Further Studies On Fertilizing Burley Tobacco In the Tennessee Central Basin

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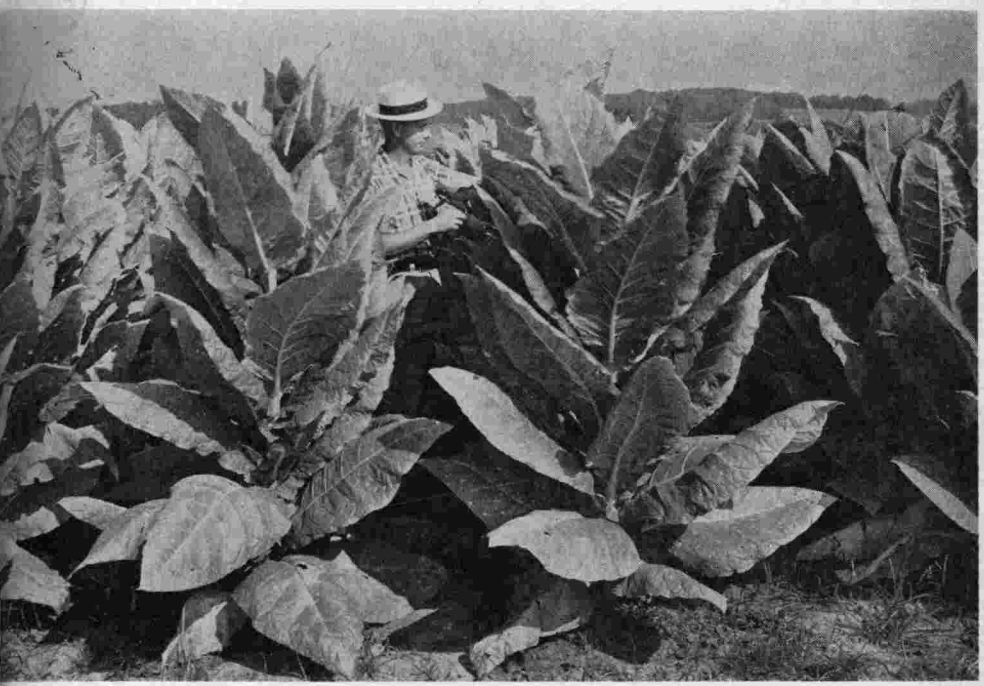

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SUMMARY

As a supplement to previous work a fertilizer experiment with burley tobacco was conducted during 1957, 1958, and 1959 at the Middle Tennessee Experiment Station. The soil used was Maury silt loam which was initially high in available phosphorus and available potassium.

By using up to 150 pounds of nitrogen per acre significant increases were obtained in total yield, yield of smoking grades, and value per acre of tobacco. Since all the nitrogen was applied broadcast, it is suggested that maximum yield might have been obtained with somewhat less than 150 pounds of nitrogen if a part of all of the nitrogen had been placed in a row.

As the nitrogen supply to tobacco was increased the cured leaf was higher in nicotine, total nitrogen, and calcium but lower in phosphorus, chlorine, and potassium.

Improvements in total yield, yield of smoking grades, and value per acre were obtained by applying up to 200 pounds of potash (K_2O) per acre. Also, as the supply of fertilizer potassium was increased the cured leaf was higher in potassium and lower in calcium. The application of 100 pounds per acre of phosphate (P_2O_5) was not beneficial.

Ten tons of manure per acre increased yield and value per acre by approximately the same amount as 75 pounds of nitrogen. Cured tobacco from all manured treatments was relatively high in potassium which is considered desirable, but such tobacco was also high in chlorine which may be detrimental to smoking quality.

ACKNOWLEDGEMENT

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CONTENTS

Further Studies On Fertilizing Burley Tobacco In The Tennessee Central Basin

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Introduction

Results of a study on fertilizing burley tobacco in the Central Basin area of Tennessee were reported in 1958 (6). Upon completion of the first experiment it was felt that a supplementary experiment should be devised to include higher rates of fertilizers than those previously applied. Consequently, a second experiment was conducted at the Middle Tennessee Experiment Station during 1957, 1958, and 1959. The results obtained are presented and discussed in this publication.

MATERIALS AND METHODS

The soil of the experimental area was Maury silt loam. The area had been in orchardgrass-Ladino clover pasture for 4 years. Soil test results showed the area to be relatively high in both phosphorus and potassium, and the pH range of several soil samples was 5.5 to 6.0.

Cover crops of oats and crimson clover were sown between tobacco crops. The cover crops were turned under about April 1 each year before a great deal of growth had accumulated.

Burley 21, a tobacco variety, resistant to wildfire, mosaic, and black root rot (3), was grown each year. The tobacco was transplanted with a tractor-drawn transplanter. Plants were spaced 15 inches apart in rows 3½ feet apart.

