GRASS GRUB (*COSTELYTRA ZEALANDICA*) POPULATIONS UNDER *PINUS RADIATA* AGROFORESTRY

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SUMMARY

Grass grub (*Costelytra zealandica* White) populations were monitored annually over 14 years from tree age 4 in an agroforestry trial at a range of tree stocking rates. The trees (*Pinus radiata* D. Don) were planted into pasture in 1973 with final stocking rates of 0, 50, 100, 200 and 400 stems/ha. Peak grass grub larval populations were generally low (less than 100/m²) for all tree stocking rates throughout this period. At tree age 18 (1991) all treatments had populations less than 10/m². There was no consistent pattern of decreasing grass grub larval numbers with increasing tree stocking rate.

Keywords: soil insects, population density, grass grub, agroforestry

INTRODUCTION

Agroforestry is the collective name for land-use systems and technologies where woody perennials are deliberately used on the same land management unit as agricultural crops and/or animals. In New Zealand, agroforestry is seen as an integrated farming and forestry operation for the economic benefit of the farmer. It encompasses pasture and livestock management, and silviculture.

Agroforestry research was undertaken in New Zealand, commencing in the early 1970's in response to lower returns from sheep farming, an improvement in timber values and a shortage of land for increased forestry plantings. A number of advantages of a 2 tier agronomic system have been identified (Billbrough 1984; Pimentel *et al* 1986). Some of the most comprehensive empirical data have come from the Tikitere agroforestry trial, established in 1973. This experiment has been described in detail (Hawke *et al* 1980; Percival *et al* 1984).

The economics of agroforestry are sensitive to a number of key forestry and agricultural parameters. A key agricultural factor is livestock carrying capacity, which is dependent on pasture productivity. Amongst the many factors which influence pasture productivity in the lighter soils of the central North Island is grass grub (*Costelytra zealandica*) (East *et al* 1980).

This contribution reports on the grass grub populations from annual surveys from 1977 (tree age 4 years) to 1991 at the Tikitere agroforestry trial, near Rotorua.

METHODS

Plantings of *Pinus radiata* were made into existing farmland in 1973 as a series of 2 ha replicated plots. Plot topography ranged from flat to moderately steep. Plots sampled were classified as flat and were unreplicated. The soil type was well drained Rotoiti sandy loam based on Kaharoa ash.

Soil sampling for macro fauna was carried out annually in April, starting in 1977 at tree age 4 years. Soil sampling methods were based on tree stocking rate and varied over time. Initially thirty 1 metre plough furrows were taken to a depth of 5 cm with final counts adjusted to a 15 cm depth based on calibration counts. On the 400 stems/ha plots 50 spade samples were taken to a depth of 15 cm. In 1991 200 soil cores of 10 cm diameter were taken to 15 cm depth from all plots. All soil samples were hand sorted in the field. Samples were taken on two parallel transects covering the full length of the plot. Plots sampled were open pasture and tree stocking rates of 50, 100, 200, and 400 stems/ha. The 50 and 100 stems/ha plots were not sampled

Proc. 45th N.Z. Plant Protection Conf. 1992: 220-222

in 1977 and no plots were sampled in 1978. Forested areas sampled were free from thinning and pruning debris, otherwise as far as practical the sampling was random along the transects.

RESULTS AND DISCUSSION

Grass grub populations were highest in 1980 and 1981 and peaked at densities of less than $100/\text{m}^2$ (Fig. 1), a level below that at which serious pasture damage occurs. Populations subsequently declined to less than $10/\text{m}^2$ in most plots by 1987 and remained at this level in 1991.

Fig. 1: Grass grub (*Costelytra zealandica*) larval density (No./m²) sampled annually from five plots with different tree stocking rates on the Tikitere Agroforestry Trial.

There was no evidence that increasing tree stocking rate had any effect on grass grub population density over the 14 year period. This result is at variance with results of East and Percival (1984) who showed a significant inverse correlation between tree stocking rate and grass grub numbers in some years. In the study by East and Percival (1984) grass grub populations peaked at densities of about $100/\text{m}^2$ and there was a gradual decline in density on all plots (tree containing plots and open pasture) as the trees matured.

Several factors may account for the decreasing grass grub population density with increasing time. Firstly as the trees became larger, pasture plant species composition changed from plant species which are considered favourable to grass grub, such as white clover (*Trifolium repens*), to less desirable species, such as *Lotus pedunculatus* (Percival *et al* 1984). The only live vascular plant material available to grass grub larvae by 1991 in the 200 and 400 stems/ha plots was *P. radiata* roots. Secondly, the percentage of pine needle litter is considerably increased as the trees mature. In 1991, the percentage cover by pine needles was visually estimated at 95% and 80% on the 400 and 200 stems/ha plots respectively (Willoughby unpubl. data). This may also result in changes to soil chemical properties as tannins and other compounds are released by the pine needles although this was not evident in 1986 (Yeates 1988). However neither of these explanations are valid for populations in open pasture where numbers were also low.

Examination of grass grub larvae from the open pasture in 1991 showed that they had ceased feeding having reached full body weight while larvae in the tree plots were still actively feeding. Larval disease levels in the open pasture were 27% (n=11) but disease was not detected in larvae from the tree plots (n=9) (Willoughby unpubl. data). Although only small numbers of grass grub were examined this result implies that different population regulation factors may be operating.

Generally only small populations of other macroinvertebrates were recorded in the annual survey and results for 1982 and 1991 are presented in Table 1. Population densities were generally higher on the 0 and 50 stems/ha areas than on the 200 and 400 stems/ha areas.

TABLE 1: Soil insect densities (No./m²) when sampled in autumn in 1982 and 1991 under increasing *P. radiata* densities.

Stocking rate Insect species	stems/ha:	1982					1991				
		0	50	100	200	400	0	50	100	200	400
<i>Costelytra zealandica</i>		43	45	16	11	21	7	4	6	7	5
<i>Heteronychus arator</i>		4	0	1	0	0	2	1	1	0	0
<i>Graphnognathus leucoloma</i>		1	0	0	0	0	21	3	2	0	0
<i>Listroderes delangnei</i>		1	0	0	0	0	36	3	1	0	0
<i>Conoderus excel</i>		2	1	1	1	1	7	14	8	0	0
<i>Inopus rubriceps</i>		0	0	0	0	0	4	10	1	1	0
<i>Staphilinidae</i> sp.		0	0	0	0	0	1	0	0	0	0
<i>Wiseana cervinata</i>		0	0	0	0	0	1	19	0	2	6

ACKNOWLEDGEMENTS

The authors thank R. East for his initiation of the survey and C. Thomson, S. L. Marshall and N. L. Bell for technical assistance.

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