USING STEAM TO REPLACE METHYL BROMIDE IN THE GOLDEN NEMATODE CONTROL PROGRAM

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Methyl bromide is used routinely as a regulatory treatment in the golden nematode control program to decontaminate items infested with the golden nematode when they are moved from regulated areas to nonregulated areas. Because of the effectiveness of methyl bromide, there has been essentially no effort to develop other types of treatments for this program. Other types of treatments are needed to ensure the integrity of the golden nematode quarantine when methyl bromide is no longer available.

We earlier found that exposure of golden nematode cysts that had been presoaked in water to 55°C was lethal to the encysted eggs. In contrast, eggs in dry cysts tolerated temperatures as high as 75ºC for brief periods. Such studies suggested that heat had potential for decontaminating items infested with the golden nematode provided the cysts were in a moist condition.

Later studies on the effect of different sources of heat on golden nematode survival showed that solar heat under clear polyethylene for 8-16 hours is not consistently lethal to the golden nematode enough for a decontamination treatment in a quarantine setting. Dry heat under polyethylene did not kill the nematode eggs even though lethal temperatures are achieved. Steam heat (60-65°C for one hour) under polyethylene was consistently lethyl to encysted eggs and appeared to be equal to methyl bromide in disinfesting equipment contaminated with the golden nematode. Since prewashing contaminated equipment with high pressure water did not hydrate the encysted eggs enough to increase their sensitivity to high temperatures it appeared that moisture to sensitize the eggs to heat was provided by steam. Later experiments demonstrated that exposure of encysted eggs to steam at 60°C for 1-2 hours killed 100% of the nematode eggs and that steam at 55°C for 1-hour completely inhibited hatching of encysted eggs.

Experiments in 1999 focused on the feasibility of steam heat as a regulatory treatment for decontaminating equipment infested with the golden nematode. The source of steam was a steambath generator model SM-12 manufactured by the Steamist Company, Rutherfored, NJ. This generator was equipped with a Model 4004-71 Paragon Electric timer and a Johnson Control thermostat Model A319 with a range of 40-100ºC. To adequately distribute the steam, the generator was plumbed with one-inch steel piping that extended in a U-shape for 6 feet from the generator. The pipe was drilled with 1/16 inch holes at 8-inch intervals.

The equipment used in these experiments was a Massey Fergeson tractor. Nylon sackettes containing five golden nematode cysts each in one gram of soil were placed in five locations on the tractor. The tractor was placed in a 7.2m^3 chamber covered with clear polyethylene (6

mil). Steam was applied to the chamber to achieve temperatures of 40, 45, 50, 55°C and maintained for one hour. Temperature in the chamber was recorded with a thermocouple temperature recorder model KTX with a range of 0-100ºC that was manufactured by the Dickson Company. The experimental control consisted of cysts contained in soil-filled nylon sackettes that were not subjected to steam.

After the treatments were complete, cysts were retrieved and subjected to a hatching test. The hatching test consisted of soaking the cysts in water for five days then placing them in potato root exudate in ELISA plates for three weeks. The number of juveniles that emerge were counted weekly and fresh exudate was added. After 3 weeks of hatching, the cysts were crushed and the number of viable and non-viable eggs remaining determined. The eggs were then used to inoculate potato plants. After 12 weeks, the plants were examined for nematode reproduction.

All steam treatments were for one hour. Hatch of golden nematode eggs varied with temperature. Hatch consisted of 483 juveniles/5 cysts from cysts not exposed to steam, 194 juveniles/5 cysts from cysts subjected to 40°C, 187 juveniles/5 cysts from cysts subjected to 45°C, 5 juveniles/5 cysts from cysts exposed to 50°C, and no hatch occurred from cysts subjected to 55°C. Location of the cysts on the treated equipment did not influence egg survival, indicating that temperature and moisture were uniform throughout the treatment chamber.

Examination of the eggs that did not hatch revealed that most of them appeared nonviable. No cysts developed on potato plants that were inoculated with eggs from cysts that were exposed to steam treatment. Several cysts developed on plants inoculated with eggs from cysts that were not subjected to steam.

The use of steam resulted in a considerable amount of condensate inside the treatment chamber which was related to the temperature achieved. Amount of condensate ranged from 0.7 liters/m^3 for the 40°C treatment to 1.2 liters/m^3 for the 55°C treatment. Overall, condensate accumulated at an average rate of 100 ml/min during treatment. The amount of condensate was reduced slightly when a double-walled chamber was used. The condensate had no apparent effects on the electrical system of the tractor.