SUMMARY

Fingerlings of white catfish, *Ictalurus catus,* were infected with 1, 10, 50, 100, 500, and 1,000 trophozoites of *I. multifiliis* per fish. There were no mortalities at rates of 1 and 10 trophozoites per fish. Infection rates of 50 and 100 trophozoites per fish resulted in a 33.3 per cent mortality in each case. Infection rates of 500 and 100 trohphozoites per fish resulted in a 100 per cent mortality.

Immunized fish were challenged at rates of 10, 30, 50, and 100 trophozoites per fish. At challenge rates of 10 and 50 trophozoites per fish, no mortalities occurred. Rates of 30 and 100 trophozoites per fish resulted in a 10.0 per cent and 17 per cent mortality, respectively.

Fish surviving an infection at 54°F. showed no immune response when challenged at 54°F. but did show an immunity when challenged at 78°F.

SIMAZINE AS A PREFLOODING TREATMENT FOR WEED CONTROL IN HATCHERY PONDS[1]

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ABSTRACT

The result of applying pre-flooding applications of simazine to warm-water hatchery ponds employed in the culture of largemouth bass, bluegill and channel catfish fingerlings is described.

Rates of 10 and 15 pounds active simazine per acre appeared to reduce the incidence of algal growths such as *Pithophora* and *Hydrodictyon* and inhibited development of submerged rooted weeds. Effects generally persisted for one production period but were not noticeable in succeeding production cycles.

Some indication was obtained that phytoplankton development was retarded but fish production was not appreciably lower in treated ponds that that in untreated ones.

The development of zooplankton did not appear to be retarded by simazine applications to bass rearing ponds.

Some advantages of pre-flooding treatment of warm-water hatchery ponds are discussed.

INTRODUCTION

An important aspect of the culture of warm-water fishes in ponds is the control of aquatic vegetation. Undesirable or excessive amounts of aquatic plants reduce the production of desirable fish food organisms and interfere with observation and harvest of the fish crop. Also, they may prevent complete utilization of supplemental feeds and increase the possibility of anaerobic conditions developing in the pond during the rearing or harvesting period.

Under hatchery conditions, control of unwanted plants by developing a bottom-shading growth of phytoplankton is not always possible. At

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the Marion National Fish Hatchery, a substantial number of the ponds employed in bass *(Micropterus salmoides* Lac.) or channel catfish *(Ictalurus punctatus* Raf.) fingerling culture fail to develop enough phytoplankton to inhibit growth of rooted weeds or filamentous algae. In bluegill *(Lepomis macrochirus* Raf.) and redear sunfish *(Lepomis microlophus* Gunther) spawning-rearing ponds, less than half of the production ponds in any given season remain weed free from the shading effects of phytoplankton. During the summer of 1961, 26 of 39 bluegill and redear ponds required treatment. In 1962, 13 of 39 ponds required treatment. In 1963, 27 of 39 were treated. For the three-year period, 66 ponds were treated, compared to 51 which did not develop enough weed growth to necessitate treatment.

When undesirable plants develop to a point of dominance, some form of control must be employed if optimum results are to be obtained from the ponds being managed. Sodium arsenite, copper sulfate, amine D acetate, silvex, and endothal have been employed on occasion to eliminate specific unwanted growths. All of these herbicides are applied in a similar manner, i.e., distributed over the weed beds or mixed with the pond water so as to establish a lethal concentration of the herbicide in the vicinity of the weeds.

While effective when properly applied, such treatments are rarely made when conditions are such that best results can be obtained. In fact, they usually are applied only after the unwanted plants have choked the pond with a heavy growth of vegetation or covered the surface with a dense mat of floating plants. Treatment under such conditions is more likely to create a condition of oxygen depletion than would be the case if applied earlier, and probably requires more herbicide to obtain control. Harvesting or other management of the pond may have to be delayed while the treatment is effecting control of the vegetation. Development of food chains may be temporarily retarded at aa critical time in the production cycle. Another weed species may replace the one for which treatment was applied, necessitating further treatment and delay in establishing optimum conditions of productivity.

To overcome the disadvantage associated with conventional methods of aquatic weed treatment, it was theorized that an inhibitory application of a herbicide applied prior to flooding the production pond would be of value provided that an agent could be found that would retard the development of unwanted aquatics without affecting the desirable phytoplankton or having a deleterious effect on the fish crop.

