

RESPONSE OF RICE TO FERTILIZER NITROGEN AND AZOLLA AND ITS ECONOMICS

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The effect of fertilizer nitrogen and Azolla on rice during *Kharif* and *Rabi*, 1984-85 were studied. In *Kharif* application of 25 Kg N each as prilled urea, urea super granule and neem coated urea besides Azolla as dual crop produced highest grain yield, net return as well as return per rupee invested while 75 Kg N as urea super granule and Azolla as dual crop produced highest straw yield. However, during *Rabi*, application of 75 Kg N as neem coated urea and Azolla as dual crop produced highest grain and straw yield, net return as well as return per rupee invested. Return per rupee invested was higher in *Rabi* than in *Kharif*.

Rice is the major consumer of fertilizer nitrogen in India and the efficiency of nitrogen utilization is very low in rice compared to upland crops. The N use efficiency in rice largely ranges between 25 to 30 per cent and seldom exceeds 50 per cent. Considering the high production cost of fossil fuel based N fertilizers, it is imperative that the field losses of N are to be minimised. Azolla is a water fern known to exist in intimate association with cyanobacterium capable of reducing molecular nitrogen (Peters, 1975). The nitrogen fixing blue green alga *Anabaena azollae* are always found in the cavities of dorsal leaves as symbiont which fix atmospheric nitrogen necessary for the growth of the fern. *Azolla-Anabaena* association efficiently fixes atmospheric nitrogen in rice field ecosystem and this water fern has been used as biofertilizer to boost rice production in Vietnam and China (Liu Chang Chu, 1979). The usefulness of Azolla and the high cost of N fertilizers put forth the need to study

the effect of different forms of urea with and without Azolla on yield and their economics.

MATERIALS AND METHODS

Two field studies were undertaken in Tamil Nadu Agricultural University, Coimbatore during *Kharif* and *Rabi* 1984-85 to study the effect of fertilizer nitrogen and Azolla on rice. Experiments were laid out in a randomised blocks design with four replications. The soil type of the experimental sites were clay loam. The treatments tried were T₁-Control, T₂-Azolla as dual crop (200 gm⁻²), T₃-Azolla as green manure (10 t ha⁻¹), T₄-75 Kg N as prilled urea (PU), T₅-75 Kg N as PU + Azolla (DC), T₆-75 Kg N as urea super granule (USG), T₇-75 Kg N as USG + Azolla (DC), T₈-75 Kg N as neem coated urea (NCU), T₉-75 Kg N as NCU + Azolla (DC), T₁₀-25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU, T₁₁-25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU + Azolla (DC).

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Prilled urea was applied in two split doses. P and K each at the rate of 50 Kg ha⁻¹ was applied basally for all the treatments.

In *Kharif* IR-50 seedlings were transplanted with a spacing of 15 × 10 cm. However, in *Rabi* Co-43 seedlings were transplanted with a spacing of 20 × 10 cm.

Grain and straw yields were recorded for each treatment separately during both the seasons. Net return was calculated for the treatment combinations by subtracting the total cost of cultivation ha⁻¹ from the gross return ha⁻¹. The net return per rupee invested was calculated using the formula,

$$\text{Return Re}^{-1} \text{ invested} = \frac{\text{Net return (Rs. ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs. ha}^{-1}\text{)}}$$

RESULTS AND DISCUSSION

The data pertaining to the grain and straw yield during *Kharif* and *Rabi* are presented in Table 1. The data showed that in *Kharif* the plots receiving 25 Kg N each as prilled urea, urea super granule, neem coated urea besides Azolla as dual crop recorded highest grain yield and this was on par with treatments 75 Kg N as USG + Azolla (DC) and 75 Kg N as NCU + Azolla (DC). However in *Rabi* the plots receiving 75 Kg N as neem coated urea besides Azolla dual cropping produced highest grain yield and this was statistically on par with treatments 25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU + Azolla (DC) and 75 Kg N as PU + Azolla (DC).