Test plots were arranged in a randomized-block design with 4 replications. An individual plot consisted of eight rows 43¾ feet long. The six center rows (less end plants), or about 1/50 acre per plot, were harvested for yield and quality evaluations. Such operations as cultivating, harvesting, and curing were done by conventional means (5, 6).

All fertilizer materials were applied by broadcasting and disking

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in. Standard acceptable sources of fertilizers (4, 5, 6, 7) were used. Ammonium nitrate (33.5% N), superphosphate (20% P_2O_5), sulfate of potash (50% K_2O), and manure (analyses unknown) were applied in this particular experiment.

Plants were topped at a medium height. Suckers were removed by hand as needed or about 2 or 3 times each year.

When cured, the tobacco was stripped from the stalk and separated into farm grades. Each grade of each plot was appraised by the Federal Tobacco Grading Service.

Table 1. Rainfall at Spring Hill, Tennessee, for 10- or 11-Day Periods and Monthly Totals During the Growing and Curing Seasons, 1957-1959.

Month and 10- or 11-day interval	1957	1958	1959
		Inches of rainfall	
May 1-10	0.06	1.92	0.00
11-20	4.22	0.68	1.48
21-31	4.42	0.22	3.89
Total	8.70	2.82	5.37
June 1-10	2.45	1.87	0.80
11-20	0.00	0.26	1.12
21-30	2.58	1.58	1.00
Total	5.03	3.71	2.92
July 1-10	0.18	4.17	0.00
11-20	0.68	1.36	0.57
21-31	1.62	3.79	3.89
Total	2.48	9.32	4.46
Aug. 1-10	0.00	0.68	2.69
11-20	0.93	1.20	0.88
21-31	0.00	0.56	0.80
Total	0.93	2.44	4.37
Sept. 1-10	1.27	0.08	2.38
11-20	3.91	1.35	0.00
21-30	1.18	3.41	0.26
Total	6.36	4.84	2.64
Oct. 1-10	1.43	0.40	2.08
11-20	0.78	0.75	1.11
21-31	1.90	0.02	0.99
Total	4.11	1.17	4.18
Nov. 1-10	1.59	1.28	0.92
11-20	3.91	1.60	1.13
21-30	1.82	1.08	2.46
Total	7.32	3.96	4.51

Values per 100 pounds and per acre were calculated on the basis of average prices paid by grade on all burley markets in individual years of the test period.

Ten plants were selected at random from each plot for chemical analyses. Three samples designated top, middle, and bottom were made up for each plot. The top sample was composed of red leaf and tips, the middle sample of lugs and bright leaf, and the bottom sample of dark and light flyings. Determinations of nicotine, total nitrogen, potassium, calcium, phosphorus, and chlorine were made on these samples by methods previously described (1, 2).

RAINFALL

Rainfall was deficient during certain periods of the growing seasons of 1957 and 1959 (Table 1). The amount and distribution of rainfall in 1958, however, were very favorable for plant growth. The 1958 crop also cured well, but there was considerable house burn of cured tobacco in the other 2 years.

RESULTS AND DISCUSSION

Yield. Overall yields of tobacco were classed as good in 1957, unusually high in 1958, and only fair in 1959 (Table 2). Yield levels

Table 2. Acre Yields of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	1957	1958	1959	Av.
			Pounds per acre		
1	0-0-200	1478	1950	1232	1553
2	75-0-200	1716	2246	1341	1767
3	150-0-200	1936	2549	1553	2013
4	225-0-200	1860	2706	1453	2006
5	150-100-200	1780	2512	1481	1924
6	150-0-0	1872	2167	1523	1854
7	150-0-100	1918	2425	1502	1948
8	150-0-300	1830	2484	1459	1924
9	75-0-100	1913	2358	1598	1956
	10 tons of manure				
10	150-0-200	2113	2626	1577	2105
	10 tons of manure				
11	0-0-200	1731	2247	1424	1801
	10 tons of manure				
12	150-0-0	2145	2539	1606	2096
	10 tons of manure				
	L.S.D.				
	.05	267	174	189	137
	.01	358	234	NS	180

were influenced by prevailing weather conditions during growing seasons as well as by fertilizer treatments.

Average results indicate that significant increases in yields of tobacco were obtained by using up to 150 pounds of nitrogen per acre. In previous experiments on the same soil type (6) the highest tobacco yield was obtained with 120 pounds of nitrogen, which unfortunately was the maximum rate of this element applied. Consequently further experimentation was necessary. It should be pointed out, however, that a given amount of nitrogen applied broadcast, as in the present experiment, is likely to be less efficient than if a part or all of the nitrogen is placed in the row. Thus, maximum yields of tobacco probably would have been obtained with somewhat less than 150 pounds of nitrogen had another placement procedure been followed.

