



Effect of different source and rate of fertilizer application through drip irrigation on yield, nutrient uptake and nutrient use efficiency by aerobic rice

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(Received: August 19, 2015; Revised received: April 11, 2016; Accepted: April 13, 2016)

Abstract: Fertigation allows precise timing and uniform distribution of applied nutrients to meet the crop nutrient demand with ensures substantial saving in fertilizer usage. In this study the effect of different source and rate of fertilizer application through drip irrigation system were evaluated on growth, yield and nutrient uptake by aerobic rice grown on sandy loamy soil, during Kharif 2013 at Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, the experiment was laid out in a Randomized Complete Block Design (RCBD) comprising of 3 replications and 10 treatments. Application of 100 per cent RDF through drip fertigation with water soluble fertilizer recorded grain and straw yield of 6503 and 9285 kg ha⁻¹, respectively and higher nutrient uptake (141.20, 19.47 and 97.17 kg N, P and K, respectively) but application of 50 per cent RDF through drip fertigation with water soluble fertilizer recorded significantly higher N, P and K use efficiency (97.20, 194.40 and 194.40 kg kg⁻¹, of NPK respectively).

Keywords: Aerobic rice, Fertigation, Nutrient uptake, Nutrient use efficiency

Introduction

Rice (*Oryzasativa L.*) is the most important staple food crop in Asia and human consumption accounts for 85per cent of total production of rice and it deserves a special status among cereals as world's most important crop. The traditional method of rice cultivation consumes around 5000 liters of water to produce one kg of grain, which is three times higher than other cereals. Traditional rice production system not only leads to wastage of water but also causes environmental problems and reduces fertilizer use efficiency. Attempts to increase water productivity either by reducing water consumption or by increasing the yields will automatically facilitate higher growth in agricultural production. Keeping these in points International Rice Research Institute developed the-aerobic rice technology to address the water crisis in tropical agriculture. In aerobic rice system, wherein the crop is established in non-puddled, non-flooded fields and rice is grown like an upland crop (unsaturated condition) with adequate inputs and supplementary irrigation when rainfall is insufficient. The water productivity of rice under aerobic conditions was 32–88 per cent higher than under flooded conditions (Bouman *et al.*, 2005).

Drip fertigation proved to efficiently provide irrigation water and nutrients to the roots of plants, while maintaining high yield production. Modern drip irrigation has arguably become the world's most valued innovation in agriculture since the invention of the impact sprinkler, which replaced flood irrigation. This is because high water application efficiencies are often possible with drip irrigation, since there is reduced surface evaporation, less surface runoff, as well as minimal deep percolation. Moreover, a drip fertigation,

through which crop nutrient requirements can be met accurately (Or and Coelho, 1996). Because of the way the water is applied in a drip system, traditional surface applications of timed-release fertilizer are sometimes ineffective, so drip systems often mix liquid fertilizer with the irrigation water. Fertilizers should be applied in a form that becomes available in synchrony with crop demand for maximum utilization of nutrients from fertilizers (Boyhan *et al.*, 2001). However, proper fertigation management also requires the knowledge of soil fertility status and nutrient uptake by the crop. Monitoring soil and plant nutrient status is an essential safeguard to ensure maximum crop productivity. Soil properties, crop characteristics and growing conditions affect the nutrient uptake (Mmolawa and Or, 2000). Few studies reported the effect of drip fertigation on crop yields and nutrient uptake patterns. Hence, it is relate to explore the impact of drip fertigation on soil fertility stats and nutrient uptake by aerobic rice to optimize fertilizer use. With this background, the present study was conducted to examine the effect different source and rate of fertilizer application involving the source on yield and nutrient uptake by aerobic rice in a sandy loamy soil.

Keeping these points in view, the present study on "Studies on fertilizer management through drip fertigation in aerobic rice" was under taken with the objectives - 1) To know the effect of combination of different sources and levels of fertilizer through drip fertigation on growth and yield of aerobic rice and 2) To assess the nutrient uptake and water use efficiency in aerobic rice.

