

HEMP EXPERIMENTS ON ORGANIC SOILS

By A. H. Wright about 1922 or 1923 See letter 2-17-41 from A.H.W.

Ever since hemp has been grown commercially in Wisconsin, occasional fields have been grown on organic (peat) soils. In the majority of such cases the quality of the fiber obtained was very unsatisfactory, but the hemp plants made a good growth and the yield of straw was generally good. In occasional years and on certain types of organic soils very good quality of fiber has been obtained. In 1919 a fairly large field (something over ten acres) was grown on the Horicon Marsh near East Waupun. The yield of straw was exceptionally good but the fiber was practically all tow and of very poor quality. In 1919 a small field of hemp was grown on the edge of the Horicon marsh, but the soil was nearly typical peat. The season was dry and the hemp plants did not grow nearly as high as in the preceding year on the same marsh. The yield of straw was not nearly as great but the quality of the fiber was fair.

In the vicinity of Union Grove, hemp has been grown on organic soils to a greater or less extent practically ever since 1916. In most cases the fiber obtained has been of poor quality but the yield of straw and of total fiber has been large. In that section hemp grown on organic soil which had been under cultivation for a long period of years and which had been fertilized either with barnyard manure or with commercial fertilizer produced a good yield of straw and fiber and also a very good quality of fiber.

The practical experience with hemp on organic soils indicates that the results are unsatisfactory; that they vary in different seasons and on different soil areas. It seems

that results obtained on no two marshes in the same year are likely to be the same. This indicates that each marsh has particular characteristics so far as the fertility of the soil and the effect of such fertility on hemp production is concerned.

The experience with the cultivation of hemp on organic soils in other states, such as Michigan, Ohio and Indiana indicates similar results to those obtained in Wisconsin. Hemp was grown for a number of years on organic soil in the vicinity of McGuffey, Ohio, and the quality of the fiber obtained in practically every year was inferior to that produced on mineral soils in other states. So long as wartime conditions created an abnormal demand and a consequent high price for hemp fiber, it was possible to produce hemp on the organic soil at McGuffey, Ohio, with profit, but after this period passed the production of hemp has been practically discontinued. The same experience has obtained on the organic soils in the vicinity of Pierceton and South Bend, Indiana, and also on the organic soils in southwestern Michigan.

The results of commercial efforts to grow hemp on organic soils suggest that the difficulty may be due to the particular fertility relationships in such soils and consequently experiments have been undertaken by the Wisconsin Station to study the problem in an effort to determine whether or not the fertility condition of organic soils can be affected by the use of commercial fertilizer to such an extent that hemp fiber of good quality can be produced on such soils.

Experiments At Madison. A series of thirty plots were planned, fertilized and planted on the University Marsh, Madison, in 1922. This marsh is organic in formation and composed of very deep peat. It is typical only of a very few marshes in the state. The area concerned was under the water of Lake Mendota up until the time it was drained by pumping. Previous to 1922 the portion of the marsh on which the hemp was planted had never been in any cultivated crop. In fact it had not been drained until the fall and winter of 1921. It was, therefore, raw peat soil on which was grown flage and other typical water-loving plants. The peat is about six feet deep. The subsoil is clay. The drainage is very good. It is classed as a non-acid marsh, but chemical analysis indicated that it is slightly acid. The plan of the Experiment including the size of the plots and the fertilizer application used are given in Table I.

Table I. - Plan of Hemp Fertilizer Plots, Madison, 1922

Series A		Series B	
Plot (1):	Treatment	Plot:	Treatment
1	: No treatment - check	30	: Duplicate of Plot 15
2	: N. 5#	29	: " " " 14
3	: P. 15#	28	: " " " 13
4	: Gypsum - 11#	27	: " " " 12
5	: No treatment - check	26	: " " " 11
6	: K. 5#	25	: " " " 10
7	: P. 7.5#-K.5#	24	: " " " 9
8	: N. 3.5#-P.7.5#-K.5#	23	: " " " 8
9	: P. 11.5#-K.15#	22	: " " " 7
10	: No treatment - check	21	: " " " 6
11	: K. 15#	20	: " " " 5
12	: P. 22.5#-K.15#	19	: " " " 4
13	: N. 7.5#-P. 22.5#-K.15#	18	: " " " 3
14	: Salt - 25#	17	: " " " 2
15	: No treatment - check	16	: " " " 1
: : : :			
$\frac{1}{2}$ Bu. rate	: 1 Bu. Rate	: $1\frac{1}{2}$ Bu. Rate	: $2\frac{1}{2}$ Bu. Rate
: Duplicate of Series A Rates of seeding an acre			
: : : :			

- (1) Size of plot, 1 X 4 rods or 1/40 acre
- (2) Amounts of fertilizer are given in pounds a plot. The fertilizers used were (N) Sodium Nitrate; (k) Potassium chlorid; (P) Acid Phosphate; (Gypsum) Calcium sulfate; (Salt) Sodium chlorid.

