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EFFICACY OF HAND DESUCKERING AND SIDE-DRESSING OF POTASSIUM SULPHATE FOR MODIFYING THE NITROGEN CONCENTRATION OF FLUE-CURED TOBACCO

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SUMMARY

During 1971 to 1974, the efficacy of two cultural practices used by tobacco growers to lower leaf nitrogen concentrations was investigated. The practices were the application of a side-dressing of potassium sulphate and the allowance of excessive sucker growth. Regular hand desuckering was used to simulate the latter treatment.

Neither hand desuckering nor side-dressing of potassium sulphate at four different times of application affected the nitrogen concentration of the leaf.

Chemical sucker control (dimethyl dodecylamine acetate) lowered the concentrations of both nitrogen and total alkaloids compared with hand desuckering. This was due to a dilution of the levels of these two components following a secondary expansion and thickening of the leaf lamina with complete sucker suppression.

Cured leaf potassium concentrations increased in the upper plant positions when the side-dressing was applied "at planting". Little response to the later applied side-dressings was recorded.

I. INTRODUCTION

Most tobacco growers in Queensland believe that sucker growth and side-dressing of potassium sulphate applied late in crop maturity reduce the effects of excessive nitrogen uptake.

Both practices are accepted in many tobacco-producing countries. However, Akehurst (1968) suggests that luxury consumption of potassium has little effect on the nitrogen concentration of the leaf. The practice of allowing a top sucker to grow gave a similar result (Woltz 1955) although this procedure was advocated by Garner (1947) to avoid rank growth of the leaves.

Many workers have found a response to applied potassium. Rates above those necessary for maximum yields continued to improve leaf quality (Hutcheson, Woltz and McCaleb 1959; McCants and Woltz 1967).

Improvement in the components of quality such as colour (Chouteau 1966; Lovett 1959) and combustibility (Hutcheson, Woltz and McCaleb 1959; Myhre, Attoe and Ogden 1956) occurred with increase in leaf potassium concentration. However, McCants and Woltz (1967) and Pinkerton (1970) found no relationship between high potassium supply and improved leaf colour. Studies on the effect of applied potassium on chemical components of the leaf have also produced inconsistent results. Akehurst (1968) states that there is no effect on nicotine content. However, Hutcheson, Woltz and McCaleb (1959) found a negative correlation between the rate of applied potassium and the concentration of total alkaloids in the leaf.

To assess the efficacy of the two cultural practises at lowering leaf nitrogen concentration three field trials were conducted from 1971 to 1974. This paper reports the results of these three trials.

II. MATERIALS AND METHODS

Design and treatments

Four time-of-application treatments of potassium sulphate and a nil treatment were combined with two sucker control treatments. The 10 treatment combinations were arranged in a randomized block design with four replications in each experiment.

Each side-dressing was applied at a rate equivalent to 84 kg ha^{-1} K in drills to either side of the row:

1. at planting;
2. when knee high;
3. after second harvest; or
4. after half harvest.

The two sucker control treatments were—

1. Hand desuckered with suckers removed seven times at 7-day intervals after topping (inflorescence removal) when greater than 2·5 cm long.
2. Chemical control—'Penar' (dimethyl dodecylamine acetate 56·5% w/v) aplied immediately after topping at 4·6 mL L^{-1}. (A second application of the same concentration was made 10 days later. Suckers were also removed at 7-day intervals after topping when greater than 2·5 cm long. The chemical was applied to the top three leaf axils using a Rega pneumatic sprayer with a coarse nozzle and a pressure of approximately 1 kg cm^{-2}).

In both treatments, tops were removed at the early to mid-flowering stage.

The hand desuckering treatment used in these experiments was not that normally practised by growers. Grower practice usually varies from leaving suckers grow unchecked for a few weeks, to leaving them remain on the plant for a much longer period. Choice of a particular practice usually depends on the extent to which the crop is overgrown.

However, unchecked sucker growth can cause considerable loss of leaf. This occurred in a previous experiment conducted by Dean, Brouwer and Ferguson (1972). In the experiments reported here, I have assumed that an insight into the effect of sucker growth on leaf nitrogen levels could be gained from regular hand desuckering.

