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ASSESSMENT OF THE NUTRIENT STATUS OF COASTAL MARINE SAND (BRIS) OF PENINSULAR MALAYSIA BY POT EXPERIMENT USING *STYLOSANTHES GUIANENSIS*.

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RINGKASAN

Kajian pasu telah dijalankan untuk menganggarkan status nutrien siri tanah Baging, Rompin dan Jambu dari kompleks tanah 'bris' di Semenanjung Malaysia. Kekacang *Stylosanthes guianensis* cv. Schofield telah digunakan sebagai tumbuhan ujian.

Tindakbalas yang sangat berkesan terdapat pada P, K, S dan Cu ke atas ketiga siri tanah, pada Ca ke atas siri tanah Baging dan Jambu, dan pada B ke atas siri tanah Jambu. Tindakbalas yang berkurangan terdapat pada B dan Mo pada siri tanah Baging dan Rompin. Ada terdapat tindakbalas yang kurang tetapi berkesan pada Mg dan B ke atas siri tanah Jambu. Tindakbalas pada P dan K bertukar menjadi bahan racun sebab kadar pembajaan yang tinggi.

Siri tanah Rompin mempunyai 'status' kesuburan yang lebih tinggi daripada siri tanah Baging dan Jambu. Ketumbuhan pada siri tanah Jambu masih tidak memuaskan walaupun nutrien yang berkurangan telah ditambah.

INTRODUCTION

The 'bris' is the name given to the complex of marine sands which extend in an almost continuous belt, varying in width from a few hundred metres to eight kilometres, on the east coast of Peninsular Malaysia. They cover an area of approximately 140,000 ha. The main variants are the recent soils, Baging and Rompin Series, the humus (sand) podzols, Rudua and Jambu Series, and the light grey ultisols, Rusila Series, (IVES, 1967). The recent soils are of sand or silty texture with the absence of genetic horizon apart from a thin humic horizon at the surface. The humus podzols are developed over old beach strand lines. They consist almost entirely of quartz sand and have an albic horizon overlying a spodic horizon. A surface (7–13 cm) horizon of humic material is present in virgin soils. The light grey ultisols are developed over recent marine sands in the poorly drained waterlogged swales between the beach strands. There is a surface humic accumulation over-lying grey, often humic loamy sand or clayey sands. Physical and chemical properties of the 'bris' soils have been reported by IVES (1967) and by LAW and TAN (1975). Physically they consist of 85–100 percent of fine and coarse sand. The Baging Series has been shown to hold only 22 mm available water (pF 2.0 – pF 4.2) in the top metre (BOLS and MAENE 1974). JOSEPH (1975) reported infiltration rates of over 40 cm/hr on these soils.

The MARDI research station at Sungai Baging (103° 20'E, 4°N) lies on the central east coast of Peninsular Malaysia. The average annual rainfall over eight years was 2858 mm and yearly mean temperature 24°C (BOLS and MAENE 1974).

The present land use is largely limited to coconut growing with cattle grazing on the natural grasses, the dominant grass being *Zoysia matrella.* Tree crops, viz. cashew and citrus, and short term crops, viz. tobacco, water melon and maize, are also cultivated to a limited

TABLE 1. PHYSICAL AND CHEMICAL PROPERTIES OF THE COMPOSITE SOIL SAMPLES FROM 0–15CM DEPTH

Soil Series	Clay	Silt	Fine sand	Coarse sand	pH (H_2O 1 : 2.5)	Carbon	Nitrogen	Easily soluble Phosphorus*	Phosphorus**	C.E.C. **** (m.e./100 g)	Exchangeable cations K	Ca	Na	Mg	Al***
	%					%		ppm			(m.e./100 g)				
Baging Series	Nil	1.2	49.8	49.0	5.4	0.51	0.04	7	82	0.90	0.13	0.11	0.07	0.09	0.21
Rompin Series	1.8	8.1	88.8	1.4	5.4	1.20	0.10	17	84	4.60	0.14	1.41	0.11	0.43	0.76
Jambu Series	Nil	1.8	6.7	91.5	5.9	2.68	0.10	11	21	1.84	0.02	0.30	0.07	0.21	0.12

