FERTILIZER EXPERIMENTS WITH CORN IN KENTUCKY

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This report gives the results of a number of fertilizer experiments conducted with corn in Kentucky. Although the results are not discussed in detail, brief interpretations of the various experiments are given. Fertilizer recommendations for corn, given in other publications of the Agronomy Department, were in part derived from the results of the experiments presented in this report.

PHOSPHORUS

Fertilizer phosphorus is required for efficient corn production on practically all Kentucky soils with the exception of the high-phosphate soils of the Inner Bluegrass and certain alluvial soils along the Ohio and Mississippi rivers. Soil where corn is grown in rotation with a sod crop is frequently more deficient in phosphorus than in other elements.

Corn was grown in a three-year rotation whith wheat and red clover from 1946 to 1959 at the Greenville, Ky., soil field. Starting in 1957, all plots were divided and phosphorus applications were continued at the original rate on half of each plot with no phosphorus applied to the other half. The yields obtained with and without phosphorus at pH 6.1 and pH 6.5, together with the soil test values, are given in Table 1. Differences in yield between the two pH levels (pH 6.1 and 6.5) were greater on plots which received lower rates of phosphorus; the phosphate fertilizer was apparently more effective at the higher pH level.

TABLE 1. - EFFECT OF PHOSPHORUS ON AVERAGE YIELD OF CORN GROWN IN ROTATION WITH WHEAT AND RED CLOVER FROM 1957 TO 1959 ON TILSIT SILT LOAM (THE EXPERIMENT WAS STARTED IN 1946, ALL PLOTS WERE DIVIDED IN 1957; PHOSPHORUS WAS APPLIED AT ORIGINAL RATE ON HALF OF EACH PLOT, AND NO PHOSPHORUS WAS APPLIED TO THE OTHER HALF, RESIDUAL.)

Pounds P_2O_5 per Acre per Rotation	Yield per Acre (bushels)					
	Limed to pH 6.1			Limed to pH 6.5		
	P Applied	No P Applied	Soil Test	P Applied	No P Applied	Soil Test
	Bu/A	Bu/A		Bu/A	Bu/A	
20	41.2	34.9	9	48.3	39.3	6
40	55.1	42.4	10	60.2	46.5	7
60	60.5	45.9	13	64.6	56.5	10
80	67.2	57.3	11	71.1	51.9	9
100	66.7	65.4	14	74.8	62.7	16
160	75.8	77.7	22	78.6	77.2	27
240	76.0	81.6	43	81.9	79.7	45
320	82.0	78.6	79	80.1	78.8	71
Average	65.6	60.5		70.0	61.6	

Since phosphorus was applied to respective plots at the given rates once during each rotation, all yields represent at least some element of response to residual phosphorus. The soil test results show that various levels of phosphorus have been established. Generally, yields increased very little, if at all, when more than 160 pounds of P_2O_5 were applied per rotation. When phosphorus applications were discontinued, yields tended to be lower on the halves of the plots which did not receive phosphorus when less than 160 pounds of P_2O_5 per acre per rotation (or 53 pounds per year) had been applied.

The results of a number of phosphorus experiments conducted on soils which tested very low or moderately low in available phosphorus are given in table 2. Past fertilization history on these fields indicated that very little or no phosphorus had been applied previously. Consequently, yield increases obtained are more marked than usually would be expected. For all of these soils except Russellville, recommendations on the basis of the soil test would be 100-120 pounds P_2O_5 per acre, and for the Russellville soil the recommendations would be 50-60 pounds. The present recommendations agree quite well with the results of these experiments.

