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INFLUENCE OF TIME OF APPLICATION OF NITROGEN FERTILIZER ON CORN YIELDS

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Soil moisture conditions can have a large effect on crop responses to nitrogen fertilization. Kentucky's usual climatic pattern of periods of heavy rainfall and relatively warm temperatures during the winter and spring seasons influences expected yield responses of corn to applied nitrogen. If nitrogen fertilizer is applied in late winter or early spring, some of it may be lost before the plants have made sufficient growth to take up appreciable quantities. The amount of loss that might be expected will be influenced by the amount of rainfall, temperature, amount of organic matter and drainage of the soil.

Nitrogen recommendations for corn given in AGR-1 (1975) suggest reducing nitrogen rates when the nitrogen is applied four to six weeks after planting on soils with restricted drainage and for certain cropping systems. A summary of the corn yield data from studies on the time of nitrogen application conducted by U.K. Agronomists may be helpful in arriving at a decision as to the most practical time to apply nitrogen fertilizer for corn production in Kentucky.

Time of Application: FALL VS SPRING

Studies of fall vs spring applications on a poorly drained soil in Ohio county and on well-drained soils derived from limestone in Simpson County were conducted initially. Ammonium nitrate was applied in November at rates to supply 80 to 160 pounds of actual nitrogen per acre on corn stalk land with no cover crop, and was compared with applications of N made just prior to planting in May. Treatments, including a no nitrogen treatment, were replicated three times. Studies in these two counties were conducted for 3 years. Average corn yields (15.5% moisture) are shown in table 1 for the treatments tested.

Table 1. - Effect of time and rate of N on corn yields (bu/A).

Rate of Actual N Per Acre	Time of Application	Ohio Co. Stendal si.l. (Poorly Drained) 1968	1969	1970	Average	Simpson Co. Pembroke and Crider si.l. (Well drained) 1968	1969	1970	Average
None	---	65	57	13	45	70	68	76	71
80	Fall	60	58	15	44	76	74	84	78
80	Spring	82	104	47	78	65	72	96	78
160	Fall	87	98	48	78	70	82	90	81
160	Spring	118	124	78	107	72	79	88	80

Comparison of yields from the fall and spring applied nitrogen on the poorly drained Stendal soil indicated a considerable loss of nitrogen each winter when no cover crop was grown.

Similar results were obtained in another experiment on a poorly drained Melvin si.l. in 1970 where fall and spring applied nitrogen rates of 100 and 200 pounds per acre were tested. Yield for the no nitrogen treatment was 17 bushels. Where 100 pounds of nitrogen was applied in the fall, a yield of only 34 bushels per acre was harvested compared to 96 bushels when the nitrogen was applied in May. Where 200 pounds of nitrogen was applied in November, a yield of only 61 bushels was obtained as compared to 137 where 200 pounds was applied just prior to planting.

Drought in the area where the experiments were located on the well-drained soils in Simpson County accounted for the low yield levels each of the three years. With this moisture limitation on yield levels, little response was obtained for the nitrogen regardless of rates or time of application.

Source of N-Ammonium Nitrate vs Urea

Urea was compared with ammonium nitrate for fall and spring applications in each of the above trials. There was little yield difference between these two nitrogen sources when both were broadcast and disked into the soil, even though urea quickly converts to ammonium nitrogen. Results of these studies indicate that much of the ammonium form of nitrogen is converted to the nitrate form and lost at temperatures found during the winter months in Kentucky.

NITROGEN AT PLANTING VS TOPDRESSING

Studies comparing the yield response to nitrogen applied either at planting or as a top dressing four to six weeks after planting were begun in 1971.

In 1971 and 1972, rates of 100 and 200 pounds of actual nitrogen per acre were compared when the nitrogen was all applied at planting, one half at planting and half as a topdressing or all as topdressing 4 to 5 weeks after planting. Ammonium nitrate was the source of nitrogen. Each treatment, including a no nitrogen treatment, was replicated four times. This experiment was located on a poorly drained soil and the corn was planted in a seedbed prepared by conventional tillage.

Average yields from the four replications for each method of application are shown in table 2. Yields were calculated on the basis of 15.5 percent moisture.

Table 2. Effect of time and rate of N application on a poorly drained soil.

Rate of Actual N Per Acre	Melvin si.l. Time of Application	1971	1972
None	---	6	39
100	all at planting	90	115
100	1/2 at planting & 1/2 topdressed*	117	126
100	all topdressed*	143	124
200	all at planting	168	138
200	1/2 at planting & 1/2 topdressed*	177	138
200	all topdressed*	160	126

* Nitrogen was topdressed 4 to 5 weeks after planting.