The several fertilizer treatments were applied on May 20 and the plots were seeded May 23. The seed used was ^{of} the Ohington variety grown at Camden, Ohio. The field was plowed during the previous fall and prepared in the spring by disking and harrowing. The soil was rather loose and the seed was planted broadcast. A good stand was obtained but it was somewhat irregular. Some seed was covered much deeper than others with the result that some plants came up considerably earlier than others and in this way produced an irregular growth. The early plants shaded the later plants and retarded their growth.

In addition to the application of various fertilizers, different rates of seeding were also used. The thinnest rate was one-half bushel an acre and the thickest rate was two and one-half bushels. In the early stages of growth the different rates of seeding produced much greater difference in height of plants than the different applications of fertilizer. At the end of the growing season some difference still obtained between the different rates of seeding. The plots seeded thickly averaged around two feet shorter in height than those which were seeded thinly. The plants in the thin seeding were much coarser than in the thicker seeding and there was a good deal more under growth in the thick seedings than in the thin seedings. From field observations only, it was concluded that the one and one-half bushel seeding was most satisfactory.

No striking difference^s were observed between the

plots receiving various fertilizers, but taking all the plots into consideration there was an average difference of two feet or more in height between the fertilized check plots and the plots receiving the complete commercial fertilizer. From a detailed observational examination of all plots it was found that the plots which received nitrogen were more succulent and weaker with a greater tendency to lodge. All plots including fertilized and check plots lodged to a considerable extent. This lodging was characteristic in that the plants were greatly twisted and bent forming a dense and ragged appearance. The plants did not go down directly, but bent and twisted downward. A large percentage of undergrowth appeared on practically all plots. The height of the plants as viewed from the edge of the field (not the average of all plants) ranged around eighty inches on the unfertilized plots and 100 to 120 inches on the plots receiving complete fertilizer.

Counts were made of the number of plants per square foot. On plots receiving the thin seeding the number of plants varied from 15 to 20 per square foot, on the medium seeding from 25 to 30 and on the heavy seeding from 30 to 50 per square foot. The seed used weighed one gram to 70 seeds. The plots were harvested about the 20th of September. Harvesting was done by hand. The stalks were spread on the stubble. The retting conditions were very unsatisfactory. There was very little moisture from the time the hemp was spread until the stalks were covered with snow. There was considerable thawing and recurrence of snow during the winter, with the result that

it was not possible to take up the hemp until late in the winter, and when conditions did permit lifting the straw it was severely over-retted. Data on quantity and quality of fiber, therefore, was not obtained.

General observational notes on this series of plots indicated that for commercial purposes none of the fertilizer treatment used corrected the usual difficulty on such soil.

Detailed botanical and chemical examination of the plants from the various plots is being made. This work is only partially completed and cannot be reported at this time. The botanical study includes examination of the cell structure of plants from the several plots with particular reference to the bast cells. Chemical studies are centered around the matter of carbohydrate assimilation. It is possible that the difficulty met with on such organic soils is due to the excess of available nitrogen which prevents a proper building up of cell walls with the result that the bast cells are large, thin walled, few in number and not bound closely together as in the case of hemp produced on suitable mineral soils.

An analysis of the soil on the University marsh plots was made by the State Soils Laboratory. These results are given in Table II.

Table I - Analysis of Soil on University Marsh Plots

Sample No.:	Nitrogen	Phosphorus	Potassium	Acidity
1	: 3.15 pc	: .183pc	: .183pc	: slight
2	: 15,750 lbs.:	: 910lbs:	: 915 lbs.:	
3	: 2.99 pc	: .207	: .215pc	: slight
	: 14,950 lbs.:	: 1035lbs:	: 1075 lbs.:	

Samples 1 and 3 were taken from different places on the unfertilized plots. The results are given in percentage and pounds an acre in the surface 8 inches.

Experiments at Union Grove. A series of fertilizer plots were planted on the Copenhagen marsh which is about six miles southeast of Union Grove in Kenosha County. The field on which these plots were located had been in cultivation two years. It had been in hemp the first year and corn the second year. The area is fairly pure peat about four to five feet deep, well drained and partially decomposed. In general observational appearance, the soil on this marsh is similar to the soil on most marshes of that section of the state. The soil was found to be slightly acid. The field plan showing fertilizer treatments is given in Table III.

Table III. Plan of Hemp Fertilizer Plots - Union Grove, 1932

Plot No.	Fertilizer Treatment - Lbs. an acre
1	No Treatment - check
2	Potassium chlorid, 200
3	Potassium chlorid - 200
	Acid Phosphate - 300
4	Sodium nitrate - 100
	Acid Phosphate - 300
	Potassium chlorid - 200
5	No treatment - check
6	Potassium chlorid - 400
	Potassium chlorid - 400
7	Acid Phosphate - 600
	Potassium chlorid - 400
8	Acid Phosphate - 600
	Sodium Nitrate - 300
	No treatment - check
9	
10	Potassium chlorid - 600
	Potassium chlorid - 600
11	Acid Phosphate - 900
	Potassium chlorid - 600
12	Acid Phosphate - 900
	Sodium Nitrate - 300

