A TECHNIQUE FOR CONTROLLING WEEDS IN STRIPED BASS REARING PONDS[a]

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Abstract: Simazine (2-chloro-4, 6-bis (ethylamino)-s - triazine) applied at a rate of 11.2 kg/ha as a preflooding treatment of striped bass (*Morone saxatilis* Walbaum) rearing ponds effectively controlled aquatic weed growth for periods of up to 172 days. In untreated ponds, weed species were dominant in 9 of 16 replications (56%). Where simazine at a rate of 11.2-14.0 kg/ha was applied to the pond bottom just before flooding, only 3 of 17 replicates (18%) supported nuisance aquatic plant species. Survival and growth of striped bass fry and fingerlings was as good or better in the treated ponds as in the untreated ones.

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In 1973, a production of 155 million striped bass larvae, was reported by 9 state fish hatcheries for use in programs for inland reservoirs and estuaries (Montgomery 1974). State and federal hatcheries utilized about 200 ha of ponds for rearing 50 million larvae to fingerling size (Stevens 1974). A major problem in the pond rearing of striped bass fingerlings is the growth of aquatic weeds, either filamentous algae or submerged rooted forms (Kirby and Shell 1975). Several paragraphs in "Guidelines for Striped bass Culture" (E. W. Bonn ed. 1976) are devoted to vegetation control covering biological, chemical and mechanical methods of control. Klingman, et al. (1975) lists 11 methods for controlling aquatic weeds, one of which is chemical control. By implication, his chemical controls are applied as ppm to the standing body of water. Each technique is effective when properly applied to a specific situation. Hatchery rearing ponds occupied by fry or small fingerling fishes represent a specialized aquatic habitat prone to invasion by weeds but populated by a crop of animals quite vulnerable to direct and indirect adverse effects of weed control efforts.

Simazine (2 - chloro-4, 6-bis (ethylamino)- s - triazine) has demonstrated effectiveness against a number of aquatic weed forms (Grisby 1958, Walker 1959, Snow 1963). The compound also is registered by the Food and Drug Administration and the Environmental Protection Agency for use as a herbicide in fishery management (Meyer, et al. 1976). Early investigations suggested low toxicity to fish and fish food organisms (Snow 1963), although Wellborn (1969) reported a 96 hr LC_{50} to striped bass fingerlings of 0.25 mg/l. More recently, Hawke (unpublished report) found that simazine as the commercial formulation Prince® had a 96 hr LC_0 of more than 4 mg/l for striped bass fry.

Snow (1967) found that simazine applied as a preflooding treatment was an effective chemical control for several weeds developing in hatchery rearing ponds stocked with largemouth bass (*Micropterus salmoides* Lac.). Since rearing pond management and vegetation control in striped bass culture are quite similar to largemouth bass culture it seemed logical to test the preflooding technique as to effectiveness in controlling weeds in striped bass culture also.

An unreplicated trial was conducted at the Marion, Alabama National Fish Hatchery in 1973. Eight ponds were devoted to the study in 1974 at the same location. In 1976 an 8 pond trial was conducted on the Auburn University Agricultural Experiment Station in the spring followed by summer trials involving 16 ponds. This paper provides details of these trials and presents the results obtained.

MATERIALS AND METHODS

Earthen ponds of 0.04 ha surface area and ranging in average depth from 70 to 100 cm were used. The water supply for the Marion ponds was a deep well system furnishing water of moderate total hardness (about 100 mg/l as $CaCO_3$). Water supply for the Auburn pond system was an 8.2 ha reservoir pond which collected runoff water having a total hardness of about 10 mg/l as $CaCO_3$.

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Weeds indigenous to the Marion ponds included *Hydrodictyon reticulatum, Pithophora* sp., *Potamogeton* sp. and *Najas sp.* In the Auburn ponds the most prevalent forms were *Pithophora* sp., *Wolffia* sp., *Eleocharis* sp., *Potamogeton* sp. and *Chara* sp.

The method described by Snow (1967) was followed, with the amount of water carrier being approximately 38 l per .04 ha pond. A commercial formulation of simazine, Princep®, (80% A. I.) was applied. In 1973 the rate was 7.0 kg/ha. In 1974, the rate was 14.0 kg/ha. The rate applied to the Auburn ponds was 11.2 kg/ha.