The yield response to 100 pounds per acre of phosphate (P_2O_5) was not favorable. A small but insignificant decrease in yield was noted each year where phosphate was applied as compared with an otherwise similar no-phosphate treatment. These results confirm earlier findings that tobacco yields may tend to decrease when fertilizer phosphorus is added to high-phosphate soils (6).

Although the soil on which tobacco was grown was initially high in potassium, average tobacco yields were increased by using up to 200 pounds of potash (K_2O) per acre. Earlier reports also show a favorable response of burley tobacco to relatively large amounts of potash (5, 6). In the first experiment (6) yields were not increased when more than 120 pounds of potash (K_2O) was applied, but that was in conjunction with only 60 pounds of nitrogen per acre as contrasted with 150 pounds in the second experiment.

When 10 tons of manure was applied either with no fertilizer nitrogen or with 75 pounds of nitrogen, the yield of tobacco was increased by approximately the same amount as when 75 pounds of nitrogen was applied alone. Manure did not significantly improve yield, however, when applied with 150 pounds of nitrogen. Potassium had no apparent effect on yield when used in addition to manure. The potassium supplied by 10 tons of manure was evidently ample to produce maximum tobacco yields on the particular soil on which the tobacco was grown.

The general appearance of plants in the field during each of the growing seasons was primarily related to the nitrogen supply. Plants which received no nitrogen exhibited mild nitrogen-deficiency symptoms and were somewhat stunted (Fig. 1). On the

Figure 1. Tobacco grown with 0-0-200. Tmt. 1, July 21, 1959.

other hand, plants which received as much as 150 pounds of nitrogen per acre or manure—or a combination of nitrogen and manure —grew vigorously, and showed no deficiency symptoms (Fig. 2).

Figure 2. Tobacco grown with 150-0-0 and 10 tons of manure. Tmt. 12, July 21, 1959.

While a favorable response to potash was obtained, the tobacco grown without potash showed little evidence of potash starvation in the field. A slight roughening of leaves was about the only evidence observed where potash was not used. The bronze-colored leaf margins associated with potash deficiency never appeared.

Value per 100 Pounds. There was comparatively little spread in prices paid for different grades of burley tobacco during the 3 years of the testing period. Consequently, average values per 100 pounds were similar for all fertilizer treatments (Table 3). Also, relatively

Table 3. Value Per 100 Pounds of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	1957	1958	1959	Av.
			Dollars/100 lb. tobacco		
1	0-0-200	59.26	68.10	66.25	64.54
2	75-0-200	60.01	68.22	67.23	65.15
3	150-0-200	60.89	67.95	66.72	65.19
4	225-0-200	60.64	68.50	65.99	65.04
5	150-100-200	60.12	68.57	66.34	65.01
6	150-0-0	61.30	67.56	64.09	64.32
7	150-0-100	61.48	68.04	67.12	65.54
8	150-0-300	61.65	69.00	66.87	65.84
9	75-0-100	60.26	68.12	66.81	65.06
	10 tons of manure				
10	150-0-200	61.64	68.13	67.08	65.62
	10 tons of manure				
11	0-0-200	60.38	68.54	65.36	64.76
	10 tons of manure				
12	150-0-0	62.44	68.19	65.80	65.48
	10 tons of manure				
	L.S.D.				
	.05	1.64	NS	NS	NS
	.01	NS			

poor curing conditions in 2 of the 3 years tended to minimize potential differences in tobacco quality among the various treatments.

Acre Value. In this experiment acre values of tobacco followed essentially the same pattern in relation to fertilizer treatments as yields (Table 4). Increases in acre values were obtained by using up to 150 pounds of nitrogen and 200 pounds of potash (K_2O) per acre. The addition of 100 pounds of phosphate (P_2O_5) was of no benefit. When used as the sole source of nitrogen, 10 tons of manure increased acre value by about the same amount as 75 pounds of chemical nitrogen. Manure also significantly increased acre value of tobacco when applied with 75 pounds of nitrogen but not with 150 pounds.

