Effect of Nitrogen sources on Aerobic Rice production under various rice soil Eco systems

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Abstract
A field experiment was conducted at the Wetlands of Tamil Nadu Agricultural University, Coimbatore during *Kharif* season of 2008 with an objective of assessing the effect of different eco systems of rice cultivation and N sources on the growth and yield of CORH-3 hybrid rice. Alternate wetting and drying and flooded rice systems of cultivation were on par with each other in terms of growth characters, yield attributes and grain yield of hybrid rice. Application of 50% of N as Urea + 50% of N as poultry manure recorded higher growth characters, yield attributes and grain yield which was closely followed by application of 100% of N as Urea. The highest water productivity was achieved by adopting alternate wetting and drying system of cultivation. Higher profit was obtained with 50% of N as Urea + 50% of N as poultry manure in an alternate wetting and drying system of rice cultivation followed by application of 100% of N as Urea in the alternate wetting and drying regime.

Key Words
Nutrient management, alternate wetting and drying, flooded rice ecosystem

India is the first among countries other than China to develop and commercialize hybrid rice technology (Siddiq, 2002). Scarcity of freshwater resources has threatened the production of the flood-irrigated rice crop. By 2025, 15 out of 75 million hectare of Asia's flood-irrigated rice crop will experience water shortage (Tuong and Bouman, 2003). To reduce water use in irrigated rice, water-saving regimes can be introduced, that aim to reduce non-beneficial water flows from rice fields during crop growth namely seepage, percolation and evaporation by Alternate Wetting and Drying (AWD) irrigation and aerobic rice system (Bouman *et al.,* 2005). Nearly 50 per cent gain in food grain productivity seen in recent times has come through adoption of fertilization practices alone. Although the performance of hybrid rice was studied under submerged conditions for agronomic yield, minimal efforts have been made to study its performance in different soil eco systems viz., alternate wetting and drying and aerobic condition. Therefore the present investigation was undertaken to study the effect of different sources of N under various systems of rice cultivation.

Materials and methods

A field experiment was conducted during 2008-2009 at the Wetland Farm of Tamil Nadu Agricultural University, Coimbatore. The soil was deep clay loamwith soil PH, electrical conductivity, organic carbon and soil available N, P and K were 7.3, 0.46%, 0.64% and 244, 17.2 kg ha^{-1} and 505 kg ha^{-1} respectively. The experiment was laid out in split -plot design replicated thrice. The main plots represented three types of rice cultivation eco systems, *viz.* 'Aerobic rice', 'Alternate wetting and drying' and 'Flooded rice'; the sub plot consisted of five different nitrogen treatments, *viz.* 100% of N as Urea, 100% of N as Ammonium sulphate, 50% of N as Urea + 50% of N as poultry manure, 50% of N as Ammonium sulphate + 50% of N as poultry manure and 100% of N as poultry manure. The recommended dose of 175:60:60 kg of NPK was applied to all the three systems of rice cultivation. However, different sources and combinations of manures were used while applying to subplots. A dose of 50% N along with 100% P and 100% K was applied as basal dose in all the subplots except subplot 5 where 100% N as poultry manure was applied as basal dose. Well-decomposed poultry manure was used and applied on a N basis only. The entire dose of 60 kg P_2O_5 per hectare was applied basally in the form of single super phosphate in all the subplots. Potassium at 60 kg ha^{-1} was applied uniformly to all the plots irrespective of the treatments.

Results and discussion

Growth parameters

Growth parameters like plant height, tillers, root length, root volume and dry matter production of hybrid rice were comparatively higher under the alternate wetting and drying rice cultivation method. This might be due to high soil aeration. In alternate wetting and drying, the action of micro organisms can be promoted and the

accumulation of poisonous substances in the soil can be avoided by favourable soil aeration (Mao Zhi, 1997). The number of tillers, root length and root volume were found to be the highest with the application of 50% of N as Urea + 50% of N as poultry manure and it was comparable with 100% of N as Urea. It might be due to the improved soil physical properties *viz.,* bulk density, infiltration rate, hydraulic conductivity by organic manures thereby the soil health favoured better growth attributes.

Yield attributes

Productive tillers, panicle length and number of filled grains were higher under alternate wetting and drying system of rice cultivation due to better aeration and microbial activity. Soil drying during grain filling and also enhanced mineralization of soil organic matter and thus N release, which is good in the short term but reduces soil fertility in the long term.

