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THE INFLUENCE OF LIME AND NITROGEN FERTILIZATION ON THE YIELD AND NITROGEN UPTAKE OF NAPIER GRASS ON MALAYSIAN PEAT SOIL

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RINGKASAN

Penyiasatan dalam beg untuk mengkaji kesan kapur dan pembajaan N ke atas tarikan N oleh rumput Napier di tanah gambut adalah diterangkan.

Tindakan semula jadi (pH) tanah gambut adalah terlalu masam untuk pertumbuhan pokok sihat dan tarikan N adalah kurang samada baja N ditaruh atau tidak. Kapur memperbaiki pengeluaran bahagian kering dan juga tarikan N daripada tanah dan sumber baja. Kadar tarikan N bergantung pada kadar berkumpulnya bahagian kering, perhubungan adalah lurus. Kandungan N pada rumput, walau bagaimanapun, turun mengikut pengeluaran bahagian kering.

Tarikan P, K, Ca dan Mg bertambah dengan mengapur dan pembajaan N dengan adanya kapur, kadar tarikan juga adalah bergantung pada kadar pengeluaran bahagian kering.

INTRODUCTION

Malaysian peat soil is relatively rich in total N, amounting to about 10.5 m. tons/ha in the top 30 cm. However, most of this large amount of N is in organic forms unavailable to plants and only a relatively small proportion of it is in mineral forms (usually less than 1%). CHEW (1973) showed that liming greatly improved the plant availability of peat N, even though this amounts to about 4% of total peat N per year, using Napier grass *(Pennisetum purpureum)* as the test-crop. Nitrogenous fertilizers are therefore needed for fodder grass production on limed peat. This paper presents data on the uptake of N by Napier grass in relation to lime and N fertilization.

MATERIALS AND METHODS

A bag experiment was conducted at the MARDI peat research station during 1973 to study the relative effects of lime and N fertilizer on N availability to Napier grass *(Pennisetum purpureum)* on Malaysian acid peat soil.

Peat bulk samples were taken to a depth of about 45 cm. from an area of virgin peat at the station and sieved through a coarse wire-mesh to remove undecomposed wood and roots and to loosen clods. After mixing the moist peat thoroughly, it was bagged in heavy duty perforated polythene bags at the rate of 9 kg. per bag. Each bag was about 21 cm. in diameter filled to a height of 28 cm. with peat. A representative sample of peat was taken during bagging for the determination of soil moisture, (gravimetric method), pH (with pH meter and 3:1 soil:water ratio) and total N content (Kjeldahl method).

Hydrated lime (as treatment only) was applied while manually mixing the peat from each bag on a plastic sheet; the lime contained 96.4% $Ca(OH)_2$. The treatments consisted of 0 and 50 gm/bag (approximately 9 tons/ha) of hydrated lime, and 0 and 60 ppm (approximately 30 kg/ha) of N as urea applied as a solution every six weeks; these levels were factorially combined to give four treatment combinations. In order to reduce variability, two bags were assigned to each treatment within each replicate and treatments were replicated thrice. The bags were kept in the open air on a cement floor. Every six weeks 15 ppm of P (as triple superphosphate) and 30 ppm of K (as sulphate of potash) were also applied as a suspension to each bag.

Local Napier grass cuttings with one node were planted at the rate of three cuttings per bag and the crop watered to maintain moisture around field moisture content (350% on d.w.b.). The grass was cut three times at intervals of six weeks. The oven-dry weight and N content of the grass were determined (Kjeldahl method) for each harvest. The total P, K, Ca and Mg contents of grass from the third (last) harvest were also determined (P by the ammonium vanadate method, K by flame photometry and Ca and Mg by EDTA titration). Soil was sampled with an auger for pH determination after each harvest.

RESULTS

Grass dry weight yield

The cumulative yields of dry grass produced are shown in *Fig. 1*. Yields were negligibly low in the unlimed treatments, even when fertilizer N was applied. Yields were increased about five-folds by applying lime. It was only in the presence of lime that fertilizer N showed any significant effect; yields were increased by about 71 percent.

