Volume : 3 | Issue : 5 | May 2014 • ISSN No 2277 - 8179

Research Paper

Growth Management of Azolla in Aquaculture Medium

Biology

KEYWORDS : Azolla, Growth, Aquaculture, Climbing Perch

Dr. Binodini Mishra

Department of Botany, Sri Jayadev College of Education & Technology, Bhubaneswar, Odisha, India.

ABSTRACT

The rice-Azolla-fish system enriches environment for rice, fish and Azolla. Climbing perches (Anabas testudineus) were subjected to four types of feeding schedule (T1-fish feed alone, T2-fish feed + Azolla, T3- Fresh Azolla alone and T4- Dry Azolla alone). These aquaculture media were utilized to estimate the growth rate of Azolla pinnata separately. Growth of A. pinnata was at par in T1 (medium with fish feed) and T2 (medium with fish feed and Azolla) and all other media are found statistically insignificant. It appears that the growth of Azolla in aquaculture medium being fertile with fish faeces.

INTRODUCTION

Azolla grows quickly, produce high yields because of the presence of *Anbaena* group as a symbiont, are a suitable size for fish grazing, do not require harvesting or chopping, and can grow in the rice field [11]. *Azolla* is rich in protein and total protein is 25-30%. Other constituents in *Azolla* are minerals, chlorophyll, *carotenoids*, amino acids, vitamins etc. [1]. It contains approximately 4% nitrogen and 41.5-45.3% carbon which make it suitable as a nitrogenous fertilizer in fish pond eco-system [23]

Of the various environmental factors, the availability of water is the most common factor limiting *Azolla* growth. 5-10cm depth of water is recommended for good growth and depth up to 30cm did not have any adverse effect on *Azolla.* The optimum pH for *Azolla* growth is reported between pH 5-7 ([18], [24], [25], [8], [17]).

In traditional rice-fish system, fish grow slowly because there is insufficient food. This problem can be solved by introducing *Azolla* into the fish growing medium in rice field. The rice-*Azolla-fish* system enriches growing medium for rice, fish and *Azolla.*

Anabas testudineus, the climbing perch is a member of labyrinth fish family, adapted to living in oxygen depleted water or on dry land. Climbing perches prefer to live in shoals [3]. They survive in brackish water and tolerate water conditions unsuitable for most other fish. Omnivorous Anabas was chosen to show its *Azolla* feeding habit efficiently [12]. It is a common and popular fish food in Asia. The regular use of inorganic fertilizers may cause environmental problems. The use of organic *Azolla* needs to be promoted for sustainable maintenance of aquaculture resources.

Selected aquatic macrophytes *(Eichornia* spp., *Typha* spp. and *Phragmites* spp.) cultured in wastewater ([16], [10], [26]) have been found to be highly efficient in removing N from primary and secondary sewage effluents, but the effluent leaving these systems usually contains unacceptable high level of P ([15], [20]). *Azolla* on the other hand has a high P-assimilation capacity [14] and can be a potentially good candidate for possible inclusion in aquaculture system for increased efficiency and effectiveness for fish.

To evaluate the potential of *Azolla* for use in fish feed and aquaculture system, it is important to develop a better understanding of the physiological processes involved, including N_2-fixation and environmental influences [13].

MATERIALS AND METHODS

An attempt was made to grow *A. pinnata* in the water containing fingerlings of *Anabas testudineus.* Fish were fed with fish feed of White Rose. It constitutes of white fish meal, shrimp meal, soyabean meal, wheat flour, wheat germ meal, dried yeast, squid, *Spirullina* gluten, 16 vitamins and 8 minerals. Four samples of water in multiples of three were taken separately in beakers from the fish culture media namely fish feeding only fish feed (T1), fish feed with *Azolla* (T2), only fresh *Azolla* (T3) and only dry *Azolla* (T4). 300mg of *Azolla* was introduced again in each beaker. The volume of the water medium was maintained up to a level by adding the water from the respective aquaculture medium. These experiments were supplemented by a glasshouse study. After 7DAI (day after inoculation), the average fresh weights (FW) of the plant were recorded. Doubling time (Dt) and relative growth rate (RGR) (Subudhi and Watanabe, 1981) of the *Azolla* along with the pH of the media were calculated. Subsamples were dried at 70^0C for a period of 48 hr to determine the % of dry weight (DW) in the tissue. Nitrogen fixation rates were determined by acetylene reduction assay (ARA) The experiment was repeated at a periodic interval of 7days.

