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Response of Aerobic Rice to Sub Surface Drip Fertigation

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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 with an objective to study the response of aerobic rice to sub surface drip ferigation. In aerobic rice, plant height, number of tillers m^{-2} and drymatter production at all the stages of observation were significantly the highest with irrigation schedule at 175% Epan compared to that of 100% Epan, All the growth parameters and yield viz., plant height, drymatter accumulation and yield 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, N Fertigation, Sub surface drip irrigation.*

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. Fertigation is a relatively new, but revolutionary concept in applying fertilizer through irrigation. It helps to achieve both fertilizer use efficiency and water use efficiency, when fertilizer applied through drip. Fertigation provides the essential nutrients directly to the plant root zone thus minimizing the cost of expensive nutrients which ultimately helps in improving the productivity and quality of farm produce.

MATERIAL AND METHODS

A field experiment was carried out for two consecutive years (2012 and 2013) at Jain Hi-Tech Agri Institute, Jalgaon, Maharashtra. 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

All the irrigation schedules differed significantly with one another at harvest. During the first year of experimentation (Table.1), significantly the tallest plants (89.0 cm) and dwarfest plants (79.2 cm) were registered in the treatments where irrigation scheduled at 175 per cent Epan and 100 per cent Epan respectively. During the second year of experimentation, plant height (97.5 cm) recorded with 175% Epan was significantly higher than that registered with irrigation scheduled at 100 per cent Epan (78.1 cm) and irrigation scheduled at 125 per cent Epan (83.7 cm). However the plant height recorded with 175 and 150 per cent Epan were statistically comparable. Both the checks i.e. aerobic rice irrigated with 120 kg N ha^{-1} and aerobic rice with supplemental irrigation at 1.5 IW/CPE ratio also recorded lower plant height in comparison to irrigation scheduled at 175 per cent Epan. The increase in plant height at higher level of drip irrigation due higher frequency of irrigation and increased availability of soil moisture to root zone under sub surface drip irrigation might have led to effective absorption and utilization of available nutrients and better proliferation of roots resulting in quick canopy growth.

During both the years, at every growth stage, plant height measured was significantly higher with 180 kg N ha^{-1} than that of 90 and 120 kg N ha^{-1} but on a par with that of 150 kg N ha^{-1} applied through sub surface drip fertigation. These results are similar with the findings of Maheswari *et al.* (2008), Mallareddy *et al.* (2013) and Prabhakar *et al.* (2012). The increased levels of nitrogen might have stimulated increased activity of meristematic cells and cell elongation of internodes resulting in higher growth rate of stem in turn promoting the plant height of rice. The interaction effect between the irrigation schedules and nitrogen levels was not significant with respect to plant height.

The highest drymatter production was recorded with sub surface drip irrigation at 175% Epan (13279 kg ha^{-1} and 13168 kg ha^{-1}) and which was on a par with 150% Epan (13145 kg ha^{-1} and 12726 kg ha^{-1}) in both the years of study. Whereas the lowest drymatter production was (12618 kg ha^{-1} and 12082 kg ha^{-1}) was recorded in irrigation schedule at 100% Epan. Dry matter production was favourably influenced by drip irrigation and fertigation levels. (Table 2). Higher dry matter production might be due to better crop growth, more number of leaves and higher leaf area as a result of maintenance of favourable soil moisture in the root zone and effective absorption by plants. These results are in conformity with the findings of Veeraputhiran *et al.* (2002) and Vijaykumar (2009) in rice.

The influence of nitrogen on drymatter production by aerobic rice was significant, during the first year of study. During the both the years of study the highest and the lowest drymatter was observered in N_4 (13591 kg ha^{-1} and 13470 kg ha^{-1}) and N_1 (12446 kg ha^{-1} and 11704 kg ha^{-1}) treatments, respectively. During the second year of study, N_3 and N_4 treatments were comparable with one another. This might be due to increased in nitrogen application might have caused increase in the photosynthate production which inturn enhanced the drymatter production in rice (Valarmathi, 1994). The results are in confirmation with those of Maheswari *et al.* (2008), Sathiya *et al.* (2008) and Kadiyala *et al.* (2012).

