Report for 1946

TOBACCO SUBSTATION AT WINDSOR

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P. J. ANDERSON
T. R. SWANBACK
A. B. PACK

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONNECTICUT

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This 25th annual report describes experimental work on tobacco culture conducted at the Tobacco Substation at Windsor during 1946.

For the majority of growers, the year was a prosperous one. The acreage was the largest in many years, the season was fair and the open field crop was sold before harvest at the highest price on record. Although labor and materials were very expensive, the price of 70 to 80 cents a pound offered for most crops produced a good profit. The shade crop is not yet sold but the demand is good and no doubt should bring as high prices as in 1945.

Weather Conditions During the 1946 Growing Season

The most significant feature of the weather in 1946 was the prolonged and rather severe drought beginning June 14 and extending through July 20, a period of 37 days. During this interval the rainfall totalled only 0.84 inch compared with the normal expectancy of more than three inches. The rain came in light, well scattered thunderstorms. The hottest weather of the season also occurred in this period with the maximum for the summer of 96 degrees on July 19 and temperatures in late June averaging five degrees above normal. Nearly half of the 37 days were clear, that is, less than four tenths average cloud cover.

With the exception of May and early June, the season as a whole was much drier than normal and about normal with respect to temperature. The transplants were set in soil that was well moistened with the storms occurring before and at planting time and this no doubt helped materially in their resistance to the drought period in mid-season. After the drought was broken by heavy storms on July 22 and 23, the closing four weeks of the season were noted by unusually cloudy, damp and rather cool weather. Cloudiness in August was about 20 per cent greater than in the previous months of June and July and, with rainfall slightly above normal, the crop recovered somewhat from the effects of the prolonged dry period. Temperatures in August were well below normal and, as a result, the four month season averaged 0.5 degree below normal.

For Windsor and vicinity, the remainder of 1946 was featured by precipitation well below normal and temperatures warmer than usual. March was very warm, the second warmest on record. The autumn months of September through November also were remarkable for giving us unseasonably warm, dry weather. Damaging blizzards, cloud bursts, winds or frosts were not observed and the few local hailstorms were not wide-spread. The frost free season (no killing frosts) extended from May 9 through October 21 for a total of 167 days.

TABLE 1. A SUMMARY OF TEMPERATURE, RAINFALL AND CLOUDINESS DURING THE TOBACCO GROWING SEASON OF 1946.

Month	10-day period	Mean temperature (° F.)	Departure from normal	Precipitation (inches)	Departure of total from 24 yr. Station ave.	Mean cloudiness (per cent sky covered)
	1-10	51.8	–2.1	0.80	......	64
May	11-20	56.7	–0.6	2.00	......	89
	21-31	62.5	1.8	2.85	......	70
		57.2	–0.3	5.65	2.22	74
	1-10	60.8	–3.7	2.10	......	61
June	11-20	65.4	–1.8	0.70	......	67
	21-30	74.5	4.9	0.14	......	50
		66.9	–0.2	2.94	–0.89	59
	1-10	72.6	1.8	0.46	......	68
July	11-20	71.6	–0.4	0.05	......	52
	21-30	70.0	–2.1	3.43	......	67
		71.3	–0.2	3.94	–0.35	62
	1-10	69.8	–1.0	1.73	......	75
August	11-20	68.0	–1.2	1.67	......	73
	21-31	65.1	–1.9	0.60	......	67
		67.5	–1.4	4.00	0.07	72
Totals and averages 4 mos.		65.7	–0.5	16.53	1.05	67

Table 1 presents a summary of the temperature, precipitation and cloudiness as observed at Windsor during the tobacco growing months of May through August.

Supply and Consumption

In planning the size of his operations for the next year, the grower is guided, not only by the price he received for his crop this year, but also by whatever statistics are available on the present stocks of tobacco owned by dealers and manufacturers and the rate of consumption. The most pertinent data for the three types of tobacco grown in the Connecticut Valley are summarized in Tables 2 and 3. These tables cover both Connecticut and Massachusetts tobacco because the two constitute one market. Data from either state alone would be misleading. The tables show the size of the crop and consumption yearly from the start of the second World War and, for comparison, the average of ten years just previous to the war.

TABLE 2. TOBACCO STATISTICS FOR ENTIRE CONNECTICUT VALLEY. ACREAGE AND PRODUCTION OF LAST FIVE YEARS COMPARED WITH 10 PRE-WAR YEARS.

Type	Acres harvested						Production (1,000 lbs.)		
	Average 1932-41	1942	1943	1944	1945	1946	Average 1932-41	1945	(Estimated) 1946
Broadleaf	7,690	6,800	6,600	7,800	8,200	8,600	11,937	13,270	14,877
Havana Seed	6,860	7,600	6,500	6,700	6,700	7,800	10,941	10,160	13,728
Shade	6,170	6,100	6,300	7,300	8,100	8,700	5,941	7,572	8,874
Total	20,720	20,500	19,400	21,800	23,000	25,100	28,819	31,002	37,479

The first feature to be noted is the expansion of acreage in 1946. The total acreage of all types of tobacco (25,100) is the largest since 1925, representing an increase of 9.1 per cent over 1945 and 21 per cent over the 10-year pre-war average. The Broadleaf acreage has been equalled only once since 1932 and that was in 1937. It is 4.9 per cent above 1945 and 11.8 per cent above the ten-year pre-war average. The Shade acreage is the largest ever grown in the Connecticut Valley except for the year 1929 when it was the same as in 1946. It represents an increase of 7.4 per cent over 1945 and 41 per cent over the pre-war 10-year average. Havana Seed acreage is the highest since 1940, an increase of 16 per cent over 1945, but only 13.7 per cent over the 10-year pre-war average.

The acreage expansion which has reached its highest peak in 1946 is, of itself, not necessarily a dangerous situation as long as it does not build up the stocks in the hands of dealers and manufacturers to too high a level. The stock statistics (of July 1, 1946) do not indicate any build-up at all. Broadleaf stocks were 10,000,000 pounds less than the pre-war 10-year period on July 1 and have been on a fairly even level since the beginning of the war period. Thirteen million pounds less of Havana Seed were on hand than in July, 1942, and the stocks have been dwindling steadily since that year. Shade shows an increase of less than 1,000,000 pounds over the pre-war average. These stocks do not, however, include the crop of 1946, which may change the balance a little. But, even allowing for that, there does not appear to be any over-production.

In view of the increasing acreage, why have the stock piles not built up more? In the first place (as shown in Table 3), cigar consumption shows the highest level since 1942. It was maintained at a high level all through the war. A 14 per cent increase in employment in cigar factories over 1945 also shows that cigar leaf is being used faster in 1946. In the second place, the export of cigar tobacco to foreign countries for 1946 is the highest on record. How long this export business will continue and what level it will attain after the world trade channels get back to normal is uncertain.

TABLE 3. TOTAL STOCKS OF TOBACCO OWNED BY HANDLERS, AND CONSUMPTION OF CIGARS.

