THE EFFECT OF BURNING AND TRASHING ON SUGARCANE LEAF ANALYSIS

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Abstract

Leaf nutrients of sugarcane variety N16 are discussed and reasons for certain trends put forward. The fertilised versus non-fertilised treatment comparison showed that although where fertiliser was applied that leaf N, P and K were higher, Mn was also higher but Ca, Mg, Si, Zn and Fe were all lower. The trashed versus burnt treatments had a less drastic effect on leaf nutrient levels and it was mainly N, P, K and Mn that benefited from trashing while higher Mg and Fe were found for the burnt treatment. Leaf Si was for the first time measured and of all the nutrients showed the most market evidence of nutrient mining.

Keywords: leaf nutrients, sugarcane, N16, trashing, fertiliser, BT1

Introduction

Five crop cycles and four varieties were used in the burning and trashing (BT1) trial at Mount Edgecombe over the period October 1939 to September 2001. Sugarcane variety N16 has been grown since 1990. Trial treatments caused numerous soil chemical, physical (van Antwerpen and Meyer, 1998) and biological (Graham *et* al., 1999, 2000, 2001) changes and cane crops responded to these changes in various ways. The effects that various fertilizer and trash management treatments had on soil macronutrients were reported earlier by van Antwerpen and Meyer (1998). However, it is generally accepted that leaf analysis is a better indicator of nutrient availability to the plant when compared with soil analysis. van Antwerpen and Meyer (2001) reported the nutritional changes occurring in cane leaves but these did not include Ca, Mg and the micronutrients as affected by the various fertilizer and trash management treatments. The purpose of this paper is therefore to evaluate changes in macro and micronutrients from leaves of variety N16 and in relation to the applied fertilizer and trash management treatments.

Methods and Materials

The data used for this paper were taken from the period 1990 to 2001, being the duration of the latest sugarcane (N16) crop cycle. A detailed description of the trial site and related treatment information was given by van Antwerpen and Meyer (2001). Leaf samples were for the first time analysed for Si, Fe, Cu and Mn during the fifth crop cycle. The latter two nutrients had been analysed only once before the 1990's only once, namely in 1971. Other nutrients for which BT1 leaf samples had been analysed for many years but which were never reported included Ca, Mg, S and Zn. The fertilizer program for the trial replaces only N, P and K at rates of 140, 20 and 140 kg/ha/crop respectively. All leaf samples were analysed by FAS and the methods of analysis were described by van Antwerpen and Meyer (2001).

Results

N, P and K

Leaf N showed little variation between treatments, being slightly higher in the fertilized treatment compared with the non-fertilized (Table 1). In terms of the threshold value for N the leaf N levels in the non-fertilized burnt treatments ranged from marginal to deficient. Leaf N benefited only slightly from the trashed treatment. The benefit in N uptake from trashing was greater for other varieties in previous crops in the trial (van Antwerpen and Meyer, 2001). Possible reasons for differential N uptake include genotype characteristics, which make better use of the available N (Schumann and Meyer, 1999) and/or after effects of the 1993/4 droughts, which resulted in higher N mineralisation rates regardless of the applied treatments. Leaf P contents were in general marginal to deficient when compared with the threshold value of 0.19%. Leaf P nevertheless showed higher values for the fertilised treatment compared with the non-fertilised (Table 1). It also showed a negative trend regarding the amount of residue retained after harvest. Possible reasons were insufficient quantities of applied P after harvests (20 kg P/ha) and that the low P content in the residue was insufficient to counteract removal by the larger biomass from the trashed treatment (see van Antwerpen and Meyer, 2001). Leaf K was satisfactory in the fertilised treatments but was deficient in the unfertilised treatments. In general, irrespective of fertiliser treatment, trash management compared to burning improved the K status from marginal to adequate K levels. The trend in leaf K uptake from trashing compared with burning is consistent with an increased trend in soil K levels from trashing (van Antwerpen and Meyer, 2001).

