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**EFFECTS OF LIME, FERTILIZER,
AND PRECEDING LEGUMES ON THE YIELDS
OF CORN AND TOBACCO**

**Experiments on Sango Silt Loam at Mericourt
Station, Clarksville**

By

C. A. MOOERS AND O. H. LONG



KNOXVILLE

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EFFECTS OF LIME, FERTILIZER, AND PRECEDING LEGUMES ON THE YIELDS OF CORN AND TOBACCO

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SOIL DESCRIPTION

The field experiments discussed in this bulletin were located on the Highland Rim. The soil was a very poor, depleted Sango silt loam known to be much in need of lime and of all the usual fertilizer elements—nitrogen, phosphoric acid, and potash. In other experiments in the same field the need of phosphate had been shown to be so great that without it neither nitrogen nor potash was effective.

This type of soil is of common occurrence in different parts of the Highland Rim. The surface soil is of yellowish-gray color, with a yellow or pale brownish-yellow subsoil. The surface drainage is described as slow, and the internal drainage as impeded by hardpan but sufficient for most farm crops. The hardpan is found at a depth of 20 to 24 inches; it is from 1 to 2 feet thick and of varying degrees of cementation.

RELATED SOILS

Related soil types, especially on level or bottom lands, often form a chain which is differentiated by internal drainage conditions. In this case the chain is Dickson-Sango-Lawrence-Guthrie, beginning with the best internal drainage and ending with the poorest. Guthrie soils are mainly forested or used for pasture. Corn and hay crops are grown only occasionally. The fact that Sango is intermediate between Dickson and Lawrence, and no sharp line of separation exists, indicates that impoverished Dickson and Lawrence soil might behave similarly to the Sango used in the experiments reported. All the types making up this chain belong to the light-colored and poorer soils of the Highland Rim and all are known to be strongly acid, very poor in phosphate, more or less deficient in potash, and as a rule poor in nitrogen.

GENERAL PLAN OF EXPERIMENTS PHOSPHATE AND POTASH

Because of the great deficiency of phosphate, the entire experimental area was treated to a uniform application of superphosphate amounting to 1000 pounds per acre of 16-percent superphosphate every 5 years. Of this amount, 600 pounds was applied for corn and tobacco, and 400 pounds for wheat. The west half of the area received 100 pounds per acre of sulphate of potash applied for

corn and tobacco and 100 pounds of muriate of potash applied for the wheat, making an average annual application of 40 pounds per acre of a 50-percent potash salt. No potash was applied to the east half.

LIMING

Ground limestone at the rate of two tons per acre was applied at the outset to the north half of each of the 100 plots used in the experiments. A like application to the same areas was made about 5 years previously.

CROP ROTATIONS

Five crop rotations were grown for comparison under the same fertilizer and liming conditions. The rotations were as follows:

	1	2	3	4	5
First year	Soybeans	Wheat	Wheat	Wheat	Wheat
Second year	Wheat	Alfalfa	Sericea	Korean L. (under)	Korean L. (removed)
Third year	Clover and Grasses	Alfalfa	Sericea	Korean L. (under)	Korean L. (removed)
Fourth year	Clover and Grasses	Alfalfa	Sericea	Korean L. (under)	Korean L. (removed)
Fifth year	Corn and Tobacco	Corn and Tobacco	Corn and Tobacco	Corn and Tobacco	Corn and Tobacco

All crops of all rotations were grown each year. In conformity to the rotational requirements, the crops were shifted annually to a different range, so that the corn and tobacco were grown only twice on the same range during the 10-year period. Both of these crops, after the first year, always followed the clover and grass of rotation 1, the alfalfa of rotation 2, the sericea of rotation 3, and the Korean lespedeza of rotations 4 and 5. For the field layout, see figure 1.

Attention is called to the fact that crimson clover for green manure was sown after both corn and tobacco of rotation 1. Fair stands and growth were obtained in nearly 3 years out of 5 and assisted materially in the soil upbuilding of that rotation.

RESULTS

EFFECTS OF LIMING

Table 1 gives the average yields obtained under both limed and unlimed conditions for the 10-year period for the various hay crops, and table 2 gives the same information for wheat. Table 3 gives the average yields of corn for the first and second 5-year periods separately. Table 4 gives the total yields of tobacco for each of the 5-year periods.