Year	Total stocks (farm-sales-weight) owned by dealers and manufacturers on July 1 (1,000 lbs.)			Large cigar consumption (tax paid withdrawals) in United States and Puerto Rico
	Broadleaf	Havana Seed	Shade	
Average 1932-41	36,697	32,445	9,508	5,232,515,600
1942	30,499	33,503	8,539	6,206,538,767
1943	25,514	32,319	8,351	5,228,313,000
1944	24,401	28,891	8,775	4,786,127,000
1945	25,898	22,451	10,150	5,014,168,000
1946	26,527	19,854	10,109	5,836,344,000

More Complete Weather Records

Weather is one of the most important influences in growing tobacco, often determining whether a season is successful or not. Results of tobacco experiments conducted in the open field are also often colored by the kind of weather prevailing while the tests were carried on. The influence of some of the weather factors are obvious, that of other factors is not so well understood. In order to correlate weather phenomena with our experiments, we have long kept such weather records as rainfall and temperature during the growing months. With the recent addition of Mr. Pack, a trained meteorologist, to our staff, we have extended this coverage by keeping more complete weather records of rainfall, temperature, sunshine, humidity and wind. These recordings are made in cooperation with the United States Weather Bureau and the Hartford Metropolitan Water Board. All records are available at all times to tobacco growers or others who are interested.

Changed Direction of Research Effort

The dual goal of all research work on tobacco is to find how (1) to improve the quality of our tobacco and (2) reduce the cost of production. All of our projects are aimed toward contributing to one of these goals and for the most part they are designed to accomplish these objects through one or more of the following means:

1. Better fertilization
2. Control of diseases
3. Control of insects
4. Development of better strains or varieties
5. Better cultural practices

Investigations along all five of these lines have been in operation since the establishment of the Tobacco Substation in 1921. Emphasis has shifted somewhat from year to year according to the urgency of need of investigation in the different fields. On the whole, however, the greatest amount of effort and time has been given to the fertilizer experiments. Moreover, more has been published in our reports and bulletins on fertilizer practices than on any other phase of tobacco growing. These practices have now become so thoroughly standardized that the need for further work on this line is less urgent and promises less return than efforts in some of the other four research fields mentioned above. Therefore, it has been decided to suspend most of the fertilizer projects, and direct the emphasis in another direction. The line that looks most promising and most in need of renewed investigation is the fourth subject listed above; viz., development of better strains or varieties—the approach through genetics.

The Genetic Approach to Tobacco Improvement

Few, if any, of our crop plants remain as they were in their wild state. They have been constantly improved and changed by selection, by importation of other varieties and in more recent times by hybridizing. The same is true of tobacco. The kind that the Indians raised would hardly be recognized as tobacco by today's growers. The "shoe-string" variety raised here a hundred years ago would be worthless on our present market.

In the trade there is always a resistance to change or introduction of new varieties or strains and a harking back to the "good old-fashioned" kinds. Many of the new-comers will always be unsatisfactory for one reason or another but inevitably the best of them earn their places and supplant the older types. Work on tobacco along this line, if carefully and scientifically carried out and if great reserve is used in adopting any innovation, offers the greatest promise of improvement of any field. It is with this in mind that we are intensifying our projects on breeding and selection.

Some of these projects have been in operation previously and will be expanded. Others were begun in 1946 and some are planned to start in 1947. Points of improvement sought are principally better quality, higher yield and resistance to disease and insects. One project on improvement of Shade tobacco, started in cooperation with the Shade growers, has been active since 1940, and has produced improved strains that are being grown more extensively every year. Rootrot resistance has also been achieved in the new Shade strains. Projects on improvement of the Havana Seed type have been carried on intermittently for many years. Particularly successful has been the search for Havana Seed strains that are resistant to black rootrot. Considerable progress has been made in developing a mosaic-resistant Broadleaf. A new project was started in 1946 to develop mosaic resistance in Havana Seed. Wildfire resistance work will be started in 1947. Another project in the genetics field started in 1946 is an exploration of the possibility of developing an open-field wrapper type of tobacco.

All plant breeding work necessarily entails long-term projects, and years may pass without any progress to report. However, if sufficient time, thought and work are devoted to it, success in obtaining strains resistant to any disease is almost assured and great improvements in quality and yield can be made.

New Fertilizer Bulletin

The results of many years of tobacco fertilizer research are published in a considerable number of bulletins and reports of the Experiment Station. Many of these are no longer available for distribution. A new bulletin, "Fertilization of Connecticut Tobacco" by Swanback and Anderson, has been written which summarizes in popular form for the grower the essential information which has been gained by these many years of experimentation. This is designed to serve as a practical guide to the grower in the intelligent fertilization of his crop. It has been mailed to all growers as Conn. Agr. Exp. Sta. Bul. 503. Extra copies may be obtained on request.

Nematodes

For the first time in the history of tobacco culture in New England, nematodes, or eel worms, have been reported causing damage to tobacco roots. These organisms cause great damage to tobacco in the southern states. It is not certain whether they have been present in this region before. They may have been overlooked and their injury ascribed to other agents, or this may represent their first incursion. They are discussed in more detail in a preliminary report on page 19.

AMMONIUM NITRATE AS A SOURCE OF NITROGEN IN THE FERTILIZER

T. R. Swanback and P. J. Anderson

The wartime scarcity of nitrogenous materials, suitable for tobacco fertilizer mixtures, is still acute. The growers are finding it difficult to fill their customary requirements of cottonseed meal and other organics. Also, these materials are very high in price.

These conditions led us to search for other materials that may be substituted in part, if not entirely, for the organics. During the recent war, government-sponsored plants produced large quantities of ammonium nitrate, and today there is still a fair supply of this material on the market. Ammonium nitrate contains 32.5 per cent nitrogen, in about equal portions of ammonia and nitrate nitrogen.

Different nitrogenous materials vary in their effect on yield and quality of tobacco. The value of ammonium nitrate on this crop had never been determined in trials at this Station, hence a series of field tests were begun in the spring of 1944.

The experiments were designed to answer the following questions:

1. Can the material be profitably used as the only source of nitrogen in the mixture?

2. What is the relative efficiency of this type of nitrogen in comparison with that of cottonseed meal?

3. Would there be any advantage in applying it in fractions at intervals during the growing season, since it is readily soluble?

4. Can it be used to supplement a mixture of commercial grade?

The soil of the test-field (on Pomeroy Lot) is a fine sandy loam of the Merrimac series. The field had grown vegetables previously but, before that, tobacco for many years.

Twenty-four (1/40 acre) plots were laid out, sufficient to furnish quadruplicates for each treatment. All the plots were in randomized block arrangement.

The experiments have been carried on for three years. Although five or more years are needed to interpret the influence of weather conditions on results, the following progress report will provide some of the information for which we have received many requests from interested growers.

Ammonium Nitrate as a Single Source of Nitrogen

All the nitrogen applied before the crop is planted. The 16 plots included in this series were quadruplicate tests on applications of 150, 175 and 200 pounds of nitrogen to the acre in ammonium nitrate in the fertilizer mixture. These rates were compared with 200 pounds of nitrogen in cottonseed meal. The other essential plant foods were furnished at equal rates for all treatments.

The three different rates of nitrogen from ammonium nitrate were used to find out whether nitrogen furnished in that form is more efficient than cottonseed meal nitrogen.

Both yield and grading (Table 4) were highest for cottonseed meal nitrogen, although none of the other treatments show results that are significantly lower statistically. There is a trend, however, indicating that ammonium nitrate employed as the only source of nitrogen, will produce a lower crop value than cottonseed meal. This conclusion is drawn both from the smaller yields and lower grade indexes.

The fact that the three different quantities of ammonium nitrate produced similar yields and gradings, suggests that the lowest increment, equivalent to 150 pounds of nitrogen to the acre, was sufficient. The absence of significant

TABLE 4. YIELD AND GRADING RECORDS OF AMMONIUM NITRATE SERIES. (COTTONSEED MEAL AND THREE RATES OF AMMONIUM NITRATE). THREE-YEAR SUMMARY.

