Section IV
Biological and Cultural Control

EARLY SEASON BACKPACK AND MASON-JAR APPLICATION OF ENTOMOPATHOGENIC NEMATODES (*STEINERNEMA CARPOCAPSAE* ALL STRAIN, *STEINERNEMA FELTIAE* SN STRAIN, *STEINERNEMA RIOBRAVIS*) (NEMATODA: STEINERNEMATIDAE) AGAINST SPOTTED CUTWORM, *AMATHES C-NIGRUM* (LEPIDOPTERA: NOCTUIDAE) AND BLACK VINE WEEVIL, *OTIORHYNCHUS SULCATUS* (COLEOPTERA: CURCULIONIDAE) ON GRAPES.

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This paper deals with the use of low pressure backpack sprayer and surface (pouring) application of entomopathogenic nematodes. These two application methods are more labor intensive and perhaps less favored economically. However, they eliminate excessive passage through application and irrigation systems and the potential impact the application equipment may have on nematodes. A few scattered reports in the literature mention the impact of application equipment on the efficacy of entomopathogenic nematodes. Decreasing efficacy was observed with entomopathogenic nematodes applied through drip line and lateral move irrigation systems. Detrimental effects on plant parasitic nematodes were observed after sprinkler application. The potential reduction in efficacy can be countered by increasing nematode inocula. However, increasing product costs have to be considered.

The objective of this study was to investigate efficacy of three entomopathogenic nematode species, *S. carpocapsae* All strain, *S. feltiae* SN strain and to a lesser extent *S. riobravis* after backpack and surface (pouring) application for early season control of two major pests on grapes, Spotted cutworm (SPC) and Black Vine Weevil (BVW) and the experimental host, Greater wax moth (GM) larvae.

Materials and Methods:

Small scale application utilizing a 10 L backpack sprayer with *S. riobravis* and *S. carpocapsae* at 1 and 2 billion/acre and water as a control was replicated 5 times and applied 6 April 1995 at Badger Mountain vineyard, Kennewick, WA. Nematodes were applied around the base of forty grape vines. A hoe was used to cover nematodes directly after application to minimize effect of ultraviolet radiation. Plots were evaluated by exposing two SPC onto the treated surface area. Movement was restricted using an inverted plastic container. The bottom was cut out, replaced with a mesh screen and put over the larvae. Additionally, two GM, enclosed in mesh cages, were buried 5 cm deep in the soil after nematode application. Larvae were exposed under field conditions for one week, recovered, rinsed and held for three days before being dissected for presence of entomopathogenic nematodes. Caged larvae were replaced at weekly intervals fir 2 additional weeks with the same procedure followed. Furthermore, soil samples were taken after nematode application and exposed to SPC and GM larvae in the lab to evaluate nematode performance under favorable conditions.

On 15 April 1996 the base of forty plants were treated with each 1 and 2 billion/acre *S. feltiae* and *S. carpocapsae*. Water was used as a control. Nematode concentration was based on an area around the base of the plant (1256.6 cm^2). To provide favorable moisture conditions, each plant received 2 gallons of water. Before nematode application, three mesh cages each containing 2 SPC and 2 BVW were buried 5 cm deep around the base of the grape plants. Nematodes were sprinkled with an inverted mason-jar through 10 holes punched into the lid. Directly after application, 1 gallon of water was poured around the base of the plant. Cages were recovered and replace after 7 days with three cages per treatment only containing SPC larvae. No cages with BVW were buried for the second evaluation date. Recovered larvae were rinsed and held in the lab for three days before presence of nematodes were evaluated. Soil sampling in the treated area was conducted immediately after the nematode application as described previously. In the laboratory 2 of each SPC and BVW were exposed to that soil sample.

Application was conducted between 5 pm-6.30 pm on a windy sunny day. Soil surface temperature was 15.3 ^{0} C, soil moisture determined gravimetrically was 16.3%.

