± 88.2		8.8 ± 6.6	

[z] April = prior to planting and fertilizer application
July = during tuber enlargement
Sept. = after vines were killed but before harvest