*0.1N HCl + 0.03N NH_4F. **6N HCl Soluble. ***N KCl extract. ****N $CH_3.COONH_4$ buffered at pH 7 extent. However frequent and high rates of fertilizer applications are required to sustain yield. Satisfactory yields of *Stylosanthes guianensis* planted for fodder were reported by VIVIAN (1959). Also it has been suggested that the greatest potential of the 'bris' probably lies in a mixed tree crop/grazing economy (IVES, 1967).

The objective of this study was to determine the nutrient status of the Baging, Rompin and Jambu Series soils for the growth of the pasture legume, *S. guianensis* cv. Schofield.

MATERIALS AND METHODS

Surface soil (0–15 cm) of the Baging and Jambu Series was collected from uncultivated areas in the MARDI Station at Sungai Baging and of the Rompin Series at the 90th mile, Pekan – Endau highway. Physical and chemical properties of the composite samples are given in *Table 1.*

The composite samples from each series were passed through a 1 cm sieve, mixed and air-dried, and placed into 15 cm diameter plastic pots lined with polythene bags. Calcium carbonate was mixed throughout the soil. Both Christmas Island Rock Phosphate (CIRP) and triple- superphosphate (TSP) were stirred into the top 2 cm of the soil. All other nutrients were applied in solution to the soil surface.

S. guianensis cv. Schofield (stylo) was used as the test plant. Pots were sown with seeds inoculated with *Rhizobium* strain CB 756 and thinned to 4 plants per pot after germination. The pots were watered twice daily to 60 percent water holding capacity with deionized water. Plant yield was determined by cutting the plant tops at the soil surface and weighing after drying to constant weight at 70°C in a forced draught dehydrator.

Three experiments were carried out.

a. **Experiment I. :– Fertilizer rate experiment.**

Three levels of P, K, Ca and Mg in 3^4 factorial combination were tested in a completely randomised design in single replication. Soils of the Baging and Jambu Series were used. Basal Cu, Zn, Mn, Co and S were applied. Plant tops were harvested at 128 days from planting.

b. **Experiment II. :– General nutrient experiment.**

The presence or absence of the nutrients Cu, Zn, B, Mn, Co, Mo, and S arranged in a ½ x 2^7 factorial combination was tested in a completely randomized design in single replication. Soils of the Baging, Rompin and Jambu Series were used. Basal P, K, Ca and Mg were applied. Plant tops were harvested at 91 days after planting.

c. **Experiment III. :– Comparison of CIRP and TSP.**

Six rates of P, either as TSP or CIRP. "A" grade dust, were tested in a completely randomized design in three replications. Soils of the Baging, Rompin and Jambu Series were used. Basal K, Ca, Mg, S, Cu, Zn, Mo, B and Co were applied. Two successive harvests, at 91 and 173 days were made for the Baging and Rompin Series and one harvest at 173 days after planting for the Jambu Series.

The P and K levels for these experiments were selected after a preliminary experiment in

TABLE 2. SIGNIFICANT DRY MATTER YIELD RESPONSES (G/POT)
EXPERIMENT 1: GROWTH PERIOD – 128 DAYS

Baging Series				Jambu Series			
	Mean Yield (g/pot)				Mean Yield (g/pot)		
	$Level_1$	$Level_2$	$Level_3$		$Level_1$	$Level_2$	$Level_3$
P***	2.1	6.5	5.3	P***	2.5	5.8	4.9
K**	3.5	6.3	4.0	K**	1.8	5.3	6.1
Ca**	3.1	4.5	5.1	Ca**	2.9	4.9	5.8
				Mg*	3.9	4.0	5.2
LSD	(P = 0.05) – 0.7			LSD	(P = 0.05) – 0.9		
	(P = 0.01) – 1.0				(P = 0.01) – 1.2		