Table 4. Acre Value of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	1957	1958	1959	Av.
			Dollars per acre		
1	0-0-200	879	1328	816	1007
2	75-0-200	1030	1532	902	1154
3	150-0-200	1180	1733	1037	1316
4	225-0-200	1129	1854	961	1315
5	150-100-200	1070	1723	984	1259
6	150-0-0	1147	1465	978	1197
7	150-0-100	1181	1651	1009	1280
8	150-0-300	1129	1714	980	1274
9	75-0-100 10 tons of manure	1153	1607	1069	1276
10	150-0-200 10 tons of manure	1302	1789	1059	1383
11	0-0-200 10 tons of manure	1046	1541	933	1173
12	150-0-0 10 tons of manure	1340	1732	1056	1376
	L.S.D.				
	.05	177	129	140	97
	.01	238	173	NS	128

Table 5. Acre Yields of Smoking Grades (Flyings, Lugs, Tan Leaf) Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	1957	1958	1959	Av.
			Pounds per acre		
1	0-0-200	818	1407	897	1041
2	75-0-200	982	1469	938	1129
3	150-0-200	1118	1810	1090	1339
4	225-0-200	1127	2048	765	1313
5	150-100-200	1028	1786	909	1241
6	150-0-0	1087	1403	717	1069
7	150-0-100	1052	1613	1095	1253
8	150-0-300	1104	1894	1090	1363
9	75-0-100 10 tons of manure	1133	1773	1001	1302
10	150-0-200 10 tons of manure	1216	1902	998	1372
11	0-0-200 10 tons of manure	980	1578	747	1102
12	150-0-0 10 tons of manure	1249	1853	975	1359
	L.S.D.				
	.05	191	347	NS	208
	.01	257	466		274

Yields of Smoking Grades. The smoking grades consisting of flyings, lugs, and tan leaf traditionally have been considered the most desirable for cigarette manufacture, but the use of other grades in cigarettes has been increasing in recent years.

Yields of smoking grades obtained with the various fertilizer treatments were very much in the same order as total yields and acre values (Table 5). Significant responses for this criterion of evaluation were obtained with 150 pounds of nitrogen and 200 pounds of potash per acre. Again, 10 tons of manure had about the same effect as 75 pounds of nitrogen. Applied fertilizer phosphorus was not beneficial.

Chemical Analyses. A partial chemical analysis of the top, middle, and bottom leaves of 10-plant samples was made each year. Percentages for nicotine, total nitrogen, potassium, calcium, phosphorus, and chlorine are reported in Tables 6, 7, 8, 9, 10, and 11, respectively.

Table 6. Percent Nicotine of the Top (T), Middle (M), and Bottom (B) Grades of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	Av.
1	0-0-200	T	3.39	1.29	2.38	2.35
		M	2.16	1.27	2.36	1.93
		B	0.56	0.37	0.77	0.57
		Average	2.04	0.98	1.84	1.62*
2	75-0-200	T	4.26	1.92	2.73	2.97
		M	2.80	1.74	2.50	2.35
		B	0.47	0.46	0.75	0.56
		Average	2.51	1.37	2.00	1.96*
3	150-0-200	T	4.50	2.62	3.54	3.55
		M	3.06	2.19	2.97	2.74
		B	0.62	0.56	1.27	0.82
		Average	2.73	1.79	2.59	2.37*
4	225-0-200	T	4.22	2.86	3.38	3.49
		M	3.01	2.60	2.97	2.86
		B	0.68	1.06	1.28	1.01
		Average	2.64	2.17	2.54	2.45*
5	150-100-200	T	4.29	2.69	3.22	3.40
		M	2.84	2.36	2.93	2.71
		B	0.33	0.87	0.94	0.71
		Average	2.49	1.97	2.36	2.27*
6	150-0-0	T	4.39	1.86	3.19	3.15
		M	2.97	1.64	2.88	2.50
		B	0.73	0.40	1.29	0.81
		Average	2.70	1.30	2.45	2.15*

Table 6 (continued)

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	Av.
7	150-0-100	T	4.26	2.34	3.82	3.47
		M	3.13	2.40	3.40	2.98
		B	0.44	0.74	1.40	0.86
		Average	2.61	1.83	2.88	2.44*
8	150-0-300	T	4.26	2.65	3.58	3.50
		M	2.85	2.09	2.98	2.64
		B	0.52	0.65	0.99	0.72
		Average	2.54	1.80	2.52	2.29*
9	75-0-100 10 tons manure	T	4.20	2.31	3.21	3.24
		M	2.92	1.86	2.54	2.44
		B	0.25	0.65	0.90	0.60
		Average	2.46	1.61	2.22	2.10*
10	150-0-200 10 tons manure	T	4.20	2.56	3.36	3.37
		M	2.80	2.28	2.85	2.64
		B	0.41	0.65	1.23	0.76
		Average	2.47	1.83	2.48	2.26*
11	0-0-200 10 tons manure	T	3.82	2.07	2.78	2.89
		M	2.75	1.90	2.19	2.28
		B	0.41	0.40	0.56	0.46
		Average	2.33	1.46	1.84	1.88*
12	150-0-0 10 tons manure	T	4.27	2.20	3.11	3.19
		M	2.94	1.92	2.70	2.52
		B	0.66	0.58	1.16	0.80
		Average	2.62	1.57	2.32	2.17*

