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RESEARCH ARTICLE

POTENTIALITY OF AZOLLA IN RICE AND FISH CULTURE SYSTEM

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ABSTRACT

The present work intended to study the potentiality of *Azolla* as a bio-fertilizer and as fish feed in a paddy cum fish culture unit. Results of three years study clearly showed in all replicatio and combination best performance was achieved in T_3 (*Azolla* incorporation before and 50 days after transplanting). *Puntius gonionotus* (Thaiputi) and *Oreochromis niloticus* (Tilapia) both obtained their highest values of average weight and length in case of T_3. The highest value of absolute growth and relative growth were always found in T_3. Highest yield of Thaiputi and Tilapia were recorded in T_3. Maximum total yield 6533 kg/ha, 7774 kg/ha and 8213 kg/ha were obtained from T_3 after 360 days in 1st, 2nd and 3rd year. Straw yield due to T_2 and T_3 were significantly higher than T_1 treated plot (T_1- 5026.5, 5337.5, 6097.5 kg/ha) and the highest straw yield was obtained from T_3 treated plot in 1st and 2nd year (T_3- 7196.3, 6105 and 7622.5 kg/ha) and T_2 in 3rd year (T_2 –600.95, 548 and 885.75kg/ha). Grain yield of BR-2 variety significantly varied (T_1-4462.5, 4745, 4510 and T_2- 5120, 5600, 5882.5 kg/ha). The highest grain yield of BR-2 variety (5405 kg/ha, 5970 kg/ha, 6379 kg/ha) was obtained with the treatment of T_3.

INTRODUCTION

Since a long time, *Azolla* has been used as bio-fertilizer of rice and supplementary food for fish. As a potential bio-fertilizer of the world, *Azolla* can be fixed about 450 kg of N/ha annually (Qi-Xiao *et al.,* 1987) and can substitute 50% urea (Watanabe, 1987). It also contributes potassium, phosphorus, zinc and iron to rice crop during its decomposition in rice soil (Kannaiyan, 1987). It is a potential source of fish fodder due to its high yield, enriched nutrients, good edibility, and lower feed coefficient (De-fu and Chun-yuan, 1987). To get optimum rice production from HYV, use of chemical fertilizer and insecticide is increasing at alarming rate as consequence land degradation occurs and natural rehabilitation process of soil becomes disturbed. Wash out during Monsoon affects adversely the adjacent water bodies. Rice production system in the beel and stagnant water is also negatively affected by the above mentioned reasons deteriorating the quantity and diversity of fishes. A major problem of raising fish in the rice field has been identified as scarcity of food sources for a long period. The present research has been undertaken to seek an eco-friendly solution and minimize the aforesaid problems.

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Azolla has been used as a bio-fertilizer of rice and supplementary food for fish grown therein.

MATERIALS AND METHODS

A three year long field experiment was carried out in Rajshahi University Campus, Rajshahi, Bangladesh. *Azolla pinnata* var. *pinnata* native to Rajshahi has been used as fish feed and bio-fertilizer in the present investigation. A high yielding rice variety BR-2, *Puntius gonionotus* (Thaiputi) and *Oreochromis niloticus* (Tilapia) were used as indicator to assess the potentiality of aforesaid *Azolla* variety. Three treatments were implemented in three plots as follows:

T_1= Urea-N 80 (30+25+25) kg/ha
T_2= Urea-N 40 kg/ha + *Azolla*
T_3= *Azolla* incorporation before and 50 days after transplanting.