Baging Series			Jambu Series		
PxK**		(g/pot)	PxK**		(g/pot)
P_{NIL}	K_{NIL}	1.8	P_{NIL}	K_{NIL}	1.8
	K_{80}	2.2		K_{80}	2.7
	K_{160}	2.2		K_{160}	2.9
P_{15}	K_{NIL}	4.8	$P_{7.5}$	K_{NIL}	2.2
	K_{80}	9.1		K_{80}	7.0
	K_{160}	5.4		K_{160}	8.1
P_{60}	K_{NIL}	3.8	P_{15}	K_{NIL}	1.2
	K_{80}	7.6		K_{80}	6.2
	K_{160}	4.4		K_{160}	7.3
PxCa*			PxCa*		
P_{NIL}	Ca_{NIL}	2.0	P_{NIL}	Ca_{NIL}	2.2
	Ca_{40}	2.0		Ca_{40}	2.5
	Ca_{80}	2.3		Ca_{80}	2.8
P_{15}	Ca_{NIL}	5.2	$P_{7.5}$	Ca_{NIL}	3.6
	Ca_{40}	6.5		Ca_{40}	5.7
	Ca_{80}	7.6		Ca_{80}	8.0
P_{60}	Ca_{NIL}	3.9	P_{15}	Ca_{NIL}	2.8
	Ca_{40}	5.9		Ca_{40}	5.3
	Ca_{80}	6.0		Ca_{80}	6.6
LSD (PxK, PxCa)		(P = 0.05) – 1.2	LSD (PxK, PxCa)		(P = 0.05) – 1.5
		(P = 0.01) – 1.7			(P = 0.01) – 2.0

*P = 0.05 **P = 0.01

which P toxicity observed at the rate of 25 kg P/ha on the Jambu Series appeared to be alleviated by the application of 100 kg K/ha.

Complete treatment details of the above experiments are given in *Appendix 1*.

Plant chemical analysis was carried out on selected treatments. For Experiment I, N, P, K, Ca and Mg analyses were on those treatments which had received 15 kg P/ha (Baging) and 7.5 kg P/ha (Jambu); for Experiment II, N, S and Cu analyses were made on those treatments

TABLE 3. THE EFFECT OF K, CA AND MG ON DRY MATTER YIELD AND CHEMICAL COMPOSITION OF *S. GUIANENSIS*. EXPERIMENT 1.

Treatments (kg/ha)		Yield (g/pot)	N	P	K	Ca	Mg
					%		
Baging Series							
P_{15}	K_{NIL}	4.8	2.47	0.16	0.31	0.82	0.32
	K_{80}	9.1	1.95	0.09	1.14	0.77	0.39
	K_{160}	5.4	2.35	0.15	2.06	0.72	0.48
P_{15}	Ca_{NIL}	5.2	2.16	0.12	0.96	0.52	0.42
	Ca_{40}	6.5	2.31	0.13	1.11	0.84	0.42
	Ca_{80}	7.6	2.26	0.14	1.19	0.91	0.34
S.E.		0.4	0.24	0.01	0.12	0.30	0.24
Jambu Series							
$P_{7.5}$	K_{NIL}	2.2	2.18	0.34	0.51	1.38	0.72
	K_{80}	7.0	1.84	0.15	1.28	0.75	0.37
	K_{160}	8.1	1.87	0.13	1.74	0.49	0.34
$P_{7.5}$	Ca_{NIL}	3.6	1.81	0.32	1.52	0.61	0.58
	Ca_{40}	5.7	2.01	0.18	1.10	0.98	0.44
	Ca_{80}	8.0	1.99	0.13	0.91	1.03	0.40
$P_{7.5}$	Mg_{NIL}	4.9	1.80	0.17	1.31	0.96	0.37
	Mg_{15}	5.1	2.12	0.24	1.28	0.79	0.47
	Mg_{30}	7.2	1.93	0.19	0.99	0.84	0.59
S.E.		0.5	0.30	0.09	0.21	0.23	0.10

*Baging Series: At 15 kg P/ha and mean of all other treatments.
Jambu Series: At 7.5 kg P/ha and mean of all other treatments.

which had received Zn; for Experiment III, P analyses were made on bulked replicate samples from the combined harvests.

