EVALUATION OF GRASS GRUB – PLANT INTERACTIONS OF GRASSES SOWN WITH AND WITHOUT WHITE CLOVER IN CENTRAL HAWKES BAY

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Summary

Studies confirmed the extraordinary tolerance of tall fescue (*Festuca arundinacea*) to grass grub (*Costelytra zealandica*) attack in spite of its ability to support high densities of this pest. Production of ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*), both as pure species and as a mixture and browntop (*Agrostis tenuis*) - white clover swards were more adversely affected by grass grub than swards of other species. Losses from grass grub damage, of prairie grass (*Bromus catharticus*), phalaris (*Phalaris aquatica*) and cocksfoot (*Dactylis glomerata*) sown with white clover were higher than when sown as pure species. With the exception of prairie and tall fescue, losses tended to parallel grass grub density.

INTRODUCTION

The more productive pastures of New Zealand are based on ryegrass and white clover. Although ideally suited to the country's climatic and agricultural conditions, these species have a number of unsatisfactory features. One of the most important of these is their extreme susceptibility to grass grub attack. The two major determinants of insect damage are pest density and host plant susceptibility. Both variables are markedly influenced by changes in host plant species (Kain and Atkinson 1977; Kain *et al* 1978) and cultivars. The host plant grass grub relationships have received a great deal of attention especially the effect of different host plants on larval performance (Kain and Atkinson 1970; Farrell and Sweney 1972 and 1974; Kain and Atkinson 1977). It is only recently however, that studies have been directed towards measuring the effect of grass grub on plant performance and the interaction between the inherent characteristic of host plants to support differing densities of grass grub and the effect of these densities on herbage production (Kain *et al* 1978).

Although attempts under artificial conditions have been made to assess the effect of grass grub on a range of host plants (Radcliffe 1971a, b) such evaluations have little practical significance unless they take account of the inherent aggregation in natural grass grub populations and the ability of the plant to support a pest density which is a characteristic of that particular species.

Kain *et al* (1978) have shown that in the central North Island region of New Zealand, cocksfoot (cv 'Apanui') and tall fescue (cv 'S170') were much more tolerant to grass grub attack than ryegrass pastures. This paper reports on the performance of these and other grass species sown with and without white clover in central Hawkes Bay over a 27 month period.

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TABLE 1: Density of grass grub found under swards of different plant species and mixtures of species.

Pasture species	Cultivar	1977		1978		1979
		Autumn/Winter No/m ²	No/m ²	Autumn/Winter No/m ²	No/m ²	Autumn No/m ²
Pure species						
ryegrass	Grasslands 'Ruanui'	298	105	72	67	156
tall fescue	Grasslands 'S170'	416	154	110	87	234
phalaris	Grasslands 'G19'	164	103	18	24	67
prairie grass	Grasslands 'Matua'	198	62	35	+	128
cocksfoot	Grasslands 'Apanui'	152	62	10	11	36
browntop	Commercial	95	18	23	7	56
white clover	Grasslands 'Huia'	372	92	85	76	488
Sown with white clover						
ryegrass		205	82	56	74	280
tall fescue		321	131	98	67	285
phalaris		280	149	120	90	342
prairie grass		318	118	87	+	213
cocksfoot		161	87	36	33	120
browntop		218	106	95	71	231
LSD (P = 0.05)		159	97	73	22	137
Main effects						
pure		231	85	45	39	116
with white clover		262	113	82	67	251
		NS	NS	*	*	**

+ = not sampled; * = $P < 0.05$; ** = $P < 0.01$.

METHODS

Studies reported herein were confined to a small plot trial at the Takapau Research Station. The trial was of a randomised block split plot design with four replicates. One third of each plot (3 x 20m) was treated with insecticide (fensulfothion 2 kg/ha applied annually in autumn). Grass grub damage suffered by each treatment was measured as the % difference in herbage production between insecticide treated and untreated sub-plots. The species and cultivars included in these studies are presented in Table 1.

Following herbicidal destruction of existing vegetation in late winter the trial area was given a shallow cultivation in early spring so as not to destroy grass grub pupae which were located 10-14 cm deep in the soil profile. All species and mixtures were sown at normal rates with a drill in spring. A limited amount of irrigation was used in February 1977 to help establishment.

