Phosphorus requirement of pasture species and the influence on botanical composition.

J. Hill[1,2], R.J. Simpson[1], A.D. Moore[1] and D. Chapman[2]

[1] CSIRO Plant Industry, PO Box 1600, Canberra, ACT, 2601
[2] Department of Animal Production, Institute of Land and Food Resources, University of Melbourne, Victoria, 3010

Abstract

This study examines the changes in botanical composition of pastures that occur as a consequence of increased fertilizer use. The critical nitrogen (N) and phosphorus (P) requirements (amount of nutrient applied to produce 90% of maximum shoot dry weight) of coexisting plant species were determined. Knowledge of the responses to N and P by the species helped to explain some of the botanical changes that were measured in a fertilized grazing system.

Key Words

nutrient requirement, superphosphate

Introduction

Adequate soil fertility is essential if high stocking rates are to be achieved in subterranean clover-based pasture. Current financial pressures are promoting increased use of P-fertilizers on NSW Tableland pastures and this may lead to changes in botanical composition. Such changes can be beneficial: eg. *Vulpia* spp. replaced by *Bromus* spp. (1), or increased phalaris content of pastures (2). In other instances, the change may not be as desirable: eg. loss of perennial native grasses (*Themeda* spp., *Poa* spp.) with replacement by annuals (*Vulpia* spp., *Hordeum* spp.) (3). In this study, a glasshouse experiment was used to measure the responses of key species from NSW Tableland grassland systems to N and P applications. The results were used to explain the effect of P fertiliser application on the botanical composition of a pasture at Hall, ACT.

Methods

Glasshouse Experiment

A number of pasture species found at a site near Hall and in other NSW Tableland pastures (see Figure 2 legend) were grown in a glasshouse in steam sterilized topsoil (pH($CaCl_2$) 4.8; Colwell extractable P 10 mg/kg) from the field site. Pots contained 1.5kg of soil and were supplied a basal dressing of all nutrients except either P (supplied as KH_2PO_4; 0-84 mg P pot^{-1}) or N (supplied as KNO_3; 0-175 mg N pot^{-1}) and were arranged in a completely randomised design. Each plant species was harvested when the shoots of its highest P or N treatment reached approximately 6g dry weight.

Field Experiment

Changes in botanical composition (basal cover) of fertilized and unfertilized pastures were determined by the point quadrat method (4) in September 1999, 2000 and 2001. An old, degraded phalaris-subterranean clover pasture growing on a yellow chromosol soil was dressed with Ca, S, K, Mo, B and Zn and was otherwise left unfertilized (typical Colwell extractable P (0-10 cm): 8-12 mg P/kg soil), or was fertilized annually with various amounts of triple superphosphate from 1994 with the intent of achieving a target Colwell extractable P of 20-25 mg P/kg during each winter. The unfertilized and fertilized pastures were grazed continuously by 9 and 18 yearling Merino wethers/ha, respectively. Each pasture system was replicated three times as part of a larger experiment. Although the stocking rates were very different, animal production per head was similar, particularly in the years leading up to the 1999-2001 period when botanical composition was measured (data not shown).

Results

Glasshouse Experiment

Critical P requirements of key species (P applied to produce 90% maximum shoot dry weight) were determined from the glasshouse experiment and covered nearly a three-fold range from the lowest species (*H. lanatus*) to the highest (*T. subterraneum*) with many species falling into two significantly different groups (Figure 1; ringed groups) on the basis of their P requirements ($P < 0.05$). The P requirement of *T.*

subterraneum was not different from that of the higher group but, being a legume, it differs in having very low reliance on soil N. The critical N requirements of the species covered a two-fold range. Some species had high requirements (eg. *H. leporinum*), and others low requirements (eg. *H. lanatus*) for both N and P.

