N x K Interactions: Corn[1]

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A study was conducted at OARDC-Western Branch near Springfield, OH for 4 years starting in 1992 to investigate the effects of N and K on corn production N uptake. The soil series was a Crosby Silt Loam with approximately 2.5% organic matter. All nutrients were in the above average levels on the soil test except for exchangeable K levels. See table 2 for soil test K levels. The corn hybrid Countrymark 735 was seeded approximately the last week of April at 35,000 seeds/acre.

A split plot design with 5 potassium treatments being the main plots and 6 nitrogen treatments being the split plots was used. Exchangeable soil K levels have been determined annually from soil samples taken in the fall. Each plot, with the exception of the check plot, received 40 lbs/acre N as starter. Applications of N were made in increments of 80 lbs/acre. After the starter, treatments of 40, 120, 200, and 280 lbs of preplant N/acre and one treatment of 200 lb/acre sidedress were applied. Precipitation records for this study are listed in table 1.

The average yield response to soil K and N treatments for 1992-1995 are shown in table 2. Yields were significantly higher with soil K levels at 200 lbs/acre and above. The yields in relation to N rate were highest in preplant N treatments of 160 lbs N/acre and above. The preplant 160 lbs N/acre treatment had no yield advantage over the 240 lb N/acre sidedress treatment. The highest yields when considering K and N interaction were with K levels above 232 lbs/acre and N rates of 160 lbs/acre with the exception of 240 lbs N/acre sidedress at the 278 lb/acre soil K level.

Tables 3-5 show the average N utilization of the corn grain in 1992-1995. With each increase of N rate, the average percent N in the grain increased significantly with 320 lbs N/acre being the highest (table 3). There was no significant difference in percent N between the sidedress and preplant treatments of 240 lbs N/acre. The average pounds of N in the grain per acre in relation to N rate was highest at 320 lbs N/acre (table 4). The lbs of grain N/acre increased significantly with each increase of preplant N. The sidedress treatment of 240 lbs N/acre was significantly lower than the preplant treatment of 240 lbs N/acre. The highest lbs grain N/acre in relation to K and N interaction was in soil K levels above 200 lbs/acre and N treatments of preplant 240 lbs/a and 320 lbs/acre. The exception was 240 lbs N/acre at 232 lbs/acre soil test K. The amount of applied N that was in the corn grain is listed in table 5. As N rate increased, the percent of applied N in the grain decreased. As the soil test K level increased, the percent of applied N in the grain increased.

Average corn fodder yields for 1992-95 are shown in table 7. The highest yield in relation to K level was at 200 lbs/acre and above. There was no significant difference above 200 lbs K/acre as measured by fodder yields. The fodder yields in relation to N treatments increased significantly with

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[1]Current research reported in this paper was funded by PPI and OSU.

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N rate to 160 lbs N/acre. The sidedress treatment of 240 lbs N/acre yielded just as well as the 160 lbs N/acre preplant and was significantly higher than the 240 lbs N/acre preplant treatment.

Tables 7-9 show the average N utilization of the corn fodder in 1992-1995. The concentration of N in the corn fodder (table 7) in relation to N rate was highest with the 320 lbs N/acre treatment. There was no difference between rates of 160 lb N/acre and 240 lb N/acre as measured by N concentration in the fodder. As K levels increased, N uptake by the fodder remained constant.

The percent of applied N in the total plant (grain and fodder combined) for 1992-1995 is shown in table 10. As N rate increased, the percent of applied N in the plant decreased. The exception was the 240 lbs /acre sidedress N treatment in which the percent of applied N increased. As the K soil level increased, the percent N in the plant increased. Figure 1 illustrates regression analysis of the N treatments and soil K level influencing the percent of applied N in the total plant. In this figure, the sidedress application has an advantage as measured by percent of applied N in the plant compared to the preplant application of the same amount of N in lower soil K levels.