*L.S.D. (.05) = 0.28
*L.S.D. (.01) = 0.37

Table 7. Percent Total Nitrogen of the Top (T), Middle (M), and Bottom (B) Grades of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	3-year Av.
1	0-0-200	T	4.28	3.12	2.87	3.42
		M	3.26	2.98	2.77	3.00
		B	2.42	2.72	2.36	2.50
		Average	3.32	2.94	2.67	2.98*
2	75-0-200	T	5.16	3.57	3.33	4.02
		M	3.82	3.49	3.25	3.52
		B	2.83	3.19	2.99	3.00
		Average	3.94	3.42	3.19	3.52*

Table 7 (continued)

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	3-year Av.
3	150-0-200	T	5.60	4.30	3.88	4.59
		M	4.40	4.24	4.06	4.23
		B	3.13	4.02	3.95	3.70
		Average	4.38	4.19	3.94	4.17*
4	225-0-200	T	5.56	5.03	4.56	5.05
		M	4.30	5.07	4.59	4.65
		B	3.34	4.88	4.29	4.17
		Average	4.40	4.99	4.48	4.62*
5	150-100-200	T	5.55	4.27	3.77	4.53
		M	4.20	4.02	3.80	4.01
		B	3.19	4.00	3.68	3.62
		Average	4.31	4.10	3.75	4.05
6	150-0-0	T	5.52	3.33	3.92	4.26
		M	4.13	3.36	3.85	3.78
		B	3.18	2.96	3.51	3.22
		Average	4.28	3.22	3.76	3.75*
7	150-0-100	T	5.50	4.23	3.85	4.53
		M	4.18	4.09	3.81	4.03
		B	3.04	3.86	3.53	3.48
		Average	4.24	4.06	3.73	4.01*
8	150-0-300	T	5.65	4.13	4.13	4.64
		M	4.28	4.14	4.08	4.17
		B	3.19	4.10	3.84	3.71
		Average	4.37	4.12	4.02	4.17*
9	75-0-100	T	5.19	3.86	3.60	4.22
	10 tons manure	M	4.18	4.13	3.64	3.98
		B	2.74	3.88	3.50	3.37
		Average	4.04	3.96	3.58	3.86*
10	150-0-200	T	5.47	4.51	4.18	4.72
	10 tons manure	M	4.07	4.56	4.21	4.28
		B	3.02	4.36	3.94	3.77
		Average	4.19	4.48	4.11	4.26*
11	0-0-200	T	4.68	3.60	3.11	3.80
	10 tons manure	M	3.57	3.59	3.05	3.40
		B	2.50	3.16	2.85	2.84
		Average	3.58	3.45	3.00	3.34*
12	150-0-0	T	5.62	3.75	3.96	4.44
	10 tons manure	M	4.38	3.98	4.04	4.13
		B	3.18	3.58	3.98	3.58
		Average	4.39	3.77	3.99	4.05*

*L.S.D. (.05) = 0.21
*L.S.D. (.01) = 0.28

Table 8. Percent Potassium (K) of the Top (T), Middle (M), and Bottom (B) Grades of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	Av.
1	0-0-200	T	3.60	3.56	3.90	3.69
		M	2.99	4.41	3.79	3.73
		B	3.10	4.74	3.12	3.65
		Average	3.23	4.24	3.60	3.69*
2	75-0-200	T	3.32	3.58	2.31	3.07
		M	3.53	4.16	3.22	3.64
		B	2.49	4.72	3.33	3.51
		Average	3.11	4.15	2.95	3.40*
3	150-0-200	T	2.80	3.28	3.21	3.10
		M	2.93	3.56	3.54	3.34
		B	3.11	4.37	3.10	3.53
		Average	2.95	3.74	3.29	3.33*
4	225-0-200	T	2.59	3.08	3.09	2.92
		M	3.09	3.30	2.86	3.08
		B	3.11	3.95	3.21	3.42
		Average	2.93	3.44	3.05	3.14*
5	150-100-200	T	3.01	3.16	2.88	3.02
		M	3.08	3.72	3.29	3.36
		B	3.21	4.14	3.78	3.71
		Average	3.10	3.67	3.32	3.36*
6	150-0-0	T	2.94	3.00	2.00	2.65
		M	2.72	3.38	1.78	2.63
		B	2.48	3.87	1.88	2.74
		Average	2.71	3.42	1.89	2.67*
7	150-0-100	T	2.96	3.15	2.64	2.92
		M	2.78	3.78	2.16	2.91
		B	3.40	4.42	1.90	3.24
		Average	3.05	3.78	2.23	3.02*
8	150-0-300	T	2.94	3.22	3.26	3.14
		M	2.82	3.92	3.30	3.35
		B	3.23	4.32	3.43	3.66
		Average	3.00	3.82	3.33	3.38*
9	75-0-100 10 tons manure	T	3.56	3.66	3.78	3.67
		M	3.41	4.45	3.05	3.64
		B	3.59	4.68	4.40	4.22
		Average	3.52	4.26	3.74	3.84*
10	150-0-200 10 tons manure	T	3.34	3.87	3.75	3.65
		M	3.90	4.40	4.17	4.16
		B	3.71	4.84	4.34	4.30
		Average	3.65	4.37	4.09	4.04*