RESULT

Growth of *A. pinnata* was at par in T1 (medium with fish feed) and T2 (medium with fish feed and *Azolla*). However, the growth of *Azolla* in medium T3 containing fresh *Azolla* and T4 medium containing dry *Azolla* differed significantly from T1 and T2. The growth in T3 and T4 were 14.69% and 39.31% less than T1 respectively. The doubling time (Dt) for *Azolla* in T1 (3.17 days) was the minimum, whereas, maximum (4.725) days in T4.

The pH of the media ranged between 6 to7. Maximum FW was noticed in T1 and T2 in which the pH ranges from 6.5-7, whereas the growth reduced below pH 6.5 in T3 & T4. The ARA value for *A. pinnata* cultured in T2 was higher than other media.

TABLE -1 Growth of *A. pinnata* grown in the water collected from different Aquaculture medium.

Treatments*	*Azolla* FW (g)	Dt (days)	pH	ARA ($n.mol\ C_2H_4.\ g(FW)^{-1}.\ min.^{-1}$)
T1 FF	1.392(0.219)	3.166	7	15.173±1.109
T2 FF+AZ	1.387(0.218)	3.172	6.5	15.887±0.596
T3 AZ(FW)	1.185(0.196)	3.532	6.2	13.513±1.668
T4 AZ(DW)	0.850(0.147)	4.725	6.0	12.187±0.611
LSD 5%	0.04			1.55
1%	0.06			

***Initial inoculums of 0.3g grown for 7days. Values in parantheses indicate RGR**

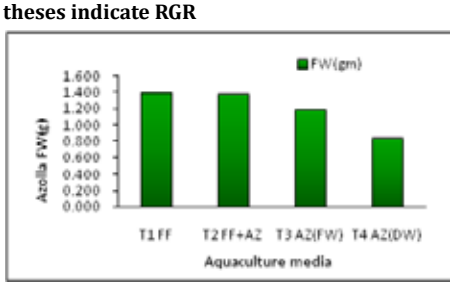

Figure1:-Effect of aquaculture media on growth of *A. pinnata.*

Volume : 3 | Issue : 5 | May 2014 • ISSN No 2277 - 8179

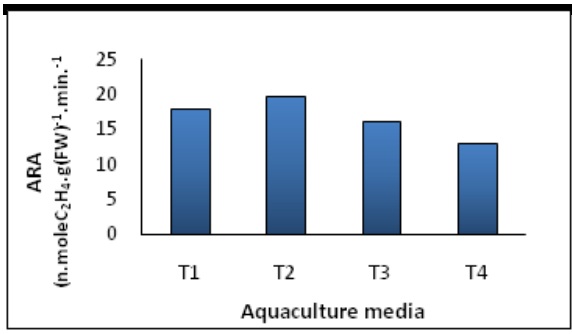

Figure 2:-Effect of aquaculture media on ARA of *A. pinnata.*

DISCUSSION

Fish feed with high crude protein level and appropriate amino acid profile make it suitable for fish. The growth of *A. pinnata* is due to the increased fertility derived from fish faeces. *Azolla* can grow without nitrogenous nutrients because of the presence of the N_2-fixing ability of the symbiotic *Anabaena.* The gradual decrease in growth rate was mainly due to the deficiency of phosphorous. If there is enough phosphorus in the aquatic environment, *Azolla* will be able to grow without the need to provide combined nitrogen such as NH_4, NO_3 [5]. Most fish farmers use complete diet of fish feed, those containing all the required protein (18-50%), lipid (10-25%), carbohydrate (15-20%), ash (< 8.5%), phosphorus (< 1.5%) and trace amounts of vitamins, and minerals. In contrast, supplemental (fish feed & *Azolla*) diets are intended only to help support the natural food (insects, algae, small fish) normally available to fish in ponds. Fish have ammonia (NH_3^+, NH_4^+) as the major excretory nitrogenous product directly excreted out to water. It has no effect on *Azolla* growth. High ammonium concentrations in wastewater had no effect on nitrogen fixation dynamics [6]. Neither ammonium nor nitrate inhibited acetylene reduction activity (ARA). At higher concentrations, the ARA was less inhibited by nitrate than by ammonium. Of the three nitrogen sources tested, nitrate-nitrogen was the least available and mobile in *Azolla* [9].

