Final Report
December 31, 2013

AN INTEGRATED APPROACH TO MITIGATING *NOSTOC* BLUE-GREEN ALGAE IN NURSERIES

for

OREGON DEPARTMENT OF AGRICULTURE
NURSERY RESEARCH AND REGULATORY COMMITTEE

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Background

Nostoc sp. is an alga, actually classified as a cyanobacterium that inhabits terrestrial sites. This particular blue-green alga has become more visible in nurseries nationwide during recent years, inhabiting gravel and groundcloth as well as other surfaces.

Nostoc sp. has the ability to form a coating over its surface, protecting the organism from stresses such as drought and extreme temperatures. During times without water the algae dries and becomes flakey, but will regrow when water returns.

The presence of this organism in nurseries creates a number of issues related to production. Worker safety is a primary issue, as the algae is slippery while wet and often grows on hard surfaces and walkways where individuals can easily loose footing. Another potential issue with this organism is its ability to grow on the bottom of containers creating an unsightly product for customers and a possible shipping problem.

Little information is available to growers about effective control methods for this alga. The literature mentions a limited number of chemicals that have been used with mixed success. Further investigation into these products is warranted in the Pacific Northwest's conditions. Personal communications have also yielded information regarding the effectiveness of heat in control of the algae. Combining various techniques of control will provide growers with various methods to fit within differing situations and production methods.

Project Objectives

1. To investigate physical, mechanical and chemical control methods of *Nostoc*, including chemical, solarization and flaming.
2. Evaluate longevity and number of applications needed for chemical control.

Methods and Time Line

Spring 2013. Obtain materials needed to perform treatments.

Summer 2013. Conduct evaluations at one site in Clackamas Co. or Yamhill Co.

Fall/Winter 2013. Data analysis and accomplishment reporting. Findings will be disseminated via popular/trade articles and extension distribution systems including the World Wide Web.

Final Results:

Methods:

Two container nursery sites were chosen in early summer 2013, one in Clackamas and one in Yamhill County. Three chemical, two physical and one untreated control treatments were applied in 1 m^2 plots with four replicates at each site on two treatment dates applied two weeks apart.

The treatments were as follows:

1. GreenClean Pro (2 lb/1000ft^2 applied as a liquid solution)
2. Axxe (10% by volume solution)
3. Copper Sulfate (2.6 oz/2 gal for 1000ft^2)
4. Heat (propane burner)
5. Solarization (Thermax, 6-mil anti-condensation plastic made by AT Films, Albert, CA.)
6. Untreated Control

The treatments were applied to the Clackamas Co. site on July 19 and Aug 2nd and the Yamhill Co. treatments were applied on July 16th and July 30th.

The 1 m^2 plot areas were rated visually on a 1-5 scale for both "percent coverage" of the plot with *Nostoc* and "health" of the *Nostoc*. Ratings were performed on three dates: the day of the first application, two weeks after the second application (4 weeks after exp. Initiation) and four weeks after the 2nd application date (6 weeks after exp. initiation). The percentage of the plot covered by algae was rated as follows:

1 = 0-20% of the plot covered with algae
2 = 20-40% coverage
3 = 40-60% coverage
4 = 60-80% coverage
5 = 80-100% coverage

The rating for health of the algae was from 1-5 with 1 being the algae appeared dead (or gone completely) and 5 appearing completely healthy.

Photos were collected of each plot on all three data collection dates. These photos were analyzed using Assess 2.0 image analysis software to give a numeric percent cover value of *Nostoc* for each plot.

Figure 1. Yamhill Co. site in July

Figure 2. Clackamas Co. site in July

Results:
The two sites had similar, but not identical results from the treatment applications. This was likely due to *Nostoc* density and health differences. The Clackamas Co. site had a large population of *Nostoc* at the experiment site. The Yamhill Co. site initially had a number of plots that had spotty *Nostoc* growth (average rating of 1.9) causing less clear results. However, both sites contributed to our knowledge about this problematic cyanobacterium.

At the Clackamas Co. site, four weeks after treatment (WAT), the rating data showed the copper sulfate plots had less than 20% of the plot covered by algae with a health rating of 1.0 (Table 1). The heat and solarization treatments also both had less algae than the untreated control plots at 20-40% coverage. The control plots all had ratings of 4-5 for both health and percent coverage throughout the trial. GreenClean and Axxe applications did not result in reduced plot coverage or health of the algae.

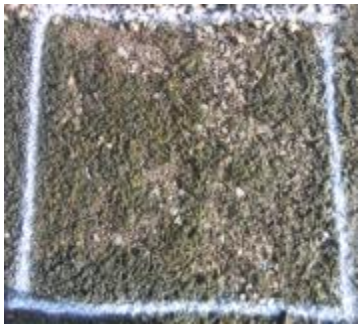
At the Yamhill Co. location, 4 WAT, solarization was the only statistically different treatment from the control for the rating data, although the plots treated by copper sulfate did have on average less than 40% algae coverage vs. 40-60% coverage for the untreated control (Table 2). Both the copper sulfate and solarization plots were rated as less healthy than the untreated control, GreenClean, Axxe and heat treatments.