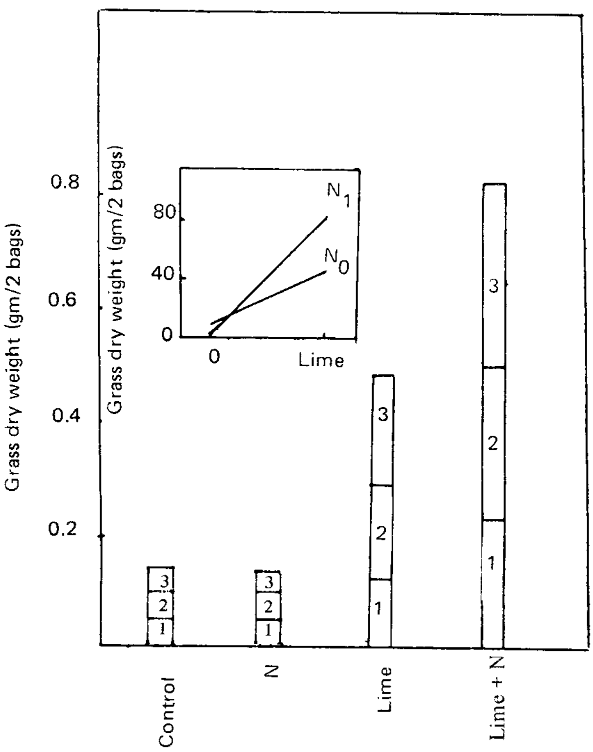

Figure 1. Grass dry weight yield in relation to lime and nitrogen in harvest 1 – 3 (inset shows line – N interaction).

Grass nitrogen content and uptake

The N content of the grass harvested was generally decreased by liming and increased, as expected, by the addition of fertilizer N. There was, however, a significant lime x fertilizer N interaction; N content was increased by N fertilizer in the absence of lime but decreased in the presence of lime (*see Fig. 2*). There was a general exponential relationship between N content of grass and the dry weight yield of grass *(Fig. 3)*.

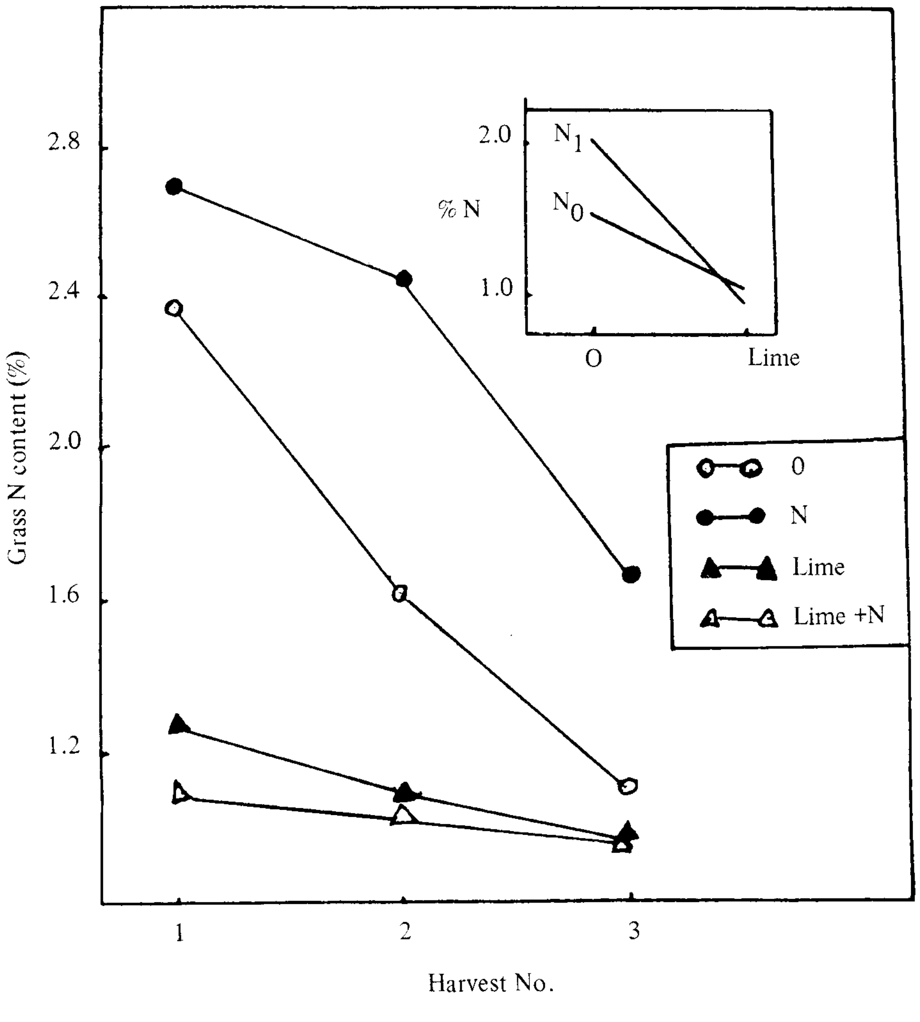

Figure 2. N content of grass in relation to lime and nitrogen.