TABLE 2 Water quality parameters from an intensive RAS (Recirculating Aquaculture System).

(Adapted from Boreham et al. 2004).

Parameter	Within system	Post up-flow filter (Liquid effluent)	Drum filter effluent (Solid wastes)
pH	5.4–6.8 (6.1)	5.4–6.6 (6.0)	5.4–6.8 (6.4)
Total ammonia nitrogen (mg/L)	20.2–37 (30.1)	20.4–36.3 (29.0)	22.8–51 (36.3)
Unionized ammonia nitrogen (mg/L)	0.003-0.089 (0.02)	0.003–0.056 (0.013)	0.005–0.123 (0.044)
Total phosphorous (mg/L)	2.7–42.5 (12.8)	4.5–42.5 (13.3)	7.1–42.5 (21.5)

(Means in the bracket)

A water body (T1 & T2) with rich phosphorus and neutral pH is a better growth medium for *Azolla* than one with poor phosphorus and acidic medium. Overall, production of *Azolla* in summer is higher than any other seasons [19]. Waters ranging in pH from 6.5 to 8.5 (at sunrise) are generally the most suitable for pond fish production [7].

A suitable concentration of phosphorus in the media appeared mandatory for good growth and high nitrogen fixation of the symbiotic association ([25], [22]). Natural water or more total alkalinity, are considered as hard water for biological purposes. Hard water is generally more productive than soft waters. Total alkalinity levels in the present study indicate productivity of the ponds was medium to high [2].

