ESTABLISHED PHALARIS AND COCKSFOOT REDUCE THE GROWTH, TURGOR AND SURVIVAL OF SUBTERRANEAN CLOVER SEEDLINGS

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Abstract

The poor persistence of subterranean clover in mixtures with phalaris is often attributed to reduced seedset due to shading and increased competition for moisture in spring. The findings of two experiments suggest that competition for water in autumn reduces clover seedling size, turgor and survival, and may contribute to poor clover persistence. They demonstrated that phalaris dries the surface soil more rapidly during clover seedling germination and establishment, reduces light penetration to the clover seedlings and decreases nitrate availability. Defoliation of the phalaris was effective at increasing clover seedling size and turgor, particularly when water was limiting.

Key words: RWC, water stress, seedling establishment.

Although subterranean clover (Trifolium subterran-eum L.) has been observed to persist poorly with phalaris (Phalaris aquatica L.) (1), there has been little research on the likely causes. Given our knowledge of the ecology of subterranean clover, the three most sensitive stages in the life cycle are likely to be seed set, hard seed break-down and the seedling germination/ establishment phase. Most importance has been placed on seed set and the potential of perennial grasses to increase moisture stress during this period which has led to the recommendation to sow earlier maturing clover cultivars in phalaris and lucerne mixtures. Recently, Leigh et al. (6) and Hallsall et al. (7) suggested that germination, root elongation and early growth of subterranean clover are reduced by the allelopathic effects of phalaris residues.

Little attention has been given to the effect of perennials on soil moisture during the germination and establishment of clover in autumn, although subterranean clover seed imbibition is known to be sensitive to increasing water potentials (8).

This paper describes two experiments conducted to investigate the effects of: (a) phalaris and cocksfoot (Dactylis glomerata) on the rate at which the surface soil dries in autumn, and their effect on clover seedling size and turgor; and, (b), defoliating phalaris on the early seedling growth and turgor of subterranean clover at high and low soil water.

Materials and methods

Experiment 1

Four replicates (9 x 20 m) each of phalaris (cv. Sirolan)/subterranean clover, cocksfoot (cv. Currie)/sub clover and pure subclover were established at Kamarah (34^{o}15'S,1460 46'E) NSW in 1995. All subterranean clover stands were a mixture of cvv. Dalkeith, Seaton Park LF and Goulburn. Soil moisture in the surface 5 cm was measured gravimetrically in autumn 1996 following 24 mm of rain on 27-28 February, which induced a clover germination, and a further 11 mm rain on 6-7 March. Subterranean clover seedlings were sampled from the three treatments 17 days after the February rainfall and their dry weight and relative water content (RWC) determined.

