Investigations on the Effect of Foliar Application of Nitrogenous Fertilizers on Growth and Yield of Chewing Tobacco *(Nicotiana tabaccum* Linn.)*

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Introduction

Chewing tobacco *(Nicotiana tabaccum* L.) is an important cash crop in the Cannanore District of Kerala. It is grown on the littoral sandy soil, as well as, on laterite loam. It seems obvious from the nature of the soils and heavy precipitation received in the locality that losses of nutrients on account of fixation in unavailable forms and leaching are inevitable. Intensive manuring is practised by the growers. The crop receives on an average over three hundred kilograms of nitrogen per hectare. The manuring bill is consequently heavy. Any attempt to bring down the cost of manuring commends itself. With this object in view investigations on the influence of foliar feeding of nitrogen on growth and yield of chewing tobacco were conducted at the Agricultural College and Research Institute, Vellayani, during 1962—'63.

Review of Literature

Nitrogen has a specific action on leaf growth and consequently it is the nutrient which most influences the yield of leaf. It is of outstanding importance, not only in its effects on the growth of tobacco, but also in its influence on various elements of quality of the cured leaf as was demonstrated by Garner (1951). Batra (1950) reported that a continuous supply of nitrogen throughout the growing period of the tobacco crop resulted in higher yield. Sajnani and Dhyani (1955) found that in hookah and chewing tobacco, nitrogen fertilizers effected increase both in growth and yield.

Volk and McAuliffe (1954) demonstrated an extensive absorption and distribution throughout the plant, of urea nitrogen applied to tobacco as foliar spray. Mother and Treffitz (1954) found that spraying with 0.2 molar ammonium nitrate could take care of the full needs of the tobacco crop for nitrogen. Increases in tobacco crop yield to the extent of 13.3 percent due to foliar application of macronutrients were reported by Hinkov (1959). Ivanovsky (1960) reported an enhancement of 12.9 per-

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cent in the yield of tobacco sprayed with a solution containing nitrate of ammonia.

Materials and Methods

The tobacco plants (var: Pannan) were grown in earthern pots of 45 cm diameter, filled with 40 kg of washed sand, collected from the Kovalam sea shore. Well-rotted farm yard manure at the rate of 2 kg per 40 kg of sand was mixed in the pots. Phosphoric acid (1 g) and potash (6 g) were applied in the form of superphosphate and potassium sulphate for every 40 kg of sand. Vigorus seedlings of uniform size were selected for transplantation. The roots were washed with pure water. Planting of seedlings was done on 15th October, 1962, in pots arranged 90 cm both ways. One percent solutions of pure fertilizer salts were prepared in distilled water and utilized within six hours for spraying the plants. 'Teepol' B—300 was added to the spray solutions which acted as wetting agent. Hohnspray atomiser No. 600 was used for spraying the fertilizer solutions. The plants were sprayed with fertilizer solution in the evening hours. The spraying was done both on the upper and lower surfaces of the leaf. The different doses of nitrogen, viz., 1g, 2g, 3g and 4 g per plant were split up into four equal parts and sprayed at fortnightly intervals, beginning from the 30th day of planting the seedlings. Control plants were sprayed with 300 ml of pure well water. As with spraying nutrients, the different doses of solid fertilizers applied to the soil were divided into four equal parts and applied at fortnightly intervals, to coincide with the dates on which foliar sprays were done. The plants were watered daily in the morning, as well as, in the evening with a hand sprinkler. The experimental lay-out was of the split-plot design in randomised block, with five replications consisting of 30 treatments each. The treatments studied were the following:—

A — Whole-plot treatments (forms of fertilizer)
- (1) Urea M_1
- (2) Ammonium sulphate M_2
- (3) Ammonium nitrate M_3

B — Sub-plot treatments (methods of application)
- (1) Foliar spray F_1
- (2) Soil application F_2

C — Sub-plot treatments (levels of nitrogen)
- (1) 0 g. per plant or per 40 kg of soil L_0
- (2) 1 g. ,, L_1
- (3) 2 g. ,, L_2
- (4) 3 g. L_4
- (5) 4 g. ,, L_4

Results

A—Growth Studies

Studies on the growth characters were carried out in respect of height of plant, number of leaves, leaf area and girth of stem at regular intervals of 3) days.

