

Original Research Article

<https://doi.org/10.20546/ijcmas.2017.604.303>

Influence of Drip Fertigation Levels on Physiological Parameters of Aerobic Rice in Western Zone of Tamil Nadu, India

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ABSTRACT

Keywords

Aerobic rice,
Drip fertigation,
Physiological
parameters,
Grain yield

Article Info

Accepted:
20 March 2017
Available Online:
10 April 2017

A field experiment was conducted during *kharif* 2016 at R&D farm of Jain Irrigation Systems Ltd., Udumalpet with seven treatments comprising of two irrigation (100% and 150% ETc) and three fertigation levels (75%, 100% and 125% RDF) in addition, surface irrigation method as a check were arranged in randomized block design and replicated thrice. Rice was grown in sandy clay soil with pH and EC of 7.6 and 0.21 (dS m⁻¹), respectively. A 115 day long variety ADT (R) 45 was used with spacing of 20x10cm. Fertilizers were applied @ 150:50:50 kg of N P₂O₅ K₂O ha⁻¹. The result indicated that surface irrigation method resulted in higher grain yields and physiological parameters except root length as it was higher with lower water and higher fertilizer level (75% ETc + 125% RDF). Within the aerobic rice treatments, drip fertigation at 150% ETc with 125% RDF recorded higher grain yields and physiological parameters and it was found to be on par with surface irrigation method.

Introduction

Rice (*Oryza sativa* L.) is one of the most important staple food crops of the world. More than two billion people in Asia are getting 60 to 70 per cent of their energy requirement from rice and its derived products. Worldwide, rice is being cultivated in an approximate area of 147 million hectares with a total production of 525 million tonnes and average productivity of 3571 kg ha⁻¹. Asia contributes 59 per cent of world population and accounts for 92 per cent of global rice production. Among many food grains cultivated in India, rice has the pride of being cultivated over an area of 43.97 million hectares with a production of 104.32 million tonnes which contributes to 41.5 per cent of

total food grain production of our Country (Anonymous, 2014). Over the past decade, we have witnessed a growing scarcity and competition for water around the world. As the water demand for domestic, municipal, industrial and environmental purposes rises in the near future, the water availability for agriculture sector gets affected. The estimated water availability for agriculture which is 83.3 per cent of total water used today will shrink to 71.6 per cent in 2025 and to 64.6 per cent in 2050 (Yadav, 2002). The future of rice production which consumes a lion's share of water (85%) used in irrigated agriculture (Barker *et al.*, 1999) will therefore depend heavily on developing and adopting

technologies and practices which will use less water with highest use efficiency. Aerobic rice is a production system in which specially developed “aerobic rice” varieties are grown in well-drained, non-puddled and non-saturated soils. With appropriate management, the system aims for yields of at least 4-6 tons per hectare. Yields were on par with irrigated puddle rice with an average of 5.5 to 6 t ha⁻¹ with 60 per cent less water. Keeping the above facts in mind, the present study was conducted with following objectives; to assess the effect of different irrigation and Fertigation levels on physiological parameters and yield of direct seeded drip irrigated aerobic rice.

Materials and Methods

A field experiment was conducted in the Research and Development Farm of Jain Irrigation Systems Ltd., located in the Udumalpet Taluk of Tirupur District (TN). The farm is situated in the Western Agro climatic zone of Tamil Nadu at 10° 34' 48'' N latitude and 77° 14' 24'' E longitude and at an altitude of 340.46 m above MSL. The soil of the experimental field is sandy clay with good drainage. The available soil nitrogen, phosphorous and potassium were 196, 6.5 and 350 kg ha⁻¹, respectively with soil pH and EC of 7.66 and 0.21 dS m⁻¹. The experiment was conducted during *kharif* 2016 with seven treatments comprising of two irrigation (75% and 100% ETc) and three fertigation levels (75%, 100% and 125% RDF) in addition, surface irrigation method were arranged in randomized block design and replicated thrice. Surface irrigation was given one day after disappearance of ponded water to depth of 2.5 cm with manual application of fertilizers. Proper weed management and plant protection measures were carried out at the appropriate time as per the recommendation. Raised beds were formed with a top bed width of 100 cm and furrows

with width of 30 cm and the crop spacing adopted is 20cm x 10cm.

