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CROP YIELDS AND NUTRIENT AVAILABILITY IN RELATION TO DIFFERENT LIME AMENDMENTS ON MALAYSIAN PEAT SOIL I. NAPIER GRASS AND SORGHUM

W. Y. CHEW and K. T. JOSEPH

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RINGKASAN

Penyiasatan dalam beg untuk perbandingan kesan dolomite, debu batu kapur dan kapur tawar pada pertumbuhan dan kegunaan zat makanan pada rumput Napier dan sekoi di tanah gambut telah dijalankan pada tahun 1973.

Perbandingan kontrol dengan ujian kapur adalah menunjukkan bahagian kering dan tarekan pokok ke atas N, P, K, Ca dan Mg dapat dibaiki dengan kegunaan kapur yang mana menyebabkan kurangnya masam tanah. Kandungan N, P dan K, walau bagaimanapun, menjadi kurang dengan kegunaan kapur disebabkan kesan cair; kandungan Ca bertambah dari ketiga jenis kapur tetapi kebaikan kandungan Mg hanya didapati dari dolomite.

Perbandingan antara tiga jenis kapur menunjukkan tiada perbezaan kesan pada kandungan atau tarekan N, P dan K. Kandungan Ca dan tarekan, walau bagaimanapun, adalah bertambah baik dengan bertambah kandungan Ca ketiga pindaan kapur; kandungan dan tarekan Mg adalah lebih tinggi pada dolomite dari yang dua jenis kapur.

INTRODUCTION

Except in the cultivation of pineapple, liming to raise soil reaction is often necessary in peat cropping, the natural peat pH (about 3.5) being very acidic. In the past the usual form of lime applied to peat has been dolomite powder which contains about 19% of MgO. It was observed that large additions of dolomite tended to reduce the level of K in grass grown on peat (values as low as 0.3% have been recorded), this being attributed to an antagonism between Mg and K such as that observed by BOLTON and SHORROCKS (1961) for rubber. The experiment reported here is an attempt to compare the relative effects of three types of lime on the availability of nutrients to crops planted on peat soil.

MATERIALS AND METHODS

A green house experiment was carried out at the MARDI Peat Research Station at Jalan Kebun to investigate the plant availability of nutrients in relation to the type of lime amendments applied, using local Napier grass (*Pennisetum purpureum*) and sorghum (*S. vulgare*) as the test-crops.

Peat was sampled to a depth of about 45 cm from an uncultivated area of drained peat at the station and sieved through a coarse wire-mesh removing undecomposed wood at the same time. The moist peat was then mixed thoroughly and bagged in heavy duty, perforated, black polythene bags at the rate of 9 kg per bag. A peat sample was taken from all over the pile for determination of moisture content (*gravimetric method*) and pH (with 3:1 w/w soil:water ratio and a pH meter).

The lime treatments consisted of 50 g/bag of each of the three types of lime: dolomite powder (containing 19.2 % MgO and 34.3 % CaO), limestone dust (containing 3.7 % MgO and 47.6 % CaO) and hydrated lime (containing 1.7 % MgO and 77.0 % CaO) plus a control. These would approximate to about 4–5 tons/acre/six inch. These three types of lime were obtained from a local source. The

lime was applied from a sieve while manually mixing the peat from each bag on a plastic sheet. In order to reduce variability, two bags were assigned to each treatment within each replicate, there being three replicates. The bags were placed on a cement floor in the open air. The Napier grass bags were separated from the sorghum bags. Napier grass was planted using one-node cuttings of a local cultivar at the rate of four cuttings per bag which was later thinned down to three. Sorghum seeds of the cultivar E178 was sown in the peat at four points at the rate of about 3 seeds per point; thinning was later carried out to one plant per point.

