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USE OF INDIGENOUS *AZOLLA PINNATA* ISOLATES OF ODISHA AS GREEN MANURE

Agricultural Science

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ABSTRACT

Azolla pinnata is mostly observed in the north eastern coastal plains, eastern and south eastern coastal plains of Odisha. Use of *Azolla* as green manure on rice plant was better than N- fertilizer as it yielded more tillers with longer panicles, more straw weight and grains. Straw weight and grain yield in wet season is less as compared to dry season. Thus, in Odisha a big amount of nitrogen fertilizer costing a huge amount of capital can be saved in each year through the use of *Azolla* as biofertilizer in the rice cropping system.

KEYWORDS

Azolla pinnata-green manure-rice plant

INTRODUCTION

Fertilizers are utilized to improve the capacity of the soil to supply the necessary nutrients in an agricultural system. In under developed countries many farmers cannot afford inorganic fertilizers. This has led to interest in bio-fertilization with emphasis on biological nitrogen fixation (Peoples et al., 1995; Wagner, 1997).

Aquatic fern *Azolla* is a promising nitrogen-fixing bio-fertilizer for rice and commonly found throughout the world floating on the surface of water of ponds, ditches, canals, channels and rice fields (Singh, 1977a & b). A symbiotic relationship with a cyanobacterium, *Anabaena azollae* (Stras.) enables *Azolla* to fix atmospheric nitrogen (N_2). Due to its rapid growth and high N content, *Azolla* has been used as a green manure for rice cultivation in Northern Vietnam (Dao and Tran, 1979), Southern China (Liu, 1979; Lumpkin & Plucknett, 1980) for centuries. The studies carried out in India (Singh, 1977a, b, c,) Philippines (Watanabe et al., 1977), USA (Talley et al., 1977) Sri Lanka (Kulasooriya & de Silva, 1977), Egypt (Yanni et al., 1994) and Africa (Capparico et al., 2000).

The agriculture in Odisha is characterized by low productivity due to traditional agricultural practices, inadequate irrigation infrastructure, small size of holding and low investment. The rice production of Odisha was 8.38 million tonnes (2162Kg/hectare) in the year 2016-17 which was 7.61% to all India rice production (Source: Directorate of Economics & Statistics, DAC & FW).

In both tropical and temperate regions, *Azolla* has been used as a replacement or supplement to the chemical nitrogen fertilizers for the rice cultivation (Lumpkin & Plucknett, 1982; Moore, 1969; Talley et al., 1977; Singh, 1979 a, b; Rojenani & Chulan, 1992). It is either grown as a green manure or as a dual crop with rice after transplantation (Rains & Talley, 1979; Singh, 1979a). The effect of *Azolla* on growth and yield of rice has been reported (Moore, 1969; Olsen, 1972; Talley et al., 1977; Singh and Singh, 1987; Singh & Singh, 1986 a, 1987b, 1994, Manna & Singh, 1989). However, report on the effect of indigenous *A. pinnata* on growth and yield of rice in different soil groups of Odisha is lacking.

Thus, the present study was aimed to grow *A. pinnata* isolates as green manure for rice with varying levels of chemical N-fertilizers in order to assess yield. The growth and N-yield of *A. pinnata* isolates at different levels of the N-fertilizer were observed so as to analyse its quantitative utilization as a biofertilizer in different agroclimatic zones of Odisha.

MATERIALS AND METHODS

Paddy soil was collected from OUAT farm, Bhubaneswar for the greenhouse experiment. Ten kg soil was added in to earthen pots of 30cm diameter and 28cm height after air drying and sieving. Fresh *Azolla* of various weights (10, 20, 30 and 40g) were incorporated in to the soil of the pots separately and left for decomposition. The soil was nicely puddled after 7 days. Three weeks old rice plants cv. Khandagiri, were transplanted at two hills per pot. Different levels of urea (30kg, 60kg and 90kg) were added separately to the pot soil after 7DAT. The pots were kept flooded until and 2 weeks before rice harvest.

The following 4 pot experiments were performed at different levels of nitrogen fertilizer@30,60 and 90kg/ha with different fresh weight of *Azolla* incorporated in the soil prior to the transplantation.

The following treatments were performed in this study (Fig.1).

