Indian J. Environ. & Ecoplan. 8 (2) : 461 - 465 (2004)

YIELD AND NUTRIENT UPTAKE OF RICE CULTIVARS UNDER PROBLEM SOILS

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ABSTRACT

Rice cultivars ASD 18 and IET 1444 were grown in two different population levels in acid and alkali soils. The rice grown in acid soil recorded higher dry matter production, grain yield, N, P, and K uptake than the rice grown in alkali soil. The variety IET 1444 was more efficient than ASD 18 in terms of grain yield but less efficient in nutrient uptake. It is because of susceptibility of IET 1444 for iron toxicity. Lower plant population resulted in efficient utilization of nitrogen and higher population favours efficient utilization of phosphorus and potassium.

Keywords: *Cultivars, Population levels, Problem soils, Nutrient uptake.*

INTRODUCTION

It is well documented that the root-zone soil differs biologically, chemically and physically from bulk soil (Carson, 1974). These changes have direct effect on plant nutrient. The root-zone effect on rice growth and nutrient uptake has not been investigated thoroughly so far under wetland rice. Since this root-zone effect is adopting mechanism for optimum crop growth, it is expected to vary from soil to soil. Detailed investigation on this aspect was not carried out so far. The present work is an attempt to study the root-zone effect of rice cultuvars in two problem soils namely acid and alkali soil under waterlogged condition.

MATERIALS AND METHODS

A potculture experiment was conducted at Agricultural College and Research Institute, Killikulan. The acid soil was collected from Rice Research station, Ambasamudram and alkali soil from Agricultural College, Killikulam. The cultivars used in this study were ASD 18 and IET 1444. The varietal characteristics are given in Table 1.

The processed soil samples were analyzed for the estimation of pH, EC, CEC, organic carbon, organic N, NH_4-N NO_3-N, available N, total N, available P, and available K by standard analytical methods.

The acid soil had a pH value of 5.21, EC of 0.10 dSm^{-1}, CEC of 4.20 C mol. (p+) Kg^{-1}, organic carbon of 0.94 per cent, available N of 285.5 ppm, NH_4-N of 28 ppm, NO_3-N of 128 ppm, organic N of 513 ppm, total N of 670 ppm, available P of 28.5 ppm and available K of 111 ppm. Alkali soil had a pH value of 8.20, EC of 0.18 dSm^{-1}, CEC of 8.20 c mol (p+)Kg^{-1}, organic carbon of 0.87 per cent, available N of 214.5 ppm, NH_4-N of 9.8 ppm, NO_3-N of 74 ppm, organic N of 672 ppm, total N of 760 ppm, available P of 8.5 ppm and available K of 155 ppm.

Table 1. **Varietal characteristics of rice cultivars.**

Varieties	Duration (days)	Parentage	Remarks
ASD 18	105	ASD 31 x IR 50	High Grain yield and non shattering, High fertilizer response, Non lodging, Medium slender white rice, Resistant to BPH & Blast, Moderately resistant to gall midge, leaf hopper, RTV and sheath rot disease.
IET 1444	105	Triveni x CO 29	Medium grain, Resistant to gall midge and Susceptible to bacterial blight.

Five Kg processed soil was transferred to tubular pot of 30 cm height and 20 cm diameter. Twenty-three days old seddlings were planted in pots at the rate equivalent to 66 hills m^{-2} and 115 hills m^{-2}. Gap filling was done after a week of transplanting to ensure uniform population levels. Fertilizer was applied at the rate of 100-50-50 kg NPK ha^{-1}. Half of the nitrogen and entire phosphorus were applied as basal. The other half of the nitrogen was applied in two splits at maximum tillering and flowering stages. Recommended plant protection measures were given.

The plant samples and paddy grain collected were weighed after drying to a constant weight by oven drying at 60°C. Then the samples were powdered in the willey mill and the powdered samples were used for analysis of nitrogen by Micro-kjeldhl method (Humphries,1956), phosphorus content by Vanado-molybdate yellow colour method (Jackson, 1973) and potassium content by Flame photometer method (Piper, 1966). The data collected were analyzed in FRBD (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The plants grown in acid soil recorded significantly higher dry matter production (15.11 g pt^{-1}) and grain yield (3.81 g pt^{-1}) than the plant grown in alkali soil (11.81 g pt^{-1} and 3.17 g pt^{-1} respectively). The two rice varieties modified the root-zone favourably to its growth in acid than in alkali soil. Between the varieties, ASD 18 recorded numerically higher DMP, grain yield than the variety IET 1444. The plants grown at the population level of 115 hills m^{-2} recorded significantly higher dry matter production (14.49 g pt^{-1}) and grain yield (3.68 g pt^{-1}) than the plants grown at the population level of 66 hills m^{-2} (Fig. 1).