Results:

Overall laboratory soil sample evaluation after backpack application in 1995 demonstrated the superior performance of *S. carpocapsae* on both the non target GM and SPC larvae in comparison to *S. riobravis* (Figure 1). Field evaluations over the whole three week sampling period showed a less pronounced effect on both insect larvae (Figure 2). Field data over the three week evaluation period showed more variability. Impact on the artificial host (GM) were more pronounced over time and achieved up to 65% with *S. carpocapsae* in comparison to *S. riobravis* (Figure 3). Impact on the target SPC larvae under field conditions was noticeable only at the first sampling date with *S. carpocapsae* at both rates. *S. riobravis* seemed to have little impact on SPC under field conditions (Figure 4).

Soil samples taken directly after mason pouring the nematodes within the treated area and exposing BVW and SPC in the laboratory confirmed the non susceptibility of BVW compared to SPC (Figure 5). Low susceptibility results for BVW were obtained from other laboratory soil samples and in the field from a variety of test as well.

At the first sampling date under field conditions, SPC proved to be more susceptible to entomopathogenic nematodes compared to BVW. No nematode induced mortality was found in the control (Figure 6).

Discussion:

S. riobravis, a nematode species isolated from Rio Grande Valley (Texas) and assumingly from tropical origin was included in the backpack experiment in 1995 to compare with *S. carpocapsae*, a temperate climate adapted nematode. Results of insufficient impact under field conditions is not surprising and underlines the adaption of *S. riobravis* to higher temperature conditions.

The backpack sprayer application eliminates the possible impact of drip line or sprinkler application. Covering the nematodes with soil directly after application reduced ultraviolet radiation thus permitting survival similar to the laboratory bioassays. Impact of both rates of *S. carpocapsae* on SPC mortality was noticeable following only on the first sampling date (Fig. 4). Field pathogenicity of GM was more variable and extended for a longer time (Fig. 3).

Small scale mason-jar application in the early season in 1996 was supposed to provide optimum moisture conditions. The wetting of the area around the base of the plants provided

favorable moisture conditions, extended persistence and helped passively distribute nematodes into the soil. Temperature range was about the typical encountered temperature for this time of the year. Superior results were obtained with *S. feltiae* against SPC. Results with both nematode species with BVW were poor. Applying the nematodes to small field plots with a mason jar or watering can might have only limited practical application potential for commercial fields but might be useful for small vineyards.