The trial area was kept trimmed over the summer and measurements of herbage production and grass grub began in autumn 1977. All treatments were harvested at a height of about 2.0 cm with a rotary mower when the mean height of actively growing cultivars was about 15 cm. All clippings were removed from the trial.

During establishment picloram 0.25 kg/ha) was applied to pure grass plots and 2,4-DB to white clover and white clover mixtures to maintain sward purity. Potassic superphosphate was applied annually in autumn at rates that ensured that neither phosphorus or potassium were limiting herbage production. Up until autumn 1977 nitrolime was applied at 50 kg/ha as a basal dressing every 6 weeks. Thereafter applications of nitrogen

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FIG. 1: Seasonal production (DM (kg/ha) of a range of grass species sown with and without white clover, left untreated $\blacksquare$ and treated $\square$ with insecticide for grass grub control, and % seasonal losses in production. Within species or mixtures LSD ($P = 0.05$) = $\square$ and between treatment LSD ($P = 0.05$) = I. (R = ryegrass, T = tall fescue, Ph = phalaris, Pr = prairie, C = cocksfoot, B = browntop.)

(N) were made at rates proportional to the mean dry matter (DM) yield of each treatment ($N = 4\%$ DM) but changed in autumn 1978 so that all application rates for untreated sub-plots in each treatment were based on the mean production of the insecticide treated sub-plots. This change was made so that N was not limiting in damaged sub-plots and therefore did not affect the recovery of severely damaged areas or the production of undamaged areas within sub-plots.

Mid season botanical dissections were carried out on herbage harvested from all sub-plots. Herbage was dissected into sown legumes and/or grasses and unsown species.

All untreated sub-plots were sampled outside a central mowing strip for grass grub in March and June by taking 16 and 12 10cm diameter cores respectively. A representative sample of treated sub-plots was also sampled (6 cores/sub-plot) to ensure that grass grub control was effective. All samples were hand sorted in the laboratory and number developmental stage and weight of grubs were recorded.

RESULTS

In these studies the year has been divided into four 3-month seasons commencing with autumn on March 1st. Grass grub densities are summarised in Table 1. Botanical composition of swards in autumn when

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grass grub damage is greatest is given in Table 2, and seasonal and annual herbage production and % losses for each of the swards under study are presented in Figs. 1 and 2.

With the exception of white clover, browntop-white clover, ryegrass-white clover and phalaris-white clover treatments, sward purity was maintained at a high level and a significant ($P<0.05$) increase in weed content was recorded in white clover (Table 2).

Losses from grass grub damage were most pronounced in autumn and winter but were greater in white clover-grass than pure grass swards (Fig. 2). Damage in swards of pure grasses decreased from 1977-78 to 1978-79 (Figs. 1 and 2). Significant losses were recorded in 1977-78 in all swards except those of pure tall fescue and were most severe in pure browntop. In 1978-79 when swards were considered to be well established losses in production were largest in pure white clover, browntop-white clover and ryegrass-white clover swards and lowest in tall fescue sown with and without white clover and in swards of pure browntop. Losses in swards of all other species were intermediate to these groups (Fig. 1).

In 1977-78 untreated prairie grass, cocksfoot and tall fescue sown without white clover produced more total herbage ($P<0.05$) than did other pure grass swards even when protected with insecticide. Cocksfoot and tall fescue sown with white clover and left untreated produced more herbage than all the other untreated white clover-grass swards. In the following season 1978-79 untreated tall fescue sown with and without white clover outproduced all other pure grass species and mixtures irrespective of insecticidal protection. Production of the untreated tall fescue with and without white clover in 1978-79 was not significantly lower than the respective insecticide treated swards.

DISCUSSION

The species under evaluation both as pure swards and with white clover were subjected to a wide range of grass grub densities over the time that these studies were conducted (Table 1). With the exception of 1977 lower ($P<0.05$) numbers of grass grub were found under pure grasses than white clover-grass swards and were generally lowest under pure cocksfoot, phalaris and browntop and highest under tall fescue (with and without

TABLE 2: Mean† autumn botanical composition (%) of pure grass species, white clover and mixed swards left untreated (un) and treated (ins) with insecticide for grass grub control.