Five plant samples in each replication were drawn at active tillering (AT) and panicle initiation (PI) for recording various physiological characters. To overcome border effect observations were made on middle plants in the row. The data obtained were subjected to statistical analysis and were tested at five per cent level of significance to interpret the treatment differences as suggested by Gomez and Gomez (1984).

Results and Discussion

Effect of drip fertigation on rice root characters

The root characters recorded at active tillering and panicle initiation stage differed due to different levels of irrigation and fertigation.

Root length

Among the treatments lower irrigation level with high fertilizer level recorded increased root length (Table 1). Drip Fertigation at 100% ETc + 125% RDF (T₃) recorded higher root length at both the stages as compared to all other treatments and it was followed by 100% ETc + 100% RDF (T₂). Vijayakumar (2009) stated that under water deficit situation, even the susceptible varieties produced slender and long roots to absorb moisture from lower layers. In the present study lower irrigation level might have put forth deeper and lengthier roots. Change in variation in moisture content in the root zone might have caused the plant root to spend more energy to extract the water and nutrients from the deeper layer and ultimately resulted in higher root length and dry weight (Narendra Pandey *et al.*, 2010).

Root volume

Root volume (Table 1) was greatly influenced by various irrigation and fertilizer amounts. Surface irrigation treatment resulted in higher root volume of 16.3 and 22.8 cc hill⁻¹ at AT and PI stage respectively. Among the drip irrigation treatments 150% ETc with 125% RDF (T₆) registered higher root volume with the values of 15.9 and 22.3 cc hill⁻¹.

However T₆ showed on par value with surface irrigation method. This was mainly because of application of water and nutrients directly to the root zone make them easily available and also maintaining moist condition around root zone which creates favourable environment for roots to grow and absorb water and nutrients more effectively. This finding is in agreement with the findings of Govindan and Grace (2012).

Root dry weight

Various irrigation and fertigation levels on root dry weight (Table 1) of rice were significantly influenced.

Data on root volume revealed that the surface irrigation (T₇) observed higher values of 3.79 and 6.41 g hill⁻¹ followed by irrigation at 100 % ETc with 125 % RDF (T₆) at both the stages. This might be due to the optimum moisture, nutrient and better aeration under drip irrigation which in turn have increased the root dry weight (Vijaykumar, 2009). Similarly, this result is in accordance with the findings of Govindan and Grace (2012).

Effect of drip fertigation on leaf area index, chlorophyll value and crop growth rate

Irrespective of growth stages the physiological parameters like leaf area index, chlorophyll index and crop growth rate was

greatly influenced by different irrigation regimes and fertigation levels.

Leaf Area Index (LAI)

At both the stages of crop growth, higher the LAI was observed with surface irrigation method (Table 1). Within the drip irrigation treatments DF at 150% ETc with 125% RDF recorded higher LAI. This was on par with 150% ETc with 100% RDF.

The reduction in LAI with lower irrigation and fertigation levels (100% ETc with 75% RDF) might be due to reduced turgor pressure under moisture stress conditions which affected the leaf cell expansion. Similar observations were also made by Nguyen *et al.*, (2009) and Bouman *et al.*, (2005). The increased leaf area index could be attributed to the increased functional leaf area and delayed leaf senescence by production of phytohormones that enhanced cell division and elongation (Elankavi *et al.*, 2009).

Chlorophyll index

In general leaf chlorophyll value was progressively increased from active tillering to panicle initiation (Table 2). The leaf chlorophyll index was found to be significantly higher with surface irrigation treatment at both the stages with values of 32.91 and 36.33 and it was at par with DF at 150% ETc with 125% RDF (T₆).

Stress fewer conditions prevailed during the growth period of rice must have increased the chlorophyll content there by increased greenness owing higher chlorophyll content. Increased leaf chlorophyll content led to increased photosynthetic rate and more dry matter production (Mohan *et al.*, 2000). These findings were also in conformity with the findings of Vanitha (2008).

