EFFECTS OF GRASS GRUB DENSITY ON PRODUCTION OF TALL FESCUE, COCKSFOOT AND RYEGRASS SOWN WITH WHITE CLOVER

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SUMMARY

The effects of grass grub *(Costelytra zealandica)* on the production of tall fescue *(Festuca arundinacea)*/white clover *(Trifolium repens)*, cocksfoot *(Dactylis glomerata)*/white clover and ryegrass *(Lolium perenne)*/white clover swards were assessed by seeding grass grubs into small plots to give autumn grass grub population densities 0 to $>600/m^2$. Herbage production measurements in autumn-winter and spring suggest that the tolerant species, tall fescue and cocksfoot, will outyield ryegrass in the presence of grass grub at densities up to the highest tested, with the greatest difference occurring between 200 and 400 grass grubs/m².

INTRODUCTION

Tolerance to insect pest attack was defined by Painter (1951) as the ability of a plant to grow and reproduce itself or to repair injury to a marked degree while supporting a population about equal to that damaging a susceptible host. Recent field studies of grass grub-pasture species interactions in the central and southern North Island have shown that grasses such as tall fescue and cocksfoot are tolerant to grass grub attack, whereas species such as ryegrass, browntop *(Agrostis tenuis)* and white clover are highly susceptible (Kain *et al* 1979; East *et al* 1980). Identification of tolerance and susceptibility in these studies depended upon the comparison of herbage production from areas treated with insecticide to exclude grass grub with that from adjacent infested areas. The range of grass grub densities encountered in the untreated areas was limited to that occurring naturally.

Average autumn grass grub densities in grass/white clover swards over a 3-year period ranged from 45 to 231/m² at Takapau (Kain *et al* 1979) and from 35 to 340/m² at Wairakei (East *et al* 1980). These studies did not fully evaluate the effects of the typical peak autumn population levels of 400 to 650 larvae/m² encountered in grass/white clover pastures in the central and northern North Island. In addition, the effects of a given grass grub density on pasture production can vary widely from year to year with such factors as weather, soil moisture and fertility (e.g., Graber *et al* 1931; Kelsey and Hoy 1950; East 1972). The objective of this study was to obtain a more precise assessment of tolerance by simultaneously measuring the effects of a wide range of grass grub population densities on the production of tall fescue, cocksfoot and ryegrass sown with white clover.

METHODS

Swards of 'Grasslands Roa' tall fescue/'Grasslands Pitau' white clover, 'Grasslands Wana' cocksfoot/Pitau white clover and 'Grasslands Nui' ryegrass/Pitau white clover were established in 2 m x 1 m plots of grass grub-free Horotiu sandy loam soil at Ruakura in November 1980. The grasses were planted out as 12-month old glasshouse-raised plants at 20 cm spacings (66 plants per plot) to ensure an initially uniform sward composition within each species combination; the white clover was established from seed sown at 3.5 kg/ha. The swards were initially mown as necessary to maintain composition and production, with 30% potassic superphosphate applied at 500 kg/ha/annum.

Following an initial production cut in February 1981, known numbers of second and third-instar grass grub larvae collected from a site at Tihoi were seeded into the plots by placing 1 to 2 cm of soil containing the grubs on to the surface and allowing the grubs to bury themselves. Survival of seeded grubs was assessed by taking 20, 5 cm diameter soil cores from each plot within 2 weeks of seeding. This revealed an average survival of 64% of the seeded grubs, with initial population densities from 0 (no grubs seeded) to 617/m² established in individual plots. A futher sampling 4 weeks later revealed 92% survival of the grubs which had been established successfully.

There were two unseeded and five seeded plots of both tall fescue/white clover and cocksfoot/white clover, and one unseeded and six seeded of ryegrass/white clover. Grass grub densities were not replicated within pasture species treatments since the aim was to relate herbage production to grass grub density. Both pasture species and grass grub densities were randomised among plots, which were surrounded with 4 cm thick timber sunk to a depth of 45 cm to prevent movement of grubs between plots.

Herbage production was measured from February to November 1981, by mowing a 2.0 x 0.45 m strip along the centre of each plot (cutting height 5 cm). The remainder of each plot was then mown and the herbage discarded. The swards were growing vigorously when the grass grubs were seeded, after above average summer rainfall at Ruakura in 1980-81, and the weather remained generally favourable for pasture growth throughout the period that herbage production was measured.

RESULTS

The initial production cut in February 1981 showed uniform herbage production and composition within each grass/clover combination, with the total production and grass and clover content differing between individual plots by less than 10% of the mean. Herbage production after the grass grubs were seeded is divided into two periods: autumn and winter (February to August) when the grubs were feeding actively, and spring (September to November) when the grubs had ceased feeding and larval growth. Production was similar in the three swards in the absence of grass grub (Table 1). The yields in Table 1 reflect the uniformly high-producing swards within the small plots and represent potential levels of production rather than actual levels to be expected under practical farming conditions.

Grass grub affected the total autumn-winter production of the ryegrass/white clover sward much more severely than the tall fescue/white clover and cocksfoot/white clover, which showed similar tolerance to grass grub (Fig. 1). Total spring production of tall fescue/white clover was unaffected by grass grub density in the previous autumn, whereas at autumn densities above 75/m² production of ryegrass/white clover failed to recover in the spring, after grass grub feeding had ceased. The cocksfoot/white clover sward showed a tendency toward incomplete recovery in spring at the highest grass grub densities.

As expected, among the individual components, ryegrass and white clover were affected more severely by grass grub than tall fescue and cocksfoot. In the ryegrass/white clover sward spring production of ryegrass was only slightly lower in the

TABLE 1: Herbage yields of grass grub-free plots in autumn-winter (February-August) and spring (September-November) (average of two plots for tall fescue/white clover and cocksfoot/white clover).

