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Effect of Potassium and Legumes on the Establishment and Growth of Pasture Mixtures in the Mid-Country of Sri Lanka

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ABSTRACT. Experiments were conducted at Meewathura and Dodangolla where Guinea 'A' (Panicum maximum, Jacq.) was grown in mono culture and with three legumes, Stylosanthes (Stylosanthes hamata), Centrocema (Centrocema pubescence) and Siratro (Macroptilium atropurpureum) at four levels of potassium (0, 30, 60 and 90 kg K_2O/ha/yr). Leaves/plant and height of grass were recorded weekly for five weeks after planting, while the drymatter yield, total nitrogen (N) and minerals were measured monthly for grass and legumes separately. Application of K did not have any significant effect ($P < 0.05$) on the height, leaves/plant, drymatter yield, N and mineral content of forages. However, application of K increased ($P < 0.05$) the K content of the grass and legumes at Meewathura. Inclusion of legumes increased ($P < 0.05$) the total drymatter yield and K content of the associated grass. Height and leaves/plant of the grass was lowest with Stylosanthes, indicating a competitive effect by this legume. However, legumes did not have any significant effect on the mineral content of the associated grass.

INTRODUCTION

Potassium is an essential element for all plants and is one of the three plant nutrients most likely to limit crop yields. According to literature, high yielding grasses like Guinea 'A' remove about 440 kg/ha/yr of K under zero grazing systems whereas, pasture legumes remove approximately 200 kg/ha/yr of K (Chandler, 1974). It has been shown that the drymatter yield of high yielding grasses such as Elephant, Guinea and Pangola could be increased with K rates up to 300-400

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kg/ha (Chandler, 1974). Several species of legumes, such as Desmodium and Stylosanthes grown in pots also increased their yield up to and equivalent of 220 kg/ha of applied K and, the optimum treatment for most pasture legume species appeared to be about 110 kg/ha/yr (Andrew and Robins, 1969).

Grass legume mixtures have been more effective than grasses as monoculture for forage production, due to its nitrogen fixation ability and high quality of legumes. Use of legumes also results in substantial savings on nitrogen fertilizer cost. Potassium deficiency was most easily noticed in mixed cultures than in monoculture grass, where grass roots were more efficient than legume roots in extracting K from soil (Blaser and Kimbrough, 1968). Therefore, if no K is added, legume yield may be sharply reduced due to dominance by grass in many pasture mixtures. When no K was added in a mixed culture of Desmodium and Setaria, Desmodium yield was sharply reduced in tropical soils (Hall, 1971). In addition, K application stimulated the drymatter yield of both grass and legumes in a mixture of Alfalfa and Orchard grass sward in Japan (Ohara and Yoshida, 1981).

Published information on the establishment and growth of legume pasture mixtures in Sri Lanka is meagre. Therefore, the objective of this study was to investigate the effect of "K" on establishment and growth of legume pasture mixtures in the Mid-Country of Sri Lanka.

MATERIALS AND METHODS

The experiment was carried out in two locations; Meewathura, Peradeniya (Mid-Country wet zone; elevation - 476 m; soil type - Alluvial) and Dodangolla, Kundasale (Mid-Country intermediate zone; elevation - 432 m; soil type - Reddish Brown Latazolic). Guinea 'A' was established as a pure stand and mixed with three legumes, Stylosanthes, Centrocema and Siratro. Inoculated legume seeds and fresh grass cuttings were used as planting material. Muriate of potash (50% K_2O) was applied as a K source at four levels (0, 30, 60 and 90 kg/ha/yr) as a basal dressing. At the establishment of the crop, 50 kg of Triple Super Phosphate was also applied. The pH of the soil was 4.9 and 5.7 in Meewathura and Dodangolla respectively and, to neutralize the soil acidity 4000 and 3000 kg/ha of dolomite was applied in powdered form. No other nutrients were added. Grass and legumes were planted in 1.5 m x 4 m plots of a spacing of 60 cm x 60 cm and 30 cm x 30 cm for grass and legumes respectively. The experiment was in a randomized complete block design with four replicates.

Leaves/plant and height of grass were recorded weekly for five weeks after planting at Meewathura. Three months after establishment of the crop, plots were harvested monthly. Drymatter yield, potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P) and total nitrogen (N) were also recorded for grasses and legumes separately at two locations.

RESULTS AND DISCUSSION

Effect of potassium

Results showed that K had no significant effect on leaves/plant and height of grass during establishment at Meewathura. Thomas (1968) reported that if a soil had a high CEC, the exchangeable K was also at a high level. As CEC was 15.14 me/100 g and initial exchangeable K was 0.16 me/100 g in Meewathura soil, the young plants may have extracted sufficient K during establishment and the response for applied K may not have been significant under field conditions. It has also been shown that the demand for K by young plants is very small, and deficiency symptoms can be observed in some pastures during growth only in K low soils (Markus and Rattle, 1965).