Fig.1: Experimental Framework

Azolla / Urea		Fresh Weight in g/pot				
		0(T_1)	10(T_2)	20(T_3)	30(T_4)	40(T_5)
Kg/Hector	0	$1T_1$	$1T_2$	$1T_3$	$1T_4$	$1T_5$
	30	$2T_1$	$2T_2$	$2T_3$	$2T_4$	$2T_5$
	60	$3T_1$	$3T_2$	$3T_3$	$3T_4$	$3T_5$
	90	$4T_1$	$3T_2$	$4T_3$	$4T_4$	$4T_5$

RESULT

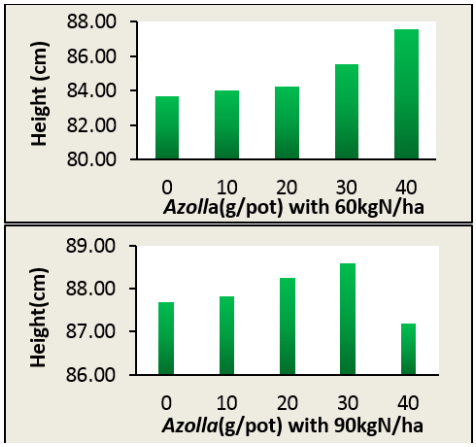
Crop response:

Pot experiments were performed taking urea (30, 60 and 90kg N/ha) and *Azolla* as green manure (10, 20, 30 and 40 g/pot). Pot without *Azolla* and urea ($1T_1$) was treated as control group. The growth was better observed in dry season than wet season. The crop response was observed on 90 day after transplantation (DAT). The response was highest with application of urea (90kgN/ha) along with *Azolla* (30gm/pot). The overall response showed a steady increase with increase concentration of urea and *Azolla.*

Height:

The height of rice plant $1T_5$ (*Azolla* 40gm/pot) was 7.5% more than that of control and at par with $2T_1$ (30kgN/ha). $2T_4$ and $2T_5$ were 5.2% and 6.5% more than $1T_5$ and $2T_1$ respectively. $3T_1$and $3T_4$ were 3% and 6% more than $2T_4$ and $2T_5$ respectively. The plant height for $4T_1$ was 6.3% more than $3T_4$. Treatment at $4T_1$in urea (90kgN/ha) gave similar response as recorded at the concentration of 60kgN/ha urea and *Azolla* 40g/pot ($3T_5$). $2T_1$ and $3T_1$ are comparable to $1T_5$ and $2T_5$ respectively. All the treatment for 90kgN/ha remained at par (fig.2). Similar trend was observed during wet season. The height of rice plant was found to be maximum at *Azolla* @40g/pot with urea @90kgN/ha ($4T_5$) in wet season.

Fig.2: Effect of varying levels of *Azolla* and Urea on the HEIGHT of rice plant

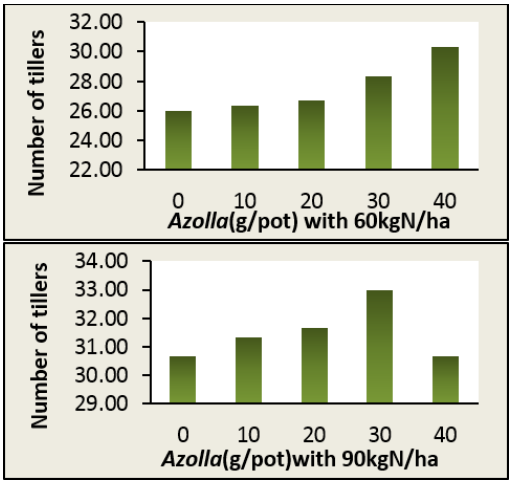


Tiller number and Panicle length :

Maximum number of tiller was found in highest level of urea (90kg/ha)) for both dry season and wet season than the control. The number of tillers for varying levels of urea was found to be increased with the increase in the quantity of green manure incorporated into the pot soil. Maximum number of tillers was found for $4T_5$ in wet season recording 248% increase over that of the control but 7.6% reduced during dry season than $4T_4$. *Azolla* 40gm/pot gave 35.3% more tillers than the control and at par with $2T_4$. Tiller number for $2T_4$ and $2T_5$ were found at par with $3T_1$ and $3T_4$ respectively for both dry and wet season, taking both urea and *Azolla* into consideration. The growth was significant in *Azolla* 40gm/pot with urea 60kgN/ha ($3T_5$) as compared to $2T_5$ during wet season (fig.3).

Similar trend was also observed in the length of the panicle during dry and wet season with regards to number of tillers. It was observed that treatments in both the seasons, T_4 and T_5 were significant over control taking *Azolla* into consideration.

Fig.3: Effect of varying levels of *Azolla* and Urea On theTILLERS NUMBER of rice plant.

