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Effects of aeration on the production of *Heterobranchus bidorsalis* fingerlings at varying stocking density in outdoor concrete tanks

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ABSTRACT: The effects of stocking density with or without aeration on survival and growth of *Heterobranchus bidorsalis* fry were examined under outdoor management systems. The fry were held at six stockin densities of 250 fry/m^3, 500 fry/m^3, 750 fry/m^3, 1,000 fry/m^3, 1,250 fry/m^3 and 1,500 fry/m^3. There was no significant difference ($P > 0.05$) in the mean weight gain and specific growth rate of fry held at the different stocking densities with aeration. However, the mean weight gain and specific growth rate decreased as stocking density increased. Average final weight of fish was significantly ($P < 0.05$) affected by aeration. Relative to initial body weight, fish growth in unaerated tanks was lower in final weight than in aerated tanks. Development of "jumpers" was significantly affected by aeration. There were significant differences in the survival of *H. bidorsalis* fry held at the different stocking densities. Highest survival was obtained at stocking density of 250 fry/m^3 while sticking density of 1,500 fry/m^3 gave the lowest survival in both aerated and unaerated treatments. Fry held at 500 fry/m^3 gave the optimum stocking density (level) in aerated tanks while stocking level of 250 fry/m^3 is ideal for optimum growth and development of fry in the outdoor concrete tanks without aeration.

Key Words: Fish stocking density; Aeration; Specific growth; *Heterobranchus bidorsalis.*

Introduction

Aeration, which is the bubbling of gaseous air through cultures, has been successfully used in indoor hatcheries to improve the growth and survival of fish larva/fry. In spite of remarkable success reported on the growth and survival of fish larval/fry in indoor hatchery, it is still beset with low survival during the fry-fingerling stage in outdoor nursery management systems. However, with paucity of information on the use of aeration in outdoor nursery phase, it is now a necessity to study the effect of aeration on the growth and survival of fry-fingerling stage during outdoor nursery phase. Studies on the effect of stocking densities without aeration on growth of different fish species have yielded different results. Optimum stocking density was reported as 60 fish/m^3 for estuary grouper, *Epinephelus salmoides* Maxell (15.2g) (Teng and Chua, 1978); 150 fish/m^3 for rainbow trout *Oncorhynchus mykiss* (Trzebiatowski *et al*., 1981); 100 fish/m^3 for *Clarias anguillaris* (2.5g) (Madu, 1989) and 285 – 375 fish/m^3 for *Mystus nemurus*

(20,45g) (Khan, 1994). The differences in optimum stocking levels reflect differences in species, culture conditions and size of used fish in the studies.

Abdalla and Romaire (1996) compared the effct of aeration on production of channel catfish (*Ictalurus punctatus*) in two ponds in which one was aerated and the other was not. He found that aeration increased fish production and consequently led to increased growth and survival. In view of this, there is a clear need to look at the effect of aeration for optimum survival and growth of the *Heterobranchus bidorsalis* fry-fingerling stage during nursery phase in outdoor tanks. The present study is aimed at determining optimum sticking density for the growth and survival of fry-fingerling of *heterobranchus bidorsalis* with and without aeration devices in fertilized outdoor concrete tanks.

Materials and Methods

The experimental fry were obtained by induced spawning with hormonal injection. The fry were reared in indoor hatchery for three weeks as described by Dada (1999). Prior to transfer of the fry into the outdoor concrete tanks (2m x 2m x 1m), each tank was filled with filtered water to a depth of 0.5m and maintained at that level. Dried pig manure was applied as the initial pond fertilizer at 100 g/m^2 to develop plankton blooms. At the start of the experiment, pooled fish were weighed and the length measured. Acclimated catfish fry were randomly assigned to each of the 24 experimental tanks at different stocking densities. The stocking densith adopted were 500, 1000, 1500, 2000 and 3000 fry per tank which translated to 250, 500, 750, 1000, 1250 and 1500 fry per m^3. The fry densities were based on the previous work on the same species, *H. bidorsalis* by Dada *et al*. (2000). Twelve of the tanks were aerated while the remaining twelve were not aerated. Aeration was effected by electric motor connected with a car air conditioner compressor and gas cylinder distributing air to the twelve experimental tanks through air hoses (Fig. 1).

Throughout the experimental period, the fry were fed a powdered artificial feed containing 40% crude protein prepared using fish meal (14.70%), soybean meal (54.10%), blood meal (4.70%), yellow maize (25.00%), vegetable oil (1.00%) and vitamin premix (0.50%) twice daily between 9.00 a.m. and 6.00 pm.m at 40% of their body weight according to Dada *et al*. (2000). Every two weeks, about 30% of the fish population were weighed using electronic top-loading balance (Mettler E200) and fast growers ("jumpers") were separated from the experimental stock. The amount of feed was adjusted every two weeks, based on the total weight of fish.

Dissolved oxygen, pH and temperature were determined following the methods described by Boyd (1981). Mean weight gain was calculated using the approach of Pitcher and Hart (1982), specific growth rate was obtained according to Brown (1957). the experiment lasted 10 weeks. At the end of the experiment, the total number of fish in each tank, mean number of "jumpers" and mean survival percentage were estimated.

