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Sericea as a Soil-Improving Crop for Corn

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By

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SUMMARY

1. An experimental range of depleted Lintonia silt loam, which had been well limed and kept in miscellaneous clovers and grasses that were annually harvested for hay, was prepared by plowing and harrowing, and seeded to *Lespedeza sericea* in the spring of 1930. The sericea made large crops, which were harvested annually, as a rule for both hay and seed.

2. Beginning in 1933, two sericea plots of 1/40 acre each were prepared each year and planted to corn. The average yield of first-year crops for an 11-year period was nearly 70 bushels per acre. A near-by range on which no legumes had been grown made an average yield of only 17½ bushels.

3. Corn was grown after corn in every case to the close of the experiments in 1943. The yields declined at the rate of nearly 6 bushels per acre for the first 5 years, and about 2½ bushels, on the average, for the last 5 years, when they had fallen to less than 40 bushels per acre.

4. Chemical analysis of the mulch material and of 1-inch layers of soil beneath it indicated an increase of 750 pounds of nitrogen per acre attributable to the sericea in the course of 15 years. The extra supply of nitrogen appears ample to account for the continued production for 6 years of corn crops yielding more than 40 bushels per acre.

5. Since the removal each year of large sericea crops, containing approximately 100 pounds of potash per acre, might give rise to potash deficiency for corn, trials were made for several years, beginning in 1939 and ending in 1943, of yearly fertilizer applications of 50 pounds per acre of muriate of potash in comparison with adjoining plots which received none. In every case the data show that no increase in yield was obtained for 1st-year corn. On the other hand, the increase for 2nd- and 3rd-crop corn was marked in every instance, averaging nearly 6 bushels per acre. The increase declined sharply thereafter from the 4th to the 7th year and dropped to nothing for the last 3 years, or the 9th to 11th crops.

6. Failure of potash to increase the 1st-year crop was attributed to the potash in the mulch material plowed under, which was adequate for the 1st crop but insufficient for the large 2nd and 3rd crops, averaging with potash nearly 68 bushels per acre. The final disappearance of potash effect was taken as an indication that the natural supply of potash in the soil was adequate for yields up to about 35 bushels per acre.

7. The Lintonia soil used was well supplied with phosphoric acid, and no trials concerning its possible value as a fertilizer were made.

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INTRODUCTION

Certain legumes are outstanding as soil-improving crops. Alfalfa, sweet clover, red clover, and crimson clover are recognized leaders; and results at the Tennessee Experiment Station show that sericea belongs in this group. It is not to be understood that these legumes are of equal value for soil improvement under all conditions. Crimson clover and sericea are widely different in their adaptability. Crimson clover is a cool-weather crop that is sown in late summer or early fall and reaches maturity the following May. In its brief span of life its growth is almost phenomenal. Sericea is a warm-weather crop that is sown in the spring and usually makes only a light growth the first year, reaching maximum growth the third year. It has a much longer life and wider range of soil adaptability than any of the other legumes mentioned.

This bulletin concerns the effects of sericea, when grown three or more years, on the yield of corn, not only the first year, but in succeeding years of corn following corn. The study involves the effect of sericea on the soil supplies of nitrogen and potash. The kind of soil used was Lintonia silt loam as found on the West Tennessee Experiment Station farm near Jackson, Madison County.

HISTORY OF THE AREA USED

The largest area used for plot experiments at the West Tennessee Station was laid off in 1909 and divided into 12 ranges. At that time, little was known about the land except that it had been cropped for many years and had become greatly depleted in productivity. Fertilizer experiments with corn have been conducted continuously on range 4, beginning in 1910. Without fertilizer, the average yield was about 14 bushels per acre. With the aid of an annual application of 100 pounds per acre of nitrate of soda, the average yield was nearly 29 bushels. Liming increased the yield 4 or 5 bushels per acre, but no increase came from either phosphate or potash.