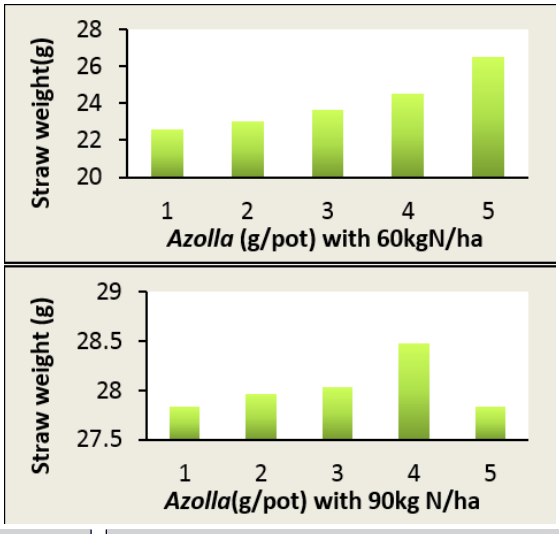


Straw weight:

It was observed that incorporation of *Azolla* as green manure (T4 and T5) was found to be significant over the control. Incorporation of *Azolla* @ 40gm/pot along with 30 and 60 kg N/ha ($2T_5$ and $3T_5$) were 31.2 and 17.6% more than urea @30kg N/ha ($2T_1$) and 60kgN/ha ($3T_1$) respectively during dry season. Straw weight for $3T_5$ was found at par with that of urea 90kgN/ha with or without *Azolla* (fig.4)

Similar trend was observed in straw weight during wet season. Straw yield for $4T_4$ and $4T_5$ were 12.32 and 25.1% more than $3T_5$ during wet season.

Fig.4: Effect of varying levels of *Azolla* and Urea On STRAW YIELD of rice plant.



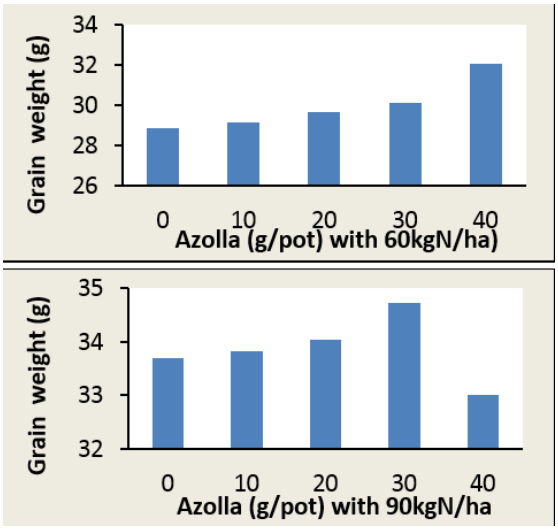
Grain yield :

The grain yield with varying levels of *Azolla* incorporation in combination with urea was found to be significantly higher than application of urea alone. The variation was observed at urea 90kgN/ha and *Azolla* 40gm/pot ($4T_5$ and $4T_5$). The yield was slightly decreased. The grain yield with urea at a higher dose is at par with lesser dose of urea and *Azolla* .

The grain yield was maximum (135.8%) in urea 90kgN/ha with *Azolla* 30gm/pot ($4T_4$) during dry season than the control. This yield was closely followed by urea 90kgN/ha with *Azolla* 20gm/pot ($4T_3$). The grain yield in combination of urea (90kgN/ha) with *Azolla* (0, 10 and 40 gm) were at par (fig.5).

The grain yield in urea (90kgN/ha) and *Azolla* (40gm/pot) was 13.8% ($4T_5$) more than $3T_5$ during wet season which is closely followed by urea (90kgN/ha) and *Azolla* (30gm/pot). The yield was significantly higher in urea with varying levels of *Azolla* than the control.

Fig.5: Effect of varying levels of *Azolla* and Urea On GRAIN YIELD of rice plant.



DISCUSSION

Crop response:

From the present study, it was found that the effect of *Azolla* as green manure on the rice plant was definitely better as compared to the N-fertilizer.

Height:

Maximum height of the rice plant was observed at higher dose of nitrate in combination with *Azolla*. Low dose of nitrate with *Azolla* can be compared with higher dose of nitrate without *Azolla*. Significant increase in plant height has been observed by Singh and Singh (1987) when *Azolla* was incorporated at early stages of rice growth period.

Tiller number and panicle length:

Urea @ 90kgN/ha resulted maximum number of tillers. It was better than urea 60kgN/ha and lower dose of *Azolla* and at par with urea 60kgN/ha and higher dose of *Azolla* in dry season. In wet season, the maximum tiller number was obtained with higher dose of nitrate in combination with higher dose of *Azolla*. The effect shows 40gm of *Azolla* replaces 30kgN/ha which is in accordance with observation made by Watanabe *et al*., (1977)). Increase in tiller number with *Azolla* application has been observed by Singh and Singh (1987). Application of *Azolla* with or without nitrate increased the length of panicle over control.

