

Efficacy of Using Split and Postplant Applications of Aldicarb for Control of *Heterodera schachtii* on Sugarbeet¹

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Abstract: Soil temperature at planting and initial population densities (Pi) significantly affected ($P < 0.05$) the chemical control of *Heterodera schachtii* on sugarbeet, *Beta vulgaris*. The fumigant 1,3-dichloropropene (1,3-D) at 9.4 g/m of row effectively controlled *H. schachtii*, resulting in increased sugarbeet yields over the nontreated control treatment at soil temperatures at planting of 8, 12, and 16 C and Pi of 4.7, 10.4, and 18.3 eggs/cm³ at planting. A split application of aldicarb, 1.3 g/m of row at planting (AP) and 28 days later (PP), and a single at-planting (AP) treatment of 2.1 g/m of row were less effective in controlling *H. schachtii* than 1,3-D at the three soil temperatures and Pi. The sugarbeet yield from the AP plus PP treatment, however, was greater than the sugarbeet yield from the AP treatment and was equivalent to the yield from the 1,3-D treatment at temperatures of 8 and 12 C and a Pi of 4.7 eggs/cm³. Sugarbeet yield from the AP treatment was significantly ($P < 0.05$) greater than the AP plus PP application at a Pi of 18.3 at a planting temperature of 8 C and Pi of 10.4 and 18.3 eggs/cm³ at soil planting temperatures of 12 and 16 C. Postplant application of 2.1 g/m of aldicarb, applied 28 days after planting, significantly increased sugarbeet yields at all soil temperatures at the lower Pi levels.

Key words: aldicarb, *Beta vulgaris*, cyst nematode, *Heterodera schachtii*, population density, soil temperature, sugarbeet, yield.

The sugarbeet cyst nematode, *Heterodera schachtii* Schmidt, parasitizes sugarbeet, *Beta vulgaris* L., in most of the major sugarbeet producing regions in the United States and causes yield losses worldwide. Because of the pathogenicity of the nematode to sugarbeet, growers must either extend crop rotations or use nematicides to reduce the nematode soil population density below the economic threshold level (3,7). Use of a volatile nematicide, 1,3-dichloropropene (1,3-D), or a nonvolatile nematicide, aldicarb, has resulted in satisfactory nematode control (4,8-11,14). Effectiveness of these chemicals is limited under certain conditions; 1,3-D is less effective in heavy clay soils than in sandy soils, and aldicarb is not effective when sugarbeets are planted at high soil temperatures or in geographical regions where soil temperatures remain high for extended periods (4,5,7,12).

To further refine control methods for *H. schachtii* on sugarbeet, a study was made to compare applications of aldicarb with a preplant application of 1,3-D at different

soil planting temperatures and different initial nematode population densities.

MATERIALS AND METHODS

All studies were conducted at Logan, Utah, in microplots fabricated from redwood. Microplot boxes were 3.0 m wide × 4.3 m long × 0.6 m deep and were open at the bottom. Boxes were buried to a depth of 0.46 m, and soil was excavated from the microplots and replaced with a 1,3-D fumigated sandy loam soil (76% sand, 14% silt, 10% clay, 0.98% organic carbon; pH 7.6). The microplots were infested with *Heterodera schachtii* cysts and the nematode population increased on sugarbeet the previous year.

Initial nematode population densities (Pi) were determined by collecting soil samples on 30-cm centers to a depth of 30 cm with a 1.9-cm-d probe, extracting cysts with an elutriator (2), separating the cysts from soil debris by an alcohol flotation method (13), and finally crushing the cysts in water in a glass tube and counting the eggs and juveniles.

Chemical treatments consisted of 1) 1,3-D at a rate of 9.4 g/m (equivalent to 168 kg a.i./ha), 2) aldicarb (15% granules) at 2.1 g/m (equivalent to 5.6 kg a.i./ha) at

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time of planting (AP), 3) aldicarb (15% granules) at 1.3 g/m (equivalent to 3.4 kg a.i./ha) AP plus 1.3 g/m postplant (PP) 28 days later, 4) aldicarb (15% granules) 2.1 g/m row PP 28 days after planting, and 5) nontreated control. The five treatments were compared at nematode soil Pi means of 4.7 (range: 3.4–6.2), 10.4 (range: 8.5–12.7), and 18.3 (range: 14.9–21.6) eggs/cm³ soil, and at staggered planting dates when soil temperatures were 8, 12, and 16 C.

Aldicarb treatments were applied 7.6 cm deep and 7.6 cm to one side of the center of the row with a manual powered single chisel applicator, and 1,3-D was applied the previous fall (2 October), in the center of the row at 15-cm intervals with a chemical injector gun. Treatments were replicated four times for each nematode Pi and soil temperature.

