NITROGEN SOURCES FOR CONNECTICUT TOBACCO

A Report on the Cooperative Tests of 1958

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This publication is a report of 1958 field trials of economical nitrogenous fertilizer materials for tobacco in Connecticut. The information in Station Bulletin 613 (2) was published to help growers interested in the use of cheaper synthetic nitrogenous fertilizers and manures which could replace the expensive ingredients, such as the oil seed and fish meals, ordinarily used in tobacco fertilizer mixtures. Although the farmers' fertilizer orders for the 1958 season had been placed by the time Bulletin 613 came off the press, the information was presented to tobacco growers, fertilizer dealers, and manufacturers during the winter and spring of 1958. This review was of great interest to many in these groups, and to the Extension Service staff concerned with tobacco.

Some farmers used suitable water-soluble and inorganic "potato" fertilizers on their total tobacco acreage in 1958, saving $50 to $70 per acre, depending upon the composition and cost of their commonly used tobacco fertilizer mixture.

Most growers of outdoor and shade tobacco, however, preferred to follow the cautious course of first using the more economical fertilizer materials on a trial basis. Hence, several simple tests were devised on a cooperative basis with the Extension Service of the University of Connecticut, representatives of the fertilizer industry, and research workers with the shade growing corporations.

SCOPE OF FERTILIZER TESTS

Although dealing here with results of simple experiments and observations of one year, valuable and reasonably well-founded indications concerning the suitability of cheaper fertilizer materials may be expected. Such information, when gathered on a number of farms distributed over the Valley, should at least equal that which can be obtained in a single year from a carefully designed experiment with many replications on the same field or farm. Furthermore, such practical field tests of the Experiment Station findings are often the final proof in determining the proper practice on a particular farm.

As mentioned before, both outdoor as well as shade tobacco were involved in these developmental tests and observations covering respectively about 3.5 and 4.7 acres. Sources of nitrogen and grades of fertilizer mixtures used are given in Table 1.

The different nitrogen sources in the following fertilizer tests were used and compared on an "efficiency" basis. About 175 pounds of nitrogen to the acre from synthetic forms, such as ammonium nitrate, have a yield and grade producing capacity equal to about 200 pounds of nitrogen in cottonseed meal or 160 pounds of nitrogen in castor pomace (2, 3).

The urea-formaldehyde nitrogen source for this program was specially made up by one of the fertilizer manufacturers. With this material, urea-

form, as the important source of a mixture of nitrogenous materials, the four somewhat different fertilizer formulas of Table 1 were made up to match as closely as possible the regular tobacco fertilizer mixtures used by the participating tobacco growers. With the second combination of nitrogen sources, indicated with urea (Table 1), two grades of experimental mixed fertilizers were made up. The other mixed fertilizers, the 8-12-12 and 6-3-6 grades, are commercial fertilizers. Except for the guaranteed 1000 pounds of cottonseed meal per ton, we do not know which other nitrogenous materials were used in formulating the 6-3-6 standard tobacco grade. Essentially, the fertilization of Connecticut tobacco varies around an application of 200 pounds of nitrogen, 100 to 120 pounds of phosphoric acid (P_2O_5), and 200 pounds of potash (K_2O) per acre.

In making these N-P-K fertilizer mixtures the standard phosphate and potash fertilizers for Connecticut tobacco growing were used. Potassium was generally supplied in the form of cottonhull ash, in most cases supplemented by some nitrate of potash or sulfate of potash-magnesia. Cottonhull ash is probably the most commonly used potash carrier and only slightly more expensive than the cheapest suitable source, sulfate of potash. Besides that, the use of cottonhull ash is helpful in keeping the sulfur content of the tobacco fertilizer mixtures as low as possible, a practice that should be followed as long as it is economically practical (3). Although the tobacco plant has a limited capacity to absorb sulfur, large applications of it, i.e. above approximately 320 pounds of SO_3 per acre (4), might impair the fire-holding capacity of the cured leaf.

All outdoor tobacco samples harvested from each plot were graded at the Conn-Mass Tobacco Cooperative by two government tobacco inspectors. In this way the most practical, impartial, and uniform evaluation of the various treatments could be expected. The evaluation of the quality of the shade tobacco test samples was done by each shade grower individually and according to his own commercial grading standards.