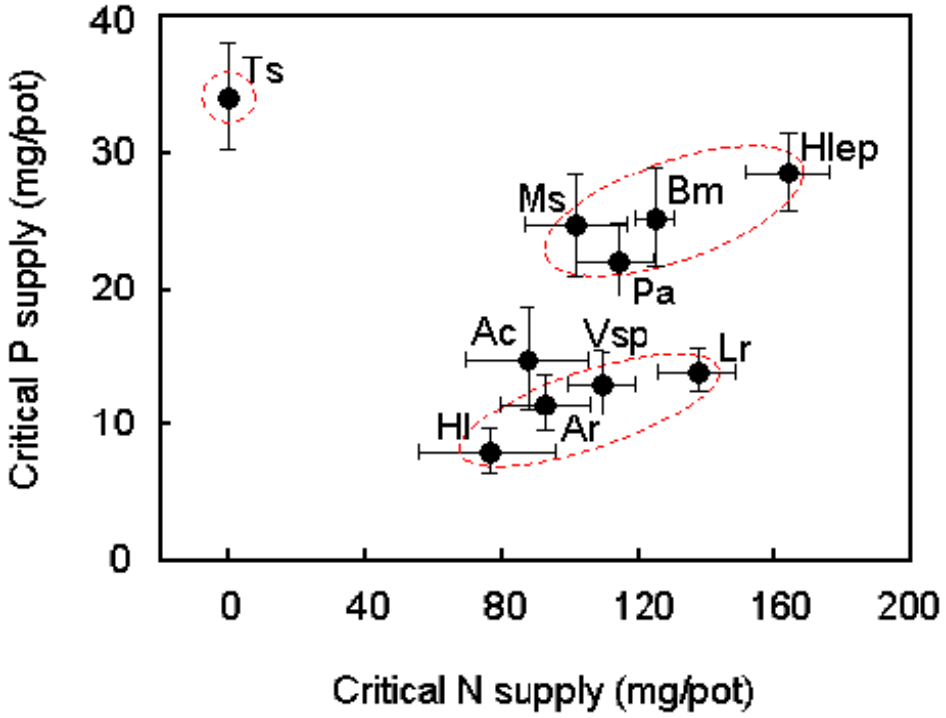

Figure 1. Critical N and P requirements of ten key pasture species: Microlaena stipoides (Ms), Austrodanthonia richardsonii (Ar); Holcus lanatus (Hl), Vulpia bromoides-V. myuros (equal mixture, Vsp)., Hordeum Leporinum (Hlep), Arctotheca calendula (Ac), Phalaris aquatica (Pa), Bromus molliformis (Bm), Lolium rigidum (Lr), and Trifolium subterraneum (Ts). Bars show 2x se.

Field Experiment

Over the 3 years of the experiment the cover of *Vulpia* spp. and *Bromus* spp. decreased whilst the cover of *H. lanatus* and *P. aquatica* increased ($P < 0.05$), irrespective of soil fertility (Figure 2). *T. subterraneum* did not vary significantly over the period. The cover of *Vulpia* spp. and *H. lanatus* was lower in the fertilized pasture system, and that of *Bromus* spp. and *T. subterraneum* (in the first two years) was higher ($P < 0.05$). *P. aquatica* was not significantly different in the two pasture systems.

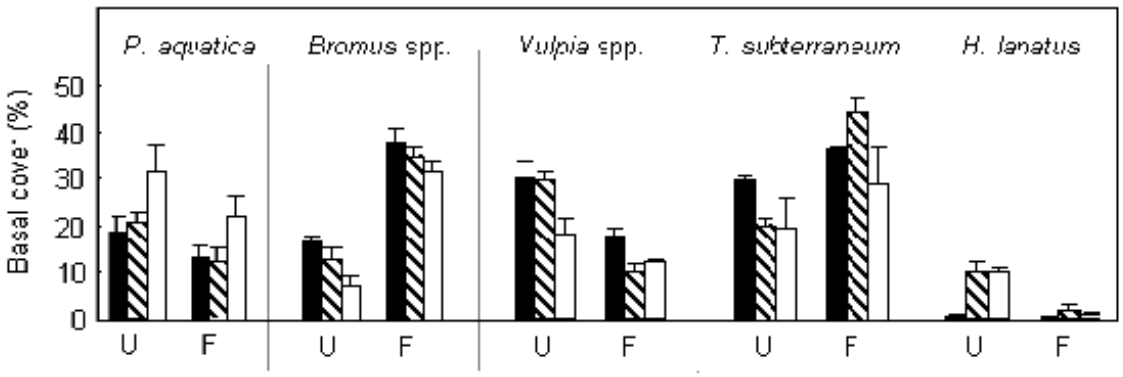

Figure 2. Percentage basal cover of five major species from unfertilized (U) or fertilized (F) pasture in 1999 (■), 2000 (▨) and 2001 (□). Bars show 1x se.

Discussion and conclusion

The critical nutrient requirements of many species helped to explain the botanical changes observed when P was applied to a pasture, and were consistent with reports of species occurrence in NSW Tableland pasture systems. For example, species such as *H. leporinum*, *P. aquatica* and *B. molliformis* are regarded as plants of fertile habitats (5) and had high critical N and P requirements. Species characteristic of infertile habitats: eg. *A. richardsonii* and *H. lanatus* (5) had low critical external N and P requirements, or in the case of *Vulpia* spp. had a low critical P requirement. *Vulpia* spp. and *H. lanatus* were more abundant in the unfertilized pasture system in this study and were replaced mainly by *Bromus* spp in the P fertilized pasture system. At other NSW Tablelands sites there is some concern that increased fertilizer use may result in displacement of native perennial grasses. The critical P requirements of these species suggest that *Austrodanthonia* species may be disadvantaged as more P fertiliser is applied, but that *Microlaena stipoides* may be favoured.

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