Table 8 (continued)

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	Av.
11	0-0-200	T	3.34	3.62	4.12	3.69
	10 tons manure	M	3.70	4.21	4.30	4.07
		B	3.70	4.98	4.66	4.45
		Average	3.58	4.27	4.36	4.07*
12	150-0-0	T	3.14	3.49	3.62	3.42
	10 tons manure	M	3.61	4.08	4.04	3.91
		B	3.54	5.04	4.38	4.32
		Average	3.43	4.20	4.01	3.88*

*L.S.D. (.05) = 0.26
*L.S.D. (.01) = 0.34

Table 9. Percent Calcium (Ca) of the Top (T), Middle (M), and Bottom (B) Grades of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	Av.
1	0-0-200	T	3.60	3.88	4.48	3.99
		M	4.82	4.28	5.50	4.87
		B	7.37	5.39	6.20	6.32
		Average	5.26	4.52	5.39	5.06*
2	75-0-200	T	3.72	4.18	4.52	4.14
		M	5.61	4.64	5.26	5.17
		B	7.40	6.28	6.97	6.88
		Average	5.58	5.03	5.58	5.40*
3	150-0-200	T	4.13	4.59	6.70	5.14
		M	5.82	5.24	6.64	5.90
		B	7.66	6.17	5.86	6.56
		Average	5.87	5.33	6.40	5.87*
4	225-0-200	T	4.16	4.98	6.44	5.19
		M	6.34	5.28	7.26	6.29
		B	7.39	6.19	7.62	7.07
		Average	5.96	5.48	7.11	6.18*
5	150-100-200	T	4.27	4.88	6.19	5.11
		M	5.87	5.28	7.42	6.19
		B	7.35	6.72	7.66	7.24
		Average	5.83	5.63	7.09	6.18*
6	150-0-0	T	3.99	4.70	6.99	5.23
		M	6.29	5.49	7.91	6.56
		B	8.19	6.60	7.52	7.44
		Average	6.16	5.60	7.47	6.41*
7	150-0-100	T	4.29	4.78	6.71	5.26
		M	5.91	4.78	7.23	5.97
		B	7.60	6.17	8.34	7.37
		Average	5.93	5.24	7.43	6.20*

Table 9 (continued)

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	Av.
8	150-0-300	T	3.83	4.28	6.23	4.78
		M	5.93	4.87	5.36	5.39
		B	7.02	6.22	6.41	6.55
		Average	5.59	5.12	6.00	5.57*
9	75-0-100	T	4.12	4.65	4.79	4.52
	10 tons manure	M	5.86	5.05	5.13	5.35
		B	7.17	5.98	7.01	6.72
		Average	5.72	5.23	5.64	5.53*
10	150-0-200	T	4.16	4.65	4.98	4.60
	10 tons manure	M	5.76	5.08	6.84	5.89
		B	7.50	5.74	5.68	6.31
		Average	5.81	5.16	5.83	5.60*
11	0-0-200	T	4.12	4.23	5.74	4.70
	10 tons manure	M	5.67	4.50	6.28	5.48
		B	6.91	5.68	6.86	6.48
		Average	5.57	4.80	6.30	5.56*
12	150-0-0	T	4.11	4.58	6.82	5.17
	10 tons manure	M	5.80	4.90	7.18	5.96
		B	7.62	6.00	7.57	7.06
		Average	5.84	5.16	7.19	6.06*

*L.S.D. (.05) = 0.60
*L.S.D. (.01) = 0.81

Table 10. Percent Phosphorus (P) of the Top (T), Middle (M), and Bottom (B) Grades of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	Av.
1	0-0-200	T	0.36	0.39	0.34	0.36
		M	0.28	0.39	0.34	0.34
		B	0.24	0.42	0.32	0.33
		Average	0.29	0.40	0.33	0.34*
2	75-0-200	T	0.34	0.28	0.30	0.31
		M	0.27	0.31	0.28	0.29
		B	0.26	0.34	0.30	0.30
		Average	0.29	0.31	0.29	0.30*
3	150-0-200	T	0.32	0.31	0.28	0.30
		M	0.26	0.29	0.27	0.27
		B	0.22	0.31	0.26	0.26
		Average	0.27	0.30	0.27	0.28*
4	225-0-200	T	0.32	0.30	0.30	0.31
		M	0.26	0.30	0.29	0.28
		B	0.28	0.30	0.29	0.29
		Average	0.29	0.30	0.29	0.29*

