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INFLUENCE OF LIME ON THE AVAILABILITY TO NAPIER GRASS (*PENNISETUM PURPUREUM*) OF SOME APPLIED NUTRIENTS ON PEAT

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RINGKASAN

Satu percubaan untuk mengkaji kesan kapur ke atas hasil dan tarikan zat P, K, Ca dan Mg yang diberi sebagai baja ke atas tanah gambut diterangkan.

Kapur mengurangkan kandungan zat P dan K sambil menambahkan kandungan Ca dan Mg di rumput Napier *(Pennisetum purpureum)*. Bagaimanapun, tarikan zat P, K, Ca dan Mg masing-masing dinaikkan oleh sebab pengapuran. Kenaikan tersebut kebanyakan kerana kesuburan rumput yang terjadi dalam keadaan tanah yang kurang masam apabila kapur ditaburkan. Tambahan pula, peratus baja P dan K yang digunakan oleh tumbuhan rumput juga meningkat sebab mengapur.

INTRODUCTION

With the exception of pineapple, most crops on Malaysian peat soil require lime to raise the soil pH in order to establish and to yield reasonably well. Thus several liming experiments have been conducted in Malaysia to determine the relative lime requirements of several annual crops on peat (CHEW, 1971; CHEW and YEONG, 1974). Furthermore, it has been shown, that yield increases due to liming are mainly the result of increase in soil pH which affects both N mineralisation rate as well as plant growth and nitrogen absorption (CHEW *et al.*, 1976). The effects of liming on the availability of major plant nutrients other than nitrogen supplied as fertilizers to peat have not been studied in Malaysia. This paper describes such an investigation.

MATERIALS AND METHODS

An experiment to study the availability to plants of applied P, K, Ca and Mg when supplied increasing amounts of hydrated lime was conducted at the Peat Research Station, Jalan Kebun, Malaysia during two seasons (1967/68 and 1968/69).

Bulk samples of peat were taken to a depth of about 45 cm, sieved, mixed thoroughly and filled into heavy duty polythene bags. Each bag contained about 18.5 litres of wet peat weighing 10 kg. The hydrated lime treatments used in this experiment were 0, 50, 100 and 200 g/bag (approximately 0, 8,16 and 32 t/ha) during the 1967/68 season and 0, 50, and 100 g/bag during 1968/69. The lime was applied by spreading peat in each bag on a plastic sheet, sieving the lime on and mixing manually. Treatments were replicated thrice. In order to reduce variability, three bags were assigned to each treatment within each replicate. Setts of local Napier grass were planted on 6 July, 1967 and 15 September, 1968 and later thinned down to 3 shoots per bag. The following nutrients were applied at planting and after each cut: 150 ppm of P (as superphosphate) 500 ppm of K (as potassium sulphate) 10 ppm of Mg (as sulphate) and 10 ppm of Cu (as sulphate). No N was applied, as the peat contained considerable amounts of this nutrient (about 10 t/ha, CHEW *et al.*, 1976).

The bags were kept in a plastic shelter and watered daily to maintain peat moisture content around field capacity. The grass was cut five times at intervals of 9 weeks in the 1967/68 experiment and only four times every 6 weeks in the later experiment. Roots were extracted at the end of each experiment by flushing with water. Dry weights of shoots and

roots were recorded. The P. K. Ca and Mg contents of the grass were determined from composite samples of the dry shoots and roots. The following methods were used for chemical analysis: P by colorimetry (vanadomolybdate method), K by flame photometry and Ca and Mg by the versenate method. Soil pH was read at each harvest using a pH–meter and a soil:water ratio of 1:3 (v/v basis).

RESULTS

Dry Weight of Grass and Soil pH

The yields of dry grass (shoots and roots) and the peat soil pH from the two seasons of this experiment are shown in *Fig. 1.* Liming greatly improved plant growth. Dry matter was linearly related to liming rate up to 100 g/bag hydrated lime above which the rate of dry matter increase was small and insignificant.

Within the range of 0–200 g/bag of lime. there was a linear increase in soil pH with liming at the rate of 1.0 pH unit for every 50 g of lime per bag (equivalent to 0.1 pH unit per ton/ha). Soil pH was maintained at their mean values throughout the experimental periods.

