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TOBACCO SUBSTATION AT WINDSOR

REPORT FOR 1931

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CONNECTICUT AGRICULTURAL EXPERIMENT STATION

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Most of the Tobacco Substation projects are long-time experiments planned to continue several years. The Annual Report contains discussions of significant yearly progress on these studies, frequently not of conclusive nature. Whenever a series of experiments has continued long enough to convince us that the questions involved have been answered as fully as they can be under our working conditions, the results as a whole are published in a separate bulletin. According to this plan, the potash fertilizer experiments, which were carried on for the last 10 years in field and laboratory, have been summarized and published as Bulletin 334, "The Potash Requirements of the Tobacco Crop." Readers are referred to this publication for information on our potash studies.

The season at Windsor was average as to temperature and rainfall. During June, excessive rains on the 10th and 11th and again on the 17th caused serious leaching of the fertilizer. On the other hand, July was excessively dry and it was necessary to irrigate most of the tobacco several times. Both extremes of precipitation were unfavorable to growth of tobacco. Table 1

Table 1. Distribution of Rainfall in Inches at the Tobacco Substation, Windsor, 1929-1931

By 10-day periods

Year	May			June			July			August	
	1-10	11-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20
1929	1.44	1.56	1.79	0.08	0.03	1.56	0.10	0.44	0.44	2.73	2.13
1930	0.43	2.01	2.04	2.38	0.73	0.62	0.93	0.69	1.01	0.63	1.53
1931	1.52	1.60	3.40	2.57	2.04	0.13	0.86	0.75	0.23	0.66	3.12

By months

Year	May	June	July	August (total)
1929	4.79	1.67	0.98	4.86
1930	4.48	3.73	2.63	2.33
1931	6.52	4.74	1.84	3.87
Mean	3.57	3.09	4.28	4.35

shows the distribution of the rainfall through the season as compared to other recent years.

The fertilizer experiments on shade tobacco at West Granby were continued. J. S. Owens, Extension Agronomist of the Connecticut Agricultural College, continued curing experiments on a number of farms throughout the Valley and the fertilizer studies on Broadleaf Tobacco in Silver Lane.

Calls by the growers for direct service from the Staff have been as numerous as in any preceding year. Some 2500 soil samples have been tested, 200 samples of seed tested for germination, and many bushels of seed cleaned. A great deal of time has been spent in farm and shop visits and in consultation with farmers on fertilizers, curing, liming, and the like. We also cooperated with the Hartford County Farm Bureau in conducting a series of meetings for tobacco farmers in November and December.

No changes in the Staff have occurred. Mr. Lacroix was again employed through the summer on investigation of tobacco insects. His report is published on pages 261 to 268. No additions to the physical equipment have been made except for the construction of a building for farm machinery, tool room, and fertilizer room.

EXPERIMENTS ON IMPROVING GROWTH OF TOBACCO ON AN UNPRODUCTIVE SANDY KNOLL

Most tobacco farms have sandy knolls where the crop is so poor that it is grown at a loss. The farmer continues to raise tobacco there only because such a knoll is a part of a better field. These unproductive spots are not only a source of financial loss to the grower, but they also hurt his pride in the crop. He would be willing to go to considerable trouble and expense if he only knew how to make the tobacco grow as well there as on the other parts of his farm.

Such knolls are usually underlaid by a gravel or coarse sandy subsoil that comes close to the surface. This condition makes the drainage too rapid and during dry hot weather the crop suffers because there is no reserve of moisture left in the soil. On the other hand, during a wet season, the increased quantity and rapid leaching of the water carry away the plant food elements (especially nitrogen), and the crop starves. Such a soil profile is not sufficiently retentive of either water or of nutrient materials to make it suitable for good crop production in any but an unusual season.

Obviously the remedy for such a condition must lie either in some method of making the soil more retentive, or in applying the fertilizer throughout the growing season, rather than at one time previous to setting.

On the Station Farm at Windsor such a sandy knoll covers about one and one-half acres on Fields V and VII. This land never produces a heavy crop. It suffers in both wet and dry seasons, clearly for the reasons mentioned above. The area is not entirely uniform; it is poorest at the crown of the knoll and improves somewhat as it slopes toward the lower parts, a condition common to most areas of this kind. The slope of the field is indicated by contour lines in Figure 19. Since there was presented here

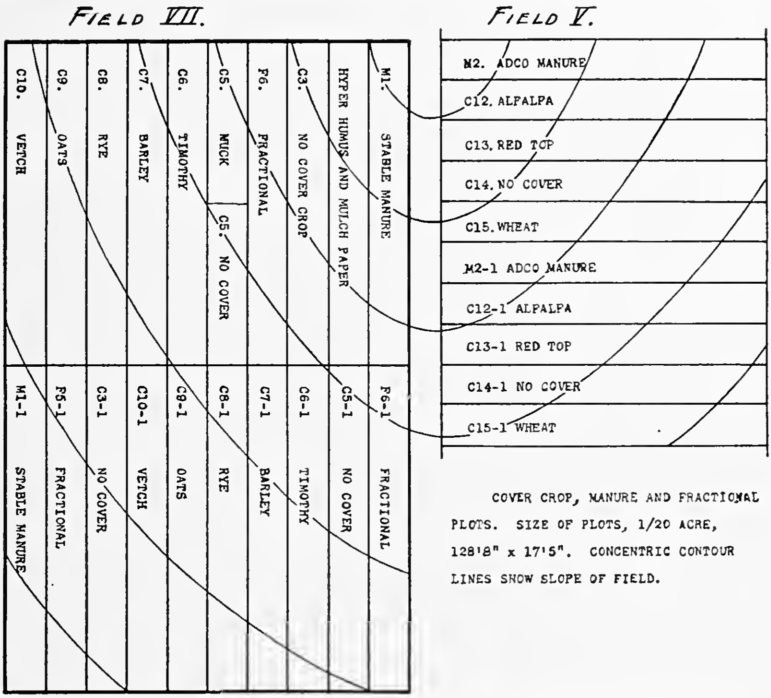

FIGURE 19. Map of the cover crop, manure and fractional application plots, 1925-1931.

an opportunity to see what could be done to better a condition known on so many farms, a set of field tests was started in 1926. Different methods have been tried to improve growth and quality of the tobacco grown under these conditions. The results have not been entirely satisfactory. We have not yet found a way to make tobacco grow as well on this spot as on other parts of the farm. We have learned, however, that certain practices will give a measurable amount of improvement, while other suggested methods have been more harmful than helpful. Progress reports have been made on some of these experiments in previous Annual Reports. Since the tests on these fields are now completed, a final summary of the entire experiment is presented here.

Since it is known that a soil with a higher content of organic matter is more retentive of water and nutrients, it was thought that some benefit might be derived from (1) the sowing of cover crops, or (2) application of manure, or (3) application of commercial humus. All of these methods were tried. An experiment was also tried on one plot where the surface soil was mixed with an application of heavy soil from another field. In another experiment, the soil was covered with mulch paper, with the idea that this might prevent leaching and conserve the moisture. Finally, in an effort to keep the nitrogen supply more uniform, the nitrogen carriers of the formula were divided and applied at three different times (fractional application) instead of at one time before setting.

For convenience and in order to make the comparative results more easily comprehended, it will be best to consider separately the results of each of these six practices. The quantity and composition of the fertilizer applied was the same on all plots for any one year (Table 2), but was changed slightly from year to year. These formulas furnished always about 200 pounds of nitrogen and the same quantity of potash. The quantity of phosphorus varied, but since this land shows no response to phosphorus, the results could hardly be affected by this variation. A small amount of magnesian lime was added whenever it was thought necessary.

Table 2. Fertilizer Mixtures Applied to Fields V and VII

Materials used	Pounds per acre					
	1926	1927	1928	1929	1930	1931
Cottonseed meal	1465	1465	1000	1000	1000	1100
Castor pomace	1324	1324	1400	1400	1400	700
Nitrate of soda	106	....	....	....	....	....
Ammophos	103	....	....	....	....	....
Precipitated bone	185	....	300	150	....	....
Sulfate of potash	165	165	100	117	117	80
Carbonate of potash	127	127	120	90	90	....
Nitrate of lime	....	106	200	200	200	....
Urea	....	36	....	....	....	....
Calurea	....	....	100	100	100	160
Nitrate of potash	....	....	100	110	110	100
Magnesian lime	....	....	....	500[1]	400	....
Ground tobacco stems	....	....	....	....	....	2000

[1]Only 250 pounds on Field V.

Cover Crops[1]

The tobacco crop on the field in question has usually been harvested the first half of August. This leaves a period of 4 to 8 weeks of growing weather in which the land would be bare unless some other crop were planted. During this period and during the winter and spring, leaching rains carry away the nutrients if the land is bare. If a cover crop is sowed it absorbs these available nutrients and retains them for the use of the next season's tobacco. Cover crops are also known to render available a certain amount of the mineral potash and phosphorus in the soil. When turned under, they help to retain the moisture and nutrients. They also have the advantage of preventing blowing or washing of the soil. Three types of cover crops were tried:

1. **Legumes.** These add nitrogen to the soil through the root nodules. Vetch and alfalfa represented this type. Clovers were not used because previous experience had shown that they are subject to winterkilling, and therefore uncertain when sowed so late in the season. The vetch also died out badly three seasons, but made a very heavy growth during the autumn so that the ground was well covered. The seed of both the vetch and alfalfa was inoculated during the early years. This was later found to be unnecessary, since there were always abundant nodules produced without further inoculation. Alfalfa grew remarkably well and was about a foot high when plowed under each spring.

2. **Non-leguminous crops which live through the winter and make a spring growth.** Rye, timothy and red top were used to represent this group. All made excellent growth and it was always easy to get a stand. The rye was usually a foot or more high when plowed under in the spring. The others made a lower mat of tops, but very thick root growth.

3. **Non-leguminous crops which make a good autumn growth but are killed when the ground freezes in winter.** Oats, barley, and spring wheat were used as the most promising of this group. All grow to be one to one and a half feet high before they are killed by freezing in late November or December. When turned under in the spring, they are dead and already partially decayed.

The rates of seeding for all the cover crops were:

Barley	2 bu. per acre	Alfalfa	20 lbs. per acre
Rye	2 " " "	Redtop	20 " " "
Wheat	2 " " "	Timothy	20 " " "
Oats	2½ " " "	Vetch	60 " " "

[1]For progress reports on this experiment, the reader is referred to Tob. Sta. Bul. 6: 55-59; Tob. Sta. Bul. 10: 72-75; and Conn. Agr. Expt. Sta. Bul. 326: 388-390.