Table 10 (continued)

Tmt. No.	Pounds per acre $N\text{-}P_2O_5\text{-}K_2O$	Grades	1957	1958	1959	Av.
5	150-100-200	T	0.35	0.29	0.28	0.31
		M	0.25	0.29	0.28	0.27
		B	0.24	0.30	0.28	0.27
		Average	0.28	0.29	0.28	0.28*
6	150-0-0	T	0.35	0.34	0.31	0.33
		M	0.26	0.41	0.33	0.33
		B	0.26	0.44	0.30	0.33
		Average	0.29	0.40	0.31	0.33*
7	150-0-100	T	0.30	0.30	0.28	0.29
		M	0.28	0.31	0.31	0.30
		B	0.27	0.31	0.27	0.28
		Average	0.28	0.31	0.29	0.29*
8	150-0-300	T	0.34	0.30	0.28	0.31
		M	0.25	0.30	0.27	0.27
		B	0.26	0.30	0.26	0.27
		Average	0.28	0.30	0.27	0.28*
9	75-0-100	T	0.30	0.29	0.30	0.30
	10 tons manure	M	0.26	0.32	0.27	0.28
		B	0.26	0.32	0.30	0.29
		Average	0.27	0.31	0.29	0.29*
10	150-0-200	T	0.33	0.33	0.27	0.31
	10 tons manure	M	0.25	0.32	0.25	0.27
		B	0.26	0.31	0.26	0.28
		Average	0.28	0.32	0.26	0.29*
11	0-0-200	T	0.34	0.31	0.32	0.32
	10 tons manure	M	0.30	0.34	0.30	0.31
		B	0.28	0.39	0.31	0.33
		Average	0.31	0.35	0.31	0.32*
12	150-0-0	T	0.34	0.30	0.28	0.31
	10 tons manure	M	0.25	0.31	0.28	0.28
		B	0.26	0.35	0.27	0.29
		Average	0.28	0.32	0.28	0.29*

*L.S.D. (.05) = 0.03
*L.S.D. (.01) = 0.04

Table 11. Percent Chlorine (Cl) of the Top (T), Middle (M), and Bottom (B) Grades of Tobacco Grown with Different Fertilizer Treatments 1957-1959.

Tmt. No.	Pounds per acre $N\text{-}P_2O_5\text{-}K_2O$	Grades	1957	1958	1959	Av.
1	0-0-200	T	1.28	0.52	0.65	0.82
		M	0.88	0.60	0.51	0.66
		B	0.74	0.58	0.60	0.64
		Average	0.97	0.57	0.59	0.71*

Table 11 (continued)

Tmt. No.	Pounds per acre N-P_2O_5-K_2O	Grades	1957	1958	1959	Av.
2	75-0-200	T	1.03	0.59	0.51	0.71
		M	0.78	0.40	0.46	0.55
		B	0.59	0.54	0.58	0.57
		Average	0.80	0.51	0.52	0.61*
3	150-0-200	T	0.75	0.46	0.42	0.54
		M	0.62	0.38	0.58	0.53
		B	0.43	0.55	0.58	0.52
		Average	0.60	0.46	0.53	0.53*
4	225-0-200	T	0.61	0.38	0.41	0.47
		M	0.67	0.34	0.39	0.47
		B	0.61	0.48	0.58	0.56
		Average	0.63	0.40	0.46	0.50*
5	150-100-200	T	0.82	0.36	0.38	0.52
		M	0.55	0.34	0.40	0.43
		B	0.50	0.54	0.66	0.57
		Average	0.62	0.41	0.48	0.50*
6	150-0-0	T	0.74	0.42	0.36	0.51
		M	0.51	0.38	0.33	0.41
		B	0.58	0.45	0.37	0.47
		Average	0.61	0.42	0.35	0.46*
7	150-0-100	T	0.78	0.42	0.34	0.51
		M	0.55	0.30	0.33	0.39
		B	0.52	0.47	0.48	0.49
		Average	0.62	0.40	0.38	0.47*
8	150-0-300	T	0.70	0.42	0.48	0.53
		M	0.60	0.48	0.48	0.52
		B	0.62	0.66	0.59	0.62
		Average	0.64	0.52	0.52	0.56*
9	75-0-100 10 tons manure	T	2.31	1.51	1.42	1.75
		M	2.23	1.68	1.54	1.82
		B	1.71	1.72	1.76	1.73
		Average	2.08	1.64	1.57	1.76*
10	150-0-200 10 tons manure	T	1.89	1.38	1.39	1.55
		M	1.94	1.36	1.37	1.56
		B	1.21	1.27	1.49	1.32
		Average	1.68	1.34	1.42	1.48*
11	0-0-200 10 tons manure	T	2.68	1.31	2.05	2.01
		M	2.64	1.62	2.42	2.23
		B	2.34	2.07	2.56	2.32
		Average	2.55	1.67	2.34	2.19*
12	150-0-0 10 tons manure	T	1.58	1.24	1.30	1.37
		M	1.67	1.45	1.47	1.53
		B	1.21	1.80	1.67	1.56
		Average	1.49	1.50	1.48	1.49*