Ponds were fertilized in each trial with a combination of organic and inorganic fertilizers. The 1973 trial received alfalfa pellets, ammonium nitrate and superphosphate as an 8-8-0 grade at a rate of 112 kg/ha with half of the nitrogen from alfalfa pellets and the remainder from the inorganic source. In 1974 fertilizer was either compost made of water hyacinth or cottonseed meal. Superphosphate (20% P_2O_5) at a rate of 45 kg/ha was combined with the organic material. Five applications were made either weekly or biweekly before and during the production period. In 1976 fertilizer was an 8-8-0 grade applied at a rate of 11 2 kg/ha at weekly or biweekly intervals depending on the plankton response of the individual pond. Nitrogen was supplied by ammonium nitrate (50%) and meat scrap (50%). Additional organic matter was provided initially by 270 kg of grass hay.

Striped bass fry 6-7 days of age and ready for first feeding were used as test animals. Enumeration was done by counting 500-1,000 fry into a white enamel pan for use as a standard for comparison. Uncounted lots were then established to visually match the counted lot. Successive application of this technique enabled the rate of stocking per pond to be approximated. A rate of 173,000 fry/ha was used in both 1973 and 1974 and 255,000 in 1976. Tempering was done during stocking to minimize the effect of water quality differences. Care was taken to exclude predators. The ponds were filled 5 days before stocking in 1974 and 1976, and 2 days before stocking in 1973.

Weeds which developed in spite of the simazine treatment were controlled with copper sulfate in 1973 and 1974 but none was used in 1976. Ponds were observed frequently to determine the need for management measures. Oxygen levels and zooplankton abundance was monitored in 1976 at weekly intervals.

The ponds were drained for a complete inventory of surviving fish after a growing period of 42-56 days. The total yield was weighed and the number determined either by actual count or number-weight relationship between counted and weighed samples and the total weight of recovered fish.

Weekly or more frequent observations and at draining enabled a determination to be made as to the success of the preflooding treatment in controlling unwanted vegetation. This could readily be ascertained by the absence of interfering forms of aquatic weeds at the time of harvesting.

RESULTS AND DISCUSSION

In the 1973 trial, the untreated pond produced 148,000 fingerlings per ha weighing 33.6 kg. Average size of the fish was 0.23 g. The treated pond had a yield of 102,750 fingerlings per ha weighing 35.8 kg. Average size of the fish was 0.35 g. Late in the 49 day production cycle it was necessary to apply 2 applications of copper sulfate to the treated pond at a rate of 0.5 mg/l to control *H. reticulatum*. In the pond not receiving simazine, 4 applications of copper sulfate were needed. Rooted weeeds (*Najas* sp.) appeared in the simazine treated pond after the algae was eliminated. This was checked with Casaron® granules at a rate of 170 kg/ha.

It was apparent from the 1973 trial that simazine at the rate applied was not toxic to striped bass fry. The rate applied also did not give effective weed control for the 49 day growing period.

Simazine treatments in 1974 (Table 1) were combined with an evaluation of 2 fertilizer treatments, cottonseed meal and compost. Significantly better production occurred in the compost treatment but no significant difference between ponds receiving simazine and those not given the herbicide was demonstrated.

Filamentous algae (*Hydrodictyon reticulatum*) developed in all of the ponds receiving cottonseed meal regardless of herbicide treatment. There was no algal growth in the 4 ponds fertilized with compost. These ponds remained a light brown color throughout the growing period showing no evidence of algal or green phytoplankton development. Presence of the filamentous algae in the cottonseed meal treatment was not surprising

Table 1. Striped bass fingerling yields from 0.04 ha ponds at Marion with and without simazine, fertilized 2 ways in 1974.

Treatment	Pond	Yield/ha No.	Yield/ha Wt. (kg)	Percent survival	Avg. size (g)
CS Meal[a] + simazine	C-2	15,600	11.4	9.0	0.73
CS Meal + simazine	C-4	30,400	22.2	17.6	0.73
	Average	23,000	16.8	13.3	0.73
CS Meal no simazine	C-9	24,600	8.1	14.2	0.33
CS Meal no simazine	C-11	27,200	19.4	15.7	0.71
	Average	25,900	13.8	15.0	0.52
Compost + simazine	C-13	57,100	26.2	33.1	0.46
Compost + simazine	C-25	58,000	10.5	33.5	0.18
	Average	57,600	18.4	33.3	0.32
Compost, no simazine	C-14	76,800	31.1	44.4	0.40
Compost, no simazine	C-15	67,400	39.0	39.0	0.58
	Average	72,100	35.1	41.7	0.49

[a]Cottonseed meal

but it was expected that simazine would inhibit growth for the duration of the growing period. No rooted weeds developed in the ponds during the period of observation.

In the 1976 spring trial, 4 ponds were treated with simazine for comparison with 4 untreated controls. Yields from these ponds are shown in Table 2. The number of fish produced and the percent survival of fry stocked were significantly higher ($P < 0.05$) in the simazine treatment than in the control. The dominant plant growth in the ponds is shown in Table 3.