Experimental technique

A summation of trial data is shown in table 1.

TABLE 1

TRIAL DATA

Trial number	Year	Plot size (ha)
I	1971	0·0007 (10 plants)
II	1972	Variable plant numbers per plot
III	1973	0·001 (15 plants)

Each trial was fertilized with 1 346 kg ha^{-1} of dolomitic limestone broadcast 4 weeks before planting and with 1 121 kg ha^{-1} of compound fertilizer (2·8 N, 5·7 P, 15·0 K) applied in drills to either side of the plants. These represented normal district practice.

The variety used in each trial was Beerwah H. This variety is a Hicks type selection from Victorian Mould Resistant Type H. It has field tolerance to strain A.P.T. 2 of blue mould (*Peronospora tabacina* Adam).

The experimental sites were located at the Beerwah Tobacco Research Farm. Soil type was an acid mottled duplex soil (Dy 5·21; Northcote 1974). The chemical status of the soil of each site was determined 2 months before transplanting (table 2).

TABLE 2

CHEMICAL STATUS OF SITES PRIOR TO TRANSPLANTING (0–15 cm)

Trial number	pH	P (p.p.m.; BSES)	Exchangeable cations (meq/100g)		
			K	Ca	Mg
I	5·4	28	0·15	0·78	0·26
II	5·5	29	0·13	0·79	0·30
III	5·5	25	0·07	0·60	0·30

Cured leaf strip yields were determined by expressing the dry weight of lamina as a percentage of the total leaf dry weight.

Leaf analyses were done on weighted samples of cured lamina from five plant positions and were expressed on an oven-dry basis. The plant positions were determined by tagging in the field. They were called lugs, cutters, lower leaf, upper leaf and tips.

Nitrogen was determined by a modified semi-micro Kjeldahl method using selenium as a catalyst. The ammonia was recovered from the digest by alkaline distillation and trapped in boric acid solution. The boric acid solution was titrated with standard hydrochloric acid.

Total alkaloids were determined by the method of Griffith (1957). Potassium was determined on a diluted triple-acid digest of plant material by flame photometry.

III. RESULTS

Effect of desuckering treatment

(1) SUCKER GROWTH. The total dry weight and nitrogen uptake of suckers removed is shown in table 3.

TABLE 3

TOTAL DRY WEIGHT AND NITROGEN UPTAKE OF SUCKERS REMOVED (kg ha^{-1})

Treatment	Dry weight			Weight of nitrogen		
	I	II	III	I	II	III
Hand desuckering . .	234	473	218	9·5	17·4	8·3
Chemical control	98	275	17	3·9	10·2	0·7

Chemical control suppressed sucker growth for 5 weeks following the initial application. When meaned over the three experiments, nitrogen uptake by this sucker growth was 64% lower than the hand desuckering treatment.

(2) CURED LEAF NITROGEN. The chemical control treatment had lower nitrogen concentrations in the lower leaf position in experiments I ($p < 0 \cdot 01$) and II ($p < 0 \cdot 05$; table 4). Chemical analyses of the upper leaf and tip positions were done on weighted bulked replicate samples and were not statistically analysed. Similar trends to the above occurred in these two plant positions.

TABLE 4

EFFECT OF DESUCKERING TREATMENT ON THE CONCENTRATION AND WEIGHT OF NITROGEN IN THE LOWER LEAF POSITION

Treatment	Nitrogen percentage			Weight of nitrogen (mg/leaf)		
	I	II	III	I	II	III
Hand desuckering . .	1·32	1·90	1·44	126	86	71
Chemical control	1·20	1·77	1·40	129	95	83
Nec. diff. 5% . .	0·06	0·12	NS*	NS	NS	11
1% . .	0·08	0·16				14

*NS—not significant

There was no difference in total nitrogen uptake between desuckering treatments in experiments I and II. However greater uptake of nitrogen occurred with chemical control in experiment III ($p < 0 \cdot 05$). Nitrogen concentrations in this experiment were similar (table 4).

(3) CURED LEAF STRIP YIELD. The chemical control treatment had higher strip yields in the lower leaf position of experiment I ($p < 0{\cdot}01$) and in the upper leaf position of experiments I, II and III ($p < 0{\cdot}01$; table 5).