TABLE 2. - EFFECTS OF PHOSPHORUS FERTILIZATION ON YIELD OF CORN

Soil Series	Tilsit	Bedford	Johnsburg	Manitou	Tilsit	Tilsit	Manitou	Colyer	Russellville
Year	1949	1953	1953	1954	1954	1955	1955	1956	1956
pH	5.5	6.3	5.8	5.4	5.0	5.2	5.6	5.3	6.1
Soil Test	3	6	3	3	9	3	3	3	12
Lb P_2O_5 per acre									
				Bu/Acre					
None	22.4	42.3	41.7	7.3	13.3	13.3	23.7	38.6	65.8
Row:									
20						27.8	43.9		
30		50.8		32.2	24.9			65.4	
40						35.8	54.0		
60								80.2	
80						37.2	61.7		
90								83.2	
Broadcast:									
30	46.7	43.7	50.6						
40									77.2
60	59.1		51.5						
80									80.0
90			58.3						
120									78.9
200				53.9	37.1		82.0	104.5	

Of particular interest are the experiments on Manitou soil in 1955 and Colyer soil in 1956. When all of the phosphorus was applied in the row, yields appeared to be leveling off at a lower level than was obtained with heavy broadcast applications. These results are in agreement with those obtained in other states where highest yields were obtained when part of the phosphorus was broadcast and part applied in the row on soils very low in phosphorus.

POTASSIUM

Most Kentucky soils contained adequate amounts of available potassium before they were cropped. However, with continued removal of harvested crops, nearly all soils in the state (with the exception of certain soils in the Eden Shale area and overflow soils along the Ohio and Mississippi) require frequent applications of potash fertilizers.

The results of a number of outlying experiments with potassium are given in Table 3. In general, yield responses to potassium applications were not so marked as those obtained with phosphorus applications. Generally, some response was obtained on upland soils showing potassium tests in the very low or low categories. The soil test does not seem as accurate for predicting potassium needs on bottom soils as on upland soils.

TABLE 3. - EFFECT OF POTASSIUM FERTILIZATION ON YIELD OF CORN

Soil Series	Manitou	Tilsit	Manitou	Burgin	Maury	Waverly	Hymon	3	Russellville	Colyer	3	3	Waverly	3	Waverly
Year of Exp.	1954	1954	1955	1954	1955	1955	1955	1955	1956	1956	1956	1956	1956	1956	1956
pH	5.8	5.0	5.6	--	5.3	5.2	6.1	6.0	6.1	5.3	5.8	5.7	5.9	--	5.0
Soil Test (K)[1]	M	L	M	L	L	L	VL	L	VL	M	VL	M	VL	M	L
Lb K_2O Per Acre[2]	Bu/Acre														
0	63.1	38.8	89.2	64.7	75.2	64.7	80.8	63.9	74.7	100.3	90.3	91.6	84.1	107.9	64.4
40				74.3	75.3				76.8						
50	67.7	37.0	83.6												
60										101.6					
80				77.0	71.5				68.1						
100	69.2	39.6	84.4			76.4	84.6	64.3			101.9	100.2	102.7	107.9	73.2
120				72.5	75.9				78.9	99.8					
160				73.1	82.2										
200															

[1] VL, very low; L, low; M, medium

[2] All K_2O applied broadcast

[3] Medium-to well-drained creek bottom soils

The effects of various rates of potassium (and nitrogen) on the yield of corn grown in a two-year rotation with wheat on Tilsit silt loam at the Greenville soil field (Table 4) show a very marked response from rates of potassium up to 160 pounds of K_2O per acre per two-year rotation (80 pounds per year).

NITROGEN

The proper use of fertilizer nitrogen is one of the most important factors in efficient corn production. Since no suitable nitrogen soil test has been developed for Kentucky, nitrogen needs are estimated on the basis of past fertilization and cropping history.

The effects of nitrogen (together with various rates of potassium) on yields of corn grown in rotation, following a sweet clover-lespedeza cover crop, are shown in Table 4. Yield responses to nitrogen were not marked, although a consistent yield increase was obtained for the first 25-pound increment of nitrogen when adequate potassium was applied. The residues of the preceding legume crop apparently contained nearly enough nitrogen for maximum yields under these conditions.