The soil for the fertilizer plots was not plowed, disked or otherwise prepared but was planted with a drill on corn stubble. The object in not stirring the land was to leave the soil as compact as possible. The fertilizers were applied to the several plots by hand on May 15 and was seeded the same day. Seeding was at the rate of one bushel an acre. Chington seed obtained from Kentucky was used. An exceptionally good stand was obtained. A good rain occurred immediately after seeding and the seasonal conditions throughout were favorable. Observations were made on the plots at several times during the growing season. The results of the fertilizer on this series of plots were striking. There was no difference between the check plots and the plots receiving potash alone. Plot 1 (check plot) should not be included in a review of the results. This plot was on the edge of the field and was partially on high land and was not true peat soil. From plot 2 to plot 12 inclusive, the soil was typical peat and results should be comparable. The check plots (5 and 9) average from two to three feet high. There were a few weeds, but not enough to cause material damage. The stalks were very thin. The stand was even and regular. The plots treated with potassium alone (plots 2, 6, and 10) averaged practically the same height as the check plots. There was in no case sufficient difference in height to indicate that the use of the potassium alone had affected the growth of the plants. The average height of these plots was from two to three feet. The general condition of these potassium plots were, so far as observations is concerned,

identical with the check plots. The plots receiving phosphorus in addition to potassium (3, 7 and 11) produced a remarkable growth compared to the check plots and potassium plots. Plants on these plots were from seven to nine feet high. The condition of the growth was unusually good. There was no lodging, very little undergrowth and the stalks were exceptionally uniform in size. The plots receiving the complete fertilizer, nitrogen, phosphorus, and potassium (4, 8, and 12) were practically the same in height as the plots receiving the potassium and potash. If anything, they were slightly higher but the difference was not appreciable. In each case these plots did not mature as early as the others. The leaves and stems remained greener considerably longer, otherwise there was no noticeable difference.

The plots were sufficiently mature to harvest the first of September and were harvested the 15th of September. The entire plots were not harvested and kept separate but instead a strip one-half rod wide was cut through the middle of all plots. This was cut by hand. The green stalks were removed from the field and spread on grass land. The plots receiving potash and phosphorus and the complete fertilizer produced stalks which were very satisfactory in appearance. They were straight, very uniform, in size, comparatively free from undergrowth and uniform in height. The stalks ret very satisfactorily on the grass land. Weather conditions were such that the retting was slow, but there was sufficient moisture to allow lifting of the straw before they were covered with snow. After retting, the straw was bundled and taken to Union Grove where it was stored until the fiber was separated from the straw. The weights of

the kiln dried straw, the line fiber, the tow and the total fiber was obtained. These results are shown in Table IV.

Table IV. Yields of Straw and Fiber from Union Grove Plots - 1922

Plot No. (1)	Fertilizer Treatment (2)	Retted Stalks (3)	Line Fiber (4)	Tow (5)	Line and Tow (6)	Percent Fiber (7)	Total Stalks (8)	Total Fiber (9)
1	Check	13#	None	2.75#	2.75#	21.15	1.04#	440#
2	K - 200#	25#	3.25#	2.19#	5.44#	21.76	2.00#	870.4
	P - 300#							
3	K - 300#	54#	7.75#	3.5 #	11.25#	20.83	4.32#	1700.0
	K - 200#							
	P - 300#							
4	N - 100#	55#	8.75#	3.5 #	12.25#	22.27	4.40#	1960.0
5	Check	9#	1.25#	.75#	2.00#	22.22	.72	320.0
6	K - 400#	11.5#	1.38#	.89#	2.27#	19.74	.93	363.2
	K - 400#							
	P - 600#	50 #	7.5	2.5 #	10.00#	30.00	4.00	1600.0
	K - 400#							
8	P - 600#	53 #	.62#	4.25#	11.50#	21.70	4.24	1840.0
	N - 200#							
9	Check	6 #	.62#	.89#	1.51#	25.16	.48	241.6
10	K - 600#	5.5#	.62#	.62#	1.24#	22.54	.44	198.4
	K - 600#							
11	P - 900#	48 #	5.75#	4. #	9.75#	21.66	3.60	1560.0
	K - 600#							
12	P - 900#	48 #	5.5 #	4.25#	9.75#	20.31	3.84	1560.0
	N - 300#							

(1) Size of plots, .5 X 2 rods or one square rod.
 (2) amounts of fertilizer are given in pounds an acre. Fertilizers applied are (K) potassium chlorid; (P) acid phosphate; (N) sodium nitrate; (3) Weights given are in pounds of kiln dried retted stalks a plot; (4) pounds a plot; (5) pounds a plot; (6) total of line and tow a plot; (7) proportion of fiber to weight of stalks; (8) calculated production of kiln dried stalks an acre; (9) calculated yield of total fiber an acre.

The results from milling the straw as shown in Table 5 bear out the field notes. The weights as given in the table do not indicate all of the difference which was actually represented for the fiber from the ched plots in addition to being very little in quantity was of very poor quality. It was practically all tow

