inch group) with electricity. In all tests with largemouth bass, only one died and this may possibly have resulted from handling. This wide selectivity between bluegill and largemouth bass does offer some encouragement for further research on the use of electricity with higher voltage and amperage for controlling overcrowded bluegill populations.

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USE OF THE RED CRAWFISH, *Procambarus clarki* (GIRARD), FOR HERBICIDAL ASSAYS

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ABSTRACT

Bioassays were conducted on two herbicides, potassium azide and sodium azide, using the red crawfish, *Procambarus clarki,* and bluegill sunfish, *Lepomis macrochirus,* as test animals. These chemicals proved to be more toxic to crawfish than to fish. Comparisons are made of laboratory toxicity values and field tests conducted in rice fields. Recommended techniques for crawfish bioassays are described.

INTRODUCTION

Crawfish production in the State of Louisiana is estimated to exceed four million dollars annually. Fifty percent of these crawfish are being produced in rice fields that are managed purposely for crawfish production (LaCaze, 1966).

Herbicides are used in these rice fields and on levees to control detrimental weed species. For this reason it has become a necessity to know the acute toxicity of certain herbicides to crawfish. This study concerns preliminary determinations on two such herbicides.

Bioassays using crawfish as test organisms have been reported for 10 insecticides by Muncy and Oliver (1963). No herbicidal toxicities have been reported for crawfish. This is due in part to the limited production of crawfish in other states and the lack of demand for such data.

MATERIALS AND METHODS

Red crawfish, *Procambarus clarki* (Girard), were obtained from a commercial crawfish pond in St. Landry Parish near Cankton, Louisiana. There was no history of any pesticides having been used in this crawfish pond. Crawfish were hauled the 200 miles to Monroe in tanks equipped with agitators. This type of hauling was necessary because only ten percent survival was recorded for crawfish shipped in wet cloth bags in styrofoam coolers. The latter type of shipping is very successful for adult crawfish but not satisfactory for the size used for bioassays (four to ten grams). Upon arrival in Monroe the crawfish were placed in large holding vats until they were needed in the laboratory. Feed consisted of commercial catfish pelletized feed, raw liver and fresh dead fish. The crawfish failed to feed on plant material after initiation of a meat diet.

Bioassays were run in a constant temperature laboratory at 25°

Centigrade. Crawfish were held in the laboratory in a 30-gallon aquarium and observed critically for at least one week before testing. Dilution water was obtained from Bayou DeSiard, a 1,215-acre lake adjacent to the laboratory. Water analyses run on the dilution water prior to tests have indicated very little fluctuation in the chemical composition (Hughes and Davis, 1963).

Bioassay containers were one-gallon, wide-mouth glass jars lined with a 6 x 3½ x 15-inch polyethylene bag. The bags were destroyed after each test to minimize the possibility of contamination. To these containers were added 1,000 milliliters of dilution water. One crawfish was placed in each bioassay container. For each four bioassay containers, one control container was used. After the bioassay containers were filled, they were placed in wooden racks that held the jars at a 30-degree angle. This allowed the crawfish sufficient shallow water to crawl to the surface, thereby eliminating the necessity of aeration.

Trial concentrations were used to determine the approximate toxicity of the herbicide. Observations on survival were made after 24, 48, 72 and 96 hours of exposure to the herbicide. Lethal and non-lethal concentrations were determined for each 24-hour period. Graduated concentrations were used until a maximum of one part per million of the herbicide separated the crawfish that lived and the ones that died. These lethal and non-lethal concentrations were verified on at least five test animals to provide a check of the results.

The two herbicides tested were potassium azide and sodium azide.

RESULTS AND DISCUSSION

Technical potassium azide was toxic to crawfish at 1.0 ppm for 24, 48 and 72 hours while no mortality was recorded at 0.5 ppm for the same times (Table 1). The toxicity decreased to 0.5 ppm and 0.25 ppm for

TABLE 1. RESULTS OF CRAWFISH BIOASSAYS PRESENTED IN PARTS PER MILLION.