The highest grain yield was associated with treatments where the crop was irrigated throughout the crop growth periods. Drip irrigation produced significantly the highest grain yield over the surface, non irrigated irrigation treatment and supplemental irrigation with IW/CPE ratio at 1.5 (Table 3). During 2012 and 2013, drip irrigation at 175 % Epan produced significantly the highest grain yield (6775 kg ha^{-1} and 7213 kg ha^{-1}) which was superior over 100 % Epan, but was on a par with 150 % Epan. Irrigation scheduled at 100% Epan &125% Epan,

Table 1. Plant height (cm) of aerobic rice at harvest as influenced by irrigation schedule and N level through sub surface drip fertigation

Irrigation Schedule	2012 Nitrogen level (kg ha^{-1})					2013 Nitrogen level (kg ha^{-1})				
	90	120	150	180	Mean	90	120	150	180	Mean
I$_1$: 100 % Epan	74.9	78.4	81.1	82.2	79.2	70.3	77.5	80.7	83.9	78.1
I$_2$: 125 % Epan	78.9	82.5	83.0	83.7	82.0	78.2	82.7	84.4	89.7	83.7
I$_3$: 150% Epan	81.0	85.1	87.2	89.1	85.6	83.9	92.5	94.2	99.1	92.4
I$_4$: 175 % Epan	83.8	87.0	90.1	94.9	89.0	92.6	96.5	98.2	102.9	97.5
Mean	79.6	83.2	85.4	87.5		81.2	87.3	89.4	93.9	
		Sem±	CD (0.05)	CV (%)			Sem±	CD (0.05)	CV (%)	
I		1.0	3.2	4.8			2.0	6.5	9.3	
N		1.8	5.3	8.8			1.4	3.9	6.1	
IXN										
N at same level of I		3.7	NS				2.7	NS		
I at Same level of N		3.4	NS				3.1	NS		
Check 1: Aerobic rice non irrigated with 120 kg N ha^{-1}					55.4					62.0
Check 2: Maize with surface irrigation at IW/CPE ratio of 1.2 with 160 kg N ha^{-1}					82.7					90.0

Table 2. Drymatter production (kg ha^{-1}) of aerobic rice at harvest as influenced by irrigation schedule and N level through sub surface drip fertigation

Irrigation Schedule	2012 Nitrogen level (kg ha^{-1})					2013 Nitrogen level (kg ha^{-1})				
	90	120	150	180	Mean	90	120	150	180	Mean
I$_1$: 100 % Epan	12200	12324	12828	13120	12618	11247	11742	12471	12868	12082
I$_2$: 125 % Epan	12349	12474	12949	13423	12799	11891	12575	13174	13443	12771
I$_3$: 150% Epan	12493	12820	13390	13877	13145	11433	12619	13235	13618	12726
I$_4$: 175 % Epan	12740	12957	13477	13943	13279	12245	12931	13544	13950	13168
Mean	12446	12644	13161	13591		11704	12467	13106	13470	
		Sem±	CD (0.05)	CV (%)			Sem±	CD (0.05)	CV (%)	
I		375	1201	12			426	1362	13	
N		40.6	1165	13			271	778	9	
IXN										
N at same level of I		812	NS				542	NS		
I at Same level of N		797	NS				533	NS		
Check 1: Aerobic rice non irrigated with 120 kg N ha^{-1}					4092					4872
Check 2: Maize with surface irrigation at IW/CPE ratio of 1.2 with 160 kg N ha^{-1}					9201					9493

Table 3. Grain yield (kg ha^{-1}) of aerobic rice as influenced by irrigation schedule and N level through sub surface drip fertigation.

Irrigation Schedule	2012 Nitrogen level (kg ha^{-1})					2013 Nitrogen level (kg ha^{-1})				
	90	120	150	180	Mean	90	120	150	180	Mean
I$_1$: 100 % Epan	4221	5471	5892	6259	5461	3978	4747	4930	5037	4673
I$_2$: 125 % Epan	5105	5530	6169	6708	5878	4895	5763	5958	6962	5895
I$_3$: 150% Epan	5543	6049	6492	6878	6241	5378	6005	6785	7355	6379
I$_4$: 175 % Epan	6005	6736	6942	7415	6775	6547	7075	7545	7685	7213
Mean	5219	5946	6374	6815		5198	5898	6305	6760	
		Sem±	CD (0.05)	CV (%)			Sem±	CD (0.05)	CV (%)	
I		199	637	13			189	606	13	
N		167	479	11			118	338	8.0	
IXN										
N at same level of I		334	NS				235	NS		
I at Same level of N		351	NS				278	NS		
Check 1: Aerobic rice non irrigated with 120 kg N ha^{-1}					2450					2589
Check 2: Maize with surface irrigation at IW/CPE ratio of 1.2 with 160 kg N ha^{-1}					5210					4772

125% &150% Epan and 150% & 175% Epan were statistically on a par during first year of experimentation. However during the second year of study, 125% Epan & 150% Epan were statistically on a par all the irrigation treatments tried recorded and with grain yield in comparison to check1 and check 2. Grain yield is mostly limited by sink capacity and the ability of grain to accept assimilates (Fukai *et al.*, 1991). Grain yield decreased with the reduced input of water in the present study. This might be because of the negative effect of water stress on photosynthetic process and its partitioning ability towards sink which reduced the yield components like number of grains and 1000-grain weight.

