THE INFLUENCE OF PHOSPHORUS SUPPLY ON BELOW GROUND INTERFERENCES BETWEEN BROWNTOP AND WHITE CLOVER

A Thesis presented in partial fulfilment of
the requirements for the degree of
Doctor of Philosophy in Soil Science
at Massey University

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1993

ABSTRACT

A low occurrence of white clover in pastures contributes to soil nitrogen (N) deficiency and a low quality feed for stock. There is evidence to suggest that competition for soil phosphorus (P) from roots of browntop plays an important role in determining the distribution of white clover in hill country swards. However, competition for soil P between roots of browntop and white clover has not been studied separately from other factors known to affect the growth and persistence of white clover (e.g., soil moisture, grazing management, shoot interferences (shading and physical impedance), and non-competitive root interferences).

In hill country pastures, P level (phosphorus fertilisers), and defoliation (grazing management), are the main factors that can be changed by farmers to alter pasture botanical composition. The high cost of superphosphate has limited the potential of farmers to manipulate pastures using fertiliser applications. Therefore, it is important to know whether roots of browntop compete with roots of white clover for soil P, and whether a low supply of soil P will contribute to more severe competition from browntop roots. The possibility of non-competitive interferences occurring between roots of browntop and white clover must also be considered. How defoliation alters the balance of P acquisition between roots of browntop and white clover needs to be determined.

Three techniques were employed to examine the nature of root interferences occurring between browntop and white clover: plant strategies; dual P isotope labelling; and a more traditional competitive settings trial using aerial partitions. Plant growth and root interferences were studied at a range of levels of soil P supply. Responses of growth and phosphorus uptake of browntop and white clover to increasing soil P supply were examined first, in the glasshouse, by growing monocultures of browntop and white clover in pots.

Two mini-sward trials (one at deficient soil P supply, the other at adequate to luxury soil P supply) were carried out in the glasshouse to allow examination of root interactions (without shoot interactions). The basis of the experimental design was to determine the relative amounts of phosphorus-32 and -33 absorbed by a central row of plants (either browntop or white clover) from two adjacent soil spaces, one dominated by white clover roots, the other by browntop roots. ^{32}P was injected into the soil on one side of the central row of plants, and ^{33}P into the other side. ^{32}P and ^{33}P uptake was assessed by harvesting the shoots of the central plants, and counting the two isotopes.

The competitive settings type trial compared the growth and P uptake of a single central plant in a small pot (no interference with other plants) with a central plant in a larger pot grown with roots associated with roots of plants of the same species (intraspecific association), or of the other species (interspecific association). Shoots of the central plant was separated from the shoots of outer plants by an aerial partition.

The growth of browntop and white clover, and the nature of root interferences occurring within and between the two species was dependent on the level of soil P supply. However, the higher root density and specific root length (SRL) of browntop compared with white clover appeared to be the most important factor determining the success of browntop at all levels of soil P supply, regardless of whether or not browntop was grown with white clover.

According to the plant strategy theory of Grime, browntop was found to be a stress tolerant plant. At low levels of P supply, the lower growth rate of browntop compared with white clover would be an important factor contributing to the dominance of browntop in hill country pastures. At adequate to luxury levels of soil P supply, shoot growth of browntop was more responsive than white clover, and browntop was capable of luxury consumption of P. The high growth rate and large demand for P contributed to the competitiveness of browntop at high P supply. However, the lower demand for P by white clover, and the high P supply may have enabled white clover to avoid competition with browntop.

On unamended subsoil, browntop reduced P acquisition by white clover roots, and had a greater P uptake in the presence of roots of white clover than with roots of other browntop plants. Therefore, evidence of root competition for soil P from browntop with white clover was found. The competitive effect of browntop appeared to be due to browntop decreasing the availability of P in the soil, explained by browntop's ability to acquire more radioactive P from the soil than white clover.

At low P supply (subsoil), P application, but not defoliation of browntop, reduced the competitiveness of browntop. At adequate P supply, the ability of browntop to acquire P was reduced by defoliation. The effect of defoliation was rapid (four days), and browntop was able to acquire P isotope to higher concentrations in the shoots than when undefoliated. Possibly the reduction of root competitiveness of browntop may be short-lived.

Some interference, other than root competition, was occurring at intermediate to luxury levels of soil P supply, and may have masked the competitive effects of browntop. White clover appeared to benefit for P acquisition from growing with browntop, due to greater local root density compared with when growing with other white clover plants. Therefore, browntop and white clover appeared to gain mutual benefit for P acquisition from the presence of roots of the other species, and the competitive effects of browntop were not of overriding importance. The possibility of autotoxicity of white clover on its own root growth was discussed in relation to rhizosphere acidity effects on the toxicity of phenolics.

At adequate to luxury levels of soil P supply, neither undefoliated browntop nor undefoliated white clover benefited from defoliation of adjacently growing white clover plants. However, at lower P supply, defoliation of white clover led to an increased P isotope acquisition by nearby browntop plants. Therefore, defoliation reduced the demand for soil P by white clover. Roots of browntop were not as tolerant of defoliation as white clover.

In the field, the mat forming behaviour of browntop, physically impeding the growth of white clover and shading white clover stolons, would reduce the severity of competition for soil P between roots of browntop and white clover. Overall, root competition for P from browntop with white clover was found not to be as important as previously thought.

The use of several experimental techniques allowed a clearer picture of the interferences that occur between browntop and white clover to be obtained. The nature of root interference changed with increasing P supply. The responses of browntop and white clover to increasing P supply was found to be enlightening when the plant strategy theory of Grime was used to compare browntop and white clover. However, the dual P isotope technique found plant interferences that were not detected by the other methods used (P response and competitive settings trial), and allowed interferences that were occurring simultaneously to be elucidated.

ACKNOWLEDGEMENTS

I wish to thank the following people for their encouragement and helpful advice during my Ph.D. programme:

Foremost thanks to my supervisors; Professor Robert White for his patience and helpful knowledge, Dr. Peter Kemp for his enthusiasm and support, and Dr. Russ Tillman for sharing his knowledge in the use of radio-isotopes and support during the writing up of my thesis.

To the technicians of the Soil Science and Plant Science (Agronomy) Departments for their continual assistance and knowledge in the field, glasshouse, and laboratory, special thanks for putting a smile on my face. Also thanks to my friends that helped with the setting up and harvesting of the glasshouse trials.

Sincere gratitude to my friends and colleagues at Massey University and in the broader Palmerston North community. Thanks to those involved in the local music industry, especially Dave White, for making my time in New Zealand both enjoyable and fruitful.

Roger Thomas and Gerard Creamer assisted greatly by providing access to laser printing for the final production of my thesis.

I acknowledge the financial assistance of the Charles and Annie Neumann Fellowship in Agriculture, C. Alma Baker Trust Fund, and Massey University Research Fund.

Finally, a special thought for my family and friends. This thesis is dedicated to my beautiful mother, Judith Pannell.

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