Pasture species	Pure				With White Clover					
	Sown grass		Weed spp.		Sown grass		Sown Clover		Weed spp.	
	INS	UN	INS	UN	INS	UN	INS	UN	INS	UN
ryegrass	95.7	93.9	4.3	6.0	66.7	67.8	18.2	12.2	15.0	20.0
tall fescue	98.5	99.4	1.5	0.6	91.9	92.7	3.7	3.6	4.5	3.7
phalaris	93.6	95.9	6.4	4.1	68.9	68.4	9.5	7.1	21.6	24.4
prairie	99.1	99.8	0.9	1.2	89.6	95.6	1.0	0.9	9.4	3.5
cocksfoot	99.5	97.2	0.5	2.8	91.7	90.1	3.7	3.7	4.6	6.2
browntop	98.3	91.5	1.7	8.4	61.3	56.5	24.0	21.0	14.7	22.4
white clover							26.3	11.6	73.7	88.4
LSD P - 0.05	14.1		12.9		14.1		10.8		12.9	

† mean of three autumns 1977, 78 and 79.

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white clover) and white clover. The low numbers of grass grub under cocksfoot-white clover reflect the low clover content found in these sub-plots (Table 2) whereas browntop-white clover and phalaris-white clover which had much higher clover content supported higher numbers of grass grub. These trends in grass grub density are in broad agreement with the findings of Kain and Atkinson (1977) and Kain *et al* (1978).

With the exception of tall fescue swards and pure browntop trends in losses in production in the autumns of 1978 and 1979 when swards were considered to be well established paralleled grass grub density. The ability of established tall fescue to support high numbers of grass grub when sown with and without white clover and still out produce all other swards irrespective of whether they were protected with insecticide is remarkable. Substantial losses (20%) did however occur in tall fescue swards in the autumn after sowing but % losses in the following autumn were small and not significant. More detailed investigations on the effects of grass grub root pruning on tall fescue are currently being conducted.

In these studies the mixtures and species most severely damaged by grass grub, ryegrass-white clover, browntop-white clover, white clover, browntop and ryegrass are the most commonly occurring species in New Zealand pastures. Therefore efforts to improve the tolerance of these species to grass grub attack through plant breeding or management could confer large increases in pasture productivity especially in areas where grass grub is a severe and persistent pest.

FIG 2. Annual production (DM kg/ha) from a range of grass species sown with (upper left) and without (lower left) white clover and left untreated ■ and treated □ with insecticide for grass grub control and % annual losses in production. Within species or mixtures LSD ($P=0.05$) = I and between treatment LSD ($P=0.05$) = I. (R = Ryegrass, T = Tall fescue, Ph = Phalaris, Pr = Prairie, C = Cocksfoot, B = Browntop, WC = White clover.)

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The relatively small annual losses (Fig. 2) resulting from grass grub damage recorded in these studies tend to obscure the very high losses recorded in susceptible swards in autumn which frequently exceeded 30% (Fig. 1). Although pure browntop only supported low levels of grass grub it suffered a disproportionately high loss in productivity even in the absence of visible grass grub damage. In autumn 1979, however, an unexpected increase in herbage production occurred in untreated pure browntop. Similar increases were also recorded from phalaris-white clover (summer 1977) and prairie grass (summer 1978-79). Temporary increases in foliage growth following root pruning are known to occur with some grasses (Troughton 1957).

Carry over effects of grass grub damage well outside the season when the pest is actively feeding and in certain cases unaccompanied by changes in botanical composition were most marked in spring 1978 (e.g., tall fescue, phalaris, prairie grass and cocksfoot sown with white clover and pure white clover, cocksfoot and prairie grass) but also occurred in the summer of 1977-78 (e.g., browntop and ryegrass). In the 1978-79 seasons carry over effects were only recorded in white clover and could be accounted for by botanical compositional changes. These carry over effects in the absence of changes in botanical composition require closer examination to determine whether or not they are associated only with young swards or occur under certain conditions in older swards. Such observations may explain the apparent losses and deterioration in pasture production reported to occur following grass grub damage even when the pest is absent or not actively feeding.

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