Range 8, where the experiments reported in this bulletin were made, is supposed to have been, at the outset, in a condition similar to that of range 4, which lies a little over 200 feet away. Range 8 was manured at the rate of 5 tons per acre in 1918. For each of the years 1922 and 1925, ground limestone was applied at the rate of 2 tons per acre. It appears that little phosphate had been used at any time. The same is true of potash, except as specified later.

Winter oats were grown from 1917 to 1922, and various clovers, grasses, and annual lespedezas were grown from 1923 through 1929. In 1930, the entire range was prepared and seeded to sericea without fertilizer.

Undoubtedly the clover and grass crops, even though removed every year as hay, materially increased the fertility of the range. Moreover, in the earlier years, at least, they helped the sericea to make excellent yields of hay, equivalent to nearly 3½ tons per acre, which was removed annually as long as the crop was grown.

THE CORN CROPS

The range was divided into 27 plots of 1/40 acre each. In 1933, two of the plots were prepared and planted to corn. These two plots were put into corn thereafter for 10 years. Two other sericea plots were prepared and planted to corn in 1934 and were put into corn for the next 9 years. In the same way, two plots of sericea were plowed up and planted to corn each year and continued in corn until 1943, the last year of this trial. The yields of corn are reported in table 1, concerning which the following statements are pertinent:

1. The yields of both grain and stover for the first year following sericea, and for each succeeding year, are shown between the horizontal lines.

2. The yields of all first crops, second, and succeeding crops are shown between the diagonals.

3. At the bottom of the table is a percentage index to the character of the season. This index was obtained from the average yields on plots 12, 13, 14, and 16 of range 1, which have been in corn continuously since 1910. These plots received 5 tons of farmyard manure per acre each year, and for the period 1933-1943 made an average yield of 51.1 bushels. The index gives the percentage variation from this average for each of the 11 years.

RATE OF DECREASE IN YIELD OF CORN UNDER CONTINUOUS CROPPING

The yield of the first crop of corn following sericea varied from 44.6 to 92.4 bushels per acre, depending chiefly on the character of the season. The 11-year average was 70.3 bushels, with decreasing yields thereafter as summarized in table 3.

Table 1 shows that following the turning under of the sericea sod, yields of 40 or more bushels of corn per acre were obtained for several years in succession. One set—plots 14 and 15—produced more than 40 bushels every year for 7 years. Two sets made a like record for 6 years, and three others for 5 years. In this connection it may well be kept in mind that the soil used was of a responsive type, well suited to sericea, which had made extra-good growth, and the sod had been accumulating litter from 3 to 13 years before being plowed up.

TABLE 1—*Yields of corn following sericea on range 8 at the West Tennessee Experiment Station.*
An 11-year record

Plot Nos.	Year crop grown and acre yields of grain and stover																						Crop
	1933		1934		1935		1936		1937		1938		1939		1940		1941		1942		1943		
	Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons	
9,10	60.6	1.66	60.4	1.73	52.5	1.38	40.7	1.15	48.1	1.12	37.2	1.03	25.9	1.18	33.8	1.02	25.7	1.00	33.6	1.03	21.4	1.15	
8,11			61.5	1.67	53.9	1.39	41.8	1.22	51.1	1.13	43.3	1.12	31.5	1.33	35.4	1.14	29.7	1.06	33.4	1.17	24.0	1.20	11th
12,13					72.0	1.49	52.9	1.46	68.2	1.40	60.0	1.33	40.7	1.57	47.9	1.19	37.5	1.27	42.9	1.22	26.3	1.29	10th
14,15							49.0	1.35	75.7	1.54	62.7	1.52	44.1	1.56	55.5	1.37	40.0	1.25	47.7	1.25	32.5	1.30	9th
16,17									91.1	1.77	74.0	1.65	55.8	1.89	69.0	1.48	44.6	1.57	53.1	1.42	34.1	1.39	8th
18,19											82.5	1.96	74.0	2.41	77.9	1.73	46.6	1.40	56.1	1.24	37.5	1.42	7th
20,21													76.8	2.88	82.2	2.00	49.9	1.63	63.2	1.37	38.6	1.34	6th
22,23															90.7	2.38	55.6	1.67	70.6	1.60	45.7	1.58	5th
24,25																	44.6	1.52	71.6	1.65	52.5	1.67	4th
26,27																			92.4	2.08	56.1	1.89	3rd
6,7																					52.3	1.80	2nd
																							1st
Rating	86.8		97.3		90.8		77.1		123.9		115.7		97.8		131.0		84.0		127.5		80.5		