N uptake was very low in the absence of lime, whether or not fertilizer N was applied and the addition of 50 gm/bag of hydrated lime improved N uptake by five-folds *(Fig. 4)*. Addition of fertilizer N with lime increased uptake by about 75%, but this constituted only about 45% recovery of the N applied as fertilizer.

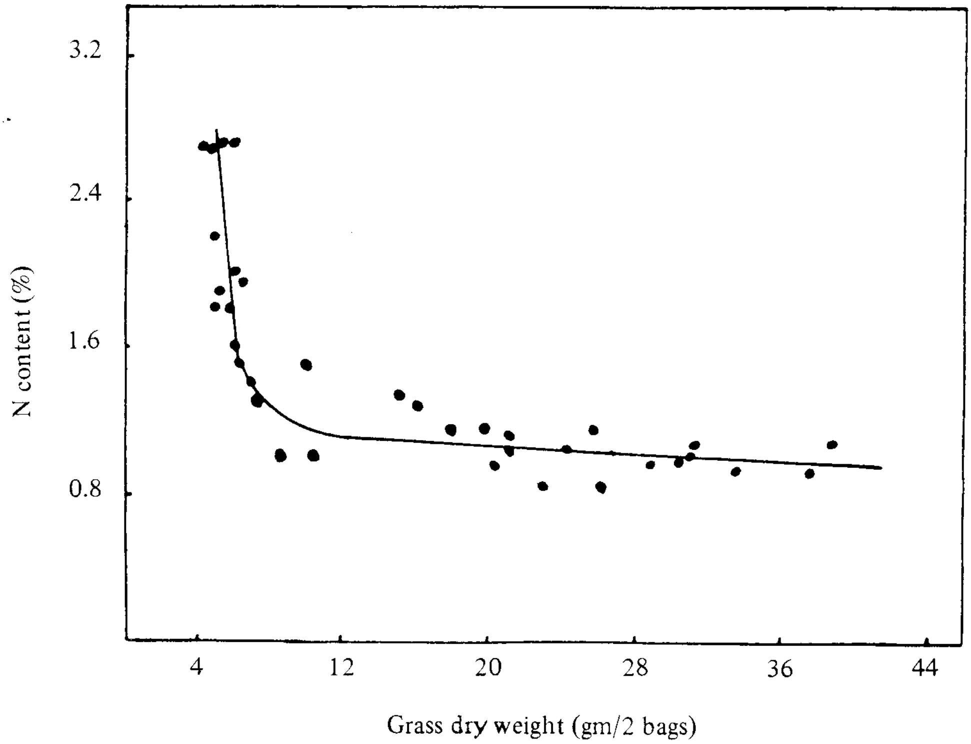

Figure 3. Relationship between N content of grass and dry matter production.

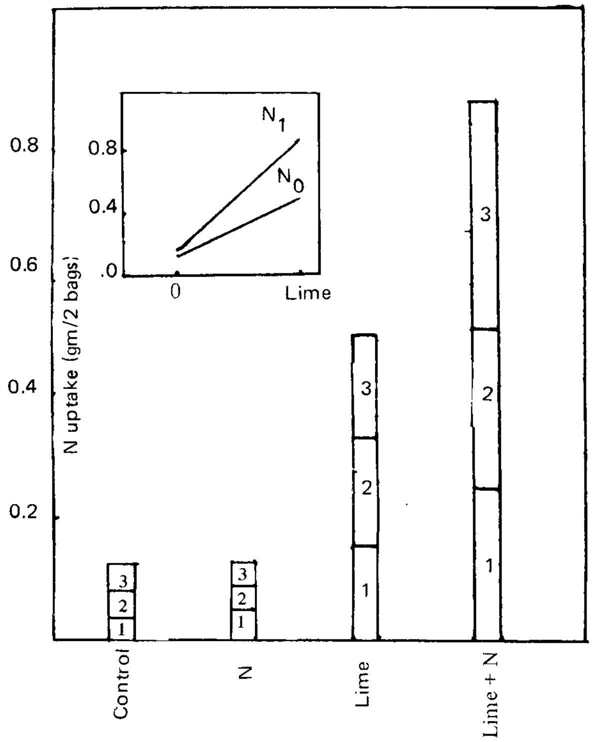

Figure 4. N uptake in relation to lime and nitrogen in harvest 1 – 3 (inset shows lime-N interaction).