WEATHER CONDITIONS

The weather during the growing season has an important bearing on results of fertilizer experiments for any one year. First of all the temperature and soil moisture conditions influence the release of nitrogen from the fertilizer mixtures.

The importance of rainfall quantity and distribution in nitrogen fertilization, that is the problem of leaching in our coarse to medium textured tobacco soils was discussed at length in Bulletin 613 (2).

In Table 2, the rainfall of the growing season is given by 10-day periods and by months. In general the 1958 season was a cool season with frequent, light rains. The longest dry spell occurred during the first 12 days of August. The dry weather started after some moderate (0.39 inch on July 29) and light (0.18 inch on July 31) rainfall. This dry period caused us to irrigate the experimental plots on Windsor loamy sand at the Tobacco Laboratory. Other growers faced by the same situation also irrigated.

In summary, the rainfall was frequent, but not heavy, and leaching was not excessive. The cloudy weather and ample moisture supply produced a good crop of thin leaves.

FIELD EXPERIMENTS, 1958

Tests on Outdoor Tobacco

The test plots with outdoor tobacco were on six farms, including the experimental farm of the Tobacco Laboratory in Windsor. Broadleaf type tobacco was used on five farms, Havana Seed on one.

The two farms in *Tolland County* are diversified farms with dairying. On both farms manure is usually spread on the tobacco land during the winter and early spring. Practically the same fields are used year after year, according to the customary continuous tobacco culture in the Valley. This supply of manure, estimated to be about 10 tons per acre annually, has always been additional to the standard application of about 3500 lbs. of 6-3-6 tobacco fertilizer mixture per acre applied one or two weeks before planting.

The field with the fertilizer tests on Farm number 1 (Table 3) had produced broadleaf tobacco for several years. Fertilization in 1956 consisted of 10 tons of stable manure plus 3500 lbs. of 6-3-6 broadcast before setting; 1957 – 1 ton cottonseed meal plus 1500 lbs. of 5-5-15 per acre broadcast; 1958 – 10 tons of stable manure and 3500 lbs. of 6-3-6 commercial tobacco fertilizer per acre before setting.

The history of the tobacco field on Farm 2 (Table 3) is as follows: 1956 – ladino grass mixture, manure and fertilizer; 1957 – tobacco with 10 tons manure plus 2700 lbs. of 8-4-8 commercial tobacco mixture per acre; 1958 – 10 tons of stable manure per acre and 1300 to 1400 lbs. 8-12-12 per acre broadcast plus about 200 lbs. ammonium nitrate sidedressed.

These experiments, sponsored by the County Agricultural Agent, consisted of two randomized blocks of four plots each on both farms. The general treatment of the field, i.e. the meal treatment on Farm 1 and the 8-12-12 treatment on Farm 2, were not assigned a plot in each block. Instead it was planned to sample these treatments on field areas neighboring each block. Through a misunderstanding, however, in both cases only one sample was taken from the tobacco grown on the general field.

The results of the fertilizer trials on these two farms are given in Table 3. On neither of the farms was there a significant differential effect on yield, quality, or fireholding capacity from any of the nitrogen sources.

Under the conditions of these experiments at least, the costly "meal" form of nitrogen is obviously not more desirable than the relatively cheap water-soluble, and readily available synthetic forms.

The meal treatment, the general fertilization of Farm 1, shows a low yield. This field was diseased with brown root rot (nematode infestation) and apparently the sample of the control treatment in this case was taken from a patch with stunted plants. According to the U.S.D.A. grading this tobacco sorted out slightly higher than the other four treatments. The sorting at the Tobacco Laboratory, however, showed just the reverse order.

The lowest U.S.D.A. grade index was given to the tobacco from one of the urea plots on Farm 2, and, here again, our own sorting graded the quality of this tobacco more in line with that from the other treatments.

The fire-holding capacity or burn test score for the tobacco was not affected by fertilizer.

Finally, the regular plow-under of stable and green manure on these farms produces a substantial amount of residual nitrogen in the soil. This is evident from the fact that 140 pounds of nitrogen in the form of water-soluble urea, supplemented or not with 100 pounds of ammonium nitrate, was just as effective in producing tobacco as the 210 pounds of nitrogen in the form of the costly meal.