All plots were duplicated and were one-twentieth acre in size. In each case one of the duplicate plots was on the poorer land and one on the better. Six plots, located as indicated in the plot map, were left without cover crops. Yields for the six years are presented in Table 3 and grade indexes in Table 4. The results show that none of these crops improved the yield or grading to such a degree that the tobacco was as good as that grown on the better parts of the farm, yet most of them produced some improvement in both

TABLE 3. COVER CROP PLOTS. YIELD RECORDS FOR FIVE YEARS

Field VII

Cover crop	Plot No.	Acre yields by years					Plot average	Treatment average
		1926	1927	1928	1930	1931		
None	C3	1279	1062	880	1120	1196	1107	1237
	C3-1	1618	1343	1185	1260	1340	1349	
	C5	1426	1221	805	1157	1098	1141	
	C5-1	1612	1291	1145	1243	1461	1350	
Timothy	C6	1373	1203	1129	1425	1293	1285	1327
	C6-1	1666	1278	1130	1243	1528	1369	
Barley	C7	1430	1296	1177	1304	1202	1282	1300
	C7-1	1507	1357	1057	1276	1389	1317	
Rye	C8	1455	1387	1276	1313	1239	1334	1432
	C8-1	1717	1404	1225	1679	1627	1530	
Oats	C9	1687	1356	1310	(1471)	(1534)	1471	1442
	C9-1	1621	1371	1070	1471	1534	1413	
Vetch	C10	1642	1430	1172	(1545)	(1508)	1459	1448
	C10-1	1479	1399	1258	1545	1508	1438	

Field V

Cover crop	Plot No.	1926	1927	1928	1930	1931	Plot average	Treatment average
None	C14	1285	1161	912	1516	1455	1266	1278
	C14-1		1217	979	1501	1471	1291	
Alfalfa	C12	1243	1198	1061	1519	1609	1326	1322
	C12-1	1191	1238	1015	1466	1675	1317	
Red top	C13	1104	1212	1115	1524	1459	1283	1274
	C13-1	1174	1240	1080	1367	1465	1265	
Wheat	C15	1364	1261	951	1427	1450	1291	1271
	C15-1	1137	1210	970	1525	1415	1251	

Table 4. Cover Crop Plots. Grade Indexes for Four Years

Field VII

Cover crop	Plot No.	Indexes by years				Plot average	Treatment average
		1927	1928	1930	1931		
None	C3	.344	.280	.217	.203	.261	.311
	C3-1	.435	.464	.281	.254	.358	
	C5	.419	.210	.265	.164	.265	
	C5-1	.481	.399	.267	.293	.360	
Timothy	C6	.450	.371	.349	.228	.350	.345
	C6-1	.443	.342	.339	.233	.339	
Barley	C7	.472	.447	.340	.196	.364	.363
	C7-1	.436	.396	.323	.292	.362	
Rye	C8	.480	.480	.390	.269	.405	.415
	C8-1	.488	.445	.378	.393	.426	
Oats	C9	.461	.521	(.415)	(.370)	.442	.428
	C9-1	.478	.395	.415	.370	.414	
Vetch	C10	.392	.474	(.408)	(.362)	.409	.424
	C10-1	.434	.554	.408	.362	.439	
Field V							
None	C14	.350	.287	.456	.299	.348	.358
	C14-1	.368	.351	.433	.319	.368	
Alfalfa	C12	.435	.344	.440	.376	.399	.390
	C12-1	.430	.325	.402	.365	.380	
Red top	C13	.399	.447	.443	.348	.409	.395
	C13-1	.455	.344	.409	.320	.382	
Wheat	C15	.377	.332	.413	.301	.356	.376
	C15-1	.448	.367	.432	.331	.395	

yield and quality. This was more apparent on Field VII than on Field V, a difference that was influenced by later side dressings with nitrogen on Field V in 1930 and 1931 (see Report for 1930).

The greatest improvement both in yield and grading, was produced by rye, oats, and vetch. Vetch, however, had a tendency to make all grades a shade darker and might not be so satisfactory if lighter colors are desired. Rye may have the fault during very dry years that it does not decompose rapidly enough, especially if it has made considerable spring growth. Under these conditions, the soil drys out excessively, with resulting poor start and growth of the young tobacco plants. Rye should be plowed under earlier in the spring than is necessary for other crops.

Effect of Cover Crops on Soil Reaction

In order to see whether any of the cover crops affected soil reaction, these plots were tested at three different times during the course of the experiment. In 1928 the soil samples were taken before the land was plowed in the spring; in 1929, at the middle of the growing season; in 1931, just after harvesting. The differences between the plots (Table 5) were too small to be significant. Apparently any of these cover crops may be used continuously without producing an important change in the degree of acidity of the soil.

Effect of Cover Crops on the Organic Matter of the Soil

Since the organic matter in the soil is the undecomposed residue of crops previously grown, or of vegetable or animal matter applied in the past, it might be anticipated that the continuous turning under of cover crops would cause an increase in the percentage of organic matter. To see whether such an increase was measurable for the length of time covered by this experiment, samples of soil were tested in 1927 and again after the close of the experiment (August 15, 1931). A comparison of the cover crop plots with those without cover showed (Table 5) that after turning under the cover crops for six years there was a difference of .134 per cent in the organic matter content, in favor of the cover crops (average of all). Calculated to the acre basis, this means that there were 2680 more pounds of organic matter to the acre in the cover crop soil than in the soil that was left bare in the winter. This does not mean, however, that there was an actual *increase* of that amount through the use of the cover crop. Reference to the analyses taken on the same plots four years before shows that the organic matter content was barely maintained at the same level on the cover plots, or even very slightly declined, but that on the no-cover plots it declined to the extent of more than a ton to the acre. It appears to be a difficult matter to increase the organic matter content of an open, sandy, leachy soil of this kind.

We may conclude then that one benefit of a cover crop on this soil is to prevent the lowering of the organic matter content. It is conceivable that the presence of the undecomposed, or partially decomposed, plants in the soil during the early growth of the tobacco crop may also be beneficial, even though they do not increase the stable or semi-permanent organic content of the soil.

TABLE 5. SOIL REACTION AND ORGANIC MATTER CONTENT OF SOILS FROM COVER CROP PLOTS

Cover crop	Plot No.	Reaction (pH) 1928 May 8	Reaction (pH) 1929 July 1	Reaction (pH) 1931 Aug. 11	Reaction (pH) Average	Organic matter per cent[1] 1927 Plot	Organic matter per cent[1] 1927 Average	Organic matter per cent[1] 1931 Plot	Organic matter per cent[1] 1931 Average
Field VII									
None	C3	5.33	4.90	5.64	5.29	1.419	1.478	1.391	1.322
	C3-1	5.27	4.75	5.70		1.688		1.379	
	C5	5.32	4.60	5.91		1.393		1.191	
	C5-1	5.17	4.67	5.64		1.414		1.327	
Timothy	C6	5.42	4.74	5.83	5.31	1.372	1.522	1.293	1.391
	C6-1	5.15	4.93	5.77		1.669		1.490	
Barley	C7	5.20	4.70	5.83	5.22	1.427	1.492	1.422	1.437
	C7-1	5.17	4.76	5.47		1.557		1.452	
Rye	C8	5.33	4.75	5.89	5.36	1.624	1.563	1.460	1.476
	C8-1	5.33	5.03	5.84		1.502		1.491	
Oats	C9	5.17	5.07	5.69	5.27	1.724	1.628	1.496	1.430
	C9-1	5.25	4.67	5.57		1.533		1.364	
Vetch	C10	5.17			5.15	1.779	1.647		1.495
	C10-1	5.24	4.70	5.50		1.515		1.495	
Field V									
None	C14		4.63	5.47	5.06	1.405	1.435	1.343	1.374
	C14-1		4.60	5.56		1.464		1.405	
Alfalfa	C12		4.60	5.15	4.96	1.586	1.507	1.527	1.521
	C12-1		4.70	5.40		1.427		1.514	
Red top	C13		4.85	5.62	5.22	1.517	1.469	1.495	1.558
	C13-1		4.80	5.60		1.421		1.622	
Wheat	C15		4.68	5.48	5.08	1.405	1.498	1.433	1.485
	C15-1		4.63	5.53		1.591		1.536	

[1]Organic matter analyses made by Dr. H. A. Lunt of the Soils Department by Paar Bomb method.

Manure[1]

It is a common practice for farmers who have a limited amount of stable manure to spread it on such light sandy knolls in addition to the regular quantity of commercial fertilizer. In order to determine and measure the benefit of this practice, four plots on the same fields (V and VII) where the soil was too sandy, were manured every autumn from 1925 to 1929 inclusive. The experiment has been fully described in previous reports and summarized in the report for 1930.

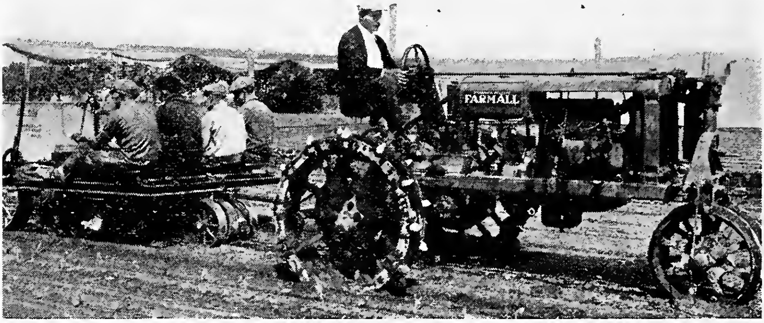

FIGURE 20. New type of two-row transplanter which was used and found to be very satisfactory on the Station farm in 1931.

Briefly, it was found that:

1. Although in some wet years early in the experiment the crop was better than on the adjacent check plots, both quantity and quality generally declined until the crop was practically worthless the last year.

2. The increased severity of black rootrot on the manure plots apparently contributed heavily to this decline.

3. The organic matter content and water holding capacity of the manured soil were considerably increased and the soil became less acid through the use of manure.

4. The burn of the leaf was as good, and, on the cigar, somewhat better, from the manured tobacco, apparently because the magnesia in the leaf was increased.

[1]For previous discussion of the progress of this experiment, see Tob. Sta. Bul. 10: 62-66; Conn. Agr. Expt. Sta. Bul. 299: 192; Bul. 311: 216-219; and Bul. 326: 384-387.

No manure was applied in the autumn of 1930, but the plots were continued in 1931 in order to see what residual effect the manure would have.

During the summer of 1931, growth of the tobacco on the manure treatment was poor, certainly no better than that on the untreated tobacco and in general, it was not so good as on the adjacent cover crop plots. Sorting showed it to be short, yellow, and of inferior quality. When the results were averaged (Table 6) it was apparent that there was no beneficial residual effect after five years' application of manure.

TABLE 6. YIELD AND GRADE INDEXES OF MANURE PLOTS. CROP OF 1931

Kind of manure	Plot No.	Acre yield	Percentage of grades								Grade index
			L	M	LS	SS	LD	DS	F	B	
None	C3	1196	—	—	11	2	22	20	17	28	.203
Stable	M1	1340	—	—	17	7	35	14	18	9	.283
None	C3-1	1340	—	—	17	—	28	13	13	29	.254
Stable	M1-1	1271	—	—	18	7	33	13	19	10	.283
None	C14	1455	2	4	15	1	38	8	13	19	.299
Adco	M2	1479	3	4	12	13	39	10	15	4	.321
None	C14-1	1471	2	2	21	2	36	10	13	14	.319
Adco	M2-1	1270	—	—	10	8	35	19	16	12	.255
Average of all plots											
Not manured		1366									.269
Manured		1340									.285

Effect of Manure on the Organic Matter Content of the Soil

The soil was tested for organic matter in 1927, 1930, and 1931. The results, presented in Table 7, show that the organic matter was increased by about 50 per cent in five years of manuring. During the following year, however, when the manure application was omitted, there was a considerable decline in the organic matter in the soil. It is apparent that organic matter in a soil of this kind rapidly disappears unless it is constantly renewed.

The conclusions should not be drawn from this experiment that no benefit may be derived from the application of manure to tobacco land under any condition. We can only say that under the conditions of this experiment on this type of soil, the use of stable manure and the artificial (Adco) manure in generous amounts in addition to a standard application of commercial fertilizer has failed through a series of years to improve materially the quantity or quality of the tobacco.

TABLE 7. ORGANIC MATTER CONTENT OF MANURED PLOTS AND CONTROLS

Manure applied	Plot No.	Percentage of organic matter					
		1927		1930		1931	
		Plot	Average	Plot	Average	Plot	Average
None	C3	1.350	1.479	1.333	1.462	1.391	1.379
	C3-1	1.557		1.560		1.379	
	C14	1.491		1.438		1.343	
	C14-1	1.517		1.517		1.405	
Stable	M1	1.672	1.744	2.057	2.267	1.259	1.714
	M1-1	1.815		2.477		2.169	
Adco	M2	1.655	1.709	2.408	2.192	2.477	2.138
	M2-1	1.762		1.976		1.800	

Commercial Humus

If we assume that the low crop-producing capacity of such light soils is due to their low content of humus or organic matter, and consequent inability to retain moisture and nutrients in solution, then a logical remedy would be to add humus directly. An experiment of this kind was tried here for two years, in which a commercial black swamp peat residue (under the trade name of Hyper Humus) was added in different amounts up to 80 tons to the acre. Results of the two years were described fully in our report for 1929.[1]

The first year there was a small improvement in both grading and yield; the second year, the differences between the tobacco grown on the plots treated with Hyper Humus and the untreated plots were too small to be significant. The addition increased the organic content by about 25 per cent. Growth of tobacco was also watched on these plots for two years after termination of the experiment, but no improvement was apparent.

The addition of commercial humus, then, failed to improve the crop-producing capacity of this soil to any worth-while degree.

[1]Conn. Agr. Expt. Sta. Bul. 311: 220-227.