N uptake was increased by lime and N fertilizer in much the same way as dry weight yield (*see Fig. 4 and compare with Fig. 1*). There was a linear relationship between these two sets of data (*see Fig. 5*).

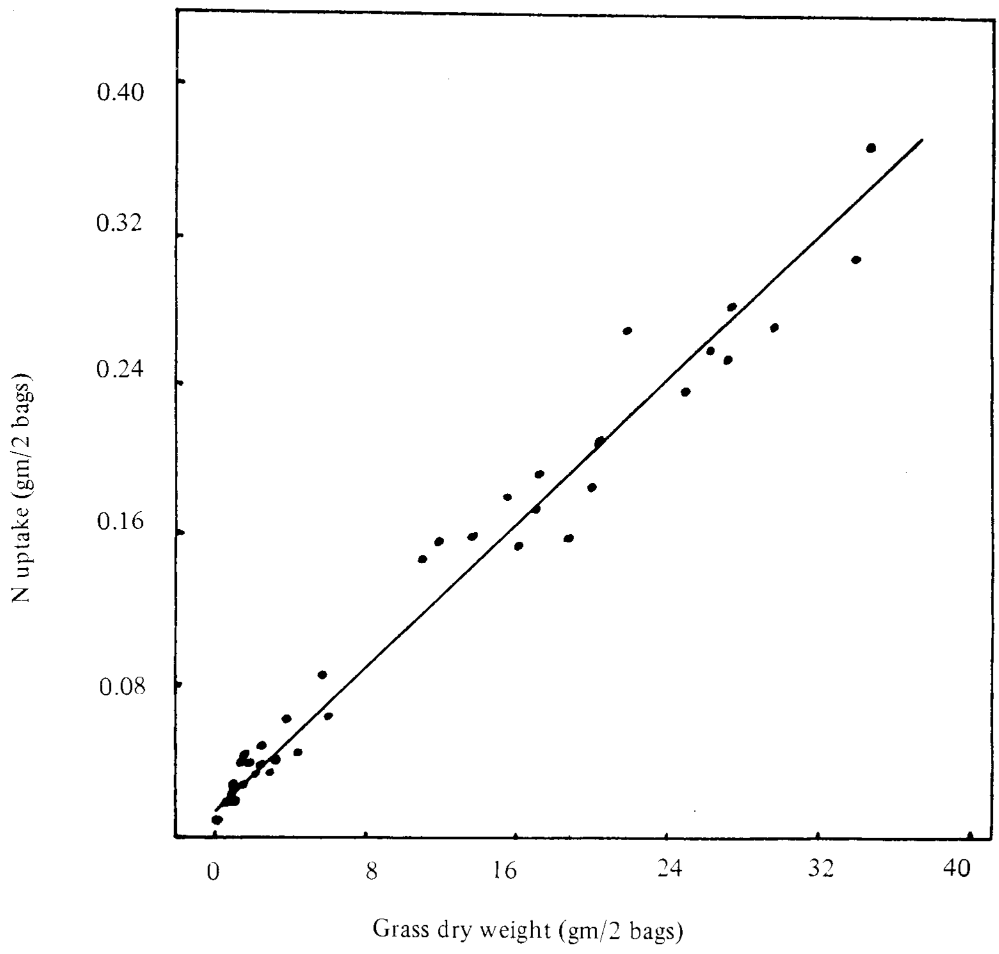

Figure 5. Relationship between N uptake and grass dry matter production.

Grass content and uptake of P, K, Ca and Mg

The contents of P, Ca and Mg in the grass from the last harvest (*see Table 1*) were not significantly affected by addition of lime or fertilizer N, although for the cations Ca and Mg, addition of lime did show some increase in their levels in the grass. The K content of grass was shown to be reduced by liming; fertilizer N had no significant effect on K content in the absence of lime, but it produced a significant depressive effect when lime was applied.

As regards nutrient uptake, addition of lime increased total uptake of P, K, Ca and Mg (*see Table 2*). N fertilizer did not increase uptake in the absence of lime, and in the presence of lime only Ca and Mg uptake were increased by addition of N fertilizer.