Plant analyses for N and P were determined on an autoanalyser after Kjeldahl digestion; K by flame photometry; Ca, Mg and Cu by atomic absorption spectrometry after ashing and S by direct emission spectrography.

RESULTS

a. Experiment I. Fertilizer rate experiment.

Significant main effects and interactions are summarized in *Table 2.*

There were strong responses to P, K and Ca on both soils (viz. Baging and Jambu Series) but the PxK and PxCa two-way tables show there was little response to any one unless the other was present. On these soils there was response to the highest level of applied Ca and the second level of applied P and K. On the Jambu Series there was a response from the

TABLE 4. EFFECT OF CU, S, B AND MO ON YIELD AND THE N, S AND CU CONCENTRATIONS IN THE TOPS OF *S. GUIANENSIS*.
EXPERIMENT II: GROWTH PERIOD – 92 DAYS

	Treatment Effects				LSD+ (P = 0.05)	Significant Responses
Baging Series:	Cu x S					
	(1)	Cu	S	Cu + S		
Yield (g/pot)	5.5	9.2	6.3	9.2	2.6	Cu***, Cu x Mo x S*
N (%)	2.2	1.7	2.9	2.5	0.5	S**, Cu**
S (%)	0.16	0.10	0.24	0.18	0.02	Cu**, S**, B*
Cu (ppm)	2.0	6.0	1.0	9.0	2.0	Cu***, Cu x S***
Rompin Series:	Cu x S					
	(1)	Cu	S	Cu + S		
Yield (g/pot)	9.5	12.1	14.0	15.3	2.8	Cu***, S***, B x Mo x S*
N (%)	1.8	1.7	2.7	2.4	0.1	S***, Cu**, Cu x S**, Mo x S**
S (%)	0.14	0.11	0.23	0.20	0.02	S***, Cu**
Cu (ppm)	2.0	7.0	3.0	7.5	0.4	Cu***
Jambu Series:	Cu x S x B					
	(1)	Cu	S	Cu + S		
Yield (g/pot) – B	2.1	2.3	2.7	4.7	0.8	Cu***, S***, Cu x S**, B x S**
+ B	1.8	2.5	2.7	6.1		Cu x B*, Cu x B x S*
N (%)	2.1	1.6	2.7	1.9	0.6	Cu**, S**
S (%)	0.14	0.10	0.30	0.22	0.20	S**
Cu (ppm)	1.0	4.0	2.0	9.0	2.5	Cu**, S**, Cu x S***

Values of N, S and Cu concentrations are averaged over '+Zn' treatment.
*P = 0.05 **P = 0.01 ***P = 0.001 +L.S.D. (P = 0.05) values for 2 factor table.

second to the third level of applied Mg. The depressive effects of the high level of P on both soils and K on the Baging Series were most evident during the first few weeks of growth and resulted in the death of some seedlings.

Chemical composition of plant tops from selected treatments are given in *Table 3.*

The increase in yield due to Ca was accompanied by increased N, Ca and K uptake on both soils and P uptake on the Baging Series, though in some instances concentrations of these nutrients were reduced. The main effect of K was in overcoming a deficiency of this nutrient. Potassium increased the uptake but reduced the concentration of Ca. Magnesium increased P uptake on the Jambu Series.

b. Experiment II. General Nutrient Experiment.