Addition of Clay Soil

Some growers have reported beneficial results from mixing a sandy surface soil with heavier soil drawn from other parts of the farm. Obviously such a practice would not be practical on a large scale, but might be used to advantage if there were only small parts of a field that were too sandy.

One of the control plots on Field VII where growth was especially poor, but uniform, was divided into two equal parts. In the

FIGURE 21. Another view of two-row transplanter, showing mechanical details.

fall of 1925 one-half of the plot was covered to a depth of 4 inches with stiff black clay soil drawn from another field. The application was repeated a year later. Even when thoroughly worked in by plowing and harrowing, this effected a distinct difference in the color of the soil. No later applications were made, but the tobacco from each half was harvested and sorted separately each year. The first three years the tobacco on the treated end appeared somewhat greener and of better growth, than that on the untreated end, but this difference was not so apparent the last two years.

The sorting records presented in Table 8, show that there was a distinct improvement, especially during the first years, in both the grading and yield. Even on the treated, however, both were disappointingly low as compared with tobacco from other parts of the farm. Possibly, if applications of the heavy soil had been made later, further improvement would have resulted, but an economic limit of the practice would soon be reached. From this experiment we may conclude that such a soil may be increased in productivity by heavy additions of stiffer clay soil, but it is questionable whether the degree of improvement under these conditions would make this method economically practical.

TABLE 8. YIELD AND GRADE INDEX ON PLOT WHERE HEAVY SOIL WAS ADDED

Treatment	Acre yield						Grade index			
	1926	1927	1928	1930	1931	Average	1928	1930	1931	Average
Clay soil added	1442	1350	1073	1326	1207	1280	.348	.298	.143	.263
No addition	1426	1221	805	1157	1098	1141	.210	.265	.164	.213

Fractional Application of Nitrogen

Poor growth on these fields is usually accompanied by the development of a lighter green or yellowish color of the leaves, especially late in the season. The plants have the symptoms of nitrogen starvation, which is more marked in wet years. The ability of this soil to retain its nitrogen is known to be low. These facts lead us to believe that at least one of the reasons for poor results on this kind of a soil, is that so much nitrogen leaches away during the early part of the season that growth is limited and the quality of the tobacco impaired. If this assumption is correct, then we should expect improved quality and yield if we could keep the store of nitrogen in the soil more constant. This may be accomplished, at least to a certain degree, by the method of fractional application of the nitrogen carriers. The usual practice is to spread all the fertilizer on the soil at one time previous to setting the plants. By the fractional application method the nitrogen carriers, particularly those in which the nitrogen is quickly available, are divided into several portions, only one of which is mixed with the regular fertilizer before setting. The other portions are spread at later intervals and worked into the soil at the side of the growing crop.

By this method, the supply of available nitrogen may be restored after the soil has been depleted by heavy rains.

Three plots on Field VII were devoted to such an experiment and the nitrogen carriers applied in three installments, the time of application being governed to some extent by the occurrence of rains during the early growing season.[1] Immediately adjacent to each of these three plots was a control plot of the same size, to which the same fertilizer was applied, but all in one application previous to setting the plants.

TABLE 9. YIELDS AND GRADE INDEXES OF FRACTIONAL APPLICATION PLOTS AND ADJACENT CONTROL PLOTS

Method of application	Plot No.	Acre yield by years						Grade index by years				
		1926	1927	1928	1930	1931	Average	1927	1928	1930	1931	Average
	C3	1279	1062	880	1120	1196		.344	.250	.217	.203	
Broadcast	C3-1	1618	1343	1185	1260	1340	1269	.435	.464	.281	.254	.324
	C5-1	1612	1291	1145	1243	1461		.481	.399	.267	.293	
	F5-1	1603	1413	1273	1591	1498		.494	.446	.442	.399	
Fractional	F6	1300	1148	1092	1235	1210	1340	.375	.392	.304	.223	.391
	F6-1	1550	1211	1225	1228	1521		.433	.455	.344	.383	

These results of fractional application over a period of five years (Table 9) show a substantial gain both in yield and in grading. A closer study of the experiment discloses that the greater differences occurred on the lighter end of the field and in those years when heavy leaching rains occurred in the first half of the growing season. It is probable that even better results could have been obtained if the fractional applications had been made always *immediately* after such rains and, in years of repeated rains, if *additional* nitrogen, beyond that planned in the experiment, had been added.

Mulch Paper

Mulch paper is said to conserve moisture and to reduce the amount of leaching immediately around the plants. Since these two objects seemed particularly desirable on this type of soil and

TABLE 10. YIELD AND GRADING OF TOBACCO FROM MULCH PAPER PLOTS AND ADJACENT CONTROL PLOTS

Treatment	Acre yield		Grade index	
	Plot	Average	Plot	Average
Mulch paper	1429	1429	.323	.323
Control 1	1278	1168	.250	.250
Control 2	1057		.250	

[1]For details and progress of this experiment, see Tob. Sta. Bul. 10: 57; Conn. Agr. Expt. Sta. Bul. 299: 193, and Bul. 326: 381.

since in previous years, tests with mulch paper had given some promise on other fields, one plot was tried with 36-inch paper in 1931, on Field VII. Two plots of two rows each were set at the same time, but without paper, to serve as controls. The sorting records, presented in Table 10, show that there was considerable improvement in both grading and yield through the use of mulch paper. These results agree with those of previous experiments we have conducted here, and with results on tobacco in Canada and Pennsylvania.

Whether the use of mulch paper is an economical practice depends on such factors as the market price of tobacco, cost of the paper, labor, and so forth.

Disease As a Limiting Factor

It is improbable that the prevalence of any disease could account for the poor growth of tobacco on these fields, or similar fields on many farms. The plants have been constantly watched and, except for occasional plants affected with calico, sore skin, or hollow stalk, the parts above ground have been remarkably free from disease. Numerous root examinations showed a few lesions of black rootrot. To see whether these or other root troubles were a factor, the soil on one section of the field was sterilized with steam in 1927. However, the growth on the steamed section was not perceptibly different from that on the rest. Since it has been proved on various other fields that this practice may be relied on to eliminate root troubles, we are warranted in concluding that root disease played no part in this problem.

We may therefore dismiss diseases as an influence. The same may be said of insects. No field is entirely free from insects, but these fields have not suffered more than the average from this source.

Summary

On this sandy unproductive knoll the yield has always been about one-half to two-thirds as heavy as on the other fields of the farm and the grading poor in proportion. Six different methods were tried to improve the yield and grading of tobacco grown. None of these practices benefited the tobacco sufficiently to make it comparable to that on the better fields, but some resulted in considerable definite improvement.

Stable manure applied annually in addition to the regular ration of commercial fertilizer produced no important difference, and in the end rendered the land unsuitable for raising tobacco because it favored black rootrot.

Application of large quantities of commercial humus resulted in no significant improvement.

Mixing the surface soil with stiff dark clay soil drawn from another field was of some value, but it is questionable whether this is practical.

The sowing of cover crops immediately after the removal of the tobacco gave a definite increase. Oats, rye, and vetch produced better results than the others.

The use of mulch paper was beneficial. That this is an economic practice in the growing of tobacco, has yet to be demonstrated.

Fractional application of the nitrogen carriers made greatest improvement.

The more promising results of the fractional application indicate that on this soil the leaching away of nitrogen is more damaging than the inability of the soil to retain moisture. This theory is strengthened by the fact that although the last two seasons these fields were irrigated frequently in dry weather to maintain a moisture supply, the crop was not much improved.

These experiments have shown factors that may contribute to the unproductive condition of such soils, but it must be admitted that we are still far from a complete understanding of the problem. There must be other and more important undesirable characteristics or constituents, or lack of some elements, in a soil of this nature that must be corrected before a normal crop can be grown consistently.

From the standpoint of a practical tobacco grower, the best course would be to avoid locating his tobacco field on such a soil, if this were possible. If, however, the location of these areas is such that he wishes to keep them in tobacco, the most promising practices are first to use rye, oats, or vetch cover crops every year, and to apply additional readily available nitrogen immediately after each heavy rain. The fractional application should be continued until the crop is at least half grown.

EXPERIMENTS WITH NITROGENOUS FERTILIZERS

Nitrogen is the first limiting nutritional factor in tobacco production in Connecticut. Furthermore, the problem of supplying nitrogen in the right amount at the right time, and in the most favorable form, is the most complicated of any in tobacco fertilization. The most important divisions of the problem are:

1. **Materials.** Of the numerous materials that may be used to supply the nitrogen in a fertilizer, which will give the optimum combination of growth and quality of tobacco? Corollary to this

is the question of the specific effects of each material on each of the different factors that go to make up quality in its broadest sense.

2. **Combinations.** It is a common opinion that no one material will give best results, but that the fertilizer mixture should contain materials that furnish nitrogen in different forms, such as nitrates, urea, and vegetable or animal organic forms. If this is sound, then what proportions should be used? What is the particular advantage of each form?

3. **Rate of application.** How many pounds does an acre of tobacco require to give the best quality and quantity of leaf? An answer to this question is complicated by the fact that the best quantity may differ with the form in which the nitrogen is supplied. Also, variation in rainfall and in type of soil have a tremendous influence on the quantity needed.

4. **Time of application.** Should all the nitrogen be applied previous to setting or should part of it be applied later to the growing crop? Here again, the type of soil, weather, and the form of the nitrogenous compound all complicate the answer. If later applications are beneficial, what is the best time to apply them? This phase of the problem necessitates a comprehensive study of leaching of nitrogen and rate of nitrification of different materials.

Investigations on some or all of these angles of the nitrogen question have been in progress every year since the Tobacco Station was established. Field plot tests have been supplemented by extensive lysimeter experiments on losses through drainage, as well as by laboratory and greenhouse studies. Reports on some of these lines have been included each year in our Annual Reports. Yet a great deal remains to be done before we can feel that the problem is even approaching a satisfactory conclusion. With the closing of the potash investigations this year, it is planned to devote more space and time to the nitrogen problem.

In this Bulletin a progress report on some of the field plots is presented.

Single Sources of Nitrogen

A fundamental step in solving the nitrogen problem is to determine the effect of each of the common nitrogen carriers when used alone, that is, as the only carrier of nitrogen in a formula in which the other nutrient elements (potash, phosphorous, and magnesia) are supplied alike to all. In 1926 such an experiment was begun in a small way on 4 one-fortieth acre plots of Field V, a sandy, leachy soil, (mentioned on page 225). The four materials on which tests were started at that time were cottonseed meal, nitrate of soda, sulfate of ammonia, and urea. Each gave 200 pounds of ammonia (equal to 164 pounds nitrogen) to the acre. Phosphoric acid was supplied at the rate of 160 pounds, and potash, 200 pounds. This was repeated the following year on the same plots and other plots were added. On these nitrate of lime and castor pomace were the only nitrogenous materials.

Results of these experiments are published in Tobacco Substation Bulletin 10, pages 60-62. Only the four original plots were continued in 1928 (See Conn. Agr. Expt. Sta. Bul. 229, p. 192) and, from this time on, all plots received 200 pounds of

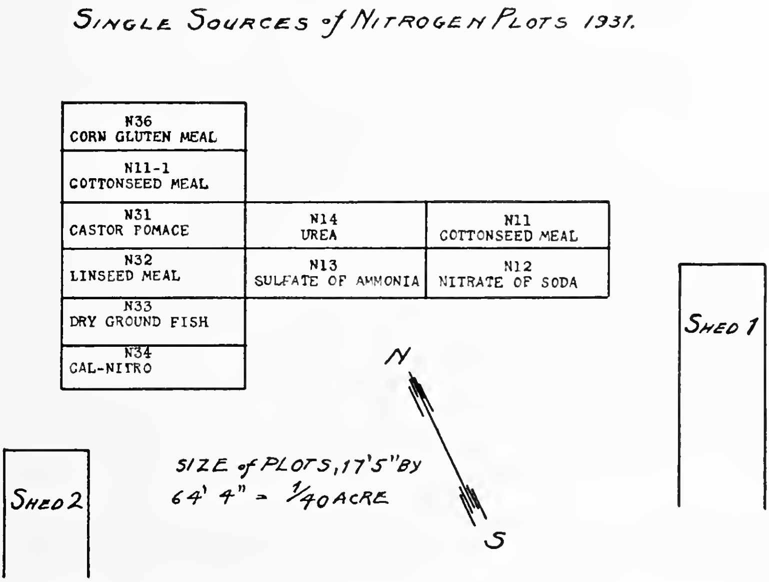

FIGURE 22. Map of the single source of nitrogen plots on Field V, 1926-1931.

nitrogen (instead of 164 as originally). In 1929, castor pomace, linseed meal and dry ground fish were added; in 1930, Cal-nitro; and in 1931, corn gluten meal. Since it was thought that the part of the field on which the four original plots were located might not be so productive as that on which the later plots were added, another cottonseed meal plot, N11-1, was located between the castor pomace and corn gluten meal plots, as indicated in Figure 22. As a further comparison between cottonseed meal and castor pomace, a plot of each was located in Field I. Half of each of these latter plots had been heavily limed in previous years. Therefore each half was harvested and sorted separately.

