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Effects of Five Insecticides on Zygospore Germination and Growth of the Green Alga *Chlamydomonas moewusii*

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The toxic effects of various pesticides on algae have been studied extensively, and several review articles containing information about algae and pesticides have been written (Ware and Roan 1970; Hurlbert 1975; Tu and Miles 1976; Butler 1977; McCann and Cullimore 1979; Lal and Saxena 1980). However, an examination of previous pesticide-algae studies reveals that toxic effects have been demonstrated chiefly with the vegetative phases of algal life histories. This is perhaps unfortunate since many algae, in addition to vegetative phases, produce reproductive stages such as gametes and spores as part of their sexual and/or asexual life cycles. For example, Chlamydomonas moewusii, a common alga in both freshwater aquatic and soil habitats, produces a thick-walled zygospore as a result of sexual reproduction. Therefore, this organism possesses in its sexual life cycle two different morphological entities, both of which could theoretically experience toxic effects from pesticides.

The only study of which we are aware which has examined toxic effects of pesticides on an algal reproductive stage is our own recent work (Cain and Cain 1983). The results of this latter study, which examined the effects of 20 different herbicides on zygospore germination and growth of C. moewusii, demonstrated that zygospore germination can be inhibited by herbicide presence, and that zygospores are more resistant than vegetative cells to some but not all herbicides. In view of these results, we felt it important to conduct a similar study with 5 insecticides, to examine and compare possible toxic effects of these compounds on both morphological stages of the C. moewusii sexual cycle.

MATERIALS AND METHODS

The following 5 insecticides were chosen for study: aldicarb, carbaryl, dichlorvos, propoxur, trichlorfon. All insecticides used were reagent-grade, obtained from Chem Service, Inc., West Chester, PA 19380, U.S.A. The C. moewusii strains, culture conditions, and procedures for preparing culture media, conducting experiments, and quantifying zygospore germination and growth were identical to those employed previously (Cain and Cain 1983). All data were analyzed by one-way analysis of variance.

RESULTS AND DISCUSSION

The effects of the insecticides on growth of C. moewusii are shown in Table 1. Analysis of variance of these data revealed that carbaryl and trichlorfon produced significant growth inhibition ($P < 0.05$) over the concentration range tested. No statistically significant inhibition of growth was produced by the remaining 3 insecticides.

Since no tested concentration of any insecticide was algicidal or produced a 50% growth inhibition relative to controls, only the highest concentration (80.0 µM) of each insecticide employed in the growth experiments was tested for effects on C. moewusii zygospore germination. These results, presented in Table 2, revealed that carbaryl significantly inhibited zygospore germination ($P < 0.05$). No statistically significant effects on germination were produced by the other 4 insecticides tested.

In our previous study (Cain and Cain 1983), 12 of 20 herbicides tested significantly inhibited growth of C. moewusii over a concentration range from 1.0-80.0 µM. Eight of these 12 also inhibited zygospore germination over the same concentration range, but only dinoseb inhibited zygospore germination to a greater degree than growth. In this latter regard, carbaryl and dinoseb are similar. With trichlorfon, as with the herbicides alachlor, atrazine, diuron, and prometon, concentrations which adversely affected growth had no significant effect on zygospore germination.

The results of this study represent the first documentation that an insecticide can produce toxic effects on an algal spore, and illustrate the need for further toxicity studies involving reproductive stages of algal life histories.

Table 2. The effects of 5 insecticides (80.0 µM concentration) on zygospore germination of C. moewusii[a].

Insecticide	Zygospore germination
aldicarb	99
carbaryl	7
dichlorvos	96
propoxur	98
trichlorfon	108

[a]Zygospore germination is expressed as a percent of controls. Figures presented are means based upon two individual experiments and a total sample size of 200 zygospores per treatment.

Table 1. The effects of 5 insecticides on growth of C. moewusii.[a]

	Insecticide concentration in medium (μM)											
Insecticide	1.0	2.5	5.0	7.5	10.0	15.0	20.0	30.0	40.0	50.0	60.0	80.0
aldicarb	100	102	102	94	107	95	106	96	107	95	91	98
carbaryl	96	98	93	97	97	92	93	85	82	79	64	54
dichlorvos	96	99	88	93	89	97	93	89	86	88	86	82
propoxur	88	98	96	102	95	91	98	92	96	94	88	87
trichlorfon	105	99	89	86	98	85	84	83	80	82	79	76

[a]Growth is expressed as a percent of controls. Figures presented are means based upon two individual experiments run in triplicate for each treatment.

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