The Ecoscan 10(1&2): 265-267, 2016 (Supplement on Rice)
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.com

STUDY ON THE NUTRIENT USE EFFICIENCY OF DRAUGHT TOLERANT RICE GENOTYPES AT THEIR DIFFERENT FERTILITY LEVELS UNDER RAINFED CONDITION

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ABSTRACT

An ongoing field experiment was conducted to study the effect of different fertility levels on N, P, K use efficiency by drought tolerant rice genotypes under rainfed condition at IGKV, Raipur. The Soil of experimental field's soil exhibited neutral reaction (pH 7.34), EC 0.26 (dSm^{-1}), medium status of organic C (0.58%), low in available N (273 kg ha^{-1}), medium in P (14.78 kg ha^{-1}), high in K status (616 kg ha^{-1}). Overall average nutrients use efficiencies for N P and K were recorded as 35.69, 18.41 and 112.75 per cent, respectively. Rice genotype R-RF-65 registered the nutrients use efficiencies for N P and K ranged as 43.55-35.65, 23.65-20.15 and 165.60-92.50, respectively. Nutrient use efficiencies were observed higher at low fertility level and vice versa. Potassium use efficiency showed very high values which was due to less crop response to the applied K fertilizer. Most of the genotypes tested for their nutrient use efficiencies performed better than local check. The crop season was favorable and no water stress occurred during entire period which favored the genotypes to perform their potential level.

KEY WORDS
Nutrient use efficiency
Nitrogen
Phosphorus
Potassium
Rice genotypes

Received : 09.01.2016
Revised : 13.03.2016
Accepted : 22.05.2016

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INTRODUCTION

Rice is most important food crop and a major food grain for more than a third of the world's population (Zhao *et al.,* 2011). In India also rice is the major crop in terms of area, production and consumption. Rice is growing in diversified environments even with low inputs. It occupies the enviable prime place among the food crops cultivated around the world and is grown in 147 MH with a production of 525 MT. About 90 per cent of rice grown in the world is produced and consumed in Asian countries. India has the largest area among rice growing countries and enjoys the second rank in production. India produces 73.8 m. tones of rice from an area of 43.0 m. ha with the productivity of 2915 kg ha^{-1} (Anonymous, 2006). Nitrogen is the most essential element in determining the yield potential of intensified agricultural system. Additional doses of nitrogen are usually applied to increase grain yield (De Datta and Buresh, 1989). The amount of nitrogen uptake and nitrogen use efficiency (NUE) of crop depends on the yield level and environmental conditions (Yoshida, 1983). Rice genotypes were reported to differ significantly in relation to nitrogen uptake, grain yield, nitrogen translocation efficiency and NUE (Borah and Deka, 1994). Rice genotypes were distinguished (Gourley *et al.,* 1993) as efficient, in efficient, and inferior types based on grain yield response in relation to nitrogen response Pinto *et al.* (2001). Zhang *et al.* (2009) studied on effects of N fertilizer application rates on grain yield and physiological N use efficiency (PE) in relation to the accumulation and redistribution of biomass and N in rice (*Oryza sativa* L.) Tayefe *et al.* (2011) evaluated the effects of nitrogen fertilizer on nitrogen use efficiency, yield and characteristics of nitrogen uptake in paddy that differences in the effects of applying nitrogen fertilizer on nitrogen use efficiency and characteristics of nitrogen uptake. Fageria *et al.* (2011) conducted a field experiment for P use efficiency and maximum grain yield was obtained with the application of 54 kg P ha^{-1}. Genotype BRS Jacana was most efficient and genotype CNAi 8569 was most inefficient in P use efficiency. Agronomic efficiency (kg grain produced per kg P applied) was significantly decreased with increasing P rates in the range of 22 to 88 kg P ha^{-1}. Arif *et al.* (2010) conducted a pot culture experiment to study the response of rice genotypes to various levels of K and results are implied that K-use efficient genotypes used the tissue K more efficiently. Rahman *et al.* (2009) worked with broad bean-rice and nitrogen accumulation at maturity always increased and FNUE decreased in spite of increased grain yield of rice. Jabbar *et al.* (2009) reported the results of a field experiment conducted in the 2005 Irrigated conditions resulted in 52% higher grain yield and 51% higher TNU compared with rainfed conditions. The average yield gain due to N application was 540 kg ha^{-1} under irrigated conditions and 484 kg ha^{-1} under rainfed conditions. There fore the present paper aims to present the nutrient use efficiency of draught tolerant rice genotypes at their different fertility levels under rainfed condition.