1. *Height*

Data regarding the effect of form of fertilizer on height of plants are summarised in Table I.

There was no significant difference among the three forms of fertilisers in their effect on the height of plant.

The effect of different levels of nitrogen on height of plant is furnished in Table II.

The influence of levels of nitrogen on height of plant was highly significant. There

TABLE I

Average height of plants (cm) as affected by form offertilizer

Days after planting	M_1	M_2	M_3	
30	13.15	13.06	13.05	'F' at 5% not sig.
60	45.17	44.96	45.21	,,
75	65.65	65.74	65.52	,,
90	68.38	68.38	68.48	,,

TABLE II

Average height of plant (cm) as affected by different levels of nitrogen

Days after planting	Levels of nitrogen					
	L_0	L_1	L_2	L_3	L_4	
30	12.85	12.76	12.83	13.51	13.50	'F' at 5% not sig.
60	39.89	42.76	44.92	47.46	50.52	C.D. at 5% – 0.064
75	58.86	61.90	65.97	69.03	72.40	0.594
90	60.88	64.42	68.83	72.50	75.46	0.444
Inference:	L_4	L_3	L_2	L_1	L_0	

TABLE III

Average height of plants (cm) as influenced by method of application of fertilizer

Days after planting.	F_1	F_2	
30	13.04	13.13	'F' at 5% not sig.
60	45.09	45.13	,,
75	65.48	65.79	,,
90	68.42	68.40	,,

was progressive increase in height of plant with the increasing levels of nitrogen (Plates VIII—X) The effect of nitrogen persisted throughout the growth period.

Table III presents the influence of method of application of fertilizer on height of plant.

It is evident that the two methods of application of fertilizer did not affect the height of plant differently.

2. *Number of leaves*

Table IV furnishes the average number of leaves per plant as influenced by the three forms of fertilizer.

There was no significant difference among the forms of fertilizers in their influence on production of leaves.

Data with respect to the effect of different levels of nitrogen on leaf number is presented in Table V.

TABLE IV

Average number of leaves as affected by forms of fertilizer

Stages	M_1	M_2	M_3	
S_1	5.30	5.32	5.20	'F' at 5% not sig.
S_2	11.32	11.26	11.46	..
S_3	14.90	14.82	14.94	..
S_4	11.94	11.80	11.94	

TABLE V

Average number of leaves as affected by different levels of Nitrogen

Stages	Levels of nitrogen					
	L_0	L_1	L_2	L_3	L_4	
S_1	5 30	5.30	5.20	5.20	5.26	'F' at 5% not sig.
S_2	10.20	10.83	11.23	12.16	12.30	CD at 5% - 0.267
S_3	12.60	14.43	14.83	16.23	16.33	- 0.275
S_4	10.50	11.23	11.90	13.03	13.30	- 0.214

Inference

S_2 $\overline{L_4\ L_3\ L_2}$ L_1 L_0

S_3 $\overline{L_4\ L_3\ L_2}$ L_1 L_0

S_4 L_4 LS L_2 L_1 L_0

The difference among levels of nitrogen in their influence on the number of leaves was statistically significant in three of the four stages of growth studied. However, there was no marked difference between the mean number of leaves corresponding to the two higher levels, L_3 and L_4 during S_2 and So, stages. There was a progressive rise in the number of leaves with the increase in the age of plant.

Table VI presents the data pertaining to the effect of methods of application of fertilizer on leaf number.

TABLE VI

Average number of leaves as influenced by methods of application of fertilizer

Stages	F_1	F_2	
S_1	5.24	5.28	'F' at 5% not sig.
So	11.30	11.38	,,
S_3	14.85	14.91	,,
S_4	11.86	11.91	,,

The difference between the mean number of leaves corresponding to the two methods of application was notstatistically significant.