The highest grain yield in *Kharif* would be due to the split application of drilled urea, slow release property of

urea super granule, nitrification inhibiting property of neem coated urea and the Azolla N added at the later period of plant growth. In *Rabi* the reasons for higher yield are nitrification inhibiting property of neem cake and also the Azolla N added during the later part of the plant growth. Moreover, the Azolla growth was rapid in *Rabi* than in *Kharif* in *Kharif*. Azolla was incorporated twice. However, in *Rabi* three Azolla incorporations were done. Rambabu *et al.* 1983 stated surface application and incorporation of N as neem coated urea and placement of 50 percent N as urea super granule with 50 per cent N as urea top dressing to be better than split application of N as urea in increasing the grain yield. Juang (1980) found urea super granule to be more efficient by 40-50 per cent than conventional prilled urea. Shankar *et al.* (1976) found significant increase in rice grain yield (3.2 q ha⁻¹) by blending urea with 20 percent neem cake. Rambabu *et al.* (1983) found basal application of N as neem coated urea to be superior to split application of urea during the main crop season. Increase in grain yield by the application of Azolla has been well documented by watanabe *et al.*, (1977) Lumpkin and Plucknett (1980) and Kannaiyan 1984)

In *Kharif* the plots receiving 75 Kg N as urea super granule along with Azolla dual cropping recorded higher straw yield of 4812 Kg ha⁻¹. However, in *Rabi* the plots receiving 75 Kg N as neem coated urea besides Azolla as dual cropping produced highest straw yield of 6589 Kg ha⁻¹. In *Kharif* slow release of N from urea super granule reduced the loss of N from N fertilizer and also extra supply of

Table. 1 Effect of fertilizer nitrogen and Azolla on grain and straw yield of rice at Coimbatore, 1984-85

Treatments	Grain yield (Kg ha ⁻¹)		straw yield (Kg ha ⁻¹)	
	Kharif (IR.50)	Rabi (CO 43)	Kharif (IR 50)	Rabi (CO 43)
Control	2269	3268	3140	5003
Azolla as dual crop (200 gm ⁻³)	2844	3694	3809	5301
Azolla as green manure (10 t ha ⁻¹)	2800	3625	4092	5284
75 Kg N as PU	3573	4679	4542	6150
75 Kg N as PU + Azolla (DC)	3912	4932	4704	6368
75 Kg N as USG	3838	4621	4709	6423
75 Kg N as USG + Azolla (DC)	4347	4817	4812	6515
75 Kg N as NCU	3637	4875	4617	6402
75 Kg N as NCU + Azolla (DC)	4232	5128	4724	6589
25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU	4001	4822	4638	6522
25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU + Azolla (DC)	4358	5055	4679	6389
SEd	139.9	200.3	100.4	152.2
CD (p=0.05)	285.7	409.1	205.0	310.8

Table 2. Economic analysis of N use in Kharif 1984. Coimbatore, India.

Treatment (N Kg ha ⁻¹)	Total cost of cultivation (Rs. ha ⁻¹)	Value of grain and straw (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	Net return per rupee invested (Rs.)
Control	4000	4687	687	0.17
Azolla as dual crop (200 gm ⁻³)	4150	5860	1710	0.41
Azolla as green manure (10 t ha ⁻¹)	4750	5811	1061	0.22
75 Kg N as PU	4366	7333	2966	0.68
75 Kg N as PU + Azolla (DC)	4516	7997	3480	0.77
75 Kg N as USG	4399	7857	3457	0.79
75 Kg N as USG + Azolla (DC)	4549	8836	4287	0.94
75 Kg N as NCU	4443	7464	3020	0.68
75 Kg N as NCU + Azolla (DC)	4593	8607	4013	0.87
25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU	4403	8158	3755	0.85
25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU + Azolla (DC)	4553	8841	4288	0.94
Value of urea N Kg ⁻¹	= Rs. 4.81	Value of Azolla tonne ⁻¹	= Rs. 75.00	
Value of USG N Kg ⁻¹	= Rs. 5.32	Value of grain Kg ⁻¹	= Rs. 1.90	
Value of NCU N Kg ⁻¹	= Rs. 5.92	Value of straw tonne ⁻¹	= Rs. 120.00	

Table. 3. Economic analysis of N use in *Rabi* 1984-85, Coimbatore, India.