From this it should be clear, as was pointed out in Bulletin 613 (2), that a good reserve of organic matter in the soil, either supplied by fertilizer, manure, rotation or cover crops, may take an important part in the nitrogen nutrition of the tobacco crop.

Now, let us look at the trials in *Hartford County*, some of which were made on fields that did not receive stable manure (Table 4). At the Tobacco Laboratory, for example, three of the nitrogen sources of Table 1 (meal, urea-form, and urea) were tested on Windsor loamy sand, a coarse textured and leachable soil with an organic matter content of about 1 per cent. After being fallow for some years this field has been in tobacco since 1955. Deep-plowing to a depth of about 14 inches diluted the original topsoil and caused a low organic matter content with no significance as a source of residual nitrogen. In this trial the meal mixture was compared with synthetic materials and also with synthetic plus a fertilized winter cover crop, receiving 60 pounds of nitrogen in early spring.

The results of these Tobacco Laboratory tests, Table 4, again reveal no significant differences among treatments. The 216 pounds of nitrogen from the meal fertilizer mixture and the comparable amount, on an "efficiency" basis, of 180 pounds of nitrogen from urea-form produced a tobacco crop of the same yield and quality.

On this sandy-textured soil 210 pounds of nitrogen in the form of urea-form gave the highest yield and quality, indicating that under the conditions of this experiment the standard application of nitrogen in the form of 3600 pounds of 6-3-6 per acre was somewhat on the low side.

The 180 pounds of nitrogen in the form of urea and sidedressed ammonium nitrate, both sources of water-soluble nitrogen of high availability, were apparently not entirely adequate, causing a nitrogen deficiency which affected only slightly the quality of the tobacco.

On the other hand, 120 pounds of the less water-soluble and readily available nitrogen from urea-form, supplemented by 60 pounds of water-soluble nitrogen fed to the cover crop, produced a satisfactory crop of tobacco.

On the Enfield silt loam and Manchester gravelly sandy loam of Farm 3 (Table 4), the meal and urea-form nitrogen produced tobacco of about the same grade index value. The yields of these single plots were not determined, but from the stunted and patchy growth in the field, it was evident that the yield from the urea-form was much lower due to a heavy nematode infestation of this part of the field. This was confirmed by a laboratory test on root-soil samples.

The same nitrogen treatments on the Ninigret sandy and fine sandy loam of Farm 4 show an important increase in tobacco quality from urea-form, but the yield was not as good as that from the rest of the field treated with meal fertilizer.

Farm 5 grew a different type of outdoor tobacco, namely Havana Seed. There was an insignificantly small difference in effect on quality, the meal treated tobacco showing the higher grade index value than the urea-form tested tobacco.

Shade Tobacco Tests

The fertilizer requirements of shade tobacco are essentially the same as those of outdoor tobacco. In some respects, however, shade tobacco presents a somewhat different proposition in that more crop residue, the tops and stalks of the tobacco plants, are returned to the same land. This would call for a somewhat smaller application of nitrogen, but shade tobacco grows more rapidly and is harvested earlier. Thus it is imperative that during its rapid growth a large supply of nitrogen should always be present and available in the soil.

The fertilizer tests with shade tobacco were generally simple and exploratory, mainly due to the late start in planning this program. On most farms the test plots consisted of a strip of land one bent wide across a shade tent, on which the standard fertilization was replaced by one of the fertilizer mixtures with the experimental nitrogen sources of Table 1. In all other respects the management of the tobacco over the whole area of the tent was identical.

Without entering into too many details concerning these tests with different nitrogen sources on shade tobacco, some general observations and conclusions should be useful to the outdoor growers. But again, one should realize that we are dealing here with first-year results. The least these tests can demonstrate, however, is that even producers of wrapper tobacco, with its prime quality requirements, realize the cost-lowering potential in the use of more economical sources and practices for the nitrogen fertilization of their crop.

All four nitrogen sources of Table 1 were tested side by side on a Cheshire fine sandy loam and on an Enfield silt loam. Neither field had been in tobacco for some years, thus excluding the possibility of any carry-over effects of previous applications of meals used in regular shade tobacco fertilizer mixtures.

