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Can Reduced Stocking Rates and Bug Lights Produce Market-Sized Catfish From Fingerlings in One Growing Season?

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The purpose of this study was to determine the feasibility of growing marketable channel catfish, Ictalurus punctatus, *from pond-run fingerlings (15.9 g/fish) using low stocking densities (7,413 or 14,826 fish/ha) and electrified bug lights to enhance natural forage available to fish. Even at low stocking densities, fish only averaged 0.2 kg at the end of the growing season. Because marketable sizes of fish were not reached over the growing season, stocking small fingerlings at these rates would not be practical under most commercial production scenarios. Nutritionally, captured insects from electrified bug lights were near a complete diet for catfish, but bug lights did not capture sufficient quantities of insects to affect fish production in either stocking density. Stocking small fingerlings at low stocking rates does not produce market-sized catfish during one growing season; commercially available bug lights did not provide adequate amounts of natural forage to affect production variables.*

KEYWORDS *Channel catfish, natural forage, fingerling stocking rates*

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INTRODUCTION

Reduction of feed costs is a primary strategy to improve the profitability of catfish farming. Reduced feeding of commercial diets by manipulation of stocking densities, improving feed conversion, or taking advantage of natural food organisms may be ways to cut costs. In addition to current high feed and fuel costs, processors are requiring larger fish (0.57 kg or greater) than past market demand (0.450.57 kg). Because of the larger fish required by processors and the current high feed and fuel costs, under certain conditions it may be beneficial to reduce stocking rates in an effort to increase growth rates and achieve market-size fish sooner.

Another possibility for improving efficiency during production would be to better utilize natural food sources. Hanging lights above ponds at night concentrates zooplankton and other aquatic insects into the area below the light (Graves & Morrow 1988). During pond culture, nighttime lighting combined with supplemental feeding or used alone enhanced growth of fingerling walleye, *Sander vitreus,* compared to not using nighttime lighting (Harder & Gotsch 2007).

In addition to better utilization of in-pond natural food organisms, it may also be possible to utilize extra-pond food organisms. Thirteen insect orders contain species that are aquatic or semi-aquatic (Merritt & Cummins 1984). Many wild fish rely on insect populations for their diet, and even intensively cultured channel catfish have been shown to consume natural feed organisms. It is estimated that the contribution of natural food such as insects to catfish in production ponds is only about 2.5% of the protein requirement and 0.8% of the energy requirement (Wiang 1977). However, if means are implemented to increase the availability of insects, they may contribute more to the diet. One method to increase the availability of insects is by using commercially available electrified bug lights hung over the pond. Heidinger (1971) used ultraviolet lights equipped with baffles and funnels to attract flying insects over caged bluegills. He estimated that twenty-five 15-watt ultraviolet lights would increase bluegill production by 351 kg in a 0.4-ha pond. Commercial ultraviolet bug lights with a killing grid of electrified wires may be an effective means of utilizing natural high-protein feed to fish. McLarney (1987) reported capturing up to 227 g of insects per bug light each night in Massachusetts, and estimated that bug lights would be much more effective in the Midwest or South.

The purpose of this study was to determine if it is feasible to grow 0.9 kg fish from fingerlings in just one growing season using low stocking densities (7,413 or 14,826 fish/ha) and electrified bug lights to enhance the amount of natural forage available to the fish.

MATERIALS AND METHODS

In April 2009, fourteen 0.4-ha ponds were filled and fertilized according to Mischke and Zimba (2004). The study used a 2 × 2 factorial design with two stocking rates (7,413 or 14,826 fingerlings/ha) and two feeding treatments (with and without bug lights for insect forage supplementation). All ponds were stocked with channel catfish (*Ictalurus punctatus*) fingerlings (15.9 kg/1,000 fish). Seven randomly selected ponds were stocked with 7,413 fish/ha, and the remaining seven ponds were stocked with 14,826 fish/ha. Also, all ponds were equipped with paddlewheel aerators, and dissolved oxygen was maintained at levels normally acceptable for channel catfish culture throughout the study. Three ponds within each stocking density treatment received supplemental forage with a commercially available electrified bug light (Stinger 100-watt, Model UVB45, Kaz, Inc., Southborough, MA) hung approximately 2 m from the shoreline.

With each light hung directly above the pond surface to provide forage, a second light was used to collect insects for determining the amount and value of forage captured per light by replacing the bottom of a 9-L bucket with a fine mesh screen (80 μm) and hanging it below the light to capture the electrified insects.

All ponds were fed a 41% protein diet daily to apparent satiation for the first three months and then switched to a 35% protein diet for the remainder of the growing season (total = 22 weeks). Biweekly water samples were collected with a tube sampler (modified from Graves & Morrow 1998) from each pond. Ammonia (Nesslerization) and nitrite (diazotization) were determined using methods outlined by Hach (1999).

