EFFECTS OF POTASSIUM AND MAGNESIUM AT THREE RATES ON YIELD AND PRICE OF FLUE-CURED TOBACCO[1]

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During the period 1969-71, a test at 33 on-farm locations was conducted in North Carolina to measure the effects of potassium and magnesium at three rates on the yield and quality of flue-cured tobacco. There was no effort to select locations with specific soil types with specific levels of nutrients. The rates of potassium (K_2O) used were 100, 150 and 200 lbs. per acre and the rates of magnesium (MgO) used were 0, 20 and 40 lbs. per acre.

There was no significant response to the rates of potassium and magnesium used in this study. The regression of relative yield and price against potassium and magnesium fertilization rates was also not significant. This indicated that on soils with the potassium and magnesium soil test levels encountered in this study no response is probable to potassium above 100 lbs. per acre or to the application of any soluble magnesium in the preplant fertilizer.

In the early 1930's 700 to 1000 pounds of mixed fertilizer per acre containing six percent potassium, expressed as K_2O[3], and 42 to 60 pounds of potassium were recommended for flue-cured tobacco. The N to potassium ratio in this fertilizer was 1:2. During the 1940's the percentage of potassium was increased to nine percent which supplied 63 to 90 pounds of potassium per acre. Since that time the use of a 1:3 nitrogen-potassium ratio in mixed fertilizers has become an accepted practice. During this period the rate of mixed fertilizer application has increased substantially until today it is not uncommon to find growers who are supplying as much as 200 to 250 pounds of potassium per acre.

Sierra (3) found no improvement in yield of flue-cured tobacco when more than 121 pounds of potassium were used in field experiments. There was no difference in price of tobacco among treatments of 0 to 242 pounds of potassium per acre. Hutcheson (2) observed no yield increase from more than 60 pounds and no price improvement from more than 30 pounds of potassium per acre.

Based primarily on work conducted during the 1920's by Garner *et al.* (1) there has been a requirement that all commercially mixed fertilizers for flue-cured tobacco contain at least 2 percent water soluble magnesium. This regulation was passed when most growers were using about 800 to 1000 pounds of complete mixed fertilizer per acre.

The objective was to supply about 20 pounds of magnesium equivalent per acre to prevent magnesium deficiency, commonly referred to as sand drown. Currently, many growers are using 2000 or more pounds of mixed fertilizer per acre which considerably increases the rate of applied magnesium. On the other hand, some are using high analysis mixtures and are applying only about 500 pounds per acre which considerably lowers the rate of applied MgO.

Woltz[4] concluded that on fields with a pH of 4.7 to 5.0, either 30 pounds of soluble magnesium in the fertilizer or 1000 pounds of dolomitic limestone was sufficient to supply the magnesium needs of a tobacco crop. Also, the residual effect of 1000 pounds of dolomitic lime per acre was effective enough to meet the magnesium requirements of tobacco even after eight years. He further concluded that if the pH is properly adjusted with dolomitic limestone, there appears to be no need to use magnesium in the mixed fertilizer.

The objective of this study was to measure the effects of potassium and magnesium at three rates on the yield and quality of flue-cured tobacco with special emphasis on determining optimum rates under a wide range of soil and climatic conditions.

MATERIALS AND METHODS

During the period 1969-71, a test at 33 on-farm locations was conducted in the flue-cured tobacco producing area of North Carolina, including the four tobacco belts in North Carolina—Border, Eastern, Middle and Old Belts. There was no effort to select locations with specific soil types with specific levels of nutrients. The fields used were those commonly used for tobacco production by growers on whose farms the tests were conducted. This "random" selection of fields resulted in the use of a very wide range of soil types and fertility levels as well as a wide range of weather conditions.

Prior to fertilizer application, soil samples were taken from the plow layer and analyzed by the Soil Testing Division, N.C. Department of Agriculture, for pH, organic matter, calcium, phosphorus, potassium and magnesium using standard methods for farmer samples **(Table 1)**.

Special fertilizer mixtures were made to include treatment variables and were applied as a preplant application in a single band in the row **(Table 2)**. The fertilizer was applied so that was three to five inches below the roots of the plants after transplanting. Sodium nitrate was the source of any additional nitrogen added based on a soil test and depth of topsoil and adjustments for leaching. The base rate of nitrogen ranged among locations from 40 to 70 pounds per acre and adjustments for leaching ranged from none to 47 pounds per acre **(Table 1)**.