Observations and measurements during the growing season showed no consistent differences in the growth of the tobacco caused by the different sources of nitrogen fertilization. At the end of the tobacco season on the more leachy Cheshire fine sandy loam no nitrogen remained, according to the Morgan soil test, with the exception of the plot treated with the urea formula. On the retentive Enfield silt loam, however, considerable amounts of post-harvest nitrogen were left in the soil from all of the synthetic nitrogen sources. In this case, the part of the field treated with the standard meal mixture did not show any nitrogen left in the soil. These observations indicate that under the soil moisture conditions of the 1958 season the nitrogen release from the meal was at least as rapid as from the water-soluble sources.

The tobacco harvested at the second and fifth priming was used to evaluate the relative effect of the nitrogen treatments on the quality of the cured leaves. In general terms, the results indicated that the standard

meal mixture consistently produced tobacco of a slightly poorer quality than did the other forms of nitrogen. The nitrogen from urea-form generally produced the best grade of tobacco, with the nitrogen from ammonia and ammonium nitrate in the 8-12-12 grade following close. The quality of the tobacco grown on the plots treated with urea nitrogen was usually not as good under the conditions of these experiments.

In all other experiments with shade tobacco only the urea-form was tested and compared with normal tobacco fertilizer mixtures.

The first test of urea-form alone was on a Merrimac sandy loam. The results were comparable to the ones just described. Observations during the growing season showed no significant differences in the growth of the tobacco on the two formulas, i.e. the regular meal mixture and the 8-7-10 grade with urea-form.

The second, fourth, and sixth priming were used for an evaluation of the relative quality and yield of the cured wrapper leaves. The tobacco grown on the standard meal mixture was sampled on each side of the bents across the field, fertilized with the experimental formula. Although the differences in quality were small, the general evaluation by experienced growers showed the following results. Second priming of leaves: quality of tobacco grown on right side of test strip best, on left side poorest; the test strip intermediate. Fourth priming: test strip almost as good as right side, left side much poorer. Sixth priming: test strip tobacco judged best, right part of field poorest. The weekly soil testing during June and the first week of July showed a lower pH for the test strip, which might have had a detrimental effect on the quality of the second priming. The difference in soil pH must have existed before the fertilizer was applied, because according to its composition the 8-7-10 grade fertilizer should be quite alkaline in its effect on the soil.

The total yield of the three primings was slightly in favor of the test strip with urea-form.

In the final two tests the results with the urea-form formula were less favorable for this new nitrogen source material. On an Enfield silt loam, field observations did not show any significant differences in the growth between the standard meal and the 8-9-10 grade with urea-form. But, although both treatments produced tobacco of better than average grade, the tobacco fertilized with urea-form was, except for the first priming, consistently of lower quality than that fertilized with meal.

In the last test, on Enfield silt loam the plants clearly started slower on those plots which were treated with urea-form in the 8-9-10 grade fertilizer. Probably as a result, the quality of the first nine leaves harvested was strikingly poorer than those from the standard. Above the thirteenth leaves, however, this difference in quality disappeared.

So it appears that the results with shade tobacco were more erratic than those obtained with outdoor tobacco. However, in almost every test with shade, a different strain of tobacco was used, and this possibly introduced a variable.

Furthermore, among the experimental fertilizer formulas and the standard meal mixtures were small differences in composition other than those due to source of nitrogen. For example, on the next to the last shade farm the phosphate content of the standard fertilizer mixture was much higher than that of the experimental mixture with urea-form. In a few cases there were also differences in the total basicity or acidity of the mixtures. These imperfections in some tests could not be avoided: time did not permit more precise formulation.

SUMMARY AND CONCLUSIONS

Fertilizer tests with different nitrogen sources were conducted on a cooperative basis on outdoor and shade tobacco farms throughout the Connecticut Valley. The object was to determine, under as many different conditions as possible, whether nitrogen fertilization of Connecticut tobacco can be put on a more economical basis. The tests of the fertilizer formulas listed in Table 1 showed that, at least under the conditions of 1958, meals are not necessary as a nitrogen source for the production of a tobacco crop of high yield and quality. Water-soluble nitrogen sources, such as ammonia, nitrate, and urea, when supplemented by sidedressing or by less soluble synthetics, such as urea-form, were practically as effective in the production of a crop as were the meals.

