INTERACTIONS BETWEEN ARTIFICIAL FERTILISERS AND GRASS GRUB LARVAE: PRELIMINARY STUDIES

R.A. PRESTIDGE, G.P. BURTON and S. VAN DER ZIJPP

*Ruakura Soil and Plant Research Station
Ministry of Agriculture and Fisheries, Hamilton*

SUMMARY

The consumption and growth rate of grass grub (*Costelytra zealandica*) were assessed when feeding on cocksfoot (*Dactylis glomerata*) and tall fescue (*Festuca arundinaceae*) that had been treated with NPK Ammo-phos fertiliser (15:12:10). Plant root nitrogen concentration was a better indicator of food quality than quantity of fertiliser applied. No relationship was observed between consumption and growth rates when feeding on cocksfoot although with one exception larvae lost weight. When feeding on treated tall fescue roots, larvae showed a 'normal' type response curve, maximum consumption and growth rates occurred when plant root nitrogen levels were 0.7% dry weight.

INTRODUCTION

The addition of artificial fertiliser to pasture influences insect populations through two dominant processes. It increases the food supply, both the quality and quantity of food, and secondly, it increases the 'living area' (Southwood 1972) available to insects as pasture growth is stimulated and plant biomass increases. A number of indirect effects may also be apparent with fertiliser addition, for example pH changes with the addition of lime.

Information on the behaviour and performance of grass grub on different hosts and under different pasture management is vital in predicting the outcome of different pasture systems on grass grub populations (Kain and Atkinson 1977). It is known that grassland insects are affected by food quality. Low levels of available nutrients, and in particular nitrogen result in poor survival and slow population increase. A low quality food source probably has little direct effect on survival in most insects. It generally operates through increased developmental times, promotion of smaller (and weaker) individuals and reduced fecundity. Increased developmental times necessarily implies longer exposure to potential natural enemies and disease organisms and smaller and weaker individuals are more easily killed by disease, weather and other factors (for examples, see Prestidge and McNeill 1981).

The recent announcement of the proposed Kapuni urea plant would suggest an increase in the usage of nitrogen in the future, especially on high producing dairy farms (O'Connor 1979). At present very little is known about the effects of nutrient levels in plants on grass grub populations.

This paper presents some initial results from a study of grass grub larval consumption and growth when feeding on pasture plants that had been treated with different rates of artificial fertiliser.

METHODS

The methods used in this study were adapted from those used to measure food consumption by black beetle (*Heteronychus arator*) (King *et al.* 1981).

One year old 'Grasslands 17' cocksfoot and 'Grasslands Roa' tall fescue plants were transplanted into a horticultural grade pumice medium and supplied with the following rates of Ammo-phos (NPK 15:12:10) fertiliser: 0 kg/ha (control), 100 kg/ha,

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300 kg/ha and 500 kg/ha in two applications at monthly intervals. Plants were trimmed to maintain a vegetative growth form and active root growth. Approximately 2 weeks after the second fertiliser application plants were removed and washed roots were fed to grass grub larvae.

Second instar grass grub larvae were collected from a mixed grass/legume pasture at Tihoi near Taupo in February 1980. The larvae were sorted, weighed and then placed singly into individual compartments of plastic ice cube trays. Freshly harvested and washed plant roots of untreated cocksfoot and tall fescue were provided as a food source and the larvae left for 5 days to adapt to the new conditions maintained at 18°C. Each tray was covered with a moist paper towel, wrapped in tinfoil to exclude light, and sealed in a plastic bag.

Every 2 days, plants were removed from the growing medium and the roots washed free of pumice. Approximately 100 mg (fresh weight) of root material from each treatment was weighed and given as a renewed food source to 40 grass grub larvae. Feeding larvae were weighed and the faecal pellets counted each time the food was changed. Consumption and growth data obtained from larvae that moulted during the trial was not included in the final analysis. The trial continued for 15 days with each plant species.

Root nitrogen levels were determined on material collected at a 2 day intervals by the standard micro-Kjeldahl technique.

RESULTS AND DISCUSSION

Influence of fertilisers on plant root nitrogen levels

There was an overall increase in root nitrogen concentration with fertilizer addition but with quite large variability of root nitrogen concentration within each fertilizer treatment (Fig. 1). This variability was most probably due to differential uptake of nutrients by individual plants and competition for nutrients between plants. For this reason total plant root nitrogen concentrations rather than fertiliser application rates were used as an indicator of plant food quality

Food quality is defined here in its broadest sense as a measure of the general excellence of the food. Nitrogen has been chosen as an indicator of food quality due to its fundamental importance to herbivores, its occurrence in the plant at low levels and its large intraseasonal concentration differences (Prestidge and McNeill 1981).

