Environmental and plant factors causing low legume seedling establishment following oversowing into drought-prone hill swards

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ABSTRACT

Legumes are a valuable component of pastures since they tend to have higher feed quality than grasses and can also fix atmospheric nitrogen in the soil. The technology for oversowing legumes has had many improvements but the success rate is poor and the legume contribution to hill country pasture production remains low. It was concluded that unpredictable weather and plant factors were the major factors causing poor pasture legume establishment from oversowing.

To determine the environmental and plant factors responsible for poor pasture legume establishment from oversowing, a series of seven trials were carried out at AgResearch, Poukawa near Hastings. The five annual and seven perennial legume species oversown in order of establishment success were; subterranean clover (*Trifolium subterraneum*), barrel medic (*Medicago trunculata*), birdsfoot trefoil (*Lotus corniculatus*), white clover (*T. repens*), strawberry clover (*T. fragiferum*), murex medic (*M. murex*), arrow leaf clover (*T. vesiculosum*), lucerne (*M. sativa*), alsike clover (*T. hybridium*), persian clover (*T. resupinatum*), Maku lotus (*L. pedunculatus*) and caucasian clover (*T. ambiguum*). Seeds of each species were oversown in autumn, winter and spring, following defoliation with glyphosate and trodden with sheep. The greatest loss of potential seedlings after oversowing was non-appearance of seedlings, which accounted for about 80% of viable seed. Overall, the contribution of sown legume species to total herbage mass was less than 12% and seedling establishment success was typically between 5 and 30%.

The relationships between eight environmental factors and seedling establishment were explored and the main influences on establishment were found to be gravimetric soil water content, soil temperature, minimum air temperature and daily wind run. A simple model based on these four factors was developed from the field trial data and extrapolated to 10 years of Lawn Road, Hastings and 5 years of Poukawa climate data and the best time, on average, for oversowing was predicted.

To test the effect of high, medium and low soil surface moisture and also to find out the fate of oversown seed two experiments were carried out in a glasshouse using caucasian, strawberry and subterranean clovers. A simple and cheap technique

based on $CoCl_2$ saturated paper strips was developed to measure the changes in soil surface moisture. The soil moisture at depth was a poor indicator of seed germination compared with the surface soil moisture. The low soil surface moisture gave lowest seedling survival. The main cause of low soil surface was wind run. The percentage of ungerminated seed was significantly higher for oversowning than to the standard seed germination test.

Two trials were carried out at AgResearch, Ballantrae, to test the effect of seed rate and seed size. It was observed that sowing rates greater than those usually recommended would increase the seedling density and legume contribution to the total herbage mass and might produce more seed for re-establishment of annual legumes in the subsequent years. Seed size did not significantly affect establishment.

The effect of seed coating and seed dressing was also monitored in a trial at Poukawa. The seed of subterranean and white clovers dressed with fungicide, insecticide and two commercial seed coatings were compared with bare seed. The commercial seed coating increased the early seed germination by 30% but not the final seedling density compared with bare seed. Apron fungicide seed dressing had a deleterious effect on seed germination. The effect of glyphosate residue and litter phytotoxicity was tested in a glasshouse experiment with birdsfoot trefoil and subterranean and white clovers. The species were oversown onto sods sprayed with glyphosate 20 days earlier and onto ordinary sand. The glyphosate residue and dead material did not have any major effect on seed germination and seedling survival.

Overall, environmental factors were found to be the key determinants of successful establishment for pasture legumes by oversowing. Both, the likely environmental conditions at the time of oversowing, and during the first few months of seedling growth need to be considered. The establishment of legume species suited to oversowing can be improved by using high sowing rates and seed coating but ultimately it is the moisture level and temperature at the soil surface that determines germination, and wind run and minimum air temperature that determines seedling survival in drought-prone hill swards.

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