Table 11 summarizes the fall soil samples taken each year to measure nitrate nitrogen remaining in the soil. The average percent of applied N remaining in the soil after harvest is shown in table 12. As N rate increased, the amount of applied N remaining in the soil increased. The amount of N remaining in the sidedress application of 240 lbs N/acre was higher than the same N rate using the preplant application. The amount of N remaining in the soil decreased as soil K level increased. This may be due to the greater soil test K levels enabling more efficient N utilization in the plant and less nitrate N remaining in the soil.

In comparing the same N rate with two methods of application, the sidedress had better N utilization over the preplant. The percent of applied N in the total plant for sidedress was significantly higher than the preplant. There was little difference in the amount of N utilized between the two in the grain. The difference between the two applications in N uptake was in the fodder. The time of application may account for this difference. The amount of nitrate N remaining in the top three feet of the soil profile was also higher in the sidedress application. This may be due to less leaching and denitrification in the sidedress application.

Table 1 Precipitation for the N X K Interaction Study on Continuous Corn 1992-95

	---------Precipitation---------				LongTerm[a]
	1992	1993	1994	1995	--avg.--
	----------Inches----------				
Oct.-Dec.	5.4	7.2	8.8	6.1	8.7
Jan.-Mar.	6.3	8.3	5.9	5.2	8.9
April	2.7	3.4	3.0	3.1	4.0
May	2.2	0.7	1.7	7.1	4.5
June	2.2	3.6	2.4	6.4	4.2
July	7.1	8.0	3.8	2.7	4.1
August	1.8	2.2	3.2	3.7	3.6
September	1.7	3.3	1.3	1.2	3.0
TOTAL	29.4	36.7	30.1	35.5	41.0

[a]Long term 47 year average

Table 2 Effect of Soil POTASSIUM and NITROGEN Fertilizer Treatments on Corn Yields for 1992-95

	Fall Soil K, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N/acre	---------- Yield (bu/acre) ----------					
0	103	124	105	96	99	105
80[a]	138	171	180	170	169	165
160[a]	143	179	203	203	207	187
240[a]	162	185	198	209	212	193
320[a]	171	191	196	206	201	193
240SD[b]	151	187	197	200	191	185
Mean	145	173	180	180	180	
	Soil K $LSD_{0.05}$ = 7					
	N tmt $LSD_{0.05}$ = 6					
	K x N $LSD_{0.05}$ =13					

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)

Table 3 **Percent N in Corn Grain as Influenced by Applied N and Soil K levels for 1992-95**

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
-----Lbs/acre-----	----------Percent N in Grain----------					
0	1.22	1.22	1.21	1.17	1.19	1.20
80[a]	1.31	1.28	1.29	1.26	1.24	1.28
160[a]	1.38	1.35	1.36	1.35	1.34	1.35
240[a]	1.40	1.38	1.38	1.38	1.41	1.39
320[a]	1.42	1.43	1.49	1.45	1.46	1.45
240SD[b]	1.40	1.39	1.41	1.41	1.40	1.40
Mean	1.36	1.34	1.36	1.34	1.34	
		Soil K $LSD_{0.10}$ =		NS		
		N tmt $LSD_{0.05}$ =		.02		
		K x N $LSD_{0.10}$ =		NS		

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)

Table 4 **Pounds N in Corn Grain per acre as Influenced by Applied N and Soil K levels for 1992-95**

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N /acre	----------Pounds Grain N/acre----------					
0	63.2	75.0	63.3	54.7	56.3	62.5
80[a]	88.4	108.2	114.1	105.4	103.3	103.8
160[a]	96.1	118.6	135.4	133.8	135.9	124.0
240[a]	111.3	125.4	134.5	141.6	146.0	131.8
320[a]	118.6	134.0	143.0	145.0	143.8	136.9
240SD[b]	100.3	127.8	135.2	137.7	133.2	126.8
Mean	96.3	114.8	120.9	119.7	119.8	
		Soil K $LSD_{0.05}$ =		5.1		
		N tmt $LSD_{0.05}$ =		4.2		
		K x N $LSD_{0.05}$ =		9.4		

