FACTORS INVOLVED IN ANNUAL MEDIC DECLINE SYNDROME IN THE MURRAY MALLEE, SOUTH AUSTRALIA

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Summary. Due to widespread decline in the production of annual medics (*Medicago* spp.), a survey was conducted over 20 paddocks in the Murray Mallee region, South Australia during 1994 to identify major factors limiting medic growth. Many plant and soil characteristics were determined including nutrition, seed bank reserves, pH, organic carbon, pathological problems, legume production, botanical composition and *Rhizobium* population sizes. Paddock management (fertiliser, herbicide and pesticide use) and history were also recorded. The survey suggested that phosphorus and zinc nutrition were major limiting factors for this region, along with low seed banks and possibly *Pratylenchus* nematodes.

INTRODUCTION

Annual medic pastures are an important component of dryland farming systems in southern Australia (7). Over recent years there has been widespread decline of medic pasture production across large regions of southern Australia and there is a general despondency concerning the value of pastures (1). Many factors have been implicated for the decline of medic pasture performance including sulfonylurea herbicide residues, pathological problems, decreased fertiliser inputs, continuous cropping, decline in wool prices and general concern over the profitability of investment in pastures. These factors may have contributed to pasture decline illustrated by reduced seed banks and reduced legume composition (4, 10).

In order to gain an appreciation of the relative importance of possible contributing factors, a number of parameters were targeted to determine which were contributing to declining pastures. The area of interest was the Murray Mallee, South Australia, chosen because this is an area with limited legume options, largely reliant upon medic pastures and an area known to be experiencing poor medic pasture production.

MATERIALS AND METHODS

Twenty pasture paddocks, near Waikerie, South Australia were sampled for various plant and soil factors in the spring of 1994. Pasture paddocks were chosen on the basis that 5 were viewed as healthy and 15 as poor, as perceived by the landholders. A 90 m transect was laid in a uniform section of each paddock, away from trees and other factors that could influence sampling and samples were usually taken at 10 metre intervals.

Medic shoot biomass and plant density were determined by counting and removing medic shoots from 6 randomly placed quadrats of 0.16 m?. The composition of the paddock (percentages of medic, grass and dicotyledonous weeds) was determined by 6 visual estimations per site. Six samples of 10 leaves were taken along the transect removing the youngest expanded blade (YEB) from medic plants. These samples were analysed using inductively coupled plasma (ICP) methods at The University of Adelaide to determine plant tissue concentrations of Fe, Mn, B, Cu, Zn, Ca, Mg, Na, K, P and S.

Ten cores (10 cm diameter, 10 cm depth) were taken along the transect to determine the amount of total medic seed reserves in the soil for each paddock. The soil was thoroughly mixed and 200 g was used for chemical analysis (Colwell P, etc.). The remaining soil was sieved, medic pods were collected, split and the total seed weighed.

Ten cores (2 cm diameter, 10 cm deep, sampled over medic plants) were taken along the transect and bulked. MPN (most probable number) counts were then made on the bulked samples (3). Twenty plants were collected along the transect and were scored for *Rhizoctonia solani* (6). Six replicate soil cores (75 mm diameter ? 150 mm) were collected and placed in a glasshouse, watered and all germinating weeds removed. Four two-day old *M. truncatula* cv. Parabinga seedlings were planted into each core and the cores kept moist. After 21 days plants were washed out of the soil and shoots dried for biomass (80 ?C for 3 days). Roots were cut into 8 mm sections and placed into mister funnels for 4 days and misted (every 15 min) into a reservoir at the bottom of the funnel. A 15 ml sample was then taken and the number (or measured subsamples) of *P. neglectus* counted under a microscope.

Details of paddock rotations, fertilisers, herbicides and yields were recorded for each paddock.