Materials and quantities of nitrogen	Plot no.	Yield Pounds per acre				Grade index				Crop index
		1944	1945	1946	Ave.	1944	1945	1946	Ave.	(RCV)[1]
Cottonseed meal	N11E	1992	2414	1986	2095	.409	.455	.472	.452	
200 lbs. nitrogen	N11F	2094	2367	1984	2108	.367	.520	.420	.432	867
per acre	N11G	1801	2345	1833	1953	.388	.471	.388	.409	
	N11H	1728	2226	1918	1948	.354	.479	.417	.417	(100)
Ave. for treatment					2026				.428	
150 lbs. nitrogen	N67	1953	2156	1873	1964	.330	.427	.420	.400	
in	N67-1	2071	2203	1819	1978	.433	.448	.423	.432	781
ammonium nitrate	N67-2	1508	2226	1652	1760	.367	.509	.371	.405	
	N67-3	1754	2180	1789	1878	.360	.476	.401	.410	(90)
Ave. for treatment					1895				.412	
175 lbs. nitrogen	N68	1931	2438	1934	2060	.405	.441	.441	.432	
per acre in	N68-1	2020	2204	1917	2015	.394	.481	.422	.430	832
ammonium nitrate	N68-2	1785	2175	1779	1880	.366	.438	.424	.413	(96)
	N68-3	1712	2343	1836	1932	.375	.471	.414	.412	
Ave. for treatment					1972				.422	
200 lbs. nitrogen	N69	1988	2250	1840	1980	.405	.416	.412	.412	
per acre in	N69-1	1943	2039	1781	1886	.416	.447	.400	.416	765
ammonium nitrate	N69-2	1706	2344	1725	1875	.346	.478	.438	.425	(88.2)
	N69-3	1606	2250	1654	1791	.347	.431	.348	.369	
Ave. for treatment					1883				.406	

[1] Relative crop value.

differences from use of increasing amounts of nitrogen is contrary to our previous findings with other nitrogenous materials where increases in crop values followed increased nitrogen supply in the soil—at least until a certain optimum was reached. Apparently, this optimum was supplied by the 150 pound rate. This is supported by soil nitrate determinations, made at approximately 10-day intervals during the growing seasons of 1944 and 1946. The results are given in Table 5.

Based on previous findings,[1,2] the average nitrate level for cottonseed meal in 1944 would be ample for optimum response in yield and grading. Since the nitrate value for cottonseed meal is the lowest for that year (about 50 p.p.m. N in the last column of Table 5), and there was a considerably higher level in 1946, it is apparent that all treatments furnished more than optimum amounts of nitrogen. Any differences that may be found between tobacco grown on cottonseed meal and that grown with any of the three increments of ammonium nitrate are obviously not due to differences in soil nitrate levels.

During the season of 1944, no leaching of nitrogen occurred. Cover cropping conserved the residual nitrogen for 1945. Although there was a good-sized tobacco crop that year, considerable residual nitrogen was carried over to 1946 in the cover crop. The accumulative effect is seen by a comparison between the average seasonal trend in nitrate levels (center and bottom of Table 5) in 1944

[1] Swanback, T. R. Ammonification and nitrification of fertilizer materials. Conn. Agr. Exp. Sta. Bul. 444: 232-244. 1941.

[2] Swanback, T. R. The relative efficiency of nitrogen in oil seed meals. Conn. Agr. Exp. Sta. Bul. 478: 93-100. 1944.

TABLE 5. NITRATE NITROGEN LEVELS IN SOILS FROM COTTONSEED MEAL AND AMMONIUM NITRATE PLOTS, 1944 AND 1946.

Source of nitrogen	Lbs. N applied per A.	Parts per million of nitrate nitrogen in the soil May 29	June 9	June 20	June 29	July 11	July 19	July 27	Aug. 7	Seasonal Average
				1944						
Cottonseed meal	200	9.5	35.0	43.0	43.2	49.7	60.5	50.7	34.0	50.7
Ammonium nitrate	150	38.3	50.5	73.0	33.5	68.2	72.0	71.7	45.4	56.6
Ammonium nitrate	175	39.6	49.7	93.2	41.2	91.2	78.5	73.2	62.7	66.2
Ammonium nitrate	200	57.1	60.1	107.3	60.2	94.7	101.7	69.8	71.5	77.8
Average seasonal trend of nitrate levels		36	49	79	45	76	78	66	53	
				1946						
		May 29	June 10	June 20	July 1	July 11	July 22	Aug. 1		
Cottonseed meal	200	39.6	47.5	84.9	79.0	79.0	172.3	106.0		86.9
Ammonium nitrate	150	37.0	68.1	85.5	88.0	88.0	122.9	63.5		77.6
Ammonium nitrate	175	51.6	81.8	96.0	112.0	93.2	156.5	43.8		90.7
Ammonium nitrate	200	44.9	85.1	93.0	101.3	110.0	181.9	47.2		94.8
Average seasonal trend of nitrate levels		43	70	90	95	93	158	65		

and 1946. In the latter year there was a five-week period (from mid-June to the middle of July) with little or no rainfall. In dry weather, nitrates (through capillary action) are steadily transferred to the surface soil. Thus, the level of nitrates, particularly at the July 22 sampling, was considerably higher than could be expected from the amounts of nitrogen applied.

Part of the nitrogen applied before and the balance at time of planting and later as side dressing. Because ammonium nitrate is a readily water-soluble material, applying the dosage of 200 pounds of nitrogen in fractions would diminish the adverse effects of leaching from excessive rains early in the season. It would also avoid an early excess of available plant food which might be detrimental to the tender roots of the young plants.

On four plots, one-fifth of the nitrogen was applied together with other fertilizer ingredients before the crop was planted, one-fifth at the time of planting, and the balance in equal portions at 10-day intervals.

Three years' results (Table 6) from this experiment show that the crop response is about the same, whether all of the nitrogen was applied at one time or the dosage divided into fractional applications. This may be taken as a further

TABLE 6. YIELD AND GRADING RECORDS OF AMMONIUM NITRATE SERIES. (200 POUNDS N IN AMMONIUM NITRATE APPLIED IN FRACTIONS). THREE-YEAR SUMMARY.

Treatment	Plot no.	Yield pounds per A. 1944	1945	1946	Ave.	Grade index 1944	1945	1946	Ave.	Crop index	Rel. crop value
200 lbs.	N70	1988	2213	1837	2025	.387	.412	.393	.403		
nitrogen	N70-1	1594	1946	1685	1816	.322	.400	.370	.385		
applied in	N70-2	1709	2003	1837	1920	.373	.419	.433	.426	769	100.6[1]
fractions	N70-3	1645	1983	1809	1871	.336	.401	.396	.399		
Ave. for treatment					1908				.403		

1 The test of 200 pounds ammonium nitrate-nitrogen applied all at one time, taken as 100.

manifestation of the fact that no serious leaching took place in the three-year period. Therefore, in the absence of leaching rains, the relative advantages of the two methods of nitrogen application cannot be evaluated.

Ammonium Nitrate Supplementing Commercial Mixtures

Earlier experiments[1] have shown that there is no advantage in adding nitrates to tobacco fertilizer mixtures, because the other nitrogenous materials generally employed will in time supply the proper need of nitrates. If nitrate is to be added to mixtures in the form of ammonium nitrate, the ammonium radical precludes the inclusion of caustic materials, since they cause ammonia to escape.

It is a common practice among tobacco growers to apply the greater part of the fertilizer before the crop is planted, and the balance as a side dressing ("second application"). The purpose of a side dressing, however, is mainly to replenish nitrogen, that has been leached from the soil, or to widen the time of its distribution.