Table 2. Striped bass fingerling yields from 0.04 ha ponds at Auburn with and without simazine, spring of 1976.

Treatment	Pond	Yield/ha No.	Yield/ha Wt. (kg)	Percent survival	Avg. size (g)
No simazine	E-13	43,423	46.15	22.0	1.06
No simazine	E-16	0	0	0	—
No simazine	E-25	0	0	0	—
No simazine	E-28	51,845	35.62	26.2	0.69
	Average	23,812	20.44	12.1	0.88
Simazine 11.2 kg/ha	E-14	132,886	58.80	67.3	0.44
Simazine 11.2 kg/ha	E-17	52,339	25.54	26.5	0.49
Simazine 11.2 kg/ha	E-26	82,226	51.74	41.6	0.63
Simazine 11.2 kg/ha	E-29	66,369	41.22	33.6	0.62
	Average	83,455	44.33	42.3	0.56

Non-planktonic plants were virtually absent from the treated ponds. In contrast, one of the untreated ponds was choked with 3 undesirable species and secondary species in 2 others were potential problems.

Six ponds were included in the 1976 summer trial of simazine treatment of striped bass fry rearing ponds. Yield data are shown in Table 4. Survival was poor and yields were low in all ponds. Since zooplankton production was as high or higher for this trial than in the spring, indications are that temperature or some other factor was the

Table 3. Plant growth in rearing pounds at Auburn used for striped bass during the spring of 1976.

Pond No.	*Treatment*	*Dominant Plants*	*Secondary plants*
E-13	Control	Phytoplankton	*Eleocharis sp.*
			unidentified filamentous algae
			Barnyard grass
E-16	Control	*Wolffia* sp.	*Echinochloa crus-galli*
		Hydrodictyon sp.	
		Pithophora sp.	
E-25	Control	Phytoplankton	*Eleocharis* sp.
E-28	Control	Phytoplankton	*Pithophora* sp.
			Wolffia sp.
E-14	Simazine	Phytoplankton	Barnyard grass
			Echinochloa crus-galli
E-17	Simazine	Phytoplankton	*Eleocharis* sp. (Trace)
E-26	Simazine	Phytoplankton	None
E-29	Simazine	Phytoplankton	None

Table 4. Striped bass fingerling yields from 0.04 ha ponds at Auburn with and without simazine, summer of 1976.

		Yield		*Percent*	*Avg.*
Treatment	*Pond*	*No.*	*Wt. (kg)*	*survival*	*size (g)*
No simazine	E-15	10,175	18.20	8.1	1.79
No simazine	E-18	3,850	9.30	3.1	2.40
No simazine	E-30	1,050	4.40	0.8	4.14
	Average	5,025	10.63	4.0	2.78
Simazine 11.2 kg/ha	E-13	10,075	29.50	8.1	2.93
Simazine 11.2 kg/ha	E-25	16,700	37.60	13.4	2.25
Simazine 11.2 kg/ha	E-27	750	3.40	0.6	4.50
	Average	9,175	23.50	7.4	3.23

Table 5. Plant growth in rearing ponds at Auburn used for striped bass fry during summer 1976.

Pond No.	*Treatment*	*Dominant plants*	*Secondary plants*
E-15	Control	Phytoplankton	*Eleocharis* sp.
E-18	Control	*Pithophora* sp.	*Micranthemum umbrosum*
E-30	Control	*Pithophora* sp.	*Wolffia* sp.
			Eleocharis sp.
E-13	Simazine	Phytoplankton	*Eleocharis* sp.
E-25	Simazine	Phytoplankton	*Pithophora* sp. (Trace)
E-27	Simazine	*Pithophora* sp.	None

dominant influence. Table 5 shows the vegetation development in the 6 ponds included in the summer trial. Weeds were a problem in 2 of 3 untreated ponds as compared to 1 of the 3 treated ponds. Reason for the failure of simazine to inhibit *Pithophora* sp. in pond E-27 is unknown. This is the only case in these experiments where *Pithophora* occurred in a pond given preflooding simaizne treatment at the 11.2 kg/ha rate.

In the final trial conducted in 1976, 6 ponds were given a preflooding treatment with 11.2 kg simazine per ha and 4 were left untreated. Table 6 shows the vegetation development after 117 or more days of production. For this longer production period during the late summer and fall, the experiment provided a conclusive demonstration of the effectiveness of preflooding treatment with simazine at a rate of 11.2 kg/ha. While the ponds were stocked with small striped bass for growth to a larger size, the stocking rate was low and the natural food supply was more than ample to provide for the needs of the fish. Table 7 shows the production data from the ponds stocked for large fingerling production. Although the data show some variation there is no indication that this was caused by the herbicide treatment. Growth and survival were as good or better in the treated ponds as in the untreated ones. Additionally, less time and labor were required to harvest the ponds which had received the preflooding simazine treatment.