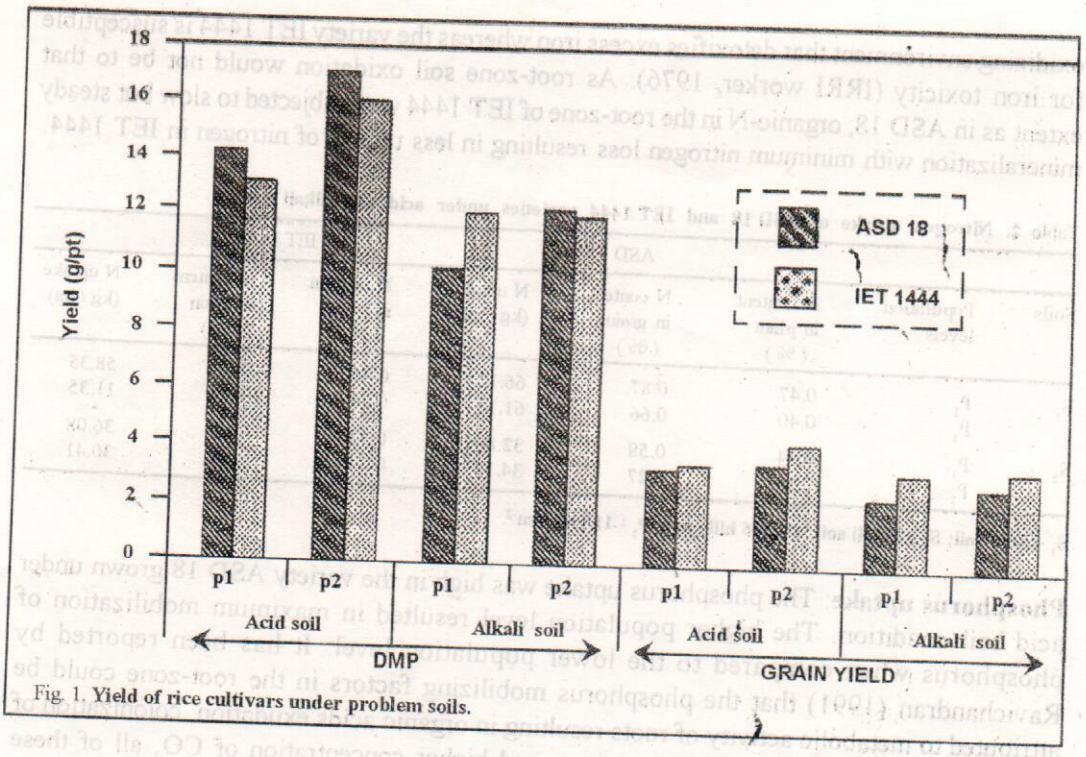

Fig. 1. **Yield of rice cultivars under problem soils.**

The Rice grown in acid soil recorded higher NPK uptake than the rice grown in alkali soil. The uptake of N, P and K was more in ASD 18 than IET 1444 in both the soils. Lower plant population resulted in efficient utilization of nitrogen whereas higher population resulted in efficient utilization of phosphorus and potassium.

Nitrogen uptake: The NH_4-N could have been mostly utilized by plant or subjected to losses by mineralisation, fixation and volatilization. Though NH_4-N in the root-zone soil was 43.61 per cent high in alkaline environment when compared to acidic environment at the time of NH_4-N estimation, it was not reflected by plants uptake because of NH_4-N to flood water and subsequent loss through volatilization. Though there was a higher mineralization of soil organic nitrogen in alkali soil, it was not much used for rice plant when compared to situation in acidic environment. Most of the nitrogen mineralized under acidic environment has been effectively utilized by plant and hence higher uptake of nitrogen by rice varieties grown in acidic environment than by rice varieties from alkaline environment(Table 2).

The variety ASD 18 recorded higher nitrogen uptake than the variety IET 1444. The variety ASD 18 is tolerant to iron toxicity diffusion of oxygen and thereby creates an

oxidizing environment that detoxifies excess iron whereas the variety IET 1444 is susceptible for iron toxicity (IRRI worker, 1976). As root-zone soil oxidation would not be to that extent as in ASD 18, organic-N in the root-zone of IET 1444 was subjected to slow but steady mineralization with minimum nitrogen loss resulting in less uptake of nitrogen in IET 1444.

Table 2. **Nitrogen uptake of ASD 18 and IET 1444 varieties under acid and alkali soils.**

		ASD 18			IET 1444		
Soils	Population levels	N content in plant (%)	N content in grain (%)	N uptake (kg / ha)	N content in plant (%)	N content in grain (%)	N uptake (kg / ha)
S_1	P_1	0.47	0.87	66.12	0.46	0.77	58.35
	P_2	0.40	0.66	61.15	0.44	0.39	11.35
S_2	P_1	0.34	0.58	32.86	0.33	0.42	36.08
	P_2	0.34	0.27	34.13	0.34	0.14	30.41

S_1 - Acid soil; S_2 - Alkali soil; P_1 - 66 hills m^{-2}; P_2 - 115 hills m^{-2}.