The yields and sorting records for all of these plots in 1931 are shown in Table 11, and a summary of yields and grade indexes for the whole experiment since 1926 are given in Table 12.

TABLE 11. YIELD AND SORTING RECORDS ON SINGLE SOURCES OF NITROGEN PLOTS. CROP OF 1931

Source of nitrogen	Plot No.	Acre yield		Percentage of grades								Grade index	
		Plot	Average	L	M	LS	SS	LD	DS	F	B	Plot	Average
Cottonseed meal	N11	1529		3	4	19	2	41	6	8	17	.334	
Cottonseed meal	N11-1	1532		4	4	18	1	37	6	12	18	.324	
Limed cottonseed meal	N11-2	1567	1582	5	6	27	9	34	5	9	5	.401	.380
Not limed cottonseed meal	N11-2	1703		11	12	24	6	33	2	11	1	.459	
Nitrate of soda	N12	728	728								100	.100	.100
Sulfate ammonia	N13	1678	1678	4	5	15	8	46	8	10	4	.352	.352
Urea	N14	1761	1761	12	9	18	6	46	2	6	1	.449	.449
Castor pomace	N31	1736		10	7	26	3	39	3	8	4	.442	
Limed castor pomace	N31-1	1650	1726	10	11	25	8	28	3	13	2	.445	.453
Not limed castor pomace	N31-1	1792		11	8	28	6	37	1	8	1	.472	
Linseed meal	N32	1629	1629	3	4	30	3	41	2	8	9	.387	.387
Dry ground fish	N33	1606	1606	5	5	23	2	39	4	10	12	.371	.371
Cal-Nitro	N34	1546	1546	4	4	21	2	43	5	11	10	.356	.356
Corn gluten meal	N36	1653	1653	7	10	23	3	35	6	10	6	.410	.410

TABLE 12. SUMMARY YIELDS AND GRADE INDEXES FROM SINGLE SOURCES OF NITROGEN SERIES 1926, 1927, 1928, 1930 AND 1931

Source of nitrogen	Plot No.	Acre yield by years						Grade indexes by years					
		1926	1927	1928	1930	1931	Average	1926	1927	1928	1930	1931	Average
Cottonseed meal	N11	1228	1131	696	1374	1582	**1202**	.288	.297	.299	.411	.380	**.338**
Nitrate of soda	N12	1440	688	585	802	728	**849**	.353	.130	.158	.186	.100	**.185**
Sulfate of ammonia	N13	1482	1386	933	1436	1678	**1383**	.370	.333	.357	.366	.352	**.356**
Urea	N14	1350	1166	876	1510	1761	**1333**	.375	.350	.443	.415	.449	**.407**
Castor pomace	N31		1135		1472	1726	**1599**		.328		.465	.453	**.459**
Linseed meal	N32				1475	1629	**1552**				.497	.387	**.442**
Dry ground fish	N33				1532	1606	**1569**				.500	.371	**.436**
Cal-Nitro	N34				1516	1546	**1553**				.472	.356	**.414**
Corn gluten meal	N36					1653						.410	**.410**

It is planned to extend this experiment by further replications on other fields, and final conclusions with regard to most of the materials must not be drawn yet. Some observations on results, however, may be profitable at this time.

Nitrate of soda. It will be observed that, in four out of five years, this material gave the lowest yield—below 1000 pounds—and the lowest index of all the materials tested. The tobacco in fact was practically worthless. In each of these four years we had heavy rains early in the growing season, which leached out the nitrogen. The lysimeter tests showed that during a series of heavy rains, there was an almost total removal of the nitrate nitrogen that had been applied. The tobacco turned yellow within a week after such rains and never recovered entirely, although, in some years, there was a partial recovery of the green color later, indicating that some nitrogen became available from the organic matter of the soil, or was still left in the subsoil and came up again. The first year of the experiment, however, was dry, and there were no early rains of sufficient duration to carry away the nitrogen. In the dry year this plot was better than the cottonseed meal plot, both in yield and grading.

The results show that, at least for a soil of this type, nitrate of soda cannot be used successfully as the only, or main source of nitrogen. The same may be said of the other nitrate forms, nitrate of lime, or nitrate of potash. There still remains the possibility of applying the nitrate in several doses during the growing season instead of all at once before setting. The complete success of even this method, however, must depend on proper weather conditions and cannot be recommended. If nitrates are used at all in tobacco fertilization on such a soil, they should be used either in small quantity in the original mixture as "starter" nitrogen, or in later side applications for quick replenishment of the nitrogen immediately after rains.

Sulfate of ammonia. Among the four materials in the original series, this has given the best average yield for the five years. In the later years, however, it has not done so well as urea. This progressive deterioration under continuous application of sulfate of ammonia may be connected with the extreme acidity of the soil which has developed on this plot. The tobacco on this plot never had the appearance of suffering for lack of nitrogen, even in wet years. Sulfate of ammonia does not leach from the soil seriously, during the growing season, and therefore is not subject to the same objection as nitrate of soda. There are, however, certain objections to sulfate of ammonia: (1) It makes the soil too acid. This might be overcome by occasional applications of lime. (2) Tobacco grown on sulfate of ammonia as the only nitrogen source is usually darker and heavier. This is shown by the high percentage of leaves classified as darks each year. (3) Both the fire-holding capacity and the color of ash are inferior.

Urea. This gave the highest grade index of any of the four. The yield was exceeded only by sulfate of ammonia, and that only in the earlier years. The tobacco on this plot, even in the wet years, showed no indication of nitrogen starvation. Apparently, serious leaching does not occur during the short growing season. When this is the only source of nitrogen there is a tendency for the leaves to be darker and coarser. Urea will be discussed more fully in a later section of this Bulletin.

Cottonseed meal. This is the standard nitrogenous fertilizer for tobacco. However, these experiments indicate that its use as the *only* source of nitrogen might not be best. Considering the averages for the five years, both urea and sulfate of ammonia gave better yields and grade indexes. In three parallel comparisons of cottonseed meal with castor pomace in 1931, the latter gave the better yield and grading.

Castor pomace. This gave results as good as any other nitrogenous fertilizer, in these experiments. Although it has a reputation for producing darker tobacco than cottonseed meal, we have not found this to be true on this soil type.

Linseed meal. The results of this were comparable to those of cottonseed meal and castor pomace, but the test was not extensive enough to warrant any final conclusions.

Dry ground fish. The same results were obtained as for linseed meal.

FIGURE 23. Three Prout hoes drawn by tractor. Side view. Huntington plantation in Windsor.

Cal-Nitro. This is a synthetic nitrogen product made from a mixture of ammonium nitrate and calcium carbonate. It contains approximately 20.6 per cent nitrogen, half of which is in the nitrate form and half in ammonia form. It is prepared as small beads and is readily mixed with the other ingredients. Like the other nitrates, Cal-Nitro absorbs moisture and becomes sticky when exposed to the air. It contains about 35 per cent of calcium carbonate.

Two years' results on one plot show it to be somewhat inferior to most of the other nitrogenous materials when used as the only source of nitrogen. If this material should find use in the fertilization of tobacco, it would probably not be as the main source of nitrogen, but might replace some of the other nitrate forms.

Corn gluten meal. This is an organic by-product of the manufacture of corn syrup, corn sugar, and corn oil, and contains the same percentage of nitrogen as cottonseed meal. There are no experiments published in which its value as a tobacco fertilizer was tested. The very favorable results of the one year in which we have tried it, show that corn gluten meal is a promising competitor for cottonseed meal and worthy of more extensive experiments.

FIGURE 24. Prout hoes drawn by tractor. Rear view.

Urea

Experiments with urea as compared with other nitrogenous fertilizers have been described so fully in our previous Reports[1] that it will be sufficient at this time to add only the results for 1931, the seventh year of the experiment. The experiment was continued on the same six plots on Field IX and two plots on Field II, as in previous years.

Tobacco on Field IX made a vigorous growth on all plots. No significant differences between plots appeared in the field

[1]Tob. Sta. Bul. 6: 12-14; Tob. Sta. Bul. 8: 33-35; Tob. Sta. Bul. 10: 55-57; Conn. Agr. Expt. Sta. Bul. 299: 190; Conn. Agr. Expt. Sta. Bul. 326: 374-376.

growth. Dry weather the latter half of July necessitated two irrigations. Growth on the two plots on Field II was not quite as good as usual. Yield and grading records for the 1931 crop are given in Table 13 and a summary of six years in Table 14.

TABLE 13. YIELD AND GRADING RECORDS OF UREA PLOTS. CROP OF 1931

Amount of urea	Plot No.	Acre yield		Percentage of grades								Grade index	
		Plot	Average	L	M	LS	SS	LD	DS	F	B	Plot	Average
None	N1-5	1540	1583	22	4	18	4	35	6	11		.492	.491
"	N1-6	1625		17	8	26	3	28	4	10	4	.489	
Half nitrogen in urea	N8	1490	1613	4	4	24	4	28	5	12	19	.345	.390
	N8-1	1736		8	5	33	3	31	4	9	7	.434	
All nitrogen in urea	N9	1722	1751	18	6	23	3	30	5	9	6	.478	.479
	N9-1	1780		16	7	25	3	34	2	5	8	.480	
None	N1-7	1870		5	4	29	4	31	6	12	9	.386	
Half nitrogen in urea	N8-2	1636		6	4	26	4	39	6	9	6	.396	

TABLE 14. UREA PLOTS. YIELD AND GRADING RECORDS FOR SIX YEARS

Yields

Year	Plots on Field II		Plots on Field IX					
	No urea N1-7	Half urea N8-2	No urea		Half urea		All urea	
			N1-5	N1-6	N8	N8-1	N9	N9-1
1925			1364	1561	1365	1597	1347	1465
1926			1501	1711	1488	1695	1622	1810
1927	1426	1386	1060	1296	1053	1441	1060	1223
1928	1157	1202	994	1105	1109	1170	1106	1206
1930	1701	1610	1361	1545	1460	1630	1505	1577
1931	1870	1636	1540	1625	1490	1736	1722	1780
Average	1539	1457	1389		1435		1452	

Grade indexes

Year	No urea N1-7	Half urea N8-2	N1-5	N1-6	N8	N8-1	N9	N9-1
1925			.268	.411	.325	.303	.257	.352
1926			.492	.473	.545	.405	.489	.445
1927	.499	.445	.337	.411	.354	.446	.312	.428
1928	.451	.473	.343	.471	.430	.434	.319	.354
1930	.445	.460	.416	.478	.451	.431	.437	.367
1931	.386	.396	.492	.489	.345	.434	.478	.480
Average	.445	.444	.423		.409		.393	

The very poor grading on plot N8 is out of line with other results and cannot fully be explained. It is partly due to bad sun burn while harvesting, as a result of which the leaves were graded as brokes.

When the averages of the six years and on both fields are examined, it is apparent that the differences, either in yield or grade index, are not large. On Field IX, increased urea gave a higher yield, but somewhat lower index. On the two plots on Field II, the yield was not so large where half of the nitrogen was from urea, but the grading was about the same.

From all results up to the present there do not appear any reasons why urea should not be substituted for a part of the more expensive organic nitrogenous materials.

Calurea Tests

The calurea tests were carried on in the same manner and on the same plots as in previous years. In the Report of the Station for 1930 is found an outline of the experiment, as well as the composition of the various fertilizer formulas.