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)

Table 5 Percent of N Applied in Corn Grain as Influenced by Applied N and Soil K levels for Years 1992-95

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N /acre	----------% of Applied N in Corn Grain----------					
80[a]	31.5[c]	41.4	63.4	63.3	58.8	51.7
160[a]	20.6	27.2	45.1	49.5	49.8	38.4
240[a]	20.0	21.0	29.7	36.2	37.4	28.9
320[a]	17.3	18.4	24.9	28.2	27.4	23.2
240SD[b]	15.5	22.0	29.9	34.6	32.0	26.8
Mean	21.0	26.0	38.6	42.4	41.1	

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)
[c]Calculation: $\frac{\text{N uptake of treated plot-N uptake of check plot}}{\text{N rate of treatment}} \times 100$

Table 6 Fodder Yield as Influenced by Applied N and Soil K levels for 1992-95

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N /acre	----------Lbs Fodder/Acre (1000 lbs)----------					
0	7.7	9.0	9.2	7.9	7.6	8.3
80[a]	10.1	11.8	11.2	11.0	12.1	11.2
160[a]	10.7	13.0	13.2	12.3	13.6	12.6
240[a]	10.0	11.4	11.8	12.6	13.0	11.8
320[a]	11.3	12.1	11.3	13.0	11.8	11.9
240SD[b]	12.3	13.3	12.3	12.9	12.8	12.7
Mean	10.4	11.8	11.5	11.6	11.8	
		Soil K $LSD_{0.05}$ =		7.1		
		N tmt $LSD_{0.05}$ =		7.2		
		K x N $LSD_{0.10}$ =		NS		

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)

Table 7 **Percent N in Fodder as Influenced by Applied N and Soil K levels for 1992-95**

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N /acre	----------% N in Corn Fodder----------					
0	.75	.63	.68	.60	.61	.65
80[a]	.87	.76	.72	.58	.66	.72
160[a]	.94	.81	.77	.77	.77	.81
240[a]	.86	.81	.82	.74	.76	.80
320[a]	.94	.90	.86	.87	.90	.89
240SD[b]	.94	.81	.84	.81	.78	.84
Mean	.88	.79	.78	.73	.75	
		Soil K $LSD_{0.05}$ =		.04		
		N tmt $LSD_{0.05}$ =		.04		
		K x N $LSD_{0.10}$ =		NS		

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)

Table 8 **Pounds N in Corn Fodder per Acre as Influenced by Applied N and Soil K levels for 1992-95**

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N /acre	----------Lbs Corn Fodder N/Acre----------					
0	63.6	61.6	71.3	51.6	50.9	59.8
80[a]	91.4	94.0	84.3	72.8	85.9	85.7
160[a]	102.1	107.5	106.9	96.8	107.8	104.2
240[a]	85.1	92.4	98.7	95.2	100.6	94.4
320[a]	105.0	109.8	93.5	112.9	104.7	105.2
240SD[b]	118.0	111.3	104.3	108.6	98.9	108.2
Mean	94.2	96.1	93.2	89.6	91.5	
		Soil K $LSD_{0.10}$ =		NS		
		N tmt $LSD_{0.05}$ =		7.6		
		K x N $LSD_{0.10}$ =		NS		

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)

Table 9 Percent of N Applied in Corn Fodder as Influenced by Applied N and Soil K levels for Years 1992-95

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N /acre	----------% of Applied N in Corn Fodder----------					
80[a]	34.8[c]	40.5	16.3	26.5	43.8	32.4
160[a]	24.1	28.7	22.3	28.3	35.6	27.8
240[a]	9.0	12.8	11.4	18.2	20.7	14.4
320[a]	12.9	15.1	6.9	19.2	16.8	14.2
240SD[b]	22.7	20.7	13.8	23.8	20.0	20.2
Mean	20.7	23.6	14.1	23.2	27.4	

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)
[c]Calculation: N uptake of treated plot-N uptake of check plot X 100
N rate of treatment