PLOT	ROTATION 1		ROTATION 2		ROTATION 3		ROTATION 4		ROTATION 5		11	ROTATION 1		ROTATION 2		ROTATION 3		ROTATION 4		ROTATION 5	
	1	2	3	4	5	6	7	8	9	10		12	13	14	15	16	17	18	19	20	21
RANGE 2	CORN	TOBACCO	CORN	TOBACCO	CORN	TOBACCO	CORN	TOBACCO	CORN	TOBACCO		CORN	TOBACCO	CORN	TOBACCO	CORN	TOBACCO	CORN	TOBACCO	CORN	TOBACCO
UNLIMED																					
LIMED																					
RANGE 3	SOYBEANS		WHEAT		WHEAT		WHEAT		WHEAT			SOYBEANS		WHEAT		WHEAT		WHEAT		WHEAT	
UNLIMED							KOREAN UNDER		KOREAN REMOVED									KOREAN UNDER		KOREAN REMOVED	
LIMED																					
RANGE 4	WHEAT		ALFALFA		SERICEA		WHEAT		WHEAT			WHEAT		ALFALFA		SERICEA		WHEAT		WHEAT	
UNLIMED							KOREAN UNDER		KOREAN REMOVED									KOREAN UNDER		KOREAN REMOVED	
LIMED																					
RANGE 5	CLOVER & GRASS		ALFALFA		SERICEA		WHEAT		WHEAT			CLOVER & GRASS		ALFALFA		SERICEA		WHEAT		WHEAT	
UNLIMED							KOREAN UNDER		KOREAN REMOVED									KOREAN UNDER		KOREAN REMOVED	
LIMED																					
RANGE 6	CLOVER & GRASS		ALFALFA		SERICEA		WHEAT		WHEAT			CLOVER & GRASS		ALFALFA		SERICEA		WHEAT		WHEAT	
UNLIMED							KOREAN UNDER		KOREAN REMOVED									KOREAN UNDER		KOREAN REMOVED	
LIMED																					
PHOSPHATE AND POTASH												PHOSPHATE									

Fig. 1—Plot arrangement, showing fertilizer and lime treatments, and crops as grown in 1934.



Fig. 2—The 1939 crop of tobacco following 4 years of wheat and Korean lespedeza, the latter turned under each year. Phosphate and potash added.

The acre yield for 1939 was 930 pounds, valued at \$119.00; the 10-year averages were 854 pounds and \$114.00.



Fig. 3—The 1939 crop of tobacco following wheat and sericea, the latter removed as hay for 3 years. Phosphate, potash, and lime treatments same as in figure 2.

The acre yield for 1939 was 1188 pounds, valued at \$153.00; the 10-year averages were 1134 pounds and \$154.00.

Table 1—*Hay crops—average yields per acre for ten-year period.*

Fertilizer and lime treatments	Rotation 1 Clover and grass	Rotation 1 Soybeans	Rotation 2 Alfalfa	Rotation 3 Sericea	Rotation 5 Korean lespedeza
	Tons	Tons	Tons	Tons	Tons
Phosphate, potash, and lime.....	1.59	2.95	2.00	2.91	1.30
Phosphate and potash.....	0.71	2.37	0.00	2.05	0.63
Phosphate and lime.....	0.69	2.29	1.30	2.40	1.06
Phosphate.....	0.33	1.57	0.00	1.81	0.58

Table 2—*Wheat—average yields per acre for ten-year period.*

Fertilizer and lime treatments	Rotation 1 After soybeans	Rotation 2 After alfalfa	Rotation 3 After sericea	Rotation 4 After Korean turned under	Rotation 5 After Korean removed
	Bushels	Bushels	Bushels	Bushels	Bushels
Phosphate, potash, and lime.....	21.9	18.4	17.5	18.8	13.9
Phosphate and potash.....	16.5	13.6	16.0	12.9	8.8
Phosphate and lime.....	18.0	21.8	19.0	20.0	15.2
Phosphate.....	11.5	14.6	16.8	13.5	10.9

The effect of liming was, in general, very striking, but varied greatly with the kind of crop. As indicated in table 5, practically no alfalfa was obtained where lime was withheld. Liming increased the yield of clover-and-grass hay 117 percent. Korean lespedeza came next, with an increase of 94 percent. Sericea and soybean hay were increased 38 and 35 percent respectively. Wheat and corn were increased 39 and 29 percent.