3. *Leaf area*

Data of leaf area per plant as influenced by the source of nitrogen are furnished in Table VII.

TABLE VII

Leaf area per plant (sq. cm) as affected by form of fertilizer.

Stage	M_1	M_2	M_3	
S_1	301.74	298,56	298.00	'F' at 5% not sig.
S_2	1912.00	1605.40	1696.00	CD at 5% - 2.329
S_3	4831.64	3926.18	4169.50	CD at 5% - 26. 85
S_4	4174.72	3391.54	3622.90	CD at 5% • 17.214
Inference	M_1	M_3	M_2	

There was a marked difference among ML M_2 and M_3 in their effects on periodical increment of leaf area. M_1 was significantly superior to M_3, while M_3 gave greater leaf area than M_2.

Data regarding the increase in leaf area produced by different levels of nitrogen are presented in Table VIII.

TABLE VIII

Leaf area per plant (sq. cm) as affected by level of nitrogen

Stages	Level of nitrogen						
	LO	L,	L_2	L_3	L_4		
S_1	295.83	300. 66	298..93	304.50	297.23	'F' at 5%	not sig.
S_2	1244.16	1476.33	1693.,00	2015.83	2260.66	CD at 5%	4.354
S_3	2838,33	3555. 50	4243. 33	5058.66	5849.73	CD at 5%	- 102.40
S	2406.83	3035. 66	3647. 16	4460.40	5098.53	CD at 5%	- 26.52.
Inference	L_4	L_3	L_2	L_1	LO		

It is seen from Table VIII that levels of nitrogen had significant effect on the leal area ofplants. With the rise in dose of nitrogen, there was a corresponding increase in the leaf area. Leaf area was observed to increase with age of plant. The rate of increase was higher during stage, ' 1 than during the S_2 stage

Table IX gives the summary data of leaf area per plant during different stages of growth as affected by method of application of fertilizer.

TABLE IX

Leaf area per plant (sq. cm.) as influenced by method of application of fertilizer

Stages	F_1	F_2	
S_1	299.38	299.42	'F' at 5% not sig.
S_2	1628.90	1847.22	'F' at 5% sig.
S_3	4000.62	4617.44	do.
S_4	3471.62	4120.54	do.
Inference	F_2	F_1	

There was significant difference between the mean values of leaf area corresponding to F_1 and F_2. Greater leaf area was consistently produced by F_2 than by F_1

4. *Girth ofstem*

The details of the data regarding the girth ofstem at harvest stage as influenced by the treatments are summarised in Table X.

TABLE X

Average girth of stem (cm) as affected by treatment

Fertilizer	Level	Method of application		Average
M_1	Lo	5.22	5.21	5.21
	L_1	5.42	5.45	5.43
	L_2	5.52	5.53	5.52
	L_3	6.43	6.54	6.48
	L_4	6.46	6.58	6.52
Average		5.81	5.86	5.83
M_2	L_0	5.31	5.32	5.31
	L_1	5.20	5.32	5.26
	L_2	5.53	5.44	5.48
	L_3	6.27	6.37	6.32
	L_4	6.29	6.39	6.34
Average		5.72	5.76	5.74
M_3	Lo	5.11	5.11	5.11
	L_1	5.42	5.36	5.39
	L_2	5.52	5.51	5.51
	L_3	6.41	6.50	6.45
	L_4	6.45	6.57	6.51
Average		5.78	5.81	5.79
Mean of the data		5.77	5.81	5.79

'F' for method of application — significant at 5% level.
C.D. (at 5%) for M means 0.041.
C.D. (at 5%) for L means 0.047.