The results from the Assess image analysis showed a similar pattern as the visual ratings of the % coverage by *Nostoc* for both locations. At the Yamhill Co. location, copper sulfate and solarization were found to be different from the controls at 22% and 7% of the plot covered 4 WAT, respectively (Table 3). In Clackamas Co., copper sulfate was most effective at 1% plot coverage, followed by heat and solarization at 62% and 65% coverage at 4 WAT, respectively (Table 4). The GreenClean and Axxe treatments were not found to be different from the control at either site.

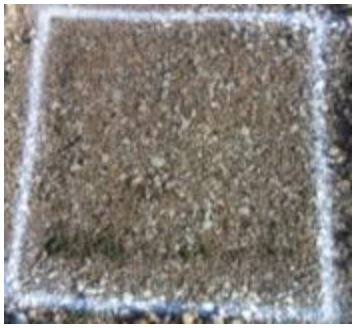
Although the two test sites showed many of the same trends, there are some likely reasons as to why some treatments were more effective at one location over the other. The heat treatment was likely more effective at the Clackamas Co. site due to different apparatus being used. The burner used at the Clackamas site had a flaming component (manufactured by Flame Engineering), whereas the burner used for the Yamhill site did not. We also believe that the solarization was more effective in Yamhill Co. due to the slope of the experimental test area. Standing water occurred on the plastic of the Clackamas Co. site, meaning that the heat was not building up as effectively as in Yamhill Co. The placement of something under the plastic to allow the water to drain off the surface would likely have increased the efficacy of the solarization treatments. It is unknown why the copper sulfate in Clackamas Co. was more effective than in Yamhill Co., although it could perhaps be attributed to *Nostoc* population differences.

Copper sulfate Solarization Untreated control

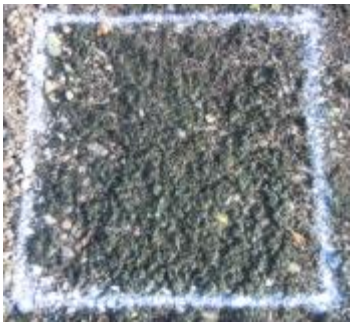
Figure 3. Copper sulfate, solarization and control plots at the Clackamas Co. site in August



Copper sulfate



Solarization



Untreated control

Figure 4. Copper sulfate, solarization and control plots at the Yamhill Co. site in August

Table 1. Nostoc treatment ratings at the Clackamas Co. location two and four weeks after the 2nd treatment application.

	Percent coverage	Health rating	Percent Coverage	Health rating
Treatment	2 Weeks after Treatment		4 Weeks after Treatment	
Green Clean	4.9 a	4.5 a	5.0 a	5.0 a
Axxe	4.8 a	4.3 a	5.0 a	4.3 b
Copper Sulfate	1.0 b	1.0 c	1.0 c	1.0 e
Heat	2.0 b	3.0 b	3.5 b	3.5 c
Solarization	2.0 b	3.0 b	3.3 b	3.0 d
Untreated Control	5.0 a	4.8 a	4.8 a	5.0 a

Table 2. Nostoc treatment ratings at the Yamhill Co. location two and four weeks after the 2nd treatment application.

	Percent coverage	Health rating	Percent Coverage	Health rating
Treatment	2 Weeks after Treatment		4 Weeks after Treatment	
Green Clean	1.8 abc	3.1 a	2.5 ab	3.4 a
Axxe	2.9 a	3.6 a	3.5 a	4.1 a
Copper Sulfate	1.5 bc	2.0 b	1.8 bc	1.6 b
Heat	2.6 ab	3.4 a	3.8 a	4.1 a
Solarization	1.0 c	1.0 c	1.0 c	1.0 b
Untreated Control	2.5 ab	3.6 a	3.0 ab	3.9 a

Table 3. Percent coverage by *Nostoc* at the Yamhill Co. location prior to, two (2 WAT) and four weeks (4 WAT) after the 2nd treatment application as determined by Assess image analysis program.

Treatment	Pre-treatment	2 WAT	4 WAT
Green Clean	17	30 ab	46 ab
Axxe	26	48 a	66 a
Copper Sulfate	28	17 b	22 bc
Heat	23	45 a	67 a
Solarization	N/A	10 b	7 bc
Untreated Control	20	47 a	55 a

Table 4. Percent coverage by *Nostoc* at the Clackamas Co. location prior to, two (2 WAT) and four weeks (4 WAT) after the 2nd treatment application as determined by Assess image analysis program.

Treatment	Pre-treatment	2 WAT	4 WAT
Green Clean	91	93 a	99 a
Axxe	93	93 a	99 a
Copper Sulfate	96	11 b	1 c
Heat	97	41 b	62 b
Solarization	93	33 b	65 b
Untreated Control	93	96 a	99 a

Benefit to Nursery Industry

Further information on control of *Nostoc* sp. in Oregon nurseries will give local growers more tools to mitigate this expanding problem that affects worker safety as well as other production related and aesthetic concerns. An integrated approach, investigating multiple control methods may give producers additional options for managing this challenging organism.