

RELATION OF SYSTEM OF FERTILIZATION TO QUALITY IN BRIGHT TOBACCO WHEN  
YIELDS PER ACRE ARE INCREASED OR DECREASED BY CULTURAL PRACTICES

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T. L. Copley

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Introduction

When flue cured tobacco became established as one of the cash crops of the Virginia farmers, the general practice was to top the plants fairly low so that they would ripen uniformly and harvest the crop by cutting the stalk. The systems of fertilization also became so standardized that practically all farmers were using fertilizers with the same analyses. In not all cases, however, was this due to any knowledge of the plant food requirement, but merely on account of the prevailing custom. For the most part, this tobacco fertilizer contained two to three percent ammonia, eight percent phosphoric acid, and either two or three percent of potash.

As the flue cured tobacco belt spread into the southern territory, experiment stations found that a better yield and quality might be secured if the tobacco plants were topped higher and the leaves primed off as they became ripe. This method of harvesting has now come into use in practically the whole of the bright belt except in a small area in the northwestern part of the territory. Even in that section, experimental results show that priming is very profitable and many growers are turning to it.

No material change in the fertilizer practices have accompanied the change in the method of harvesting and the same

amounts and analyses are now used as formerly. The usual yield when the plants were topped for cutting was between 500 and 800 pounds to the acre. With higher topping and closer spacing, the yield may be increased from twenty-five percent to fifty percent, and yields of 1000 to 1500 pounds of cured leaf per acre are not unusual.

The purpose of this project was to determine whether the high yields resulting from changed cultural practices required increased amounts of the standard 3-9-3 fertilizer, or a different ratio of the plant food elements. In addition to the determination of the most satisfactory analysis of fertilizer, the proper height of topping and distance of spacing of the plants was ascertained. The old method of harvesting by cutting was also compared with the priming method.

### Methods and Treatments

The experiment was begun at the Chatham Experiment Station in 1930 with the idea that it was to be continued through 1931, and the two years' results to be included in this report. On account of the severe drought which prevailed in 1930, both the yield and quality of the crop was so impaired that the results were considered valueless and are not included.

In 1931 the experiment was conducted on the Charles Davis farm about two miles south of the experiment station. The soil is classified as a fine sandy loam of the Granville Series, and is considered one of the best types of bright tobacco soil. It is in the famous White Oak Mountain tobacco area.

One-fortieth acre plots were used and each plot contained ten rows, three and one-half feet apart. The spacing of the plants in the rows varied as shown in the outline. Unless otherwise stated, the treatments of all plots were identical and the cultural practices conformed with the prevailing custom of the section. All plots were harvested priming the leaves as they ripened except those of section A, which were cut. After being cured the tobacco was graded, weighed and sold, and the value per acre, the percent of stand was determined, and the results given are on the basis of one hundred percent stand.

The experiment consisted of eight fertilizer treatments which permitted the comparison of 1000 and 1500 pounds of the standard 3-8-5 fertilizer: 3, 5, and 7 percent potash, 3, 4, and

5 percent ammonia and 3, 10 and 12 percent phosphoric acid. Across each fertilizer plot were eight sub-sections on which the height of topping and spacing of the plants was varied as shown in Table 1. In the first two sections (A and B), the plants were topped at ten leaves and spaced thirty-six inches apart in the row. The next three sections (C, D and E) were topped at fourteen leaves and spaced thirty, twenty-four and eighteen inches apart respectively. The last three sections were similar to sections C, D, and E except they were topped at eighteen leaves. By such spacing and topping the number of plants per acre ranged from 4150 to 8300 and the number of leaves varied from 40,000 to 150,000 per acre.

#### Review of Literature

Numerous publications on the production and fertilization of tobacco are available, though nothing was found which mentioned any relationship between the yield and the fertilizer requirement of the crop. The only means of determining any such relationship was by considering the normal yields of the various flue cured tobacco growing areas and determining the most effective fertilization for those areas.

For the flue cured area of Virginia where the custom has been to top low and harvest the crop by cutting the stalk, Hutcheon and Berger (2) state that a 3-6-3 fertilizer gave better

results than any other analysis. This conclusion is also borne out by the results given in the unpublished report for 1930 of the Chatham Experiment Station, in which it is shown that a variation of that ratio did not prove beneficial. These results were obtained on a Cecil sandy loam soil, and it is probable that the same results would not have been obtained on a more desirable type of tobacco soil.

