THE USE OF GRASSES AND LEGUMES FOR WEED CONTROL IN PASTURES

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Summary

The weed flora and succession, seasonal growth of weeds and effects of nine grasses and six legumes on weed yield are described from establishment year data of a study of grass-legume mixtures. An analysis to interpret the interaction of sown grasses and legumes on weed suppression is described. Weed control by sowing appropriate cultivars is demonstrated.

INTRODUCTION

The concept of the ecological niche developed by Harper (1970) and others provides the theoretical basis to this paper. Soils used for arable or pastoral purposes usually contain large numbers of dormant seed of many different weeds. Hyde and Suckling (1953) and unpublished data of F.E.T. Suckling show this to be the case for a wide sample of soils under long term or permanent pasture in New Zealand. Seed-bed preparation for pasture establishment provides appropriate conditions for the breaking of dormancy, germination and establishment of the resident weed population. Full exploitation of a niche which a weed species has the potential to fill is determined by the amount of interference from other weed or sown crop or pasture species which can also potentially occupy that niche. A knowledge of the resident weed flora, their habitat preferences and the competitive characteristics of desirable crop and pasture species can lead to considerable weed control by sowing seed mixtures of specified composition and rate.

METHODS

The data presented is from an experiment sown in April 1973 at Grasslands Division, DSIR, Palmerston North. The objective of the experiment was to measure the productivity of grass-legume mixtures based on the nine grasses and six legumes listed in Table 1. These cultivars were sown as monocultures and in 54 two species grass-legume mixtures. Seed rate for each cultivar provided the same number of viable seeds per unit area as provided by 40 kg/ha Manawa ryegrass. A further area was left unsown to provide a measurement of the composition and productivity of the resident weed population without interference from sown species.

Performance of the swards was measured under rotational grazing by sheep. Measurement procedures and some aspects of sown species production are given elsewhere (Harris 1977, Harris and Hoglund 1977). There were also two nitrogen treatments which are not distinguished in this paper, and three replications. Soil type was Kairanga silt loam

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TABLE 1: Grass and legume cultivar treatments

'Grasslands' cultivar	Botanical Name	Symbol Fig. 3
'Ruanui' perennial ryegrass	<i>Lolium perenne</i>	R
'Nui' perennial ryegrass	<i>Lolium perenne</i>	N
'Paroa' Italian ryegrass	<i>Lolium multiflorum</i>	P
'Manawa' short-rotation ryegrass	<i>L. (multiflorum x perenne)</i>	M
'Ariki' ryegrass	<i>L. ((multiflorum x perenne) x perenne)</i>	A
'Matua' prairie grass	<i>Bromus catharticus</i>	Mt
'Kahu' timothy	<i>Pbleum pratense</i>	K
'Apanui' cocks foot	<i>Dactylis glomerata</i>	Ap
'G4710' tall fescue	<i>Festuca arundinacea</i>	Tf
No grass sown		Cg
'Hamua' broad red clover	<i>Trifolium pratense</i>	Hm
'Turoa' Montgomery red clover	<i>Trifolium pratense</i>	Tu
'Pawera' tetraploid red clover	<i>Trifolium pratense</i>	Pw
'Huia' white clover	<i>Trifolium repens</i>	Hu
'Pitau' white clover	<i>Trifolium repens</i>	Pt
'Maku' tetraploid lotus	<i>Lotus pedunculatus</i>	Mk
No legume sown		Cl

topdressed annually with 300 kg/ha potassic superphosphate. For the highest yielding mixtures this fertile soil produced in excess of 20 000 kg/ha/ann. For all the sown swards percentage composition of harvested dry matter of sown grasses, sown legumes and weeds was determined. Full species dissection of the unsown treatment was carried out.

RESULTS AND DISCUSSION

To illustrate the principles being considered a sample of data from the establishment year of the experiment is presented.

Weed flora and succession

A full listing of the species present in the unsown treatment is given in Table 2. To clarify the pattern of succession from sowing these species have been grouped in seven categories and the percentage content of six groups plotted in Fig. 1. The weed population was first mainly composed of short-lived dicotyledonous annuals, then of toad rush and then poa annua. As these declined into summer the percentage content of prostrate perennials and later establishing dicotyledonous annuals increased. The content of broad-leaved dock fluctuated as these were periodically checked by hand weeding and a spot spraying with asulam. Hand weeding also periodically removed

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the group of pasture grasses and legumes except browntop, and the content of these averaged 1.8% over the year.