Three rice –Azolla- fish plots, each covering an area of 231 m². Every plot had a central rectangular trench serving as a fish refuge. The total refuge area was 15 X 15 m², with an average depth of 1m. All the plots were divided into 4 equal sub-plots by one transverse and one longitudinal ditch 20 cm deep and 10 cm wide, to facilitate the access of fish into the rice field. The total non-planted area was 17.4m.The fishes were stocked after transplanting the rice seedlings, at the rate

of 15000 fingerlings/hectare. Both *Oreochromis niloticus* and *Puntius goniontus* in equal number were raised in each treatment plot. Growth of Thaiputi and Tilapia were assessed by measuring weight and length with an interval of 120 days starting from zero days. The length and weight of fishes were measured just prior to 120, 240 and 360 days after release. The condition factor 'K' based on the cube law was calculated in numerical terms by using following formula (Mishra and Saksena, 1992):

$$K = \frac{W}{l^3} \times 10^5$$

Where, K = condition factor, W = weight of fish in gm, l = length of fish in cm, 10^5 = is a constant. The absolute growth and relative growth of fingerlings was also calculated by following formula:

$$\text{Absolute growth} = \frac{W_1 - W_0}{t_1 - t_0}$$

$$\text{Relative growth} = \frac{W_1 - W_0}{W_0(t_1 - t_0)} \times 100$$

W_0 = weight at any time t_o
W_1 = weight at any late time t_1

RESULTS AND DISCUSSION

Average weight of Thaiputi and Tilapia of three treatment plots was found to be increased after 120, 240 and 360 days of experimentation (Tables 1-2). The highest values of average weight were always found in T_3. Most of the workers have found that the growth of fish depends upon the availability and composition of food and the physical and chemical characteristics of water (Agarwal and Saksena, 1979; Saksena and Kulkarni, 1982; Kamal, 1982 and Sinha *et al.*, 1986). Average length of Thaiputi and Tilapia was always found to be increased after 120, 240 and 360 days of experimentation (Tables 1-2). In three consecutive years of study, the highest value of average length was obtained in T_3. As revealed from (Table 1-2) during the period of optimum body length of Thaiputi and satisfactory body length of Tilapia were achieved by using *Azolla* as supplementary food.

The length-weight relationship and coefficient of condition factor are the methods usually employed for fish growth determinations. The condition factor also indicate impact of feeding, seasonal cycle of gonads, high metabolic rate etc., in various water bodies (Hart, 1946; Le-cren, 1951; Brown, 1957, Qayyum and Qasim, 1964; Bhatt, 1968; Das and Shrivastava, 1979; Saksena and Kulkerni, 1982). The observed condition factor of Thaiputi of various treatments clearly indicated that the condition factor increased in T_1, T_2, and T_3 after 120 and 240 days of experimentation but after 360 days the condition factor decreased compared with that value after 240 days except in T_1 and T_2 of 2nd year and T_3 of 3rd year (Table-1). The highest value of condition factor was found always in T_3. Increased values of condition factor of Tilapia were in T_1, T_2 and T_3 after 120 and 240 days of experimentation. But a decreased value was obtained after 360 days except in T_3 of 1st year and T_2 of 2nd year (Table-2). The reason of decreased condition factor is lesser weight gain compared with length. Many workers like Kamal (1982) and Sinha *et al.* (1986) have found that the condition factor and growth of fish depends upon the availability and composition of food and the physico-chemical characteristics of water. The observed values of absolute growth of Thaiputi and Tilapia were always found to be constantly increasing in T_1, T_2, and T_3 after 120, 240 and 360 days of experimentation (Tables 1-2). The highest value of absolute growth was always found in T_3. It implies that T_3 was most suitable for fish culture. The observed value of relative growth of Thaiputi and Tilapia were found to be increased in T_1, T_2 and T_3 after 120, 240, 360 days of experimentation (Table 1-2).

The highest value of relative growth was always found in T_3. Most of the workers have found that the growth of fish depends upon the availability and composition of food and the physico-chemical characteristics of water (Agarwal and Saksena, 1979; Saksena and Kulkarni, 1982; Kamal, 1982; and Sinha *et al.* 1986). Present work was also fit well with those findings. In aquaculture systems depending at least to some extent on food, fish growth is primarily determined by the size of the 'scope for production', i.e., the difference between routine and maximum metabolism, and the quantity and quality of food available (Van Dam, 1995). The scope for production depends (among other factors) on the dissolved oxygen concentration and temperature.