The main yield responses were to Cu and S but there were also small responses to B and Mo. The magnitute of these responses and their interactions in terms of dry matter yield and N, S and Cu concentrations are shown in *Table 4.*

Response to Cu and S occured on three soils. Response to S resulted in increased N concentration. Sulphur concentration was increased from 0.10 to the order of 0.20 percent. Likewise the yield response to Cu was accompanied by a large increase in Cu concentration.

Boron increased dry matter yield on the Jambu Series in the presence of Cu and S. Deficiency symptoms were evident on plants in treatments which had received Cu and S. There was a visual response to B in the presence of Cu on the Baging Series but B had no significant effecf on dry matter yield. No visual symptoms or responses were observed on the Rompin Series but there was a small yield increase to a combined B and Mo application in the presence of S. The visual responses and deficiency symptoms only became evident in the last few weeks of the experiment.

The yield response to Mo on the Rompin Series was also accompanied by a small but significant increase in nitrogen concentration in the presence of added B and S. But for the Baging Series, while there was a significant increase in yield to Mo in the presence of Cu and S, Mo addition did not result in an increase in N concentration.

No responses occurred to either Zn or Mn.

c. **Experiment III. Comparison of CIRP and triple-superphosphate.**

The total dry matter yield responses to increasing rates of P applied as either TSP or CIRP and average P concentrations in the tops of *S. guianensis* are shown in *Figure 1*.

Stylo growth was significantly (P=0.01) increased by P applied as either TSP or CIRP. Highest yields were obtained at the rate of 40, 80 and 10 kg P/ha as TSP and at 80, 160 and 40 kg P/ha as CIRP on the Baging, Rompin and Jambu Series, respectively. Higher rates of P as TSP depressed stylo growth on all three soils. This depression was most pronounced on the Jambu Series, particularly during the seedling stage of growth.

The rate of growth on the Jambu Series was much slower than on the other soils. This was particularly noticeable during seedling establishment. Nodulation was poor and confined to the crown area on plants grown on the Jambu Series, whereas the entire root system was nodulated on plants from the moderate P treatments on the other soils.

Phosphorus concentration in the plant tops increased with increasing rates of P applications. The increase was progressive over the full range of treatments. At the lowest P treatment, all plants, irrespective of soil had approximately equal concentration of 0.05 to 0.06 percent P in their tops. At the highest P treatment, stylo fertilized with TSP had concentrations of 0.21, 0.25 and 0.47 percent while stylo fertilized with CIRP had concentrations of 0.09, 0.11 and 0.20 percent on the Baging, Rompin and Jambu Series, respectively.

DISCUSSION

Phosphorus was the most deficient nutrient on all soils tested. Response ranged from 12-fold on the Rompin and Jambu Series and up to 18-fold on the Baging Series. Maximum response to TSP was to 40 and 80 kg P/ha on the Baging and Rompin Series, respectively, but only to 10 kg P/ha on the Jambu Series, whereas with CIRP there was response to the highest level applied on all soils. Yields from CIRP were lower than those from comparative levels of TSP except where high levels of TSP resulted in seedling growth depression. Recoveries of applied P in shoot growth for TSP and CIRP were, respectively, for the Baging Series at 80 kg P/ha, 41 and 12 percent; for the Rompin Series at 80 kg P/ha, 49 and 18 percent; and for the

