EFFECT OF WOODY AND HERBACEOUS LEGUMES ON THE GROWTH AND NUTRIENT CONTENT OF TWO TROPICAL GRASS SPECIES

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Resumen
Se realizó un experimento factorial (2 X 2 X 5) con dos especies de gramineas, *Panicum maximum* Jacq. (Var. CIAT 16061) y *Brachiaria humidicola* Rendle (Var. CIAT 679) en monocultivo o en asocio con *Centrosema macrocarpum* (Benth). Había cinco niveles de adición de mantillo: ninguno; *Erythrina poeppigiana* (Walp.) O.F. Cook (138 g maceta^{-1}) para dar 150 kg N ha^{-1}; *E. poeppigiana* (276 g maceta^{-1}) para dar 300 kg N ha^{-1}; *Acacia mangium* Will. (86 g maceta^{-1}) para dar 150 kg N ha^{-1} y *A. mangium* (173 g maceta^{-1}) para dar 300 kg N ha^{-1}. El mejor crecimiento de gramíneas con mayor contenido de nutrientes se obtuvo con el nivel más alto de *E. poeppigiana* y asocio con *C. macrocarpum.* Sin embargo, el mantillo de *A. mangium* también tenía efecto significativo sobre el control. El efecto de *C. macrocarpum* fue siempre positivo.

Palabras claves: *Acacia mangium, Brachiaria humidicola, Centrosema macrocarpum Erythrina poeppigiana,* N supply, nutrient cycling, nutrient use efficiency, *Panicum maximum*, tropical pastures

Introduction

It should be possible to increase both the growth, N content and nutritional value of tropical pastures by associating them with either herbaceous legumes or N-fixing-trees. A range of different strategies are possible, utilizing either herbaceous or arboreal legumes in association with different grass species. The present research was carried out to see to what extent growth and nutrient content of two grass species, widely used in the humid tropics, could be improved by the addition of prunings of N fixing trees and/or by association with herbaceous legumes. Efficiency of nutrient absorption has been used to estimate how much of a nutrient applied in different forms is utilized by the crop to which it is applied and how much is taken up by other sinks within and outside of the system (Novoa and Loomis, 1981, Moll et al., 1982)

Methodology

A completely randomized experiment was set up in a greenhouse in Turrialba, Costa Rica (9°53' N, 83°38' W, altitude of 603 m). Temperatures in the greenhouse varied between 20.3 and 32 °C during the experiment. The design was a 2 X 2 X 5 factorial with two grass species, *Panicum maximum* Jacq. (Var. CIAT 16061) and *Brachiaria humidicola* Rendle (Var. CIAT 679), grown alone or in association with *Centrosema macrocarpum* Benth. There were five levels of mulch addition: none; *Erythrina poeppigiana* (Walp.) O.F. Cook (138 g pot^{-1}) to give 150 kg N ha^{-1}; *E. poeppigiana* (276 g pot^{-1}) to give 300 kg N ha^{-1}; *Acacia mangium* Will. (86 g pot $^{-1}$) to give 150 kg N ha^{-1}, and *A. mangium* (173 g pot^{-1}) to give 300 kg N ha^{-1}. The *E. poeppigiana* contained 260 mg g^{-1} dry matter with an N content

of 42.1 mg g^{-1} The *A. mangium* contained 449 mg g^{-1} DM with an N content of 21.0 mg g^{-1}. The trial was carried out in pots with an upper diameter of 26 cm and a height of 21.2 cm, giving a volume of 0.0098 m^3, which were filled with soil taken from the experimental farm of CIAT in San Isidro del General, Costa Rica, which is classificed as an Ultisol with pH 5.2 and 55% Al saturation. Seeding rates were 4.5 kg $ha^{-1}$for *P. maximum*, 3.5 kg ha^{-1} for *B. humidicola* and 2 kg $ha^{-1}$for *C. macrocarpum*.