Results also showed that K had no significant effect on total drymatter yield, total N, Ca, Mg and P content of grass and legumes at both locations. According to literature, (Welch and Scott, 1961) freshly applied K could be fixed and released slowly by soils, therefore no response was shown in Guinea grass to applied K during the first year of growth. Bolton and Dirks (1979) showed that the application of lime to increase the soil pH was usually associated with a decrease in exchangeable and water soluble K level in soils and thereby, a reduced K uptake by plants. Further more, addition of dolomite to the soil resulted in an increase in Ca and Mg contents of the soil and thereby a reduction in K uptake by plants (Mengel, 1971). Since the present experimental sites were limed by adding dolomite, the uptake of K by grass and legumes may have been reduced. These would have been causes for the non significant response to applied K in this study.

However, application of K had increased (P < 0.05) the K content of grass and legumes compared to the control at Meewathura (Table 1).

Effect of legume

Legumes decreased the growth of the associated grass (Table 2). Although this did not sharply affect the leaves/plant of the grass, the legumes decreased the height of grass and this was prominent with Stylosanthes (Table 2). Although the seed germination of Stylosanthes was irregular, early growth was faster during establishment. Stylosanthes can adapt to any soil condition after germination and could give successful establishment (Date and Norris, 1979). Centrocema and Siratro had no significant effect on leaves/plant and height of the grass (Table 2). Although these legumes had successful seed germination they showed poor initial establishment.

According to the results, inclusion of legumes increased (P < 0.05) the total drymatter yield and N content of the associated grass, and highest N value was observed with Stylosanthes (Table 3). This increase in total drymatter yield and N may have been due to the N fixation of the legume and thereby an increase in soil N for the associated grass. Velasqvez and Bryan (1975) also reported similar results for a pure stand of *Digitaria decumbence* and a mixture with Siratro. However, total drymatter yield of grass and Stylosanthes mixture recorded the lowest value when compared to other two legumes (Table 3). Stylosanthes species could adapt to grazing or cutting either by having a prostrate habit or woody stem (Date and Norris, 1979). Also Stylosanthes could adapt to both acid and alkaline and infertile soils (Date and Norris, 1979). Therefore, Stylosanthes may have competed well with fast growing Guinea 'A' grass and increased the N content of the associated grass compared to other two legumes.

CONCLUSION

Application of K did not have any significant effect on the leaves/plant and height of the grass during establishment. Furthermore, application of K did not have any significant effect on total drymatter yield, N and mineral content of the grass and legumes however, it increased (P < 0.05) the K content of associated grass and legume

Table 1. Effect of Potassium on the Mineral Content (%) of the Grass and Legumes at Meewathura.

K levels	Grass					Legumes				
kg K_2O/ha/yr	N	K	Ca	Mg	P	N	K	Ca	Mg	P
0	1.54	0.90[b]	0.09	0.26	0.59	2.47	0.54[b]	0.75	0.46	0.66
30	1.55	1.51[a]	0.09	0.30	0.59	2.55	0.92[a]	1.04	0.58	0.68
60	1.52	1.29[a]	0.08	0.25	0.57	2.40	0.72[b]	0.84	0.54	0.68
90	1.52	1.31[a]	0.08	0.24	0.58	2.39	0.84[a]	1.06	0.58	0.74

Values followed by same letters in a column are not significantly different at $P < 0.05$

Table 2. Effect of legumes on leaves/plant and height of grass during establishment.

Treatment	Leaves/plant and Height Grass	Weeks after establishment				
		1	2	3	4	5
Grass in Monoculture	Leaves/plant	2.0[ab]	4.6[b]	5.7[a]	6.7[a]	8.5[b]
	Height (cm)	22.7[a]	32.1[a]	54.7[a]	82.3[a]	102.7[a]
Grass with Stylosanthes	Leaves/plant	1.7[b]	4.3[bc]	4.9[b]	5.6[c]	8.9[ab]
	Height (cm)	22.4[a]	29.7[b]	40.7[c]	53.8[c]	71.7[c]
Grass with Siratro	Leaves/plant	2.1[a]	4.9[a]	4.8[b]	6.0[b]	9.1[a]
	Height (cm)	23.2[a]	32.3[a]	44.9[b]	64.6[b]	84.2[b]
Grass with Centrocema	Leaves/plant	2.1[a]	4.1[c]	4.7[b]	6.1[b]	9.1[a]
	Height (cm)	22.5[a]	31.8[a]	44.9[b]	64.2[b]	83.4[b]

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

Table 3. **Effect of legume on the total drymatter yield (kg/ha/yr) and N content (%) of grass at Meewathura and Dodangolla.**

Treatment	Meewathura		Dodangolla	
	DM Yield	N%	DM Yield	N%
Grass in Monoculture	19950^{c}	1.42	13450^{c}	2.12^{c}
Grass with Stylosanthes	21350^{b}	1.70^{a}	13950^{b}	2.26^{a}
Grass with Siratro	23100^{a}	1.53^{b}	15650^{ab}	2.19^{a}
Grass with Centrocema	23800^{a}	1.59^{b}	16200^{a}	2.20^{b}

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

during growth. This non significant response to applied K may have been due to high initial exchangeable K in the soil, limited uptake of K by plants due to K fixation, and high level of Ca and Mg content in the soil due to liming.

Legumes decreased the leaves/plant and height of the grass during establishment. This response was very much higher for Stylosanthes compared to other two legumes. Being a small shrub, Stylosanthes competed very well with the aggressive Guinea 'A' under the studied soil conditions. Legumes also increased the total drymatter yield and N content of the associated grass.

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