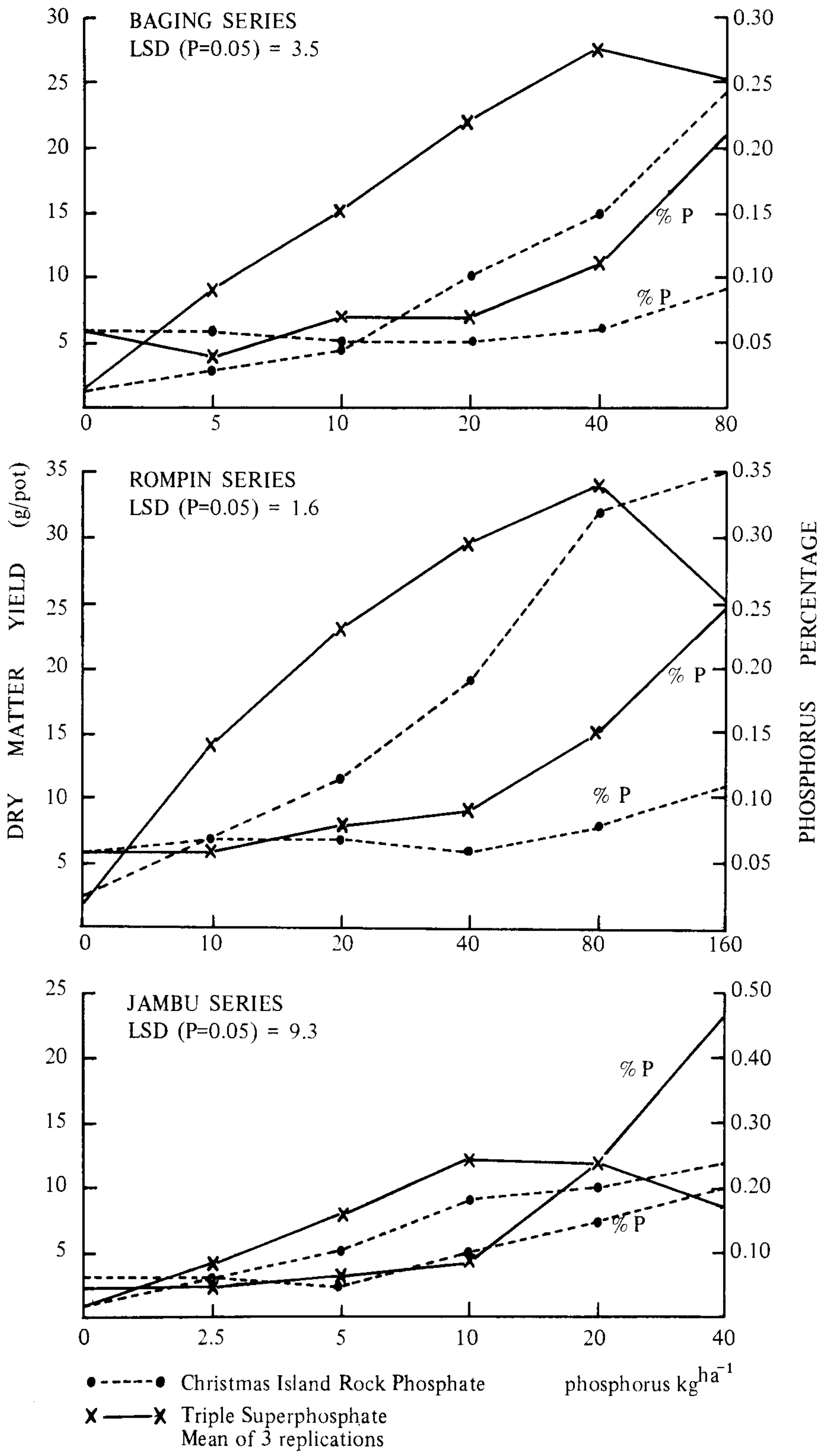

Fig. 1. Mean Dry Matter Yield and Phosphorus concentrations in the Tops of S. guianensis grown on the 'bris' soils. Experiment III; growth period – 173 days.

Jambu Series at 10 kg P/ha, 57 and 41 percent *(Figure 1)*. Though response from CIRP was less than that of TSP, rock phosphate could play an important role in field phosphorus fertilization if leaching losses of soluble phosphate prove to be high. OZANNE *et al.*, (1961) found apparent leaching losses of 17 to 18 percent of applied superphosphate on sandy soils in an area where the rainfall was only 560 mm.