The difference in yield and quality between outdoor tobacco grown with meal and outdoor tobacco grown with one of the new, cheaper combinations of sources was insignificant in all tests. And, as Table 3 and 4 demonstrate, where there is a small difference it is often in favor of the cheaper sources.

As for shade tobacco, these first year's results are somewhat erratic. In three tests, no striking differences were found; in two tests the new nitrogen sources were detrimental to the quality and yield of the tobacco as compared to that grown with meal.

SUGGESTED NITROGEN SOURCES AND PRACTICES FOR TRIAL

The results of the fertilizer tests in 1958 lead to the same conclusions reported in Bulletin 613 (2).

Many commercially available materials can be used as nitrogen sources, either alone or combined in mixed fertilizers. The important point is to use these nitrogenous materials intelligently, that is, to understand and to use them in accordance with their peculiar properties: resistance to loss by leaching, effect on soil reaction, and time, rate, and amount of decomposition. With such knowledge the rising cost of tobacco production could be met in part by a more efficient management of the nitrogen.

As is well known, the most efficient management of nitrogen on sandy textured soils such as our tobacco soils, is an application at planting time supplemented by a sidedressing of a readily available source of nitrogen, such as nitrate of ammonia, about 3 to 4 weeks after transplanting.

Application of all of the fertilizer before planting should be based on the use of water-insoluble nitrogenous organics. For this resistance to leaching one has to pay a premium, but the synthetic materials such as the mixed urea-form and nitrogen compounds of intermediate solubility, Table 2, are cheaper than most meals while they are not less resistant to leaching. As a matter of fact, from our 1958 observations, we would conclude that the urea-form combination of nitrogen forms was sometimes too slow in releasing nitrogen. Therefore, the addition of at least

20 pounds of readily available nitrogen to the urea-form may be wise in making up the tobacco fertilizer formula.

Winter cover crops can economically provide some slowly available nitrogen. First, the nitrogen left over by the preceding tobacco crop is absorbed. Then the nitrogen content of cover crops can be further increased by topdressing in early spring with immediately available nitrogen sources. This organic form of nitrogen, after being plowed under, has a rate of availability somewhat similar to that of the meals. A well fertilized winter cover crop will help build or maintain the organic matter content of the soil. The additional growth due to the nitrogen topdressing will more than compensate for the organic material supplied by meals.

A second way of converting economical soluble nitrogen sources into organic sources is through an application at the time the cover crop is being plowed under. Concentrated nitrogen solutions, which can be supplied with relative ease and a high degree of effectiveness, are becoming more and more in demand for this purpose.

Manure, if available, is of course an excellent substitute for the meals. Manure supplies organic matter, and the crop-producing value of the nitrogen is roughly estimated at about 50 per cent of the nitrogen in the manure.

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Table 1. Sources of nitrogen and fertilizer grades used in tobacco fertilizer tests, 1958

Grades of mixed fertilizers	Sources of nitrogen	Nitrogen, per cent: Nitrate	Ammoniacal	Organic: Water-soluble	Organic: Water-insoluble	Total
8-12-12 L.C.[1]	**Ammonia**[2] (*ammoniated superphosphate*)	....	5.92	.08	.03	....
	Ammonium nitrate	2.06	....	....	....	8.09
9-11-13)	**Urea**	....	....	6.0	....	....
9-11-12)	Ammonium sulfate	....	2.50	....	....	....
	Nitrate of potash	.90	....	....	....	9.40
9-7-10)	**Urea-form**	....	....	....	2.08	....
8-7-10)						
8-7-9)	Intermediate soluble	....	....	.... 1.31	....	....
8-9-10)						
	Urea	....	....	1.85	....	....
	Ammonia (*ammoniated superphosphate*)	....	2.11	....	....	....
	Nitrate	.66	....	....	....	8.01
6-3-6 (*1000 lbs. cottonseed meal per ton*)	Cottonseed **meal**	1.26	.30	2.18	2.84	6.58

[1] Low chlorine grade.
[2] Main source **identifies** combination of nitrogen sources.