TABLE 4. - EFFECTS OF VARIOUS RATES AND COMBINATIONS OF NITROGEN AND POTASSIUM ON AVERAGE YIELD OF CORN GROWN IN TWO-YEAR ROTATION WITH WHEAT (LESPEDEZA-SWEET CLOVER COVER CROP) FROM 1952 TO 1959, INCLUSIVE, ON TILSIT SILT LOAM

Pounds N per acre for corn	Pounds K_2O per acre[1]					
	0	40	80	160	320	Av
	Bu./Acre					
0	36.0	40.6	50.3	58.2	60.4	49.1
25	24.4	41.4	54.5	64.6	64.1	49.8
50	22.8	47.5	55.5	64.7	65.7	51.2
75	18.1	47.0	58.1	63.3	58.2	48.9
Av	25.3	44.1	54.6	62.7	62.1	-
Soil Test	54 VL	59 VL	70 VL	130 M	273 H	

[1]Rates refer to total K 0 applied per two-year rotation.

The results of a number of outlying experiments with corn are given in Table 5. Three of these experiments were on newly-cleared land, and in every instance a marked response to nitrogen was obtained. In eight of these experiments, where sod was plowed for corn, a mathematical evaluation of the response curves indicated that the average maximum profitable nitrogen application was approximately 80 pounds N per acre. When corn followed legumes (red clover or lespedeza), maximum yields were usually obtained with lower rates of nitrogen than when corn followed grass sods.

TABLE 5. - EFFECT OF NITROGEN ON YIELD OF CORN

Soil Series	Manitou	Tilsit	Burgin	Maury	Manitou	2	2	Waverly	2	Waverly	Colyer	Russellville	Bedford	Tilsit
Year	1954	1954	1954	1955	1955	1956	1956	1956	1956	1956	1956		1956-9	1956-9
Stalks per acre (1000)	10.5	10.5	14.0	14.0	10.5	9.5	10.0	8.0	10.5	10.0	14.0	14.0	10.5	10.5
Preceding crop[1]	R	R	S	S	S	S	L	S	C	S	R	S	L	L
Lb N per acre						Bu/Acre								
0	12.9	22.4	72.6	67.6	60.6	87.0	71.3	45.9	102.0	71.0	59.2	74.8	74.3	63.7
30												75.8		
40			68.3	82.6										
50											93.4			
60						86.1	102.2	79.6	112.1	71.0		83.7	75.3	68.5
80			76.0	82.8										
100	53.9	37.1			82.0						104.5			
120			74.0	93.9		100.2	110.8	78.1	107.9	69.5		78.9		
160			69.9	84.0										
180						101.9	100.2	102.7		73.2				
200	63.1	38.8	72.9		82.7						99.8			

[1]S - sod, C - corn, L - legume, R - cleared land
[2]Medium-to-well-drained creek bottom soils.

In Table 6, yields are given of corn grown following a mixture of red and Ladino clover at Princeton for 6 years. A mathematical evaluation of the average response curve indicated that the maximum profitable rate of nitrogen was about 45 pounds N per acre. However, the stalk population was low in these experiments.

TABLE 6. - EFFECT OF NITROGEN ON CORN YIELDS FOLLOWING RED AND LADINO CLOVER ON PEMBROKE SILT LOAM AT PRINCETON 10,500 STALKS PER ACRE)

Pounds N per acre	1954	1955	1956	1957	1958	1959	Av
				bu/acre			
0	37.2	44.7	77.3	99.2	77.0	85.7	70.2
30	39.8	60.0	84.3	103.8	81.1	92.3	76.9
60	38.1	60.2	90.6	101.1	83.5	91.6	77.5
120	39.0	64.0	90.0	107.1	88.6	93.6	80.4

Table 7 gives the corn yields obtained at Greenville following various legumes. Profitable increases were obtained for as much as 60 pounds of nitrogen per acre following lespedeza, red clover, or sweet clover. In 1959, higher yields were obtained when corn followed sweet clover than when it followed red clover.