The introduction of simazine and its resultant effectiveness as an algicide and submerged rooted weed killer (Grigsby, 1958, Walker, 1959, Snow, 1963) along with progress made in the control of weeds in field crops by means of pre-emergence application of herbicides stimulated a series of pond experiments with simazine which began in 1960 and was repeated in several production situations during three production seasons.

The general pattern of operation was to apply 10-15 pounds of active simazine per surface acre of pond as a water suspension to the dewatered pond bottom one to several days before the pond was flooded. Enough water (about 80 gallons per acre) was used to permit complete coverage of the pond bottom. The treatment solution was applied as a fine mist employing a 150 gallon power sprayer equipped with 50 feet of hose. The spray pattern was wide enough to cover most of the pond bottom. If all the bottom could not be reached, a knapsack sprayer was used to treat the inaccessible sections. As soon as the bottom was treated, the pond drain was closed to prevent loss of herbicide by leaching or runoff. Observations were made of vegetation development subsequent to treatment and data on the crop of fish produced was obtained when the pond was drained.

Rates of active simazine varied from 10 to 15 pounds per acre, with most being applied at the lower amount. Applications were made in the early spring in bass rearing ponds or in the late spring and early summer in bluegill, redear sunfish and catfish rearing ponds.

Preliminary work on the toxicity of simazine to zooplankton along with field tests of the herbicide as an algicide indicated that it had a low level of toxicity to aquatic fauna (Snow, 1963). This conclusion was substantiated by the findings of Jones (in press), Stairs[2], Phillips[3] and Walker (1964).

Preflooding treatments of bass rearing ponds

A total of 6 ponds was included in the evaluation of the technique in bass rearing. The ponds were treated with simazine as described above. They were then filled with water and fertilized with an 8-8-0 grade organic-inorganic combination at a rate of 100 pounds of 8-8-0 per acre per application with an application being made weekly for 3-5 weeks. Later fertilization depended upon the food supply and the duration of the production cycle. From three to eight applications were required to provide what was considered to be an ample food supply for the small fish.

The work of Stairs (op. cit.) measured the effect of 10 and 15 pounds of simazine per acre as a preflooding treatment on the development of zooplankton in bass rearing ponds. Samples taken from the 6 treated ponds showed no appreciable difference in the amount of zooplankton present when compared to samples taken from untreated ponds fertilized at the same rate. No algae or rooted vegetation developed in the ponds treated with simazine as a preflooding application. By comparison, one of three untreated control ponds developed enough algae to require treatment before fish harvest.

Fish production was numerically less in treated ponds than in the untreated ones. It appeared that production was not significantly decreased by the use of simazine. Yields from ponds receiving preflooding applications of simazine are shown in Table 1.

Preflooding treatment of bluegill and redear sunfish spawning-rearing ponds

Two factors added increased interest to the tests of simazine as a preflooding treatment for bluegill and redear sunfish rearing ponds. The first was that the growing period for these species was longer than for bass. Secondly, the food chain for bluegill and redear under the Marion procedure of culture is based on phytoplankton as the producing organism instead of added organic material as in bass rearing ponds. Consequently, observation included phytoplankton density measurements as indicated by light penetration of surface waters. A Secchi disc was employed to obtain the depth of light penetration which was measured in inches.

The procedure followed in bluegill or redear spawning-rearing ponds was similar to that already described for bass rearing. Fertilization with an inorganic 8-8-0 mixture at a rate of 100 pounds per acre per application was commenced as soon as water was present. Applications were made at weekly intervals for three consecutive weeks and bi-weekly thereafter until water temperatures dropped to below 60°F., or the crop was harvested. After cool weather, fertilizer was applied less frequently and was discontinued when winter began.

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2 Stairs, S. W., Pre-flood control of filamentous algae and pond weeds in hatchery ponds with simazine. Term Problem Report, Warm-water Inservice Training School, Marion, Alabama. 1962. 11 pp.

3 Phillips, Ray, Toxicity of selected aquatic herbicides to specific fish food organisms. Term Problem Report, Warm-water Inservice Training School, Marion, Alabama. 1963. 9 pp.

Table 1. Yields from bass rearing ponds given preflooding treatment with simazine.

