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EFFECT OF SUB SURFACE DRIP FERTIGATION ON WATER PRODUCTIVITY, NITROGEN USE EFFICIENCY AND ECONOMICS OF AEROBIC RICE

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Abstract

A field experiment was carried out for two consecutive years (2012-13 and 2013-14) on a sandy loam soil of Jain Hi-Tech Agri Institute, Jalgaon, Maharashtra, India with an objective to study the response of aerobic rice to sub surface drip ferigation. In aerobic rice, water productivity and nitrogen use efficiency (NUE) enhanced with the increase in water input from 100% Epan to 175% Epan through drip irrigation during both the years of study and net return, gross returns and return per rupee investment were significantly the highest with irrigation schedule at 175% Epan compared to that of 100% Epan, water productivity and nitrogen use efficiency decreased with increasing N fertigation levels at same irrigation schedule. Net return, gross returns and return per rupee investment were significantly increased with the increase in N level from 90 to 180 kg N ha^{-1} and maximum values were registered with 180 kg N ha^{-1}.

Key words : Aerobic rice, sub surface drip irrigation, N Fertigation.

Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop in Asia. Asia's food security depends largely on the irrigated rice fields, which produces three quarters of all rice harvested. But, rice is a profligate user of water, consuming half of all fresh water resources. The increasing scarcity of water threatens the sustainability of the irrigated rice production system and hence the food security and livelihood of rice producers and consumers. Therefore, a more efficient use of water is needed in rice production. But as every drop of water received at the farmer's field by way of rainfall, surface irrigation or pumped from aquifers, is valuable and needs to be used effectively. There is a need to produce more rice with less water, which is crucial for food security. Recently, rice grown as upland crop like wheat and maize where soil is well drained, non puddled and non saturated soils known as aerobic rice is gaining importance as it provides effective use of rain that falls on the farmer's field. As there is no standing water and the farmer can skip irrigation if soil moisture status is sufficient for crop, aerobic rice cultivation will also curb methane production and saves water without affecting the productivity.

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Materials and Methods

A field experiment was carried out for two consecutive years (2012 and 2013) at Jain Hi-Tech Agri Institute, Jalgaon, Maharashtra, India. The experimental soil was sandy loam soils which had pH of 7.3 and soil was low in organic carbon (0.37%), available nitrogen (184.4 kg ha^{-1}), available phosphorus (11 kg ha^{-1}) and available potassium (257.3 kg ha^{-1}) experiment was laid out in split-plot design with four replications. Four irrigation schedules were taken as main plots and four nitrogen levels in sub plots in drip system for both rice and maize crops. Irrigation schedules for rice included I_1: Sub surface drip irrigation (SDI) at 100% pan evaporation (Epan), I_2: SDI at 125% Epan, I_3: SDI at 150% Epan and I_4: at 175% Epan with four nitrogen levels *viz*., N_1: 90; N_2: 120; N_3:150; and N_4:175 kg ha^{-1} through fertigation. Outside the layout of the main experiment, two checks and one check were tested in rice and maize crops, respectively. The checks for rice crop included, Check 1: Aerobic rice non-irrigated with 120 kg N ha^{-1}, Check 2: Aerobic rice with supplemental irrigation at IW/CPE ratio of 1.5 with 120 kg N ha^{-1}. The cultivars used for the study were '25P25' (Pioneer Hybrid). N was supplied as per the treatment through fertigation commencing from 10 days after sowing up to 80 days after sowing using water soluble specialty fertilizers (urea phosphate and urea) through the ventury fitted to the drip system at weekly interval. P_2O_5 was supplied @ 60 kg ha^{-1} as Mono ammonium phospahte during first fertigation uniformly to all the treatments. For checks, it was applied as Single super phosphate as basal dose. Uniform dose of K_2O @ 50 kg ha^{-1} was applied for all the treatments including checks as basal through MOP.

Results and Discussion

Water productivity (g grain kg^{-1} of water) with respect to irrigation plus effective rainfall was influenced by irrigation schedules under drip irrigation. The highest water productivity was obtained in the irrigation schedule of 100% Epan. It was found to be reduced with increased water input from 100% Epan schedule to 175% Epan during both the years of study. Water productivity was the lowest in supplemental irrigated aerobic check during both the years.. Similar findings had been brought out by many workers (Balamani *et al*., 2012 and Sridharan and Vijayalakshmi, 2012). It could be attributed due to more precise dosage and timing of irrigation water applied in relation to crop transpiration and soil water holding capacity in drip irrigation (Doorenbos and Pruit, 1984). Increase in N levels from 90 to 150 kg N ha^{-1} through fertigation resulted in higher water productivity which might be attributed to increased yield under higher nitrogen levels with a constant rate of applied water. This was in agreement with Mallareddy *et al*. (2013).