From May through July insects were captured daily from each light. The samples were weighed and then frozen for later analysis. All captured insects were combined by month to obtain composite monthly samples for May, June, and July. The frozen insects were freeze-dried and ground. Crude protein (combustion method) and crude fat (ether extraction method) of samples were determined with methods described by the Association of Official Analytical Chemists (AOAC, 2000). Minerals and amino acids were analyzed by Eurofins Scientific Inc., Des Moines, Iowa.

Data were analyzed with the MIXED procedure in SAS version 9.2 software (SAS Institute, Cary, NC; Littell, Milliken, Stroup & Wolfinger 1996) using the covariance structure, autoregressive of order 1. Mean comparisons were made using the least significant difference test at $\alpha = 0.05$. For final production data, the main effects of stocking rate and presence or absence of a bug light and their interactions were analyzed by two-way ANOVA in SAS version 9.2 software (SAS Institute, Cary, NC).

RESULTS AND DISCUSSION

Total kg of fish harvested was higher at the 14,826/ha stocking rate (1,562 kg/ha) compared to 1,319 kg/ha at the 7,413/ha rate, but fish size and survival were highest at the 7,413/ha stocking rate. There were no differences in feed conversion. Tucker and Robinson (1990) suggested stocking fingerlings 27 to 41 kg/1,000 fish, because smaller fingerlings will not grow to an average weight of 0.57 kg in a 200-d growing season stocked at 9,884 or 14,826 fish/ha. Our data confirms that small fingerlings (15.9 g), even when stocked as low as 7,413 fish/ha, will only attain a harvest weight of about 0.2 kg/fish. Total production in this study was substantially less than the 5,828 and 7,958 kg/ha reported by Tucker and Robinson (1990) when stocking larger fingerlings at 11,119 and 19,768 fish/ha, respectively. Also, mortality rates in our study were higher at either stocking rate compared to only 5% and 15% reported by Tucker and Robinson (1990) when stocking larger fingerlings at 11,119 and 19,768 fish/ha, respectively. The poor production and survival in this study is probably due to the small-sized fingerlings stocked, as all measured water quality variables were typical of catfish ponds. Nitrite concentrations increased over time, but there were no treatment effects or treatment interactions. Total ammonia concentrations also increased over time and were significantly ($P < 0.05$) higher in the ponds stocked at 14,826 fish/ha (2.09 ± 0.113) compared to ponds stocked at 7,413 fish/ha (1.55 ± 0.113). Because marketable sizes of fish were not reached over the growing season, stocking small fingerlings at the rates used in this study would probably not be practical under most commercial production scenarios.

Addition of bug lights had no effect on fish growth or water quality, and no significant interactions were found in harvest variables between stocking rate and the presence of a bug light (Table 1). The electrified bug lights used in this study did not increase production in either stocking density.

TABLE 1 Effects of Stocking Rate (7,413 or 14,826/ha) and the Presence of Bug Lights on Catfish Fingerling Production Variables After a 200-d Growing Season

		Stocking rate		Analysis of variance		
Variable	Bug light	7,413/ha	14,826/ha	Light	Stocking	Light*stocking
Kg Harvested	Yes	498 ± 42.2	639 ± 42.2	0.5215	0.0254	0.3601
	No	561 ± 36.6	627 ± 36.6			
Kg/1,000 Fish	Yes	190 ± 16.8	144 ± 16.8	0.1780	0.0240	0.7722
	No	209 ± 14.6	171 ± 14.6			
Feed Conversion	Yes	2.3 ± 0.20	1.9 ± 0.20	0.3623	0.2473	0.2878
	No	1.9 ± 0.17	1.9 ± 0.17			
Survival	Yes	0.92 ± 0.011	0.75 ± 0.011	0.4511	0.0130	0.4799
	No	0.92 ± 0.008	0.61 ± 0.008			

*Interaction between bug lights and stocking rates

The bug lights captured several different orders of insects, but the majority of insects captured were of the orders Hemiptera, Coleoptera, Diptera, and Lepidoptera. The quantity of insects captured was variable from light to light and from night to night, and ranged from 0 to 251 g. The daily take averaged 27, 21, and 12 g/light/night for May, June, and July, respectively (Figure 1). Although the maximum weight we caught was similar to the maximum weight reported by McLarney (1987), we expected to catch larger quantities of insects because of the still, sultry nights in this region compared to the cooler nights of Massachusetts where the McLarney (1987) study was done. The weight of insects captured per light was similar to that reported by Merkowsky, Handcock, and Newton (1977), and Newton and Merkowsky (1976) in Arkansas.

One potential reason for not collecting more insects was that the electrified grid on the bug lights clogged with insects quickly and required daily cleaning. The clogging of the grid may have prevented additional insects from being captured. Other insect capture devices may be more efficient at capturing insects, such as the ultraviolet bug light with baffles used by Heidinger (1971) or the bug light with an impeller fan described by McLarney (1987).