MATERIALS AND METHODS

The experiment was carried out during *Kharif* season, 2012 at the Instructional Farm, Indira Gandhi Krishi Vishwavidhyalaya, Raipur (CG). In order to investigate the effect of nitrogen, phosphorus and potassium fertilizer on growth and yield in rice cultivar, The experiment was laid out in split plot design having three fertility levels as main plots and twelve rice genotypes as sub plot and replicated rice (Table 1). The fertility levels were taken as no fertility level (00:00:00 kg ha^{-1} N:P:K), medium fertility level (45:30:20 kgha^{-1}N:P:K) and high fertility level (90:60:40 kg ha^{-1} N:P:K) and treatments under sub plots as rice genotypes . Twelve rice genotypes having drought tolerance character were selected and taken as treatments as per the details given below (Table 1):

Plant chemical analysis

Grain and straw samples were taken at harvest and allowed to sun dry for a week, then grinded and used for chemical analysis for different parameters as under, Then the nitrogen in digested material was distilled by automatic KEL plus system (Amma, 1989). Phosphorus content was determined by vanadomolybdo - phosphoric acid yellow color complex method as described by Jackson (1973), Potassium content was determined by flame photometer as described by Chapman and Pratt (1961). analyzed for Micronutrient (Fe, Mn Cu and Zn) content by atomic absorption spectroscopy (Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

The data presented in Table 3 show that nitrogen use efficiencies of different rice genotype ranged from 31.83 to 39.60 per cent with overall average value of 35.69 per cent. The highest NUE was recorded by R-RF-65 (V5) that yielded maximum grain produce. Medium fertility level exhibited higher efficiency than that of higher fertility level. Similar results on nitrogen use efficiency as influence by N, P and K levels were also reported by Zhang *et al.* (2009) and Swain *et al.* (2006).

Table 4 showed the average phosphorus use efficiency ranged from 14.59 to 21.90 per cent with overall mean value of 18.41 per cent. Similar to NUE, R-RF-65 genotype has recorded maximum PUE and lowest by IBD-I-85. The doses of P application affected P use efficiency. It was higher in case of medium fertility level than that of high fertility level. Similar results on nitrogen use efficiency as influence by N, P and K levels were also reported by Fageria *et al.*,2011 and Zhang *et al.* (2009).

Table 5 showed the average potassium use efficiency in relation to rice genotypes and two fertility levels. Potassium use efficiency ranged from 79.35 to 138.48 per cent with overall mean value of 113 per cent. The highest potassium

Table 1: Treatment details

Main plot: Fertilizer treatment (three)	
F_0	Low (00:00:00 NPK kgha^{-1})
F_1	Medium (45:30:20 NPK kgha^{-1})
F_2	High (90:60:40 NPK kgha^{-1})
Sub plot: Rice genotype (Twelve)	
V-1	IR-83388-B-B-108-3
V-2	IR-83388-B-B-129-3
V-3	IR-82589-B-B-84-3
V-4	IR-83383-B-B-129-4
V- 5	R-RF-65
V-6	IR-83377-B-B-93-3
V-7	R-RF-69
V-8	IR-83383-B-B-141-2
V-9	IBD-I (Local entry)
V-10	R-RF-85 (Local entry)
V-11	IR-64
V-12	MTU-1010

Table 2: Physico-chemical properties of experimental soil

Properties	Rating/value
pH (1:2.5)	7.34
EC (dSm^{-1})	0.26
CEC (c mol (p$^+$) kg^{-1})	38.21
Organic C (g kg^{-1})	0.58
Available N (kg ha^{-1})	273
Available P (kg ha^{-1})	14.78
Available K (kg ha^{-1})	616
Available Zn (ppm)	2.70
Available Fe (ppm)	5.97
Available Mn (ppm)	6.38
Available Cu (ppm)	1.37
Mechanical analysis	
Sand (%)	20
Silt (%)	36
Clay (%)	44
Textural class	Clay