The two year average of 23 bushels of corn per acre from the no-nitrogen plots indicates that the soil contained very little nitrogen.

Time of application of the 100 pound rate of nitrogen in 1971 resulted in a 53 bushel yield difference (90 bushel at planting compared to 143 bushel topdressed) but only a 9 bushel difference in 1972. The reason for this variation in results is believed to be due largely to the soil moisture conditions. In 1971 heavy rainfall in late May and early June caused a loss of part of the nitrogen applied at planting while in 1972 rainfall and soil moisture was not excessive and little nitrogen was lost between applications.

It should also be noted that the 200 pound rate of nitrogen at planting time produced slightly higher yields both years than the plots topdressed with 200 pounds of nitrogen per acre. Some nitrogen stress prior to the topdressing is believed to have lowered the yield potential slightly on this soil which is extremely deficient in nitrogen.

In 1974 rates of 100, 125 and 150 pounds of nitrogen applied at planting were compared with topdressing on the same soil type. The no nitrogen plots averaged 46 bushels per acre. The 100 pound rate at planting yielded 108 bu. compared to a 122 bu. yield from the topdressed plots. Plots receiving 125 pounds of nitrogen at planting averaged 102 bushels per acre compared to a 140 bushel yield for the topdressing. The 150 pound rate at planting produced yields of 112 bushels compared to the topdressing yield of 142 bushels. Plots receiving 200 pounds of nitrogen at planting averaged 141 bushels per acre.

Time and rate of nitrogen application has also been studied for 3 years on no-tillage planted corn (fescue sod) on a soil with restricted drainage. Yield data are shown in table 3.

Table 3. - Effect of time and rate of nitrogen on no-tillage planted corn - restricted drainage.

Rate of Actual N Per Acre	Hampshire si.l. Time of Application	1972	1973	1974	Average
None	----------	91	78	59	76
150	all at planting	101	106	105	104
150	1/2 at planting & 1/2 topdressed*	---	141	129	---
150	all topdressed*	123	142	127	131

* Nitrogen was topdressed 5 to 6 weeks after planting.

Yield data indicate a loss of some of the nitrogen applied at planting time each year at this location.

In another experiment with no-tillage planted corn, on a well drained soil, yield response to time of nitrogen application was studied at rates of 75 and 150 pounds of nitrogen per acre. Corn yields in bushels per acre calculated on the basis of 15.5 percent moisture are shown in table 4.

Table 4. - Effect of time and rate of N on no-tillage planted corn - well drained soil.

Rate of Actual N Per Acre	Allegheny si.l. Time of Application	1972	1973	1974
None	----------	80	108	136
75	all at planting	127	156	---
75	all topdressed	147	158	---
150	all at planting	156	175	162
150	all topdressed	160	168	144

The above results of corn yields as influenced by nitrogen fertilization at planting versus topdressing can be partially explained by the accumulation of N by the corn plant throughout the growing season. Table 5 shows the accumulation of total N by the above-ground parts of corn grown in Maury silt loam soil at several dates during the 1972 growing season.

Table 5. - Accumulation of N by corn at several dates in 1972 for two rates of N fertilization and two tillage systems-well drained soil.

Days After Planting	0 lbs of N/acre (preplant)		150 lbs of N/acre (preplant)	
	No-till	Conv.	No-till	Conv.
	---------- lbs of N in plant/acre ----------			
34	3	3	4	4
49	38	45	68	67
76	52	94	156	137
97	91	114	194	180
Harvest*	100	126	211	204

*Estimate calculated on basis of nitrogen accumulation data for 1971 crop.

As can be seen from Table 5, corn accumulated little N during early growth regardless of whether it had been fertilized with N. For this reason, large amounts of N are not required by corn during its early growth stages; but, the demand for N increases greatly as plants begin rapid growth after 4-6 weeks from planting. Since the risk of losing soil N in Kentucky by leaching and/or volatilization is much greater if applied preplant than if applied after planting, the risk of N losses can be minimized if topdressed 4-6 weeks after planting.

SUMMARY

Based on data from these studies on time of application of nitrogen under climatic conditions in Kentucky it appears there is considerable risk of nitrogen loss during the winter and early spring months. The amount of loss appears to be closely related to soil moisture conditions from the time nitrogen is applied until the crop makes rapid growth. The wetter the soil the greater the risk of loss.

With higher nitrogen costs, delaying nitrogen fertilization on corn reduces the risk of loss and may increase the efficiency of the applied nitrogen. Where it is feasible to apply a topdressing 4 to 6 weeks after planting the possible advantages of this practice should be considered.