The treatments were replicated twice in a randomized complete block design at each farm. Each plot consisted of four rows of sufficient length to be .033 acre in size. Length of rows varied from 90.8 to 103.7 feet because of different row widths at the different farms.

Other than the potassium and magnesium variables, all cultural practices such as cultivation, varieties,

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[3]*Throughout this paper, reference to rates of potassium are based on calculations as K_2O and rates of magnesium are based on calculations as MgO. Woltz, W. G. Unpublished data. Department of Soil Science, North Carolina State University, Raleigh, North Carolina 27607.*
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Table 1. Soil test values, topsoil depth, and nitrogen rates at each location

Location	Soil Test Values[1] pH	OM %	Ca	P Index	K Index	Mg Index	Topsoil Depth[2] Inches	N Applied Base	Adjustment lbs/A	Total
1	5.7	2.1	49	46	62	97	9	40	0	40
2	5.8	0.7	28	100+	27	13	20	70	39	109
3	6.1	0.9	32	74	38	43	10	50	12	62
4	5.4	1.2	36	66	43	22	14	60	47	107
5	5.2	2.0	40	100+	33	10	9	55	20	75
6	5.5	0.8	39	76	31	11	11	40	32	72
7	5.3	1.8	61	100+	50	36	12	50	17	67
8	5.8	0.5	29	100+	44	14	9	55	36	91
9	6.2	1.6	60	40	44	68	10	50	16	66
10	5.0	0.9	25	26	15	17	9	40	17	57
11	5.1	1.1	43	58	22	62	8	40	22	62
12	5.3	0.9	30	68	70	29	10	40	10	50
13	5.2	1.1	26	100+	17	21	20	70	27	97
14	5.8	1.1	43	100+	44	28	12	50	24	74
15	5.4	1.5	35	82	40	19	20	70	2	72
16	5.6	0.5	18	74	21	9	12	45	30	75
17	5.3	1.6	22	22	12	36	20	70	0	70
18	6.0	0.9	37	78	54	26	20	70	0	70
19	6.0	0.6	41	100+	30	22	20	55	19	74
20	5.8	1.3	50	30	33	67	8	40	0	40
21	5.3	0.6	43	58	44	14	9	40	0	40
22	5.8	0.7	55	100+	54	47	8	40	0	40
23	5.4	1.5	45	56	72	37	9	40	10	50
24	5.9	0.6	26	100+	28	15	20	70	26	96
25	6.0	0.9	25	100+	37	24	18	65	0	65
26	5.7	2.0	34	42	40	30	15	50	16	66
27	6.3	2.0	73	36	76	71	9	40	0	40
28	5.2	1.6	23	74	50	15	9	50	22	72
29	5.2	1.3	33	100+	40	43	9	40	0	40
30	5.8	1.5	65	64	25	77	11	40	12	52
31	5.5	1.3	43	90	64	34	9	40	22	62
32	5.7	1.1	52	52	42	63	11	50	10	60
33	6.5	0.8	68	100+	39	73	14	60	16	76

[1] *Ca index x 0.05 = Exchangeable Ca, me/100 g. Mg index x 0.01 = Exchangeable Mg, me/100 g. K index x 0.004 = Exchangeable K, me/100 g.*
[2] *Either A horizon or plow layer, whichever is deeper.*

Table 2. Rate of preplant nutrients per acre for each of the 33 experiments

Treatment	N*	P_2O_5	K_2O	MgO
A	40	72	100	20
B	40	72	150	20
C	40	72	200	20
D	40	72	150	0
E	40	72	150	40

* *Additional N added in accordance with soil test information and top soil depth.*

Table 3. Response of flue-cured tobacco to rates of potassium and magnesium in the preplant fertilizer

Treatment	Yield* lbs/A	Price* dol/cwt.
K_2O, lbs/A		
100	2354	75.12
150	2342	74.97
200	2367	75.11
LSD .10	NS	NS
MgO, lbs/A		
0	2325	75.13
20	2342	74.97
40	2307	75.26
LSD .10	NS	NS