Table 3: Nitrogen use efficiencies of different rice genotypes in relation to fertility levels

S.No.	Rice genotype	Symbol	Fertility levels		Mean
			Medium	High	
1.	IR-83388-B-B-108-3	V1	0.4208	0.3223	0.3715
2.	IR-83388-B-B-129-3	V2	0.4028	0.3313	0.3670
3.	IR-82589-B-B-84-3	V3	0.3953	0.3658	0.3805
4.	IR-83383-B-B-129-4	V4	0.4068	0.3448	0.3758
5.	R-RF-65	V5	0.4355	0.3565	0.3960
6.	IR-83377-B-B-93-3	V6	0.3840	0.3325	0.3583
7.	R-RF-69	V7	0.3778	0.3383	0.3580
8.	IR-83383-B-141-2	V8	0.4023	0.3200	0.3611
9.	IBD-I-85 (Local entry)	V9	0.3653	0.2713	0.3183
10.	R-RF-85 (Local entry)	V10	0.3778	0.2668	0.3223
11.	IR-64	V11	0.3913	0.2913	0.3413
12	MTU-1010	V12	0.3680	0.2980	0.3330
	F-MEAN	0.3939	0.3199	0.3569	

Table 4: Phosphorus use efficiency as influenced by rice genotypes and fertility levels

S.No.	Rice genotype	Symbol	Fertility levels Medium	High	Mean
1.	IR-83388-B-B-108-3	V1	0.2398	0.1570	0.1984
2.	IR-83388-B-B-129-3	V2	0.1990	0.1685	0.1838
3.	IR-82589-B-B-84-3	V3	0.2213	0.1705	0.1959
4.	IR-83383-B-B-129-4	V4	0.2008	0.1568	0.1788
5.	R-RF-65	V5	0.2365	0.2015	0.2190
6.	IR-83377-B-B-93-3	V6	0.2095	0.1738	0.1916
7.	R-RF-69	V7	0.1863	0.1620	0.1741
8.	IR-83383-B-141-2	V8	0.1973	0.1655	0.1814
9.	IBD-I-85	V9	0.1623	0.1295	0.1459
10.	R-RF-85	V10	0.1860	0.1168	0.1514
11.	IR-64	V11	0.2270	0.1853	0.2061
12	MTU-1010	V12	0.1943	0.1725	0.1834
	F-MEAN		0.2050	0.1633	0.1841

Table 5: Potassium use efficiency as influenced by rice genotypes and fertility levels

S.No.	Rice genotype	Symbol	Fertility levels Medium	High	Mean
1.	IR-83388-B-B-108-3	V1	1.8048	0.9648	1.3848
2.	IR-83388-B-B-129-3	V2	1.8838	0.8040	1.3439
3.	IR-8258a9-B-B-84-3	V3	1.3803	0.8658	1.1230
4.	IR-83383-B-B-129-4	V4	1.1528	0.5835	0.8681
5.	R-RF-65	V5	1.6560	0.9250	1.2905
6.	IR-83377-B-B-93-3	V6	2.5948	1.1593	1.8770
7.	R-RF-69	V7	1.1355	0.6360	0.8858
8.	IR-83383-B-141-2	V8	1.5208	0.6923	1.1065
9.	IBD-I-85	V9	1.0735	0.6863	0.8799
10.	R-RF-85	V10	1.2350	0.9198	1.0774
11.	IR-64	V11	1.0648	0.7355	0.9001
12	MTU-1010	V12	1.0763	0.5108	0.7935
	F-MEAN		1.4648	0.7902	1.1275

use efficiency was found with IR-83377-B-B-93-3 and lowest with MTU-1010 (local check). Low dose of potassium application recorded higher KUE than that of higher dose under high fertility level. Potassium use efficiencies were accounted overestimated even more than 100 per cent which shows higher K uptake than the application dose as the available K status of the experimental field soil was very high due to which crop response to the applied K was meager. Under such condition, K use efficiency estimation becomes indefinable. Similar results on nitrogen use efficiency as influence by N, P and K levels were also reported by Fageria *et al.,* 2010 and Zhang *et al.* (2009) .

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