EFFICACY OF WEEKLY AGRIBROM TREATMENTS FOR CONTROL OF ALGAL AND FUNGAL GROWTH IN A TOBACCO TRANSPLANT FLOAT-PRODUCTION SYSTEM[1]

TOBACCO SCIENCE

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Two experiments were conducted to determine the effectiveness of Agribrom (1-bromo-3-chloro-5,5-dimethyl-2,4-imidazolidine-dione) for control of algal and fungal slimes on the surface of the growth medium used in the float method for production of tobacco (*Nicotiana tabacum* L.) transplants in greenhouses. In the first experiment, Agribrom was sprayed weekly on the surface of the growth medium at 0, 10, or 20 mg L^{-1} beginning on the date of seeding or at two weeks after seeding. In the second experiment, Agribrom was sprayed weekly at 0, 10, 20, 400, or 800 mg L^{-1} beginning on the date of seeding, or at 10 or 20 mg L^{-1} beginning two weeks after seeding. Both experiments were harvested after five weeks. Agribrom applications had no effect on the number of plants or biomass production in either test. Agribrom also had no significant effects on algal or fungal growth in either experiment at any treatment rate, regardless of the timing of application. These data indicate that spray applications at concentrations up to 800 mg L^{-1} of Agribrom applied at weekly intervals either at seeding or emergence will not control algal or fungal growths in tobacco transplant float-production systems.

Additional key words: *Nicotiana tabacum*, greenhouse transplant culture, algicide, nontarget effects, Chlorophyceae, Cyanophyceae.

INTRODUCTION

Agribrom (1-bromo-3-chloro-5,5-dimethyl-2,4-imidazolidine-dione), a product produced by Great Lakes Chemical Corporation (West Lafayette, Ind.), has been labelled for several years for control of algae in greenhouses (7). Hickman & Viss (3) concluded that Agribrom would effectively eliminate algal growths from greenhouse walkways, under greenhouse benches, and on evaporative cooling system pads. Tayama et al. (9) reported good control of algae and microbial slimes on subirrigation mats and in evaporative cooling systems. There is some evidence that Agribrom will control diseases in greenhouse plug production of ornamental plants, but recent studies of Agribrom for control of diseases of ornamentals suggest that its effectiveness may vary considerably with treatment rate and method of application (1,2,4,6). Some damage to ornamentals has occurred following use of this product for disease control (1,2,5,9).

Many tobacco (*Nicotiana tabacum* L.) growers in North Carolina have converted to greenhouse float systems for production of transplants to reduce the labor requirements for managing plant beds and pulling transplants (4). Dense surface growths of algae, bacteria, and fungi are common in these float systems. A number of growers and commercial producers of tobacco transplants have tried to control these algal and fungal growths by spraying Agribrom onto the surface of the growth medium immediately after planting. The results of this single application generally have not been satisfactory.

The objectives of this study were (1) to evaluate the efficacy of surface-spray applications of Agribrom for control of algal and other microbial slimes in float-production systems using more frequent applications and higher application rates than normally used by tobacco transplant growers; and (2) to determine the effects of Agribrom on the growth of tobacco seedlings.

MATERIALS AND METHODS

Two successive experiments were conducted during the spring of 1991 in a greenhouse using a float system containing 33 x 66-cm polystyrene trays with 200 cells per tray. Each cell had a volume of approximately 27 cm^3. Before seeding, trays were steam-sterilized, filled with Metromix 220® (W. R. Grace & Co., Cambridge, Mass.) soilless growth medium, and dibbled to compact the growth medium. A vacuum-operated seeding device was used to place one pelleted seed (variety Northrup King K-326) into each of the 200 cells. Seeded trays were floated on a solution containing 150 mg N L^{-1} prepared from Peters® water-soluble 20-10-20 fertilizer (Grace Sierra Horticultural Products Co., Milpitas, Calif.). An additional 100 mg N L^{-1} from 20-10-20 was added four weeks after seeding. Additional polystyrene foam was placed between trays to act as separators and to reduce light penetration and algal buildup in the underlying nutrient solution. A maximum-minimum thermometer was used to monitor ambient air temperature at the media surface.

Agribrom usually is applied in greenhouse plug culture by injection into the irrigation system at 20 mg L^{-1} during each mist cycle (or about 10 times per hour during the day). However, mist irrigation systems are not normally used in tobacco transplant float-production systems. Consequently, all Agribrom treatments were applied as surface sprays (60 mL solution per tray) using a backpack sprayer to thoroughly wet the entire surface of the growth medium, leaves of emerged seedlings, and exposed surfaces of the tray. In the first experiment, Agribrom was applied weekly at treatment concentrations of 0, 10, or 20 mg L^{-1}, beginning either at seeding or two weeks after seeding. An additional set of three trays, dibbled, but without plants, was included in this experiment to evaluate algal and fungal growth in the absence of seedlings. In the second experiment, Agribrom was applied at 0, 10, 20, 400, or 800 mg L^{-1} weekly, beginning at seeding, or at 10 or 20 mg L^{-1} beginning two weeks after seeding.