The above levels of 40, 80 and 10 kg P/ha as TSP for the Baging, Rompin and Jambu Series cannot be taken as optimum levels of phosphorus fertilization. Average plant P concentration were 0.11, 0.15 and 0.09 percent P, respectively. These are below the critical value of 0.16 percent P reported by BRUCE (1974). Thus although higher levels of applied P caused toxicity on initial application, P supplementation subsequent to seedling establishment may have been required to maintain an adequate plant P concentration over the 173 days of Experiment III Similarly, P was also likely to have been limiting growth at the conclusion of Experiment I eventhough the intermediate P level gave greater final yields than the higher P level. *Table 3* shows that the plant P concentrations at the higher yielding treatments were below 0.16 percent.

Application of 80 kg K/ha on the Baging and Jambu Series increased plant K concentration to levels above the 'critical' values of 0.6 to 0.8 percent K reported for tropical legumes (ANDREW and ROBINS, 1969). Other pot culture experiments have shown that response to K also occurs on the Rompin Series (THAM and KERRIDGE, unpublished data). The growth depression at the high K level on the Baging Series *(Table 2)* was probably due to salt injury at the seedling stage of growth, but the effects were not evident in plant chemical analysis at harvest. HALL (1971) has reported toxic effects of KCL on the growth of *S. humilis.*

Plant Ca concentrations of 0.52–0.61 percent Ca in the absence of added Ca are low for ***Stylosanthes.*** The usual Ca concentration in *Stylosanthes* species is of the order of 1.2 to 1.6 percent (JONES, 1974). It is likely that response would have been obtained to higher levels of Ca addition as response continued to 80 kg Ca/ha. Nevertheless 80 kg Ca/ha, which is equivalent to an addition of 0.4 me/100 g to the 1800 g soil, represents a considerable increase in the Ca status of the Baging and Jambu Series soils *(Table 1)*. Calcium does not appear to have increased P utilization by stylo in the Jambu Series of Experiment 1 where there was an increase in dry matter yield from 3.6 to 8.0 g/pot without an increase in P uptake *(Table 3)*. Calcium response has not been found on the Rompin Series (THAM and KERRIDGE, unpublished data). This is in accord with the higher Ca level of 1.41 me/100 g of this soil *(Table 1)*.

Plant Cu concentrations of 1–3 ppm were at deficient levels on all soils in the absence of applied Cu but there were no distinct Cu deficiency symptoms as reported by ANDREW and THORNE (1962). Copper alone increased plant Cu concentrations to 4–7 ppm. This was further increased to 7.5–9 ppm when S was applied *(Table 4)*.

Sulphur concentration were below the critical values of 0.14 to 0.17% reported for tropical legumes (ANDREW, 1977). They were maintained above these levels when S was added. Nevertheless, in the presence of added Cu, adequate S may have been limiting N fixation as plant N concentrations were lower in the 'Cu + S' than the 'S' treatment *(Table 4)*.

The B deficiency symptoms observed on the stylo grown on the Jambu and Baging Series developed on the shoot tips. Internodes were shortened and leaves were malformed, thick in texture and dark green in colour.

The lack of response in shoot N to Mo addition on the Baging Series may have been because S was limiting. The Mo response on the Rompin Series was relatively small in both dry matter yield and shoot N.

Plant growth was satisfactory on the Baging and Rompin Series when nutrient deficiencies were corrected but still remained relatively poor on the Jambu Series. The lower total yields may in part be due to exhaustion of an initially adequate P supply. However it was also observed that the initial growth rate was slower on the Jambu Series soils. This may in part be due to the poorer nodulation of stylo plants grown on the Jambu Series. The Jambu Series has a very high coarse sand fraction and much lower total P and exchangeable K than the other soils.

TEITZEL and BRUCE (1973) found major deficiencies to P, Ca, K and Cu and lesser deficiencies to Mo, S, Zn and B on soils derived from beach sands on the wet tropical coast of North Queensland. Phosphorus toxicity occured with superphosphate when the P level was raised from 25 to 50 kg P/ha. It was ameliorated by K, Ca and Zn.