The record may appear to indicate that 6 years or more of sericea was required for maximum increase in yield. Careful study of the question, however, led to the conclusion that the evidence does not warrant a positive statement to this effect, especially as there was no means of accurately checking inherent differences in the fertility of different segments of the experimental range.

TABLE 2—*Yields of corn following sericea on range 8 at the West Tennessee Experiment Station on a seasonal-adjustment basis.*

An 11-year record

Plot Nos.	Year crop grown and acre yields											Crop
	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	
9, 10	69.8	62.1	57.8	52.8	38.8	32.2	26.5	25.8	30.6	26.4	26.6	
8, 11		63.2	59.4	54.2	41.2	37.4	32.2	27.0	35.4	26.2	29.8	11th
12, 13			79.3	68.4	55.0	51.9	41.6	36.0	44.6	33.6	32.7	10th
14, 15				63.6	61.1	54.2	45.1	42.4	47.6	37.4	40.4	9th
16, 17					73.5	64.0	57.1	52.7	53.1	41.6	42.4	8th
18, 19						71.3	75.7	59.5	55.5	44.0	46.6	7th
20, 21							78.5	62.8	59.4	49.6	48.0	6th
22, 23								69.3	66.2	55.4	56.8	5th
24, 25									53.1	56.2	65.2	4th
26, 27										72.5	69.7	3rd
6, 7											65.0	2nd
												1st

Figure 1 visualizes the decrease in the yield of corn under continuous cropping as described. The actual first crop, second crop, and later yields are depicted by the solid line, or curve. The broken line was obtained from the adjusted yields given in table 2, as calculated by application of the index[1] to actual yields. The adjusted yields as given in table 3 are believed to furnish the better criterion of the average annual reduction in yield, especially for the last 3 years, when the number of replications was greatly reduced.

TABLE 3—*Actual and adjusted[1] yields of corn following sericea.*

Year after sod turned	Plots averaged	Yield per acre		Decrease in yield	
		Actual	Adjusted	Actual	Adjusted
	Number	Bushels	Bushels	Bushels	Bushels
1st	11	70.3	69.0	.....	.....
2nd	10	65.6	64.6	4.7	4.4
3rd	9	59.1	57.5	6.5	7.1
4th	8	52.8	50.7	6.3	6.8
5th	7	46.7	43.6	6.1	7.1
6th	6	41.2	39.4	5.5	4.2
7th	5	36.1	35.6	5.1	3.8
8th	4	34.7	33.8	1.4	1.8
9th	3	28.5	29.8	6.2	4.0
10th	2	28.8	28.1	.3+	1.7
11th	1	21.4	26.6	7.4	1.5

[1]Based on yields of continuous corn crops, range 1, plots 12, 13, 14, and 16.

Corn, like other cereal crops, when grown continuously will reach a nearly constant low level of production, which varies with the inherent character of the soil. What this would be on range 8 is probably best indicated by the

[1]See table 1.

yields obtained on near-by range 10, where no clover or other legume had been grown, and which was planted in corn continuously for the period 1933-1943. The average yield under this condition was only 17.5 bushels per acre, with a seasonal variation from 8.6 to 28.2 bushels.