Five weeks after seeding, plants were clipped at the surface of the growth medium, counted to determine plant density, dried for 48 hours at 70°C, and weighed to determine dry-shoot biomass. After plants were removed from the trays, relative densities of algal and fungal growths and a reddish-brown slime resembling oxidized iron were made using a visual, subjective rating scale of 0 to 5, where 0 represented complete absence of growths and 5 represented dense coverage across the entire surface of the tray. Visual ratings were used, because there are no other methods to quantify these growths. Algae were collected from the trays and surface of the nutrient solution and examined microscopically.

Each experiment was established in a randomized complete block design with three replicates per treatment.

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Seedling dry weight, density, and visual rating data were subjected to an analysis of variance and means were separated using the Duncan's multiple range procedure (8).

Two additional experiments were done to determine whether the source of algal contamination was the clay-coated seed or another component of the float system. To determine if seeds were the source of contamination, either sterilized (autoclaved) or unsterilized seeds were placed in petri dishes on filter paper moistened with nutrient solution. Ten seeds were placed into each dish, and each treatment was replicated three times. Petri dishes were placed in a completely randomized order in a growth chamber. They were incubated at 25 ± 3°C with a 12-h photoperiod for one week and examined daily for appearance of algae. In another experiment, three trays containing Metromix 220 were floated in a small hydroponic system without seeding or dibbling, and they were observed over a two-week period for the appearance of algae. Light, temperatures, and nutrients were similar to those in the initial two greenhouse studies, except that this experiment was conducted in a separate greenhouse to avoid cross-contamination from the other experiments. All trays and other materials were new, and trays were steam-sterilized as described previously.

RESULTS AND DISCUSSION

Algae appeared on the growth medium and trays within one week after seeding in all treatments in both of the initial greenhouse experiments. Algae were distributed over the entire system by the end of the experiments (five weeks). There were no significant differences in algal growth among any of the treatments in either experiment, but densities were slightly lower in the second test than in the first (**Table 1**). Microscopic examination revealed that the dominant forms were the blue-green alga, *Oscillatoria* sp. (Cyanophyceae: Oscillatoriales), and an unidentifiable green alga similar in appearance to *Chlorococcum* sp. (Chlorophyceae: Chlorococales). A flagellated green alga, *Chlamydomonas* sp. (Chlorophyceae: Volvocales), also occurred to a lesser extent on the trays and potting medium, but it was the dominant form found on the surface of the nutrient solution. Dense growths of algae, especially blue-green algae and *Chlamydomonas*, occur commonly in greenhouses whenever suitable temperatures, light, high moisture, and nutrients are present. There is no information available about the sensitivity of any of these algae to Agribrom.

Fungal growth and the reddish-brown slime resembling oxidized iron also appeared about the same time as the algae. The reddish-brown slime occurred on all exposed surfaces of trays, spacers, and potting medium, whereas the fungal growth was limited to surfaces of the potting medium and adjacent upper surfaces of trays. There were no significant differences among treatments in either experiment, with respect to fungal growth. Only in the first experiment did any significant differences occur among treatments, with respect to the reddish-brown slime (**Table 1**). It is uncertain why these differences occurred, as there were no consistent patterns of slime development with treatment. Examination by the soil microbiology laboratory revealed only that the fungal growths and the reddish-brown slime were not pathogens and most likely were saprophytes.

Slightly lower densities of algae, fungi, and reddish-brown slime were observed in the second experiment, which may be a reflection of less-suitable growing conditions. Additionally, the plants were smaller, less dense, and less uniformly distributed within the trays than in the first experiment. Under these conditions, there was less shading of the algae from the seedlings. Light intensities reaching the surface of the growth medium would have been higher, and presumably (not measured), the surface temperature of the growth medium would have been higher during the day than in the first experiment. Very warm temperatures and high sunlight intensities are detrimental to the development of algae and fungi.

Agribrom treatment had no effect on seedling number, total dry matter, or average plant weight in either experiment (**Table 1**). Plant numbers, dry weights, and average weights per plant were significantly lower for the second experiment, compared with the first. Poorer seedling growth in the second experiment may be related to less suitable growing conditions, particularly the higher ambient air temperatures noted in the greenhouse at that time.