An experiment was made where ammonium nitrate was used as a side dressing to supplement the nitrogen in a 5-4-8 formula, thus making the total plant food equal to an 8-4-8 grade. Composition of the 5-4-8 original application was:

480	pounds	Castor pomace
400	"	Cottonseed meal
124	"	Uramon
240	"	Superphosphate, 20%
480	"	Cottonhull ash (35% K_2O)
160	"	Landplaster
116	"	Dolomite
2,000	pounds	

This formula is sufficiently basic to neutralize the acidifying action of ammonium nitrate, added directly to the soil.

Four plots were fertilized at the rate of 2,500 pounds to the acre of the above mixture and then Havana Seed tobacco was planted. At the time of second hoeing, the equivalent of 230 pounds of ammonium nitrate per acre was supplied as a side dressing. A summary of the results from three years is found in Table 7.

TABLE 7. YIELD AND GRADING RECORDS OF AMMONIUM NITRATE SERIES (AMMONIUM NITRATE SUPPLEMENTING COMMERCIAL FERTILIZER). THREE-YEAR SUMMARY.

Treatment	Plot No.	Yield, lbs. per acre 1944	1945	1946	Ave.	Grade index 1944	1945	1946	Ave.	Crop index
2500 lbs.	N71	2005	2391	2062	2130	.410	.439	.465	.445	
5-4-8 per A.	N71-1	2028	2344	2069	2128	.412	.419	.476	.446	
plus 230 lbs.	N71-2	1737	2297	1908	1963	.375	.434	.406	.406	904
ammonium nitrate as side dressing	N71-3	2103	2435	2063	2166	.419	.498	.395	.427	
Ave. for treatment					2097				.431	

[1] Conn. Agr. Exp. Sta. Bul. 391: 79-82. 1937.

Both yield and grading in all and any of the three years were on a par with, if not better than, the response to cottonseed meal as a single source of nitrogen.

Summary

Experiments with ammonium nitrate have been carried on for three years. The results may be summarized as follows:

1. Used as the only source of nitrogen in tobacco fertilizer mixtures, the material did not quite measure up to the results obtained with cottonseed meal but the differences are too small to be statistically significant.

2. The ammonium radical of this material is quickly converted to nitrate in the soil.

3. One hundred fifty pounds of nitrogen per acre in ammonium nitrate yielded nearly the same crop value as 200 pounds cottonseed meal nitrogen.

4. The soil nitrate levels produced by 200 pounds cottonseed meal nitrogen and 150 pounds nitrogen from ammonium nitrate, were of the same magnitude.

5. Most promising results were obtained with ammonium nitrate as a side dressing to supplement a 5-4-8 formula, thus furnishing sufficient plant food to equal an 8-4-8 grade. Both yield and grading compared favorably with those obtained from the use of cottonseed meal.

BORAX FOR TOBACCO LAND

T. R. Swanback

In previous publications[1] it was pointed out that boron (an active element in borax) is essential to normal growth of tobacco and that small amounts of borax added to tobacco land may improve the crop value as much as 12 per cent. The improvement was mainly due to a greater production of wrapper grades.

Since borax applications, especially to acid land, with limited amount of lime material to act as "buffer", always must be made with caution, it was stated that it is a safe practice to include five pounds of borax per ton of fertilizer. Up to that time, however, no experimental work had been done at this Station to determine what quantity of borax in *mixed* fertilizers will produce the greatest improvement in quality.

In the spring of 1946 an experiment was laid out on a field of old tobacco land which was "rested" in rye grass in 1945. The object was to test the effect of increasing amounts of borax mixed in the fertilizer. The soil is a fine sandy loam of the Merrimac series, with a pH-value of 5.0. There was an ample amount of residual plant food, but relatively low calcium content (about 400 parts per million of CaO). The boron content amounted to about .35 p.p.m.

[1] Swanback, T. R., Plant Phys. 2: 475-486. 1927.
.... Conn. Agr. Exp. Sta. Bul. 410: 394-395. 1938.
.... Conn. Agr. Exp. Sta. Bul. 493: 5-8. 1946.
.... Soil Science 62: 137-150. 1946.

The field was divided into 20 plots, to include five treatments in quadruplicate:

1. Check, no borax applied.
2. Five pounds of borax per acre.
3. 10 pounds of borax per acre.
4. 20 pounds of borax per acre.
5. 40 pounds of borax per acre.

The borax was mixed with the fertilizer, which was a 6-3-6 mixture, applied at the rate of 3,400 pounds per acre. The material was broadcast and harrowed in, about 10 days before planting Havana Seed tobacco.

In the early part of the season there was some indication that scattered plants in all four plots with the heaviest application of borax, were stunted in growth. After topping, however, the field appeared quite uniform.

The yield data in Table 8 also indicate that the average yield per acre did not differ from that of the check plots. As observed in previous tests, borax applications do not affect the yield. Significantly better grading, however, was obtained with 10 and 20 pounds borax to the acre. The crop value of the latter treatment was nearly 12 per cent higher than the check.

TABLE 8. YIELD AND GRADING RECORDS OF BORAX PLOTS. CROP OF 1946.

Treatment	Plot no.	Yield Lbs. per A. Plot	Ave.	Percentages of grades L	M	LS	SS	LD	DS	F	B	Grade index Plot	Ave.
	A	1800		1	5	48	11	29	1	5	—	.455	
No Borax	B	1982	1852	6	8	38	10	35	1	2	—	.475	.455
	C	1790	±77	2	4	43	11	33	3	4	—	.444	±.012
	D	1837		6	5	33	14	36	2	4	—	.446	
	A	1701		10	9	29	14	30	3	5	—	.471	
5 lbs. Borax	B	1844	1866	5	8	37	10	33	4	3	—	.460	.465
per acre	C	2010	±112	9	10	36	9	32	1	3	—	.494	±.022
	D	1907		5	7	29	9	44	2	4	—	.433	
	A	1520		7	10	31	13	31	2	6	—	.458	
10 lbs. Borax	B	2093	1821	6	9	35	8	38	—	4	—	.466	.473[1]
per acre	C	1854	±203	9	6	32	12	36	2	3	—	.469	±.015
	D	1815		14	7	30	9	34	1	5	—	.498	
	A	1840		9	8	31	14	33	1	4	—	.471	
20 lbs. Borax	B	1859	1884	13	10	30	12	30	2	3	—	.503	.499[1]
per acre	C	1853	±59	15	8	30	11	32	—	4	—	.411	±.016
	D	1985		12	9	34	9	34	—	2	—	.509	
	A	1750		8	3	28	14	38	4	5	—	.435	
40 lbs. Borax	B	1841	1850	11	11	26	9	36	2	4	1	.476	.475
per acre	C	1832	±64	12	8	27	13	35	2	3	—	.481	±.026
	D	1975		11	10	36	9	30	1	3	—	.508	

[1] Grading is significant at $P = < .02$.

Applications of 40 pounds of borax per acre did not improve the grading beyond the 20-pound rate. It is therefore inferred that the need of boron for this land was satisfied with less than 40 pounds of borax to the acre. If smaller increments had been used, it is probable that the optimum would have fallen somewhere between the last two rates.

With respect to injurious dosages of borax in fertilizers, Jenkins and Bailey in the Fertilizer Report for 1920,[1] report that 10 and 20 pounds of borax per

[1] Jenkins, E. H. and E. Monroe Bailey, Conn. Agr. Exp. Sta. Bul. 223: 58-59. 1920.

acre was injurious to potatoes and other crops. The fertilizer, however, was applied in the row, which would double or triple the effect in comparison to broadcast. They add that "lime and gypsum (landplaster), as well as manure, seemed partially to neutralize the poisonous action".