Pond	Rate/acre simazine	Estimated rate of stocking	Yield per acre No.	weight
S-7	10	60,000	48,600	64
S-13	10	60,000	42,300	59
S-24	10	60,000	56,200	105
Average			49,000	76
S-11	15	60,000	40,000	46
S-25	15	60,000	56,900	69
Average			48,500	58
S-9	0	60,000	70,300*	46
S-18	0	60,000	54,700	100
S-21	0	60,000	50,200	84
Average			58,400	77

*Obviously an appreciable error of estimating the fry stocked occurred in this pond.

Observations were made at weekly intervals to determine the dominant type of plant growth and to obtain the depth of light penetration. The forms of aquatic weeds most prevalent in the Marion pond system during the summer months include branched summer algae, *Pithophora sp.*, and *Najas sp.*, probably *Najas flexilis* (Wild.) Rostk and Schmidt. The blue-green alga, *Anabaena flos-aquae* (Lyngb.) Breb. also develops to undesirable levels on occasion. The over-abundance of *Anabaena* then results in oxygen depletion if a period of cloudy weather ensues or if growth ceases because of other factors. Trouble of this nature is routine in well fertilized bluegill or redear sunfish spawning-rearing ponds during the summer months at the Marion Station.

Of the 13 ponds given preflooding treatment with simazine, two developed *Pithophora* to the extent that it would have interfered with rearing or harvesting the fingerling fish crop. This development did not occur until about 80 days after treatment. Fourteen untreated ponds out of 55 observed developed dominant growths of *Pithophora sp.* None of the treated ponds became infested with *Najas sp.* or other rooted vegetation, while 4 out of 55 untreated ponds developed this form of weed. None of the ponds receiving simazine as a bottom spray developed *Anabaena sp.* in a quantity judged to constitute an oxygen depletion hazard. During the same period, thirteen out of 55 untreated ponds developed objectionally heavy growths of this blue-green algae.

Table 2 lists the individual bluegill and redear sunfish spawning-rearing ponds included in the study. One of the noteworthy results of the treatment was the reduced phytoplankton development in the treatment ponds. As is shown by the average light penetration values for the treated ponds, phytoplankton appears to be inhibited although all ponds treated developed a light bloom of green plankton algae. Seldom was the growth noticeably heavy even though similar amounts of fertilizer were more than ample to produdce heavy bloom in untreated ponds.

Yields of treated ponds were examined to determine whether they were lower than untreated ones. Average production per acre from treated ponds was 141,200 fish weighing 204 pounds; from untreated ponds it was 116,500 fish weighing 271 pounds. The range in treated ponds was from 92,300 fish weighing 191 pounds to 224,200 fish weighing 274 pounds. This compared to a per acre range of numbers from untreated ponds of 47,100 fish weighing 215 pounds to 301,000 fish weighing 380 pounds. Based on results from four treated ponds, preflooding application of 10 pounds of simazine per acre does not seem to significantly reduce either the number of weight of bluegill or redear sunfish fingerlings.

The study included 9 ponds treated and observed during the summer of 1964 which had not been drained at the time this report was written. While no production data are available, seine samples from these ponds indicate that all were supporting an excellent crop of uniform sized fingerlings in what was considered to be normal numbers.

Table 2. Production in bluegill and redear sunfish spawning-rearing ponds treated with preflooding application of simazine.

Pond	Species	Rate of simazine per acre	Average light penetration in inches	Yield per acre No.	Yield per acre Weight
S-38	Redear Sunfish	10	33	92,300	191
S-13	Bluegill	10	28	224,200	274
S-32	Bluegill	10	32	94,200	138
S-34	Bluegill	10	29	154,200	212
Average				141,200	204
Average[4]	Bluegill or Redear	0	27	116,500	271

[4] Average of production measured in 21 bluegill and redear sunfish spawning-rearing ponds.

Preflooding treatment of channel catfish rearing ponds with simazine

During the 1962 production season, two ponds to be used as rearing ponds for channel catfish fingerlings were given preflooding treatment with simazine; one at the rate of 10 pounds per acre and the other at a rate of 15 pounds per acre. The ponds were fertilized with a 100-pound application of inorganic 8-8-0 per acre during the production period, Additionally, supplemental feeding was carried out with the feeding rate starting at a rate about one pound per acre per day and gradually increased to a maximum of about 20 pounds per acre per day. Observation was carried out for a period of 90-130 days, depending on the individual pond. Three untreated rearing ponds also were included in the observations.

