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NOTES

Effects of Cutrine-Plus and Cide-Kick II on the Growth of Algae and Cyanobacteria

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INTRODUCTION

Cutrine-Plus (copper triethanolamine chelate)[3] is frequently used in combination with the surfactant Cide-Kick II[4] for the control of aquatic weeds under the premise that the surfactant enhances the effectiveness of Cutrine-Plus. Chelated copper formulations like Cutrine-Plus stay in solution longer than copper sulfate and tend to give better algae control, as well as greater safety for fish (Watson 1989). It inhibits photosynthesis by binding to the chloroplast membrane and disrupting photosynthetic electron transport (photosystem II) (WSSA 1989). Under field conditions, Cutrine-Plus is reputed to be effective in controlling a broad range of macro- and micro-algae.

Cide-Kick II is a 100% active non-ionic penetrant used to enhance activity of herbicides or pesticides, reduce surface tension for better wetting and has a natural sticking action. This paper describes the effect of the herbicide Cutrine-Plus and the surfactant Cide-Kick II, singly and in combination, on the growth and survival of four species of algae and cyanobacteria.

MATERIALS AND METHODS

Two species of green algae and two species of cyanobacteria were included in these tests; 1) the planktonic unicellular green alga (Chlorophyceae) *Selanastrum capricornutum* (ATCC 22662), 2) the filamentous benthic mat-forming green alga *Spirogyra communice* (UTEX LB 2462), 3) the bloom-forming, planktonic, filamentous cyanobacterium (Cyanophyceae) *Oscillatoria* sp. (local isolate, Florida) and 4) the filamentous, benthic, mat-forming cyanobacterium *Lyngbya wollei* (local isolate, Florida). Artificial culture medium was used for the growth of all the species (Phlips et al. 1992). The medium was adjusted to pH 8.2 and pH was monitored in all treatment groups. Temperature was maintained at 30C for the unicellular species *S. capricornutum* and *Oscillatoria* sp., and 25C for the filamentous species *S. communice* and *L. wollei.* The filamentous species were bubbled with air. All species were maintained at light levels between 130 to 140 µ mole photons m^{-2} s^{-1} with a 14:10 day-night rhythm.

A series of 500-ml batch culture flasks were set up for testing the effects of Cutrine-Plus, Cide-Kick and a combination of both on each species. Each flask contained 300 ml of sterile medium. For the effect of Cutrine-Plus, the following concentrations were tested: 0.00 (control), 0.05, 0.10, 0.25, 0.5, 1.0, 1.5, 2.0, 5.0, 7.5 ppm of copper (Cu). For the effect of Cide-Kick II the following concentrations were tested: 0.00 (control), 0.15, 0.29, 0.58, 1.16, 2.32, 3.48, 4.64, 6.96, 9.28 ppm of active surfactant. For the effect of the combination the same concentrations of Cutrine-Plus as above were tested enriched with 0.58 ppm of Cide-Kick II in each flask, equal to the manufacturers recommended dose rate. All tests were run in triplicate.

Ten ml of actively growing phytoplankton (*S. capricornutum* and *Oscillatoria*) were used as inocula. The filamentous species were inoculated by filtering the algae over a sterile filter, dividing the algae on a sterile plate and dividing into equal parts for inoculation of each flask. Flasks were then incubated in illuminated water baths at the irradiance and temperature levels described above. Biomass increase in each flask was determined after five days of growth. The biomass of the two filamentous algae was measured in terms of dry weight. The contents of each flask was filtered through Gelman glass fiber filters (type A/E, 47 mm) and dried at 80C for 24 hours. The biomass of unicellular (*S. capricornutum* and *Oscillatoria*) species was measured as chlorophyll-*a* (chl-*a*) using spectrophotometric analysis of acetone-extracted samples (APHA 1989).

Linear regression analysis was conducted using General Linear Models procedures (SAS 1988) using 5-day data sets to determine significance ($p<0.05$) of treatment effects. Inhibition of growth was expressed in terms of the concentration of the active element, i.e. copper or surfactant, which caused 50% reduction in yield (chlorophyll or dry weight) after 5 days of culture; referred to as EC50.

RESULTS AND DISCUSSION

The range of susceptibility to Cutrine-Plus among the species tested was relatively narrow (Table 1). The most sensitive

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[3]Cutrine-Plus is a registered trademark of Applied Biochemists, Inc., Milwaukee, Wisconsin 53218.

[4]Cide-Kick II is a registered trademark of Brewer International, Inc., Vero Beach, Florida 32961-6006. Received for publication April 28, 1995 and in revised form January 6, 1996. Mention of a trademark or a proprietary product does not constitute a guarantee or warranty of the product by the University of Florida or the U.S. Department of Agriculture, and does not imply its approval to the exclusion of other products that may be suitable.

Table 1. Predicted level of Cutrine-Plus, ppm of Copper (Cu), yielding 50% inhibition of growth, EC50, at the fifth day of culture. Growth was measured as dry weight for *Spirogyra communice* and *Lyngbya wollei*. Growth was measured as chlorophyll *a* ($\mu g\ L^{-1}$) spectrophotometrically for *Selenastrum capricornutum* and *Oscillatoria* sp.

Species	EC50	95% Confidence interval
	Cutrine-plus	
Spirogyra communice	0.88	0.81-0.95
Lyngbya wollei	1.63	1.51-1.75
Selenastrum capricornutum	2.10	0.98-2.30
Oscillatoria sp.	1.73	1.60-1.94
	Cutrine-plus with addition of Cide-Kick II	
Spirogyra communice	4.50	1.95-7.05
Lyngbya wollei	1.73	1.41-2.05
Selenastrum capricornutum	3.10	2.20-4.00
Oscillatoria sp.	1.60	1.45-1.75

species was *S. communice* with an EC50 of 0.88 ppm. The EC50 for the other three species tested fell within the 95% confidence intervals of each other. All species tested exhibited sensitivity to Cutrine-Plus, 50% inhibition of growth, near the 1 ppm concentration suggested by the manufacturer as the maximum application rate.

There was no significant inhibition of algal or cyanobacterial growth over the range of Cide-Kick II concentrations tested in this study. Growth of all species, except *S. capricornutum*, was higher with Cide-kick II than in the control group without surfactant, indicating a stimulatory effect. Cide-Kick II is reputed to enhance the uptake of nutrients by algae, perhaps accounting for the observed stimulatory effect.

The effects of Cutrine-Plus with and without Cide-Kick II were not significantly different in three of the experimental cases, *S. capricornutum*, *Oscillatoria*, and *L. wollei*. In the case of *S. communice* the inhibitory effect of Cutrine-Plus with Cide-Kick II was empirically less pronounced than the effect of Cutrine-Plus alone. These results do not demonstrate any enhancement of the inhibitory effects of Cutrine-Plus from the addition of Cide-Kick II for the species tested and under the laboratory conditions used in these tests.

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