Straw weight and grain yield:

Straw weight was maximum with higher dose of urea and *Azolla* in dry season. In wet season, higher dose of *Azolla* (40gm) with urea 90kgN/ha yielded maximum result. Maximum straw weight in wet season is less as compared to dry season. Higher dose of *Azolla* is comparable with lower dose nitrate. Higher dose of *Azolla* with lower dose of nitrate are comparable with higher dose of nitrate and lower dose of *Azolla*. Similar trend was observed in grain yield. Incorporation of 8-10 tons of fresh *Azolla*/ha produced the same rice

yield as that obtained with application of 30-40kgN/ha through ammonium sulphate, the increase in grain yield being 47% over control (Singh, 1977b). Use of 7000 kg/ha *Azolla* compost has an effect equivalent to 94.5 kg/ha of urea, which is 73% more over control in wet season (Carrapico *et al*., 2000; Watanabe, 1982; Van Hove, 1989; Yanni *et al*, 1994). This finding agrees with data obtained in pot experiment. Increase in grain weight with *Azolla* application has been observed by Singh and Singh (1987). It proves the potential use of *Azolla* as a green manure in rice cultivation. Green manuring is more suited for short duration rice (CRRI report). Accordingly, the result was encouraging in short duration variety "Khandagiri" used in the present study where *Azolla* was substituted for 30 kg N/ha of urea.

POSSIBLE FERTILIZER SAVING:

In Odisha rice is grown in more than 4million ha producing 8.38million tonnes of rice (Technical report or EARAS, Dir. of Eco. and Stat., 2016- 2017). Contribution of Odisha to the food grain basket of the country is estimated at about 7.61% in 2016-17. Normally the farmers use 1 bag (50kg)of urea (46%N) at transplanting and another bag at panicle initiation stage per acre, thus total 46kg N/acre corresponding to about 114kg N /ha is used for rice. Taking 4million hectare as rice area, the nitrogen consumption comes about 456000ton/ rice crop in Odisha. On the average, *Azolla* caused rice grain yield equivalent to application of 30 kg N/ ha, corresponding to saving of $1/4^{th}$ of the present consumption Rs.260/ bag of urea i.e. Rs. 130/ha. Therefore about Rs. 520 million can be saved through the use of *Azolla* as biofertilizer per rice crop in Odisha.

Thus in Odisha a big amount of nitrogen fertilizer costing a huge amount of capital can be saved in each year through the use of *Azolla* as biofertilizer in the rice cropping system.

REFERENCES

[1] Alalade, O. A. and Iyayi, E. A. (2006), "Chemical composition and the Feeding value of *Azolla (Azolla pinnata)* meal for egg-type chicks." International Journal of Poultry Science, 5 (2), 137-141.

[2] 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.

[3] Bhuiyan, B.R. 1970, " Physico-chemical qualities of some ancient tanks of Sibsagar, Assam." Environmental Health, 12, 129-134.

[4] Binoy, V. V. and Thomas, K. John. (2006), "Climbing perch (*Anabas testudineus* Bloch) recognizes members of familiar shoals." Current Science, 90(3), 10.

[5] 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.

[6] Castanares, M. A., Alma, G. (2005), "A comparision of the nutritive value of *Azolla (A. pinnata var. imbricata)* and duckweed *(Lemna perpusilla)* for Nile tilapia *(Oreochromis niloticus* L.)." Fish and Fisheries, 6 (3), 186.

[7] 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.

[8] 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.

[9] Craig, S. (2009), "Understanding Fish Nutrition, Feeds, and Feeding." Virginia Cooperative Extension, 420-256.

[10] FAO (Fisheries and Aquaculture Department), (1987). Introduction to Aquaculture. Lectures presented by V. G. Jhingran at ARAC for the Senior Aquaculturists course.

[11] FAO Training Series 2 Improving Pond Water Quality. ftp://ftp.fao.org/fi/CDrom/FAO_Training/FAO_Training/General/x6709e/Index.htm

[12] 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.

[13] Lakshman, G. (1979), "An ecosystem approach to the treatment of wastewater." J. Environ. Qual., 8,353-361.

[14] Liu, Chung-chu (1988), "The "Rice-*Azolla*-Fish" system. Organic recycling in Asia and The Pacific." Rapa Bulletin, FAO, Bangkok, 4, 37.

[15] I to, O. and Watanabe, I. (1983), "The Relationship between combined Nitrogen uptakes and Nitrogen Fixation in *Azolla-Anabaena* Symbiosis." New Phytologist, 95(4), 647–654.

[16] 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.

[17] 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.

[18] 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.

[19] 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.

[20] Reddy, K. R. and Shutton, D. L. (1984), "Water hyacinth for water quality improvement and biomass production." J. Environ.Qual., 13, 1-8.

[21] Singh, B. N. (2002), "*Azolla*: Biofertilizer for Rice" from the CRRI, Cuttack. URL: http://www.crriicar.org/

[22] 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.

[23] 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.

[24] 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.

[25] 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.

[26] 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).

[27] 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.

[28] 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.

[29] Wolverton, B. C. (1982), "Hybrid waste water treatment system using anaerobic microorganism and reed *(Phragmites communis)*." Econ. Bot., 36, 373-380.