Since so many growers, through the State soil testing service, ascertain the lime requirements of their fields and apply lime according to the needs of the crop, it is much safer now to apply borax in fair amount without danger of crop injury.

As pointed out in a previous report, however, it must again be emphasized that inclusion of more than five pounds borax per ton of fertilizer constitutes *one-time* application which should not be repeated without consulting the Agricultural Station. Moreover, a *one-time* application of not more than 20 to 25 pounds of borax to the acre might be tried by the individual grower on fields in good production, but where tobacco seems to be lacking in quality.

FEEDING THE PLANTS IN THE SEEDBED

T. R. Swanback

One of the most important tasks in tobacco growing is to produce strong and healthy plants in the seedbeds, and to get them ready in time for planting. Therefore, it is little wonder that the grower shows great anxiety when beds do not develop according to expectation. Besides weed and disease problems, proper feeding of the plants needs attention. The most satisfactory method of fertilizing tobacco beds is to apply manure and a complete fertilizer mixture in the fall. Usually, no further fertilization is necessary.

Sometimes, however, even though the beds have been properly fertilized the previous autumn, winter precipitation and continuous watering of the beds may force available plant food down below root depth. In such cases, further feeding will be advisable.

The first plant food to suffer from leaching is nitrate nitrogen, and the least affected is phosphorus. Therefore, when the grower notices that the plants are not progressing as expected (turning pale green), the first step would be to replenish the nitrate. This is most conveniently done by adding nitrate of soda in solution. Properly fertilized beds should need no other treatment.

The common method of adding a so-called "starter" (4-10-0) might even defeat the purpose, because an excess of phosphate (or some other anion in excess) would retard the uptake of nitrates. This is supported by reports from some growers that the (4-10-0) "starter" showed no response. Obviously, the grower would then turn to some other product offered on the market, in lieu of proper information on plant feeding.

Recently two "starters", Vigoro and V H P F, were offered on the market and they have been used by some growers with more or less success. In an attempt to test their merits in comparison with nitrate of soda, an experiment was conducted in the spring of 1946 on a seedbed at the Tobacco Substation in Windsor.

A 150 foot bed was divided in eight equal parts, two of which served as checks, and the others as duplicate treatments for (1) nitrate of soda, (2) Vigoro and (3) V H P F.

A standard recommendation for nitrate of soda was employed, *i.e.,* three pounds to 50 gallons of water and one gallon of solution applied per sash (6′ x 3′). Vigoro was added at the rate of 20 pounds per 1,000 square feet and V H P F at two pounds (as suggested by the manufacturers) respectively.

Nitrate of soda was applied twice and the other materials three times. This was done because the nitrogen requirements (according to soil tests) were met after the second application of nitrate of soda, while this was not true for the other two materials. They also were applied in solution form to facilitate comparison to nitrate of soda.

From casual observations on growth, it was indicated that the nitrate-of-soda treatment produced more luxurious growth than the other treatments. As judged by actual green weight, it is seen in Table 9 that the Vigoro treatment produced the heaviest plants and roots.

TABLE 9. WEIGHT OF SEEDBED PLANTS (TOPS) AND ROOTS, TOP-ROOT RATIO.

Treatment	No. of plants [1]	Weight per plant (gms.) Per area	Ave.	Tops only	Weight of roots per plant Per area	Ave.	Average top-root ratio
Check A	45	1.52	1.57	1.483	.080	.0895	16.94
Check B	55	1.61			.095		
V H P F A	75	1.82	2.00	1.895	.100	.105	18.05
V H P F B	75	2.17			.110		
Nitrate of soda A	88	2.46	2.32	1.136	.180	.184	6.17
Nitrate of soda B	70	2.18			.187		
Vigoro A	64	2.81	2.93	2.702	.241	.228	11.85
Vigoro B	51	3.05			.215		

[1] The number and location of plants was determined by throwing a hoop over the plants and counting those inside the circle. Nearly all the plants, except the checks were of a size ready to plant.

Root development of young seedlings is perhaps most important. The best criterion, however, on balance between tops and roots is expressed by a top-root ratio. The lower the value for this number, the more adequate is the root system for the individual plant. We find the lowest value for the nitrate-of-soda treatment, and the highest for plants treated with V H P F, with Vigoro being intermediate.

Theoretically, plants from nitrate-of-soda treatment would have the best chances of re-establishing themselves after transplanting, followed by Vigoro, check and V H P F. In order to ascertain the effect of treatment on transplanting, 20 plants from the individual areas were set out and growth was observed for about four weeks. At the end of this period the check plants were as firmly established as any of the treatments, among which there were no visual differences.

Eight plants from each treatment were carefully removed from the soil and examined. The healthiest and most spreading roots seemed to occur on the check plants, while there was no apparent difference in the appearance of roots from treated plants.

In Table 10 are found the weights of "tops" and roots and the top-root ratios.

TABLE 10. TOP AND ROOT WEIGHT OF TRANSPLANTED PLANTS.

Treatment	Weight (in gms.) per plant		Top-root ratio
	Tops	Roots	
Check	27.5	2.1	13.1
V H P F	22.5	2.1	10.7
Nitrate of soda	18.9	1.15	16.4
Vigoro	16.8	1.15	14.6

If these data be compared with those in Table 9, we find that the weights of the tops and the top-root ratio are directly in reverse, *i.e.,* the check plants having the lowest top weight at planting time are now the heaviest. The V H P F produced seedbed plants with the widest top-root ratio and the field plants possess the narrowest ratio in the series. From these results, it may be inferred that if plants have a well developed root system, or rather, tops and roots properly balanced at transplanting time, the re-setting shock may be reduced. In general, it may be concluded from this limited experiment that if plants are re-set with an abundant root system, the plants' energy can be applied to the tops and, conversely, plants set out with poorly developed roots must devote much energy in developing these.

As to the choice between the materials tested, nitrate of soda is preferable on beds where the nitrogen is the limiting factor. Although the other two materials furnish a complete fertilizer, the nitrogen may not be in a quickly available form to replenish this element for fast growing plants, such as tobacco.

DOPLEX PLASTIC GLAZING AS A SUBSTITUTE FOR GLASS IN SEEDBED SASH

Some of the disadvantages of the glass sash ordinarily employed by tobacco growers are:

1. The sash are heavy and require a lot of back-breaking work in taking them on and off during the growing of the plants.

2. The glass panes are easily and frequently broken during ordinary handling or by accidents. This involves loss of valuable time if they are replaced, or insufficient protection of the plants if they are not replaced.

3. Loose fitting panes allow leakage of warm air from the beds.

All of these faults could be overcome if we could replace the heavy glass with some light, transparent durable (plastic) material. In previous reports (Conn. Sta. Buls. 311: 273; 444: 269, and 457: 247) experiments with two plastic materials "Cel-o-glass" and "Lumarith" have been recorded. Neither of these, for reasons discussed in the bulletins cited, was found to be satisfactory.

During the season of 1946, another plastic material, "Doplex Plastic Glazing" (supplied by the Dobeckmun Company of Cleveland, Ohio) was tested on the seedbeds at the Station. Throughout the seedbed period, frequent comparisons were made between plants grown under Doplex and those grown under glass sash in adjacent sections of the same bed. No actual measurements of plants were taken, but the repeated observations did not show any better growth under one type of cover or the other. All were ready to set in the field at the same time. Plants from each were set in adjacent rows in the field. No observable differences in field growth were found. It was concluded that, as far as the plants were concerned, it made no difference whether they were started under glass or under Doplex.