Tobacco did not show any gains from liming as an average of all rotations, but did show good indirect effects from the liming of alfalfa and sericea in rotations 2 and 3, the gain attributable to lime being 18 and 12 percent respectively. Liming, where potash was withheld, was particularly unfavorable to the tobacco after Korean lespedeza both where this legume was turned under and where it was removed.

EFFECTS OF POTASH

The effects of the potash applications, as of liming, were very striking and widely different for different crops. As shown in table 5, the yield of clover-and-grass hay was increased, on the average, 123 percent; alfalfa hay, 54 percent; and tobacco, 36 percent; while sericea hay was increased only 17 percent and Korean hay only 16 percent. Of the two grain crops, wheat was unaffected and corn showed an increase of only 6 percent.

EFFECTS OF PRECEDING LEGUMES

The comparative effects of preceding legumes on the production of both corn and tobacco are a prominent feature of the experimental series (Figs. 2, 3, and 4). In the analysis of the data, consideration should be given to certain conditions which undoubtedly influenced the outcome. The alfalfa was sown in the fall, and on the limed plots made good growth the following year. Sericea, on the other hand, was sown in the spring and made little growth the first

Table 3—*Corn—average yields per acre, by five-year periods.*

Five-year period	Fertilizer	Rotation									
		1—Clover and grass		2—Alfalfa		3—Sericea		4—Korean under		5—Korean removed	
		Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
		Bushels	Tons	Bushels	Tons	Bushels	Tons	Bushels	Tons	Bushels	Tons
1934-1938	Phosphate, potash, and lime.....	42.4	1.71	51.8	1.95	42.6	1.72	52.2	1.84	44.9	1.65
1939-1943	Phosphate, potash, and lime.....	60.9	2.20	60.6	2.33	57.2	2.13	54.1	2.07	46.9	1.71
	Increase.....	18.5	0.49	8.8	0.38	14.6	0.41	1.9	0.23	2.0	0.06
1934-1938	Phosphate and potash.....	34.6	1.56	29.5	1.40	27.7	1.36	34.5	1.37	27.4	1.26
1939-1943	Phosphate and potash.....	47.1	1.95	47.5	1.89	45.2	1.79	41.8	1.57	31.1	1.43
	Increase.....	12.5	0.39	18.0	0.49	17.7	0.43	7.3	0.20	3.7	0.17
1934-1938	Phosphate and lime.....	42.3	1.60	51.5	1.65	47.7	1.62	43.3	1.46	40.5	1.62
1939-1943	Phosphate and lime.....	51.0	1.77	56.3	1.83	49.1	1.63	44.7	1.61	36.7	1.40
	Increase.....	8.7	0.17	4.8	0.18	1.4	0.01	1.4	0.15	¹ -3.8	-0.22
1934-1938	Phosphate	27.2	1.26	31.0	1.29	33.0	1.21	36.6	1.19	33.0	1.26
1939-1943	Phosphate	40.2	1.44	50.8	1.44	47.5	1.56	44.5	1.58	35.0	1.42
	Increase.....	13.0	0.18	19.8	0.15	14.5	0.35	7.9	0.39	2.0	0.16

¹Minus sign indicates decrease for second 5-year period.Table 4—*Tobacco—average yields per acre, by five-year periods.*

Five-year period	Fertilizer	Rotation				
		1—Clover and grass	2—Alfalfa	3—Sericea	4—Korean under	5—Korean removed
		Pounds	Pounds	Pounds	Pounds	Pounds
1934-1938	Phosphate, potash, and lime	1085	1041	989	900	935
1939-1943	Phosphate, potash, and lime	803	1387	1278	808	616
	Increase.....	¹ -282	346	289	-92	-319
1934-1938	Phosphate and potash.....	1014	903	767	876	790
1939-1943	Phosphate and potash.....	900	1195	1167	898	629
	Increase.....	-114	292	400	22	-161
1934-1938	Phosphate and lime.....	726	824	667	550	494
1939-1943	Phosphate and lime.....	627	1224	920	384	286
	Increase.....	-99	400	347	-166	-208
1934-1938	Phosphate.....	765	718	628	784	635
1939-1943	Phosphate.....	762	981	891	652	475
	Increase.....	-3	263	263	-132	-160

¹Minus sign indicates decrease for second 5-year period.