Table 6. Plant growth in rearing ponds at Auburn used for striped bass fingerlings during summer and fall 1976.

Pond No.	*Treatment*	*Dominant plants*	*Secondary plants*
E-15	Control	*Eleocharis sp.*	*Pithophora sp.*
E-18	Control	*Pithophora sp.*	*Pithophora sp.* *Wolffia sp.*
E-28	Control	*Pithophora sp.*	*Wolffia sp.* *Eleocharis* sp.
E-29	Control	*Pithophora sp.*	*Wolffia sp.*
E-13	Simazine	Phytoplankton	None
E-14	Simazine	Phytoplankton	None
E-17	Simazine	Phytoplankton	None
E-25	Simazine	Phytoplankton	None
E-26	Simazine	Phytoplankton	None
E-30	Simazine	Phytoplankton	None

Table 7. Striped bass large fingerling yields from 0.04 ha ponds at Auburn and without simazine, summer and fall 1976.

Treatment	*Pond*	*Yield*		*Percent*	*Avg.*
		No.	*Wt. (kg)*	*survival*	*size (g)*
Control	E-15[a]	1,275	23.4	60.7	18.35
Control	E-18[b]	300	5.7	14.6	18.92
Control	E-28[a]	2,800	49.9	57.4	17.82
Control	E-29[a]	4,125	69.2	84.2	16.77
	Average	2,125	37.1	54.2	17.97
Simazine 11.2 kg/ha	E-13[b]	1,150	16.2	54.8	14.04
Simazine 11.2 kg/ha	E-14[a]	3,200	56.0	64.0	17.50
Simazine 11.2 kg/ha	E-17[a]	3,600	92.9	85.7	25.80
Simazine 11.2 kg/ha	E-25[b]	900	12.1	42.9	13.39
Simazine 11.2 kg/ha	E-26[a]	4,100	115.5	82.4	28.18
Simazine 11.2 kg/ha	E-30[b]	125	1.6	5.9	13.00
	Average	2,179	49.1	56.0	18.65

[a]Stocking rate 4,250-5,075 7.5 cm fingerlings/ha, production period 172 days.

[b]Stocking rate 2,125 7.5 cm fingerlings/ha, production period 117 days.

In the 1976 trials, the residual effect of previous preflooding treatments was not studied although 3 trials were conducted in the same series of 12 ponds that year and several ponds were treated twice (Table 8) during 1 growing season. This could have

Table 8. Frequency of treating experimental ponds at Auburn with simazine in 1976.

Pond (E-series)	*Months treated*
13	June and August
14	April and August
15	Not treated
16	Not treated
17	April and August
18	Not treated
25	June and August
26	April and August
27	June
28	Not treated
29	April
30	August

contributed to the 172 days of weed-free operation in ponds E-13, and E-25. However a single treatment in E-30 controlled weeds during the late summer and fall where *Pithophora* sp. had been dominant during the early summer. Future research should deal with the duration of weed inhibition and the amount of herbicide needed to control weeds in the second and third crop of a given production season.

In this study which spanned 3 growing seasons and involved 17 treated pond replications at a rate of 11.2-14.0 kg of simazine/ha applied as a preflooding treatment, aquatic weeds developed in 3 of 17 treated ponds (18%). In untreated control ponds, weeds were dominant in 9 of 16 replicates (56%). Growth and survival were as good or better in treated ponds than in untreated ones. The fish crop was more readily harvested from the treated ponds. Less stress was placed on the fish and less labor was required for harvesting and processing. For ponds at Auburn, the simazine treatment at a rate of 11.2 kg/ha as a preflooding application gave good weed control for 172 days. Under different soil, water and weed infestation conditions it may be necessary to increase the rate or use another method of treatment. Cook and Smith (1976) used applications of simazine at rates of 2.0 and 3.0 mg/l in the Marion pond system as a pond treatment after filling. No adverse effects to striped bass fingerlings were noted and both *Hydrodictyon* sp. and *Pithophora* sp. were effectively controlled. My preflooding treatments in 1973 and 1974 were performed in these ponds and failed to inhibit *Hydrodictyon* at rates of 5.7 and 14.0 kg/ha. This would be approximately 1.5 mg/l in a filled pond at the higher rate.

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