Ca, Mg and Si

During the nineties leaf samples had consistently showed a lower Ca and Mg content in the trashed treatments compared with those burnt. The mean leaf Ca contents for the burnt and all tops removed (Bto), burnt and tops retained (Bt) and trash (T) management over the duration of the fifth crop cycle were 0.284%, 0.287% and 0.275% respectively. The mean leaf Mg contents for the same treatments were 0.189% (Bto), 0.181% (Bt) and 0.178% (T). Soil samples showed a similar trend, which was due to the net higher export rate of these cations in the stalks away from the site because of the larger biomass produced under trash management. The trial site has not received any lime or gypsum since its inception 1939 and yet, the latest (2001) leaf Ca and Mg values indicate that they are present in sufficient amounts when compared with the FAS threshold values of 0.15% and 0.08% respectively (Table 1).

The mining of nutrients as affected by the fertiliser treatments was also observed for silicon. The Si levels across all fertiliser treatments were about 26% lower than the non-fertilised treatments. It appears that the application of a fertiliser containing no Si over the last 63 years is having a negative effect on the availability of Si, although leaf values between 1.42 and 2.73% is considered to be moderate to high (Clements, 1967). Another reason for the reduction in Si availability could be the lower soil pH values of the fertilized treatments (Savant *et al*., 1997). Further evidence for the latter was the sudden increase in the Mn to SiO_2 ratio from 15 for the non-fertilized to 26 for the fertilized treatments which is comfortably below the ratio values of 62 and 100 above which cane growth was reported to be suppressed in Mauritius and Hawaii respectively (Clements, 1967). Soil pH of the fertilized treatments was significantly lower at 5.5 compared with 5.7 for the non-fertilized treatments. The trashed treatment also had a further acidifying affect, which lowered soil pH even further to about 5.4 for the fertilized treatments and 5.6 for the non-fertilized treatments in the last crop cycle (van Antwerpen and Meyer, 1998, 2001). The removal of bases (Ca and Mg) and Si (desilification) due to nutrient mining results in increased acidification (Epstein, 2001). Despite the loss of Si from the vertisol, leaf Si levels is still well above the threshold value of 0.75%.

Table 1. Leaf nutrient content for variety N16.

Nutrient	Mean	Treatment						Mean	
		BtF	BtFo	BtoF	BtoFo	TF	TFo	Burnt	Trashed
N (%)	Mean	1.821	1.691	1.759	1.713	1.863	1.783	1.746	1.823
	Std dev	0.221	0.219	0.192	0.230	0.171	0.203	0.216	0.187
P (%)	Mean	0.178	0.141	0.173	0.123	0.189	0.138	0.154	0.164
	Std dev	0.027	0.030	0.029	0.026	0.029	0.030	0.028	0.030
K (%)	Mean	1.215	0.875	1.111	0.702	1.313	0.911	0.976	1.112
	Std dev	0.207	0.175	0.183	0.108	0.210	0.170	0.168	0.190
Ca (%)	Mean	0.287	0.279	0.284	0.293	0.275	0.300	0.286	0.288
	Std dev	0.046	0.041	0.054	0.044	0.044	0.039	0.046	0.042
Mg (%)	Mean	0.181	0.192	0.189	0.202	0.178	0.187	0.191	0.183
	Std dev	0.032	0.034	0.035	0.037	0.031	0.034	0.035	0.033
S (%)	Mean	0.190	0.178	0.189	0.183	0.188	0.181	0.185	0.185
	Std dev	0.025	0.026	0.028	0.028	0.023	0.027	0.027	0.025
Si (mg/kg)	Mean	1.455	1.908	1.458	2.178	1.583	1.950	1.750	1.767
	Std dev	0.168	0.255	0.095	0.123	0.283	0.306	0.160	0.295
Zn (mg/kg)	Mean	17.5	18.8	18.6	21.8	17.7	21.3	19.2	19.5
	Std dev	2.1	5.0	2.2	3.3	2.2	3.7	3.2	3.0
Cu (mg/kg)	Mean	6.3	6.2	6.2	6.2	6.0	6.3	6.2	6.2
	Std dev	0.6	1.3	0.8	1.1	0.8	1.1	1.0	1.0
Fe (mg/kg)	Mean	112.1	120.9	131.0	132.1	106.2	110.8	124.0	108.5
	Std dev	20.3	32.0	39.7	40.4	12.5	6.6	33.1	9.5
Mn (mg/kg)	Mean	39.5	35.1	39.1	35.3	43.9	36.9	37.3	40.4
	Std dev	5.0	6.1	5.7	6.0	6.1	9.3	5.7	7.7