Nutrient Contents of Grass

The contents of P. K. Ca and Mg of the grass in the two seasons are summarised in *Fig. 2.* Liming reduced the contents of P and K in the dry grass. This decrease which was most marked in the case of K, was linear up to 100 g/bag lime and curved thereafter. The contents of Ca and Mg in the grass increased when lime was applied; however. this increase was not significant above the 50 g/bag lime rate.

Nutrient Uptake and Recovery

The uptake of the four plant nutrients P. K. Ca and Mg in relation to lime rate is shown in *Fig. 3.* The uptake of P and K was increased in both seasons with liming up to the 50 g/bag level of lime above which there was little or no increase. The uptake of Ca and Mg to lime, on the other hand. was linearly related to lime rate over the whole range of lime treatments. occurring in both the 1967/68 and 1968/69 seasons.

The recovery rates of applied nutrients are illustrated in *Table 1* by the nutrients P and K; Ca and Mg are not considered here because these were found in relatively large amounts in the lime. Liming increased the recovery rate of applied P and K, but above 50 g/bag lime, no increase in recovery rate was obtained in all cases except for P in the 1968/69 season, where increasing the lime rate to 100 g/bag improved the recovery of applied P.

DISCUSSION

The positive response of dry matter and also uptake of applied nutrients to liming obtained in the present experiment are most likely due to pH increase. as shown by CHEW *et al.*, (1976) for nitrogen (see also *Fig. 1*). Since plant growth and N uptake was low when no lime was applied. it would appear that unless peat pH is increased from about 3.5 (natural pH of unlimed peat). plants absorb nutrients from the soil at a very low rate; this has also been shown by several workers (HOAGLAND and BROYER. 1940; HEWITT, 1952; HURD and SUTCLIFFE. 1957; MURPHY. 1959). This reduced rate of nutrient absorption is probably also due to inhibition of root growth in the presence of a high concentration of H ion, a possibility suggested by JACOBSON *et al.*, (1950) and ECK *et al.*, (1957) and also to reduced availability of nutrients at the low pH of unlimed peat (TROUG, 1951). The increased growth. nutrient uptake and fertiliser recovery rate in limed peat soil supports this view.