Table.1 Root characters and LAI of aerobic rice as influenced by drip irrigation and fertigation levels

Treatments	Root Length (cm)		Root volume (cc hill ⁻¹)		Root dry weight (g hill ⁻¹)		LAI	
	AT	PI	AT	PI	AT	PI	AT	PI
T ₁ - DF at 100% ETc with 75% RDF	17.1	23.6	12.8	18.0	2.98	5.05	2.98	3.95
T ₂ - DF at 100% ETc with 100% RDF	18.3	25.3	13.7	19.2	3.18	5.38	3.13	4.15
T ₃ - DF at 100% ETc with 125% RDF	19.1	26.4	14.3	20.1	3.33	5.64	3.25	4.30
T ₄ - DF at 150% ETc with 75% RDF	15.7	21.7	14.2	19.9	3.30	5.59	3.24	4.29
T ₅ - DF at 150% ETc with 100% RDF	17.0	23.5	15.1	21.3	3.52	5.96	3.42	4.53
T ₆ - DF at 150% ETc with 125% RDF	17.2	23.8	15.9	22.3	3.70	6.26	3.55	4.70
T ₇ - SI with soil application of 100% RDF	16.5	22.8	16.3	22.8	3.79	6.41	3.64	4.81
S Ed	0.4	0.6	0.3	0.4	0.06	0.10	0.09	0.12
CD (P=0.05)	1.0	1.3	0.6	0.8	0.14	0.23	0.20	0.25

Note: DF– Drip Fertigation ETc – Crop Evapotranspiration AT-Active tillering
 SI – Surface Irrigation RDF – Recommended Dose of Fertilizer PI- Panicle Initiation

Table.2 Chlorophyll index, crop growth rate (CGR) and grain yield of aerobic rice as influenced by drip irrigation and fertigation levels

Treatments	Chlorophyll index		CGR (g m ⁻² day ⁻¹)		Grain yield
	AT	PI	AT-PI	PI-F	
T ₁ - DF at 100% ETc with 75% RDF	27.13	29.95	27.13	29.95	3741
T ₂ - DF at 100% ETc with 100% RDF	28.48	31.45	28.48	31.45	4152
T ₃ - DF at 100% ETc with 125% RDF	29.57	32.65	29.57	32.65	4448
T ₄ - DF at 150% ETc with 75% RDF	29.45	32.52	29.45	32.52	4343
T ₅ - DF at 150% ETc with 100% RDF	30.98	34.21	30.98	34.21	4821
T ₆ - DF at 150% ETc with 125% RDF	32.16	35.51	32.16	35.51	5110
T ₇ - SI with soil application of 100% RDF	32.91	36.33	32.91	36.33	5304
S Ed	0.08	0.88	0.53	0.58	176
CD (P=0.05)	1.80	2.03	1.20	1.33	420

Note: DF– Drip Fertigation ETc – Crop Evapotranspiration AT-Active tillering
 SI – Surface Irrigation RDF – Recommended Dose of Fertilizer PI- Panicle Initiation

Crop growth rate (CGR)

Different drip fertigation levels significantly influenced the rate of rice crop growth at different stages (Table 2). The higher CGR was observed with surface irrigation (T₇). Among the drip irrigation treatment higher dip fertigation level (150% ETc with 125% RDF (T₆)) recorded the higher CGR. The higher crop growth rate at higher nutrient and

water levels might have resulted in the accumulation of relatively more dry matter through increased photosynthetic efficiency due to optimum leaf area (Ombir Singh *et al.*, 2007).

Effect of drip fertigation on grain yield of aerobic rice

Irrigation and fertigation schedules significantly influenced the grain yield of rice

(Table 2). Surface irrigation method registered higher grain yield (5304 kg ha⁻¹) and it was on par with 150% ETc with 125% RDF (T₆) with yield of 5110 kg ha⁻¹. The higher grain yield of aerobic rice might be associated with increase in growth and physiological characters were observed under higher moisture regime. These findings were in agreement with results of Gupta *et al.*, (2003). And also, the higher grain yield was might be due to increase in yield attributing characters under high soil moisture regime as a result of frequent irrigation (Shekara *et al.*, 2010).

It can be concluded that in water stressed areas drip irrigation at 150% ETc with 125% RDF fertigation may be adopted. The surface irrigation can be totally replaced by this treatment for sustained rice productivity.

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How to cite this article:

Ramadas, S. and Ramanathan, S.P. 2017. Influence of Drip Fertigation Levels on Physiological Parameters of Aerobic Rice in Western Zone of Tamil Nadu, India. *Int.J.Curr.Microbiol.App.Sci.* 6(4): 2609-2613. Doi : <https://doi.org/10.20546/ijemas.2017.604.303>