Chemical	24-hour		48-hour		72-hour		96-hour	
	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead
Potassium azide (tech)	0.5	1.0	0.5	1.0	0.5	1.0	0.25	0.5
Potassium azide (gran)	1.0	2.0	1.0	2.0	1.0	2.0	1.00	2.0
Potassium azide (tech)*	0.5	1.0	0.5	1.0	0.5	1.0	0.50	1.0
Potassium azide (gran)*	1.0	1.5	0.5	1.0	0.5	1.0	0.50	1.0
Sodium azide (tech)	0.6	1.0	0.4	0.6	0.4	0.6	0.40	0.6
Sodium azide (gran)	0.8	1.0	0.8	1.0	0.8	1.0	0.80	1.0
Sodium azide (tech)*	0.8	1.0	0.4	0.6	0.4	0.6	0.40	0.6
Sodium azide (gran)*	0.8	1.0	0.4	0.6	0.4	0.6	0.40	0.6

* Added 50 grams of mud to container.

96 hours for the lethal and non-lethal concentrations, respectively. When 50 grams of mud were added to the bioassay container, the lethal concentration was 1.0 ppm in 96 hours. The technical potassium azide was less toxic to bluegill sunfish than to crawfish. The 24 and 48-hour TL_ms (median tolerance limits) to bluegill were 4.0 ppm and 3.5 ppm, respectively, using the methods of Hughes and Davis (1963).

The granular formulation of potassium azide was less toxic than the technical formulation without the addition of the mud. However, when the mud was added the toxicity approximated that of the technical formulation. Field tests conducted in a rice field at Stuttgart, Arkansas, with granular potassium azide (Sills, 1966) indicated a 90-percent mortality of red crawfish at the end of 48 hours using 1 ppm of the herbicide. A one-hundred percent mortality was recorded for 48 hours at 1.5 ppm. This compares favorably with the laboratory results. Potassium azide should not be applied to rice fields in concentrations greater than 0.25 ppm where crawfish are present for propagation. Sills (1966) further indicated that 10 days after application of the herbicide, no mortalities to crawfish were recorded at concentrations up to 2 ppm.

Therefore, there is a possibility that crawfish can be added to a rice field after the toxic effect of the herbicide has decreased. Further studies should be conducted to determine the effects on crawfish reproduction before this recommendation is made. Granular potassium azide was again less toxic to bluegill sunfish than to crawfish. The 24 and 48-hour TL_ms were 6.0 ppm and 2.5 ppm, respectively.

Two formulations of sodium azide were also tested. The granular formulation was slightly less toxic to crawfish than the technical formulation. When the mud was added to the containers of both formulations, the toxicities were the same. These toxicities closely agreed with that for the technical sodium azide without mud. Crawfish that were exposed to sub-lethal concentrations of sodium azide exhibited some irritation. Most of the crawfish held in concentrations of sodium azide from 0.4 ppm to 1 ppm would exhibit autotomy. This type of reaction to irritants has been noted on occasion by other workers (LaCaze, 1966).

Sodium azide was more toxic to bluegill sunfish than potassium azide. The 24 and 48-hour TL_ms for the technical formulation of sodium azide were 1.5 ppm and 1.3 ppm, respectively. The granular formulation of sodium azide was less toxic to bluegill sunfish than the technical formulation for 24 hours (1.8 ppm) but was more toxic at the end of 48 hours (0.8 ppm).

On the basis of the foregoing data, it is apparent that the use of potassium azide is preferable to sodium azide for weed control in rice fields where crawfish production is desired.

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EVALUATION OF ROTENONE SAMPLING WITH SCUBA GEAR

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ABSTRACT

Eleven rotenone studies were evaluated with SCUBA gear between 1961-1964 to determine the numbers and weights of fish that do not float to the surface and are not recovered. It was determined that 74% of the number and 95% of the weight of all fishes present in the sample area were recovered on the surface within a 52-hour period. Fingerling fishes represented 91% of the unrecovered population by numbers; intermediates, 6%; and harvestable-size fish, 3%. The species of fish which were lost in the greatest numbers were threadfin shad,