REFERENCE

[1]Basak, B., Pramanik A. H., Rahmnan, M.S., Taradar S.U. and Roy, B.C. (2002), "Azolla (Azolla pinnata) as a feed ingredient in broiler ration. Int." J. Poult. Sci., 1, 29- 24. | [2]Bhuiyan, B.R. (1970), "Physico-chemical qualities of some ancient tanks of Sibsagar. Assam." Environmental Health, 12, 129-134. | [3]Binoy, V. V. and Thomas, K. John. (2006), "Climbing perch (Anabas testudineus Bloch) recognizes members of familiar shoals." Current Science, 90(3), 10. | [4]Boreham, S., Ingram, B. A, Jones, P. L. and Collins, R.O. (2004), "Water quality and intensive Murray cod aquaculture." In: Ingram, B. A. and De silva, S. S. (2004), Developments in Intensive Commercial aquaculture Production Technology for Murray cod. Final report to Fisheries research and Development Corporation (Project No. 1999/38). Development of Primary Industries, Melbourne. | [5]Costa, M.L., Santos, M.C.R. and Carrapico, F. (1999), "Biomass characterization of A. filiculoides grown in natural ecosystems and wastewater." Hydrobiologia, 415, 323-327. | [6]Costa, M.L., Santos, M.C.R., Carrapico, F. and Pereirac, A. L. (2009), "Azolla-Anabaena's behaviour in urban wastewater and artificial media-Influence of combined nitrogen." Water Research, 43(15), 3743-3750. | [7]FAO (Fisheries and Aquaculture Department) (1987), "Introduction to Aquaculture." Lectures presented by V. G. Jhingran at ARAC for the Senior Aquaculturists course. | [8]Gowd, R.M.B., Lakshmipathy, K., Subramanium, C. K. and Srinivasan, N. A. (1980), "Azolla can be grown in sunlight with soil pH range of 5.3 to 6.4 around Bangalore." Curr. Res., 9, 40-41. | [9]Ito, O. and Watanabe, I. (1983), "The Relationship between combined Nitrogen uptakes and Nitrogen Fixation in Azolla-Anabaena Symbiosis." New Phytologist, 95(4), 647–654. | [10]Lakshman, G. (1979), "An ecosystem approach to the treatment of wastewater." J. Environ.Qual., 8, 353-361. | [11]Liu, Chung-chu (1988), "The 'Rice-Azolla-Fish' system." Organic recycling in Asia and The Pacific. Rapa Bulletin, FAO, Bangkok, 4, 37. | [12]Mishra, B. (2013), "Effect of Azolla Supplementation in the Fish Feed on the Growth of Climbing Perch, Anabas testudineus." American International J. of Res. in Science, Technology, Engineering & Mathematics. 4(1), 22-24. | [13]Peters, G. A., Toia, R. E., Evans, W. R., Crist, D. K., Mayne, B. C. and Poole, R. E. (1980), "Characterization and comparision of five N2-fixing Azolla-Anabaena association. 1. Optimization of growth conditions for biomass increase and N content in a controlled environment." Plant, Cell and Environ. 3, 261-269. | [14]Reddy, K. R. and DeBusk. W. F. (1984), "Phosphorus removal by Azolla caroliniana cultured in nutrient-enriched water." In Symp. : Nijhoff, M./ Junk, W. (Eds) Practical application of Azolla in rice production. The Hague. | [15]Reddy, K. R. and Shutton, D. L.(1984), "Water hyacinth for water quality improvement and biomass production." J. Environ.Qual., 13, 1-8. | [16]Reddy, K. R., Campbell, K. L., Graetz, D. A. and Portier, K. M.(1982), "Use of biological filters for agricultural drainage water treatment." J. Environ. Qual., 11, 591-595. | [17]Singh, B. N. (2002), "Azolla: Biofertilizer for Rice" from the CRRI, Cuttack. URL: http://www.crriicar.org/ | [18]Singh, P. K. (1977), "Multiplication and utilisation of fern "Azolla" containing nitrogen-fixing algal symbiont as green manure in rice cultivation." RISO, 36, 125-137. | [19]Speelman, E. N., Van Kempen, M. L., Barke, J., Brinkhuis, H., Reichart, G. J., Smolders, A. J. P., Roelofs, J. G. M., Sangiorgi, F., De Leeuw, J. W., Lotter, A. F. and Sinninghe Damste, J. S. (2009), "The Eocene Arctic Azolla bloom: environmental conditions, productivity and carbon drawdown." Geobiology, 7, 155–170. | [20]Stowell, R. M., Ludwig R. M. R., Colt, J. and Tchobanoglous, G. (1981), "Concept in aquatic treatment system design." J. Environ. eng. proc. Amer. Soc. Civil Eng, 107, 919-940. | [21]Subudhi, B. P. R. and Watanabe, I. (1981), "Differential phosphorus requirements of Azolla species and strains in phosphorus limited continuous culture." Soil Sci. Plant Nutr., 27, 237-242. | [22]Talley, S.N., Talley, B.J. and Rains, D.W.(1977), "Nitrogen fixation by Azolla in rice fields." In: Genetic Engineering for Nitrogen Fixation. Hollander, A. (Eds.), Plenum Press, New York, 259-281 | [23]TFYP (Tenth Five Year Plan). Working Group Sr. No. 16/2001. Report of The Working Group on Fisheries for the Tenth Five Year Plan, Govt. of Ind., Planning Commission.:- (http://planningcommission.nic.in/aboutus/committee/wrkgrp/fishery.pdf). | [24]Tuzimura, K., Ikeda, F. and Tukamoto, K. (1957), "Studies on Azolla with reference to its use as a green manure for rice fields." J. Sci. Soil Manure, 28, 17-20. | [25]Watanabe, I., Espinas, C. R., Berja, N. S. and Alimango, B. V. (1977), "Utilization of Azolla–Anabaena complex as a nitrogen fertilizer for rice." IRRI Res. Pap. Ser., 11,1-6. | [26]Wolverton, B. C.(1982), "Hybrid waste water treatment system using anaerobic microorganism and reed (Phragmites communis)." Econ. Bot., 36, 373-380. |