TABLE 1. P, K, CA AND MG CONTENT OF NAPIER GRASS IN LAST (THIRD) HARVEST

Treatment	% NUTRIENT IN DRY GRASS			
	P	K	Ca	Mg
Control	0.548a	3.05b	0.293c	0.222d
N	0.534a	3.56b	0.365c	0.139d
Lime	0.549a	2.20	0.457c	0.301d
Lime + N	0.553a	1.33	0.449c	0.472d
L.S.D. (5%)	N.S.	0.58	N.S.	N.S.

Values in a column followed by a common letter do not differ significantly at the 5% probability level.

TABLE 2. PLANT UPTAKE OF P, K, CA & MG IN LAST (THIRD) HARVEST OF GRASS

Treatment	Nutrient uptake (mg/2 bags)			
	P	K	Ca	Mg
Control	23.7a	139.5c	12.6e	9.4f
N	18.4a	86.3c	9.2e	5.0f
Lime	104.8b	418.3d	64.6	59.3
Lime + N	115.2b	434.3d	145.9	153.7
L.S.D. (5%)	28.0	149.2	62.4	38.4

Values in a column followed by a common letter do not differ significantly at the 5% level of probability.

DISCUSSION

Liming greatly increased both the production of total grass dry weight and the total N uptake. These responses to lime were most probably due to pH increase, as previously shown by CHEW (1973). In the control bags (*see Table 3*), soil pH (3.67) was too low for healthy plant development and probably also for efficient N mineralization. As plant development was poor, addition of fertilizer N to unlimed peat did not appreciably increase N uptake, although soil pH was slightly increased (probably due to formation of ammonia). Liming with about 9 tons/ha hydrated lime to raise soil pH to about 4.7 improved N uptake from peat soil from 0.17% to 0.80% of total peat N. It was only in the presence of lime that fertilizer N showed its effects on plant growth and N uptake. However, recovery of applied N was low (about

TABLE 3. N UPTAKE IN RELATION TO TOTAL PEAT AND FERTILIZER N

Treatment	(a) Total N uptake (gm/2 bags)	(b) Total N (peat + fertilizer) (gm/2 bags)	(c) = (a)/(b) % of total N absorbed	Soil pH
Control	0.110	62.809	0.17	3.67
N*	0.125	63.662	0.20	3.71
Lime + N	0.504	62.809	0.80	4.74
Lime + N***	0.883	63.669	1.39	4.90

*N at the rate of 60 ppm (about 30 kg/ha) every 6 weeks.
**Lime at 50 gm/bag (approximately 9 m. tons/ha).
***Lime and N at the above rates.

45%); this was most probably due to considerable losses of N through volatilization (e.g. RAJARATNAM *et al.*, 1973), leaching or immobilization by soil micro-organisms.

The uptake of N by the crop, which is an indication of available N, depends on the rate of dry matter production, N uptake being linearly related to dry matter. Where peat soil pH favours high dry matter accumulation, N uptake will be correspondingly high. However, as dry matter increases with liming, a dilution effect is brought about so that the N (or crude protein) content of grass is reduced, giving rise to the exponential relationship observed *(Fig. 3)*. As addition of N to limed peat did not appreciably increase grass N content, it would appear that the present rate of N (approx. 240 kg/ha/annum) is inadequate to meet the needs of the grass crop under peat conditions.

Liming improved the uptake of the other four plant nutrients for which analyses were carried out (P, K, Ca and Mg). Only in the presence of lime did fertilizer N improve the uptake of these elements, particularly Ca and Mg. It appears that the uptake of these elements like that of N, also depended on the rate of dry matter production.

It was not possible to determine the effects of fertilizer N on the availability of peat N in this experiment because labelled N was not used. It has been shown, however, that on peat, N fertilization can reduce the rate of N mineralization from the soil (MALCOLM 1972, MACIAK 1972).

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SUMMARY

An investigation in bags to study the effects of lime and N fertilization on the N uptake of Napier grass on peat is described.

The natural reaction of peat was too acidic for healthy plant growth and N uptake which were poor whether or not fertilizer N was applied. Liming greatly improved dry matter production and also N uptake both from soil and fertilizer sources. The rate of N uptake depended on the rate of dry matter accumulation, the relationship being linear. The N content of grass, however, decreased exponentially with dry matter production.

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