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of 6.5-mm-o.d. acrylic tubing) within holes melted in the sides of wells. Highly flexible latex tubing (6.5-mm i.d.), interconnecting vertical cylinders, wells, and return lines to the reservoirs, enables the easy maneuvering of wells on the microscope stage and bench. The wells yield good optical resolution and are easily cleaned.

A complete list of parts is available from the authors.

LITERATURE CITED


Foliar Spray Effects of Selected Amino Acids on Sunflower Infected with Meloidogyne incognita

A. A. Osman and D. R. Viglierchio

Overman and Woltz (3) indicated that amino acid antimetabolites applied to the soil suppressed reproduction of Paratrichodorus minor (Trichodorus christiei) and root galling caused by Meloidogyne incognita on tomatoes. Eight DL-amino acid antimetabolites similarly decreased the population of Aphelenchoides ritzemabosi on Lucerne, whereas DL-alanine suppressed the population of Heterodera spp. without harming the host plants (5). Evans and Trudgill (1) found that DL-methionine was toxic to H. rostochiensis (Globodera rostochiensis) infecting potato plants. Methionine did not act as a contact nematicide; it was presumably ingested in sap extracted from giant cells after being taken up by the host plant. Krishna Prasad and Setty (2) showed that two amino acids used as foliar sprays on tomato had no adverse effect on plant growth and vigor, but significantly affected the development and reproduction of M. incognita. Parvatha Reddy et al. (4) reported that DL-methionine suppressed root galling, egg-mass production, and fecundity of M. incognita on tomatoes. The amino acid also delayed the completion of the nematode life cycle by about 8-9 d. DL-methionine reduced the number but not the size of giant cells incited by M. incognita.

We extended this line of exploration to include a comparison of the effects of other amino acids as foliar sprays on the biology of a population of M. incognita on sunflower.

Stock cultures of M. incognita were maintained on tomatoes (Lycopersicon esculentum) cv. VF 145 in the greenhouse. Sunflower (Helianthus annus) cv. Hybrid 894 seeds were planted in 10-cm pots containing a steam-sterilized mixture of clay soil and sand (1:1). Two-week-old sunflower

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Seedlings, one plant per pot, were inoculated with 1,000 freshly hatched second-stage larvae of *M. incognita* by pouring the nematode suspension into four holes around the base of the plant. After inoculation the holes were closed by pressing the soil and watering. The different amino acid concentrations were applied as foliar sprays once, after 7 d, or twice, 7 and 15 d after inoculation. The amino acid solutions were uniformly atomized over the plants, care being taken to see that no amino acid solution fell on the soil. Hoagland solution, 1/2 strength, was used for watering as needed.

The number of galls and egg-masses and plant shoot heights and weights were determined for each treatment 45 d after nematode inoculation (Table 1).

In single spray applications the number of galls on plants treated with phenylalanine at each concentration were significantly (*P = 0.01*) fewer compared to the control. Similarly, plants with the two highest concentrations of cysteine had significantly (*P = 0.05*) fewer galls. The number of galls on plants treated with the lowest concentration of cysteine, and each concentration of valine, did not differ from the controls. All treatments, except valine at the lowest concentration, significantly (*P = 0.01*) reduced the number of egg masses/plant, compared to the control. Plant shoot heights and weights were not significantly affected by any treatment. No plant growth disorder was observed by the application of these amino acids.

In double spray applications nearly all amino acid concentrations were effective in inhibiting root galling. The maximum suppression in root galling occurred with phenylalanine at 1,000 μg/ml, but 4,000 μg/ml had no effect. Egg-mass production with the 1,000 μg/ml phenylalanine was the lowest observed among the amino acids tested. Again, as observed by others (1,3,4,5), there appeared to be no adverse effect on plant growth as a result of amino acid application.

These findings support the contention that selected amino acids applied as post-planting treatments may have a role in the

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Amino Acid</th>
<th>Concentration (μg/ml)</th>
<th>No. of galls per plant</th>
<th>No. of egg-masses/plant</th>
<th>Plant shoot Height (cm)</th>
<th>Plant shoot Weight (g)</th>
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<td>Control</td>
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<td>216</td>
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<td>2,000</td>
<td>237**</td>
<td>116**</td>
<td>65</td>
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<tr>
<td></td>
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<td>4,000</td>
<td>180**</td>
<td>88**</td>
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<td>121**</td>
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<td>127**</td>
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<td>100**</td>
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Difference from control *P = 0.05, **P = 0.01.
integrated pest management philosophy. The intent would be to reduce or delay the nematode population build-up until an acceptable yield was assured, as is usual with toxic nonfumigant nematicides. An added benefit of nematode control with amino acids is the human nutritional value of any residual material. Furthermore, these findings clearly establish the feasibility of alternative chemotherapy as a practical, safe means of managing nematode pest populations for acceptable crop production.

LITERATURE CITED


Susceptibility of Pupae of Two Cocoon-forming Lepidopterous Species to the Entomogenous Nematode, Neoaplectana carpocapsae (Rhabditida: Steinernematidae)

Patricia L. Moyle and Harry K. Kaya

The entomogenous nematode, Neoaplectana carpocapsae, and its associated bacterium, Xenorhabdus nematophilus, infect a number of insect species in different orders. Infectivity tests have been conducted primarily against larvae of pest species with little information available on the infectivity of N. carpocapsae to lepidopterous pupae. Schmiege (8) demonstrated that pupae of the spruce budworm, Choristoneura fumiferana, were slightly susceptible to N. carpocapsae, and Lewis and Raun (5) reported that 30% of the pupae of the European corn borer, Ostrinia nubilalis, were infected by the nematode compared to 100% infection of larvae and adults. Pupae of the sphingid, Herse convolvuli, were moderately susceptible to N. carpocapsae (4). Exposure of pupae of the beet armyworm, Spodoptera exigua, and of the armyworm, Pseudaletia unipuncta, to N. carpocapsae resulted in ca 75 and 50% mortality, respectively (2). Naked pupae (without silken cocoons) of Galleria mellonella exposed to similar conditions as the armyworms resulted in 100% mortality. These results confirmed earlier studies by Sandner and Stanuszek (7) with pupae of G. mellonella. This paper reports the ability of N. carpocapsae to infect pupae within silken cocoons of G. mellonella and Bombyx mori.

Stock suspensions of infective juveniles of N. carpocapsae (DD-136 strain) were obtained by infecting G. mellonella larvae as described by Dutky et al. (1) and maintained at 10 C in 0.1% formalin at a concentration of 1,000 nematodes per ml. New nematode stocks were obtained every 3-4 wk.

To obtain intact silken cocoons containing pupae of G. mellonella, late last instar larvae were placed in a plastic petri dish (15 x 100 mm). About 3-4 d after cocoon formation, cocoons containing prepupae were transferred to a clean petri dish. Pupae in 3-5-d-old silken cocoons were used in all tests. Five pupae were placed in a petri dish containing two pieces of filter paper (Whatman no. 1) to which ca 1,000