Nitrogen use efficiency (NUE) (kg grain kg^{-1} N applied) of aerobic rice enhanced with the increase in water input from 100% Epan to 175% Epan through drip irrigation during both the years of study (table 1). However, NUE was the highest in low irrigation schedule with high nitrogen level and the lowest in non-irrigated check. Improved N use efficiency in aerobic rice with increased water input was also reported by Mahajan *et al*. (2012). With the increase in the level of nitrogen, NUE gradually decreased in aerobic rice. The highest NUE was recorded with 90 kg ha^{-1}. The NUE was higher with sufficient amount water and with higher level of nitrogen. This was in accordance to the statement that crop response to applied nutrients typically follows a diminishing return function as yields approach the potential limit (Hegde *et al*., 2007). These results corroborate with Shekara *et al*. (2010).

Gross return, net return and return per rupee of investment were higher in drip irrigation schedule of 175%

Table 1 : Water productivity (kg ha^{-1}mm^{-1}) and nitrogen use efficiency (kg grain kg^{-1} N applied) in aerobic rice as influenced by irrigation schedule and nitrogen level through fertigation.

Treatment	2012-13		2013-14	
	Water productivity (kg ha^{-1}mm^{-1})	Nitrogen use efficiency (kg grain kg^{-1}N applied)	Water productivity (kg ha^{-1}mm^{-1})	Nitrogen use efficiency (kg grain kg^{-1}N applied)
I_1N_1	0.73	46.9	0.69	44.2
I_1N_2	0.81	45.6	0.72	39.6
I_1N_3	0.76	39.3	0.66	32.9
I_1N_4	0.75	34.8	0.60	28.0
I_2N_1	0.89	56.7	0.85	54.4
I_2N_2	0.82	46.1	0.87	48.0
I_2N_3	0.80	41.1	0.79	39.7
I_2N_4	0.81	37.3	0.82	38.7
I_3N_1	0.96	61.6	0.93	59.7
I_3N_2	0.90	50.4	0.91	50.0
I_3N_3	0.84	43.3	0.90	45.2
I_3N_4	0.83	38.2	0.87	40.9
I_4N_1	1.04	66.7	1.14	72.7
I_4N_2	1.00	56.1	1.07	59.0
I_4N_3	0.90	46.3	1.00	50.3
I_4N_4	0.89	41.2	0.91	42.7
Check 1	1.20	20.4	0.77	21.6
Check 2	0.60	43.4	0.66	39.8

Check 1: Aerobic rice non irrigated with 120 kg N ha^{-1}

Check 2: Aerobic rice with supplemental irrigation at IW/CPE ratio of 1.5 with 120 kg N ha^{-1}.

Table 2 : Economics of aerobic rice as influenced by irrigation schedule and N level through sub surface drip fertigation.

Treatment		2012			2013	
	Gross return (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Returns perrupee investment	Gross return (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	Returns perrupee investment
I_1N_1	59633	34442	1.4	55835	30643	1.2
I_1N_2	76694	51124	2.0	66534	40964	1.6
I_1N_3	82526	56578	2.3	69055	43108	1.7
I_1N_4	87607	61282	2.4	70501	44175	1.7
I_2N_1	71553	46312	1.8	68661	43420	1.7
I_2N_2	77449	51829	2.0	80782	55162	2.2
I_2N_3	86409	60411	2.3	83493	57495	2.2
I_2N_4	93868	67492	2.6	97437	71062	2.7
I_3N_1	77591	52299	2.1	75289	49998	2.0
I_3N_2	84597	58927	2.3	84120	58450	2.3
I_3N_3	90669	64621	2.5	94990	68,942	2.7
I_3N_4	96152	69726	2.6	102932	76507	2.9
I_4N_1	84029	58687	2.3	91603	66261	2.6
I_4N_2	94118	68398	2.7	98962	73243	2.9
I_4N_3	96954	70856	2.7	105480	79382	3.0
I_4N_4	103551	77075	2.9	107385	80910	3.1
Check 1	34540	18474	1.2	36460	20393	1.3
Check 2	73106	53740	2.8	66924	46858	2.3

Check 1: Aerobic rice non irrigated with 120 kg N ha^{-1}
Check 2: Aerobic rice with supplemental irrigation at IW/CPE ratio of 1.5 with 120 kg N ha^{-1}

Epan and 150 kg N ha^{-1} closely followed by that realized at 120 kg N ha^{-1} in the same irrigation schedule (table 2). The above economic parameters were lower with 100% Epan irrigation schedule and 90 kg N ha^{-1}. In general, the net return and return per rupee of investment were lower during 2012 despite of increased yield. It was due to the lower minimum support price for the rice grain prevailed in 2013 compared to the same during 2012. Higher moisture regime was reported to realize greater net returns and return per rupee invested in several studies (Pasha, 2010; Shekara *et al*., 2010 and Murthy and Reddy, 2013).

Net return and return per rupee of investment were negative in rainfed rice during both the years due to extremely lower yields. All the economic parameters were higher in flooded check among all the treatments. The above parameters obtained with supplemental irrigation at IW/CPE ratio 1.5 and 120 kg N ha^{-1} were higher than those with all the treatment combinations except the combination of 175% Epan with 90, 120 and 150 kg N ha^{-1}. Similar results were obtained by Kadiyala *et al*. (2012).

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