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Effect of calcium applications to soil on flue-cured tobacco in north Queensland

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Summary

Virginia Bunch peanuts often require Ca applications when grown on tobacco soils in north Queensland. Three rates of Ca (150, 300, 450 kg/ha Ca) were applied as lime or gypsum to a red earth to determine the effects on yield and quality of tobacco. There were no differences in yield or quality ($P<0.05$). Rate and source of Ca changed N and Mg contents in the cutters (second lowest set of four commercial leaves) and Ca content in the tip leaf position (top four commercial leaves) ($P<0.05$). These results show that, in the short term, soil Ca applications would not reduce yield or quality of tobacco.

INTRODUCTION

Peanuts (*Arachis hypogaea*) have been grown in the Mareeba-Dimbulah area since the early 1940s but it was not until the late 1970s that production expanded to a maximum of 400 ha in 1978. Although some tobacco growers have diversified to produce peanuts during the wet season, the main peanut growing area has been centered around Tolga, on red basaltic soils with high exchangeable calcium (Ca) levels (<4.0 m eq./100 g). The main variety grown on these soils was the large seeded Virginia Bunch (V.B.) while on the tobacco soils of low exchangeable calcium status (<2.5 meq./100 g) in the Mareeba-Dimbulah area, Red Spanish was the only variety grown with consistent yield.

In 1978, the Peanut Marketing Board was encouraging the production of V.B. peanuts because of market demand. Soil application of Ca is a prerequisite for successfully producing V.B. peanuts on soils with less than 1.4 meq/100 g exchangeable Ca, to ensure that developing fruit have an adequate supply of Ca (Armour *et al.* 1985 in press). However, liming has not been recommended as a standard practice in tobacco (*Nicotiana tabacum*) production here or overseas, and local farmers are reluctant to apply calcium to peanut crops grown in rotation with tobacco. There are several overseas reports of adverse effects from applying calcium to tobacco: undesirable chemical changes in cured leaves grown on heavily limed sandy soils (Darkis, Dixon, Wolf and Gross 1937), poor leaf quality associated with high leaf Ca and Mg levels (Elliot and Brich 1958) and increased incidence of disease at soil pHs greater than 5.6 (McCants and Woltz 1967).

In contrast, there have also been reports that applications of lime have increased yield and quality of tobacco (Lelacheur and Mackay 1968; Thomson, Watson and Monk 1956). Peedin and McCants (1977) found that yield and value per hectare were increased by applying dolomitic lime at 1120 kg/ha/year in both years. Gypsum applications of up to 168 kg/ha Ca had either no effect (5 sites) or increased yield and value (1 site) ($P<0.05$).

Low-analysis fertiliser mixtures, based on superphosphate and containing more than 10% Ca, have traditionally been used for tobacco production. At the average application rate in the Mareeba-Dimbulah area this would supply approximately 130 kg/ha Ca, and has probably provided sufficient calcium for plant growth. The increasing use of high-analysis fertiliser mixtures has reduced calcium applications by up to 100% and this trend increases the possibility of calcium deficiency occurring in tobacco.

The objective of this study was to determine the effects of Ca applied as lime or gypsum on yield and quality of flue-cured tobacco grown in north Queensland.

MATERIALS AND METHODS

The field experiment was conducted in 1979 at Southedge Tobacco Research Station on a red earth, locally named Morganbury Loamy Sand (Gn 2.14, Northcote 1974). Some soil chemical attributes (0 to 15 cm) were: pH (1:5 H_20) 6.1; organic carbon (Walkley and Black 1934) 0.4%; and exchangeable cations (N NH_4 Cl, pH 7.0) K 0.19, Ca 1.21, Mg 0.44 meq./100 g. Particle size analysis was coarse sand 51, fine sand 38, silt 6 and clay 6%.

Experimental design was 3×2+3, completely randomised with four replications. Calcium treatments were three rates (150, 300, 450 kg/ha Ca) by two forms, lime (36% Ca) or 'dump' gypsum (a byproduct of superphosphate production, 20.5% Ca). Three additional treatments were: nil Ca, and 34 kg/ha Mg as $MgSO_4.7H_20$ applied at the 450 kg/ha Ca rate of both lime and gypsum. Seven weeks before transplanting, calcium and magnesium treatments were broadcast after primary cultivation and incorporated by rotary hoe.

After transplanting (tobacco variety CSIRO 40 T), all plots were fertilised with a band application of a fertiliser mixture (9.7% N, 5.0% P, 28.8% K, 6.3% S) at 550 kg/ha. Plant and row spacing was 0.53 m and 1.2 m respectively, and plots consisted of 4 rows of 20 plants (total) of which 2 rows of 16 plants were harvested (datum). Conventional cultural practices were followed throughout the growth of the crop.

At harvest each of four plant positions was sprayed with a different coloured paint to identify samples for chemical analysis. The four positions were: lug (lowest four commercial leaves), cutter (next four commercial leaves), tip (top four commercial leaves) and leaf (that between cutter and tip). Leaf from each plot was sorted into bundles of similar leaf type, which were each graded by Tobacco Leaf Marketing Board appraisers according to the 1979 price schedule. Leaf quality assessment for each plot, expressed in cents per kilogram, was obtained from the weighted average price of all bundles from a plot.

Cured whole leaf samples from the four plant positions were oven-dried at 70°C, ground and digested (micro-Kjeldahl). Nitrogen and phosphorus were determined colorimetrically using an auto-analyser, potassium by flame photometry, and calcium and magnesium by atomic absorption spectrophotometry. Reducing sugars were determined by an inverse colorimetric procedure using potassium ferricyanide, and total alkaloids by steam distillation.