In the other belts of the flue cured area, somewhat different results have been obtained with fertilizer experiments. The main difference being in the potash content of the fertilizer. Moss, et al (3) concludes that for North Carolina conditions a fertilizer containing three to four percent ammonia, six to eight percent phosphoric acid, and four to six percent potash gives best results.

The general recommendation for Georgia is one thousand pounds per acre of a 3-8-5. Carr (1) shows in the results of a four years' experiment conducted at Tifton, however, that eighty pounds potash gave larger yields and better quality than smaller amounts. Beneficial results are also obtained with heavier applications of phosphoric acid, which seems to be contrary to results secured with the Virginia and North Carolina experiment.

The general recommendations of the Tobacco Fertilizer Committee for the flue cured area call for an application of one thousand pounds per acre of a 3-3-5 fertilizer for average conditions, and the same amount of a 4-3-6 fertilizer on thin soils where the yields are low. This Committee states that where very high yields are produced, by high topping and close spacing, as much as eight percent potash may prove profitable.

The advantages of the priming method of harvesting over the cutting method have been discussed by Moss (4), and it is shown that the type of tobacco can be improved and the yield increased twenty-five to thirty-five percent by priming. He recommends that the plants be topped two to six leaves higher for priming than for cutting.

Williams (5) states that North Carolina experiments show conclusively that by more intensive fertilization and closer planting the yield of tobacco can be increased without injuring the quality. His report shows an increase of two hundred forty pounds per acre in yield and fifty dollars in value by priming the leaves instead of cutting the stalk. It is also noted that increasing the nitrogen content of the fertilizer tends to increase the susceptibility of the plant to rots and disease, while increased potash tends to have the opposite effect.

### Presentation of Data

The total yield and value per acre for all treatments is shown in Table 1. This table shows whether or not increasing the number of plants and leaves per acre requires an increase in the amount of fertilizer or a different ratio of the plant food elements.

If the results of all eight of the cultural treatments are averaged and only the fertilizer factor is considered, the best analysis for average conditions may be determined. If the results of all eight fertilizer treatments for each of the topping and spacing treatments are averaged, a conclusion may be drawn as to which method results in the greatest returns per acre. Table 2 shows results of the fertilizer treatments and Table 3 the results of the spacing and topping treatment.

A record of the rainfall for each ten day period of the growing season of 1931 is given in Table 4.

Table 1.- Effect of fertilizers on yield and value with different spacing and topping.

Plot	Yield Fertilizer	Sec. A		Sec. B		Sec. C			Sec. D			Sec. E			Sec. F			Sec. G			Sec. H			
		Topped 10 leaves						Topped 14 leaves						Topped 18 leaves										
		36 in. cut	:	36 in. primed	30 in. primed	:	24 in. primed	:	18 in. primed	30 in. primed	:	24 in. primed	:	18 in. primed	30 in. primed	:	24 in. primed	:	18 in. primed	30 in. primed	:	24 in. primed	:	18 in. primed
1	1000 lbs. 3-8-5	452		600		761		854		1125		638		723		869								
2	1500 lbs. 3-8-3	691		855		1091		755		1000		759		655		1103								
3	1000 lbs. 3-8-5	525		687		1140		889		1012		761		1053		1058								
4	1000 lbs. 3-8-7	755		812		1052		910		954		787		1032		1160								
5	1000 lbs. 4-8-6	500		653		1260		968		921		939		1400		1210								
6	1000 lbs. 5-8-6	538		1034		855		1123		1191		660		634		896								
7	1000 lbs. 3-10-5	554		532		785		663		782		1250		826		1000								
8	1000 lbs. 3-12-5	560		976		869		1090		755		1076		1073		1130								