After the tobacco was cured it was brought to the McCormick warehouse in Bloomfield, where it was graded under the supervision of Howard McCormick. This was done with a view to obtaining a commercial unprejudiced opinion of the crop. The various fertilizer treatments were not known to the graders. The results are in close agreement with those of last year, with the

Table 15. Yield and Sorting Records on Calurea Plots. Crop of 1931

Nitrogen from calurea	Plot No.	Acre yield		Percentage of grades								Grade index	
		Plot	Average	L	M	LS	SS	LD	DS	F	B	Plot	Average
None	N25	2022	1913	4	9	37	5	38		6	1	.452	.467
	N25-1	1907		11	11	31	5	35		6	1	.489	
	N25-2	1890		13	9	23	8	39		6	2	.471	
	N25-3	1833		2	12	40	6	32		7	1	.454	
Half of the nitrogen from calurea	N26	1950	1889	10	6	29	7	42		5	1	.463	.451
	N26-1	1894		6	6	32	7	43		5	1	.444	
	N26-2	1953		4	7	44	6	35		4		.473	
	N26-3	1759		1	9	38	7	33		9	3	.424	
All the nitrogen from calurea	N27	1993	1948	6	7	35	3	42		6	1	.454	.461
	N27-1	2102		3	5	43	5	39		5	1	.455	
	N27-2	1881		11	10	30	8	34	1	4	1	.485	
	N27-3	1817		2	10	41	6	33		7	1	.451	

exception that the grade index for the all-calurea treatment is nearly the same as for the standard formula. The grading records are shown in Table 15 and a summary of three years results in Table 16.

Table 16. Calurea Series. Summary of Three Years' Results

Nitrogen from calurea	Plot No.	Acre yield				Grade index			
		1928	1930	1931	Average	1928	1930	1931	Average
None	N25	1300	1959	2022	1643	.387	.422	.452	.446
	N25-1	1140	1745	1907		.404	.507	.489	
	N25-2	1174	1675	1890		.419	.444	.471	
	N25-3	1273	1798	1833		.400	.506	.454	
Half of the nitrogen from calurea	N26	1128	2002	1950	1616	.398	.459	.463	.438
	N26-1	1160	1728	1894		.395	.491	.444	
	N26-2	1257	1720	1953		.394	.448	.473	
	N26-3	1092	1745	1759		.413	.455	.424	
All the nitrogen from calurea	N27	1223	1932	1993	1653	.386	.454	.454	.436
	N27-1	1201	1760	2102		.387	.476	.455	
	N27-2	1113	1651	1881		.400	.400	.485	
	N27-3	1298	1861	1817		.425	.462	.451	

Since some tobacco dealers and growers think that the use of calurea or urea may have a bad effect on the quality of tobacco—an effect that might not show at the time of sorting—all the tobacco of the three top grades of the 1931 crop was submitted after fermentation to experts who had had long experience in judging tobacco. This was done to obtain a commercial opinion on it. J. W. Alsop, of J. W. Alsop, Inc., and Roswell Billings, of P. Lorillard, and Co., kindly consented to act as judges. After carefully examining all samples of each grade they put them into three classes, 1, 2, and 3. Their classification of the samples as given in Table 17, shows that, in their opinion, the fertilizer mixtures that contained calurea produced tobacco of just as good quality as those without calurea.

Comparison of Nitrate of Soda and Nitrate of Lime As Mineral Sources of Nitrogen

Field Experiments

In the 1930 Report of this Station (p. 379) a detailed description is found of the field tests comparing nitrate of soda and nitrate of lime as mineral sources of nitrogen. The test was continued in 1931 without any changes in fertilizer formulas.

TABLE 17. GRADING OF TOBACCO FROM CALUREA PLOTS BY EXPERTS. No. 1 EQUALS BEST GRADE; No. 2, NEXT; AND No. 3, POOREST

Proportion of nitrogen from calurea	Plot No.	Grading by experts[1]			
		Lights	Mediums	Seconds	All
None	N25	1	1	3	26
	N25-1	3	3	2	
	N25-2	1	3	3	
	N25-3	3	2	1	
One-half	N26	2	2	1	24
	N26-1	2	2	1	
	N26-2	1	1	3	
	N26-3	3	3	3	
All	N27	1	2	1	22
	N27-1	2	1	2	
	N27-2	3	3	2	
	N27-3	2	1	2	

Fertilizers were applied on June 5 and plants set on June 15. The tobacco made a fairly good growth on all the plots (Table 18), but it suffered somewhat from drought at the end of the growing season, not being irrigated.

From the records it is found that the yield as well as the grade index is highest where one-fifth of the nitrogen is derived from

TABLE 18. YIELD AND SORTING RECORDS OF NITRATE OF LIME PLOTS. CROP OF 1931

Source of nitrate nitrogen	Plot No.	Acre yield		Percentage of grades								Grade index	
		Plot	Average	L	M	LS	SS	LD	DS	F	B	Plot	Average
Nitrate of soda, ⅕	N1-8	1784	1725	18	10	18	5	34	2	12	1	.482	.451
	N1-9	1666		9	7	22	6	39	4	11	2	.420	
Nitrate of lime, ⅕	N18	1877	1806	26	9	13	5	36		10	1	.526	.486
	N18-1	1734		12	6	25	6	34	3	13	1	.446	
Nitrate of soda, ½	N2-3	1521	1631	5	4	24	8	31	5	20	3	.368	.430
	N2-4	1740		19	10	19	7	30	2	11	2	.492	
Nitrate of lime, ½	N16	1843	1749	16	6	16	8	39	4	10	1	.452	.422
	N16-1	1655		8	6	20	8	32	9	13	4	.391	

[1]No. 1 is the best grade, 2 medium, and 3 poor, so that in the sum of "all" the highest figure is the lowest grading.

nitrate of lime. In either case there is a reduction both in yield and grading when one half of the nitrogen is in the nitrate form. This is probably due to the more rapid leaching of nitrogen in the nitrate form.

TABLE 19. NITRATE OF LIME SERIES. SUMMARY OF YIELD AND GRADE INDEXES FOR FOUR YEARS

Source of nitrate nitrogen	Plot No.	Acre yield by years					Grade indexes by years				
		1927	1928	1930	1931	Average	1927	1928	1930	1931	Average
Nitrate of soda, 1/5	N1-8	1232	1162	1858	1784	1471	.386	.452	.486	.482	.445
	N1-9	1239	1097	1719	1666		.454	.463	.419	.420	
Nitrate of lime, 1/5	N18	1246	1153	1795	1877	1505	.385	.446	.503	.526	.445
	N18-1	1265	1153	1814	1734		.387	.446	.419	.446	
Nitrate of soda, 1/2	N2-3	1145	1098	1403	1521	1357	.352	.422	.405	.368	.408
	N2-4	1185	1080	1685	1740		.344	.421	.462	.492	
Nitrate of lime, 1/2	N16	1348	1076	1839	1843	1456	.457	.408	.469	.452	.417
	N16-1	1128	1088	1674	1655		.386	.376	.394	.391	

A summary of four years' results, found in Table 19, shows good agreement with the results of this year.

From the data presented the following conclusions may be made:

1. Supplying one half of the nitrogen in nitrate form resulted in reduction of both yield and grading.

2. Nitrate of lime gave somewhat better results than nitrate of soda.

TABLE 20. CHEMICAL ANALYSES OF TOBACCO FROM NITRATE OF LIME SERIES. CROP OF 1930[1]

Nitrogen treatment	Plot No.	Percentage of bases in dry leaf[1]				Total bases
		CaO	MgO	K_2O	Na_2O	
Nitrogen in nitrate of soda, 1/5	N1	4.91	1.69	6.66	.092	13.35
Nitrogen in nitrate of soda, 1/2	N2	4.35	1.11	7.59	.168	13.21
Nitrogen in nitrate of lime, 1/5	N16	5.66	1.08	6.39	.066	13.20
Nitrogen in nitrate of lime, 1/2	N18	5.60	.98	6.53	.064	13.17

[1]Air dry basis.

Chemical Analyses

In order to see to what extent the percentage of the four mineral bases was influenced by the various fertilizer treatments in this experiment, unfermented samples of darks and seconds of the 1930 crop (after removal of midribs) were analyzed for CaO, MgO, K_2O and Na_2O. An average of the two grades from duplicate plots is given in Table 20.

These data show that when nitrate of soda was used, the potash increased in the plant somewhat in proportion to the nitrate of soda added to the soil. The soda similarly increased, but the intake was quite small compared with the amount added in the fertilizer. There is, however, no particular advantage in raising the potash content above a certain limit, that is, to produce an improper balance with lime and magnesia, since it will cause the tobacco to burn black, as has been found in our potash experiments. Nitrate of lime has increased the percentage of calcium in the leaf and at the same time slightly reduced the content of magnesia.

An interesting feature in the above table is that the sum of the bases in tobacco seems to remain fairly constant, irrespective of fertilizer treatments. This tendency has been observed in previous analyses at this Station. Those, however, did not include sodium.

Nitrophoska

Nitrophoska tests were continued in 1931 according to the same outline as in 1929 and 1930, of which a full statement is made in the Report for 1930, pages 377-379.

Fertilizer was applied on May 27 and plants set on June 12. No lime or top dressing was applied to these plots. They were, however, irrigated twice during the growing season, on July 30, and about a week later. The tobacco made vigorous growth on all the plots up to the date of harvesting, August 20.

Table 21. Yield and Sorting Records of Nitrophoska Plots. Crop of 1931

Proportion of Nitrophoska	Plot No.	Acre yield		Percentage of grades								Grade index	
		Plot	Average	L	M	LS	SS	LD	DS	F	B	Plot	Average
None	N28	1793	1778	14	12	27	5	31		9	2	.493	.487
	N28-1	1764		14	11	25	5	32	1	10	2	.481	
Half Nitrophoska	N29	1813	1835	8	10	30	4	35	1	9	3	.451	.465
	N29-1	1856		13	9	28	5	32	2	9	2	.478	
All Nitrophoska	N30	1813	1817	7	9	29	4	39	1	9	2	.440	.443
	N30-1	1820		8	8	29	7	37	1	9	1	.446	

The leaves were sorted in the Station warehouse. Yield and grading records are listed in Table 21 and a summary of two years' results in Table 22. These show a somewhat increased yield, but a slightly reduced index when Nitrophoska is used. A longer period of testing is needed to draw final conclusions.

TABLE 22. NITROPHOSKA SERIES. SUMMARY OF TWO YEARS RESULTS

Nitrophoska used	Plot No.	Acre yield by years			Grade index		
		1930	1931	Average	1930	1931	Average
None	N28	1884	1793	1818	.491	.493	.482
Standard formula	N28-1	1829	1764		.464	.481	
Half Nitrophoska	N29	1813	1813	1853	.457	.451	.460
	N29-1	1856	1856		.453	.478	
All Nitrophoska	N30	1915	1813	1856	.435	.440	.449
	N30-1	1875	1820		.473	.446	

EFFECT OF ADDING GYPSUM TO THE SOIL

The application of gypsum (land plaster or calcium sulfate) to soils for the purpose of increasing yields of various crops, is an ancient practice in agriculture. In some sections and for some crops, it has been beneficial; in other places, careful experiments have shown that it is without value. Gypsum has also been recommended and used at times on tobacco land, although not so much in recent years as formerly. The writers are not acquainted with any published experiments in which its effect on the yield and quality of tobacco has been tested.

There appear to be no theoretical reasons for believing that gypsum would benefit tobacco under our conditions. As a plant food, it could supply only calcium and sulfur. Both of these elements are essential to plant growth, but there are no indications that a shortage of either ever occurs in our soils under practical tobacco culture. The benefits derived from its use in some sections are most likely due to the fact that those soils are deficient in one of these elements. In our case there is the danger of getting too much sulfur in the leaves.

Even though it should have no nutritive value, the possibility still exists that gypsum may effect some change in the soil that would indirectly benefit tobacco. It has been established by experiments in various localities that it causes no significant change in soil reaction. Cubbon[1] who thoroughly reviewed the investigations on gypsum and supplemented them by further original experiments, found

[1]Cubbon, M. H. Calcium sulfate as a soil amendment. N. Y. (Cornell) Agr. Expt. Sta. Memoir 97. 1926.

that (1) it was not beneficial to crops, (2) it depressed the nitrate accumulation, and (3) did not affect bacterial activity, carbon dioxide production, catalylic power of soil, or potash liberation. It changed slightly the physical condition of the soil, in that its water-holding ability was increased somewhat. There is considerable difference of opinion among investigators as to whether gypsum aids in liberation of potash (more fully discussed in a recent bulletin by the writers[1]).