* *Average of 33 locations.*

Table 4. The response of flue-cured tobacco to potassium in relation to the potassium soil test index

Soil Test K Index	Number of Locations	Yield Response Range	Yield Response Average	Price Response Range	Price Response Average
		lbs/A		dol/cwt.	
100 vs 150 lbs. K_2O/A					
0-25 (Low)	6	−521 to + 90	−111	−1.23 to +1.44	+0.34
25-50 (Medium)	20	−212 to +118	− 16	−3.54 to +1.72	−0.28
>50 (High)	7	−133 to +485	+ 83	−1.97 to +1.23	−0.36
100 vs 200 lbs. K_2O/A					
0-25 (Low)	6	−699 to +536	−103	−1.32 to +1.38	−0.25
26-50 (Medium)	20	−188 to +325	+ 32	−1.28 to +2.28	+0.12
>50 (High)	7	−331 to +387	+ 54	−1.97 to +0.53	−0.19

Table 5. The response of flue-cured tobacco to rates of magnesium in relation to the magnesium soil test index

Mg Soil Test Index	Number of Locations	Yield Response Range	Yield Response Average	Price Response Range	Price Response Average
		lbs/A		dol/cwt.	
0 vs 20 lbs MgO/A					
0-25 (Low)	14	−278 to +333	+ 4	−2.09 to +0.42	−0.29
26-50 (Medium)	11	−223 to +327	+ 2	−1.24 to +1.72	+0.19
>50 (High)	8	−129 to +488	+61	−1.10 to +1.74	+0.33
0 vs 40 lbs MgO/A					
0-25 (Low)	14	−240 to +175	− 3	−1.16 to +1.40	−0.01
26-50 (Medium)	11	−213 to −487	−16	−0.77 to +1.50	+0.09
>50 (High)	8	−320 to +168	−46	−0.23 to +1.22	+0.33

of the farms on which the tests were conducted and were uniform over the experimental area.

The tobacco from each plot was sorted into farm grades, weighed and assigned U.S. Standard Government grades by a U.S. Department of Agriculture Tobacco Inspector. The average auction price for a given marketing period was assigned each grade and the yield (pounds per acre) and price (dollars per hundredweight) were computed.

The data were analyzed using analysis of variance and regression techniques. In the analysis of variance the treatments were tested for significance using the treatments by location interaction error term. In the regression analysis the yield and price data were converted to a relative basis at each location where treatment A was given a value of 100 when considering response to potassium fertilization (Treatments A, B, and C) and treatment D likewise was given a value of 100 when considering response to magnesium fertilization (Treatments D, B, and E). For comparative purposes this eliminated numerical differences among locations due to soil, weather, and other uncontrollable variations.

RESULTS AND DISCUSSION

There was no significant response to the rates of potassium and magnesium used in this study **(Table 3)**. The regression of relative yield and price against potassium and magnesium fertilization rates was also not significant. This indicates that on soils with the potassium and magnesium soil test levels encountered in this study no repsonse is probable to potassium above 100 lbs. per acre or to the application of any soluble magnesium in the preplant fertilizer. The latter observation is in agreement with Woltz[4]. In another regression analysis there was a tendency for there to be a larger response to potassium on those soils testing high in potassium. The soils were subsequently classified according to soil test potassium index values and the response to 50 lbs. potassium per acre (100 vs 150 lbs/A) and 100 lbs. potassium per acre (100 vs 200 lbs/A) computed to better comprehend this trend **(Table 4)**. The average yield response to 50 lbs. potassium per acre was negative (—111 lbs/A) on the six soils testing low in potassium but positive (83 lbs/A) on the seven soils testing high in potassium. There was a similar trend in the yield response to 100 lbs. potassium per acre. This was not observed for price response to potassium or for yield and price response to magnesium **(Tables 4 and 5)**. This trend is not consistent with the generally accepted concept of a larger probability of response on soils testing low in a particular nutrient and no definitive explanation of this observation is offered at this time.

From a practical standpoint, a grower should not expect any response to an application of more than 100 lbs. potassium per acre on soils such as those used in this study. Response to soluble magnesium included in the fertilizer applied to tobacco is also very unlikely where pH levels are suitable for tobacco growth and excessive leaching does not occur.

LITERATURE CITED

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