Attempts to ascertain the origin of algal, fungal, and reddish-brown slime were inconclusive. No algae, fungi, or

Table 1. Influence of intermittent spray applications of Agribrom on plant growth and the development of surficial algal and fungal slimes in a tobacco transplant float-production system.[a]

Treatment	No. of plants	Dry weight	Avg. plant weight	Rating of surface slimes[b]		
				Algae	Fungi	Brown Deposits[c]
		----- g -----	----- g -----			
Experiment 1						
Control, plants present, no Agribrom	189 NS[d]	14.9 NS	0.07 NS	5.0 NS	4.8 NS	4.7a[e]
No Plants, no Agribrom	-----	-----	-----	5.0	5.0	2.3a
10 mg/L at seeding, 1, 2, 3, and 4 wks	180	14.7	0.08	4.8	4.0	1.7b
10 mg/L at 2, 3, and 4 wks	178	14.8	0.08	5.0	5.0	1.7b
20 mg/L at seeding, 1, 2, 3, and 4 wks	182	14.9	0.08	5.0	5.0	3.0a
20 mg/L at 2, 3, and 4 wks	185	14.6	0.08	5.0	5.0	2.3a
Experiment 2						
Control, plants present, no Agribrom	131 NS[d]	7.0 NS	0.05 NS	4.0 NS	3.7 NS	1.3 NS
10 mg/L at seeding, 1, 2, 3, and 4 wks	133	7.2	0.05	4.3	1.0	1.3
10 mg/L at 2, 3, and 4 wks	134	8.0	0.06	4.3	1.7	1.3
20 mg/L at seeding, 1, 2, 3, and 4 wks	141	9.6	0.07	5.0	3.3	1.0
20 mg/L at 2, 3, and 4 wks	132	8.1	0.06	4.3	1.3	1.3
400 mg/L at seeding, 1, 2, 3, and 4 wks	143	8.1	0.06	4.7	2.0	1.3
800 mg/L at seeding, 1, 2, 3, and 4 wks	132	8.2	0.06	3.7	1.3	2.3

[a] Data are means of three replicates.
[b] Rated using a visual scale of 0 to 5, where 0 represents no accumulation and 5 represents heavy accumulation of slimes.
[c] Brown deposits are assumed to be ferric oxide resulting either from precipitation at the surface of the potting medium or possibly from the activity of iron bacteria.
[d] NS = Nonsignificant treatment means according to analysis of variance.
[e] Means followed by the same letter are not significantly different according to Duncan's New Multiple Range procedure ($\alpha = 0.05$) (8).

reddish-brown slimes appeared in the growth chamber experiment in which autoclaved versus unsterilized seeds were compared. The dense growths of algae, fungi, and reddish-brown slime observed in the two experiments with Agribrom did not appear on untreated trays or the potting medium when the trays were neither seeded nor dibbled, even though conditions were similar to those in the Agribrom tests. Limited growth of *Chalamydomonas* sp. did occur on the surface of the nutrient solution.

These results indicate that weekly spray applications of Agribrom to the surface of the growth medium, even at high rates, may be of little value for controlling algal or fungal growths in float systems used for production of tobacco transplants. Conditions in these experiments were quite different from those occurring in plug production for ornamental plants, however. In the float-production system, watering is provided via subirrigation rather than by regular misting cycles throughout the day. The substrate in float systems is constantly saturated, in contrast to a mist system, which maintains moist but not saturated conditions in the growth medium. Surface evaporation from the float system also tends to concentrate nutrients at the surface of the growth medium. The saturated conditions and surficial accumulation of nutrients enhance algal growth. The failure of Agribrom to control algae and fungi in the float system appears to reflect both the infrequency of treatment (weekly vs. throughout the day with each misting cycle) and more suitable growing conditions for the algae and fungi. Bromine, the active component of Agribrom, is inactivated quickly by organic matter and other readily oxidizable materials, such as ferrous iron. Even at the highest treatment rate (800 mg L^{-1}), the activity of Agribrom probably dissipated rapidly. Also, the infrequency of treatments in this study resulted in application of substantially less Agribrom than would have occurred in a mist system. Only 1,100 mg M^{-2} was applied over the five-week treatment period using weekly applications at 800 mg L^{-1} compared to 5,425 mg M^{-2} using 20 mg Agribrom L^{-1} in the misting system described previously.

The results of these experiments indicate that the primary reasons for the ineffectiveness of Agribrom in commercial tobacco transplant float-production systems may be the combination of conditions highly conducive to algal and fungal growth and the infrequency of Agribrom applications. Further research is needed to determine if more frequent applications of Agribrom, possibly through a mist system, would give improved control of algae and fungi in float-production systems. Examination of other algicides applied to the nutrient solution or as a surface spray also is warranted.

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