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DETERMINATION OF MOLYBDENUM REQUIREMENT ON ESTABLISHED GRASS-LEGUME PASTURE, MALAYSIA

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RINGKASAN

Tindakbalas molybdenum terhadap campuran *Centrosema pubescens* dengan rumput pastura di tanah-tanah siri Durian, Munchong dan Prang telah dikaji. Molybdenum meningkatkan lagi kandungan nitrogen pada *C. pubescens* di semua kawasan dan hasil di tiga kawasan di mana kajian telah dijalankan. Penilaian peningkatan kandungan N telah dicadangkan sebagai cara yang paling tepat untuk menentukan banyaknya molybdenum yang diperlukan.

INTRODUCTION

The requirement for molybdenum by pasture legumes on soils of the Bungor, Durian, Melaka, Munchong and Rengam Series was studied in pot culture and in small plot experiments (THAM and KERRIDGE, in preparation). *Centrosema pubescens* was observed to be more responsive to molybdenum than *Pueraria phaseoloides* which in turn was more responsive than *Stylosanthes guianensis.* Strong responses to molybdenum occurred on the soils where *C. pubescens* was grown, namely the Bungor, Melaka and Rengam Series. On the other hand, there was only a limited yield increase on the Munchong Series soil and a response in plant nitrogen concentration on the Durian Series soil where *P. phaseoloides* had been grown as the test plant. It was considered desirable to determine the response by *C. pubescens* on these two soils.

Further, the use of molybdenum as a micronutrient fertilizer has not been widely adopted for use on commercial pastures. This is partly due to a feeling that sufficient molybdenum may be added as a contaminant in commercial fertilizer (JOSEPH, 1970). Hence, when investigating field responses to molybdenum by *C. pubescens* on these soils, it was considered appropriate to carry out experiments on established farm pastures with a history of fertilizer application. An experiment on the Prang Series soil was included as Mo deficiency had not been confirmed in the field on this soil.

MATERIALS AND METHODS

Experiments were carried out on three soil types on the Padang Hijau farm of the National Livestock Development Corporation, Kluang, Johore. These sites had been cleared from rainforest immediately prior to planting.

Site 1. Durian Series – Orthoxic Tropudult; pH, 4.6; Ex. bases, 1.9 me/100 g.

Pasture: *Panicum maximum* (common guinea) – *C. pubescens*, established April 1975. This pasture had been heavily overgrazed down to a 4 cm stubble with *Paspalum conjugatum* as the dominant species.

Previous fertilizer: 130 kg P/ha as Christmas Island A grade rock phosphate, 70 kg P/ha as triple superphosphate.

Treatments: a. Molybdenum (Mo), 0 and 200 g/ha as sodium molybdate.

b. Phosphorus (P), 0 and 50 kg/ha as muriate of potash.

c. Lime, 0 and 1000 kg/ha as ground limestone.

Design: 2 replicates x 2^4, randomized block. Plot size, 4m x 4m.

Procedure: Uniformity cut, 23.6.77; treatments applied 27.6.77; harvests 25.8.77 and 22.10.77; four quadrats cut at 10 cm height per plot, 0.5m x 1m for uniformity cut and first

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harvest, 1m x 1m for second harvest.

Site 2. Munchong Series – Tropeptic Haplorthox; pH, 4.5; Ex. bases, 2.0 mg/100g.

Pasture: *Digitaria decumbens* cv. Transvala – *C. pubescens*, established January 1975. Pasture was uniform and had been under moderate grazing pressure.

Previous fertilizer: 170 kg P/ha as Christmas Island A grade rock phosphate, 65 kg P as triplesuperphosphate, 100 kg K/ha as muriate of potash.

Treatments: Molybdenum, 0 and 200 g/ha, as sodium molybdate. Basal K and P were applied at the rates used at Site 1.

Design: 8 replicates, randomized block, Plot size 4m x 4m.

Procedure: Treatments applied 22.9.76; harvests, 14.11.76 and 16.1.77; four 0.5m x 1m quadrats cut at 10 cm height per plot.

Site 3. Prang Series – Haplic Acrorthox; pH, 4.6; Ex. bases, 1.7 me/100g.

Pasture: *Setaria anceps* cv. Kazungula – *C. pubescens* established February 1974. Pasture was uneven and overgrazed.

Previous fertilizer: 170 kg P/ha as rock phosphate, 40 kg P/ha as triple-superphosphate; 10 kg K/ha as muriate of potash.

Treatments: a. Molybdenum, 0 and 200 g/ha, as sodium molybdate.

b. Phosphorus + Potassium, 0 and 40 kg P + 50 kg K/ha, as triplesuperphosphate and potassium chloride, respectively.

Design: 4 replicates x 2^2, randomized block; plot size 4m x 4m.

Procedure: Uniformity cut, 22.9.76; fertilizer applied 22.9.76; harvests 15.11.76 and 16.1.77; two 1m x 1m fixed quadrats cut at 10 cm height per plot.

Although the main objective was to determine response to Mo, treatments for other nutrients were included where the pastures were not vigorous. Responses by guinea grass to P and lime had been obtained on the Durian Series soil while P and K responses had been observed on the Prang Series soil. Uniformity cuts were made at sites on the Durian and Prang Series soils because of uneven botanical composition; in addition, fixed quadrats were used at the site on the Prang Series.

The harvested material was separated into grass and legume, weighed, and subsamples dried in a forced draught oven at 70°C. Nitrogen analyses were made on the whole legume shoot from Munchong and Prang Series experiments and on tip samples (last three expanded leaves plus stem) from the Durian Series. Nitrogen was determined by a modified Kjedahl method of WILLIAMS and TWINE (1967).