RESULTS AND DISCUSSION

The sites surveyed were typical of the low-rainfall, mallee wheatbelt, with a winter dominant mean rainfall of 230 - 275 mm. Soils in this region are solonized brown soils (loam, clay loam or sandy loam) associated with siliceous dunes, generally of low fertility (2). Organic carbon in the soils varied from 0.39 to 0.97 % with an average of 0.58 %. Soil pH (H2O) varied from 7.3 - 8.8 (av. 8.3), suitable to the large populations of *Rhizobium meliloti* present at all sites (Table 1).

Table 1. Selected soil and plant attributes from 20 paddocks in the Murray Mallee.

	Soil pH (H2O)	*Rhizobium meliloti* # per g soil (? 10^{-3})	Medic biomass (g/m?)	Medic density (#/m?)	Medic seed (g/m?)	Composition (%) medic	grass	dicot weeds
Range	7.3 - 8.8	0.8 - 101	4.5 - 68.5	20 - 1000	0.02 - 83.75	18 - 69	1 - 68	2 - 57
Mean	8.3	19.1	26.2	417.3	16.1	44.9	29.2	25.7

Medic biomass was particularly low (Table 1) and this was probably a function of the drought year (50-60 % of mean long term rainfall) in the region during 1994. The number of plants per square metre was, however, high and may have provided substantial pastures had soil moisture or other factors not been limiting. The medic seed bank remaining at the time of sampling was considered satisfactory (~200 kg/ha) at 7 sites and insufficient at all others. Medic seed banks may have been larger if sampled before break of season rains because they would have been depleted by the large number of germinated plants present at most sites. Low soil seed banks may reflect medic decline due to other factors and may be a primary cause of poor medic-based pasture growth.

Botanical composition of pastures varied markedly across sites and while many paddocks could be considered adequate, with a large legume component, others had percentages of grass that would limit their usefulness in a cropping rotation.

Sulfonylurea herbicides had only ever been used in 3 of the 20 paddocks, possibly not reflecting more typical use in the region, which would be higher. While the persistence of sulfonylurea herbicides is particularly long (up to 6 years) under low rainfall conditions and alkaline soils (5), the time since application in the 3 paddocks (6-8 years) was thought to have been long enough for these herbicides not to have affected medic growth.

Soil phosphorus varied from 5 to 16 mg/kg (Colwell). According to recent large scale surveys and experimental data the majority of values were below the level thought to be critical for pastures in the

Mallee (15 - 25 mg/kg; (8); Fig. 1). This corresponds with generally low rates of phosphate applied in the area (data not shown).

(b)

(a)

(c)

