THE EFFECT OF MOISTURE AND METHOD OF APPLICATION ON THE ESTABLISHMENT OF THE ENTOMOPHAGOUS NEMATODE (*Heterorhabditis bacteriophora*) IN PASTURE

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SUMMARY

Suspensions of infective larvae of the entomophagous nematode, *Heterorhabditis bacteriophora,* were applied to pasture in dry conditions, during rain and immediately prior to irrigation. Three application techniques were used; a conventional spray, a jet squirt treatment and a soil drench. The jet squirt and soil drench treatments gave better establishment than the conventional spray. Few nematodes became established when applied in dry conditions but when applied during rain or prior to irrigation, better establishment was achieved.

INTRODUCTION

Increasing pesticide costs and potential resistance to insecticides have stimulated the search for alternative methods of pest control in recent years. One such method is by the inundative release of biological control agents.

Entomophagous nematodes of the genera *Steinernema* and *Heterorhabditis* can be reared economically (Bedding 1981, Wouts 1981) and their potential for control of New Zealand's pasture pests in the field has been demonstrated (Kain *et al* 1981, 1982; Jackson and Trought 1982).

Field applications of nematodes have not always given good control of pests (Poinar 1979), mainly because of early death of the nematode through desiccation (Petersen 1982). Desiccation is influenced by the method of application and environmental conditions at the time of, and after, application.

The effect of three methods of application, conventional spray, jet squirt and soil drench, carried out at different times and in a variety of weather conditions, on the early survival and establishment of the nematode *H. bacteriophora* in pasture was studied. The results are presented here.

METHODS

In 13 trials, carried out at different times throughout the late summer and autumn, 1983, 1 x 10^5 nematodes were applied to 1 m^2 plots of pasture on irrigated borders on a Paparoa soil type in Canterbury. Each trial was laid out in a randomised block design, with three treatments and three blocks. The treatments were 3 methods of application of nematodes:

A. Conventional spray. Carried out with a hand held sprayer to give a rate of water equivalent to 600 litres/ha.
B. Jet squirt. A one metre boom with nozzles spaced at 15 cm apart giving a rate of water equivalent to 1000 litres/ha.
C. Soil drench. Through a watering can applying the equivalent of 10,000 litres of water/ha.

The blocking was carried out on the basis of soil moisture with three levels obtained by border dyke irrigation.

The trials were carried out between January and April under three levels of moisture. Four applications were made in dry conditions, five in wet conditions during or following rain, and four with supplementary irrigation equivalent to 10 mm of rain applied immediately after application through a watering can to all treatments. Soil moistures and temperatures were recorded for each trial and rainfall data were also collected (Table 1).

TABLE 1: Mean (and range of) weather and soil conditions at time of nematode application.

	Dry	Rain	Supplementary irrigation
Mean soil moisture %	18 (11-22)	20 (12-28)	18 (15-22)
Mean soil temperature at 10 cm (°C)	18 (17-19)	12 (8-16)	17 (14-19)
Mean rainfall for day of application and preceding day (mm)	0.9 (0-2.8)	9.2 (trace-28.3)	1.0 (0-2.6)

The nematodes, strain V16, were reared on an artificial diet (Wouts 1981) and extracted before application to the plots. Following application, nematodes were collected from watch glasses previously set into the pasture and examined to determine any effects of method of application on viability.

After 1 week nematode survival in the soil was checked. Five 2.5 cm diameter x 15 cm deep soil cores were taken from each plot, mixed, and 250 ml of the soil placed in a sealed pottle with three wax moth (*Galleria melonella*) larvae confined at the base (Bedding and Akhurst 1975). The soil moisture level in the pottle was adjusted to 20-23% and the pottle placed in an incubator at 30°C for 1 week. The wax moth were then examined for nematode infections characterised by a distinctive brick red colouration. Infection was confirmed by dissection. Death of wax moth larvae from other causes was uncommon (<7%). If more than one larvae was dead in any pottle for reasons other than nematode attack the soil sample was retested.

Statistical analysis was carried out within each moisture level (dry, rain, irrigated) for each pair of treatments by calculating the mean difference between the treatments for each of the four (or five) trials, and carrying out a t-test to check for significant difference. This procedure is the most appropriate for analysis of a series of trials and is further elaborated by Saville (1980).

TABLE 2: The effect of conditions and methods of application of nematodes on the percentage of infected nematodes.

Methods	Conditions of application		
	Dry	Rain	Supplementary Irrigation
A. Conventional	3	6	22
B. Jet squirt	3	50	64
C. Soil drench	0	36	53
Contrast t values			
A v B	—	-5.0*	-4.5*
A v C	—	-2.7+	-4.2+
B v C	—	1.8	0.7

(+, P< 0.10; *, P< 0.05)

RESULTS

Examination of nematodes collected in watch glasses indicated that none of the methods of application affected nematode viability. Mean soil moistures under the different levels of irrigation in the treatment blocks ranged from 11-28%. However, no differences in nematode infection relating to these soil moistures were found so results from each treatment block have been combined.

The best results, with up to 64% of wax moth larvae infected, followed application with supplementary irrigation although good nematode recovery was also obtained following application during rain. When application occurred in dry conditions there was very little wax moth infection. In moist conditions (with either rain or irrigation) the jet squirt and soil drench techniques gave significantly higher infection rates than the conventional spray (Table 2).

DISCUSSION

The results show the difficulty of establishing nematodes in dry conditions, even when applied in a soil drench. Thus it appears that some supplementary moisture is necessary for successful establishment. Bedding and Miller (1981a) have suggested that survival of nematodes will be enhanced with application during rain. This was confirmed in these trials. However, this is difficult to achieve in Canterbury where summer rainfall is irregular. A further disadvantage is that rainfall in the region is usually accompanied by low temperatures, as it was in this study (Table 1), which can be below the threshold for activity of the nematodes (Jackson unpublished); this could leave them exposed and vulnerable to later desiccation on the soil surface.

The inferiority of the conventional spray method of applying nematodes was probably due to desiccation on the soil surface. Bedding and Miller (1981b) found that soil injection gave better results than surface application to potted plants. Both jet squirt and soil drench apply water in solid streams which percolates into the surface layers of soil carrying the nematodes with it. The advantage of the jet squirt system is that this is achieved with less water. Once in the soil nematodes move on films of moisture and may survive long dry periods (Simons and Poinar 1973).

The best results with nematodes for the control of pasture pests have followed mid-summer applications (Kain *et al* 1981, 1982; Jackson and Trought, 1982) but, in Canterbury at least, this is a time of little rainfall. Thus it appears that success with nematodes is most likely in irrigated pastures where application can be accompanied by irrigation. The jet squirt technique would seem to be the best application method. The soil drench technique appears to be impractical due to the high volume of water required.

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