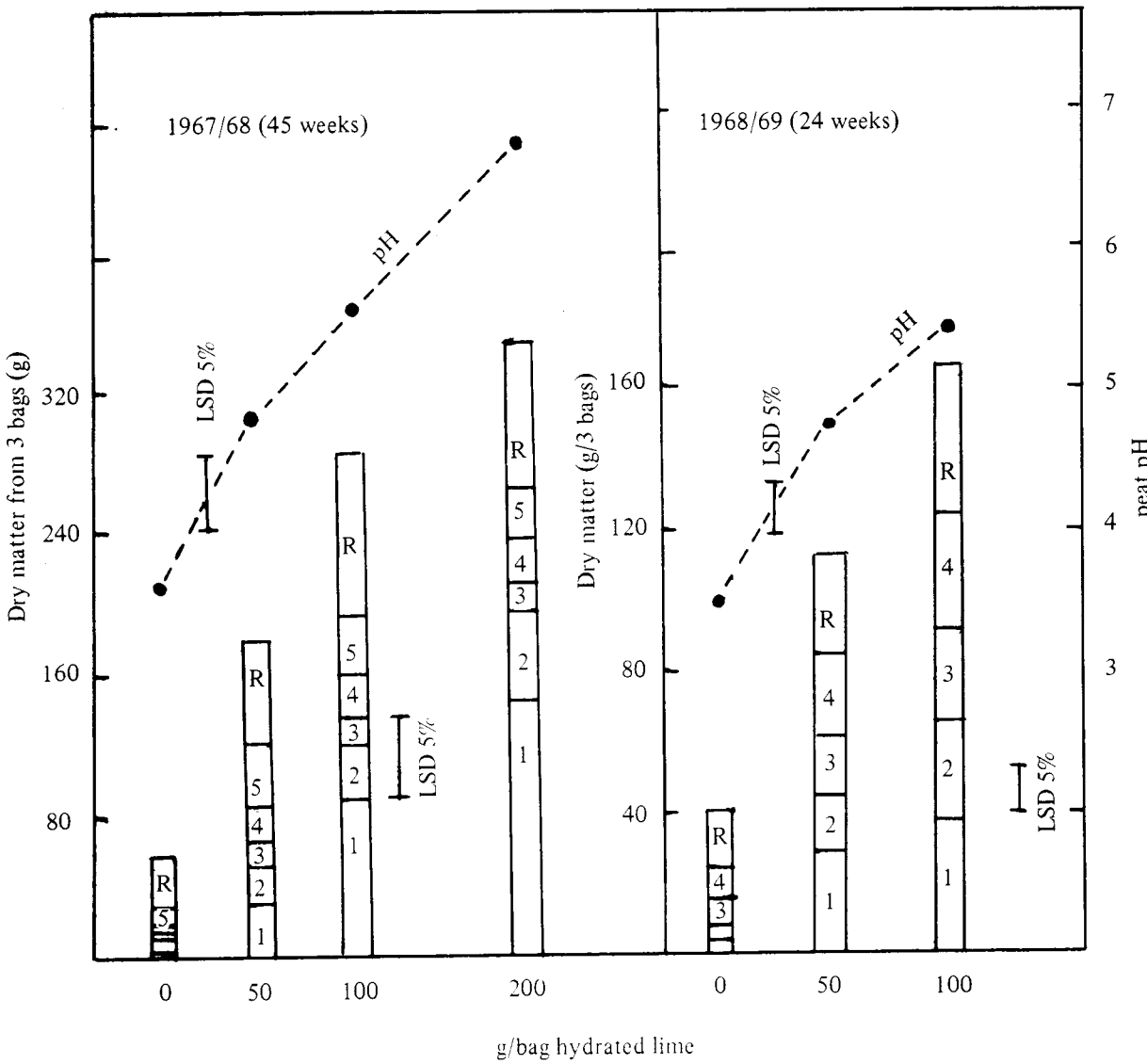

Figure 1. Cumulative dry matter yields of Napier grass at harvests 1 5 and roots (R) in relation to lime rate (LSD 5% values for total dry matter of shoots and roots and also for soil pH are shown as vertical bars). Broken lines are the mean pH values in relation to lime rate

