CONSTRAINTS TO PRODUCTION OF ANNUAL MEDIC (MEDICAGO SPP.) PASTURES IN SOUTHERN AUSTRALIA

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ABSTRACT

A field experiment was used to determine the effects of the root lesion nematode (Pratylenchus neglectus) and phospate and zinc nutrition on the production of annual medic pastures. Elimination of nematodes (nematicide increased shoot and seed production significantly and zinc and nematicide in combination significantly reduced numbers of nematodes present in roots.

KEYWORDS

Annual medics, nematodes, *Pratylenchus*, phosphorus, zinc

INTRODUCTION

Annual medics (*Medicago* spp.) are an important resource for low rainfall (<400 mm) wheatbelt pastures of southern Australian farming systems. Medics are adapted to alkaline soils and have an ability to persist through 1 or 2 year cropping phases due to hard-seededness and have allowed the extension of legume based pastures into semi-arid regions.

Over recent years concerns have been raised in the rural sector with regard to the successfulness of using annual medics in rotations for southern Australian farming systems (Reeves and Ewing 1993; Wilson and Simpson 1993). Medic-based pastures have experienced widespread problems as indicated by farmer concerns (Crosby 1993). The reasons for medic pasture “decline” are many and complex (see Wilson and Simpson 1993; Reeves and Ewing 1993) and a wide number of environmental and management factors have contributed to their decline. Of particular interest to this study were inadequate soil phosphate and zinc nutrition and the effects of root lesion nematodes,

Phosphorus is commonly deficient in South Australian soils and additions are essential to maintain fertility status and productivity of agricultural land (Wilhem *et al*. 1996). Medics have a particularly high requirement for phosphorus and deficiencies significantly reduce nitrogen fixation (Dahmane and Graham 1981).

Zinc deficiencies are common in the sandy mallee soils of South Australia and applications of zinc significantly increase medic pasture production (Hannam *et al*. 1994). Trace elements can reduce invasion or incidence of damage by pathogens (Graham, 1983).

Root lesion nematodes *Pratylenchus neglectus* are widely distributed in the wheat belt of South Australia (Vanstone *et al.*, 1996). Although resistance of cereal crops and annual medics to *P. neglectus* invasion has recently been investigated (Farsi *et al*. 1995; Vanstone *et al.* 1996) there has been little evidence to determine the effect of root lesion nematode invasion on yield reductions in medic pastures.

A survey was conducted in 1994 to determine the likely constraints to medic based pasture production (Denton and Bellotti, 1996). The survey identified a number of factors which limit medic pastures but their impact upon pasture production could not be proven. As a follow up to the survey, an experiment was devised to investigate whether pasture production could be improved by the addition of phosphorus, zinc and by removal of nematodes using a nematicide.

A survey conducted in 1994 indicated that the limitations to growth of medic-based pastures were phosphorus, zinc and *P. neglectus* (Denton and Bellotti, 1996). In order to confirm the results and experiment was devised to investigate whether pasture production could be improved by the addition of phosphorus, zinc and by removal of nematodes.

METHODS

A field experiment was conducted to investigate the ability of applied phosphorus, zinc and nematicide in ameliorating low soil P, low plant tissue Zn and root lesion nematode damage. A weed free site was established and maintained using herbicides and *Medicago truncatula* cv. Caliph was sown at 15 kg ha^{-1}. The design of the experiment was a 2 X 2 X 2 factorial randomised complete block design with treatments of 1) ± 150 kg ha^{-1} triple super phosphate (20 % phosphorus), 2) ± 2 applications of ZnSO4 (16.7 % zinc w/v): (1.5 and 2 L ha^{-1}) and 3) ± 2.55 kg ha-1 Temik® (aldicarb nematicide) with six replicates; plots were 1.3 X 13 m. The entire site was sprayed with insecticide twice during the experiment in order that the nematicide did not confound the experiment (aldicarb is also an insecticide). Plants were harvested for spring shoot biomass and maximum seed production and *P. neglectus* were extracted and counted from root samples at 10 and 17 weeks.