Table 10 Percent of N Applied in Total Plant as Influenced by Applied N and Soil K levels for Years 1992-95

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N /acre	----------% of Applied N in Total Plant----------					
80[a]	65.8[c]	82.0	80.0	90.1	102.5	84.1
160[a]	44.6	55.9	67.3	77.7	85.2	66.1
240[a]	28.9	33.8	41.2	54.5	58.1	43.3
320[a]	30.2	33.5	31.9	47.0	44.1	37.3
240SD[b]	38.1	42.8	43.8	58.4	52.0	47.0
Mean	41.5	49.6	52.8	65.5	68.4	

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)
[c]Calculation: N uptake of treated plot-N uptake of check plot X 100
N rate of treatment

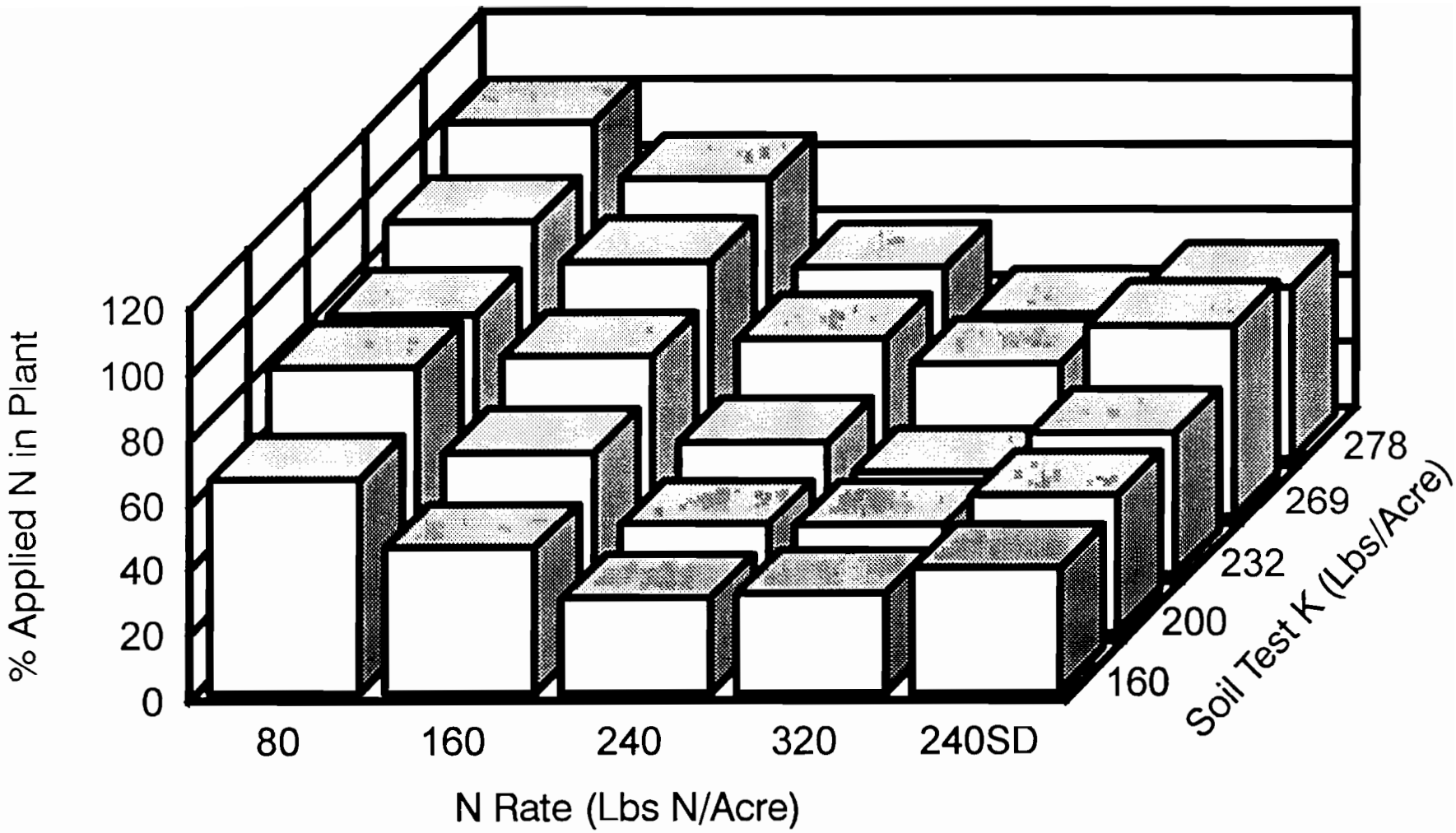

Figure 1: Percent applied N in total plant relative to K level and N treatments

Table 11 Nitrate NITROGEN in the Soil after Harvest (1992-1995)

		Soil Test K, lbs/a					
TN	Depth	160	200	232	269	278	Mean
Lbs N /acre	Inches	----------Lbs NO_3-N/acre----------					
0	0-12	11	10	11	10	9	10.0
	12-24	7	6	6	6	7	6.4
	24-36	9	7	7	7	8	7.4
	Total	27	23	24	23	24	23.8
80[a]	0-12	23	14	15	14	16	16.4
	12-24	11	10	9	8	13	10.3
	24-36	14	12	8	8	8	10.1
	Total	48	36	30	30	37	36.8
160[a]	0-12	49	32	29	19	23	30.4
	12-24	21	11	11	9	12	12.9
	24-36	19	12	12	12	10	12.8
	Total	89	55	52	40	45	56.1
240[a]	0-12	50	41	48	35	40	42.9
	12-24	28	23	17	23	14	21.0
	24-36	27	22	18	13	16	19.2
	Total	105	86	83	71	70	83.1
320[a]	0-12	97	79	94	67	83	83.9
	12-24	44	26	32	25	25	30.4
	24-36	39	31	32	20	23	28.8
	Total	180	136	158	112	131	143.1
