FUNGICIDAL, HERBICIDAL , AND NEMATICIDAL ACTIVITIES OF ESSENTIAL OILS IN SLOW-RELEASE FORMULATIONS

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The pesticidal activities of proprietary slow-release formulations of selected volatile compounds of plant origin were studied in greenhouse and microplot experiments. Cinnamic aldehyde, eugenol, and oils of garlic, rosemary, thyme, and mustard seed, were encapsulated in micro-granules to form slow-release formulations. All these materials are used commonly in the food and perfume industries. In a greenhouse nematode experiment the formulations were applied as a suspension (400 mgs granules/100 ml water) onto the soil surface of pots (10-cm diam, PVC) containing each 1 kg soil. The soil was a silt loam (pH 6.2; CEC <10 meq/100 g soil; org. matter <1.0%) from a cotton field infested with root-knot (*Meloidogyne incognita*), spiral (*Helicotylenchus dihystera*), and lesion (*Pratylenchus brachyurus*) nematodes as the main phytopathogenic species. Immediately after treatment each pot was covered with a clear 1.5 mil thick low density polyethylene bag held tight against the outer wall of the pot by a rubber band. Each treatment and control was represented by 7 replications (pots) arranged in a randomized complete block design on a greenhouse bench. Eight days after application, the bags were removed and soil samples (100 cm^3) were collected from each pot for nematological analysis (salad bowl incubation) and the pots were then planted with 'Hutcheson' soybean (5 seed/pot). After seven weeks the plants were removed from the pots, data on plant growth were recorded and final soil samples and roots were incubated to determine nematode numbers.

Soil and root populations of the root-knot nematode were significantly reduced by applications of thyme, rosemary and eugenol alone, and in combinations with garlic. Some combinations of garlic with mustard were very active against the nematode while formulations with cinnamic aldehyde alone or with garlic were generally ineffective. Numbers of spiral nematodes in the roots were lowest in plants from pots treated with garlic-mustard combinations or with thyme. Rosemary treatments increased root populations of the lesion nematode while the other treatments had no effect on this nematode. Treatments without mustard resulted in the tallest plants with the heaviest roots and shoots. The inclusion of mustard in the formulations resulted in either no change in shoot height or in smaller increases in shoot and root weights when compared to the other formulations.

The fungicidal action of the slow-release formulations was assessed in an experiment with a sand-peat mix infested with a virulent isolate of *Rhizoctonia solani* obtained from diseased cotton seedlings. Application of slow release granules was by mixing directly with the sand-peat mix contained in pots (1 kg mix). The pots were covered with polyethylene bags and placed in a cool (20C) room for 4 days when the bags were removed and 30 annual morningglory (*Ipomoea*

spp.) seed were spread on the sand-peat surface and then covered with a 1 cm thick layer of moist sand. The pots were placed back in the cool room for two days and were then transferred to a greenhouse bench. Statistical design was as described for the experiment with nematodes. The number of morningglory plants was determined at 10, 12, 14, and 17 days after application of the formulations. Following the last count the plants were separated from the sand-peat medium, and were washed and weighed. The condition of the root systems was assessed visually using a scale of 1-5 where 1 represented perfectly healthy roots and 5 roots with restricted root system with severe necrosis and lesions caused by the fungus. Efficacy was based on calculation of the area under the curve defining the number of morningglory plants per pot (Y axis) and days after treatment for the period between the 10 and 12 days after application (X axis).

R. solani eliminated over 70% of the possible morningglory plants. The disease was most successfully dealt with by formulations containing garlic oil. Least active compositions were those containing cinnamic aldehyde, rosemary, and thyme in increasing order of efficacy. Granules with eugenol were the most effective among the single component formulations. The most effective compound formulations were those containing garlic + eugenol and garlic + mustard; these formulations were the only ones with increased fungicidal activity over that obtained with garlic alone.