TABLE 5

EFFECT OF DESUCKERING TREATMENT ON THE PERCENTAGE STRIP YIELD OF THE LOWER AND UPPER PLANT POSITIONS

Treatment	Experiment number					
	Lower leaf			Upper leaf		
	I	II	III	I	II	III
Hand desuckering ..	74·9	76·8	75·2	78·7	78·8	75·9
Chemical control	76·3	78·2	74·9	80·7	81·0	76·9
Nec. Diff. 5% .. 1% ..	0·7 1·0	NS	NS	0·7 1·0	0·8 1·1	0·5 0·7

(4) TOTAL ALKALOIDS. The effect of desuckering treatments on the concentration of total alkaloids in cured lamina (table 6) was similar to their effect on the concentration of nitrogen (table 4). The concentration was significantly lower with chemical control in experiment I ($p < 0{\cdot}01$). Similar trends occurred in experiments II and III.

TABLE 6

EFFECT OF DESUCKERING TREATMENT OF THE CONCENTRATION AND WEIGHT OF TOTAL ALKALOIDS IN THE LOWER LEAF POSITION

Treatment	Total alkaloid percentage			Weight of total alkaloids (mg/leaf)		
	I	II	III	I	II	III
Hand desuckering ..	1·87	2·80	1·68	178	128	81
Chemical control	1·53	2·60	1·45	164	145	91
Nec. diff. 5% .. 1% ..	0·18 0·24	NS	NS	NS	NS	NS

No differences in the weight of total alkaloids per leaf was recorded.

Effect of side-dressing treatment

(1) CURED LEAF NITROGEN. Side-dressing treatment had no effect on either nitrogen concentration or total nitrogen uptake in the lower leaf position (table 7). The upper leaf and tip position results from weighted bulked replicate samples also showed no treatment effect.

TABLE 7

EFFECT OF SIDE-DRESSING TREATMENT ON THE CONCENTRATION AND WEIGHT OF NITROGEN IN THE LOWER LEAF POSITION

Treatment	Nitrogen percentage			Weight of nitrogen mg/leaf		
	I	II	III	I	II	III
No side-dressing	1·26	1·80	1·39	127	89	78
At planting	1·26	1·82	1·41	133	94	85
When knee high	1·23	1·83	1·39	130	92	73
After second harvest ..	1·31	1·88	1·48	127	86	71
After half harvest ..	1·25	1·84	1·43	121	94	78
Nec. diff. 5% .. 1% ..	NS	NS	NS	NS	NS	NS

(2) CURED LEAF STRIP YIELD. The side-dressing treatment, 'when knee high', had a higher strip yield than the 'no side-dressing' treatment in the upper leaf position of experiment I (table 8; $P < 0 \cdot 05$). No significant differences occurred in the leaf positions of the other two experiments.

(3) CURED LEAF POTASSIUM. The 'at planting' side-dressing produced a higher potassium concentration than the 'no side-dressing' treatment in the lower leaf (experiment III; $P < 0 \cdot 01$), upper leaf (experiments II and III; $P < 0 \cdot 05$) and tip positions (experiment III; $P < 0 \cdot 01$; table 9). This treatment also had a higher potassium concentration than the 'knee high' (lower leaf; $P < 0 \cdot 01$) and 'after second harvest' (lower leaf and tips; $P < 0 \cdot 05$) treatments of experiment III.

The 'after half harvest' treatment had a higher potassium concentration than the other treatments in the upper leaf position of experiment II ($P < 0 \cdot 01$). However, no differences were recorded in experiments I and III or in the tip position.

IV. DISCUSSION

I recognized at the commencement of these studies that the hand desuckering treatment chosen varied from normal grower practice in crops exhibiting symptoms of excessive nitrogen uptake. I felt, however, that an insight into the effect of sucker growth on leaf nitrogen levels could be gained from a treatment of regular hand desuckering.