Fertilizers containing 124 ppm of N, 30 ppm P and 128 ppm of K were applied as a basal dressing to sorghum. Micronutrients containing 40 ppm of copper sulphate, 15 ppm of each of the sulphates of manganese, zinc, iron and magnesium as well as sodium molybdate and 10 ppm of borax were also applied in the basal dressing to both sorghum and Napier grass. The latter received NPK fertilizers containing 62 ppm N, 15 ppm P and 33 ppm of K every six weeks. Water was applied at intervals of 1–2 days to maintain soil moisture level around field moisture content (about 350 % on d.w.b.). The grass was cut a total of three times at intervals of six weeks. Two sorghum plants per bag were first sampled eight weeks after planting and again six weeks later. The oven-dry weight and N, P, K, Ca and Mg contents of the harvested plant materials were determined for each harvest by the following methods: hot-air oven drying at 70°C overnight and ground in a cross-beater mill, N by micro-Kjeldahl digestion, P by the ammonium vanadate method, K by flame photometry and Ca and Mg by the EDTA titration. The nutrient content of sorghum from the second sampling was not analysed because the samples were accidentally lost in an oven fire. Soil was sampled with an auger for pH determination after each harvest.

RESULTS

Crop Yields

The yields of sorghum and Napier grass (shown in *Table 1*) were greatly increased by application of lime. However, no significant difference in yield was obtained between the three types of lime.

Crop Nutrient Contents and Uptake

The contents of N, P, K, Ca and Mg in the dry matter produced by Napier grass and sorghum are shown in *Table 2* and the uptake values of the same nutrients by the two crops are summarized in *Table 3*. The percentage contents of N, P and K were reduced by addition of lime, there being no difference in the relative effects of the three lime amendments. The uptake of these three nutrients were observed to be greatly increased by the presence of lime and again, no significant difference between the three ameliorants was observed. As for Ca, its level in the plant materials harvested was increased by liming and, for sorghum but not for Napier grass, there was a significant trend in the Ca content in the order hydrated lime: > limestone dust > dolomite. The Ca uptake was increased with liming and the same relative difference between the three types of lime was again observed to be significant for sorghum but not for Napier grass. There was, however, no significant difference between the effects of hydrated lime and limestone dust. As far as Mg was concerned, its level in the grass and sorghum dry matter was increased by dolomite but not by hydrated lime and limestone dust. Its uptake, however, was increased by each type of lime and dolomite gave the highest uptake amongst the three lime types.

TABLE 1. DRY WEIGHT YIELDS OF NAPIER GRASS AND SORGHUM IN RELATION TO DIFFERENT LIME AMENDMENTS ON PEAT

Crop	No. weeks from planting	Dry Weight (g/2 bags)				
		Control	Dolomite (50 g/bag)	Limestone dust (50 g/bag)	Hydrated lime (50 g/bag)	L.S.D. (5%)
Napier Grass	6	2.18	23.12 a	21.07 a	19.48 a	4.19
	12	1.71	18.21 b	15.54 b	15.77 b	4.36
	18	4.85	23.78 c	24.37 c	22.52 c	4.95
	TOTAL	8.74	65.11 d	60.98 d	57.77 d	–
Sorghum	8	0.76	64.12 e	65.47 e	61.82 e	5.87
	13	5.77	100.31 f	98.12 f	90.91 f	24.09

Footnote: Values in a row with the same letter are not significantly different at the 5% probability level.

TABLE 2. PLANT NUTRIENT CONTENTS IN RELATION TO DIFFERENT LIME AMENDMENTS ON PEAT

Crop*	% nutrient in dry weight				
	Control	Dolomite (50 g/bag)	Limestone dust (50 g/bag)	Hydrated lime (50 g/bag)	L.S.D. (5%)
		% N			
NG	2.27	1.23 a	1.05 a	1.13 a	0.51
S	1.25	1.01 b	1.01 b	0.91 b	0.35
		% P			
NG	0.585	0.402 c	0.421 c	0.497 c	0.105
S	0.311	0.199 d	0.206 d	0.216 d	0.025
		% K			
NG	3.47	2.51 e	2.75 e	3.02 e	0.84
S	1.76	1.03 f	0.87 f	1.13 f	0.59
		% Ca			
NG	0.248	0.365 g	0.396 g	0.398 g	0.490
S	0.149	0.279	0.390	0.493	0.096
		% Mg			
NG	0.277 h	0.347	0.280 h	0.282 h	0.050
S	0.206 i	0.447	0.222 i	0.283 i	0.075

*NG = Napier grass; S = Sorghum (immature)

Footnote: Values in a row followed by the same letter are not significantly different at 5% probability level.