Insect mortality

Insect mortality was higher on cocksfoot than on tall fescue. Most of the mortalities were associated with escape from the individual feeding compartments into other compartments and subsequent larval combat. Both grass species were treated

Fig. 1 Influence of NPK fertiliser on plant root nitrogen concentration.

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similarly but escape was greater when the larvae were feeding on cocksfoot. Fertiliser treatment and plant nitrogen level effects were not significant, reinforcing the view that plant nutrient levels do not directly affect insect mortality throughout the range normally found in plants.

Food consumption

Food consumption was determined indirectly by counting the number of faecal pellets produced each feeding session. This is not altogether accurate due to gut retention times (Walbauer 1968) but the same type of response is produced as by the weight specific consumption rate (Prestidge unpubl. data). Consumption on tall fescue was maximum at root nitrogen levels of 0.7% dry weight (Fig. 2). Maximum consumption was approximately three times greater than consumption at lower levels. High plant nitrogen levels also depressed insect consumption, a phenomenon that has been found elsewhere (Prestidge 1981). Consumption when feeding on cocksfoot with different root nitrogen levels was nonsignificant ($p > 0.1$) but the trend indicates maximum consumption at 0.7% nitrogen. A t test on the consumption of untreated cocksfoot and tall fescue revealed that larvae consumed significantly ($p < 0.01$) more when feeding on tall fescue.

Insect weight changes

When feeding on tall fescue, grass grub weight changes followed a 'normal' shaped curve with weight losses occurring at low and high root nitrogen levels. Maximum body weight increases occurred at 0.7% nitrogen i.e. on those values that had the highest consumption. Larvae consistently lost weight when feeding on cocksfoot. This effect needs to be examined further using 3rd instar larvae before field testing. It is possible that 'Grasslands 17' has resistance to attack by grass grub larvae as Farrell and Sweeney (1974), Farrell (1975) and Kain and Atkinson (1977) indicate no resistant properties in 'Grasslands Apanui' cocksfoot.

Kain and Atkinson (1977) have shown that larval weight gain is a good indicator of field survival. Low and high plant root nitrogen levels promoted negative body weight gains. It may be that tall fescue is an unusual grass species as it is known to be favourable to grass grub and also to be remarkably tolerant to attack (East *et al.* 1980). However, if the root nitrogen levels which produced negative weight gains represent levels which could be easily achieved under field conditions in grazed pastures, then nitrogen applications may be a valuable tool for manipulating grass grub populations. Low root nitrogen levels were achieved in this trial by growing plants in a low fertility situation without legumes, but high root nitrogen levels could easily be obtained with fertiliser application.

Fig 2. Insect consumption (No. faecal pellets/insect/day) when feeding on plant roots with different nitrogen concentrations.

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Fig. 3 Grass grub weight changes (mg/insect/day) when feeding on plant roots with different nitrogen concentrations.

CONCLUSIONS

From these studies it is apparent that plant nutrient levels can have a major effect on insect growth and performance. Results from work involving pot trials and small plot trials will need to be examined with caution and rigorously defined. On a more speculative note, manipulation of plant nutrient levels may provide a management technique that will help to control grass grub attack. Obviously further work will concentrate on this aspect.

REFERENCES

- East, R., Kain, W.M. and Douglas, J.A. 1980. The effect of grass grub on the herbage production of different pasture species in the pumice country. *Proc. N.Z. Grassl. Assoc.* 41: 105-15.
- Farrell, J.A.K., 1975. Effects of food plant species on the weight loss, survival and fecundity of adult *Costelytra zealandica* (Coleoptera: Scarabaeidae). *NZ Jl. Agric. Res.* 18: 303-5.
- Kain, W.M. and Atkinson, D.S. 1977. Development of resistant pasture and methods of pasture management for grass grub (*Costelytra zealandica* (White)) control. *NZ Jl. Agric. Res.* 20: 507-17.
- King, P.D., Mercer, C.F. and Meekings, J.S. 1981. Ecology of black beetle (*Heteronychus arator*). Influence of plant species on larval consumption, utilisation and growth. *Ent. Exp. & Appl.* 29: 109-16.
- O'Connor, M.B. 1979. Kapuni urea, too much, too dear. *NZ Farmer* 100(20): 25, 27, 29.
- Prestidge, R.A. 1981. Instar duration, adult consumption, oviposition and nitrogen utilisation efficiencies of leafhoppers feeding on different quality food (Auchenorrhyncha: Homoptera). *Ecol. Ent.* (In press.)
- Prestidge, R.A. and McNeill, S. 1981. The role of nitrogen in the ecology of grassland Auchenorrhyncha. *Symp. Brit. Ecol. Soc.* 22: (in press).
- Southwood, T.R.E. 1972. The insect/plant relationship — an evolutionary perspective. *Symp. Roy. Ent. Soc.* 6: 3-33.
- Waldbauer, G.P. 1968. The consumption and utilisation of food by insects. *Adv. Insect Physiol.* 5: 229-288.