Ordinary glass lets only about 1 per cent of the ultra violet rays pass through it, while Doplex Plastic Glazing (according to the manufacturers) allows the passage of 60 per cent of these rays. As far as could be determined, this difference had no influence on growth, disease resistance or any other observable characteristic of the plants.

The three disadvantages of glass sash mentioned above were overcome or greatly reduced by Doplex. A satisfactory sturdy sash with Doplex is less than one half as heavy as a glass sash and is comfortably handled by one man. This involves a considerable saving of labor. There was no breakage during the season and no replacements had to be made. The length of life of this material under our conditions is another important point that should be determined by further trial. If it does not deteriorate too rapidly by alternate storage and repeated use, it may profitably be used to supplant glass for seedbed covers.

TOBACCO DISEASES IN 1946

P. J. Anderson

Most of the common diseases of tobacco caused less than average damage in 1946. Two notable exceptions were wildfire and nematode diseases. Diseases not observed at all during the season were blackfire, Fusarium wilt, Alternaria spot and hollow-stalk.

Wildfire. In our report on this disease for 1945 it was suggested that since, after many years of retirement, it had appeared in scattered fields in 1945, this might signal the start of a series of epidemic years such as we experienced in the early 'twenties. Its behavior in 1946 furnishes further evidence of a build-up. It was observed in a number of seedbeds in different parts of the State and Massachusetts during the first week of June, 1946. From the beds it was carried into the fields and by the first week in July some fields, especially in the northern part of the tobacco-growing section, were thoroughly infested. Its further spread was checked by the drouth which lasted in most of the tobacco area from the middle of June to the 20th of July. With the return of rainy weather after that, wildfire started to work up toward the top leaves and caused severe damage in many fields before they were harvested. The greater part of the farms in the central part of the tobacco section, however, suffered little damage or were entirely free of wildfire. The relatively few centers of infection, coupled with the checking effect of the long drouth, saved the tobacco of this section from severe losses.

Treating the seedbed with Bordeaux mixture is still considered the best preventive measure against wildfire. Pathologists in Kentucky have shown that the disease can be controlled in the seedbeds by thorough sprinkling with a

3-4-50 Bordeaux mixture early in the season when the plants are in the two-leaf stage and repeating the dose 10 days later. The mixture is applied with a sprinkling can at the rate of one quart per square yard. If it should be found necessary to spray with Bordeaux mixture later, it should not be done at the same time as Fermate is applied for control of mildew. The two fungicides are not compatible.

Nematodes. See special article on page 19.

Ammonia injury. This seedbed trouble, fully discussed in our report for 1945, was seen in a number of beds this year. Usually, it came as a result of seeding the beds too soon after steaming.

Pythium damping off in seedbeds, occurring when the plants are in the two or four-leaf stage, was noted early in several beds. Typically, all the little seedlings in areas five to twelve inches across, toppled over and lay prostrate with shrivelled stalks. Insufficient aeration was the principal contributing factor.

Bed-rot (*Pythium aphanidermatum*) was observed in many beds this year and was often mistaken for mildew by the growers. This disease occurs from the time the plants are an inch high up to setting time. Affected areas were usually only a few inches across but there was a complete kill of all plants in the area. Rotted plants formed a crust over the soil surface.

Mildew (blue mold). The most surprising feature about mildew this year was its early appearance. The first case was seen on May 1 which is ten days earlier than has ever been recorded here. Since the coming of spring was much earlier than usual this year, possibly the earlier appearance of mildew could have been anticipated. By the middle of May, it was found in beds from widely separated sections. It is worthy of note that no case of mildew was seen in 1946 in any bed where the owner had sprayed properly with Fermate. Fermate is now used by all the large growers and by the majority of the smaller ones. None of the growers of large acreages was seriously troubled with mildew this year. Those who lost their plants were growers of small acreages who did not think it worthwhile to spray or beginners who had no experience with mildew. There was no trouble with mildew in the fields. Results of controlled tests with Fermate dust and with other fungicides are discussed on page 23.

Mosaic (calico) appeared to be a little more prevalent than usual, especially in the Broadleaf variety. In the breeding work, where we are attempting to obtain Broadleaf with a high resistance, a strain was isolated this year which proved to be completely immune to mosaic. Whether this strain is commercially acceptable has not yet been determined.

Sore shin was found in Havana Seed in considerable abundance in the northern part of the Valley late in the season. It has never affected Broadleaf or Shade to any extent.

Dead blossom leaf spot did not cause much trouble this year but became prevalent in Shade tobacco late in the season when only the least valuable top leaves were still on the plants.

Pole rot did not cause a great deal of damage this year, probably because the curing season for the most part was quite dry. The form known as "slimy-stalk" was brought to our attention by many growers. In every case the associated fungus was found to be Botrytis. In no case was Sclerotinia found. The relative prevalence of these two fungi is just the reverse of 1945.

Black rootrot. This root trouble was not found in serious extent anywhere this year. The relative freedom of the Havana Seed crop is probably due to the high proportion of rootrot resistant strains that are now grown in the Valley. Rootrot resistant strains of Shade are also being grown in larger amount. The Broadleaf type is not as subject to black rootrot as the other two types. The value of chlorpicrin (Larvicide) as a fungicide against the black rootrot was determined in one Shade field in Windsor that is always seriously affected with rootrot. Larvicide is extensively used in the seedbeds here for killing weeds but we have never had occasion to find how effective it is against fungi. In the worst part of this field the Larvicide was drilled into the soil three weeks before the plants were set and at the usual rate for treating seedbeds. On five bents it was applied equally over all the soil. On five other bents it was concentrated in strips where the rows were to be set later. The rest of the field was untreated. The difference in growth between the treated and untreated parts was remarkable, even at a distance. The treated plants were four feet tall when the untreated were only half as tall. On hot days when the untreated plants wilted badly, no wilting occurred on the larger treated plants. The treated bents produced a better than normal yield; the untreated, a crop that did not pay to harvest. When the roots were dug, there were very few lesions on the treated plants while they were so numerous on the untreated that a large part of the root system was destroyed. There could hardly be any doubt about the value of Larvicide against the black rootrot fungus. Larvicide is, however, not recommended for field application, at least not at the rate and time of application used in this test, because it has an adverse effect on the combustibility of the cured tobacco.

Brown rootrot. Several cases of brown rootrot were observed where tobacco followed hay or cereal crops. Possible relation of some of this brown rootrot to meadow nematode is mentioned on page 23.

ROOT NEMATODES

P. J. Anderson and T. R. Swanback

Nematodes, or eel worms, are a class of very small worms, usually of microscopic size, thousands of species of which live in soil and in fresh and salt water. Many of them live also on and in the bodies of both dead and living animals and plants. Those that live parasitically in the tissues of living plants and animals cause various disorders or diseases. To the average person, nematodes are an unknown word, unless he has read of the hook-worm disease or of trichinosis of human beings who have eaten insufficiently cooked pork. Or he may have seen a so-called "horsehair snake" swimming in water, a veritable giant among the nemas.

At least two species of nematodes are known to cause serious damage to tobacco in the more southern tobacco sections of this country. Up to the present year, however, no nematode troubles of tobacco were reported from Connecticut. It has been generally believed in the past that these tobacco nematodes are not able to withstand the severity of a New England winter. In the summer of 1946, however, severely stunted tobacco fields were observed here with roots infested with two species of parasitic nematodes.