Statistical Analyses

The data collected were subjected to one-way analysis of variance and differences among means were detected by the Least Square Difference Multiple Range test at the 5% probability level (Sokal and Rohlf, 1981).

Results

Table 1 shows the comparative survival and growth of fry at the different stocking densities with or without aeration in the outdoor concrete tanks during the experimental period. Survival decreased with increase in stocking level and ranged between 10.1% and 68.1% in aerated tanks while the survival ranged between 5.3% and 50.6% in unaerated tanks. The highest percentage survival (68.1%) was obtained with treatment 1 (500 fish/tank or 250 fish/m^3) aerated tanks while the lowest (5.43%) was obtained in treatment 6 (3000 fis/tank or 1500 fish/m^3) in unaerated tanks. There was no significant difference ($P > 0.05$) in the survival values between stocking densities 1 and 2 aerated. The highest specific growth rate (6.84%/day)

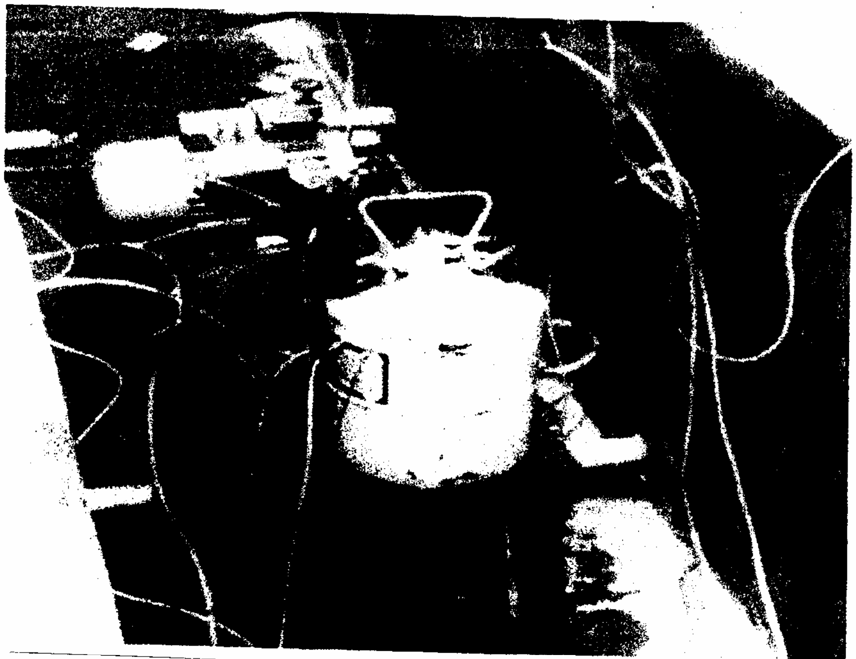

Figure .1:

Electric motor aerator for aeration of water in outdoor experimental concrete tanks

Table 1: A summary of fingerling production of *H. bidorsalis* at different stocking densitities with or without aeration in an outdoor concrete tanks. (Paper 14201).

Stocking level	Fish/m^3	With aeration						Without aeration					
		Initial wt.(g)	Final wt.(g)	% Surv.	ADG (%)	SGR (%)	Mean No. of Jumpers	Initial wt. (g)	Final wt. (g)	% Surv.	ADG (g)	SGR (%)	Mean No. of Jumpers
500	250	0.06	7.19a	68.1	0.10	6.84	1.5	0.05	4.59a	50.6	0.07	6.46	3.5
1,000	500	0.06	5.91a	63.2	0.08	6.56	2	0.05	2.20a	41.6	0.03	5.41	6
1,500	750	0.06	4.72a	44	0.07	6.24	3	0.05	2.13a	34.5	0.03	5.36	8.5
2,000	1,000	0.06	3.75a	31.2	0.05	5.91	3.5	0.05	2.02a	10.9	0.03	5.28	9
2,500	1,250	0.06	3.40a	15.6	0.05	5.77	5.5	0.05	1.35b	8.70	0.02	4.71	5.5
3,000	1,500	0.06	2.57a	10.1	0.04	5.37	8.5	0.05	1.45b	5.43	0.02	4.81	4.5

Mean valued in the same vertical row with similar alphabets are not significantly different ($P>0.05$).

Values are means of two replicates.

was obtained with treatment 1 (500 fish/tank or 250 fish/m^3) aerated and there was no observed significant difference with other aerated treatments. Average final weight of fish was significantly affected by aeration (Table 1). Relative to initial body weight, fish growth in unaerated tanks was lower in final weight than in aerated tanks.

The development of "jumpers" increased with increase in stocking level in aerated tanks in contrast to what was observed in unaerated tanks where the development of "jumpers" increased with increase in stocking level up to a maximum of 2000 fry/tank. Development of "jumpers" was affected by aeration (Table 1). The number of "jumpers" recorded in unaerated tanks was significantly higher ($P < 0.05$) than that in unaerated tanks.