Inference: (1) M_1 M_3 M2 (2) F_2 L_4 L_3 L_2 L_1 L_0

It is seen from the Table X that the mean girth of stem was affected differently by source of fertilizer. M_1 was found to be distinctly superior to M_2, but on par with M_3. Influence of level of nitrogen on girth of stem was statistically significant. Higher levels L_4 and L_3 produced greater girth of stem than the lower levels L_0 and L_1 and the control. However, the difference between L_4 and L_3 was not much marked. With regard to the effect of method of application of fertilizer, results reveal that the influence of F_2 on girth character was significantly greater than that of F_1.

B. Yield Studies

Data with respect to total weight of green leaf recorded at the time of harvest and of cured leaf are furnished in Tables XI and XII and graphically represented in figures 1, 2, 3 and 4.

TABLE XI

Total weight (g.) of green leaf per plant

		Method of application of fertilizer		
Fertilizer	Level	F_1	F_2	Average
	Lo	149.0	147.0	148.0
	L,	198.0	238.0	218.0
M_1	L_2	245.0	285.0	265.0
	L_3	342.0	398.0	370.0
	1.4	397.0	468.0	432.5
Average		266.2	307.2	286.7
	Lo	152.0	154.0	153.0
	L,	169.0	181.0	175.0
M_2	L_2	198.0	220.0	209.0
	L_3	266.0	308.0	287.0
	L_4	309.0	356.0	332.5
Average		218.8	243.8	231.3
	Lo	148.0	146.0	147.0
	L_1	167.0	198.0	182.5
M,	L_2	204.0	266.0	235.0
	L_3	284.0	337.0	310.5
	L_4	333.0	397.0	365.0
Average		227.2	268.8	248.0
Mean of data		237.40	273.28	255.33

'F' (at 5%) for F highly significant 4.75
C. D. for M means 0.960
C D. for L means 1,240
Inference: M_1 MS M_2 F_2 F_1 L_4 T-s L_2 L_1

TABLE XII

Total weight (g.) of cured leaf per plant

Fertilizer	Level	Method of application of fertilizer F_1	F_2	Average
M_1	Lo	31.68	31,68	31.79
	L_1	41.60	49.60	45.60
	L_2	51.00	58.80	54.90
	L_3	70.44	79.60	75.02
	L_4	81.40	95.50	88.45
Average		55.224	63.08	59.152
M_2	Lo	32.40	32.40	32.40
	L_1	35.80	38.20	37.00
	L_2	41.60	46.00	43.80
	L_3	55.20	63.48	59 34
	L_4	63.80	73.20	68.50
Average		45.760	50.656	48.208
M_3	Lo	31.60	31.32	31.46
	L_1	3540	41.60	38.50
	L_2	42.80	55.20	49.00
	L_3	58.80	69.20	64.00
	L_4	68.80	82.30	75.55
Average		47.480	55.924	51.702
Mean of data		49.488	56.550	53,019

• Fat 5% for F sig.	4.76
C. D, for M means	0,523
C. D. for L means	0.750
Inference	M_1 M_3 M_2 F_2 F_1 L_4 L_3 L_2 L_1

Results summarised in tables XI and XII show that the yield of green leaf and cured leaf are affected markedly by the three forms of fertilizer, M_1, M_2 and M_3. The influence of the three sources of nitrogen in increasing the leaf yield was in the order $M_1 > M_3 > M_2$. The mean yield values were found to increase progressively with the rise in the doses of nitrogen applied. Comparison of the effects of the two methods of application of fertilizer, F_1 and F_2 on yield of leaf revealed that F_2 was markedly superior to F_1,

Discussion

Foliar sprays of nitrogen fertilizers had marked influence on the vegetative growth characters of the tobacco plants. Foliar application of nitrogen at the rate of 4 g per plant produced on the average about 23, 30, 22 and 95 percent increase in height, number of leaves, girth of stem and leaf area respectively. (Plates I & IX) In pro-