Three field plots to which gypsum was applied in different amounts were included in an experiment on absorption of calcium in 1929, and have been continued up to the present. Since these plots yielded some results that are of interest outside the original purpose of the experiment, a summary is presented here.

The experiment included 4 one-fortieth acre plots on the better part of Field V, a Merrimac sandy loam. All were fertilized alike (see fertilizer for cover crops on page 226). No gypsum was added to one plot, and 500, 1000, and 5000 pounds per acre were supplied to the other three in the spring of 1929. All were set uniformly to Havana seed tobacco. Destruction of the 1929 crop by hail prevented taking records. In 1930, the plots were continued, but only half as much gypsum was applied to each. In 1931, no additional gypsum was applied.

Observations of the growing crop throughout these three seasons showed no marked differences between the tobacco on the four plots. The yield and grading records for the last two years are shown in Table 23.

TABLE 23. GYPSUM PLOTS. YIELD AND GRADE INDEXES FOR TWO YEARS

Quantity of gypsum applied		Acre yield by years			Grade index by years		
1929	1930	1930	1931	Average	1930	1931	Average
None	None	1554	1440	1492	.408	.319	.364
500	250	1733	1548	1641	.438	.462	.450
1000	500	1617	1830	1724	.440	.420	.430
5000	2500	1465	1662	1564	.324	.394	.357

These results disclose that there was a definite and consistent improvement, both in yield and grading, from the lower applications, but not from the highest.

Effect of gypsum on the absorption of mineral bases and of sulfur. The original object of this experiment was to see whether the calcium content of the plants would be increased by these heavy applications of calcium sulfate. If it were, what

[1]Potash requirements of the tobacco crop. Conn. Agr. Expt. Sta. Bul. 334. 1932.

influence would it have on the other mineral bases? Also there was the question as to how much the sulfur had been increased. Samples of the crop of 1930 were therefore analyzed for these three bases and for sulfur. The results are presented in Table 24.

TABLE 24. EFFECT OF GYPSUM APPLICATION ON CHEMICAL COMPOSITION OF THE TOBACCO AND ON FIRE-HOLDING CAPACITY. CROP OF 1930 (AIR DRY BASIS ON UNFERMENTED TOBACCO)

Annual application of gypsum, pounds per acre		Percentage of compounds found in the leaf				Duration of burn (seconds)
1929	1930	K_2O	CaO	MgO	S.	
None	None	5.55	5.40	1.71	.45	56
500	250	7.03	6.26	1.56	.63	52
1000	500	6.68	5.47	1.43	.70	43
5000	2500	6.16	6.69	1.43	.88	24

The percentages given in this table are averages of two grades (darks and seconds) from each plot. The percentage of calcium in the leaf was increased slightly by the application of gypsum, but this increase was not in proportion to the quantity applied. The percentage of potash absorbed was increased by gypsum, but the smaller quantity of gypsum had more effect than the very heavy applications. The quantity of magnesia was somewhat reduced by gypsum, a result that would naturally be anticipated when the other bases were increased. The absorption of sulfur was increased regularly, but not proportionately, by increasing quantities of gypsum. The results on sulfur intake agree with our results with other fertilizer compounds containing sulfur, such as sulfate of ammonia (Tob. Sta. Bul. 10: 44-47) and sulfate of potash (Conn. Agr. Expt. Sta. Bul. 311: 212-214). All of these experiments show that although the sulfur content of tobacco under our conditions cannot be raised or lowered as readily as that of such elements as chlorine or potash, there is a definite response to increased sulfur application. Moderate quantities of sulfur in the fertilizer would be of no serious importance, but the use of excessive amounts certainly should be avoided if it is desired to keep down the percentage of sulfur in the leaf.

Influence on fire-holding capacity. In order to see what effect this increase in sulfur content has on the fire-holding capacity, leaves from the four grades of each of the plots were tested by the usual strip test. The average duration of burn for the four grades on each plot is shown in the last column of Table 24. The results show that the increase in sulfur produced by the heaviest gypsum application had a marked detrimental effect on the fire-holding capacity of the leaf, and even the smaller application had some effect. These results confirm our conclusions previously drawn from tests with other sulfates.

Conclusions. The use of gypsum in these experiments has both increased the yield and improved the grading of the tobacco. It has also raised the percentage of potassium and calcium in the leaf, but such increase is probably of no particular advantage in our tobacco. Gypsum increased the sulfur content and reduced the burning capacity.

In view of these results, it seems that caution should be used in the application of gypsum to tobacco land.

FRENCHING, OR STRAP-LEAF DISEASE

A severe case of frenching near Unionville was called to our attention in August. It is not a very common or widespread disease in this state and in general is not of serious economic consequence. But, since it does occur sporadically and on some fields, may injure the crop considerably, or in less severe cases, cause the grower some concern, the following statement and illustrations may be of interest.

The principal symptoms by which one may readily recognize the disease are illustrated in Figures 25, 26 and 27. These are photographs of plants taken from the Unionville field. The leaves are thick, narrow and strap or sword-shaped, and have wavy, scalloped or crinkled margins. In severe cases all the leaves on a plant are affected; in less severe instances, the lower leaves are normal or partly so, showing that the attack occurred after the plants were partly grown. In such cases as those shown in Figures 25 and 26 the stalk fails to elongate properly and the whole plant appears as a bush of dagger-like leaves in abnormally large number set very close together. This appearance may be intensified by abnormal branching of the stalk. Such plants never reach normal height and are naturally worthless in cigar leaf tobacco. Although this disease is usually described as characterized by chlorosis or fading out of the green color, this symptom was not noticed in this case. The color was normal and there was no indication of nitrogen starvation. Practically all of the plants were ruined on about an acre, while varying percentages of the plants were affected on the remainder of the field and in an adjacent field.

The soil was a good sandy loam (Hinckley or Merrimac), in no way different from other fields in that section. The reaction of the soil was between 6.00 and 7.00 pH, which is higher than the average soil in this state. A good tobacco fertilizer with adequate quantity of nutrient materials had been used.

Investigations in other states where frenching occurs have shown that the malady is not infectious and thus there is no danger of spreading it.

FIGURE 25. Frenching. Badly affected Havana Seed plant transplanted from Unionville field.

Considerable investigation has been made to discover the cause of frenching, but as yet no fully adequate explanation has been published. All agree that it is not associated with parasitic fungi, bacteria, or insect attacks. It is probably a malnutrition trouble.

Wolf and Moss (5)[1] who studied the disease in North Carolina, state: "Excessive soil moisture, due to a wet season, proximity to the water table, to ditches, to stumps, or to small basins where the water may collect, is very commonly associated with the disorder.

FIGURE 26. Frenching. Another plant from the Unionville field.

"The use of excessive amounts of commercial fertilizer has been offered as the most reasonable explanation for the occurrence of frenching in some instances.

"It has been noted on the Tobacco Experiment Farm at Oxford, N. C., that on certain plats, which had received no fertilizer, practically all of the plants were frenched. Here no cause other

[1]Numbers in parenthesis refer to references listed on page 260.

than the mineral deficiency could be found, since all plants on adjacent plats remained normal."

Garner (1) says: "The disease is not infectious and is due to some unfavorable condition of the soil. The disease may occur

FIGURE 27. Frenching. A normal tobacco leaf in center compared with two frenched leaves.

at any stage of development and often only the upper part of the plant is affected. Defective drainage seems to be a contributory cause of the disease and it appears that deficiencies in plant food may cause symptoms of the trouble." Johnson (2) states: "The disease is frequently found on soils exposed in one way or another to excessive water. This together with its occurrence at times on portions of fields in poor tilth, indicates a relation to soil aeration. On the other hand, frenching seems to have considerable relation to soil fertility, or at least to a deficiency of certain fertilizing elements, but in combination with these factors certain weather conditions must apparently exist to bring about its expression."

Valleau and Johnson (4) conducted extensive experiments with Turkish tobacco and decided that frenching was caused by deficiency of available nitrogen. As a result of later investigations, however, Karraker and Valleau (3) state: "It now appears less probable that frenching of tobacco is directly caused by a deficient supply of nitrogen." However, they found a definite relation between liming and frenching. The disease occurred only on soils above 6.00 pH. The authors state: "It seems evident that liming favors frenching on at least some soils." This is in agreement with experiments by Jacobson at the Station in New Haven and with our field observations. It seems to be fairly well substantiated, therefore, that a high soil reaction—above 6.00 pH—is one of the conditions necessary for the development of the disease. Since, the majority of fields with this reaction grow normal tobacco, it is obvious that this is not the main cause. From the Report of the Director of the Kentucky Agricultural Experiment Station for 1930, page 24, we quote, "It seems probable that the frenching of tobacco in the field is nearly always associated with phosphorus or potassium deficiency when it occurs in the early part of growth of the plants, and that when associated with nitrogen deficiency, it occurs only in the later growth of the plants."

Obviously we are still much in the dark with respect to a true explanation of the cause of this disease. The only recommendation that can be made is that the grower keep the reaction of his soil below 6.00 pH, and if this is impracticable and the disease appears year after year on a field, that he use some other field for tobacco.

1. Garner, W. W. Tobacco culture. U. S. Dept. Agr. Farmers' Bul. **571**: 20. 1929.
2. Johnson, James. Tobacco diseases and their control. U. S. Dept. Agr. Bul. **1356**. 1924.
3. Karraker, P. E., and W. D. Valleau. Frenching of tobacco and liming. Amer. Jour. Agron., **22**: 283. 1930.
4. Valleau, W. D., and E. M. Johnson. Tobacco frenching—a nitrogen deficiency disease. Ky. Agr. Expt. Sta. Bul. **281**: 179-253. 1927.
5. Wolf, F. A., and E. G. Moss. Diseases of flue-cured tobacco. N. C. Dept. Agr. Bul. **263**—(Vol. 40, No. 12): 22-24. 1919.

TOBACCO INSECTS IN 1931

Donald S. Lacroix

The studies on tobacco pests begun in 1930 were continued this season according to the same methods.

Prevalence of Various Species

The eastern field wireworm (*Pheletes ectypus* Say.) was quite troublesome in many sections, but as a whole appeared less so than in 1930. As is often the case, two plantings and in some instances three were necessary before the larvae disappeared. On July 19 a severe infestation (probably a different species) was still present in Thompsonville.

Adults of this insect were flying May 29 to June 6 and could be collected in large numbers on the sides of some shade tents in Windsor. Two hundred adults caged on a single tobacco plant did a small amount of feeding on the leaves. Many of them burrowed into the soil for a distance of one and one-half to two inches. Although females containing eggs were present, no eggs were deposited in the cage.

The potato flea beetle (*Epitrix cucumeris* Haw.) did not cause such widespread injury on tobacco in 1931 as the year before. Adults could be found in every field visited, but serious trouble was experienced on relatively few plantations. On the whole, Havana Seed tobacco was damaged more than Shade grown this year.

Tobacco horn worms (*Phlegethontius quinquemaculata* Haw. and *P. sexta* Johan.) were far more abundant in 1931, appeared earlier than usual, and caused much more trouble than in 1930.

In the New Milford district, much injury to tobacco resulted from activities of the tarnished plant bug (*Lygus pratensis* Linn.). This insect pierces the growing tip, causing the leaves that unfold from the terminal bud to be malformed. It is a pest that is becoming more and more important, and plans are being made to study it fully.

The spined stink bug (*Euschistus variolarius* Beauv.) was also abundant in the New Milford section. This, too, is a piercing insect, and causes the leaves to wilt down. However, after a few days the plant recovers and is normal.

Thrips (sp.) were found on the lower leaves of tobacco in only two fields.

Early in July the stalk borer (*Papaipema nitela* Guen.) occurred on several plantations in limited numbers.

Grasshoppers (*Melanoplus femur-rubrum* DeG., *Dissosteira carolina* Linn., *Scudderia curvicauda* DeG. and *Neoconocephalus ensiger* Haw.) caused less trouble in 1931 than in 1930.