Yields of Thaiputi and Tilapia were found to be increased in T_1, T_2 and T_3 after 120, 240 and 360 days of experimentation (Table 1-2). The highest yields of Thaiputi and Tilapia were always recorded in T_3. Maximum total yield 6533 kg/ha, 7774 kg/ha and 8213 kg/ha were obtained from T_3 after 360 days in 1st, 2nd and 3rd year. Defu *et al*. (2001) observed almost same results of total fish yields (6990 kg/ha). Fish yields from rice fish culture are preferably expressed as not fish yields to have a clear understanding of the yield potential (Haroon and Pittman, 1997). These authors reported net fish yields of silver barb and Tilapia in monoculture of 271.03 and 758 kg/ha, respectively (size 11.2 g and 30.7 g, respectively, density 7500 /ha, period 78 days). Silver barb *(Puntius gonionotus*) production in our experiment was higher because of a much higher growth rate, higher stocking density, food supply and long period of culture.

Straw yield of all three treatments varied from each other in consecutive years of study. Straw yield due to T_2 and T_3 were significantly higher than T_1 treated plots in all three years (T_1- 5026.5, 5337.5, 6097.5 kg/ha). Highest straw yield obtained from T_3 treated plot in 1st and 2nd year (T_3- 7196.3, 6105 and 7622.5 kg/ha) and T_2 in 3rd year (T_2 –600.95, 548 and 885.75kg/ha). Grain yield of all three treatments significantly varied (T_1-4462.5, 4745, 4510and T_2- 5120, 5600, 5882.5 kg/ha) from each other in all the three years of study. The highest grain yield (5405 kg/ha, 5970 kg/ha, 6379 kg/ha) was obtained with the treatment of T_3 treated in all three years. The result obtained during this study clearly establishes that using *Azolla* in paddy cum fish culture can optimize both growth and

Table 1. Growth measurement of *Punctius gonionotus* of three treatments plots in 1st 2nd and 3rd year

	year	1st yr			2nd yr			3rd yr		
T	Parameters/Time	A. 120 days	A. 240 days	A. 360 days	A.120 days	A. 240 days	A. 360 days	A. 120 days	A. 240 days	A. 360 days
	A. weight (gm)	30	250	470	30	260	580	30	300	670
	A. length (cm)	14.25	25	32	14.45	26	34	15.1	25.5	34.75
T_1	Cf (K)	0.0000104×10^5	0.000016×10^5	0.0000143×10^5	0.000099×10^5	0.000147×10^5	0.000147×10^5	0.000087×10^5	0.000018×10^5	0.0000159×10^5
	A. growth	0.1641666	0.99875	1.2769444	0.1641666	1.0404166	1.5825	0.1641666	1.2070833	1.8325
	R. growth	1.59385	9.6966	12.39751	1.59385	10.10113	15.36407	1.59385	11.71925	17.79126
	Yield Kg/ha	220	1833	3447	220	1907	4344	220	2200	4913
	Av.wt gm	40	275	480	40	280	620	40	320	680
	Av.length cm	15.7	25.75	32	15.2	25.5	33	16.15	26.8	35.5
T_2	Cf (K)	0.0000103×10^5	0.000016×10^5	0.0000146×10^5	0.000113×10^5	0.000168×10^5	0.000172×10^5	0.00095×10^5	0.0000166×10^5	0.0000151×10^5
	A. growth	0.2475	1.1029166	1.3047282	0.2475	1.12375	1.6936111	0.2475	1.2904166	1.8602777
	R.growth	2.40291	10.70792	12.6672	2.40291	15.1569	16.44282	2.40291	12.52831	18.06094
	Yield Kg/ha	293	2017	3595	293	2053	4547	293	2347	4987
	Av.wt gm	50	290	500	50	330	650	50	370	700
	Av.length cm	16.1	26	32	15.6	26.5	37	16.1	28.5	34
T_3	Cf (K)	0.0000119×10^5	0.0000164×10^5	0.0000152×10^5	0.0000131×10^5	0.0000177×10^5	0.0000128×10^5	0.0000119×10^5	0.0000159×10^5	0.0000178×10^5
	A.growth	0.330833	1.165417	1.3602777	0.3308333	1.3320833	1.7769444	0.3308333	1.49875	1.915833
	R. growth	3.21197	11.31472	13.20657	3.21197	12.93284	17.25188	3.21197	14.55097	18.60032
	Yield Kg/ha	367	2127	3667	367	2420	4767	367	2713	5133