Micronutrients

Leaf S showed little variation between treatments as sufficient quantities was present when compared to the threshold value of 0.12% (Table 1). In general Zn, Cu and Fe levels were slightly higher for the fertilised compared to non-fertilised treatments. With the exception of Fe and Mn, there were no discemable treatment effects on micronutrient uptake. Leaf Mn levels was higher in the presence of fertiliser and it is known that Mn accumulates in the soil under acid conditions. Leaf Fe levels were markedly lower in the trash compared to burnt treatments. It is also known that trashing can exacerbate Fe deficiency symptoms through the temporary complexing of Fe as iron humate compounds.

Conclusions

This assessment of leaf data for the fifth crop cycle indicates that the N and K fertiliser recommendations applied were adequate but that the current 20 kg/ha P applied is not sufficient for this soil. The results imply that the 20 kg/ha P recommended in the FAS whole cycle crop recommendations should be raised to 30 kg P/ha. All the other nutrients are being supplied in sufficient quantities. The mineralisation capacity of the vertic soil on which the trial is seated was sufficient to supply cane from the non-fertilized treatments with enough Si, Mn and Cu. The applied residue benefited only K, Si and possibly Mn leaf contents. The removal of nutrients through cane stalk deliveries to the mill (mining effect) negatively affected leaf P, Ca, Mg, Zn and Fe.

REFERENCES

Clements, HF (1967). Effects of silicate on the growth and leaf freckle of sugarcane in Hawaii. *Proc Int Soc Sug Cane Technol* 12: 197-215.

Epstein, E (2001). Silicon in plants: Facts vs. concepts. In: *Silicon in Agriculture*. Datnoff, LE, Snyder, GH and Korndörfer (Eds). Elsevier, ISBN 0-444-50262-9.

Graham, MH, Haynes, RJ and Meyer, JH (1999). Green cane harvesting promotes accumulation of soil organic matter and an improvement in soil health. *Proc S Afr Sug Technol Ass* 73: 53-57.

Graham, MH, Haynes, RJ and Meyer, JH (2000). Changes in soil fertility induced by trash retention and fertilizer applications on the long-term trash management trial at Mount Edgecombe. *Proc S Afr Sug Technol Ass* 74: 109-113.

Graham, MH, Haynes, RJ, Zelles, L and Meyer, JH (2001). Long-term effects of green cane harvesting versus burning on the size and diversity of the microbial community. *Proc S Afr Sug Technol Ass* 75: 228-234.

Savant, NK, Snyder, LE and Datnoff, LE (1997). Silicon management and sustainable rice production. *Adv Agron* 58: 151-199.

Schumann, AW and Meyer, JH (1999). Robust leaf N thresholds for foliar diagnosis based on exponential-Fourier functions. *Proc S Afr Sug Technol Ass* 73: 73-74.

van Antwerpen, R and Meyer, JH (1998). Soil degradation II: Effects of trash and inorganic fertilizer on soil strength. *Proc S Afr Sug Technol Ass* 72: 152-158.

van Antwerpen, R, Meyer, JH and Turner, PET (2001). The effects of cane trash on yield and nutrition from the 61 year old BT1 trial at Mount Edgecombe. *Proc S Afr Sug Technol Ass* 75: 235-241.