**DELAYED ACTION OF AN ENTOMOPHAGOUS NEMATODE
(*HETERORHABDITIS* sp. (V16)) FOR GRASS GRUB CONTROL**T.A. JACKSON¹ and W.M. WOUTS²¹MAFTech, P.O. Box 24, Lincoln²Entomology Division, DSIR, Auckland

Entomophagous nematodes have shown considerable promise as control agents for insect pests, especially those inhabiting the soil (Poinar 1983). In New Zealand they have been effective in field trials against grass grub (*Costelytra zealandica*) (Jackson and Trought 1982, Kain *et al* 1982), porina (*Wiseana* sp.) (Kain *et al* 1981, van der Mespel *et al* 1986) and black vine weevil (*Otiorhynchus sulcatus*) (Jackson *et al* 1985). In all cases control was obtained in the season of application but, where assessed, the nematodes have been considered ineffective for longer term control (van der Mespel *et al* 1986). In this note we report on a trial in which the nematodes became established without any apparent effect in the first season but then gave good control of grass grub in the second.

A culture of the nematode *Heterorhabditis* sp. (V16) was originally provided by Dr R. Bedding (CSIRO, Tasmania) and mass reared on artificial media (Wouts 1981). The trial was laid down on a border dyke irrigated pasture at the Winchmore Irrigation Research Station, Canterbury. Nematodes were applied on 11/1/84 (soil moisture 30%, temperature at 50 mm, 22°C) at the rate of 0.5M/m² in a soil drench of 2 litres water/m² through a watering can. The design was randomised with five replicates of treated and untreated plots, each 3 x 3 m. An estimate of grass grub population density was made before application and nine, 64 mm diameter cores per plot were taken to a depth of 150 mm on 2/3/84 and 10/4/84. In 1985, five, 150 mm spade cubes/plot were taken on 21/1/85, 22/4/85 and 11/6/85. Nematode survival at the site was assessed throughout the experiment by using wax moth larvae to trap the nematodes from soil samples (Bedding and Akhurst 1975). Soil temperature at 50 mm and soil moisture (0-100 mm) were recorded from similar pasture under the same irrigation regime on an adjacent site throughout the trial.

In the first population density estimate, 6 weeks after application, 9% of the grass grub larvae in the treated plots were found dead with nematode infections. Nematodes were isolated in the wax moth traps from all treated plots indicating their successful establishment. Despite this, the nematodes had a negligible effect on the population 6 and 12 weeks after application (Fig. 1a). When the site was resampled in January 1985, however, 14% of first and second instar larvae in the treated plots were found to be infected by nematodes and the larval population was significantly reduced ($P < 0.05$) compared with the untreated (Fig. 1a). This level of infection represents only a small proportion of the total number that had been infected as the cadavers rapidly collapse and disappear.

Nematode trapping in February, May and June 1985 showed that the nematodes had spread throughout the site. Sampling in an area adjacent to the trial revealed invasion by the nematodes as 56% of the grass grub larvae were found dead with nematode infections (20/36 from 7 spade samples). No naturally occurring entomophagous nematodes have been isolated from pasture in the area and the nematodes recovered from the trapping were identified as *Heterorhabditis* sp.

Soil moisture levels were above 20% for the whole period. In January 1984 mean soil temperature was 17.4°C dropping to a minimum of 5.4°C in July 1984. The summer of 1985 was warmer with a January mean of 19.6°C (Fig. 1c).

The results indicate the importance of monitoring nematode trials beyond the season of application. In 1984 nematode trapping and recovery of infected larvae revealed that, although the nematodes had become established on the site, the level of infection was insufficient to cause any significant reduction of grass grub numbers.

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Fig. 1: (a) Grass grub populations 1984/85 following nematode application. Treated, +----+; untreated, 0----0. Assumed population trend Nematode recovery from treated (□) and untreated (Δ) plots. (b) Grass grub life cycle at Winchmore; E, egg; L, Larvae; P, pupae; A, adult. (c) Seasonal pattern of maximum and minimum soil temperatures (50 mm) at the Winchmore Irrigation Research Station.

After May, soil temperatures would have been too low for activity by this nematode. Molyneux (1986) has shown that *Heterorhabditis* sp. (V16) is barely active at 12 °C and it has only shown a low infectivity of grass grub larvae at 15 °C (Jackson unpublished). High levels of infection and mortality occurred when the temperatures rose again above this threshold in summer 1984/85. It is likely that the nematodes had their greatest effect against early larvae in the Dec/Jan period (Fig. 1b). Eggs are not affected by heterorhabditid nematodes and at the pupal stage temperatures were too low for infection.

Heterorhabditid nematodes have the potential to establish in pasture and cause considerable mortality when conditions are favourable. In this case the reason for their success may have been the higher soil temperatures of the 1984/85 summer. The nematodes survived on the site for at least 18 months and by the second season they had spread throughout the site. This may have been aided by the border dyke irrigation. While the spread of the nematodes to the untreated areas was clearly demonstrated their contribution to the population decline in these areas was less clear. Grass grub populations on irrigated pastures throughout the area declined during the trial for unknown reasons.

Long term survival in the soil is an important attribute of entomophagous nematodes and should be considered in selection of nematodes for pest control. Also nematodes with lower temperature thresholds for infection need further evaluation as these would have a longer period of activity and would be less affected by seasonal variations in temperature.

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REFERENCES

- Bedding, R.A. and Akhurst, R.J., 1975. A simple technique for the detection of insect parasitic rhabditid nematodes in soil. *Nematologica* 21: 109-110.
- Jackson, T.A. and Trought, T.E.T., 1982. Progress with the use of nematodes and bacteria for the control of grass grub. *Proc. 35th N.Z. Weed and Pest Control Conf.*: 103-106.
- Jackson, T.A., Pearson, J.F. and Barrow, T., 1985. Control of the black vine weevil in strawberries with the nematode *Steinernema glaseri*. *Proc. 38th N.Z. Weed and Pest Control Conf.*: 158-161.
- Kain, W.M., Wyeth, T.K., and Kale, A.J., 1981. Preliminary field studies on the use of an indigenous parasitic nematode for the control of porina. *Proc. 34th N.Z. Weed and Pest Control Conf.*: 173-175.
- Kain, W.M., Bedding, R., and van der Mespel, C.J., 1982. Preliminary evaluation of parasitic nematodes for grass grub (*Costelytra zealandica* (White)) control in the Central Hawkes Bay of New Zealand. *N.Z. J. Exp. Agric.* 10: 447-450.
- Molyneux, A.S., 1986. *Heterorhabditis* spp. and *Steinernema* (= *Neoaplectana*) spp.: Temperature and aspects of behaviour and infectivity. *Experimental Parasitology* 62: 169-180.
- Poinar, C.O. Jr. 1983. Recent developments in the use of nematodes in the control of insect pests. *Proc. 10th Int. Congress of Plant Protection, Brighton*. 751-758.
- van der Mespel, G.J., Kain W.M., and Wouts, W.M., 1986. Evaluation of an entomophagous nematode (*Steinernema bibionis*) for the control of porina larvae (*Wiseana* spp.) in the Otaki district. *Proc. 39th N.Z. Weed and Pest Control Conf.*: 114-116.
- Wouts, W.M. 1981. Mass production of the entomogenous nematode *Heterorhabditis heliothidis* (Nematoda: Heterorhabditidae) on artificial media. *Nematology* 13: 467-469.