Material and Methods

The field experiment was conducted from July 2013 to December 2014 Zonal Agricultural Research Station, University of

Agricultural Sciences, GKVK, Bengaluru. The experimental site is situated at between 12° 51' N latitude and 77° 35' E longitude at an altitude of 930 m above mean sea level (MSL). Soil type of the experimental field is red sandy clay loam. MAS 946-1 variety of aerobic rice maturing in about 145 days (Anon., 2007) was planted at a spacing of 25 cm x 25 cm in rows accommodating 1.60.000 plants per hectare.

The experiment was laid out in randomized complete block design with ten treatments with three replications. The treatments consisted of combinations of different dose and type of fertilizers viz., T₁: Surface irrigation with soil application of RDF, T₂: 50 % RDF (50 % basal with NF +50 % top dress through DF with NF), T₃:75 % RDF (50 % basal with NF + 50 % top dress through DF with NF), T₄:100 % RDF (50 % basal with NF +50 % top dress through DF with NF), T₅: 50 % RDF (50 % basal with NF + 50 % top dress through DF with WSF), T₆: 75 % RDF (50 % basal with NF + 50 % top dress through DF with WSF), T₇:100 % RDF (50 % basal with NF + 50 % top dress through DF with WSF), T₈:50 % RDF through drip fertigation with WSF, T₉:75 % RDF through drip fertigation with WSF and T₁₀: 100 % RDF through drip fertigation with WSF.

The sowing was taken up on July 28th, 2013 by maintaining the intra and inter row spacing of 25 cm with seed rate of 5 kg ha⁻¹. Immediately after sowing the seeds are covered with soil with the help of plank (UAS, Aerobic Rice brochure, 2007). The normal fertilizers used were Urea, Di ammonium phosphate (DAP) and muriate of potash (MOP) as N, P and K sources, respectively and the water soluble fertilizers are 19:19:19 and calcium ammonium nitrate. The experimental data recorded were subjected to analysis by using Fisher's method of Analysis of Variance (ANOVA) given by Rangaswamy (2010). The levels of significance used in *F* and *t* test was a *p* = 0.05.

Results and Discussion

Nutrient uptake: Total uptake of NPK by aerobic rice was significantly affected by both fertilizer source and rates of fertilizer application (Table-1). Drip fertigation recorded greater NPK uptake over furrow irrigation in control treatment. This result is normal and reflects that less soil nutrients and in turn recovery is taken up under furrow irrigation in sandy loamy soil. Further, frequent supply of nutrients with irrigation water in fertigation treatments significantly increased NPK. The applied NPK in soluble form in fertigation treatments may have been distributed better through root zone of aerobic rice than soil applied treatments, and producing more available amounts for plant uptake. Uptake of NPK was highest under application of 100 per cent RDF through drip fertigation with water soluble fertilizer (141.20, 19.47 and 97.17 kg N, P and K, respectively). This may be due to the application of higher rate of nutrients. Further, it was followed by 100 and 75 per cent RDF in which 50 per cent applied as basal with normal fertilizer and 50 per cent top dress through drip fertigation with water soluble fertilizer (131.00, 17.90, 89.66 and 126.50, 17.00, 86.20 kg N, P and K, respectively) and 75 per cent of RDF through drip fertigation with water soluble fertilizer (131.00, 17.50 and 91.20 kg N, P and K, respectively). This is mainly due to higher dry matter production and yield. This increase in uptake per plant was due to better availability of nutrients and water in root zone as a result of frequent fertigation schedule which in turn promoted better root activity as indicated by increased root volume. Further it was also due to higher or increased availability of nutrients from usage of water soluble fertilizer besides reduction in loss of nutrients due to reduced leaching of nutrients in drip fertigation as compared to soil application of fertilizer with surface irrigation. These results are in conformity

Table-1: NPK uptake (kg ha⁻¹), Nutrient use efficiency (kg kg⁻¹), Grain and straw yield in aerobic rice as influenced by drip fertigation