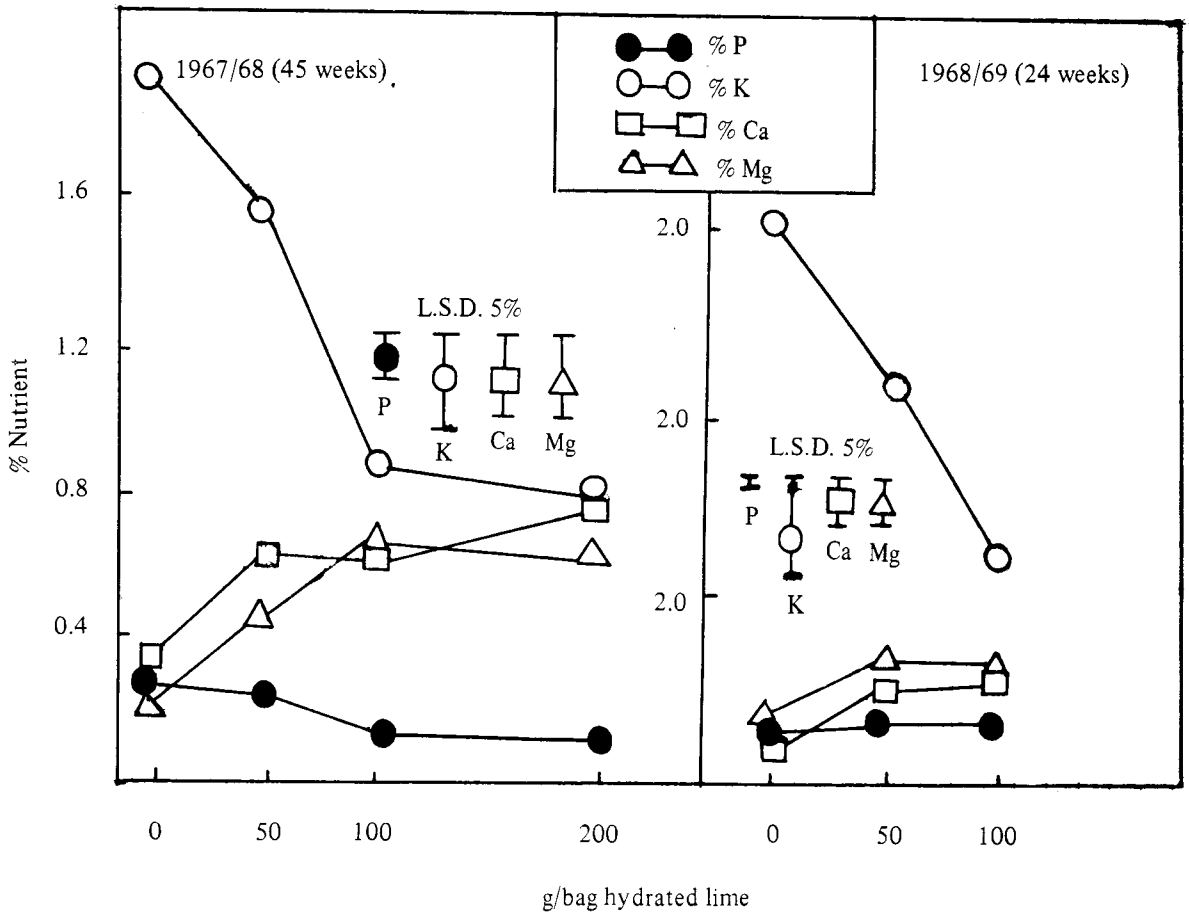

Figure 2. Nutrient content of grass in relation to lime rate (LSD 5% values and duration of experiments shown)