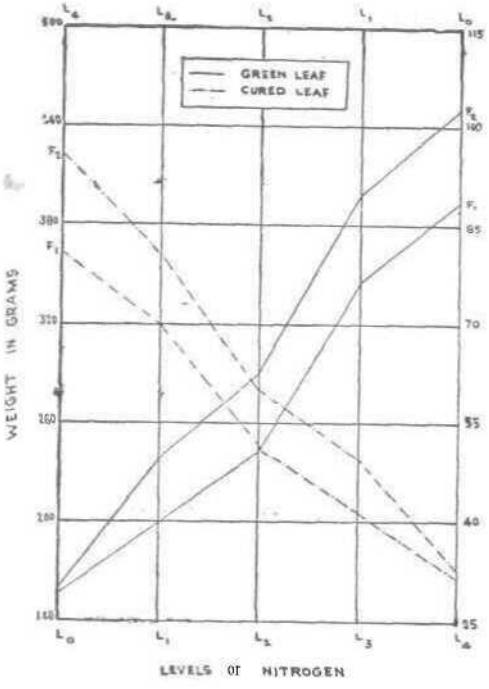

Fig. 1. Effect of method of application of fertilizer (Urea) on weight of green leaf and cured leaf

portion to the increase procured in the growth characters, sprays of nitrogen enhanced the yield of green and cured leaf. Foliar spraying at the rate of 4 g of nitrogen per plant increased the weight of green leaf by 132 per cent and the cured leaf yield by 123 per cent over the controls (Figure 14). It is evident that nitrogen applied as foliar spray was effectively assimilated and induced increases in leaf yield.

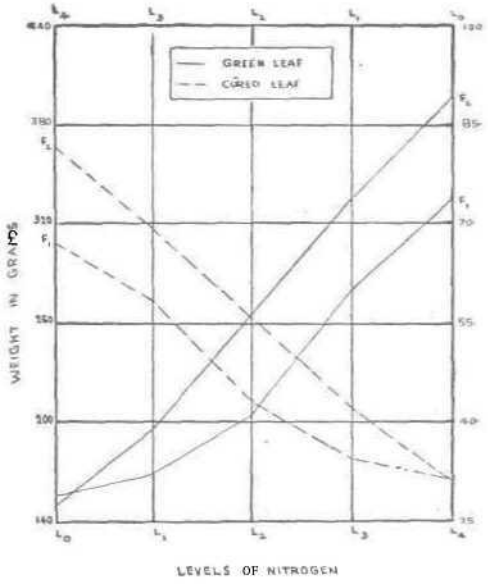

Fig 2. Effect of method of application of fertilizar (Ammonium sulphate) on weight of green leaf and cured leaf

In influencing the vegetative growth aspects like leaf area, girth of stem and the yield potentiality of the plants, the three sources of nitrogen viz., urea (M_1). ammonium sulphate (M_2) and ammonium nitrate (M_3) exhibited marked variation among themselves (Plates V–VII) The relative efficiency ofthe fertilizer sprays was in the order, $M_1 > M_3 > M_2$. Th beneficial effect of urea may be due to the fact that it is highly soluble and is least toxic to leaf tissue. It is absorbed and metabolized by plants more rapidly. Volk and McAuliffe (1954) demonstrated extensive absorption and distribution of urea nitrogen throughout the tobacco plant within 24 hours.

A comparison of the efficiency of the two methods of application of fertilizers viz.,