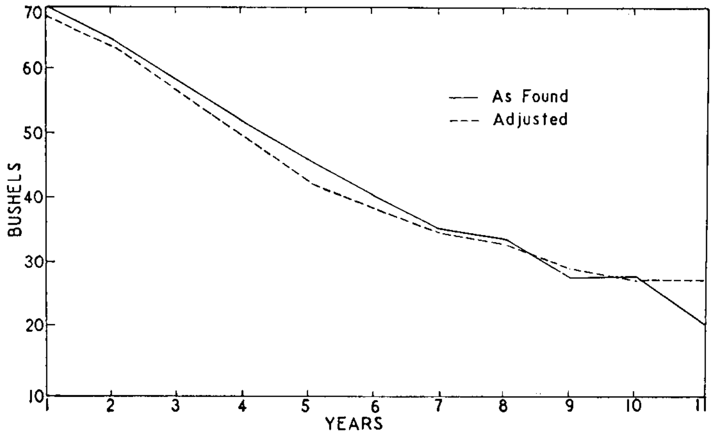

Fig.1—Decrease in yield of corn grown continuously after sericea sod plowed up.

INCREASE OF SOIL NITROGEN FOLLOWING SERICEA

As previously indicated, the sericea in these experiments was planted in the spring of 1930; and two or more crops were harvested annually. Early in 1945, samples of the mulch material that had accumulated on each of 3 plots which had been undisturbed for nearly 15 years were taken for analysis. Likewise the weight per measured square foot of the mulch material was obtained. These samples included not only the more recent and little-decomposed leaves and stubble, but also material which had undergone considerable humidification along with a thin and not separable layer of soil estimated to be .27 inch in thickness. Separate samples of soil were taken representing the first-, second-, third-, and sixth-inch layers underlying the mulch and the .27-inch surface layer.

Table 4 gives the percentages of nitrogen in the different samples. As would be expected, relatively high percentages were found in the mulch material, which includes the .27-inch soil layer. The first inch of soil after removal of the mulch material is definitely better supplied with nitrogen than any lower layer. The second and third inches show decreasing percentages, and the sixth-inch layer is the lowest of all. In table 5 is presented an estimate of the average quantity of nitrogen per acre in the different layers. This could be approximated roughly from the percentages of nitrogen found and the assumption that an acre-inch of this soil when air-dry weighs 320,000 pounds. In the case of the mulch materials, the air-dry weight from each square foot was obtained, so that the 397 pounds given as the weight of the nitrogen per acre is more exact than the figures for the underlying layers, although the latter are on at least a comparable basis. The calculated amounts below the mulch material are 543 pounds of nitrogen in the first inch of soil, 309 pounds in the second inch, 250 pounds per inch in the third, fourth, and fifth inches, and 189 pounds in the sixth inch. The average total per acre at a depth of 7.27 inches is 2188 pounds.

TABLE 4—*Nitrogen content of air-dry mulch material and of soil samples taken at various depths below mulch material from each of three plots kept in sericea for fifteen years.*

Sample	Total nitrogen in samples from—			Average
	Plot 1	Plot 2	Plot 3	
	Percent	Percent	Percent	Percent
Mulch material . .	.412	.369	.648	.476
Underlying soil				
1st inch . . .	.113	.161	.235	.170
2nd inch . .	.082	.088	.120	.097
3rd inch . .	.080	.069	.085	.078
6th inch . .	.060	.061	.056	.059

In the years before sericea was grown, this area had been turned and harrowed many times, thus mixing the surface soil very thoroughly. Turning and thorough harrowing were done prior to the seeding of the sericea. Table 4 indicates that the percentages of nitrogen had leveled off at the third inch. The conservative assumption was therefore made that this soil contained in the neighborhood of .078 percent of nitrogen at the outset. By the use of the same soil weights as in the preceding estimation, the total nitrogen at the outset was calculated to be 1498 pounds, so that the estimated gain in nitrogen per acre after 15 years of sericea production is 750 pounds. In view of the annual removal of the sericea crop, this is a large gain, which would appear to account for the large increases in the yield of corn.