It is the purpose of this preliminary note to record the occurrence of nematode infestations in Connecticut and to discuss the effects on the crop. Experiments on control have been started but results of treatments are not yet available.

Root-knot Nematode

The first species found on tobacco roots here in 1946 was the root-knot nematode, [*Heterodera marioni* (Cornu) Goodey]. This nematode is probably the best known of all plant parasitic eel worms. As indicated by its common name, it produces knots or swellings on the roots of plants it attacks. It does not confine its attacks to one particular kind of plant. Over a thousand species of plants are known to be parasitized by this one kind of nematode. The irritation of the worm inside the tissue of a growing root stimulates it to produce superfluous root cells resulting in the development of galls or enlargements which vary in dimensions from less than pin-head size to an inch or more in diameter. The size of the galls depends on the severity of infestation. The galls also vary in shape; they may be globose, spindle-shaped, smooth or convoluted on the surface, often like beads on a string or united into irregular distortions of the root system.

These symptoms, however, are all below the ground and cannot be seen unless the plant is up-rooted. Of more interest to us is the effect of such abnormal root-development on the parts of the plant above ground. The aerial growth is stunted or retarded in proportion to the degree of infestation of the roots. This reduces the size and number of marketable leaves and, in the case of tobacco, slow growth reduces quality. Badly infested plants may be quite worthless. Only rarely does infestation become so severe that a plant dies. During hot days the leaves wilt and flag in a manner similar to plants infected with rootrot.

Eel worms are very active and move through the soil until they come to a young root which they proceed to penetrate and from which they suck out the juices, thus setting up the irritation that causes gall development. Mature male nematodes are distinguishable from females by their size and shape. The male (Figure 1C) is about 1/20 to 1/15 of an inch long but only about 1/40 as wide as long, this thread-like shape being responsible for the common name, "eel worms", and their size making them invisible to the unaided eye. The female, as she matures, loses her eel-like form and becomes globular or pear-shaped (Figure 1D). She now has a diameter of 1/40 to 1/20 of an inch and is permanently imbedded in the root tissues. When the root-knot is broken open, the females may often be seen as pearly white globules just large enough to be visible to the naked eye. A female reaches maturity in about four weeks.

Then she deposits a large number of eggs (up to 500) (Figure 1E) in the root tissues. When the eggs hatch within the roots, the young worms may grow up in the tissue of the same plant and induce further galls or they may escape to other roots.

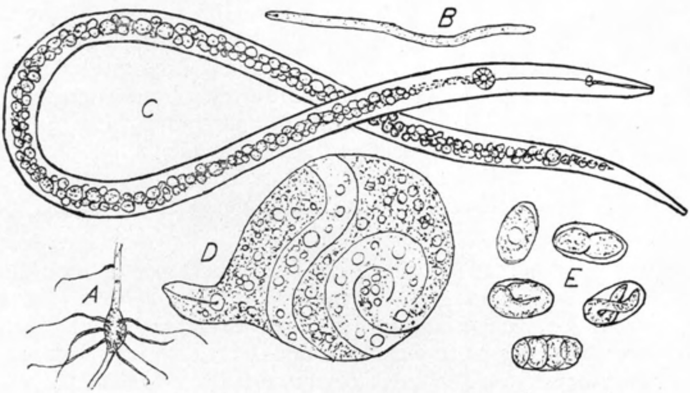

FIGURE 1. Root-knot nematode. A. Knot on lateral root. Natural size. B. Very young nematode (larva). C. Mature male. D. Mature female. E. Eggs. Stages of development of the larva within them. (All drawings except A are greatly enlarged).

They are active only in warm soil, 55° F. and above. Therefore, they cause little field damage in the northern states but are frequently quite destructive in greenhouses. When the ground is frozen, this species is killed but there are probably individuals that survive below the frozen top soil.

A few cases of root-knot on vegetables in the field have been reported from Connecticut and, therefore, the writers have looked for it on tobacco but failed to find a single occurrence up to 1946. This year in one Shade tent in Windsor, there were large areas of several acres where the tobacco plants were so stunted that they were practically worthless and made little growth during the whole season. The above-ground appearance was that of a severe rootrot infection but when the plants were dug up, the roots did not have the symptoms of either black or brown rootrot. There were, however, numerous small swellings or galls (Figure 1A) on the smaller roots. These galls varied in size from those that were so small that they were hardly noticeable, up to the largest that were not over a half inch long and less than a quarter of an inch thick. Most of them were so inconspicuous that one might easily overlook them unless he washed the soil from the roots and examined them closely. A bunch of fine lateral roots grew from about each knot. These clusters of laterals could be spotted more readily than the swellings and afforded the easiest means of diagnosis. Affected plants wilted during hot dry weather long before healthy plants in the same field began to wilt. The soil in this field is very sandy, a type that is known to favor nematodes. Tobacco has been grown here for many years.

When the knots were examined microscopically, the swollen egg-laying females (Figure 1D) were readily located in the tissues of the galls, and the young nemas (Figure 1B) and mature males were abundant on the surface of the roots.[1]

The infested parts of this field did not produce enough good leaves to pay for growing the crop. Shade tobacco is a very expensive crop to grow. Any field that is as severely stunted as the infested parts of this field will be grown with heavy financial loss. The discovery of this infestation raises a number of questions that are of financial interest to the grower and biological interest to the investigator: (1) Are nematodes just becoming established here for the first time? (2) Will this trouble, which has ruined thousands of acres of tobacco land in the south, continue to spread and make our land unusable? (3) Or is this merely a sporadic occurrence, which may or may not be repeated in future years? (4) What means are at hand for controlling root-knot infestation?

It is quite possible that this is not the first appearance of root-knot in our tobacco fields. It may have occurred in milder form in previous years but have been overlooked, the damage being attributed to other agents. During past years, the writers have seen many cases of poor growth in parts of fields which could not be explained on the basis of nutrient deficiencies, soil or weather conditions or known rootrots. Presence of the small galls on the roots might be easily missed unless one was looking for them specifically. Possibly, the occurrence of weather or soil conditions more favorable to the survival of this species may have been responsible for this more severe case in 1946. If this is the true explanation, we need not anticipate more trouble in the future than in the past, *i.e.,* the severity of our winters will continue to give us relative freedom from serious damage. It is well known that damage from nematodes on other crops is apt to come and disappear with the years. If, however, this is a new and hardier strain of the organism that has been introduced or developed here, we may look for more widespread losses in the future.

Three methods of control of nematodes are employed. (1) *Crop rotation.* By keeping the land fallow or growing crops that are not susceptible for a series of years, the population of nemas may be reduced so that another crop of tobacco may be grown. This method is not practical under our system of continuous tobacco growing. (2) *Development of resistant strains.* Certain strains of tobacco have been bred which are highly resistant to root-knot. Naturally, we know of no such strains in our tobacco types here. It would probably require years of breeding and selection to obtain such desirable strains. If, however, root-knot trouble should increase, breeding for this purpose would be undertaken. (3) *Treating the soil with chemicals that kill the nematodes before the crop is planted.* An increasing number of such nematicides is being developed and they appear to be practicable and not too expensive. Some of them are under trial here now on the infested field previously described. This third method appears more immediately promising under our circumstances.

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[1] Dr. G. Steiner, Chief Nematologist of the U. S. Department of Agriculture, kindly confirmed our identification of this species as *Heterodera marioni* (Cornu) Goodey.