Of the treated ponds observed, none developed growths of *Pithophora sp.* or *Najas sp.* Oxygen depletion was not a problem in either. In one of the untreated ponds, about 1200 fingerlings were lost when a heavy concentration of plankton algae died suddenly. Secchi disc measurement of light penetration showed an average of 22 inches for the treated ponds. Untreated ponds had an average measurement of 22 inches also. Two of the three untreated ponds supported heavy phytoplankton blooms with the average light penetration being influenced by the third which seeped badly and remained clear.

Yields apparently were not appreciably affected by the simazine application. Table 3 shows yield data as well as other pertinent measurements. As can be noted, the limited sample for comparison does not make a strong case for either reduced or increased production.

Table 3. Production in channel catfish rearing ponds receiving pre-flooding simazine treatment.

Pond	Simazine/acre	Average light penetration in inches	Yield per acre No.	Yield per acre Weight
S-17	0	17	41,600	1,711
S-19	0	24	83,900	1,573
S-22	0	16	64,900	1,557
S-31	0	30	38,200	1,057
S-30	10	23	95,300	1,791
S-35	15	22	44,800	2,035

Had vegetation been a problem in the untreated ponds, treatment could have resulted in increased production however, as experience in rearing this species in ponds indicate that best utilization of supplemental feed is obtained in a weed-free pond. Also, harvesting is considerably more difficult even in a moderately vegetated pond as compared to one with a clean bottom.

Discussion

Simazine treatment of the bottoms of ponds used for rearing largemouth bass, bluegill, redear sunfish and channel catfish fingerlings prior to filling apparently inhibited the growth of *Hydrodictyon reticulatum*, *Pithophora sp.*, and *Najas sp.* for the entire production season except in two cases where *Pithophora* developed. Certain forms of phytoplankton including species of the genus *Anabaena* also wans suppressed to some degree, although what was considered to be a "light" bloom of phytoplankton developed in all of the treated bluegill, redear and channel catfish ponds.

Comparison of the yields of fingerling fishes in treated ponds with those in untreated ones indicated that the yield was not appreciably reduced by the application of simazine. When considered in the light of data on toxicity of simazine to aquatic fauna, this is expected in bass and catfish rearing units. Since there appeared to be a reduction of phytoplankton growth in simazine treated bluegill or redear sunfish spawning-rearing ponds, a corresponding reduction in poundage of these species could theoretically be expected. Had variables been controlled in these ponds, the effect of the treatments on phytoplankton could have been measured more accurately. Under the production conditions existing where these data were obtained, such effects were unmeasurable. They do not appear to be great enough to preclude use of simazine as a preflooding treatment for hatchery ponds under environmental conditions such as those existing where the work was carried out.

Several benefits accrue from applying the herbicide prior to starting the production cycle.

1. Algal and rooted weed infestations are minimized.
2. Time and rate of application of herbicide as well as its action are predictable after a few trials in a given environment.
3. Depression of the food supply at a critical time in the production cycle of the pond is avoided.
4. Possibility of oxygen depletion caused by decaying weeds or dieoff of phytoplankton is minimized.

The major disadvantage to the use of simazine as a preflooding treatment of warm-water hatchery ponds is the expense of the herbicide. At present, the cost is approximately 30 dollars per acre for the herbicide alone. Where production is lowered by obnoxious aquatic plants this amount is justifiable. However, if only a small percentage of the production ponds are infested with weeds, one can hardly justify treating all ponds as a precautionary measure. Under such conditions, treatment of ponds having a previous history of weed development seems to be the best course of action, dealing with other problems as they arise by using a suitable herbicide applied by the conventional method.

Possibly a lower rate of simazine would provide effective control. This is especially true for ponds having more sand in the bottom mud. The bottom soil of the ponds on the Marion National Fish Hatchery is alluvial in origin, variable, but mostly high in silt and clay. Reports from three federal hatcheries located in areas with soils of lawer clay content indicate that about half as much simazine is required for effective pond treatment of algae as is the case at Marion. This influence could extend to the preflooding treatment as well.

Observation of ponds having a bottom application of simazine indicates that the duration of simazine herbicidal activity is in the general range of 80-120 days. This period of weed inhibition is ample for most hatchery production cycles. It would be too short to justify use of simazine in a cropping system of longer duration if cost is a primary consideration.

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