These results show that multiple nutrient deficiencies of P, Ca, K, Cu and possibly S, B and Mo can be expected for legume growth on the 'bris' soils. They also illustrate that little response can be expected to any one nutrient without the correction of other nutrient deficiencies. However, because of the coarse texture and lack of an active organic fraction, toxicities can be readily induced by high rates of fertilizer applications. On the other hand a major problem in the field will be to provide a continuous supply of nutrients under the leaching regime expected from the intense rainfall of the area. Again, because of proximity to the sea, S deficiency may not be as pronounced in the field as it was in these pot culture experiments. Thus further work is required to examine the slow rate of growth experienced on the Jambu Series and to confirm nutrient deficiencies in the field. Further work to determine a suitable field fertilizer strategy is also imperative.

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SUMMARY

Pot experiments were undertaken to assess the nutrient status of the Baging, Rompin and Jambu Series soils of the 'bris' complex of Peninsular Malaysia. The legume *Stylosanthes guianensis* cv. Schofield was used as test plant.

Major responses occured to P, K, S and Cu on the three soils, to Ca on the Baging and Jambu Series, and to B on the Jambu Series. Lesser responses occurred to B and Mo on the Baging and Rompin Series. There was a small but significant response to magnesium and boron on the Jambu Series. Responses to P and K were changed to toxicity by heavy applications.

The Rompin Series had a higher fertility status than the Baging and Jambu Series. Growth on the Jambu Series remained relatively poor even after application of deficient nutrients.

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APPENDIX I. FORMS OF COMPOUND AND RATE OF NUTRIENT APPLICATION (KG ELEMENT/HA)

Nutrient	Chemical Used	Experiment I		Experiment II			Experiment III		
		Baging Series	Jambu Series	Baging Series	Rompin Series	Jambu Series	Baging Series	Rompin Series	Jambu Series
Cu	$CuCl_2.2H_2O$	*2.98	-do-	0, 2.98	-do-	-do-	*2.98	-do-	-do-
Zn	$ZnCl_2$	*3.84	-do-	0, 3.84	-do-	-do-	*3.84	-do-	-do-
B	$Na_2B_4O_7.10H_2O$	0.2	-do-	0, 0.04	-do-	-do-	*0.04	-do-	-do-
Mn	$MnCl_2.4H_2O$	–	–	0, 0.69	-do-	-do-	–	–	–
Co	$CoCl_2.6H_2O$	*0.12	-do-	0, 0.06	-do-	-do-	*0.06	-do-	-do-
Mo	$NH_4Mo_7O_{24}.4H_2O$	*0.04	-do-	0, 0.04	-do-	-do-	*0.04	-do-	-do-
S	Na_2SO_4	*15	-do-	0, 15	-do-	-do-	–	–	–
Mg + S	$MgSO_4$	–	–	–	–	–	*10 + 13	-do-	-do-
P	$Ca(H_2PO_4)_2$	–	–	*30	*80	*10	–	–	–
P	$NaH_2PO_4.2H_2O$	0, 15, 60	0, 7.5, 15	–	–	–	–	–	–
P	CIRP 'A dust'/TSP	–	–	–	–	–	0, 5, 10, 20, 40, 80	0, 10, 20, 40, 80, 160	0, 2.5, 5, 10, 20, 40
K	$KHCO_3$	0, 80, 160	-do-	*80	-do-	-do-	*80	-do-	-do-
Ca	$CaCO_3$	0, 40, 80	-do-	*80	-do-	-do-	*80	-do-	-do-
Mg	$MgCl_2$	–	–	*12	*22	*20	–	–	–
Mg	$MgCO_3$	0, 15, 30	-do-	–	–	–	–	–	–

*Basal Application. Conversion Factor: 1 kg/ha = 1.82 mg/pot.