TABLE 2: Weed categories and species

(1) Early establishing dicotyledonous annuals associated with cultivation	Mainly shepherd's purse (<i>Capsella bursa-pastoris</i>), twin cress (<i>Corynopus didymus</i>) annual mouse-ear chickweed (<i>Cerastium glomeratum</i>), dwarf montia (<i>Montia verna</i>), chickweed (<i>Stellaria media</i>), also, spurrey (<i>Spergularia arvensis</i>), cress (<i>Cardamine</i> sp), black nightshade (<i>Solanum nigrum</i>), sow thistle (<i>Sonchus oleraceus</i>), allseed (<i>Polycarpon tetraphyllum</i>)
(2) Toad rush	<i>Juncus bufonius</i>
(3) Poa annua	<i>Poa annua</i>
(4) Docks and thistles	Mainly broad-leaved dock (<i>Rumex obtusifolius</i>) and also Scotch thistle (<i>Cirsium vulgare</i>)
(5) Prostrate Perennials	Mainly pearlwort (<i>Sagina procumbens</i>), <i>Oxalis corniculata</i> , dandelion (<i>Taraxacum officinale</i>), also <i>Hydrocotyle moschata</i> , daisy (<i>Bellis perennis</i>), yarrow (<i>Achillea millefolium</i>), narrow-leaved plantain (<i>Plantago lanceolata</i>)
(6) Later establishing dicotyledonous annuals	Mainly cudweed (<i>Gnaphalium</i> sp), fleabane (<i>Erigeron</i> sp), <i>Veronica verna</i> and also stinking mayweed (<i>Anthemis cotula</i>)
(7) Pasture grasses and legumes	White clover, red clover, ryegrass, timothy, tall fescue, browntop (<i>Agrostis tenuis</i>)

Weed dry matter production

To show the separate and combined effects of sown grasses and sown legumes on weed growth the Nui ryegrass – Hamua red clover mixture is used as an example (Fig. 2). Total weed DM yields in kg/ha for the period shown were: unsown treatment 5 300; Nui monoculture 350; Hamua monoculture 1 610 and the mixture 430.

By the second grazing the sown species had begun to suppress the weeds to a considerable extent. The greatest suppressive effect was exerted by the grass. Considerable weed growth occurred in the Hamua red clover monoculture until November. However production of Hamua increased markedly from September to a maximum in December-January when the weed content was reduced to a very low level.

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FIG 1: Weed succession in unsown area. Weed categories defined in Table 2.

FIG. 2: Seasonal distribution of weed production in unsown area and swards sown with Nui ryegrass and Hamua red clover.

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Analysis of weed suppression effects

Figure 2 presents one of 54 possible comparisons of the effect of sown species on weeds. By using a form of regression analysis (Breese and Hill 1973) the following can be defined:

- (1) the mean effects of sown grasses or sown legumes on weed content averaged over a range of mixtures;
- (2) the sensitivity of weeds to increasing grass competition in the presence of a particular legume (or conversely to increasing legume competition with a specific grass);
- (3) specific effects of particular grass-legume mixtures which deviate from the above grass or legume effects.

This analysis has been applied to yields from the regrowth period between grazings on 30 October and 26 November 1973 (Figure 3). At this stage there was a diverse weed flora and weed yield in the unsown treatment was high. The horizontal axis plots the mean weed yield in the presence of nine grass cultivars and the plots not sown with grass averaged over all legume treatments. Ryegrass cultivars reduced weeds to a much greater extent than did prairie grass, timothy, cocksfoot and tall fescue. Mean legume effects on weed yield are plotted as the vertical axis. Differences between legumes in their effect on weed yield were less than those shown by the grasses but were nevertheless significant. Hamua red clover reduced weeds most and Maku lotus and Pitau white clover caused no more weed reduction than treatments not sown with a legume.

FIG. 3: Regression analysis of effects of sown grasses and sown legumes on weed yields. (For key to abbreviations see Table 1)

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Weed yields in individual mixtures containing Maku lotus, Huia white clover and Hamua red clover are plotted along the vertical axis against the grass associate means. Analysis of variance showed that there was a significant interaction between the grass associate effect and the legume effect. Regression analysis partitions this interaction into a part accounted for by differences among the slopes of regression of the different legume treatments, and a residual item which is related to the deviation of the weed yields in specific mixtures from the general slope of the regressions. In this example the interaction is accounted for by the heterogeneity of the regression slopes. The reyglasses caused marked reduction of weeds regardless of the legume in the mixture. With less competitive grasses the legume effect on weed suppression became more important. Thus the red clovers, as shown by the lower regression coefficients (b), maintained greater weed control as the grass associate effect became less than did the white clovers, lotus and grass-only treatments.

These differences in weed suppression on a fertile soil by grasses and legumes relate to differences of establishment rate, cool season growth rates and plant habit which determine the amount of ground cover and hence shading. The example (Fig. 3) shows that on average ryegrasses control weeds to about 5% of the potential weed yield. Due attention should be paid to these important competitive effects when using herbicides to control weeds in pastures. If desirable species are sparse, or through herbicidal damage or inappropriate management are not able to occupy the space made available by the selective removal of weeds, then the weed problem may be aggravated. In such cases it may be appropriate to oversow seed of suitably competitive grass and/or legume species (Henderson and Popay 1976).

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