THE INTERACTION OF NITROGEN AND PHOSPHORUS ON THE GROWTH, NUTRIENT STATUS AND NODULATION OF *STYLOSANthes HUMILIS* H.B.K. (TOWNSVILLE STYLO)

by C. T. GATES and J. R. WILSON

C.S.I.R.O. Division of Tropical Agronomy, St. Lucia, Brisbane, Australia

SUMMARY

The growth response of *S. humilis* to six levels of phosphorus × five levels of nitrogen × three levels of potassium in association with *Rhizobium* CB103 is described for plants growing in a nitrogen deficient, light textured, solodic soil.

Phosphorus greatly stimulated growth and nodulation at all levels of nitrogen addition. The effect of nitrogen interacted strongly with level of phosphorus application, with response in yield of tops to nitrogen increasing with phosphorus level up to P₀₀ (kg superphosphate/ha). The addition of nitrogen depressed nodulation at P₀ - P₁₂₅ but was beneficial at P₂₅₀ - P₁₀₀₀. Visual observations suggested that high nitrogen checked growth initially but despite this the high nitrogen–high phosphorus combination produced the largest and best nodulated plants.

There were only minor responses to potassium in this trial.

Particular balanced combinations of nitrogen and phosphorus stimulated successful nodulation of *S. humilis*, enabling it to achieve higher yield and nitrogen content than from symbiotic nitrogen alone.

INTRODUCTION

*Stylosanthes humilis* is a legume which has shown a remarkable capacity to adapt to infertile soils and also an ability to respond well to an improved nutrient situation, in particular from application of phosphorus. These characteristics have been major factors contributing to its agrostological usefulness. Further study of nutrient response in this species is warranted, with the ultimate aim of determining the physiological attributes which make this adaptive capacity possible. It is also important to assess whether plants can...
develop an effective symbiosis as well as achieve maximum growth when all nutrients are supplied at high levels.

The present paper describes an experiment in which a wide range of mineral nitrogen and phosphorus treatments were applied to *S. humilis* plants nodulated with the commercial strain of rhizobium. It is deduced that mineral nitrogen is not necessarily detrimental to nodulation and that, when in balance with favourable levels of phosphorus, it may have a beneficial effect not only on plant growth but also on nodulation.

**MATERIALS AND METHODS**

Pots containing 2840 g of oven-dry, infertile solodic soil were surfaced-sown with seed of *S. humilis* inoculated with rhizobium strain CB103. The seed was covered with a quartz-gravel mulch. The soil was maintained at pF 2 by frequent watering to weight with de-ionised water.

Nutrients were pipetted onto the soil at sowing and treatments comprised a factorial combination of 6 phosphorus × 5 nitrogen × 3 potassium levels, replicated twice. Phosphorus was applied as NaH$_2$PO$_4$.2H$_2$O equivalent to 0, 62.5, 125, 250, 500 and 1000 kg superphosphate/ha (P$_0$–P$_{1000}$; 0.0756 g NaH$_2$PO$_4$.2H$_2$O/pot = 125 kg superphosphate/ha). Nitrogen was applied as NH$_4$NO$_3$ to give 0, 7.5, 15, 30 and 60 ppm N on an oven-dry soil basis (N$_0$–N$_{60}$; 0.486 g NH$_4$NO$_3$/pot = 60 ppm N). Potassium was applied as KHCO$_3$ equivalent to 0, 187.5 and 375 kg KCl/ha (K$_0$–K$_{375}$; 0.314 g KHCO$_3$/pot = 187.5 kg KCl/ha). KHCO$_3$ was used because *S. humilis* is adversely affected by KCl in pot culture and bicarbonate has been found to be a satisfactory source of potassium for *Stylosanthes* (Gates and Wilson, unpublished data). Sulphur and molybdenum were applied as a basal dressing, sulphur as Na$_2$SO$_4$.10H$_2$O at 1.48 g/pot (= 125 kg superphosphate/ha) and molybdenum as Na$_2$MoO$_4$.2H$_2$O at 0.9 mg/pot (= 0.5 kg/ha).

The plants were grown in mid-summer in a glasshouse for 49 days after sowing. The natural daylength (mean 12.2 h) was extended with low intensity light to 13.9 h/day. Plants were thinned to four per pot. Pots were randomized within blocks every third day.

At harvest, plant tops were cut at soil level and dried at 80°C in a forced-draught oven. The roots from one replicate (90 pots) were washed free of soil, placed in dishes of de-ionized water and ranked on the basis of amount and vigour of nodulation per unit of root tissue. The roots were then dried as for tops.

Nitrogen and phosphorus were analysed by the method of Williams and Twine. Analyses of variance followed standard procedures, except that rankit transforms were used for the nodulation data. Trends for nitrogen response were assessed on a quasilogarithmic scale on the X-axis, which allotted equal intervals to the nitrogen additions.