TABLE 5—*The average quantity of nitrogen per acre found in sericea mulch material and in specified underlying layers to a total soil depth of 7.27 inches.*

Based on table 4 and the assumed weight of 320,000 pounds for an inch of soil

Total nitrogen per acre in—	Quantity
	Pounds
Mulch material (includes .27 inch of surface soil)	397
Soil underlying mulch material	
1st inch	543
2nd inch	309
3rd inch	250
4th inch	[1]250
5th inch	[1]250
6th inch	189
Total	2188

[1]**Assumed.**

EFFECTS OF POTASH ON CORN FOLLOWING SERICEA

As found at the West Tennessee Station, Lintonia silt loam is comparatively well supplied with both phosphate and potash. Under continued heavy crop removal without return of the plant-food elements, pronounced potash deficiency develops, but only slight phosphate deficiency, according to the available experimental evidence. The potash removed by 3½ tons of hay per acre would amount to about 100 pounds a year, a high rate of removal. To test the question, one plot each of four pairs of plots planted to corn in 1939 was given a fertilizer treatment of 50 pounds of muriate of

TABLE 6—*Effects of fifty pounds per acre of muriate of potash, applied annually, on the yield of corn in the sericea-corn experiments.*

Crop	Year	Without potash		With potash	
		Plot No.	Yield per acre	Plot No.	Yield per acre
			Bushels		Bushels
1st	1939	20	77.1	21	76.4
	1940	22	90.7	23	90.7
	1941	24	44.6	25	44.6
	1942	26	93.6	27	91.1
	Average		76.5		75.7
2nd	1939	18	70.0	19	77.9
	1940	20	77.9	21	86.4
	1941	22	50.4	23	60.7
	1942	24	70.7	25	72.5
	1943	26	55.7	27	56.4
	Average		64.9		70.8
3rd	1939	16	53.6	17	57.9
	1940	18	69.3	19	86.4
	1941	20	49.3	21	50.4
	1942	22	70.0	23	71.1
	1943	24	48.6	25	56.4
	Average		58.2		64.4
4th	1939	14	48.6	15	39.6
	1940	16	65.0	17	72.9
	1941	18	43.2	19	50.0
	1942	20	64.3	21	62.1
	1943	22	40.7	23	50.7
	Average		52.4		55.1
5th	1940	14	54.6	15	56.4
	1941	16	42.1	17	47.1
	1942	18	54.3	19	57.9
	1943	20	40.0	21	37.1
	Average		47.8		49.6
6th	1941	14	37.9	15	42.1
	1942	16	50.0	17	56.1
	1943	18	35.0	19	40.0
	Average		30.7		34.6
7th	1942	14	47.9	15	47.5
	1943	16	30.7	17	37.5
	Average		39.3		42.5
8th	1943	14	30.0	15	35.0
9th	1943	12	26.4	13	26.1
10th	1943	8	25.4	11	22.5
11th	1943	10	22.1	9	20.7
Avg. 8th, 9th 10th, 11th crops			26.0		26.1

potash per acre. These were plots 20 and 21, which had been in sericea up to that time; plots 18 and 19, which went to corn for the second year; plots 16 and 17, which were planted to corn for the third year; and plots 14 and 15, on which corn was grown for the fourth year in succession. In like manner, for the years 1940, 1941, and 1942, sericea sod of two plots was plowed up for first-year corn, one plot receiving potash and the other no

TABLE 7—*Summary of the effects of potash on the yield of corn in the sericea-corn experiments reported in table 6.*

Crop	Replications	Yields per acre		Increased yields per acre from potash	
		Without potash	With potash		
	Number	Bushels	Bushels	Bushels	Bushels
1st	4	76.5	75.7	None	
2nd	5	64.9	70.8	5.9	Avg. 6.1
3rd	5	58.2	64.4	6.2	
4th	5	52.4	55.1	2.7	Avg. 2.9
5th	4	47.8	49.6	1.8	
6th	3	30.7	34.6	3.9	
7th	2	39.3	42.5	3.2	
8th	1	30.0	35.0	5.0	Avg. 0.1
9th	1	26.4	26.1	-0.3	
10th	1	25.4	22.5	-2.9	
11th	1	22.1	20.7	-1.4	

potash. In this way, with the corn growing continuously after once being started, a series of yields were obtained showing the effects of potash application from first-year corn after sericea to the eleventh year of continuous corn. The detailed yields are given in table 6, and a summary is given in table 7.