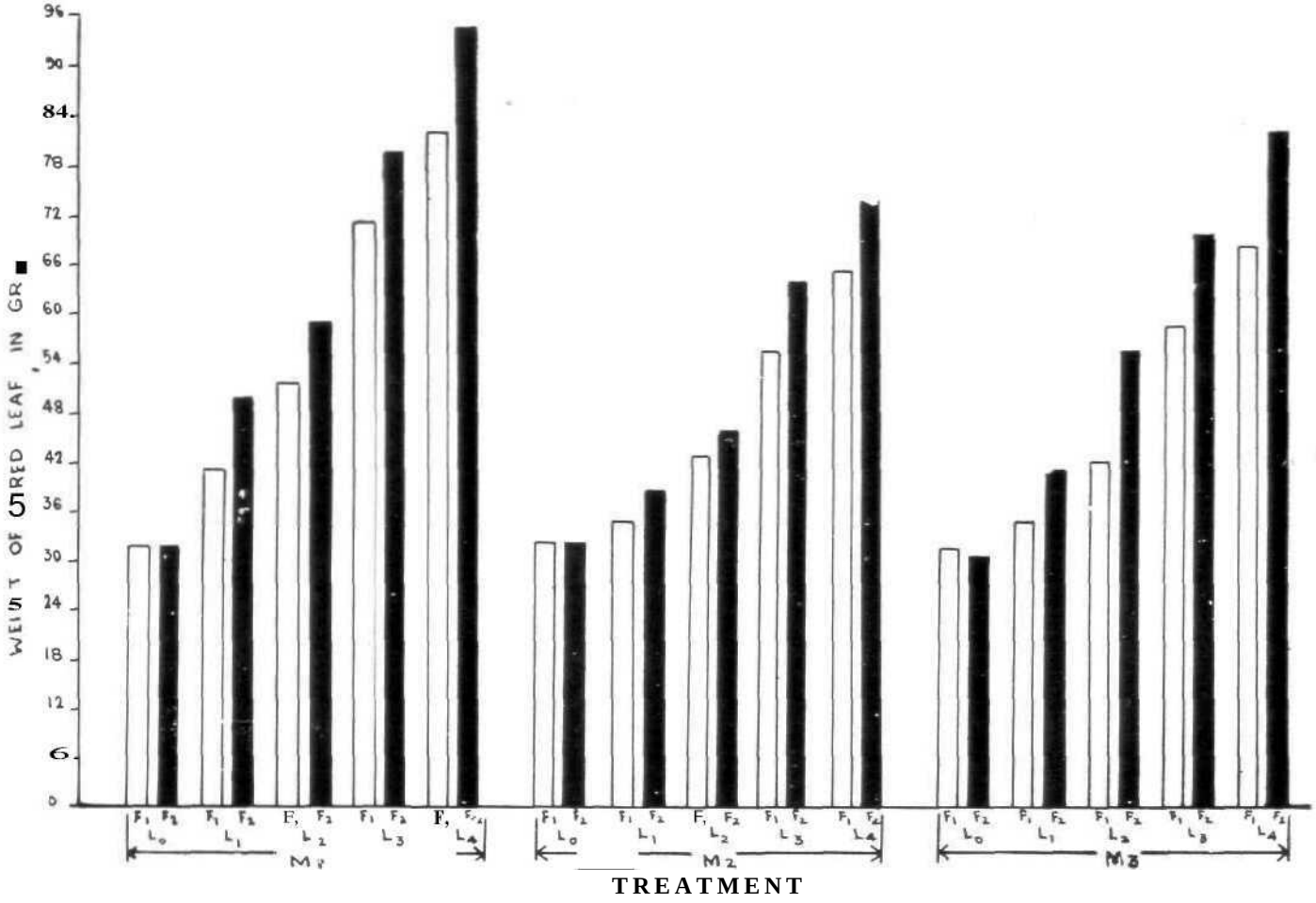

Fig. 4. Weight of cured leaf for different treatments

	Urea	F_1	Foliar application	L_0	Control
M_2	Ammonium sulphate	F_2	Soil application	L_1	1 g N/plant
M_3	Ammonium nitrate			L_2	2 g N/plant
				L_3	3 g N/plant
				L_4	4 g N/plant

Plate I. Effect of foliar application of nitrogen on tobacco
Left:–Control *Right*:– Treated

Plate II. Effect of foliar and soil application of Urea on tobacco.
Left:– Foliar *Right*:– Soil

Plate III. Effect of foliar and soil application of Ammonium sulphate on tobacco.
Left:– Foliar *Right*:– Soil

Plate IV. Effect of foliar and soil application of Ammonium nitrate on tobacco.
Left:– Foliar *Right*:– So/7