*L.S.D. (.05) = 0.17
*L.S.D. (.01) = 0.23

Nicotine and Total Nitrogen. Average results indicate that percentages of nicotine and total nitrogen tended to vary in direct proportion to the amount of chemical nitrogen supplied to the plants. Each increment of fertilizer nitrogen gave larger percentage values for these two constituents than the next lower increment.

The effects of 10 tons of manure per acre on the concentrations of nicotine and total nitrogen in the tobacco leaf were only moderate. In no case did manure significantly increase or decrease the percentage of nicotine when compared with treatments specifying identical amounts of chemical nitrogen without manure. Tobacco grown with manure in addition to 0- and 75-pound rates of nitrogen, however, was significantly higher in total nitrogen than that grown with these same rates of nitrogen without manure.

Potassium. A relatively high potassium content is considered a desirable characteristic of burley tobacco because of the favorable influence of this element upon burning properties, finish of leaf, and other attributes of tobacco quality.

Average results indicate that the percentage of potassium in the tobacco leaf increased with each addition of potassium in the fertilizer. The difference in the potassium content of tobacco grown with 300 pounds of K_2O per acre and that grown with 200 pounds, however, was negligible.

The decrease in concentration of leaf potassium with an increase in fertilizer nitrogen reflects the pattern usually observed when fertilizer nitrogen is the variable. Such variations are ordinarily explained on the basis of dilution, since larger yields are obtained with the higher rates of nitrogen. Thus, the point is well taken that when sufficient nitrogen is applied to produce large yields, enough potassium should be supplied also to assure a satisfactory concentration of the latter element in the tobacco leaf.

All manure treatments produced tobacco of relatively high potassium content, even where no chemical potassium was applied. The efficiency of manure as a supplier of potassium to plants is probably due to its favorable influence on soil physical properties as well as to its content of potentially available potassium. The latter point is emphasized by the fact that, regardless of the amount of chemical potassium applied, no treatment which did not include manure produced tobacco with as high a potassium concentration as any other treatment which included manure.

Calcium. Since calcium and potassium ions compete for entrance into plant roots, an increase in the absorption of one of these

elements usually results in a corresponding decrease in the absorption of the other. Consequently, the percentage of calcium in the tobacco leaf tended to vary directly with the amount of nitrogen and indirectly with the amount of potassium applied in the fertilizer. Manure did not significantly influence the calcium percentage of tobacco. Similar observations were made in previous work (5, 6).

Phosphorus. Variations in the phosphorus content of tobacco grown with different fertilizer treatments were comparatively small. There was a distinct trend among treatments which did not include manure, however, one related to the amount of nitrogen supplied the plants. Each increment of nitrogen applied up to 150 pounds per acre decreased the phosphorus percentage of the cured leaf under that of the next lower increment. The competition of nitrate and phosphate ions for entrance into plant roots possibly was responsible for the effects observed. Similar effects of nitrogen on the phosphorus content of the tobacco were observed and reported earlier (6).

Chlorine. Chlorine applied in commercial fertilizers is readily absorbed by the tobacco plant, and it is traditional to caution growers to use low-chlorine sources of fertilizers on cigarette types of tobacco. An increase in the chlorine content of cured tobacco increases the ability of the tobacco to absorb moisture which, with other unknown factors, reduces the capacity of the tobacco to burn.

In the work reported here, the percent chlorine of burley tobacco tended to decrease as applied fertilizer nitrogen was increased. This effect can be explained on the basis of competition of chloride and nitrate ions for entrance into the plant, and also because of a dilution effect where larger yields are obtained with the higher rates of nitrogen.

Another slight trend is noted in respect to the potassium supply. Since sulfate of potash contains about 2% chlorine as an impurity, it can be expected that the chlorine content of tobacco will rise slightly as further additions of this material are made.

Manures from farm animals are usually suppliers of chlorine since common salt and other materials containing chlorine are included in the rations fed. Tobacco in all treatments that included manure was comparatively high in chlorine. Within the group of treatments which included manure, the chlorine percentage of tobacco decreased with an increase in commercial nitrogen applied, apparently for reasons already stated. These results should serve to further caution tobacco growers to apply only moderate amounts of manures to their crops.

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