RESULTS AND DISCUSSION

The main responses were to molybdenum which significantly increased the yield of centro on the Durian and Prang Series soils and the nitrogen concentration of centro on all three soils *(Table 1)*. The likelihood that these yield responses were due to the molybdenum treatment was increased in both harvests on the Durian Series and the first harvest on the Prang Series soil by a covariance analysis using yield data obtained in the uniformity harvest. Statistical analysis of the total centro yields gave probabilities intermediate between those for the individual harvests (Durian, $P = 0.033$; Prang, $P = 0.018$). However, the coefficient of

TABLE 1: THE EFFECT OF MOLYBDENUM ON YIELD AND NITROGEN CONCENTRATION OF *C. PUBESCENS*

	Yield (kg/ha)						
		Original means		Means adjusted by covariance		Nitrogen (%)	
Harvest	Uniformity	1	2	1	2	1	2
			Durian Series				
Mo_0	180	210	230	200	230	3.28	3.54
Mo_{200}	160	320	310	330	310	3.66	3.76
Probability†	0.837‡	0.043	0.037	0.004	0.011	0.003	0.021
C.V. (%)	67‡	53	35	37	29	5	8
			Munchong Series				
Mo_0		400	240			3.19	3.46
Mo_{200}		500	260			3.67	3.69
Probability		0.243	0.795			0.035	0.040
C.V. (%)		37	25			11	5
			Prang Series				
Mo_0	150	190	70	180	70	3.06	2.94
Mo_{200}	100	290	140	300	140	3.58	3.57
Probability	0.479‡	0.082	0.008	0.026	0.014	0.002	0.002
C.V. (%)	86‡	44	39	37	42	7	9

† Probability that the difference between Mo treatments was due to chance.

‡ Values derived on the assumption on that treatments had been applied.

variation (C.V.) remained high with all statistical analyses of yield. This illustrates the difficulty in conducting experiments on pastures with a variable legume composition.

The nitrogen concentration of centro was a more precise measure of response to molybdenum than dry matter yield, particularly on the Durian and Munchong soils *(Table 1)*. Earlier pot culture studies with centro also showed a more marked effect of molybdenum on nitrogen concentration than on yield (WATSON, 1960). This suggests that changes in nitrogen concentration may be a preferable way to determine if molybdenum is deficient for optimum nitrogen fixation. Larger numbers of plots have been used and hence chemical analyses made in these studies than would be feasible for more routine determinations of the need for molybdenum. However, it should be possible to reduce the replication by use of matched sites and determination of differences in legume nitrogen concentration from each member of the matched pair prior to and after molybdenum application. The absolute molybdenum requirement of tropical legumes would appear to be too low to use plant molybdenum concentration in assessing molybdenum status (JOHANSEN 1978).

Both the yield and nitrogen data suggests that molybdenum deficiency was more severe on the Prang Series soil.

Response on Munchong Series soil was lower than expected from results of another field experiment on the same soil with *P. phaseoloides* (THAM and KERRIDGE, 1981). It is possible that commercial fertilizers may have contributed some molybdenum. Phosphate rocks usually contain less than 10 ppm molybdenum but a few sources contain much larger amounts (SWAINE 1962). Christmas Island rock phosphate contains less than 3 ppm molybdenum (J.S. HOARE, personal communication). Thus application of Christmas Island rock phosphate to give 150 kg P/ha could contribute as much as 3 g molybdenum which is sufficient to give some response on a deficient soil (ANDERSON 1946). Fertility transfer by animals also may have affected the response. The pasture at the Munchong soil site was grazed by dairy cows which received large amounts of concentrate feed and a mosaic of dark green and yellowish patches of centro was evident. Nitrogen concentrations in the nil molybdenum treatment ranged from 2.7 to 3.7% whilst they were always greater than 3.5% in the treatments with molybdenum.

The only other significant responses were to phosphorus by centro and to lime by guinea grass for the combined yield data on the Durian Series soil. Lime increased the total yield of guinea grass from 2420 to 2710 kg DM/ha and phosphorus the total yield of centro from 460 to 610 kg DM/ha. The response of guinea grass to lime confirms a previous response (THAM and KERRIDGE, in preparation). The phosphorus response is surprising in view of the apparent previous high application of phosphorus fertilizers to this site. The phosphorus concentrations of centro tips at 0 and 40 kg P/ha were 0.23 and 0.26% at harvest 1 and 0.20 and 0.22% at harvest 2, respectively. Unpublished data of the author suggests a critical value of 0.20% for shoot tip samples of centro.

Grass yields were similar between harvests and sites and ranged from 1200 to 1700 kg DM/ha at each cutting interval. The coefficients of variation were less than for the legumes, below 20% on the Durian and Munchong sites and 30% on the Prang site. A noteworthy observation was the good recovery of the sown species on the Durian and Prang sites following fencing off the areas from grazing stock to obtain the yield measurements. However, legume yields were still low at the conclusion of the trials.

In conclusion, these results have demonstrated a molybdenum requirement by centro when grown in association with a grass on the Durian, Munchong and Prang Series soils in the presence of heavy application of commercial fertilizers. Further, molybdenum requirement of centro and grazed pastures can be determined more readily and precisely by measuring changes in nitrogen concentration than dry matter yield.

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SUMMARY

Molybdenum response to *Centrosema pubescens* – grass pastures on soils of the Durian Munchong and Prang Series was examined. Molybdenum increased the nitrogen concentration of *C. pubescens* at all sites and the yield at three sites. Evaluation of an increase in N concentration was suggested as the most precise means of determining molybdenum requirement.

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