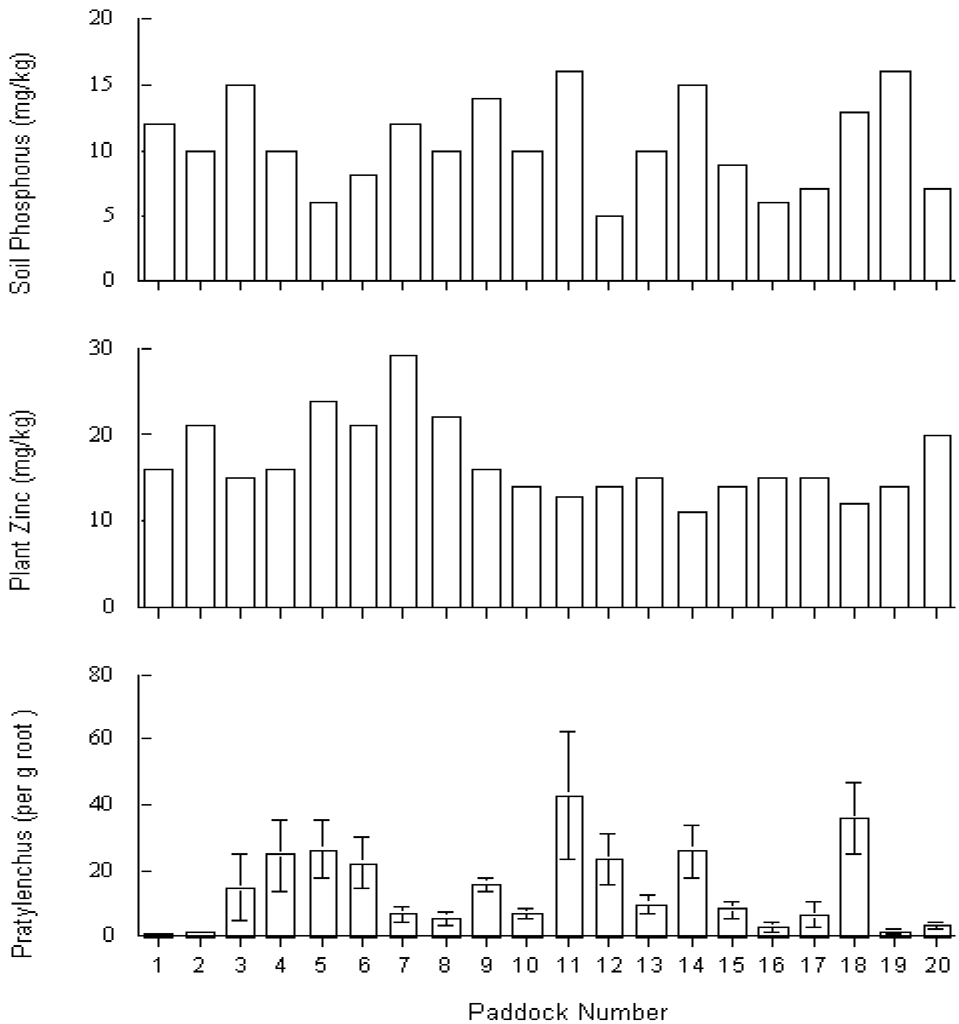

Figure 1. Soil phosphorus (a), plant tissue zinc (b) and the number of *Pratylenchus neglectus* (? 10-3) that colonised *M. truncatula* cv. Parabinga roots after 21 days growth (c) for the 20 sites sampled. Bars show standard errors (n=6).

Tissue zinc was lower than expected and often below 20 mg/kg, a concentration critical for growth of *Medicago* (9; Fig. 1). Due to the drought conditions at the time of sampling, it is thought that zinc may have been concentrated within shoots and thus the values that are presented may be considered as over-estimates. Other soil and plant nutrients were in concentrations considered adequate for medic pasture growth.

P. neglectus (root lesion nematode) populations were variable both within and between paddocks. *P. neglectus* is known to multiply rapidly within the roots of most medic species under favourable conditions and will feed on root hairs and even root nodules, interfering with growth and nitrogen fixation (V. Vanstone, pers. comm., Univ. of Adelaide). A level that will cause significant loss of biomass and reduce production is currently not known for annual medics, although populations of *P. neglectus* can certainly be increased during a pasture phase (S. Taylor, pers. comm., SARDI).

Rhizoctonia solani was found at 3 sites and only at the smallest detectable level, in a similar trend with the rest of South Australia (D. Roget, pers. comm., CSIRO, Divisions of Soils). A wetter year with early rains may exacerbate *Rhizoctonia*.

While this survey was restricted to a small number of sites within a specific area, it provides some useful data with which to gauge factors that are causing major problems to medic pastures. The severity of these factors may vary on a yearly basis depending upon climate, management and history of the paddock. The resultant pasture will reflect the complex interactions of these factors. Pathological problems, for example, may vary depending upon soil phosphorus and zinc nutrition. The question remains whether adequate levels of phosphorus and zinc can reduce any impact of *P. neglectus* or other pathological problems.

CONCLUSIONS

Paddocks sampled were generally deficient in phosphorus and zinc, at levels below that which will sustain good medic growth. The amount of damage caused by pathological diseases will vary from season to season. Further research is needed to quantify firstly, the damage caused to medics by *Pratylenchus*, and secondly, the relationship between P and/or Zn nutrition and susceptibility of medics to fungal pathogens or nematodes.

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