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Research Paper

Influence of coir pith application on soil moisture distribution with different irrigation regimes of aerobic rice (*Oryza sativa*) cultivation under trickle irrigation system

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ABSTRACT

An experiment was conducted during the summers of 2019 and 2020 at the AICRP Water Management field, Tamil Nadu Agricultural University, Madurai, Tamil Nadu to study the effect of coir pith application on soil moisture distribution of aerobic rice (*Oryza sativa* L.) with different irrigation regimes. Treatment consisted of 3 irrigation regimes, viz. I_1, Trickle irrigation at 120% Pan Evaporation (PE); I_2, 100% PE, and I_3, 80% PE. Experiment separately, maintained the surface irrigation of IW: CPE 1.20 as control. The well-composed coir pith @375 kg/ha was spread over the raised beds and leveled well with surface soil. Soil samples were collected in vertical and horizontal directions for determining soil moisture by gravimetric method. Soil moisture appropriation was plotted graphically as contour maps used by the surfer. Results revealed that trickle irrigation at 120% PE with coir pith application improved the yield attributes of aerobic rice compared to surface irrigation (IW: CPE 1.20) owing to coir pith's favourable hydrological and physical properties to hold and spread the water in the raised bed area.

Key words: Aerobic rice, Coir pith, Irrigation regimes, Soil moisture distribution, Trickle irrigation

Rice (*Oryza sativa* L.) is the staple food crop for the greater part of the total populace impacts the livelihoods and financial matters of a few billion individuals. Swamp-flooded rice requires a great deal of water for puddling, relocating and water systems. Further, critical water misfortunes happen through drainage, permeation and vanishing. It is assessed that it polishes off 3000 to 5000 litres of water to deliver 1 kg of rice. In India, the yearly per capita accessibility of water might lessen to 1340 cubic meters in 2025 and 1140 cubic meters in 2030 (Suhag, 2016). The declining water availability and the increasing cost of water endanger the traditional system of puddled transplanted rice cultivation (Maraseni *et al.,* 2018). This shortage of water is forcing farmers to adopt water-saving and cost-effective rice cultivation techniques. Aerobic rice is one of the methodologies in rice creation that prompts a lot of water-saving (Anbarasu *et al.,* 2022).

Trickle water system has been polished for a long time for its viability in decreasing soil surface dissipation, expanding the harvest yield and water use efficiency (WUE) (Sivanappan, 2004). Along with coir pith application it may highly enhance WUE and water productivity of rice cultivation. Trickle water system frameworks for the most part comprise trickle drops of water that have release rates changing from 2.0 to 8.0 l/h. The connections between application rates, soil properties and the subsequent water circulation for regular trickle drops of water are proven and factual (Bresler *et al.,* 1982). The wetting designs during application comprises two zones; (I) a soaked zone near the trickle drop of water and (ii) a zone where the water content declines toward the wetting front. Expanding the release rate for the most part brings about an expansion in the wetted soil breadth and a decline in the wetted profundity (Ah Koon *et al.,* 1990; Assouline, 2002). Subsequently, the water application rate and coir essence layer on the dirt surface is a variable, which decides the dampness conveyance around the trickle connected with root circulation and plant water take-up designs. Keeping this in view, present study was carried out to concentrate on the utilization of coir substance and dampness dissemination designs under different degrees of water systems executed by oxygen-

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consuming rice development under a trickle irrigation framework.

MATERIALS AND METHODS

An experiment was conducted during the summers of 2019 and 2020 at the AICRP Water Management field, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai (9°54′N and 78°54′E), Tamil Nadu. The experiment soil was clay loam with *p*H 7.04, EC 0.33 dS/m and organic carbon 0.42%. The field analysis was spread out by randomized block design (RBD), replicated thrice. The treatments consisted of 3 irrigation regimes, *viz*. I_1, Trickle irrigation at 120% PE; I_2, Trickle irrigation at 100% PE; and I_3, Trickle irrigation at 80% PE. Independently, followed the surface water system (IW: CPE 1.20) using RDF (recommended dose of fertilizers) in the soil as the correlation's control.

