Efficacy of Commercial Algaecides to Manage Species of *Phytophthora* in Suburban Waterways[1]

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Abstract

Many commercial algaecides contain copper compounds as active ingredients. *Phytophthora* spp. and other oomycetes are known to be sensitive to copper-based fungicides. Therefore, algaecides registered to manage algae in natural waterways and irrigation waters also might be effective for mitigating or even eradicating *Phytophthora* species, including *P. ramorum*, in these same waterways. Many of the commercially available algaecides are registered for use in diverse natural and agricultural water environments, and water treated with these products may be used for swimming, fishing, watering livestock, and irrigating turf and ornamental plants immediately after treatment. Consequently, these algaecides appear to be relatively safe for both humans and the environment. Experiments in our laboratory have demonstrated that two algaecides with copper-based active ingredients were toxic to zoospores, sporangia, and chlamydospores of *P. ramorum* and to zoospores of six other species of *Phytophthora*.

Chlamydospores (5 x 10^3 spores/ml), sporangia (2.5 x 10^3 sporangia/ml), and zoospores (1 x 10^5 spores/ml) of A1 and A2 isolates of *P. ramorum* were exposed to commercial rates of two algaecides (0.8 ppm of copper carbonate and 1.0 ppm of copper-triethanolamine + copper hydroxide) for 0, 0.5, 2, 4, 8, and 24 hours. Treated propagules were collected on membrane filters and then washed to remove algaecide residues. Filters were inverted on PAR-V8 selective medium, and plates were placed at 20 °C so propagules on the filters could germinate and produce colonies. For both isolates, zoospores were not recovered after 30 minutes of exposure to either algaecide. Compared to the non-treated control, viabilities of chlamydospores and sporangia of both isolates were reduced significantly at 2 and 4 hours of exposure to the algaecides; no chlamydospores or sporangia remained viable at 8 or 24 hours of exposure. In addition, zoospores of *P. cryptogea*, *P. nicotianae*, *P. palmivora, P. citricola, P. cactorum,* and *P. citrophthora* were exposed to each algaecide for 30 and 60 minutes. Zoospores from any of the species were not recovered at either 30 or 60 minutes of exposure to the algaecides.

To evaluate the efficacy of commercial algaecides to manage species of *Phytophthora* that occur naturally in suburban waterways, six streams in three urban communities in the northwestern region of South Carolina were selected, and water in each stream was collected and treated twice. These streams were known to be infested with naturally occurring populations of species of *Phytophthora* based on previous studies conducted by our research team. At each stream, each of twelve 20 liter buckets was filled with 15 liters of water in 1 liter aliquots. The buckets were returned to the laboratory and were held at room temperature (22 to 25 °C) for the duration of the experiment. Four buckets were not treated and served as controls, four buckets were treated with 0.8 ppm copper carbonate (Captain®, SePRO Corp.),

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and four buckets were treated with 1.0 ppm copper-triethanolamine and copper hydroxide (K-Tea®, SePRO Corp.). The rates used were those recommended on current product labels. Prior to treatment (0 hours), the initial mean density of propagules (as colony-forming units [cfu]/liter) was calculated for each set of four buckets. Density was determined by removing three 200 ml aliquots from each bucket and passing each aliquot through a polycarbonate membrane filter with 3 μm pores. Filters were inverted onto PARPH-V8 selective medium, and plates were held at 20 °C for 2 to 3 days. Filters then were removed and colonies of *Phytophthora* spp. were counted. After algaecides were added, the water in each bucket was stirred periodically and sampled at 1 and 4 hours to determine density of *Phytophthora* spp. Filters receiving aliquots from treated water were washed with distilled water to remove algaecide residue before being placed on selective medium. Mean density in each treatment was calculated for each sample time for each of the six streams, and data were analyzed independently for each stream.

Results from the two trials for each stream were similar, so data were combined for analysis. Initial densities of *Phytophthora* spp. in the six streams varied and ranged from 38 to 136 cfu/liter. For each stream, initial densities for the three treatments were not significantly different ($P = 0.05$). In the non-treated control from each stream, densities at 1 and 4 hours did not change significantly from that at 0 hours. However, *Phytophthora* spp. were not recovered in water from any stream that had been treated with algaecide; in other words, no colonies developed on isolation plates after 1 or 4 hours of exposure to algaecide. In all six streams, densities of *Phytophthora* spp. in treated water at 1 and 4 hours were significantly different from densities at 0 hours and from densities in non-treated water. In summary, commercial algaecides used at rates recommended on product labels appear to have excellent potential to manage *Phytophthora* spp. in waterways.

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