Plant lice were numerous on sungrown fields, but not abundant enough to injure the plants.

Springtail (*Proisotoma minuta* Tully). Two infestations of

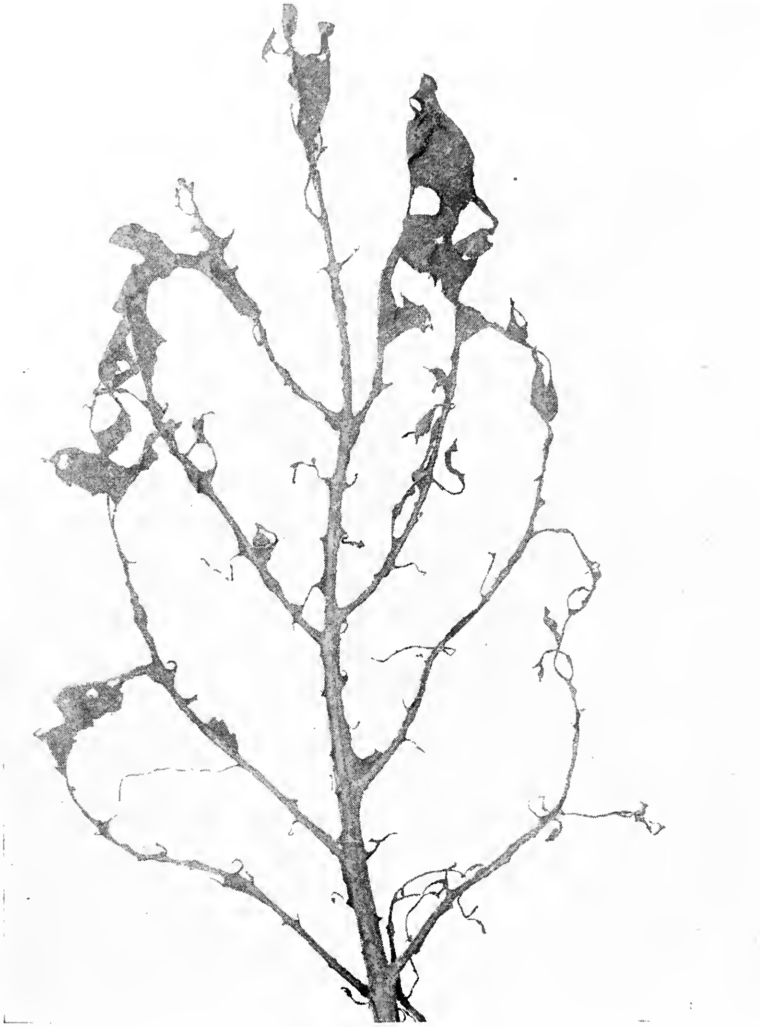

FIGURE 28. Injury by spotted cutworms to leaf of Broadleaf tobacco.

springtails were observed June 13 and 19 in Suffield. In each case these minute insects occurred in such numbers that they filled parts of furrows and horses' hoof prints in the soil to a depth of an inch or more. No tobacco had been set at the time. The insects disappeared with the coming of warm, dry weather.

On July 20 our attention was called to a late, serious infestation of the spotted cutworm (*Agrotis c-nigrum* Linn.) on two fields

FIGURE 29. Work of stalk girdler on young tobacco plant.

of Broadleaf tobacco in South Windsor. Upon investigation it was found that in each case the tobacco was adjacent to a timothy field, and that the larvae were noticed on the tobacco about two days after the hay was cut. Also, each hay field was a new planting, that is, had been seeded the year before. The larvae were very abundant on the lower leaves and ground in three rows next to the stubble, and were eating all leaf tissue down to the midrib and coarser leaf veins (Figure 28). In some cases they had chewed into the base of the stalk. From 35 to 50 larvae could be found on and around each plant.

A third field, this one in East Windsor, developed a similar infestation under the same conditions as those that existed on the South Windsor farms. Heavy spraying of the three outside rows and the use of poisoned bran bait on the fourth and fifth rows was recommended to check the infestation. Four days later many dead worms could be picked up under plants, and the situation was well under control. Nearly all the worms were practically full grown, and at least 75 per cent bore the eggs of parasites near

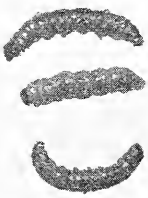

FIGURE 30. Larvae of stalk girdler. Enlarged.

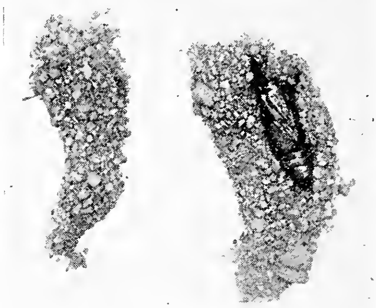

FIGURE 31. Cocoons of stalk girdler. One at right cut open to show pupa. Enlarged.

the front end of the body. A few non-parasitized larvae were placed in rearing jars and pupated July 25-29, 1931. Emergence of moths took place August 10-17, 1931.

Cutworms of all species were very abundant this season. Even the early broods which attack newly set plants were so numerous that two applications of poisoned bran bait were necessary to hold them in check on many plantations. In a few cases the application of poisoned bait did not result in the usual satisfactory control, and the plants were reset twice.

The corn root webworm (*Crambus caliginosellus* Clem.) made its appearance this year on a field of sungrown tobacco in Windsor. This worm, living beneath the soil, girdles the stalk of newly set plants just below the soil surface, and eventually enters the stalk and tunnels upward (Figure 29). It is a small active worm, (Figure 30) about one-half inch long, dirty yellow to light brown in color, and always accompanied by a lot of web and silk strands. At first sight, a field infested with this insect looks much as though wireworms were at work, but an examination of the plant stems shows a girdling, as well as a tunneling.

Many larvae were collected and placed in rearing jars. Pupation took place June 30 to July 3, and the emergence of moths occurred from July 9 to July 15, the greatest number coming out July 13. Eggs deposited loosely by the moths failed to hatch. Pupation takes place in an earthen cell made up of silk webbing and loose soil. These tough cells are pear-shaped (Figure 31) and range in length from one-half to three-fourth inch and in width (at widest part) from three-eighth to one-half inch. They were found from 1 to 3 inches below the surface of the soil. The adult is a small, light brown moth about half an inch long, of nervous temperament, flying with rapid zig-zag movements, and always darting to cover when disturbed.

This insect belongs to a large group of stem girdlers that ordinarily feed on grass and weeds, and this fact probably explains how it happened to occur on tobacco. The plantation was in sod the year before tobacco was planted, which was ideal for the development of the girdler. On plowing and planting to tobacco, the natural food was not available, so the larvae attacked the crop present. The insect has been reported as being injurious to tobacco in Virginia. (See U. S. Dept. Agr. Bull. 78. 1914).

Life History Studies on the Potato Flea Beetle

Little is known of the life history of this insect on tobacco. This summer preliminary steps were taken to observe the various stages in its development. Eggs were obtained from the beetles throughout the month of July and a few were laid in early August. Egg deposition was somewhat erratic. To observe this, 200 and 400 beetles were caged together in celluloid cylinders, each cylinder having a cheese cloth bottom and voile top. These were placed on blotting paper on pots of moist soil, and the eggs were deposited on the blotting paper. The papers carrying the eggs were placed on moist paper in tin salve boxes.

Often eggs were obtained in but a few hours after the insects were admitted to the rearing cages. In many instances the beetles would deposit no eggs over a period of days. Some were placed in a greenhouse where the temperature was very high, others in the basement of the laboratory where it was fairly cool and constant, and still others in the office where the temperature was variable. Little difference in results was noticeable, except that the adults died in a few hours when kept in the greenhouse. Eggs deposited early in July hatched in three days. Those deposited late in July hatched in seven days. Larval development was curtailed by the great abundance of saprophytic fungi which got into the rearing containers.

An interesting feature that came up in connection with insecticide tests was the fact that no infestation of flea beetles developed on the shade plots treated with fluosilicates last year. The same plots used last year were screened off, in preparation for further insecticide tests, but the only beetles found were on a few plants near the edges of the tent. These pots were dusted last year with cryolite and with barium fluosilicate.

A rather severe infestation developed on some Havana Seed grown in concrete pits, near the seed beds. One dusting of barium fluosilicate stopped further feeding by the beetles, and as there was no rain during the following weeks, the dust remained until harvest. The flea beetle population on the Experiment Station plantation in 1931 was less than one-third of that in 1930. Last year the infestation was much heavier on the shade grown than on the sungrown tobacco, while this year the opposite was true. (See Table 25).

TABLE 25. FLEA BEETLE POPULATION ON STATION TOBACCO, 1931

Number of flea beetles on 25 plants

Date	Sun grown		Shade grown		Total
	Section 1	Section 2	Section 3	Section 4	
June 26	2	11	21	29	63
27	3	17	16	13	49
29	3	18	8	13	42
30	10	14	10	11	45
July 1	11	6	7	14	38
2	7	10	6	3	26
3	11	7	4	13	35
7	7	3	5	5	20
9	8	6	4	7	25
10	4	3	8	6	21
11	9	11	12	7	39
13	27	26	31	10	94
14	21	17	26	5	69
16	22	11	30	21	84
17	37	19	52	25	133
20	52	36	101	33	222
21	64	33	117	38	252
23	79	57	82	21	239
27	91	73	21	12	197
29	62	54	9	6	131
31	58	71	picked	picked	
Aug. 5	37	28			
10	16	21			

Insecticide Tests

Wireworms are without a doubt the cause of considerable losses in the Connecticut Valley and may be rated among the most important tobacco pests with which we have to contend.

Many materials that might kill or repel the worms without damage to the young plants have been used. In 1931, several materials were tried in a series of tests, Pyrethrol, Red Arrow, rotenone, naphthalene and others.

Pyrethrol. This insecticide contains pyrethrum (a material of plant origin which is toxic to insects but not to plants or man) and soap. Two dilutions of Pyrethrol in water were used in the tests; 1 to 50, and 1 to 25. The mixture was used in the soil in resetting plants, and in a further test, in which three wireworms were placed in the soil with each of 25 plants. At a strength of 1 to 50, the insecticide apparently had no effect on either the plants or the wireworms. At the 1 to 25 strength the plants were severely injured and the wireworms only paralyzed.

The method employed in applying the insecticide was to dig a small hole in the soil, place the wireworms in the hole, pour in the material, and set the plant.

Red Arrow. This is another pyrethrum-soap combination of some value in controlling many pests. It was used in the same way as Pyrethrol and at the same time, at dilutions of 1 to 100 and 1 to 25, with results essentially the same, except that the injury to the tobacco plant was not quite so pronounced.

Rotenone. This is a plant product that has recently received much attention as an insecticide. It is said to be very effective against some insects at extremely weak dilutions. Rotenone was used at the same time as the Pyrethrol and Red Arrow and under the same conditions, at dilutions of 1 to 5000 and 1 to 1000. It had no ill effect on the plants and did not seem to interfere with the activities of the wireworms.

Naphthalene. Naphthalene, often used as a repellent for certain insects, is best known in the form of "moth balls," which are placed in closets, trunks, and chests to keep out clothes moths. Some tobacco growers have tried to control wireworms by merely placing a cloth bag filled with moth balls in the setter barrel. This material is not soluble in water, so that little benefit may be obtained by using it in this manner.

Several tests were made with naphthalene in the granular form, which was applied dry around the roots and also in suspension in water. When it was applied dry, one teaspoonful to a plant, most of the wireworms were repelled. In one or two cases, they were paralyzed. The effect on the plants in this form was somewhat erratic. In some cases, it had no harmful effect, and in others a severe setback was the result.

As this seemed the most promising material tried, other tests were made to determine the effect of naphthalene on plants in several types of soil. First of all, the naphthalene must remain in suspension in water so that it may be carried to the soil evenly from the setter barrel. To obtain this kind of a solution, several materials were tried along with the naphthalene, including wood alcohol, ether, acetone, and others. The most satisfactory results were obtained by grinding the naphthalene to a powder and mixing it with Kayso, a commercial casein product.

This naphthalene-Kayso mixture was applied to transplants in the water used in setting, at rates of one-fourth, one-half, or a full teaspoon of naphthalene to a plant. Twenty-five plants were transplanted in each dilution and 25 in clear water as checks. In each case where naphthalene was used the plant suffered a setback which was proportional to the amount used.