Nutritional analysis revealed that the insects were greater than 60% crude protein and greater than 10% fat on a dry matter basis (Table 2). A similar study by Merkowsky, Handcock, and Newton (1977) determined that captured insects from ponds in southeast Arkansas were 63% protein,

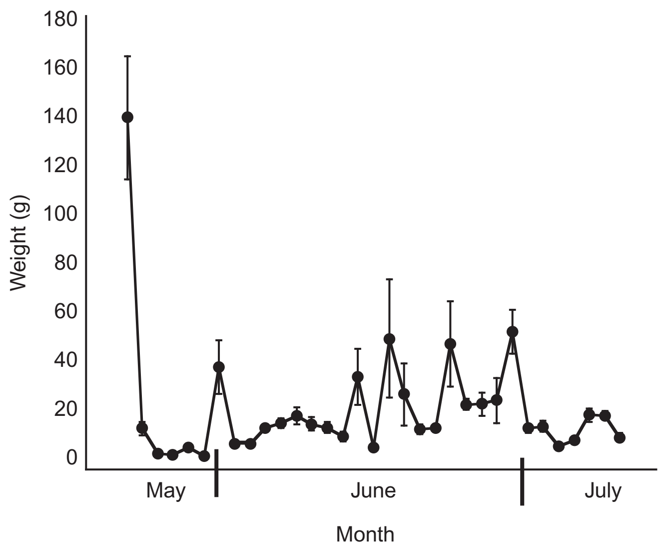

FIGURE 1 Mean weight (g) of insects caught each day from electrified bug lights placed over 0.4 ha ponds at the National Warmwater Aquaculture Center in Stoneville, Mississippi, from May through July 2009.

TABLE 2 Proximate Composition and Mineral Composition (Dry Matter) of Insects Collected from Electrified Bug Lights from May Through July Over Ponds at the National Warmwater Aquaculture Center in Stoneville, Mississippi. Channel Catfish Requirements as Reported by Robinson and Li (2002) are Given in the Final Column for Comparison

	Month			
	May	June	July	Requirement
Proximate Composition (%)				
Crude Protein	66.5	62.7	61.4	
Crude Fat	12.3	12.3	10.1	
Dry Matter	41.2	68.6	81.0	
Ash	4.36	4.53	4.50	
Minerals				
Iron (ppm)	485	437	494	20
Phosphorus (ppm)	8,252	9,038	8,889	3,000–4,000
Cobalt (ppm)	<0.75	<0.75	<0.75	ND[a]
Copper (ppm)	24	16	14	4.8
Manganese (ppm)	38	28	32	2.4
Selenium (ppm)	1.65	2.48	1.36	0.25
Zinc (ppm)	194	176	190	20

[a]Not determined but assumed to be required.

16.5% carbohydrate, and 8.6% fat. All minerals except cobalt were in excess of the requirements determined for channel catfish fingerlings (the requirement for cobalt by channel catfish has not been determined; Robinson & Li 2002) (Table 2). The essential amino acids found in the insects also

TABLE 3 Amino Acid Composition (Percentage of Protein) of Insects Collected from Electrified Bug Lights from May Through July over Ponds at the National Warmwater Aquaculture Center in Stoneville, Mississippi. Channel Catfish Requirements as Reported by Robinson and Li (2002) are Given in the Final Column for Comparison

Amino acid	May	June	July	Requirement
Indispensible				
Arginine	4.9	5.4	5.4	4.3
Histidine	3.2	2.8	2.8	1.5
Isoleucine	3.7	3.7	3.8	2.6
Leucine	6.4	6.3	3.8	3.5
Lysine	5.6	6.1	6.2	5.1
Methionine + Cystine	2.3	2.8	2.8	2.3
Phenylalanine + Tyrosine	6.5	7.7	7.5	5.0
Threonine	3.4	3.7	3.9	2.0
Tryptophan	1.7	1.5	1.4	0.5
Valine	10.1	5.5	6.2	3.0
Dispensable				
Alanine	6.5	6.6	6.8	
Aspartic acid	7.7	8.4	8.8	
Glutamic acid	10.5	11.3	11.9	
Glycine	6.4	5.4	5.0	
Proline	5.1	4.6	4.7	
Serine	4.2	5.4	5.3	

appear to meet the requirements for channel catfish (Robinson & Li 2002) in every month. Table 3 presents total amino acid composition rather than available amino acids, because digestibility of the insects is not known. If 80% digestibility is assumed, lysine and methionine + cystine would fall short of the requirements in each month sampled. Also, arginine and leucine would each be short of the requirement in one of the sampling months.

In the present study, each pond was fed with an average of 15.3 kg of commercial diet daily, while the bug lights only captured 20.2 g of insects daily—only 0.1% of the total diet. Assuming electrical cost of $0.08/kWh and running the lights for 8 h/night, the average of 27 g of insects caught per night in May cost $2.96/kg. With the vast quantities of insects present around culture ponds, it may be possible to capture larger quantities of this highly nutritious feed source more efficiently using methods other than electrified bug lights.

Stocking small fingerlings (15.9 kg/1,000 fish), even at low stocking rates (7,413 or 14,826 fish/ha) and using a high protein diet, did not produce market-sized catfish by the end of the growing season. Additionally, commercially available bug lights with electrified grids did not provide adequate amounts of supplemental natural forage to affect production variables.

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