Evaluation of a Seed-Treatment Method with Acetone for Delivering Systemic Nematicides with Wheat and Rye

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Abstract: Seeds of 'Coker 68-15' wheat and 'Maton' rye were immersed for 5 min in acetone solutions of oxamyl, carbofuran, or phenamiphos containing 0, 0.25, 0.5, 1.25, 2.5, or 5.0% (w/v) nematicide; after drying, seeds were planted in pots containing 500 gm of sandy loam naturally infested with *Hoplolaimus galeatus* and *Tylenchorhynchus claytoni*. In sterilized soil, only the 5% concentrations of all nematicides were toxic to rye, whereas both the 2.5 and 5% concentrations were damaging to wheat. Phenamiphos was generally the most phytotoxic compound. Numbers of *T. claytoni* in soil declined sharply in response to seed treatment with all nematicides. In soil planted with wheat, numbers were reduced 80% by the 1.25% treatment; little additional control was shown with higher concentrations. Soil with rye showed a 40-60% reduction in numbers of *T. claytoni* with the 1.25% solutions and little change at higher concentrations. *Hoplolaimus galeatus* developed only in pots with rye; root populations were suppressed (30-50%) by treatment with 1.25% or higher concentrations of all nematicides. *Key Words:* control, oxamyl, carbofuran, phenamiphos, *Secale, cereale, Triticum aestivum, Hoplolaimus galeatus, Tylenchorhynchus claytoni.*

Nematicides as seed treatments have not been widely used because many (such as the halogenated hydrocarbons) are too phytotoxic and because, perhaps, nonfumigants have been thought to give poor control when they are used in this manner. Because of the tolerances of seeds to organic solvents (2, 5), we felt that systemic nematicides warranted testing. This paper reports results on the efficacy of oxamyl, carbofuran, and phenamiphos in acetone solutions as seed treatment for control of selected plant parasitic nematodes.

MATERIALS AND METHODS

Seed treatment: Technical-grade oxamyl, carbofuran, and phenamiphos were dissolved in acetone at concentrations of 0, 0.25, 0.50, 1.25, 2.50, and 5% (w/v). Lots (100 gm) of seed of 'Coker 68-15' wheat (*Triticum aestivum* L.) and 'Maton' rye (*Secale cerale* L.) were immersed for 30 seconds in beakers containing 100 ml of a given solution. After immersion, seeds were dried quickly by spreading them on a sieve under a current of air. The seeds were then stored in the dark at 23 ± 2C until used.

Phytotoxicity: The effects of the nematicides on each plant species were determined by planting treated seed in waxed cardboard cartons containing 500 gm of a methyl-bromide treated sandy loam (sand 74%, silt 15%, clay 11%). Each carton was planted with 20 seeds from a specific treatment and replicated 5 times. Cartons were arranged in a completely randomized design in the greenhouse. Emergence was determined at 14 days after planting and the degree of injury was rated on a 0 to 5 scale (0 represented no injury; 1, plants with occasional yellow spots at tips of leaves but otherwise vigorous; 2, yellow spots at tips of leaves more frequent; 3, yellow spots at tips of leaves and occasionally in other areas of the leaves; 4, yellow spots at tips and other parts of leaves with occasional marginal necrosis; 5, marginal necrosis in most leaves accompanied by frequent spotting of leaves in the stunted plants).

Nematode control: A sandy loam soil (0.5 bar) similar to that for the phytotoxicity studies was collected from a cotton field under monoculture infested with *Tylenchorhynchus claytoni* Steiner and *Hoplolaimus galeatus* (Cobb) Sher. Waxed cardboard cartons were filled with 500 gm soil each and planted with 20 seeds from a given nematicide treatment. The cartons were arranged into seven completely randomized blocks in the greenhouse. After 1 month, plants were counted, 50-cm^3 soil samples from each carton were assayed for nematodes (3), and nematodes in roots were determined by incubating washed roots for 72 h in a thin film of water in a beaker. Nematodes which emerged were collected on a 38-μm (400-mesh) sieve and counted.

All data were analyzed by analysis of variance, and differences between means were evaluated for significance with the

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modified Duncan's multiple range test (4).

RESULTS AND DISCUSSION

Phytotoxicity in wheat (Fig. 1-A) was minimal for all nematicides in solutions containing less than 1% concentrations. Seeds tolerated up to 1.25% phenamiphos or carbofuran. Index values ≤ 2 were considered acceptable since the effect was temporary and disappeared with time. The two highest concentrations of all nematicides were highly phytotoxic. Rye was most tolerant of all three nematicides (Fig. 1-B).