Plant height of the grasses was measured weekly. Biomass production was evaluated 10 and 15 weeks after planting by cutting the grass at 10 cm from the soil surface and drying the contents at 60 °C for 24 hours. Grasses were separated from legumes manually. N content was determined by the Kjeldahl method; Ca, Mg, K and P were determined by perchloric acid digestion followed by atomic absorption for Ca, Mg and K and ammonium molibdate colorimetry for P. Efficiency of nutrient absorption was calculated as: {(g nutrient in harvested plant in treatment)-(g nutrients in control)}/ (g nutrient applied) (Van Sanford and McKown, 1986; Bertsch, 1995).

Results and discussion

The analysis of variance indicated significant differences and interactions among all factors. In all cases *B. humidicola* showed greater plant height and biomass production than *P. maximum*. Highest values for plant height and biomass for both grass species were obtained with the higher level of *E. poeppigiana* mulch, which corresponded to 300 kg N ha^{-1}. Application of *A. mangium* mulch, although producing lower values of plant height and biomass than *E. poeppigiana*, still produced significantly higher values than the control pots without mulch application. Efficiency of nutrient absorption for N, Ca, Mg and K showed significant effects for mulch and for the interactions grass species X associated legume, grass species X mulch. Nutrient concentration in the grasses increased when mulch application was increased and were higher in *P. maximum.* (Table 1). Statistically significant differences in the nutrient concentration in the roots when associated with *C. macrocarpum* was observed for N, Ca, Mg, P and Mn. Higher N concentrations were found in both grass species when associated with this legume. In all associated treatments, highest nutrient concentrations were found with *B. humidicola*. Levels of Ca, K, P, Zn and N were significantly affected by the mulch X association interaction. Concentrations of Ca and P were greater in the associated treatments. N levels were also higher with mulch application but were not proportional to the amount of mulch applied. Only K concentrations showed a significant effect for the grass X mulch interaction, being greater with *B. humidicola* than with *P. maximum* but the control had a lower K concentration than either mulch at either level.

Conclusions

It was concluded that both plant height and biomass production were affected by mulch application although the degree of the effect depended on the quantity and type of mulch applied. Nutrient concentration and efficiency of nutrient absorption depended on mulch species, mulch application rates, legume association, as well as genetic differences in the capacity of grass species to absorb nutrients from soils.

Literature Cited

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Table 1. Mean concentrations (%) of nutrients in foliage as determined by grass species, mulch addition and presence of *Centrosema macrocarpum* (simple effects).

Factor	Grass species		Mulch addition				Presence of *C. macrocarpum*	
Nutrient	*P. maximum*	*B. humidicola*	*E. poeppigiana* (276 g pot^{-1})	*E. poeppigiana* (138 g pot^{-1})	*A. mangium* (173 g pot^{-1})	*A. mangium* (86 g pot^{-1})	With	Without
Ca	0.054 a	0.020 b	0.053 a	0.039 b	0.034 bc	0.031 bc	0.047 a	0.027 b
Mg	0.020 a	0.015 b	0.025 a	0.018 b	0.016 bc	0.015 cd	0.021 a	0.013b
K	0.246 a	0.188 b	0.32 a	0.21 bc	0.24 bc	0.195 c	0.258 a	0.177 b
P	0.006 b	0.008 a	0.010 a	0.007 b	0.007 b	0.006 c	0.009 a	0.005 b
N	0.024 a	0.018 b	0.285 a	0.21 b	0.204 bc	0.180 cd	0.246 a	0.171 b
Cu	0.009 a	0.007 b	0.011 a	0.008 b	0.008 b	0.007 bc	0.010 a	0.006 b
Zn	0.017 b	0.027 a	0.042 a	0.018 b	0.015 b	0.021 b	0.028 a	0.016 b
Mn	0.104 a	0.83 b	0.126 a	0.095 b	0.093 b	0.081 bc	0.114 a	0.073 b

Values followed by same letter in same row for each factor (grass species; mulch addition; presence of *C. macrocarpum*) do not differ significantly by Tukey test at $p < 0.05$