Phosphorus uptake: The phosphorus uptake was high in the variety ASD 18 grown under acid soil condition. The higher population level resulted in maximum mobilization of phosphorus when compared to the lower population level. It has been reported by Ravichandran (1991) that the phosphorus mobilizing factors in the root-zone could be attributed to metabolic activity of roots resulting in organic acids exudation, colonization of organic acids produced by microorganisms and higher concentration of CO_2 all of these increased with population level (Table 3).

Table 3. **Phosphorus uptake of ASD 18 and IET 1444 varieties under acid and alkali soils.**

		ASD 18			IET 1444		
Soils	Population levels	N content in plant (%)	N content in grain (%)	N uptake (kg / ha)	N content in plant (%)	N content in grain (%)	N uptake (kg / ha)
S_1	P_1	1.81	0.18	173.72	1.83	0.12	161.23
	P_2	1.81	0.27	210.11	1.71	0.24	188.23
S_2	P_1	1.45	0.28	102.50	1.72	0.26	143.88
	P_2	1.74	0.29	152.89	1.58	0.24	131.57

S_1 - Acid soil; S_2 - Alkali soil; P_1 - 66 hills m^{-2}; P_2 - 115 hills m^{-2}.

Potassium uptake: Available potassium was maximum in the root-zone of rice grown in alkali soils (307.9 kg ha^{-1}) when compared to acid soil (118.6 kg ha^{-1}). As this trend was not reflected in potassium uptake, factors like adverse Ca/K ratio, Fe/K ratio etc., might have reduced the K-uptake. Alkali soil used in this study had an exchangeable Ca : K ratio of 73, whereas in the case of acid soil it was only 14. The potassium uptake increased with

Table 4. **Potassium uptake of ASD 18 and IET 1444 varieties under acid and alkali soils.**

Soils	Population levels	ASD 18			IET 1444		
		N content in plant (%)	N content in grain (%)	N uptake (kg / ha)	N content in plant (%)	N content in grain (%)	N uptake (kg / ha)
S_1	P_1	1.81	0.18	173.72	1.83	0.12	161.23
	P_2	1.81	0.27	210.11	1.71	0.24	188.23
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population level due to mobilization of potassium in the root-zone. (Table 4). It might be due to intense microbial activity, organic acid secretion by root, dissolution effect of organic acids etc. (Raghu and MacRae, 1996; Stevenson, 1967 and Nagarajan *et al*., 1970).

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Forthcoming Conferences/Symposia/ Workshops

1. International Conference on "Environmentally friendly spray application techniques" in Warsaw, Poland to be held on 4 - 6 October, 2004. Contact : Dr. G. Duruchowski; E-mail: gdoru@insad.pl.

2. 20th Annual International Conference on "Soils, sediments and water" in Anherst, Massachusetts, United States to be held on 18 October, 2004. Contact : Dr. Denise Leonards; E-mail; info@umasssoils.com.

3. Third IUCN World Conservation Congress on "Conservation strategies of endagered species" in Bangkok, Thailand to be held on 17 November, 2004. Contact: Dr. Ursula Hiltbrunner; E-mail: Ursulahiltbrunner@iucn.org.

4. National Workshop on "Pragmatic management of industrial pollution" in Rourkela to be held on 20-21 November, 2004. Contact : Dr. R. K. Patel, Convener - cum - Organising Secretary, Department of Chemistry, National Institute of Technology, Rourkela - 769 008 (Orissa).

5. 11th National Symposium on "Hydrology with focal theme on water quality" in Roorkee to be held on 22-23 November, 2004. Contact: Dr. C. K. Jain, Convener, National Institute of Hydrology, Roorkee - 247 667 (Uttranchal).

6. National Seminar on "Zoology and Human Welfare" in Allahabad to be held on 22-24 November, 2004. Contact: Dr. Ashok Verma, Organising Secretary, Department of Zoology, Dr. Shyama Prasad Mukherjee Govt. Degree College, Phaphamau, Allahabad - 211 013 (U. P.).

7. 4th International Symposium on "Environmental hydraulics" in Hong Kong, China to be held on 15 November, 2004. Contact: Dr. K. M. Lam, E-mail: iseh4@hkcc.nku.hk.

8. The first International Conference on "Environmental science and technology" in New Orleans, Louisiana, U. S. A. to be held on 23-26 January, 2005. Contact: Dr. William G. Lyon, E-mail: Conference@AASci.org.

9. 7th AZRA Conference on "Recent trends in applied zoological researches towards food and nutritional security and their impact on environment: Challenges ahead" in OUAT, Bhubaneswar to be held on 14-16 February, 2005. Contact: Dr. Anand Prakash, Principal Scientist & Head, Division of Entomology, Central Rice Research Institute, Cuttack - 753 006, Orissa.

10. 2nd Biotech Congress on "Innovations in biotechnology and their applications" in Nagpur University to be held on 18-20 December, 2006. Contact: Professor S. U. Meshram, Chairman/ Head, Rajiv Gandhi Vikas Biotechnology Centre, Nagpur University, Nagpur - 440 033 (M.S.).