TABLE 8

EFFECT OF SIDE-DRESSING TREATMENT ON THE PERCENTAGE STRIP YIELD OF THE LOWER AND UPPER PLANT POSITIONS

Treatment	Experiment number					
	Lower leaf			Upper leaf		
	I	II	III	I	II	III
No side-dressing	75·8	77·9	75·7	79·5	80·3	76·6
At planting	75·5	77·4	74·1	79·2	79·3	76·0
When knee high	76·2	77·1	75·7	80·8	80·0	76·7
After second harvest ..	75·8	77·3	75·4	79·6	80·2	76·3
After half harvest ..	74·8	77·8	74·3	79·3	79·7	76·4
Nec. diff. 5% ..	1·2	NS	NS	1·1	NS	NS
1% ..	1·6			1·5		

TABLE 9

EFFECT OF SIDE-DRESSING TREATMENT ON THE PERCENTAGE OF POTASSIUM IN THE PLANT POSITIONS

Treatment	Experiment number								
	Lower leaf			Upper leaf			Tips		
	I	II	III	I	II	III	I	II	III
No side-dressing	1·76	1·26	1·61	1·34	0·86	1·46	0·97	0·88	1·24
At planting	1·81	1·33	1·87	1·32	1·04	1·66	0·99	1·02	1·49
When knee high	1·77	1·37	1·65	1·32	1·01	1·51	0·95	1·04	1·37
After second harvest	1·84	1·45	1·67	1·36	1·03	1·47	1·05	1·02	1·30
After half harvest	1·88	1·28	1·75	1·39	1·85	1·58	1·01	0·92	1·35
Nec. Diff. 5%	NS	NS	0·17	NS	0·18	0·17	NS	NS	0·16
1%			0·22		0·24	0·23			0·21

Hand desuckering did not lower leaf nitrogen concentrations below those of the chemical control treatment (table 4) even though a much greater uptake of nitrogen occurred through sucker growth (table 3).

Woltz (1955) investigated a variety of desuckering treatments, some of which were similar to those practised by local growers. He concluded that failure to top and sucker did not offset the adverse effects caused by over-fertilization. Prolonged sucker growth did not substantially affect the nitrogen concentration of the leaf.

Tobacco growers generally believe that suckers depend on the leaf for their mineral nutrition since they arise from the leaf axil and along the adjacent leaf surface. Anatomical studies of the leaf axil have shown that the vascular systems of the primary, secondary and tertiary suckers are linked directly with the vascular system of the plant (Seltmann and Kim 1964). It is unlikely then that leaves act as major sources of nutrition for sucker growth. The results of the above studies confirm this.

The chemical treatment was more successful at lowering leaf nitrogen concentrations (table 4). Higher strip yields, which reflect an expansion of the leaf lamina following complete sucker suppression, indicate that these lower concentrations occurred by dilution (table 5).

Dean, Brouwer and Ferguson (1972) reported lower total alkaloid concentrations with this chemical when compared with a treatment of regular hand desuckering. Total alkaloids have been shown to be positively correlated with the nitrogen concentration of the leaf (Woltz, Reid and Colwell 1948; McCants and Woltz 1967; Yoshida 1971). In the above experiments, total alkaloid concentrations were also found to be lower with the chemical control treatment (table 6). When expressed on a weight per leaf basis, no differences were found.

The major response to side-dressing occurred with the 'at planting' treatment. This treatment increased the potassium concentration of the lower leaf (experiment III), upper leaf (experiments II and III) and tip positions (experiment III; table 9). However, there was no decrease in the nitrogen concentration of the leaf (table 7). In general, there was little response in the potassium concentration of the cured leaf to the later applied side-dressings.

Lovett (1959) found increased leaf area and weight per unit area with increased levels of applied potassium. Similarly other workers have attributed a dilution effect as the cause of lower concentrations of total alkaloids (McCants and Woltz 1967). In experiment I, the side-dressing, 'when knee high' increased the strip yield above the control. However, in general, there was no consistent relationship between strip yield and side-dressing treatment (table 8).

Given the relatively high initial rate of applied potassium in all tobacco growing districts of Queensland, it is unlikely that a reduction in the nitrogen concentration of the leaf by dilution will occur with additional side-dressings.

I conclude therefore that there is no worthwhile benefit to a reduction in the nitrogen concentration of the leaf by either allowing sucker growth on the plant or by applying side-dressings of potassium above the recommended base level.

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