The potato flea beetle is probably next in importance to wireworms in the Connecticut Valley. Although barium fluosilicate used as a dust, controls the adults quite satisfactorily, the residue left on the leaf is not desirable. With this in mind, nicotine sulfate was tried this season, combined with soap or with Penetrol. Since the tests were carried out only on sungrown tobacco, conclusive results were not obtained. It seemed to hold the infestation in check to a slight degree, but the difference between treated and untreated areas was not great.

CURING EXPERIMENTS IN 1931

The experiments in curing shade tobacco under controlled conditions during the past season were planned to study the effect of alternate periods of high and low relative humidity, the temperature being held constant. As a check on these conditions, tobacco from the same lot was kept under unvarying conditions of both temperature and humidity.

In the first two runs, one chamber was kept at as high a humidity as was practicable, the other one as low as could be obtained conveniently. The alternations were secured by exchanging the tobacco on the upper tiers of the two chambers at 12-hour intervals, the lower tiers of both chambers being kept undisturbed to serve as the checks. Thus, tobacco cured under alternations of humidity was compared with two lots of the same picking cured under more extreme conditions.

In the two later runs, one chamber was kept constantly at an assumed optimum of temperature and humidity, while in the other chamber the humidity was raised 10 per cent above optimum for

12 hours of each day, and dropped 10 per cent below for the succeeding half day. This was done by using two humidity control instruments set at the desired figures, the proper instrument being connected to the control mechanism at the desired time. Hence in runs 3 and 4, the effect of varying humidity was compared with constant humidity at or near the optimum. Figure 32 shows hygrothermograph charts of one of the latter runs. The upper

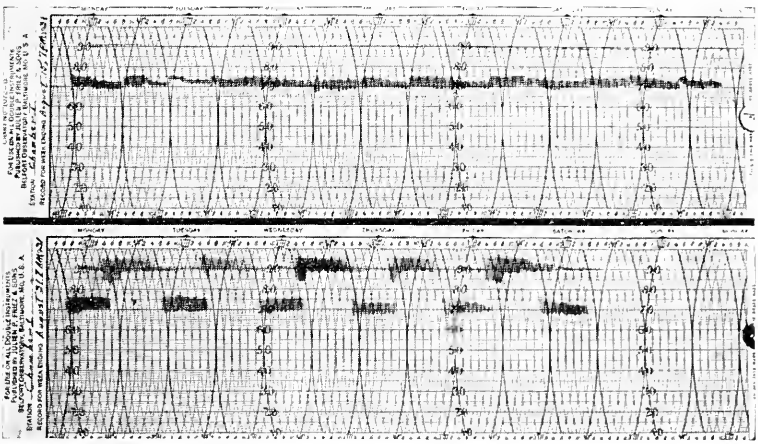

FIGURE 32. Hygrothermograph charts showing constant humidity (above) and alternating humidity (below). Temperature line at 90° in both.

chart was from the chamber operated at constant conditions, the lower from the chamber where the humidity was changed at 12-hour intervals. The broader band in each case indicates the range in relative humidity, and the narrower band the range in temperature.

TABLE 26. SUMMARY OF CURING RESULTS, 1931

First run, first picking. Both chambers at 90° F.

Description of treatment	Notes on tobacco while curing	Notes on sweated tobacco
High humidity 90-95%	Cured in 12 days. Final color chocolate brown. Cure slow for first picking. Pole sweat developed in 7 days, caused considerable damage.	Color uniform but a dull greyish red cast. Much pole sweat, causing high percentage of brokes.

TABLE 26. SUMMARY OF CURING RESULTS, 1931 (*Continued*)

Description of treatment	Notes on tobacco while curing	Notes on sweated tobacco
Low humidity 70-75%	Cured in 9 days. Final color greenish olive. Leaves not very elastic. No pole sweat.	Colors very good, leaves bright, mostly light brown. No pole sweat.
Alternate humidity	Cured in 10 days. Final color a medium brown. Uniformity of colors good. Trace of pole sweat appeared while tobacco was in moist chamber.	Not as bright as low humidity lot, but much superior to high. Few brokes due to pole sweat. Colors not so uniform as might be expected.
Second run, second picking. Both chambers at 90° F.		
High humidity 90-95%	Cured in 17 days. Final color reddish brown. Yellow stage of curing much prolonged. Pole sweat damage pronounced.	Colors much too red—almost brown or cinnamon brown. Great deal of brokes due to pole sweat.
Low humidity 70-75%	Cured in 14 days. Final color greenish to olive brown. Fleshy midribs noted during later stages of curing.	Colors very good in most leaves, but slightly lemon yellow on some leaves that would otherwise be L's.
Alternate humidity	Cured in 15 days. Final color light olive brown. Very little mottling of leaves.	Colors incline a little more toward those of high humidity conditions, mostly a light cinnamon brown. Tips a little dark.
Third run, third picking. Both chambers at 90° F.		
Constant humidity 80-85%	Cured in 15 days. Final color ranged from medium to dark reddish brown. No pole sweat under these conditions. Colors of leaf not uniform.	Colors rather dark brown, but generally satisfactory. Some spotty leaves, but not as pronounced as before sweating.

Table 26. Summary of Curing Results, 1931 (*Continued*)

Description of treatment	Notes on tobacco while curing	Notes on sweated tobacco
Alternate humidity 70-75% and 90-95%	Cured in 15 days. Final color rather dark brown, all leaves nearly the same. Colors on leaf uniform. Only a trace of pole sweat.	Colors just a little darker than under constant conditions. Leaf colors more uniform, little if any yellow spotting. Leaves near a pole sweat condition called "water cock."
Fourth run, fourth picking. Both chambers at 85° F.[1]		
Constant humidity 75-80%	Cured in 12 days. Final colors very diverse, leaves mottled red, olive and yellow.	Practically all tobacco too dark and nearly worthless, due to being overripe.
Alternate humidity 65-70% and 85-90%	Cured in 12 days. Final color deep reddish to olive brown. Color on leaf quite uniform.	Same as for constant humidity.

Table 26 shows the characteristics of the tobacco in curing and after sweating. Tobacco from the same bent of the Station shade tent was used for all runs. The sorting records for the above lots of tobacco are shown in Table 27.

Table 27. Sorting Record of Shade Tobacco in Curing Chambers, 1931

Humidity		L	LL	LC	XL	M	D	Br	Grade index
Run 1	High humidity	20.3	12.7	29.1	15.2			22.7	2.662
1	Low humidity	34.2	28.0	25.6	9.8			2.4	3.708
1	Alternate humidity	24.7	29.3	30.9	8.0			7.1	3.450
Run 2	High humidity	16.4	19.3	21.1	8.6			34.6	2.484
2	Low humidity	27.2	23.3	41.7	3.9			3.9	3.601
2	Alternate humidity	21.5	30.5	36.2	9.6			2.2	3.488
Run 3	Constant humidity	5.9	17.3	42.2	5.5	12.2	9.3	7.6	2.636
3	Alternate humidity	7.2	19.1	36.2	6.2	7.4	15.9	8.0	2.560
Run 4	Constant humidity			7.9		13.7	77.3	1.1	.893
4	Alternate humidity			3.6		11.3	85.1		.760

[1]The tobacco for the fourth run was overripe, being picked 12 days later than the field picking. This was unavoidable, since this run could not be started until the third run was complete.

It can be seen from an examination of these tables that the best tobacco from the first and second pickings was produced under constant low humidity, that alternations of humidity produced almost as good grade indexes, and that constant high humidity caused trouble both from pole sweat and darker colors. No significant difference between constant optimum conditions and alternate conditions was found in the sweated tobacco from the third picking, while the results on the fourth picking were vitiated by the extreme ripeness of the tobacco.

The effect of subjecting the tobacco to alternate periods of high and low humidity was to produce a much more uniform color distribution on the cured leaf, but not a great difference on the sweated leaf. This was to be expected, as the conditions of high humidity and temperature that are maintained while tobacco is sweating would tend to blend the colors.

It is also to be noted that the use of equal periods of high and low humidity, with equal increases and decreases of moisture above and below the optimum, produces a tobacco more nearly like that produced under constant high humidity. In other words, in order to obtain a tobacco intermediate in color between those produced at the extremes, it is not necessary to have the tobacco under high humidity conditions more than one-third of the time, or even less. These results indicate that judicious handling of the tobacco in the shed, occasionally permitting the leaves to become moist and the colors to become more evenly distributed, should be practiced.

Observations on the occurrence of pole sweat during the three years in which the experiments have been in progress, indicate that the malady is apt to develop any time after the tobacco is in the yellow stage, providing the air is near saturation. It was noted at temperatures of 80 and 85° F. with humidities of more than 85 per cent, and at temperatures of 90 to 95° with humidities of 95 per cent. In one instance, a temperature of 100° with a humidity of 100 per cent obtained for a few hours as a result of the controls sticking, and the increase of pole sweat was very marked.

Production of Color as Related to Rate of Curing

For any given lot of tobacco, a rather wide range of colors may be produced by differences in the rate of curing. Table 28 is presented to show in part the distribution of colors for different pickings under various combinations of temperature and humidity. The number in parenthesis following each entry designates the picking.

The range of humidity shown in Table 28 is the greatest that can be secured with these chambers, while the temperatures chosen are those most likely to be encountered under field conditions and conveniently obtainable in the curing chambers.

TABLE 28. COLORS OF SHADE TOBACCO CURED UNDER CONTROLLED CONDITIONS

Degrees F.	Percentage of relative humidity				
	60 - 70	70 - 80	80 - 85	85 - 90	90 - 95
80°			Reddish brown (1) Reddish brown, deeper shade (2) Very reddish brown (4)		
85°			Dark brown (3) Dark reddish brown (3) Very deep brown (4)	Very deep brown (4)	
90°	Greenish yellow (1)	Light brown (1) Very light brown (2)	Medium to dark brown (3) Chocolate brown (3)	Light reddish brown (1) Light cinnamon brown (2) Dark brown (3)	Dull reddish brown (1) Medium brown (1) Cinnamon brown (2)
95°			Light olive brown (1) Light brown (2) Dark olive brown (3) Blue black (4)	Deep olive brown (3)	

The effect of increasing the humidity while keeping the temperature constant can be ascertained by reading from left to right on the 90° column. As the humidity is increased without changing the temperature, the tobacco cures more slowly, and the colors produced are progressively darker. First picking ranged in color from greenish yellow through light browns to reddish and medium browns. Second picking tobacco was very light brown at the lowest humidity used and cinnamon brown at the highest.

Conversely the effect of increasing the temperature while maintaining the relative humidity at a constant figure is to hasten the rate of curing and produce lighter colors. This may be seen by reading down on the 80-85 per cent humidity column. First picking ranged from reddish brown to light olive brown; second picking from reddish brown to light brown; third picking from dark reddish brown through medium brown to dark olive brown; and fourth picking from dark reddish brown to blue black. In regard to temperature, it can be seen that 95° F. hastened the curing so much that olive shades were found with all pickings, except the second, culminating with blue black for fourth picking. In general, olive shades are the result of such rapid curing that some of the original green pigment in the leaf is fixed without change during the curing process, and may be darkened by sweating.

Reddish shades are invariably the result of too slow curing, and are associated with conditions that are found most likely to produce pole sweat, viz., 80-85 per cent humidity with 80-85° F., and 90-95 per cent humidity with 90° F.

The best colors, therefore, are found under conditions that represent intermediate conditions with respect to both temperature and humidity. High temperatures can be used only in conjunction with fairly high humidities, unless for limited periods of time. Low temperatures will produce tobacco of good color only when the humidity is kept low. In these experiments we have not been able to maintain constantly a sufficiently low humidity to produce good colors at 80° F., and 85° has not been much more successful. The best colors were produced for first and second pickings at a temperature of 90° F. and humidities of 70-80 per cent, and the next best at a temperature of 95° and a humidity of 80-85 per cent. Later pickings always produce darker tobacco, and the results obtained do not permit as definite conclusions. Extreme conditions are more apt to produce valueless tobacco, but it would seem that a temperature of 85-90° F. combined with a humidity of about 80 per cent, is the most favorable condition.