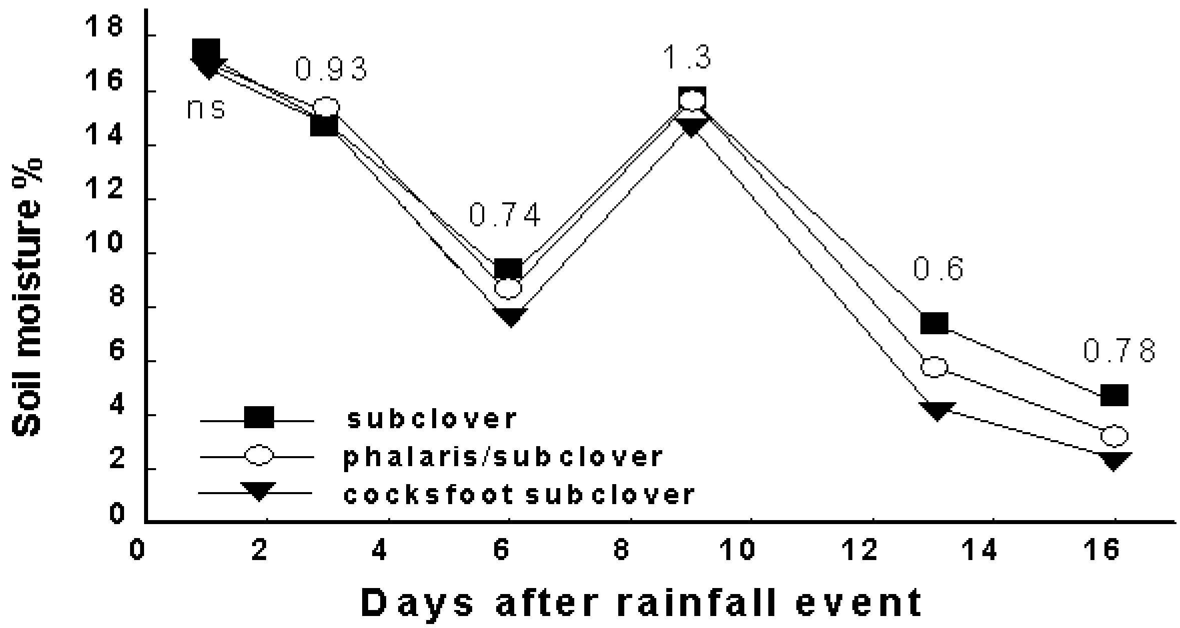

Figure 1

Experiment 2

Subterranean clover seed was germinated between well established phalaris plants grown in large tubs 60 x 80 x78 cm deep. The treatments included: 2 levels of phalaris defoliation (defoliated to 6 cm and undefoliated), 2 levels of water supply (high and low), and plus or minus root competition. The latter treatment was achieved by inserting rectangular perspex sleeves between selected phalaris plants to exclude phalaris roots from competing with the clover seedlings in the area between the phalaris plants. Six clover seedlings were randomly sampled from each treatment 7, 14 and 21 days after emergence and their dry weight and RWC determined.

Results and discussion

Table 1. The number of sub clover seedlings present (plants/m²) following germinating rains in late February-early March in perennial grass and pure clover swards and their survival until late autumn.

Sward	13 March	29 March	15 May
Pure sub clover	679	1207	964
Phalaris/sub clover	89	52	1
Cocksfoot/sub clover	65	1	<1
l.s.d. 0.05	74	119	8

Experiment 1

Following rainfall in February and March, the surface profile dried fastest in the cocksfoot swards, which was the more active grass, and slowest in the pure clover (Fig. 1). Since clover seed is sensitive to low levels of moisture (8) and imbibed seeds can dehydrate rapidly as soil moisture declines (4, 5), the rapid drying of the soil apparently reduced the clover germination. This was confirmed by the number of seedlings that emerged as a percentage of the summer seed pool in the different swards: 18% in pure clover compared with only 4% in the phalaris/clover and cocksfoot/clover swards. Of those which emerged, 960 seedlings/m^2 survived until late autumn in the pure clover compared with <1/m^2 in phalaris/clover and cocksfoot/clover (Table 1). Although the measured differences in soil moisture were only small, clover seedlings 17 days after the germinat-ing rain were twice as large in pure clover compared with either mixture. Clover seedlings in the phalaris swards had substantially lower RWC (-34%) values than in pure clover (75%) indicating a higher level of moisture stress in the presence of phalaris.

Clover seed reserves were similar in all swards, so this was not the cause of the greater number of seedlings in pure clover. These findings demonstrate that phalaris and cocksfoot can reduce seedling clover survival and that competition for water is a major cause of poor clover persistence in perennial grass pastures.

Experiment 2

This experiment demonstrated that defoliated phalaris did not compete with clover seedlings as strongly as undefoliated phalaris. Defoliation of phalaris increased clover seedling growth (Fig. 2)., presumably in response to increased light or improved water availability. Increased seedling growth under low water was attributed in part to improved water availability as reflected in the higher clover RWC values of the seedlings. However, even under high water where seedlings had high RWC values (>80%), clover seedling size increased where phalaris roots were excluded. This was most likely due to an increased supply of mineralised nitrate, which was significantly higher inside the sleeves (160 mg/g soil) than outside (3 mg/g). ?Phosphorus supply was similar in both the root excluded and non-excluded area. Available nitrate in the surface soil in autumn has been shown to be much higher in annual swards that lack a perennial component (2, 3) and this may be important in promoting early growth of the clover seedlings.