Table 2. Distribution of rainfall in inches for the growing season of 1958 at the Tobacco Laboratory in Windsor

May		*June*		*July*		*August*	
1–10	1.57	1–10	.34	1–10	1.31	1–10	.12
11–20	.35	11–20	.84	11–20	1.08	11–20	1.70
21–31	1.21	21–30	1.06	21–31	1.14	21–31	1.28
Total	3.13	Total	2.24	Total	3.53	Total	3.10
Mean[1]	3.56	Mean	3.47	Mean	3.67	Mean	4.01

[1] Hartford, Connecticut, 1905–58.

Table 3. Effects of various sources of nitrogen on Broadleaf tobacco grown on two Tolland County farms in fertilizer tests, 1958

Main source of nitrogen	Fertilizer materials[1]: Grade mixture	Broadcast[2]	Sidedress[3]	Nitrogen applied per acre[4]	Yield per acre	Grade index[5]	Fire-holding capacity[6]
		Lbs.	Lbs.	Lbs.	Lbs.	Points	Points
		Farm 1 — Soil type: Ninigret+Agawam fine sandy loan					
Meal	6-3-6	3500		200	1578	40	90
Ammonia	8-12-12[7]	1600	140	175	1869-2041	33-34	65-68
Urea-form	9-7-10	1950		176	1561-1887	34-42	84-100
Urea	9-11-13	1554	100	174	1852-1904	35-39	68-76
Urea	9-11-13	1554		140	1784-1818	37-41	61-81
		Farm 2 — Soil type: Merrimac fine sandy loam					
Meal	6-3-6	3500		210	1732-1869	36-44	103-120
Ammonia	8-12-12[7]	1350	200	175	1835	44	103
Urea-form	8-7-10	2100		168	1887-1904	31-37	98-114
Urea	9-11-13	1554	100	174	1698-1955	34-36	100-116
Urea	9-11-13	1554		140	1784-1938	28-36	115-116

[1] In addition to these treatments winter-spread manure had been applied at the rate of about 10 tons per acre.
[2] Pounds per acre fertilizer mixture, broadcast before planting.
[3] Pounds per acre ammonium nitrate, sidedressed 3 to 4 weeks before planting.
[4] Rate on an "efficiency" basis (see remarks page 2).
[5] U.S.D.A. packing score; the higher the score, the higher the quality of the tobacco.
[6] U.S.D.A. burn test score; the higher the score, the better the burn of the tobacco.
[7] Low chlorine grade.

Table 4. Effects of various sources of nitrogen on Broadleaf and Havana Seed tobacco grown in Hartford County in fertilizer tests, 1958

Main source of nitrogen	Fertilizer materials: Grade mixture			Nitrogen applied per acre	Yield per acre	Grade index	Fire-holding capacity
		Broadcast[1]	Supplement				
		Lbs.	Lbs.	Lbs.	Lbs.	Points	Points
			Tobacco Laboratory – Soil type: Windsor loamy sand				
Meal	6-3-6	3600		216	1903-2196	37-43	76-118
Urea-form	9-7-10	2005		180	1976-2269	35-43	43-101
Urea-form	9-7-10	2340		210	2049-2342	36-45	74-81
Urea	9-11-12	1600	100[2]	180	1830-2049	32-34	84-108
Urea-form	9-7-10	1337	375[3]	60+120	1903-2049	38-40	63-102
Urea-form	9-7-10	1670	375[3]	60+150	1757-2123	30-41	56-89
			Farm 3 – Soil type: Enfield silt loam, eroded and Manchester gravelly sandy loam, eroded				
Meal	6-5-6	3500	500[4]	240		31	98
Urea-form	8-7-9	2200	300[4]	194		32	110
			Farm 4 – Soil type: Ninigret sandy loam and fine sandy loam				
Meal	6-3-6	4000		240	2131	29	84
Urea-form	8-7-9	2200		176	1802	39	100
			Havana Seed Tobacco				
			Farm 5 – Soil type: Narraganset silt loam				
Meal	6-3-6	3500		210	2460	35	80
Urea-form	8-7-9	2240		180	2428	33	71

[1] Pounds per acre fertilizer mixture, broadcast before planting.
[2] Pounds per acre ammonium nitrate, sidedressed 4 weeks after planting.
[3] Pounds per acre nitrate of soda, topdressed on rye cover crop, April 10, 1958.
[4] Pounds per acre 6-3-6 tobacco fertilizer mixture, sidedressed.