Table 5—Average increases in crop yield attributable to soil treatment.

Crop	Treatment and increase of crop	
	Lime	Potash
	Percent	Percent
Alfalfa hay	(¹)	54
Sericea hay	38	17
Clover-and-grass hay	117	123
Soybean hay	35	40
Korean lespedeza hay	94	16
Wheat—grain	37	0
Corn—grain	29	6
Tobacco	0	36

¹No alfalfa without lime.

year. In fact, it usually does not make maximum growth until the third year. Alfalfa, therefore, has the advantage as a soil-improving crop by reason of its quick arrival at a full-crop status, and hence would be expected to affect in particular the results obtained in the earlier years of rotation establishment.

Like the alfalfa, the red clover of rotation 1 made little or no growth except on the limed plots. Even where limed, it produced and maintained good stands with increasing difficulty. This was partly offset by the crimson clover.

The Korean lespedeza soon became self-seeding, and in time spread from the plots of rotation 4 to the sericea plots of rotation 3, to the ultimate detriment of the sericea.

EFFECTS ON CORN

During the first 5 years the effects of the different legumes on the yield of corn were decidedly mixed, in that the order of yield lacked much of being consistent with the kind of legume. Table 6-A depicts the results obtained from the 5-year average. Some consistency appears in the case of Korean lespedeza. Where turned under, it is at the top twice—once with the phosphate treatment and once with the phosphate-potash-lime treatment. With the phosphate-potash treatment it ranked second once, and with the phosphate-lime treatment it ranked third once. On the other hand, where the Korean was removed as hay the yields of corn ranked appreciably less, occupying fifth place twice and third place twice.

Table 6-B shows that during the second 5 years a decided change has taken place, with consistent standing the rule. Alfalfa ranks first, clover and grass second, sericea third, Korean-under fourth, and Korean-removed fifth.

EFFECTS ON TOBACCO

The effects of the preceding legumes on the production of tobacco, as shown in table 7, are similar to those found for corn, in that for the first round of the rotation there was little consistent relationship between the preceding legumes and the comparative rank of the tobacco crop which followed.

Table 6—Order of yields of corn as affected by the preceding legume.

Fertilizer	A. Rank first 5 years					B. Rank second 5 years				
	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
Phosphate, potash, and lime.....	Korean under	Alfalfa	Korean removed	Sericea	Clover and grass	Clover and grass	Alfalfa	Sericea	Korean under	Korean removed
Phosphate and potash	Clover and grass	Korean under	Alfalfa	Sericea	Korean removed	Alfalfa	Clover and grass	Sericea	Korean under	Korean removed
Phosphate and lime.....	Alfalfa	Sericea	Korean under	Clover and grass	Korean removed	Alfalfa	Clover and grass	Sericea	Korean under	Korean removed
Phosphate	Korean under	Sericea	Korean removed	Alfalfa	Clover and grass	Alfalfa	Sericea	Korean under	Clover and grass	Korean removed

Table 7—Order of yields of tobacco as affected by the preceding legume.

Fertilizer	A. Rank first 5 years					B. Rank second 5 years				
	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
Phosphate, potash, and lime.....	Clover and grass	Alfalfa	Korean removed	Korean under	Sericea	Alfalfa	Sericea	Korean under	Clover and grass	Korean removed
Phosphate and potash.....	Clover and grass	Alfalfa	Korean under	Korean removed	Sericea	Alfalfa	Sericea	Clover and grass	Korean under	Korean removed
Phosphate and lime.....	Alfalfa	Clover and grass	Sericea	Korean under	Korean removed	Alfalfa	Sericea	Clover and grass	Korean under	Korean removed
Phosphate	Korean under	Clover and grass	Alfalfa	Korean removed	Sericea	Alfalfa	Sericea	Clover and grass	Korean under	Korean removed