* R. growth – Relative growth A. growth –Absolute growth Cf – Condition factor Av. wt gm- Average weight in gram Av. length cm – Average length in centimeter A. 120days-After 120days

Table 2. Growth measurement of *Oreochromis niloticus* of three treatments plots in 1st 2nd 3rd year

	Year	1st year			2nd year			3rd year		
T	Parame ters /Time	After 120 days	After 240 days	After 360 days	After 120 days	After 240 days	After 360 days	After 120 days	After 240 days	After 360 days
	Av. wt gm	35.7	103.3	215	38.57	106.6	280	31.4	103.3	285
	Av.length cm	12.5	15.9	21.55	13.79	17.2	24.4	13.67	17.9	25.6
T_1	Cf (K)	0.0000181×10^5	0.0000263×10^5	0.000214×10^5	0.0000144×10^5	0.000208×10^5	0.0000192×10^5	0.0000122×10^5	0.0000179×10^5	0.0000164×10^5
	A.growth	0.22425	0.39379	0.572778	0.248083	0.4075	0.75336	0.188333	0.39375	0.767222
	R.growth	2.54829	4.47443	6.50883	2.81912	4.63068	8.5606	2.14015	4.47443	8.71843
	Yield Kg/ha	261	756	1577	283	782	2053	230	756	2090
	Av. wt gm	52	130	250	53.3	130	380	54.3	140	375
	Av. length cm	14.26	17.6	22.95	14.98	19.7	27.15	15.1	18	27.5
T_2	Cf (K)	0.0000178×10^5	0.0000238×10^5	0.0000206×10^5	0.0000159×10^5	0.0000169×10^5	0.0000189×10^5	0.0000157×10^5	0.0000241×10^5	0.0000179×10^5
	A. growth	0.36	0.505	0.65	0.370833	0.505	1.0311111	0.379167	0.546667	1.017222
	R. growth	4.0909	5.73863	7.61363	4.21401	5.73863	11.71717	4.30871	6.21212	11.55934
	Yield Kg/ha	381	953	1833	391	953	2787	398	1027	2750
	Av. wt gm	75	170	390	80	180	410	76	190	420
	Av. length cm	14.63	20.7	26.95	16.48	19.55	27.5	16.74	21	28.5
T_3	Condition factor(K)	0.000026×10^5	0.0000191×10^5	0.0000199×10^5	0.0000179×10^5	0.0000242×10^5	0.0000197×10^5	0.0000161×10^5	0.0000207×10^5	0.0000181×10^5
	A. growth	0.55171	0.67166666	1.0588888	0.5934166	0.71333333	1.1144444	0.56	0.755	1.142222
	R. growth	6.27701	7.632507	12.03282	6.75104	8.10606	12.66414	6.36363	8.57954	12.97979
	Yield Kg/ha	550	1247	2866	587	1320	3007	577	1393	3080

* R.growth – Relative growth A.growth –Absolute growth Cf – Condition factor Av. wt gm- Average weight in gram Av. length cm – Average length in centimeter A.120days –Average 120 days.

yield in the environment of northern Bangladesh. Technology developed demands field trail.

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