Value per acre and per pound

1	1000 lbs. 3-8-5	\$53.30	9.6	\$43.30	7.2	\$54.70	7.8	\$57.50	6.6	\$60.50	5.4	\$31.70	4.6	\$36.30	5.4	\$45.20	5.2								
2	1500 lbs. 3-8-3	63.00	7.3	68.50	8.	80.90	7.4	47.70	6.3	65.00	6.5	23.30	3.9	19.50	3.	52.80	4.8								
3	1000 lbs. 3-8-5	57.00	10.8	65.80	9.6	91.50	8.	65.30	9.6	77.00	7.6	47.00	6.2	66.50	6.3	49.30	4.5								
4	1000 lbs. 3-8-7	73.20	9.3	71.20	8.7	89.20	8.5	77.30	8.5	62.40	6.5	46.30	5.9	63.50	5.9	69.00	6.0								
5	1000 lbs. 4-8-6	33.60	7.7	30.30	4.7	73.50	5.8	79.50	7.2	80.90	8.3	61.10	6.2	63.20	4.5	70.00	5.8								
6	1000 lbs. 5-8-6	31.50	5.4	27.40	2.7	24.10	2.3	70.70	6.3	93.00	7.7	62.20	7.2	30.70	4.8	46.80	5.2								
7	1000 lbs. 3-10-5	41.00	7.7	21.70	4.0	22.00	2.8	33.50	5.5	65.20	6.3	75.00	6.0	52.30	6.3	50.00	5.								
8	1000 lbs. 3-12-5	30.00	5.4	34.20	3.5	33.90	3.9	55.50	5.1	66.40	8.8	37.00	8.1	65.60	6.1	60.40	7.2								

### Weather Conditions of Five Growing Months

Hard rains about the time the crop was planted washed the plots badly and interfered with the stand on some of the plots. However, for most of the growing period, the weather was favorable.

After the tobacco had been primed the second or third time heavy rains set in and continued for two or three weeks. This caused the tobacco to make too much growth and materially reduced the quality of the cured leaf. Some of the plots which were cut and harvested before these heavy rains were not so adversely affected and had a decided advantage over those plots which were primed and matured later. It may be observed in Table 3 that these heavy rains fell from the latter part of July until about the same time in August, which is the most important period in influencing the quality of the crop produced.

Table 4.- Rainfall for each ten-day period of the five growing months of 1931.

Month	Ten-day period	No. of inches	Total
May	1 - 10	1.53	3.53
	11 - 20	.59	
	21 - 31	1.36	
June	1 - 10	3.10	7.36
	11 - 20	.00	
	21 - 30	4.26	
July	1 - 10	2.11	3.33
	11 - 20	.20	
	21 - 31	1.02	
Aug.	1 - 10	1.72	6.74
	11 - 20	1.32	
	21 - 31	3.70	
Sept.	1 - 10	.25	.99
	11 - 20	.05	
	21 - 30	.69	
			22.00

## Discussion of Results

Low Topping (10 leaves):- Section A of Table 1 shows that when plants were spaced thirty-six inches apart and topped to ten leaves and cut largest returns and greatest value per acre was obtained when a 3-3-7 fertilizer was used. If nitrogen is increased above three percent both yield and value is decreased. There is a slight increase in yield where the phosphoric acid is increased but the value is reduced.

Section B shows that when tobacco was spaced and topped as in A, but the leaves harvested by priming instead of cutting, greatest yields were obtained from a 5-3-3 fertilizer. However, the quality of the tobacco from this plot was low and highest value per acre was obtained from the 3-3-7 fertilizer as is the case where the tobacco was cut. There is no consistent advantage from increasing the phosphoric acid in this series.

These data indicate no marked advantage for priming when the plants are topped low. They also show that there is no reason for changing the amount of fertilizer used when plants are topped low and primed.

Medium Topping (14 leaves):- When plants were topped to fourteen leaves, the highest yield and money value per acre were obtained on plot 6, Section B, which received one

thousand pounds of 5-3-6 fertilizer to the acre and was spaced eighteen inches apart in the rows. However, plot 3, Section C, which received one thousand pounds of 3-3-5 fertilizer and was spaced thirty inches apart in the row returned only one and one-half dollars less per acre. This is not sufficient to pay the additional cost of fertilizer and extra expense of planting and cultivating the increased number of plants. In comparing plots 3 and 4 in which the potash was increased to 5 and 7 percent with plot 1 on which the amount of potash was only 3 percent, it was found that the yield and value increased as the potash was increased. Increasing the nitrogen to 4 percent as in plot 5 also gave a profitable increase in both yield and value. Five percent nitrogen also gave good results when the plants were spaced eighteen inches apart, but with thirty inch spacing, the quality was very poor and the tobacco diseased badly. Additional phosphoric acid increased neither yield nor value per acre on the sections which were topped to fourteen leaves.

If Section A, which was topped to ten leaves and cut, are compared with Sections C, D and E, which were topped to fourteen leaves and primed, it will be seen that higher topping and priming greatly increases both yield and value per acre. This was true in the case of each of the fertilizer treatments tried.