RESULTS AND DISCUSSION

Soil phosphorus and plant tissue zinc were low across all of the survey sites (Table 1). Mean plant tissue zinc was lower than the critical level set for pasture legumes (16-20 mg kg^{-1}) and would limit 50-75 % of the pastures. Numbers of *P. neglectus* were variable both within and between sites, but the effect upon pasture growth was uncertain, particularly because the region experienced a drought (50-60 % of mean long term rainfall in the region during the survey year, 1994).

The experimental site initially had 10 mg P kg^{-1} soil, soil O.C. was 0.39% and medic shoots from the site had 16 mg Zn kg^{-1} plant tissue; initial autumn *P. neglectus* densities were ~1 g^{-1} soil and the site received 270.3 mm rainfall during the season. At 10 weeks untreated plots contained 3 X 10^{3} *P. neglectus* g^{-1} root, which was only one eighth the density from the previous year (2.47 X 10^{4} ; Table 1, Fig. 1a). Invasion of roots was reduced by a combination (interaction) effect of aldicarb and zinc ($P<0.05$; Fig 1a). Although the data did not show any significant effects from phosphorus application, the combination of all 3 treatments reduced the number of *P.neglectus* in the roots to nil. Later in the season (17 weeks) , the number of nematodes were more evenly distributed across treatments and were determined by the interacting effects of temik and phosphorus.

Aldicarb also significantly increased spring shoot dry matter means from 442 to 669 kg ha^{-1} (across treatments; Fig. 1b). This trend was translated into seed production which also increased from 82 to 118 kg ha^{-1} through application of aldicarb to the pasture ($P<0.05$; comparing ± aldicarb treatments; Fig. 1b). Although aldicarb reduced the numbers of *P. neglectus* in roots and increased shoot and seed biomass, it is unclear whether the nematicide had other effects on plant growth.

Addition of phosphorus (without zinc) caused an increase in plant tissue concentration from 0.170 to 0.410 %, which exceeds the minimum critical concentration range (0.4 %; Smith 1986). The interactions between phosphorus and zinc treatments reduced the phosphorus and zinc concentrations and indicated that there were either antagonistic effects or a dilution of the element in the youngest leaves due to increased growth.

CONCLUSION

Pature production was improved by the addition of aldicarb and although numbers of *P. neglectus* were reduced, other factors may have been involved. The high rate of phospate applied to the site, provided relatively few improvements to the pasture indicating that either 1) there was inefficient use of the phosphorus supplied or 2) that P was bound by the soil. This work represents an initial investigation into a complex problem and will assist in further research directions. Further work needs to be done to investigate whether nutrition has a role in reducing *P. neglectus*.

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Table 1

Selected factors determined from a survey of 20 paddocks in the Murray Mallee, South Australia, 1994.

Factor	Mean	Range	Trial Site	Critical Value
Soil phosphorus (mg kg^{-1})	10.55	5 - 16	10	15 - 25 A
Plant tissue zinc (mg kg^{-1})	16.85	11 - 29	16	20 B
Number of *P. neglectus* mg^{-1} root	14.2	0.63 - 43.0	24.7	?
Soil pH (H_2O)	8.3	7.3 - 8.8	8.4	
($CaCl_2$)	(7.4)	(6.5-7.9)	(7.5)	
Rhizobium meliloti number mg^{-1} soil	19.1	0.8 - 101	20.3	

[A] see Reuter *et al.*, 1995

[B] see Smith, 1986

Figure 1

Numbers of *P. neglectus* that invaded roots at 10 weeks and 17 weeks (a) and spring shoot and maximum seed biomasses (b) of *M. truncatula* cv. Caliph. Treatments A, P, Z, C represent additions of aldicarb (nematicide), phosphorus, zinc and control (no additions)