Increasing the nitrogen supply from 90 to 180 kg ha^{-1} increased the rice yield significantly under sub surface drip fertigation. The highest grain yield was recorded at 180 kg ha^{-1} during both the years. It increased by 23.4 and 23.1 per cent during 2012 and 2013, respectively with the application of 90 kg ha^{-1}. In aerobic system, the dominant form of N is nitrate and relatively little ammonia volatilization is expected after fertilizer nitrogen application (Zhang *et al.*, 2009). The alternate moist and dry soil conditions may stimulate nitrification-denitrification processes in dry sown rice, resulting in loss of nitrogen through N_2 and N_2O (Prasad, 2011). In a study conducted by Kadiyala *et al.* (2012) at Hyderabad, 48-58 per cent of applied nitrogen depending on the dose was found to be lost form soil-plant system in aerobic rice. the adequately N fertilized crop benefited from higher rates of nitrogen nutrition that might have resulted into a more vigorous and extensive root system of crop leading to increased vegetative growth means for more efficient sink formation and greater sink size, greater carbohydrate translocation from vegetative plant parts to the grains and longer leaf area index during grain filling period, ultimately reflected in higher grain yield of aerobic rice in these treatments.

LITERATURE CITED

Fukai S, Li L, Vizmonte PT and Fisher K S 1991 Control of grain yield by sink capacity and assimilate supply in various rice cultivars. *Experimental Agriculture*, 27: 127-135.

Kadiyala M D M, Mylavarapu R S, Li Y C, Reddy G B and Reddy M D 2012 Impact of aerobic rice cultivation on growth, yield and water productivity of rice-maize rotation in Semiarid Tropics. *Agronomy Journal*, 104 (6): 1757-1765.

Maheswari J, Bose J, Sangeetha S P, Sanjutha S and Priya R S 2008 Irrigation regimes and N levels influence chlorophyll, leaf area index, proline and soluble protein content of aerobic rice (*Oryza sativa* L.). *International Journal of Agricultural Research*, 3 (4): 307-316.

Mallareddy M, Padmaja B, Veeranna G and Reddy V V 2013. Response of aerobic rice to irrigation scheduling and nitrogen doses under drip irrigation. *Journal of Research, ANGRAU,* 41 (2): 144-148.

Prasad R 2011 Aerobic rice systems. *Advances in Agronomy*, 111: 207-247.

Prabhakar K, Sagar G K, Chari M S, Rao M S and Sekhar S C 2012 Effect of irrigation schedules and nitrogen levels on growth and yield of aerobic rice. *The Andhra Agricultural Journal*, 59 (2): 174-176.

Sathiya K, Sathyamoorthi K and Martin G J 2008 Effect of nitrogen levels and split doses on the productivity of aerobic rice. *Research on Crops*, 9 (3): 527-530.

Veeraputhiran R, Kandasamy O S and Sundar singh S D 2002 Effect of drip irrigation and fertigation on growth and yield of hybrid cotton. *Journal of Agricultural Resource Manage*, 1 (20): 88-97.

Vijayakumar P 2009 Optimization of water and nutrient requirement for yield maximization in hybrid rice under drip fertigation system rice (*Oryza sativa* L). M. Sc. Thesis, Dept. Of Agronomy, Agri. College and Res. Instt., (TNAU), Madurai.

Valarmathi R 1994 Improving rice productivity in late *rabi* for sustainable agriculture in Periyar-Vaigai command area. *M. Sc Thesis.* Tamil Nadu Agricultural University, Coimbatore, India.

Zhang L, Lin S, Bouman B A M, Xue C, Wei F, Tao H, Yang X, Wang H, Zhao D and Dittert K 2009 Response of aerobic rice growth and grain yield of N fertilizer at two contrasting sites near Beijing, China. *Field Crops Research*, 114: 45-53.

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