The number of wheat and rye plants emerging/pot in fumigated soil was little affected by dipping of seeds in the nematicide-acetone solutions; the only suppression occurred with the highest concentration of phenamiphos. In infested soil, emergence of wheat (Fig. 1-C) was increased by treatment with oxamyl or carbofuran solutions; phenamiphos had no significant effect on emergence. Emergence of rye in infested soil (Fig. 1-D) was only 64% in the control and was significantly suppressed by treatment with all nematicides at the two highest nematicide concentrations. Phenamiphos was most phytotoxic, in contrast to carbofuran, which did not affect emergence at concentrations below 2.5%. The effect of oxamyl solutions at low concentrations was variable.

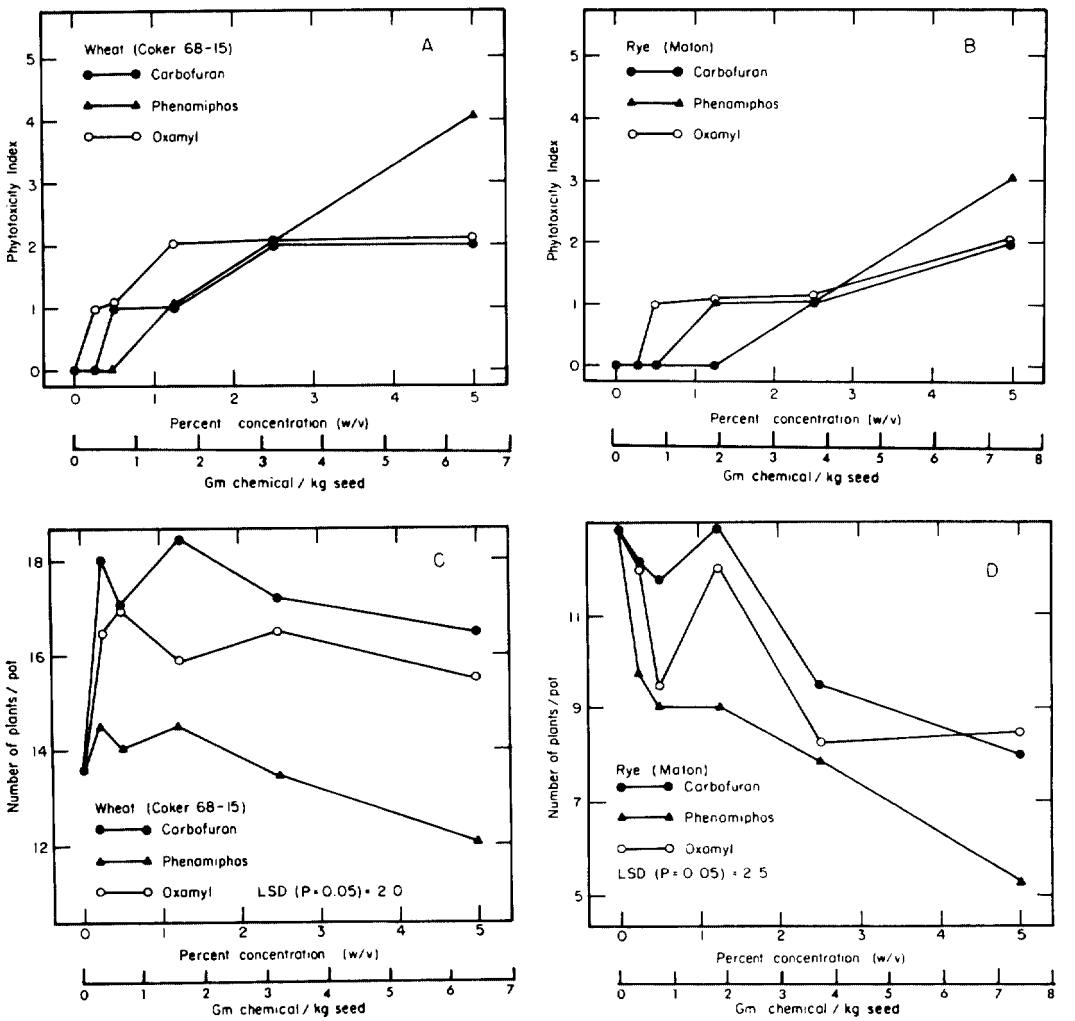

FIG. 1-(A-D). Effects of nematicide seed treatments on wheat and rye. *A & B)* Phytotoxicity of plants in sterilized soil (0-2, negligible to slight damage; 3-4, moderate damage; 5, severe stunting and necrosis of leaves). *C & D)* Plant emergence in nematode-infested soil.