TABLE 3. PLANT NUTRIENT UPTAKE IN RELATION TO DIFFERENT LIME AMENDMENTS ON PEAT

Crop	Nutrient uptake (g/2 bags)				
	Control	Dolomite (50 g/bag)	Limestone dust (50 g/bag)	Hydrated lime (50 g/bag)	L.S.D. (5%)
			N		
NG	0.231	0.752 a	0.706 a	0.701 a	0.120
S	0.006	0.643 b	0.651 b	0.515 b	0.155
			P		
NG	0.058	0.283 c	0.278 c	0.309 c	0.451
S	0.007	0.128 d	0.134 d	0.136 d	0.010
			K		
NG	0.292	1.747 e	1.793 e	1.853 e	0.112
S	0.018	0.653 f	0.570 f	0.695 f	0.135
			Ca		
NG	0.024	0.256 g	0.272 g	0.252 g	0.031
S	0.003	0.180	0.254 h	0.306 h	0.146
			Mg		
NG	0.023	0.247	0.192 i	0.179 j	0.015
S	0.002	0.280	0.145 j	0.175 j	0.110

NG = Napier grass; S = Sorghum (immature)

Footnote: Values in a row followed by the same letter are not significantly different at the 5% probability level.

DISCUSSION

Dry matter yield increase due to application of lime was due primarily to increase in soil pH, as shown by CHEW (1973). *Table 4,* which summarizes the values of soil pH obtained, shows the increase in soil pH with liming. It also shows that there was no significant pH difference at all between the three types of lime, which accounts for the lack of difference in their relative effects on the yield of dry matter.

The contents and uptake of the major plant nutrients N, P and K in the harvested dry matter were each decreased by liming, as previously demonstrated (CHEW 1973). This was the result of a dilution effect on nutrient content as dry matter increased due to liming, although liming increased the total N, P and K uptake by the two crops. As there was no significant difference between the three lime types in dry matter and content of these three elements, the same negative result was obtained for the uptake of N, P and K. It would appear, therefore, that on peat the use of dolomite does not decrease K availability more than when hydrated lime and limestone dust are applied at rates of the magnitude of 10 tons/ha.

TABLE 4. MEAN SOIL REACTION OF PEAT IN RELATION TO THREE LIME AMENDMENTS

Crop	Soil pH				
	Control	Dolomite	Limestone dust	Hydrated lime	L.S.D. (5%)
Napier Grass	3.6	4.7	4.5	4.6	0.2
Sorghum	3.8	4.7	4.6	4.5	0.2
MEAN	3.7	4.7	4.6	4.6	–

As all three lime amendments contained appreciable amounts of Ca, both the content and the plant uptake of this element were naturally increased by their application. However, in the case of sorghum, the Ca uptake was positively related to the Ca content of the lime. Since this response was not obtained in the case of Napier grass, this probably indicates the greater sensitivity of sorghum to applied Ca than Napier grass.

As is to be expected, dolomite increased the Mg content of the crop dry matter as well as Mg uptake, and these increases were greater than for limestone dust and hydrated lime, since the latter two types of lime contained appreciably less Mg than dolomite, and the amount of Mg applied as a fertilizer was low.

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SUMMARY

An investigation, in bags, to compare the relative effects of dolomite, limestone and hydrated lime on the growth and availability of nutrients to Napier grass and sorghum grown on peat soil was conducted in 1973.

Comparison of the control with lime treatments showed that dry matter and plant uptake of N, P, K, Ca and Mg were greatly improved by liming as a result of reduced soil acidity. The contents of N, P and K, however, was reduced by liming due to a dilution effect; the Ca content was increased by all three types of lime but improvement in the level of Mg was only observed in the case of dolomite.

Comparison of the three types of lime showed no difference in their effects on the contents or uptake of N, P and K. The Ca content and uptake, however, improved with increasing Ca content of the three lime amendments; the content and uptake of Mg was greater for dolomite than for the other two lime types.

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