High Topping (18 leaves):- When plants were topped to eighteen leaves as in Sections F, G and H, the largest yield was obtained when one thousand pounds of a 3-12-5 fertilizer was applied and plants spaced thirty inches apart, while the highest value per acre was obtained with a 3-12-5 fertilizer and thirty inch spacing.

Increasing the potash to five and seven percent as in plots 3 and 4 increased the yield and value per acre though the increase was not as marked as with medium topping of Sections C, D and E. Increasing the nitrogen to four percent when the plants were topped to eighteen leaves increased the yield but gave no consistent increase in returns per acre. The yield and value were both less when five percent nitrogen was applied than with four percent. Both returns and yield were materially increased to ten and twelve percent and the greatest increase was obtained when the plants were spaced thirty inches apart in the row.

Topping to eighteen leaves did not prove as profitable as fourteen leaves except when all the plant food elements were increased as in plots 7 and 8. There was little consistent difference between thirty, twenty-four and eighteen inch spacing.

Table 2.- Comparisons of Fertilizers

Plot	Fertilizers	Yield per acre	Value per acre	Value per pound
1	1000 lbs. 3-3-3	771	47.84	6.2
2	1800 lbs. 3-3-3	835	53.21	6.0
3	1000 lbs. 3-3-3	891	66.17	7.4
4	1000 lbs. 3-3-7	939	69.00	7.3
5	1000 lbs. 4-3-3	788	62.14	6.4
6	1000 lbs. 5-3-3	898	48.30	5.4
7	1000 lbs. 5-10-5	798	45.12	5.6
8	1000 lbs. 3-12-5	941	56.63	6.0

Table 3.- Topping, spacing and harvesting tests

Section			
A	Topped 10 leaves, 614 spaced 36, cut	48.45	7.9
B	Topped 10 leaves, 769 spaced 36, primed	45.30	5.9
C	Topped 14 leaves, 976 spaced 30, primed	58.73	6.
D	Topped 14 leaves, 907 spaced 24, primed	63.37	7.
E	Topped 14 leaves, 967 spaced 18, primed	71.30	7.4
F	Topped 18 leaves, 890 spaced 30, primed	54.65	6.2
G	Topped 18 leaves, 932 spaced 24, primed	54.76	5.9
H	Topped 18 leaves, 1082 spaced 18, primed	57.94	6.2
	Aver. sections C, 250	64.47	6.8
	D & E (14 leaves)		
	Aver. sections F, 958	55.85	5.8
	G & H (18 leaves)		
	Aver. sections C 933	56.79	6.1
	& F(spaced 30 in)		
	Aver. sections D 920	59.06	6.4
	& G(spaced 24 in)		
	Aver. sections E 1110	64.62	5.8
	& H(spaced 18 in)		

### Conclusions

1. The optimum number of leaves to be left on a plant depends upon the amount of well balanced plant food in the soil.

2. When plants are spaced thirty-six inches apart in three and one-half foot rows and topped to ten leaves, the optimum amount of plant food was one thousand pounds of 5-8-7 fertilizer to the acre. This was true when plants were harvested by cutting as well as when pruning was practiced.

3. When plants were topped to fourteen leaves, highest yield and value were obtained when they were spaced eighteen inches apart and fertilized with one thousand pounds of 5-8-6 to the acre. However, when extra cost of plants, cultivation and additional fertilizer is considered, the most economical results were obtained from thirty inch spacing and one thousand pounds of 5-8-5 fertilizer to the acre.

4. When plants were topped to eighteen leaves, the most economical returns were obtained from thirty inch spacing and one thousand pounds of 3-12-5 fertilizer.

5. Within the limits of the fertilizer treatment used, topping to fourteen leaves gave better results than topping to eighteen leaves.

6. Results from spacing vary greatly with the amount of plant food applied, but no definite conclusion can be drawn from the data at hand.

7. Increasing both nitrogen and potash gave favorable returns when the total number of leaves to the plant was increased from ten to fourteen.

8. Increasing the phosphoric acid failed to increase returns except when the plants were topped to eighteen leaves.

9. Both yield and value was generally increased by topping to fourteen leaves and pruning over topping to ten leaves and harvesting by cutting.

10. The data suggests that topping to eighteen leaves may be profitable if all plant food elements are increased. However, it is thought that extremely high topping and close spacing would give disastrous results in dry years and that medium high topping and spacing would be better under average conditions.

11. Under the conditions of the experiment, increasing the potash from the usual three percent to five percent or higher was profitable in all cases.

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