PROJECT NO. 14

ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
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PROJECT TITLE: Evaluation of alternative methods for managing algae in California rice fields.

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LEVEL OF 2005 FUNDING: $23,820

OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO ACCOMPLISH OBJECTIVES:

Objective 1. Comparison of rice field soil copper levels with those from natural wetlands.

We will collect samples from rice fields spread across a wide geographic area that includes the rice growing region in northern California. Prior to the addition of water to rice fields, we will collect five soil samples equally spaced along a transect that bisects each field. The location of each sample will be recorded with a sub-meter Trimble XRS-Pro GPS unit. These samples will be sent to the UC DANR Analytical laboratory and analyzed for total copper and DPTA extractable copper (i.e., potentially available copper). Similar samples will be collected from natural wetlands within the same region. The hypothesis that total copper and DPTA available copper in these two types of systems differ will be compared statistically using analysis of variance. This information will allow us to determine the extent that copper levels in rice fields differ from those in natural wetlands.

Objective 2: Determine the potential of GreenClean and copper/adjuvant mixes to effectively reduce green and blue-green algal populations that are dominant in California rice fields.

Nostoc isolated from California rice fields will be exposed to concentrations of GreenClean, combinations of copper and AquaPrep, and other available copper chelated formulations in laboratory conditions at Purdue University in West Lafayette, Indiana.

We will also conduct field experiments using plastic buckets. Each bucket will be considered a replicate. Prior to treatment we will collect algal samples to determine the

species present and their biomass. We will collect water samples to determine alkalinity and water hardness. We will use a YSI multiprobe instrument to measure pH, dissolved oxygen, and conductivity. There will be four replicate buckets for each treatment. The treatments will consist of the following: controls (untreated), selected concentrations of GreenCleanPro (15, 45, and 90 pounds $acre^{-1}$), combinations of copper and AquaPrep, and combinations of chelated copper formulations. Following application of the treatments we will measure algal dry weight after 7 days by harvesting the algal material in each of the buckets. We will establish this basic experiment in at least three fields, more if sufficient cooperators can be found. We will use analysis of variance with planned orthogonal contrasts to test hypotheses about efficacy of the new algaecide relative to copper sulfate. These procedures are slightly modified from the proposal. Experiments were conducted in California rice fields and at the Exotic & Invasive Weeds Research Unit facilities in Davis, California.

SUMMARY OF 2005 RESEARCH (major accomplishments), BY OBJECTIVE:

Objective 1. Comparison of rice field soil copper levels with those from natural wetlands

Total copper for soil samples collected from seventeen rice fields had a mean value of 63.1 mg kg^{-1} which was significantly greater ($P < 0.0001$, $t_{125} = 4.39$) than the average value of 54.3 mg kg^{-1} for soil samples collected from nine wetlands in the same region. Variation in total copper was greater for rice fields with values ranging from 29 to 101 mg kg^{-1} compared to values that ranged from 41 to 66 mg kg^{-1} for wetlands. The total copper levels in wetland soil samples did not appear to be related to the length of time since the wetland was used as a rice field. Available copper (DTPA extractable) was also greater for rice field soils (mean = 15.9 mg kg^{-1}) than for wetland soils (mean = 10.0 mg kg^{-1}). The difference was statistically significant ($P < 0.0001$, $t_{128} = 8.43$). In the rice field soil samples available copper was 25% of total copper and in wetland soils available copper was 18% of total copper. When the present total copper levels for rice field samples were compared to similar values for samples collected during 1994, they were in agreement with predicted levels assuming that an additional 1.1 mg kg^{-1} is added each year that 15 lb per acre of bluestone is applied each year.

Objective 2: Determine the potential of GreenClean and copper/adjuvant mixes to effectively reduce green and blue-green algal populations that are dominant in California rice fields.

In laboratory cultures, the chelated copper product, Cutrine Ultra, significantly reduced chlorophyll content of *Nostoc* isolated from a California rice field at 0.4 to 0.8 parts per million (ppm) of copper. These doses are within label rates. However, once the product was removed by replacing the culture medium with medium not containing Cutrine Ultra, *Nostoc* at 0.4 ppm recovered. In an additional laboratory experiment, the bacterium SG-3 significantly reduced final *Nostoc* yield, but the effect was a reduction in growth rate rather than an actual kill of the biomass. Results from several outdoor and field experiments indicated that none of the products examined significantly and consistently reduced growth of algae collected from California rice fields. The products examined

were copper sulfate (1 or 2 ppm), Clearigate (0.5 X and 1X maximum labeled rate), Cutrine granular (1 X maximum labeled rate), Cutrine Ultra (0.5 X and 1X maximum labeled rate), Radiance (0.5 X and 1X maximum labeled rate), B6005 (0.5 X and 1X maximum labeled rate), and GreenCleanPro at 15, 45, and 90 pounds acre^{-1} (= maximum labeled rate)). Similar results were obtained when *Nostoc* biomass was measured as dry weight or as chlorophyll content. In an additional field study, we found that barley straw (applied at 225 pounds acre^{-1}) did not significantly reduce algae in rice fields. We conducted four additional field experiments using a combination of zinc sulfate (50 pounds acre^{-1}) and potassium sulfate (130 pounds acre^{-1}). This combination reduced *Nostoc* biomass by about one-half.

PUBLICATIONS OR REPORTS:

The following oral/poster reports were made in 2005:

D. F. Spencer. 2005. Results of 2004 algae study in rice fields. Big Valley Ag Services-Bear River Supply 2005 Rice Grower Update, Yuba City, California, March 15.

D. F. Spencer. 2005. Results of 2004 algae study in rice fields. Butte County Rice Growers Association 2005 Rice Grower Update, Richvale, California, March 17.

D. F. Spencer and C. A. Lembi. 2005. Spatial and temporal variation in the composition of filamentous algae present in California rice fields. Aquatic Plant Management Society 45th Annual Meeting, San Antonio, Texas, July 10-13, 2005

CONCISE GENERAL SUMMARY OF CURRENT YEAR′S RESULTS:

The level of total copper in rice field soils was 16% higher than in wetland soil samples. A greater percentage of copper was present in a biologically available form in rice field soils compared to wetland soils. For wetland soil samples, there did not appear to be a strong relationship between the total copper present and the number of years since a particular wetland had been used for rice culture. Although an alternative algicide (i.e., a chelated copper compound) reduced *Nostoc* growth under laboratory conditions, none of the alternative algicides that we tested (four copper containing products, a chloride based product, and a hydrogen peroxide based product) consistently reduced growth of *Nostoc* under near-field conditions.