Enhances the partitioning of assimilates from vegetative tissues to grains. This is in line with the findings of Hao Zhang *et al*. (2008). Higher yield attributes were registered with 50% of N as Urea + 50% of N as poultry manure and comparable with 100% of N as Urea. More number of early formed tillers under steady supply of N due to mineralization of poultry manure with 50% of N as Urea increased the productive tillers and thereby increased the numbers of panicles. This is mainly because of organic manures have low nutrient content and slow release of N and Poultry manure usually contains a lot of P so that in these treatment much more P was applied which explains the observed results.

An appropriate combination of organic and inorganic nutrient sources was found to enhance the efficiency of nutrients and ultimately increased the growth and yield attributes of rice as reported by studies of earlier workers. (Maragatham, 1996; Battacharya and Nain, 2001).

Yield

A higher grain yield was obtained with the alternate wetting and drying system of cultivation and it was on par with flooded rice (Table 1). This was due to the increased value of yield attributing characters like panicle number, panicle length, thousand grain weight and low sterility percentage. A similar finding was reported by Viraktamath (2006). Rice grain yield obtained from 50% of N as Urea + 50% of N as poultry manure was found to be the highest and it was on par with 100% of N as Urea. This might be due to continuous and steady supply of N into the soil solution to meet the required nutrients for physiological processes, which in turn improved the yield. Also increased nutrient uptake especially of N and P resulted in increased photosynthetic rate and increased plant growth. Increased photosynthetic rate resulted in higher translocation to sink and more grain yield.

Nutrient uptake

The alternate wetting and drying system recorded more nutrient uptake due to enhanced root activity as evident from the presence of longer roots and higher root volume which in turn increased total dry matter production and nutrient uptake (Rajesh and Thanunathan, 2003). Improved uptake of NPK was observed with 50% of N as Urea + 50% of N as poultry manure. The N mineralized during the decomposition of organic manures would have enhanced N availability in the rhizosphere resulting in increased nutrient uptake by rice and resulting in increased dry matter.

Water productivity

Water productivity is the term used to express the incremental crop yield and income for every unit volume of water used. The alternate wetting and drying system of rice cultivation resulted in the highest water productivity (5.66 kg ha^{-1} mm^{-1}) and the lowest water productivity was recorded for the flooded rice method (Table 2). The alternate wetting and drying system of rice cultivation resulted in higher yield for the moderate quantity of water consumed. This is in line with the findings of Tran Thi Ngoc Huan *et al.* (2008).

Table 1. Effect of N sources and various eco-systems of cultivation on grain yield, straw yield (kg ha^{-1}) and harvest index of hybrid rice.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
Systems of rice cultivation			
M_1	3974	6148	0.35
M_2	6949	10841	0.37
M_3	6206	10412	0.35
SEd	295.5	525.9	0.004
CD (P=0.05)	797.8	1085.5	0.010
N sources			
S_1	5793	10623	0.36
S_2	5415	8934	0.34
S_3	6020	10991	0.38
S_4	5610	9339	0.33
S_5	5193	8069	0.33
SEd	270.6	519.2	0.01
CD (P=0.05)	558.4	1069.6	0.02
Interaction			
M X S SEd	422.4	844.3	0.02
CD	NS	NS	NS
S X M SEd	468.6	910.9	0.02
CD	NS	NS	NS

Main plot	Sub plot
M_1 - Aerobic rice M_2 - Alternate Wetting and Drying M_3 - Flooded rice	S_1 - 100% of N as Urea S_2 - 100% of N as Ammonium sulphate S_3 - 50% of N as Urea + 50% of N as poultry manure S_4 - 50% of N as Ammonium sulphate + 50% of N as poultry manure S_5 - 100% of N as Poultry manure

Table 2. Water productivity (kg ha^{-1} mm^{-1}) of hybrid rice under different eco systems of cultivation.

Treatments	Total water used (mm)	Water productivity (kg ha^{-1} mm^{-1})
M_1	764	5.20
M_2	1227	5.66
M_3	1543	4.02
Mean	1178	4.96

Data not statistically analysed

M_1 - Aerobic rice
M_2 - Alternate Wetting and Drying
M_3 - Flooded rice

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