Species	kg DM/ha Autumn-winter	kg DM/ha Spring
tall fescue/white clover	6770	8340
cocksfoot/white clover	6430	9030
ryegrass/white clover	6510	9050

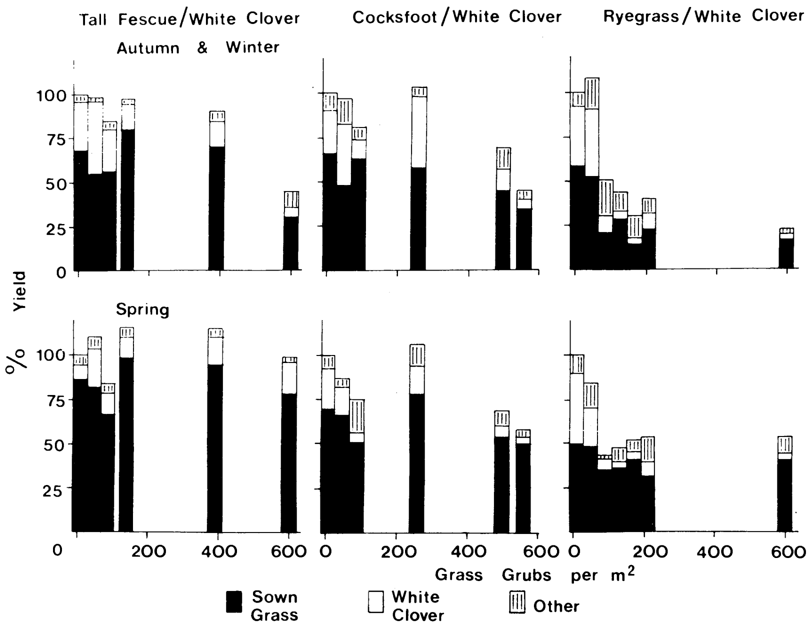

Fig. 1: Autumn-winter and spring herbage production of grass/white clover swards at different initial grass grub population densities (February). Herbage production expressed as percentage of total yield in unseeded plots.

seeded plots than in the unseeded (Fig. 1), but this may reflect a swing in the ryegrass/white clover balance of the unseeded plot in favour of white clover rather than recovery of the ryegrass in the seeded plots from grass grub damage. A similar increase in white clover content did not occur in the unseeded plots of the other two swards.

DISCUSSION

Tolerance to grass grub attack may be of more practical use in grass/clover pastures than resistance, i.e., the ability to suppress grass grub numbers to low levels. Unlike tolerant grasses, none of the pasture species known to be resistant to grass grub are of practical value in reducing the impact of grass grub on the production of grass/legume mixtures, with the exception of lucerne *(Medicago sativa)* (East *et al* 1980). The ability of grazing systems to sustain some losses in pasture production without affecting animal production (Kain 1979) makes utilisation of plant tolerance more feasible than in systems where even very low pest populations cause economic damage, e.g., export fruit production. In addition, the lack of selection pressure placed on pest species by tolerant compared to resistant plants suggests that tolerance might provide more effective long-term control, since resistance ultimately leads to the appearance of pest biotypes which have overcome the resistance factors (Sutherland 1979). Nevertheless, tolerant plants must be able to produce satisfactorily even at the highest pest populations likely to be encountered frequently in the field for this approach to be fully effective.

The herbage production-grass grub density relationships in Fig. 1 are specific to the environmental conditions of this experiment but they suggest that grass grub may have relatively little effect on the autumn-winter production of Roa tall fescue/white clover and Wana cocksfoot/white clover pastures until grub populations reach high levels (>400/m^2), with little or no carry-over effect of grass grub damage on production in the subsequent season, at least in the case of tall fescue. First-year tall fescue pastures are more susceptible to grass grub damage than older pastures (Kain *et al* 1979; N.A. Thomson, pers comm), but the plants were in their second year when exposed to grass grub attack in this study.

The sensitivity to pest attack of rotationally grazed pastoral systems depends upon the available pasture in the entire grazing system relative to animal requirements (Kain 1979). Grass grub populations typically increase steadily in newly infested pastures until they reach a peak level, after which numbers frequently decline naturally to low levels (East and Kain 1982). Only a few paddocks on a farm will usually support peak population levels in a given year, with more paddocks containing medium population levels (200 – 400/m^2). Population monitoring in 26 paddocks in the Waikato and the North Island volcanic plateau from 1979 to 1982 has revealed that on average 9% of the paddocks contained autumn populations greater than 400/m^2 in any one year, whereas 34% contained more than 200/m^2 (East, unpublished information). The difference in herbage production between the tolerant grasses, tall fescue and cocksfoot, and the susceptible species, ryegrass, appears to be greatest at medium population levels (Fig. 1), confirming the potential of these tolerant species for reducing pasture losses caused by grass grub.

Tolerant cultivars of ryegrass and white clover may eventually provide the best solution to pasture pest problems in New Zealand, but until such cultivars are commercially available tolerant species such as tall fescue and cocksfoot provide a useful alternative to direct control methods such as insecticides and cultivation. Tall fescue has shown exceptionally high productivity and considerable drought tolerance in addition to its tolerance of grass grub (Kain *et al* 1979; East *et al* 1980). It is possible, however, that grass grub may increase to higher peak population levels under tolerant than under susceptible pasture species, eventually causing significant pasture damage, e.g., if tolerant species have the effect of raising the threshold population density for the density-dependent larval mortality which regulates grass grub populations (East 1972, 1979; Kain 1975). A full evaluation of the usefulness of tolerant pasture plants for overcoming grass grub damage will therefore depend upon the results of long-term population and damage assessment studies.

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