Soil fertility was determined and fertilizer added to bring fertility levels to those used in commercial sugarbeet production (110 ppm potash, 60 ppm nitrates, 20 ppm phosphates) immediately before planting. Microplots were planted on 56-cm row spacings, four rows per microplot, at a 7.6-cm seed spacing, with a commercial sugarbeet seed, 'Tasco AH-3'. No herbicides were used, and the plots were hand weeded. Plots were irrigated from a sprinkler irrigation system. A total of 2.5–3.0 cm water was applied immediately after planting, and plots were irrigated every 6–7 days until thinning and every 4–5 days thereafter until harvest. Twenty-eight days after planting, the plots were hand thinned to a 30-cm spacing. Except for the aldicarb PP treatment which was not treated until after thinning, a plant was sacrificed every 20-cm of row (20 per replicate) immediately before thinning each plot, stained in hot lactoglycerol (1:1:1 lactic acid:glycerol:distilled water) and acid fuchsin to determine infection of seedlings by nematodes. Plants were bedded immediately after thinning and hand cultivated until the beet canopy covered the rows.

Soil temperatures were recorded with two clock-driven thermographs located in

two separate microplots. Each thermograph had two 3.7-m-long cables with sensors placed 15 cm deep in the soil. Plants were grown for 1,024 degree days, using a base threshold temperature of 8 C (1,5), regardless of planting time. At the termination of the experiment, plants were harvested, root weights were determined, and nematode infection and root weight data were subjected to an analysis of variance.

RESULTS

Soil temperature, type of nematicide, time of chemical application, time of planting, and nematode Pi greatly affected nematode infection of sugarbeet seedlings and sugarbeet yields (Fig. 1). The soil fumigant 1,3-dichloropropene significantly ($P < 0.05$) controlled nematode infection and increased sugarbeet yields above that of the nontreated control at all initial soil temperatures and nematode Pi; these results are consistent with data from previous studies (6). All aldicarb treatments also significantly ($P < 0.05$) controlled nematode infection and increased sugarbeet yields over the nontreated control. Nematode control was significantly greater ($P < 0.05$) in 1,3-D plots than the aldicarb AP or AP plus PP plots at Pi of 10.4 and 18.3 at planting temperatures of 8 and 12 C, and all Pi at 16 C. Nematode control was also significantly greater ($P < 0.05$) in the aldicarb AP treatment than in aldicarb AP and PP plots at the same temperatures and Pi. The AP plus PP application of aldicarb at Pi of 4.7 eggs/cm³ at planting temperatures of 8 C and 12 C significantly ($P < 0.05$) increased the sugarbeet yield above a single aldicarb AP treatment, and sugarbeet yields were similar to those obtained in 1,3-D plots. Sugarbeet yield from AP plus PP was significantly less ($P < 0.05$), however, than 1,3-D at Pi 4.7 at a planting temperature of 16 C, and at all planting temperatures at Pi of 10.4 and 18.3 eggs/cm³ soil. Sugarbeet yield from the AP plus PP treatment was also significantly ($P < 0.05$) less than that from a single AP treatment of aldicarb at 8 C at a Pi of 18.3 eggs/cm³, and at 12 and 16 C and Pi of 10.4 and 18.3 eggs/