Composite soil samples were taken at two depths (0 to 15, 15 to 30 cm) from each treatment, at three sampling times (before calcium and magnesium were applied, at time of transplanting and after harvest). These were analysed for pH and exchangeable, K, Ca and Mg.

RESULTS

Agronomic performance

Leaf yield and quality (Table 1) were not affected by form or rate of calcium applied, nor by application of magnesium.

The ranges in constituent concentrations in cured leaf over all leaf positions were: N, 1.24 to 1.71%; P, 0.23 to 0.50%; K, 2.08 to 4.63%; Ca, 2.60 to 4.18%; Mg, 0.40 to 0.88% reducing sugars, 10.2 to 27.3%; and total alkaloids, 0.87 to 2.75%.

Source and rate of calcium had no consistent effect on levels of P, K, reducing sugars and total alkaloids in cured leaf.

There were significant interactions ($P<0.05$) between calcium rate and source for N and Mg contents of cutters, and for Ca content of tips (Table 2). N and Mg contents increased with increasing rate of gypsum but decreased with increasing lime rate. Similar non-significant trends were also observed for N in lugs and leaf and Mg in the tips. Ca in the tips increased ($P<0.05$) with increasing rate of lime but tended to decrease with increasing gypsum rate.

Soil attributes

The addition of lime or gypsum did not significantly change pH nor exchangeable soil Ca, Mg or K at either sampling depth at any of the three sampling times.

Table 1. Effect of soil Ca applications on total and saleable yield and quality of tobacco

Treatment kg/ha Ca	Yield (kg/ha)		Quality c/kg
	Total	Saleable	
0	4008	3411	328.6
Lime			
150	4048	3445	340.3
300	3891	3330	326.2
450	4099	3184	333.1
450+34 Mg	3893	3147	334.0
Gypsum			
150	3942	3153	326.7
300	4213	3287	342.4
450	4190	3526	321.9
450+34 Mg	4127	3435	336.0
l.s.d. (P=0.05)	411.9 (n.s.)	409.8 (n.s.)	26.4 (n.s.)

Table 2. Effect of source and rate of Ca on the N, Ca and Mg content of cured leaf from four positions

Treatment (kg/ha Ca)	N %				Ca %				Mg %			
	Lug	Cutter	Leaf	Tip	Lug	Cutter	Leaf	Tip	Lug	Cutter	Leaf	Tip
0	1.57	1.45	1.24	1.53	3.98	2.76	2.60	3.24	0.85	0.52	0.40	0.53
Lime												
150	1.71	1.69	1.44	1.63	4.18	2.94	2.41	2.71	0.80	0.54	0.44	0.56
300	1.60	1.42	1.25	1.54	3.62	2.58	2.41	3.21	0.71	0.48	0.45	0.54
450	1.54	1.37	1.24	1.58	3.61	2.63	2.76	3.53	0.70	0.40	0.38	0.50
Gypsum												
150	1.64	1.37	1.20	1.50	3.96	2.88	2.69	3.41	0.71	0.41	0.38	0.48
300	1.64	1.56	1.30	1.52	3.99	2.66	2.37	2.97	0.66	0.46	0.51	0.55
450	1.76	1.63	1.33	1.56	3.85	3.02	2.37	3.02	0.88	0.51	0.43	0.57
l.s.d. ($P<0.05$), Source×rate	n.s.	0.26	n.s.	n.s.	n.s.	n.s.	n.s.	0.62	n.s.	0.14	n.s.	n.s.

DISCUSSION

Changes in the N content of cured leaf observed in this experiment differ from those of Peedin and McCants (1977) who found that N content was increased (non-significantly, $P<0.05$) by 1120 kg/ha/year of dolomitic lime, whereas gypsum at rates of up to 168 kg/ha Ca had no consistent effect. They suggested that the higher N contents associated with liming were the result of rapid mineralisation of organic matter.

There is considerable variation in reported changes in cation content of tobacco with applications of Ca and Mg. LeLacheur and Mackay (1968) found that while cation contents varied with sites and years, rates of dolomitic lime of up to 5 t/ha reduced Ca content and increased Mg content at four out of five sites but reduced K content at all sites. Peedin and McCants (1977) reported that Ca and Mg contents were increased by lime while the effect of gypsum was comparatively small. Potassium content was reduced by lime in the second year of application but increased in both years with gypsum at rates of up to 168 kg/ha Ca. In sand culture, Pinkerton (1970) found that increasing solution concentrations of Ca reduced K and Mg content.

Although exchangeable Mg levels are low in the soils used for tobacco production in the Mareeba-Dimbulah area, the lack of yield response is consistent with previous unpublished research by the Queensland Department of Primary Industries, and by CSIRO.

The absence of any consistent significant difference in yield, quality and cured leaf chemical constituents suggests that, in short term, Ca applications to peanuts grown in rotation with tobacco would not adversely affect tobacco yield or quality. This agrees with the results of a study at Moreton Bay, Queensland using dolomite at up to 4480 kg/ha/year for 2 years (H. Green, pers. comm.). Peanuts used as a rotation crop can play an important role in improving returns and diversifying primary production in the Mareeba-Dimbulah irrigation area. Weed and nematode control in subsequent tobacco crops is an additional benefit as weedicides used in peanut culture reduce weed burden and peanuts are non-host to root-knot nematodes (*Meloidogyne javanica*), thus reducing nematode numbers.

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