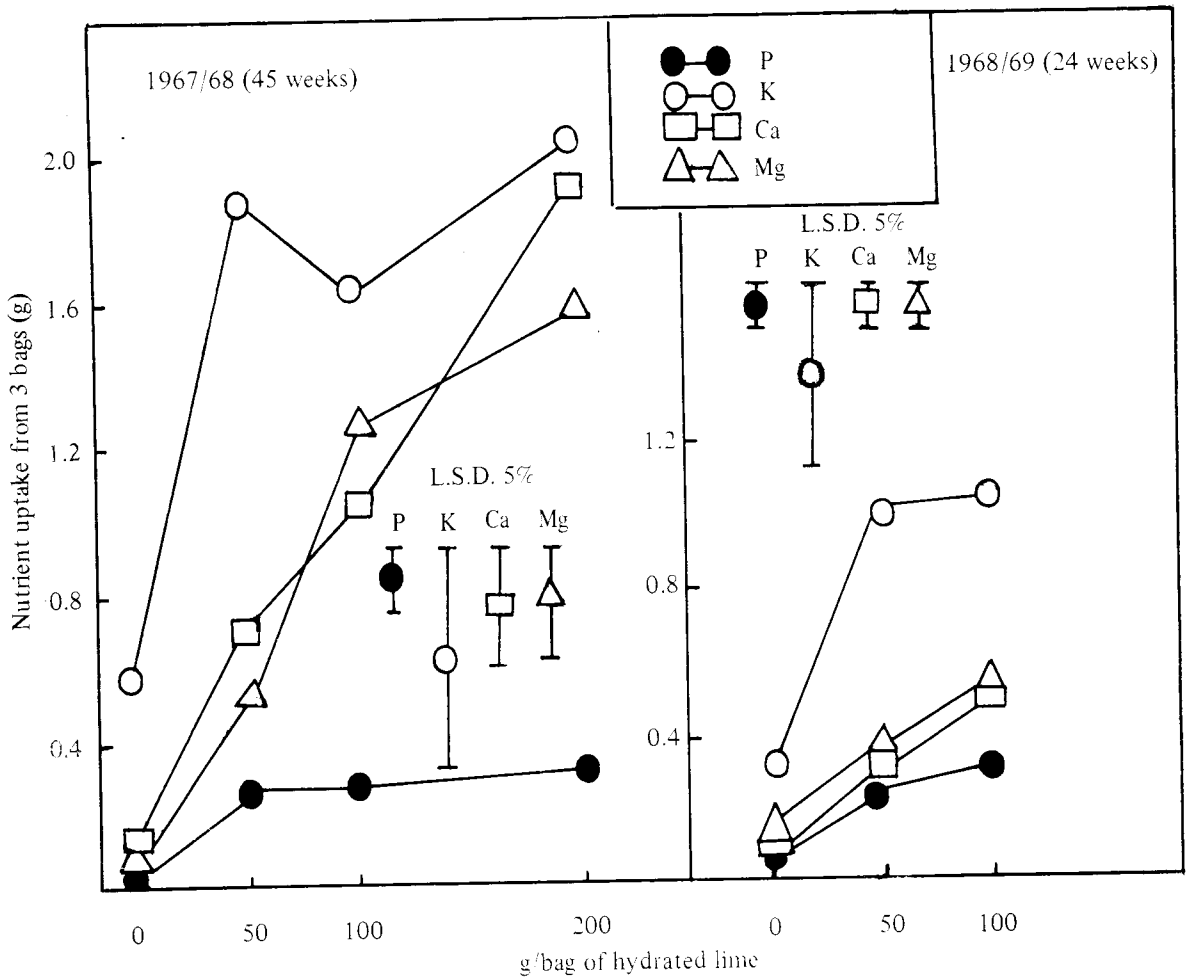

Figure 3. Nutrient uptake of P, K, Ca and Mg by Napier grass (LSD 5% values and duration of experiments shown)

TABLE 1. RECOVERY OF FERTILIZER P AND K

Lime (g/bag)	Percentage recovery			
	P		K	
	1967/68	1968/69	1967/68	1968/69
0	16.29	12.78	33.47	43.14
50	54.13a	46.21	85.13b	85.74c
100	51.19a	62.60	74.70b	77.99c
200	50.10a	–	80.82b	–
LSD ($P \leqslant 0.05$)	19.97	17.59	10.96	16.61
CV (%)	23.9	20.1	19.1	22.8

Values in a column followed by the same letter are not significantly different at $P \leqslant 0.05$.

A reduction in the contents of P and K in the grass dry matter as a result of liming was observed although the uptake of P and K was increased by liming. This is to be expected, as the rate of dry matter production was so greatly increased by lime that a dilution effect must have resulted. A similar observation was made by CHEW *et al.*, (1976) for nitrogen. There was no such dilution in the case of Ca and Mg, as these two nutrients were freely supplied by the lime, Ca being a main constituent and Mg a major impurity of the commercial grade of hydrate lime used in this experiment.

The results of grass yield and uptake of P, K, Ca and Mg in this paper suggest that although yields are increased by liming up to 200 g/bag (32 t/ha) optimum uptake of nutrients was obtained at the lower lime rate of 50 g/bag (8 t/ha) . From the point of view of recovery of fertilizers, therefore, there is little value in increasing lime beyond the rate of 50 g/bag or 8 t/ha and it is even possible that lower lime levels (not studied) than this can bring about similar nutrient uptake.

Recovery of P was very low (about 50–60%) compared to that of K (up to 85%). Although soluble P was applied, it was possibly converted into insoluble phosphates of Ca in the presence of lime but when no lime was applied, as in the control treatment, soil pH was too low for efficient nutrient uptake to take place. K, however, was relatively freely available and not easily leached away because of the high cation exchange capacity of peat (about 150 m.e.%) and this probably accounts for its relatively high recovery rate.

SUMMARY

Lime reduced the contents of P and K but increased the contents of Ca and Mg in Napier grass *(Pennisetum purpureum)*. However, the uptake of P, K, Ca and Mg was each significantly increased by liming. This increased was mainly due to improved plant growth as a result of lowered soil acidity when lime was applied. The recovery of fertilizer P and K was also increased by addition of lime.

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