The herbicidal and nematicidal activities of a slow release formulation containing 15% mustard oil and 85% garlic oil was tested in a microplot (1 ft^2) experiment with soil infested with root-knot nematode (*M. incognita*) and a variety of annual weeds. The formulation was applied by drenching (1" acre water) at rates 0 – 200 lbs a.i./A, followed by coverage of the plots with clear polyethylene (1 mil). After 10 days the plots were planted with 4-week old Impatiens seedlings. Weed control was directly proportional to the amount of active ingredient applied (Fig. 1). . Final populations of microbivorous nematodes were not affected by the treatments; however, root-knot juveniles were controlled or eliminated by rates $\geq$ 100 lbs ai/A (Fig. 2). Decline in numbers of root-knot nematode juveniles in relation to rates was adequately described by exponential functions. Final populations of microbivorous nematodes were not affected by the treatments.

Data from the study suggest encapsulation may be useful for development of formulations with herbicidal, fungicidal and nematicidal activities based on natural compounds with high vapor pressures.

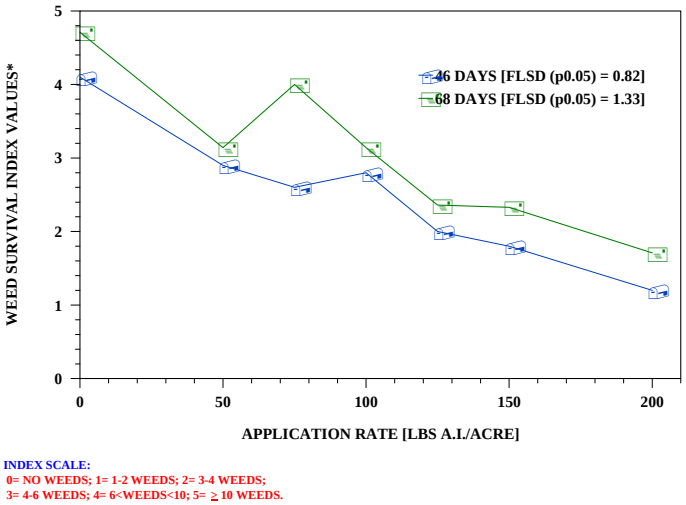

Figure 1. Relationship between weed survival and application rate of a slow release formulation containing 85% garlic and 15% mustard oils in a microplot experiment with Impatiens at the Auburn University campus.

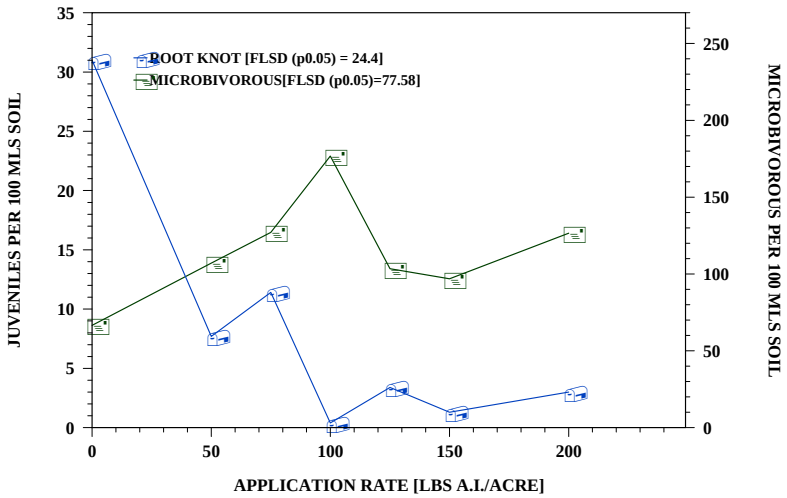

Figure 2. Relationship between nematode numbers and application rate of a slow-release formulation containing 85% garlic oil and 15% mustard oil in a microplot experiment with Impatiens at the Auburn University campus.