240SD[b]	0-12	119	91	94	68	53	85.1
	12-24	37	23	23	16	19	23.6
	24-36	33	25	26	17	21	24.5
	Total	189	139	143	101	93	133.2
$LSD_{0.05}$	(N) tmt	3	NxD	5	NxK		5
	(K) level	3	KxD	5	NxKxD		12
	(D) depth	2					

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant
[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)

Table 12 **Percent of Nitrogen Applied Remaining in Soil (0-3ft.) in October as Influenced by Applied N and Soil K levels for Years 1992-95**

	Fall Soil K level, lbs/acre					
TN	160	200	232	269	278	Mean
Lbs N /acre	------% of Applied N Remaining in Soil------					
80[a]	26.0[c]	13.5	17.1	9.7	14.9	16.3
160[a]	38.7	24.1	16.1	11.4	10.9	20.2
240[a]	32.6	28.1	20.5	20.2	22.0	24.7
320[a]	46.8	36.8	37.8	29.8	34.5	37.1
240SD[b]	68.6	48.8	45.7	30.5	35.3	45.8
Mean	42.5	30.2	27.4	20.3	23.5	

[a]40 lbs N with planter plus balance as broadcast NH_4NO_3 preplant

[b]40 lbs N with planter plus balance as broadcast UAN sidedress(SD)

[c]Calculation: $\frac{\text{N remaining in treated plot-N remaining in check plot}}{\text{N rate of treatment}} \times 100$

PROCEEDINGS OF THE TWENTY-SIXTH

NORTH CENTRAL EXTENSION-INDUSTRY

SOIL FERTILITY CONFERENCE

Published for
The North Central Extension-Industry Soil Fertility Conference
by
Potash & Phosphate Institute
700 - 22nd Avenue, South
Brookings, SD 57006
605-697-7149

November 20-21, 1996

St. Louis Westport Holiday Inn
St. Louis, Missouri

Volume 12

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