TABLE 7. - EFFECT OF NITROGEN ON CORN YIELDS FOLLOWING VARIOUS LEGUMES ON TILSIT SILT LOAM AT GREENVILLE (10,500 STALKS PER ACRE)

Pounds N per Acre	Lespedeza				Red Clover	Sweet Clover
	1956	1957	1958	Av	1959	1959
	Bu/A	Bu/A	Bu/A	Bu/A	Bu/A	Bu/A
0	71.1	64.1	101.8	79.0	61.1	77.6
30	81.7	69.1	109.0	86.6	67.4	79.6
60	87.4	74.6	110.9	91.0	80.1	86.5

Table 8 shows the effect of nitrogen on the yield of corn grown following corn (second-year corn). In general, a more marked response to nitrogen was obtained than when corn was grown following a legume (Table 7). Profitable increases were obtained, at least, for 60 pounds of nitrogen per acre, and the type of response obtained indicates that higher rates than were used in the experiments would have been profitable. Yields of second-year corn (Table 8) were considerably lower than yields of corn following legumes (Table 7). Whether this is the result of nitrogen deficiency or deterioration of soil structure is not known, but additional work is being conducted at this location.

TABLE 8. - EFFECT OF NITROGEN ON YIELD OF CORN ON TILSIT SILT LOAM AT GREENVILLE WHEN PRECEDING CROP WAS ALSO CORN (10,500 STALKS PER ACRE)

Pounds N per acre	1957	1958	1959	Average
		Bu/Acre		
0	40.9	25.3	53.1	39.8
30	45.7	70.0	68.8	61.5
60	47.7	75.1	74.5	65.8

Table 9 gives the effects of various rates of nitrogen at different stalk populations for five experiments. Several effects of nitrogen fertilization and stalk population are clearly shown by these experiments:

1. When no nitrogen or 50 pounds of nitrogen was applied, yields were generally not increased or were depressed when the stalk population was increased.

2. When 100 or 200 pounds of nitrogen was applied, higher yields were obtained with higher stalk populations.

3. Although the data are not given, considerable stalk breakage occurred when 200 pounds of nitrogen was applied, particularly at a population of 21,000 stalks per acre.

4. For high yields, nitrogen applications of 150 to 180 pounds per acre may be profitable.

TABLE 9. - EFFECT OF NITROGEN AND RATE OF PLANTING ON YIELD OF CORN

Pounds N per acre	Stalks per acre	WDB[1] 1958	PDB[2] 1959	WDB 1959	WDB 1959	Grenada 1959	Av
0	10,500	64.4	24.4	61.7	84.0	56.7	58.2
	14,000	52.7	21.7	54.1	98.2	66.3	58.6
	21,000	46.7	24.8	53.8	85.7	53.2	52.9
Av		54.6	23.6	56.5	89.3	58.8	56.6
50	10,500	75.6	64.1	81.9	95.2	72.5	77.8
	14,000	91.4	54.3	87.5	108.9	62.8	81.0
	21,000	83.8	53.4	80.7	114.4	53.9	77.2
Av		83.6	57.3	83.4	106.2	63.1	78.7
100	10,500	83.2	72.6	79.3	98.9	66.3	80.1
	14,000	94.7	77.6	98.1	111.0	66.4	89.6
	21,000	106.2	72.5	103.3	129.5	69.8	96.3
Av		94.7	74.2	93.6	113.2	67.5	88.6
200	10,500	78.7	71.4	84.8	108.6	80.0	84.7
	14,000	106.0	97.3	100.2	122.2	81.8	101.5
	21,000	104.6	95.1	98.5	140.0	79.6	103.5
Av		96.4	87.9	94.5	123.5	80.5	96.6

[1]Bottom soil, well drained.
[2]Bottom soil, poorly drained.

These data show that heavier rates of nitrogen must be combined with higher stalk populations, if high corn yields are to be obtained. When the types of response obtained in the experiments shown in Table 9 are compared with those obtained in the preceding experiments, it seems probable that stalk population may have limited yields in many of the preceding experiments. Field observations, together with results of other experiments, indicate that 21,000 stalks per acre is probably too high for optimum production and that a population of about 16,000 is probably most desirable when yield, ease of harvest, and possibility of drouth periods are considered. When the planting rate is increased, additional potassium may help reduce stalk breakage.

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