Treatments (N Kg ha ⁻¹)	Total cost of cultivation (Rs. ha ⁻¹)	Value of grain and straw (Rs. ha ⁻¹)	Net return (Rs ha ⁻¹)	Net return per rupee invested (Rs)
Control	4000	6809	2809	0.70
Azolla as dual crop (200 g m ⁻¹)	4150	7654	3504	0.84
Azolla as green manure (10 t ha ⁻¹)	4750	7521	2771	0.56
75 Kg N as PU	4366	9628	5261	1.20
75 Kg N as PU + Azolla (DC)	4516	10134	5618	1.24
75 Kg N as USG	4399	9550	5151	1.17
75 Kg N as USG + Azolla (DC)	4549	9933	5384	1.18
75 Kg N as NCU	4443	10030	5586	1.26
75 Kg N as NCU + Azolla (DC)	4593	10533	5940	1.29
25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU	4403	9943	5540	1.26
25 Kg N as PU + 25 Kg N as USG + 25 Kg N as NCU + Azolla (DC)	4553	10371	5817	1.28

Value of urea N Kg⁻¹ = Rs. 4.81
 Value of USG N Kg⁻¹ = Rs. 5.32
 Value of NCU N Kg⁻¹ = Rs. 5.92

Value of Azolla tonne⁻¹ = Rs. 75.00
 Value of grain Kg⁻¹ = Rs. 1.90
 Value of straw tonne⁻¹ = Rs. 120.00

Azolla N at the later period of crop growth would have resulted in increased dry matter production which in turn increased the straw yield. The combination of Azolla along with different forms of fertilizer nitrogen produced higher yields when compared to different forms of fertilizer nitrogen alone.

The data pertaining to net return and return per rupee invested during *Kharif* and *Rabi* are presented in Table 2 and 3.

The net return gets increased with the application of N fertilizer with or without Azolla. Application of 25 Kg N

each as prilled urea, urea super granule neem coated urea besides Azolla dual cropping gave the highest net return of Rs. 4288 ha⁻¹ in *Kharif* followed by the application of 75 Kg N as urea super granule and Azolla dual cropping (Rs 4287 ha⁻¹). The return per rupee invested was less than one in *Kharif* for all the treatments. So it is not economical to follow these treatment combinations during *Kharif*. The main reason for this is the lower yield in *Kharif*. Due to high day and night temperatures (20.8/30.8°C) that prevailed during *Kharif*, the Azolla growth was poor and only two incorporations were done.

In *Rabi* application of 75 Kg N as neem coated urea along with *Azolla* dual cropping gave the highest net return of Rs.5940 ha⁻¹ followed by the application of 25 Kg N each as prilled urea, urea super granule, neem coated urea besides *Azolla* dual cropping which gave the net return of Rs.5817 ha⁻¹. The return per rupee invested was also high from the application of 75 Kg N as neem coated urea along with *Azolla* dual cropping and *Azolla* green manuring all the other treatments recorded higher (more than one) net return per rupee invested. This might be due to the higher grain and straw yield.

From the results it was concluded that the effect of application of 25 Kg N each as prilled urea, super granules, neem coated urea besides *Azolla* dual cropping and 75 Kg N as neem coated urea besides *Azolla* dual cropping were same in both *Kharif* and *Rabi* seasons in respect of grain yield.

REFERENCES

- JUANG, T.C. 1980. Increasing nitrogen efficiency through deep placement of urea super granules under tropical and subtropical paddy conditions. In: *Increasing nitrogen efficiency for cultivation*, Taipei, Taiwan, FFTC., PP 83-101.
- KANNAIYAN, S. 1984. Studies on the application of *Azolla* for rice. Int. Workshop on *Azolla* use. Benken. Bangkok, Thailand P.36.
- LIU CHUNG CHU, 1979. Use of *Azolla* in rice production in China. In: *Nitrogen and Rice* Int. Rice Res. Inst., Manila Philippines, P.375-394.
- LUMPKIN, T.A. and D. L. PLUCKNETT, 1980. *Azolla*: Botany, Physiology and use as a green manure. *Econ. Bot.*, 34: 111-153.
- PETERS, G.A. 1975. The *Azolla-Anabaena azollae* relationships III. Studies on metabolic capabilities and further characterisation of the symbiont. *Arch. Microbiol.*, 103: 113-122.
- RAMBABU, P. K.G, PILLAI and N. NARSA REDDY. 1983. Effect of modified urea materials and their methods of application on dry matter production, grain yield and nitrogen uptake in rice. *Oryza* 20 (2 & 3) . 86-90
- SHANKAR, H., B. RAM and K.S. RATHI. 1976. Effect of neem cake blended urea on the yield and uptake of nutrients by rice grown under transplanted and direct sown conditions. *J. Indian Soc. Soil Sci.*, 24 (2) : 211-213
- WATANABE, I., C. R. ESPINAS, N.J. BERJA, and B. V. ALIMAGNO, 1977. Utilization of the *Azolla-Anabaena* complex as a nitrogen source for rice. Int. Rice Res. Inst., Res. paper Ser. No. 11 : 15.