Meadow Nematode

Eel worm species of the genus Pratylenchus are known as meadow nematodes and they cause root damage on a considerable number of plants. The meadow nematode that attacks tobacco roots has been identified as *Pratylenchus pratensis* (De Man) Filipjev. It is not so well known as the root-knot nematode because it does not produce spectacular symptoms comparable to the root galls. The symptoms are quite similar to those of brown rootrot. The young nemas may be found in the cortical tissues where they may either girdle the root and cause the cells to die in a depressed ring or they may produce longitudinal brown dead areas. As the small roots die, the root system tries to maintain itself by pushing out new roots. Repetition of this process causes a matted or bearded brush of laterals, a condition reminiscent of brown rootrot. Since the causal agent or agents of brown rootrot have not yet been determined, it is not unlikely that much of the stunting that has been attributed to brown rootrot may be due to the attack of meadow nematodes. The whole field of tobacco root troubles is in need of further investigation and clarification. These nematodes have been found in Virginia to be associated with black rootrot symptoms. Moreover, it is interesting that meadow nematodes are usually found in fields affected with root-knot. Diseased roots from the root-knot field discussed previously were found by Dr. W. A. Jenkins, nematologist of the Virginia Agricultural Experiment Station, to be infested also with the meadow nematode. On other fields here, affected with meadow nematode, however, there were no root-knots. Other species of nematodes of the genera Dorylaimus, Diploscapter, etc., have also been found on the surface of the roots in our infested fields but have not been seen in the tissues and it has not been demonstrated that they have any pathological influence.

Above ground, the affected areas are not distinguishable from those stunted by rootrot. Some affected areas under observation in 1946 never produced plants of sufficient size to be worth harvesting.

Suggested methods of control are the same as those for root-knot. Chemical soil treatments are being tested here.

FURTHER EXPERIMENTS ON CONTROLLING MILDEW IN THE SEEDBEDS

P. J. Anderson

Spraying the seedbeds twice a week with Fermate at a dilution of one to two pounds of the dust in 50 gallons of water has come to be the standard practice for control of mildew (blue mold). Almost all growers are now using this method to some degree, at least. Properly applied, it gives complete control of the disease. The only failures observed in 1946 were due to starting to spray too late or using too little Fermate.

Although Fermate seems to be completely satisfactory for this purpose, there may be some more convenient method of applying the fungicide and, secondly, there may be some other fungicide that would give as good control but which would not have to be applied as often as Fermate (twice a week). The double object of a seedbed experiment this year was to explore these two possibilities.

Pathologists in some southern tobacco regions have reported success in applying the Fermate as a dust instead of a spray. Some growers find it more convenient to dust than to spray. For the benefit of such growers we wished to determine whether Fermate applied in dry form is as effective in preventing disease as when applied as a spray. For our tests we used a 20 to 80 dust, 20 parts of Fermate to 80 parts of an inert carrier.

It has also been reported from experiments in other tobacco sections that bismuth subsalicylate is just as effective as Fermate and has the added advantage of giving longer protection to the plants. If it is found that this material can be used here effectively, the plants will not have to be sprayed so often and, moreover, they will be resistant to fungus attack for a longer period after they are set in the field. Preliminary experiments here in 1943 (Conn. Agr. Exp. Sta. Bul. 478: 109) with bismuth subsalicylate gave good control of mildew but failed to show any longer protection than Fermate. Subsequent to that time, however, other bismuth preparations containing bismuth subsalicylate and certain "wetting agents", have appeared on the market. Two of these compounds, Bismuth A and Bismuth B, differing principally in the wetting agents they contain, were included in the 1946 tests.

Method of procedure. The seedbed was divided into six-foot sections by eight-inch planks which would prevent actual contact of the plants of adjacent sections but would not prevent spores from blowing from one to the other. The fungicide treatments for the different sections were as follows:

1. Sprayed with Fermate, one pound in 50 gallons of water.
2. Dusted with 20-80 Fermate powder.
3. Sprayed with Bismuth A, one pound in 50 gallons of water (later reduced to one half pound).
4. Sprayed with Bismuth B, one pound in 50 gallons of water (later reduced to one half pound).
5. Control sections. Neither sprayed nor dusted.

Starting on May 6 when the plants were about an inch high, the fungicides were applied twice a week until May 31. Later sprays were omitted in order to see how soon the disease would spread in the absence of the fungicides.

All sections were thoroughly inoculated with fresh mildew spores on May 14, May 21 and June 15. The method of inoculation was to put diseased leaves, with abundance of fresh spores on the surface, in a sprinkling can of water and agitate violently until the spores were washed from the leaves into the water. After this spore-bearing water had been sprinkled broadcast over the bed, the plants were shaded a day or two to give most favorable conditions for infection.

Results. At the original concentrations, the bismuth sprays caused considerable burning, especially the Bismuth B compound. This caused dead tips and margins of the leaves. After the concentration was reduced to one half the original, however, this injury gradually disappeared. The plants on the bismuth plots were also paler green than those in the check plots. The Fermate plots, both sprayed and dusted, were darker green than the check plots, and there was no leaf injury at any time.

One week after inoculation, the disease first appeared on the leaves of the check plot and thereafter developed very rapidly so that a week later nearly all the plants in this section were affected. The plants in all of the sprayed and dusted sections remained healthy. On May 24, at the height of infection, all plants in sample areas of the sections were pulled and examined individually to determine the percentage of infection in the variously treated plots. The sample areas were impartially taken by throwing a barrel-hoop into each successive section and then pulling and examining all plants within the ring where the hoop happened to come to rest. The average infection on the unsprayed plots was 93 per cent. No infection was found in any of the sprayed or dusted plants which fell within the hoops. By diligent searching, an occasional diseased leaf could be found in the treated plots but this was well under 1 per cent and did not occur at all in the sampled areas.

Conclusions. All of the fungicides tested gave practically perfect control of the disease under conditions which produced 93 per cent of infected plants in the untreated bed. As far as percentage of control is concerned, it made no difference which one of these materials was used. It must be remembered that in this test all eight applications of the fungicide were made exactly according to schedule and with care to see that all leaves were hit by the spray or dust. Attention to these points appears to be more important than the choice of fungicide.

In examining the plants at time of pulling, it was noted that the Fermate dust covered the *lower* surfaces of the leaves better than any of the sprays. Since, however, both sprays and dust gave perfect control, there does not seem to be any advantage in this coverage of the lower leaf surface. According to these results, the choice between dusting and spraying is a matter of personal preference of the operator. If he prefers to dust because it involves less labor, or is less tiresome, or because he has better equipment for dusting, he may anticipate just as good control of mildew by dusting as by spraying with Fermate. The cost of the material is somewhat higher for the dust than for the spray, but a small saving in labor would readily compensate for this.

Comparing the two bismuth preparations, Bismuth A is preferable to Bismuth B because of less danger of leaf injury. Bismuth A did not mix with water as easily as Bismuth B. The bismuth preparations are more expensive than Fermate at present but this difference need not be a serious objection if a real advantage over Fermate should be found.

After the last spray on May 31, there was abundant opportunity for the spores to spread from the checks to the previously treated sections, although the weather was not very favorable for mildew. After two weeks a small percentage (less than 5 per cent) of diseased plants was found in all plots. The bismuth plots, however, showed just as much disease as the Fermate plots at this time. A later inoculation on June 15 failed to increase materially the percentage of infection but this was probably due to the hot dry weather which stopped further spread of mildew. None of the results from the tests of 1943 or 1946 indicates that the bismuth salts gave a longer protection of the plants than does Fermate. It must be noted, however, that in neither of these years were the weather conditions such as to give severe enough conditions to warrant final conclusions.