Mean daily growth rate ranged between 0.04g and 0.10g in aerated tanks while the range was between 0.02g and 0.07g in unaerated tanks and observed to decrease with increase in stocking level in aerated and unaerated tanks. The economics of the fingerling production as it relates to the present study was also undertaken (Table 2). Two key elements or factors are brought into play when the economics of production are considered. They are:

(a) The percentage survival at the end of the experimental period,

(b) The final growth rate.

Table 2 shows that the stocking level of 500 fish/tank produced the best growth rate of 7.2g and highest percentage survival of 68.1% or 341 fish. The second stocking level of 1000 fish/tank recorded the final weight of 5.9g or approximately 63.2% or 632 fish.

Discussion

The results of this study have shown that stocking density affects the growth and survival of *H. bidorsalis* under outdoor management systems. Similar results were found in other mudfish. *C. gariepinus* maintained at a density of 100 fry/m^3 grew significantly faster than when it was maintained at 500 fry/m^3 (Madu, 1989) without aeration. Fish stocked at higher densities (values) showed a significant decrease in the mean fish weight, weight gain per fish, specific growth rate as well as survival, compared to those at the lower stocking densities. This conforms with the findings of Haylor (1992) who stated that specific growth rate decreases with increase in density. The increase in the development of "jumpers" as the stocking levels increased further support the effect of overcrowding. A similar trend was reported by Ita *et al.* (1989) for the fry of *C. anguillaris* under outdoor hatchery management systems. Higher stocking density (value) agve rise to fewer but bigger "jumpers" ($P < 0.05$). The better survival and growth of fry at high stocking density with aeration indicates amenability to intensive management practices.

Mortality of fish during the study might have resulted mainly from cannibalism and space effects, even though two weeks samplings were carried out to remove the fast growers ("jumpers"). Abdalla and Romaire (1996) reported significant and consistent increases in channel catfish (*Ictarus punctatus*) fish production in aerated ponds compared with unaerated ponds. Survival increased in aerated tanks compared with unaerated tanks (Table 1). Although average final weight was not significantly different among aeration treatments, survival decreased with increase in stocking density (Table 1). Most mortalities in tanks occurred during the first two weeks of stocking. This may be due to change in the environment of the fish from the indoor to outdoor tanks which require acclimatization of the fish to the new environment. The water quality parameters measured were within the desired range recommended for clariid catfishes by Viveen *et al*. (1986).

The results of the present study have, therefore, shown that apart from stocking density, aeration of outdoor tanks also influences the growth performance of fry. The study has also shown that the growth rate of the fry was faster at the lowest stocking density (500 – 1000). The highest survival of 68.1% was also observed at 250 fry/m^3 in the aerated tanks. The practical implications of these results are that *H. bidorsalis* fry can be grown optimally in outdoor concrete tanks at a relatively high stocking density with aeration. The growth and survival were considerably affected by density. This fact should be taken into account when stocking outdoor nursery tanks for practical fry rearing to fingerling stage. The outdoor nursery tanks should be aerated in order to improve the survival of fry to fingerling.

Table 2: Production statistics for 100,000 fingerlings of *Heterobranchus bidorsalis* in outdoor concrete tanks with or without aeration.

Tank Size (m^3)		WITH AERATION				WITHOUT AERATION			
	Stocking level (fish/tank)	Final wt. (g)	% Survival	No. of fish	Estimated No. of tanks	Final wt. (g)	% Survival	No. of fish	Estimated No. of tanks
4	500	7.2	68.1	341	98	4.6	50.6	253	84
4	1,000	5.9	63.2	632	53	2.2	41.6	416	80
4	1,500	4.7	44.0	660	50	2.1	34.5	518	64
4	2,000	3.8	31.2	625	53	2.0	10.9	218	153
4	2,500	3.4	15.6	390	86	1.4	8.7	218	153
4	3,000	2.6	10.1	303	110	1.5	5.4	162	206

In a large population of fingerlings, the difference of about 1g recorded for 500 fish/tank and 1000 fish/tank may not be quite discernible. Fish farmers will therefore be willing to pay the same price for the fingerlings from these two treatments. Whereas the fingerlings from 1500 fish/tank which recorded the highest survival of 660 in terms of absolute number has a final weight of 4.7g which may not attract similar price when compared to the first two. In order to obtain the final weight of about 7g, there will be need to manage the system for two or three weeks. During these extra weeks of rearing, there are bound to be some more mortality, there will be more expenditure of energy, feeding and maintenance which will further push up the production costs. An elongation of the rearing period will also lead to a reduction in overall turnover as rearing can only take place for 6 months in a year.

When all these are considered, the best option that can guarantee highest revenue, largest turnover and a reduced production cost will be the tank with 1000 fish/tank. In view of the fairly low survival rate in those tanks without aeration, it will be advisable for a fish farmer operating in areas without electricity to procure portable generators. Based on survival rate of 63.2% with stocking density of 500 fish/m^3 after a nursery period of 10 weeks, a fish farmer needing about 100,000 fingerlings every 10 weeks of 6 months breeding season would be expected to own a minimum of 53 concrete tanks measuring 4m^3 while about 84 concrete tanks of similar size would be required based on survival of 50.6% without aeration.

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