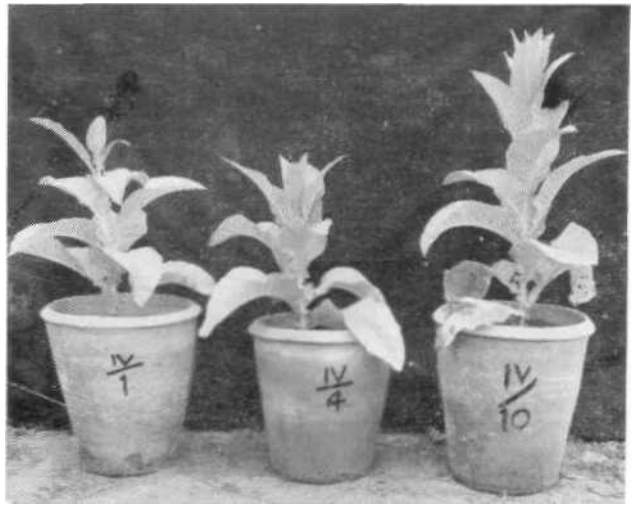

Plate V. Effect of foliar application of Urea on tobacco (30 days after planting)
to right: - Control (Water-sprayed), Control (No water spray), Treated

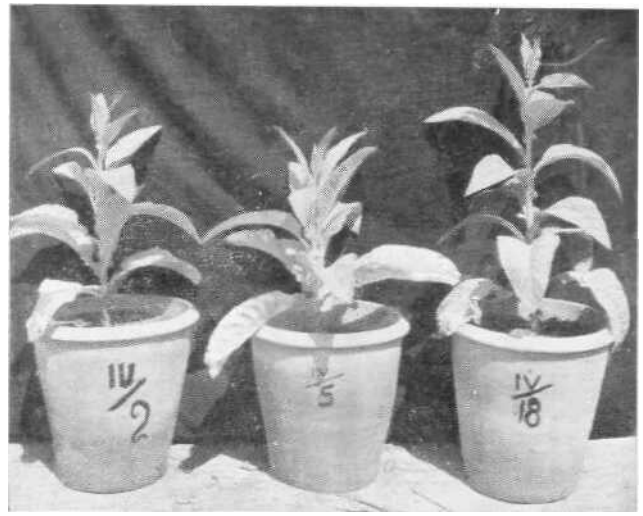

Plate VI. Effect of foliar application of Ammonium sulphate on tobacco (30 days after planting)
Lefttoright:– Control (Water-sprayed), Control (No water spray), Treated

Plate VII. Effect of foliar application of Ammonium nitrate on tobaco (30 days after planting)
Left to right:– Control (Water sprayed); Control (No water spray), Treated

Plate VIII. Effect of different levels of Urea applied as foliar spray (30 days after planting)
Left to right:– Control (Water-sprayed), Control (No water spray), 1 g N/ plant, 2 g N/ plant 3 g N/plant and 4 g N/ plant

Plate IX.– Effect of different levels of Ammonium sulphate applied as foliar spray (30 days after planting)

Left to right.– Control (Water-sprayed)., Control (No water spray); 1 g. N/plant; 2, g N/plant; 3 g N/plant and 4 g N/plant

Plate X.– Effect of different levels of Ammonium nitrate applied as foliar spray (30 days after planting)

Left to right.– Control (Water-sprayed); Control (No water spray) 1 g. N/plant; 2 g. N/plant; 3 N/plant; 4 g. N/plant.