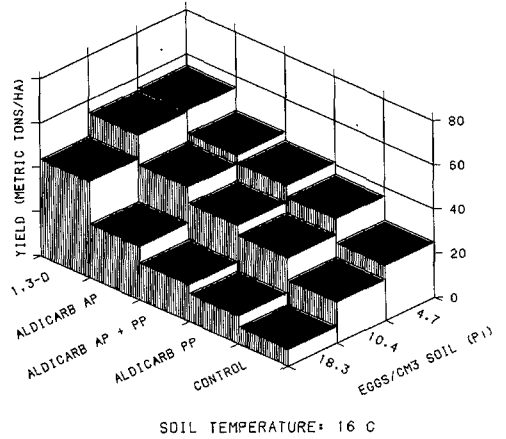
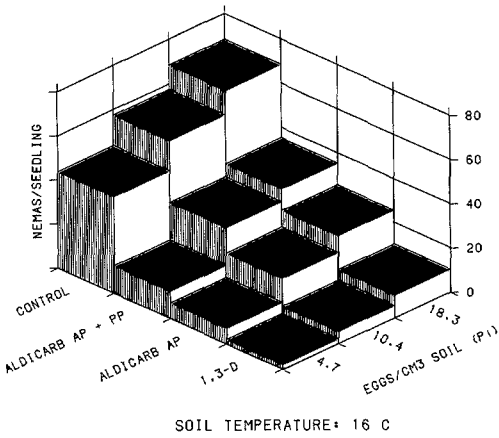
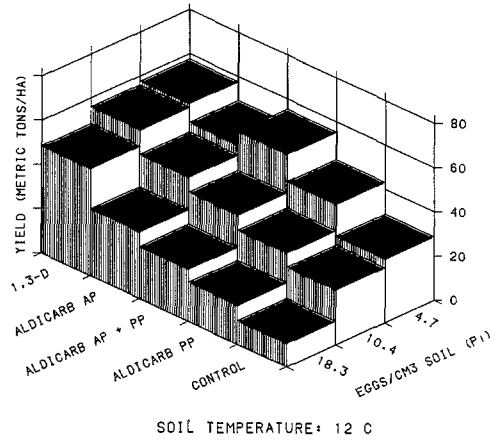
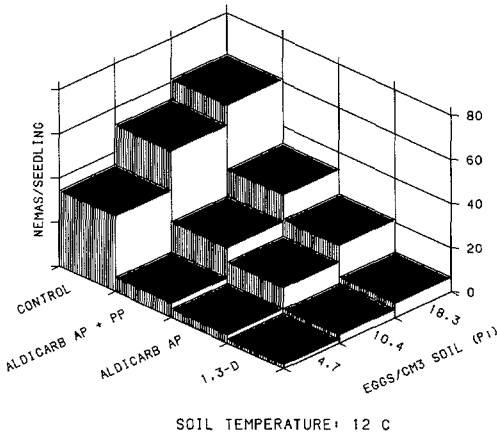
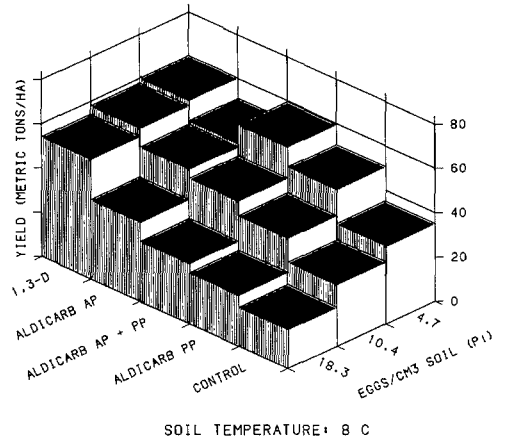
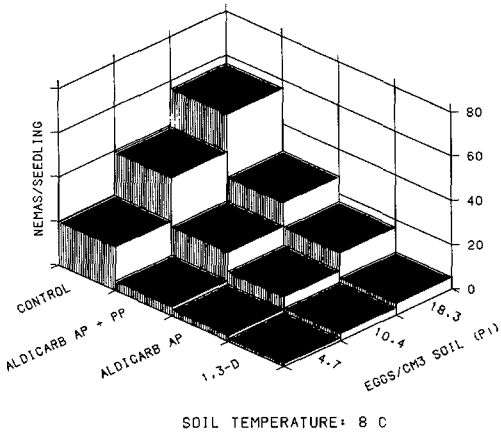


FIG. 1. Effect of initial soil population density (P_i) and soil planting temperature on chemical control of *Heterodera schachtii* as determined by juvenile infection (P_i) of sugarbeet seedlings and sugarbeet yields (AP = at-plant application; PP = postplant application). Split application soil planting temperatures = 8 C AP + 17 C PP; 12 C AP + 23 C PP; 16 C AP + 25 C PP. Single PP temperatures = 17 C, 23 C, and 25 C. Juvenile infection ANOVA LSD ($P < 0.05$) = 7.8, and sugarbeet yields ANOVA LSD ($P < 0.05$) = 6.3.

cm³ soil. Sugarbeet yield from a single post-plant application of aldicarb made on 28-day-old plants at soil temperatures of 17, 23, and 25 C, and a Pi of 4.7 eggs/cm³ soil was similar to the AP application at 8 and 12 C, but were significantly less ($P < 0.05$) than the AP application at all soil planting temperatures at a Pi of 18.3 eggs/cm³.

DISCUSSION

Field observations have shown split and postplant applications of aldicarb do not consistently control *H. schachtii*, and growers have become reluctant to use these methods of control. Field observations have also shown that the postplant application is effective only when sugarbeets are planted early in a field on which a nonhost crop has been grown for at least 1–2 years. This study confirms these observations, and it is apparent that the effectiveness of postplant application of aldicarb is dependent on environmental conditions, mainly soil temperature, and the nematode Pi.

Important findings on the biology of *H. schachtii*, and its relationship to the growth of sugarbeet plus the effect of nematicides, volatile and nonvolatile (3,7,10,11), have helped in the understanding of the host-parasite relationship between this nematode and sugarbeet. The biology and control of *H. schachtii* should continue to be studied in order to develop better control methodologies for a specific geographical area.

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