Fig. 1: Nematode Lab Pathogenicity to A. c-nigrum and G. mellonella 1995

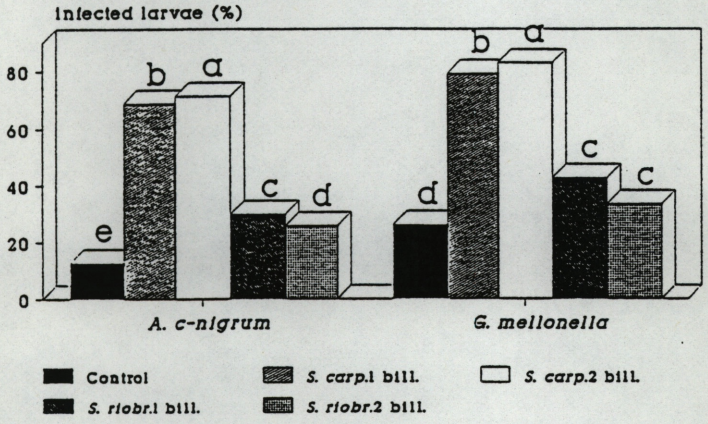

Fig. 2: Nematode Field Pathogenicity to *A. c-nigrum* and *G. mellonella* 1995

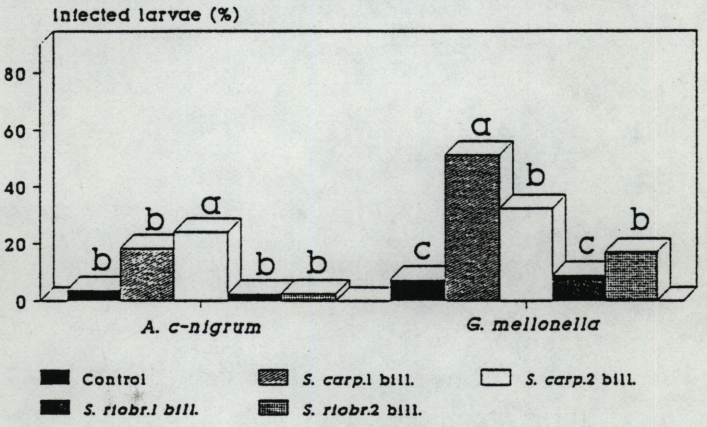

Fig. 3: Nematode Field Pathogenicity over three Weeks to *G. mellonella* 1995

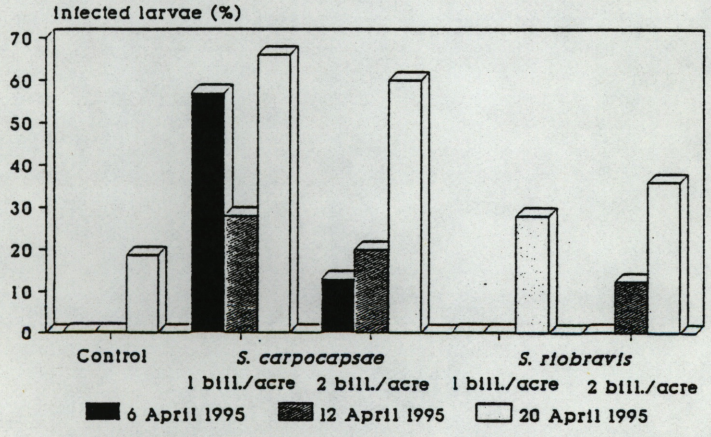

Fig. 4: nematode Field Pathogenicity over three Weeks to *A. c-nigrum* 1995

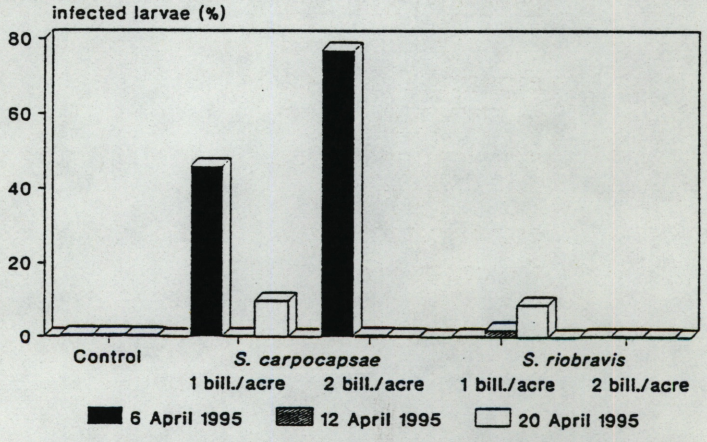

Fig. 5: Nematode Lab Pathogenicity to *A. c-nigrum* and *O. sulcatus* 1996

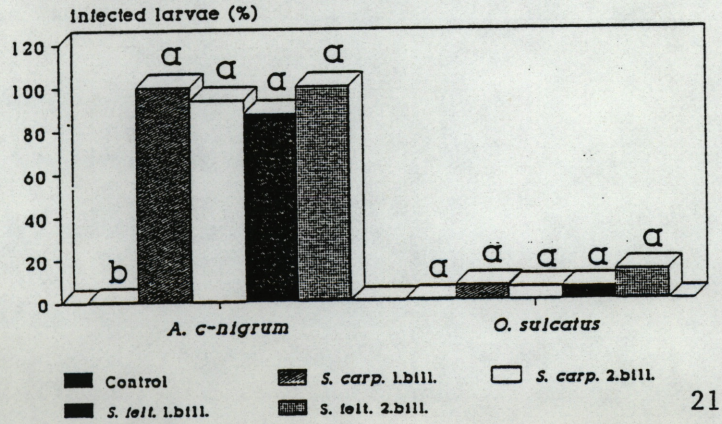

Fig. 6: Nematode Field Pathogenicity to A. c-nigrum and O. sulcatus 1996