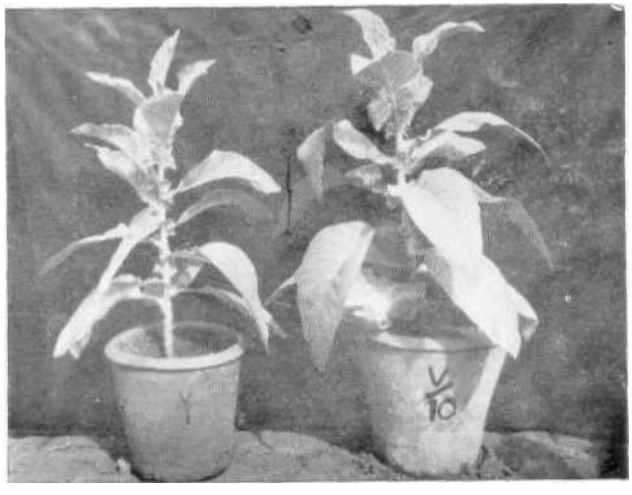

Plate XI.– Effect of foliar application of Urea (4 g. N/plant) on tobacco

Left- Control *Right*- Treated

Plate XII.– Effect of soil application of Urea (4 g. N/plant) on tobacco

Left.– Control *Right*- Treated

foliar spraying and soil application reveals that all the growth and yield characters of tobacco plant except height and number of leaves were influenced more effectively by the application of solid fertilizers (Plate II-IV) The mean yield of cured leaf from plants receiving soil applied nitrogen was

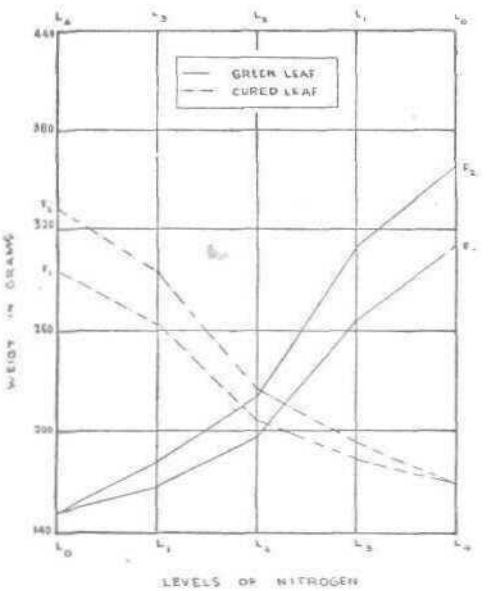

Fig. 3. Effect ofmethod of application of fertilizer (Ammonium nitrate) on weight of green leafand cured leaf

162 per cent over the control plants, while the corresponding value in the case of foliar application was only 123 per cent (Plates XI and XII)

The results of the experiment show that even though considerable increase in growth and yield of tobacco plant is obtainable with foliar sprays of nitrogen fertilizers, it cannot be considered as a substitute for the effective practices of soil application of fertilizers in comparable quantities.

Summary

In order to study the effects of foliar application of nitrogenous fertilizers on chewing tobacco and to compare them with those of soil application of solid forms of fertilizers, an experiment was conducted during 7962-63 at the Agricultural College and Research Institute, Vellayani. Results of the studies on growth and yield characters which are presented in this paper may be summarized as below:-

Foliary spray of nitrogenous fertilizers increases the vegetative aspects of chewing tobacco, like height of plant, number of leaves, girth of stem and leaf area.

Foliar application of nitrogen favourably influences leaf yield of chewing tobacco.

Urea is the ideal spray material.

Even though considerable increases in growth and yield of tobacco plants are obtainable with foliar sprays of fertilizers, it cannot replace the effective practices of soil application of fertilizers.

References

1. Batra, B (1952) *Punjab Farmer, 4* (2): 226-227
2. Garner, W. W. (1950) The production of tobacco, McGraw Hill Book Co, Inc.,
3. Hinkov, T. P. (1959) Foliar Nutrition of Tobacco plant, Tabak, 1959 20 (4) 44-95
4. Ivanosky, M. (1960) Foliar Nutrition of Tobacco Rev. Ind. Tobacco 35,43 44 *Hon. Abst.* **40** No. 2, 1960.
5. Volk R. and McAuliffe, C. (1954) Soil Sci. Soc. Am., Proc., 18, 308-12 (1954) *Ann. Rev. Plant Physiol.*, 10, 1959