Treatments	Uptake (kg ha ⁻¹)			Nutrient use efficiency (kg kg ⁻¹)			Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index
	N	P	K	N	P	K			
T ₁	83.40	13.00	61.20	33.75	67.49	67.49	3375	6296	0.35
T ₂	89.33	13.50	69.90	33.92	67.83	67.83	3392	6628	0.34
T ₃	97.87	14.10	74.60	38.95	77.89	77.89	3895	7285	0.35
T ₄	105.73	15.90	81.27	43.00	86.00	86.00	4300	7961	0.35
T ₅	101.67	15.00	75.83	41.07	82.13	82.13	4107	7090	0.37
T ₆	126.50	17.00	86.20	56.00	112.00	112.00	5600	8462	0.40
T ₇	131.00	17.90	89.66	61.44	122.88	122.88	6144	8659	0.42
T ₈	117.83	16.50	83.54	48.60	97.20	97.20	4860	7717	0.39
T ₉	131.00	17.50	91.20	56.64	113.28	113.28	5664	8664	0.40
T ₁₀	141.20	19.47	97.17	65.03	130.05	130.05	6503	9285	0.41
S.Em ±	4.95	0.60	3.33	3.19	6.37	6.37	318.75	409.23	0.03
CD @ 5%	14.72	1.78	9.90	9.47	18.94	18.94	947.04	1215.87	NS
CV (%)	7.51	6.50	7.12	11.54	11.54	11.54	11.54	9.08	15.03

Note: NF: Normal fertilizer; WSF: Water soluble fertilizer; DF: Drip fertigation; RDF: Recommended dose of fertilizer (100:50:50 kg NPK ha⁻¹)
Treatments are: T₁:Surface irrigation with soil application of RDF; T₂: 50% RDF (50% basal with NF+50%top dress through DF with NF); T₃:75% RDF (50% basal with NF+50%top dress through DF with NF); T₄:100% RDF (50% basal with NF +50%top dress through DF with NF); T₅:50% RDF (50% basal with NF+50%top dress through DF with WSF); T₆:75% RDF (50% basal with NF+50%top dress through DF with WSF); T₇:100% RDF(50% basal with NF+50%top dress through DF with WSF); T₈:50 % RDF through drip fertigation with WSF; T₉:75 % RDF through drip fertigation with WSF; T₁₀:100% RDF through drip fertigation with WSF

with the findings of Hebbaret *al.* (2004), Sundrapandiyan(2012), Richakanna (2013) and Gururaj (2013).

Nutrient use efficiency: Drip fertigation treatments in general registered higher nutrient use efficiency as compared to surface irrigation with direct soil application of nutrients (Table-1). Among the different drip fertigation treatments, 50 per cent RDF through drip fertigation with water soluble fertilizer recorded significantly higher N, P and K use efficiency (97.20, 194.40 and 194.40 kg kg⁻¹, of NPK respectively) as compared to other treatments. The results from the current study revealed that water soluble fertilizers showed higher nutrients use efficiency as compared to normal fertilizers with drip fertigation. This is attributed to better availability of moisture and nutrients throughout the crop growth stages in drip fertigation system leading to better uptake of nutrients, production of higher dry matter and in turn economic yield. These findings are in conformity with the findings of Gururaj (2013), Vijaykumar (2009) and Soman (2012).

Yield: Significantly higher grain and straw yield was recorded in 100 per cent RDF through drip fertigation with water soluble fertilizer (6503kg ha⁻¹respectively) than the other treatments (Table-3). Higher grain yield may be due to its superiority in producing higher productive tillers hill⁻¹, panicle length, thousand seed weight and total number of filled grains panicle⁻¹ with lower per cent chaffyness than the other treatment. This was mainly attributed that higher number of productive tillers were due to continuous availability of water and nutrients that resulted in higher uptake of nutrients in turn production of higher dry matter under drip fertigation. These findings are in conformity with the findings of Vijaykumar (2009); Soman (2012) in rice PriteeAswathy *et al.*, (2014) in maize. There was no significance difference in harvest index among the treatments. Whereas 100 per cent RDF in which 50 per cent applied as basal

with normal fertilizer and 50 per cent top dress through drip fertigation with water soluble fertilizer recorded the highest harvest index (0.42).

Aknowledgements

The first author is thankful to RKVY project o Enhancing water productivity in command areas of Karnataka for financial support.

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