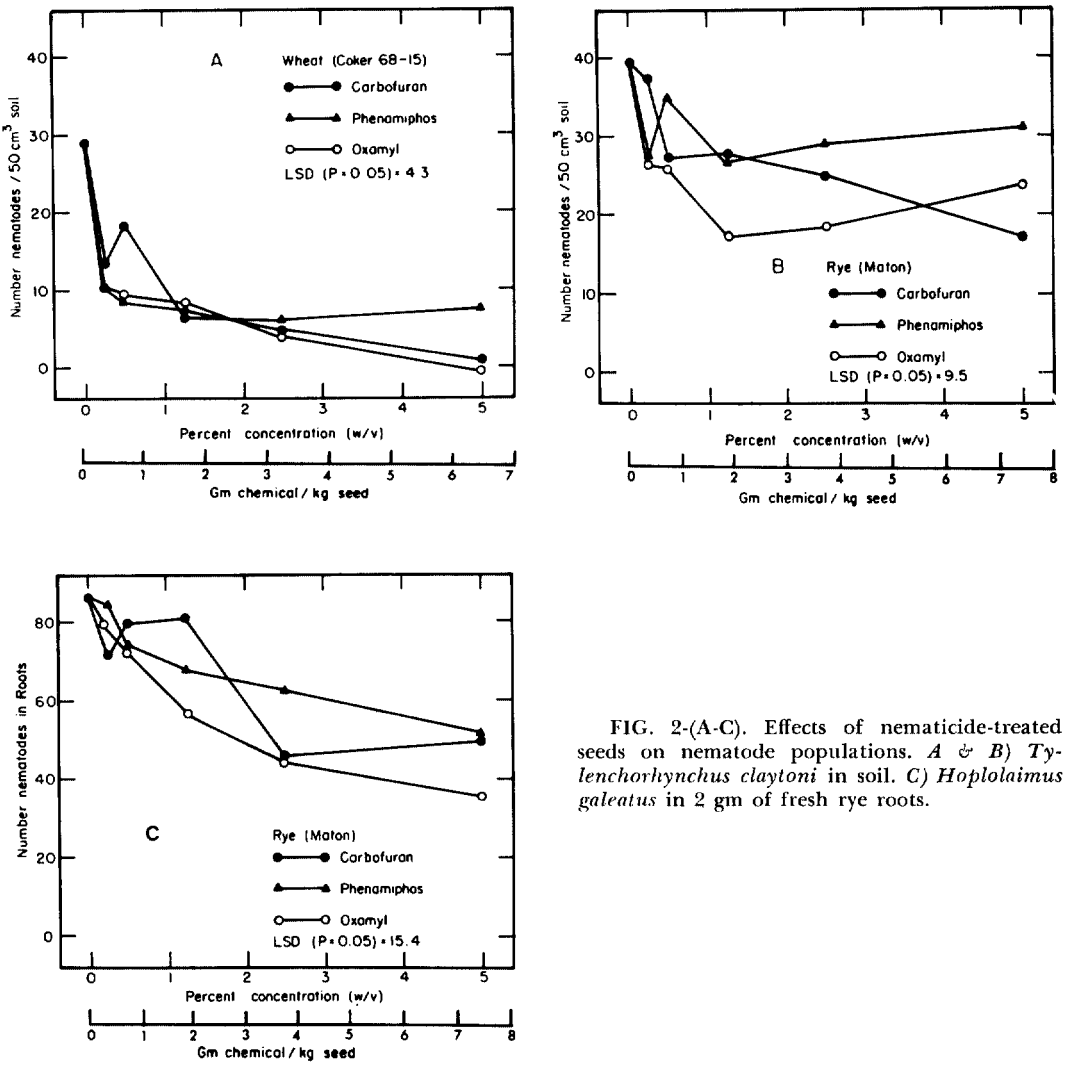

FIG. 2-(A-C). Effects of nematicide-treated seeds on nematode populations. *A & B) Tylenchorhynchus claytoni* in soil. *C) Hoplolaimus galeatus* in 2 gm of fresh rye roots.

At sampling, the only plant-parasitic nematode in soil in significant numbers was *T. claytoni*. All nematicides suppressed *T. claytoni* at 0.5% concentration with little additional response at higher rates on wheat (Fig. 2-A). A similar trend was observed on rye. (Fig. 2-B). Soil population of non-parasitic nematodes (data not shown) followed a pattern similar to that described for *T. claytoni*. *Hoplolaimus galeatus* was the only nematode in significant numbers in the roots and only in rye (Fig. 2-C). Carbofuran effectively controlled nematodes in roots at concentrations higher than 1.25% and phenamiphos and oxamyl controlled them, by 27 and 24% respectively, with the 1.25% solutions.

Our results show that some control of *T. claytoni* and *H. galeatus* in pots can be attained by coating seeds at nonphytotoxic nematicide rates. Although the mode of action was not determined, the nematicides probably killed by contact and by systemic activity of the compound in the root. Nematode invasion of roots may have been suppressed, an action which would result in a decline of nematodes in roots and soil.

The treatment proposed in this paper, if effective under field conditions, will be particularly useful in crops such as forage species where conventional nematicide applications are considered too expensive at present (1).

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