DISCUSSION OF THE EXPERIMENTS WITH POTASH

The data show clearly that potash did not increase the yield of the first corn crop after sericea. This was true in every one of the 4 years of trial. The average yield was 76.5 bushels of corn without potash and 75.7 bushels with potash. The second and third years in corn, the plots receiving potash outyielded the untreated plots in every instance, with an average annual increase of 6.1 bushels. The fourth-year crop indicates an increase from potash in 3 of the 5 trials, with an average increase of only 2.7 bushels. A like increase was obtained from the fifth-, sixth-, and seventh-year crops, but the average from the eighth through the eleventh year, with one exception, showed no increase from the potash applications. In the case of the exception, only one pair of plots was involved, so that little significance can be attached to the results, which therefore are included with those obtained in the following 3 years.

The question naturally arises as to the causes of the varied responses obtained. For example, why was there no response to potash from first-year corn? This result can be attributed to the accumulation of mulch material during the life of the sericea. Laboratory determination of potash at various depths of soil from old sericea plots showed a distinct accumulation of available potash in the surface 1½ inches of soil. Apparently, when this accumulation was turned under, no potash was required by even the largest first-year corn crop. The carry-over, however, was insufficient for the good-sized yields of the second and third years, when potash vied with nitrogen as the limiting factor in crop production. Afterward the soil's potash re-

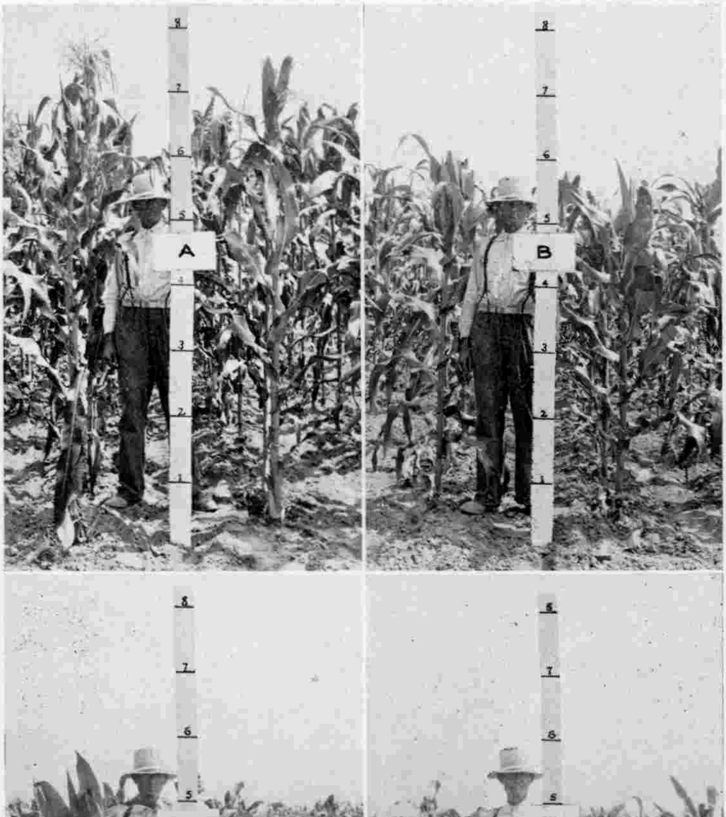

Fig. 2—Characteristic growth of corn plants at various intervals following the turning under of sericea sod.

A—1st year, after sericea 12 years B—3rd year, after sericea 10 years
C—6th year, after sericea 7 years D—10th year, after sericea 3 years

serves came nearer and nearer to meeting the requirements of the dwindling corn crop until from the eighth through the eleventh year fertilizer potash had no effect. In short, nitrogen again had become the sole limiting factor. That this is a satisfactory explanation is borne out by the results previously mentioned of the experiments on range 4.

GENERAL CONCLUSIONS

Under ordinary conditions, sericea leaves an appreciable residue of nitrogen even when subject to annual crop removal. Medium to poor land in high-yielding sericea for 3 or more years can be expected to produce large yields of corn for several successive years, but attention should be given to the possible potash and phosphoric acid requirements of the soil.