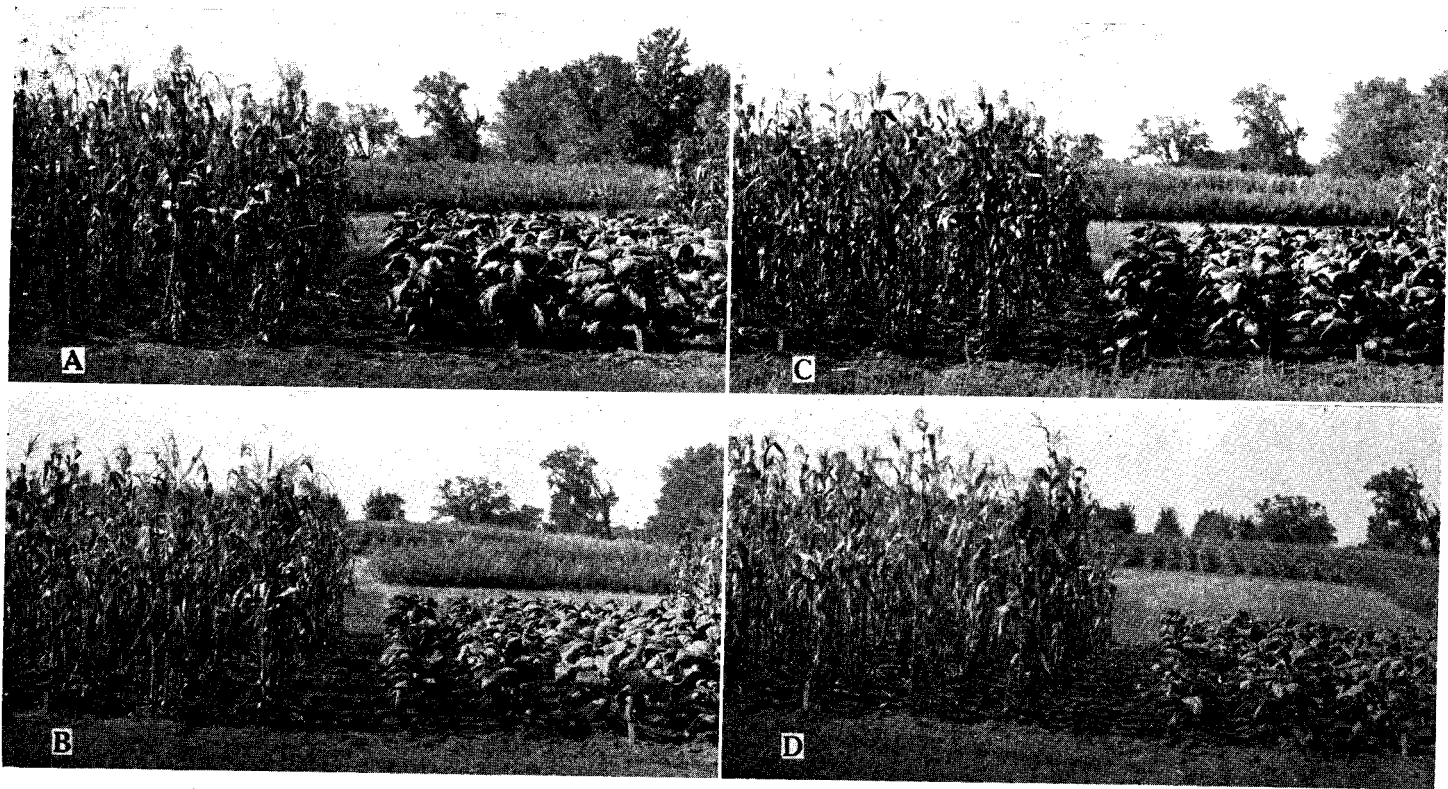


Fig. 4—Corn and tobacco, 1941 crop, after legumes as follows: A, alfalfa removed as hay; B, Korean lespedeza turned under; C, sericea removed as hay; D, Korean removed as hay.

It is noticeable, however, that under three of the four fertilizer and lime conditions sericea ranked in only fifth place. Korean removed as hay never ranked above third place; where turned under for green manure it was in first place only once, and elsewhere was in either third or fourth place.

In the second round of the rotation, or the second 5 years, a decided change took place in the rating of the legumes. Alfalfa ranked first under all four conditions, sericea was second under all conditions, and clover and grass came third in three of the four conditions. Korean turned under was third once and fourth three times, and where removed as hay it was in fifth place under all conditions.

The evidence from both corn and tobacco gives a very low rating to Korean lespedeza as a soil-improving crop. This was especially noticeable where it was removed as hay. Even where turned under, its rank for the second 5 years of the trials was below the other legumes, all of which had been removed for hay.

Sericea made an excellent showing, producing good crops under all the fertilizer and liming conditions, and giving a good account of itself as a preceding crop for either corn or tobacco.