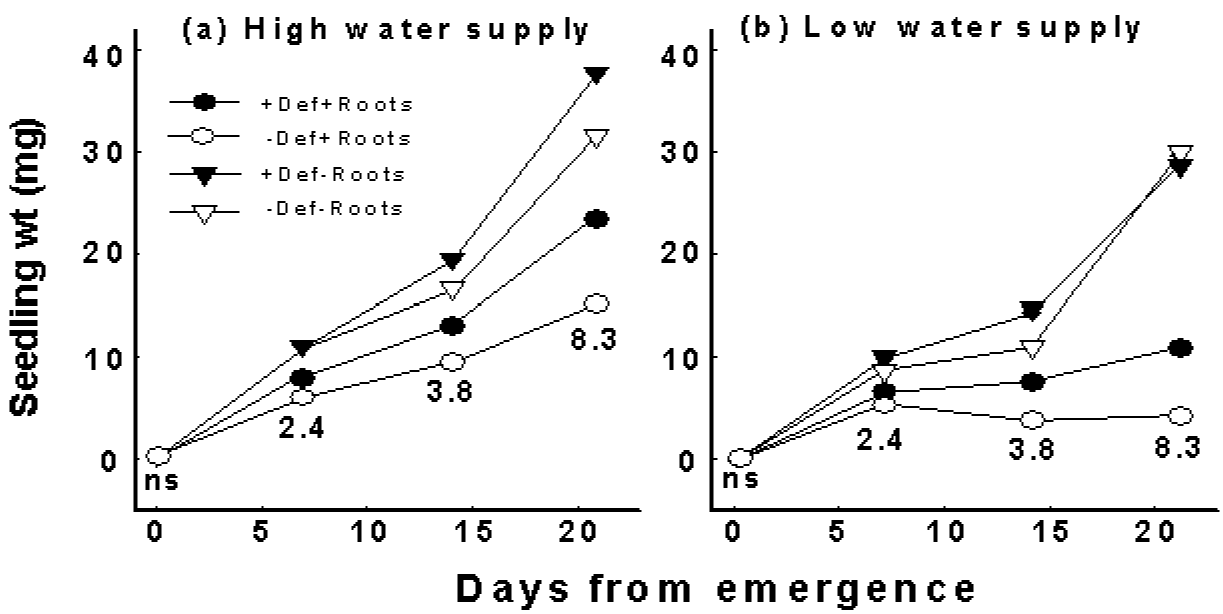

Figure 2

Conclusions

The failure of subclover to persist at an adequate level in many perennial grass swards can be explained in part by poor seedling establishment in autumn as a result of additional moisture stress and other factors induced by the perennial. Competition for light appeared to be important and defoliation of phalaris was found to be a useful strategy to increase both light and water availability to the clover seedlings. Careful management of the perennial grass to minimise competition with the legume component in autumn will become more important as perennials are grown in drier wheat belt environments to reduce ground water recharge and soil acidification. Attention should also be focussed on selecting annual legumes which have hard seed break-down patterns which guard against premature germination, particularly where there is a high probability of late summer, early autumn rain.

Acknowledgements

We gratefully acknowledge the financial support of the International wool Secretariat and the Grains Research and Development Corporation and the technical assistance of Mr Tony Swan.

References

1. Clements, B. 1997. Grass. Soc. NSW, Newsletter 12 (2), p.17.

2. Dear, B. S. and Cocks, P. S. 1997. Aust. J. Agric. Res. 48, 683-693.

3. Dear, B. S. Cocks, P. S., Wolfe, E. C. and Collins, D. 1998. Aust. J. Agric. Res. 49, 41-51.

4. Mc William, J. R., Clements, R. J, and Dowling, P. M. 1970. Aust. J. Agric. Res. 21, 19-32.

5. McWilliam, J. R. and Dowling, P. M. 1970. Proc. XI Int. Grass. Cong., Surfers Paradise, Queensland, Aust. pp. 578-583

6. Leigh, J. H., Halsall, D. M. and Holgate, M. D. 1995. Aust. J. Agric. Res. 46, 179-188.

7. Halsall, D. M., Leigh, J. H., Gollasch, S. E. and Holgate, M. D. 1995. Aust. J. Agric. Res. 46, 189-207.

8. Roberts, F. J. 1966. Aust. J. Agric. Res. 21, 19-32.