The experimental field was completely furrowed with duck foot, cultivator and rotovator to get fine tilth. Then raised beds were manually formed with a 90 cm top bed width and 30 cm furrow width (Fig. 1). The well-composed coir pith @ 375 kg/ha was spread over the raised beds and leveled well with surface soil. The paddy seeds (var. CO-51) were drilled physically on 22 February 2020 at 20 cm × 10 cm dividing and obliged 5 lines in a solitary raised bed. The horizontal was spread out in the focal point of each bed. A trickle irrigation system was planned once in 3 days according to the treatments. In the control plot, a surface water system to a profundity of 5 cm was planned by IW: CPE of 1.20. The quantity of water was calculated:

$$WRc = CPE \times Kp \times Kc \times Wp \times A$$

where WRc, Computed water requirement (per plant);

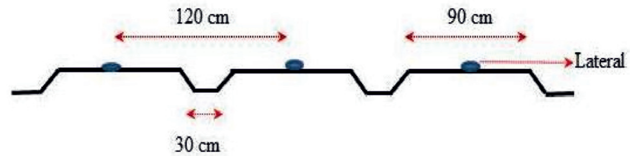


Fig. 1. The layout of raised beds trickle irrigation system

CPE, Cumulative pan evaporation for 3 days (mm); Kp, Pan factor (0.8); Kc, Crop factor; Wp, Wetting percentage (0.2); A, Area per plant.

Soil moisture distribution

Soil moisture distribution was determined according to Liven and Van Rooyen (1979). The soil samples were taken at maximum actual water requirements by auger before and 2 hours after irrigation from different locations. For each of these locations, soil samples were gathered from various profundities from the soil surface, which were 0, 15, 30, and 45 cm in the vertical and horizontal directions. Soil moisture content was measured by gravimetric methods. Soil moisture content percentage was determined as dry weight (soil moisture by weight) and calculated as:

$$S.M.W = (W1 - W2) \times 100 / W2$$

where W1, weight of the wet soil sample (g); W2, weight of the oven-dried soil sample (g) at 105°C for 72 hours.

By using the "contouring program Surfer" we obtained a contouring map for different moisture levels with depths.

RESULTS AND DISCUSSION

Soil moisture dynamics under trickle irrigation system

Soil moisture distribution over 90 cm raised bed top

Table 1. Soil moisture depletion pattern under trickle irrigation system of aerobic rice cultivation

Depth (cm)	I_1, 120% PE						
	-45	-30	-15	0	+15	+30	+45
0	29.58	30.89	41.15	46.47	42.07	31.15	29.54
15	16.25	27.38	39.79	44.77	39.23	27.38	16.28
30	3.84	14.22	25.66	33.38	26	14.59	4.05
45	0.44	18.8	22.75	22.74	13.29	10.85	0.57
				I_2, 100% PE			
0	20.84	29.23	40.67	44.27	40.36	28.31	21.15
15	9.8	23.16	37.55	43.24	36.23	24.19	9.45
30	1.36	11.02	29.67	31.14	22.23	12.37	1.86
45	0	7.78	12.26	20.29	11.15	7.38	0
				I_3, 80% PE			
0	16.78	24.83	38.9	43.66	39.86	23.4	17.65
15	9.9	22.47	34.78	40.46	35.86	21.85	10.45
30	5	10.1	19.98	29.58	20.48	10.48	4.9
45	0	5.78	11.45	19.68	10.43	5.38	0

width applied with coir pith was found to be extended horizontally under the trickle irrigation system (up to 45 cm) whereas the vertical movement was restricted to up to 30 cm only (Table 1).

The soil moisture contents estimated at different depths and distances from the emitter were analyzed and plotted graphically as contour maps (Fig. 2). The moisture was well distributed from the emitter placed at 45 cm of the top raised bed. This significant change in soil moisture distribution was primarily due to the application of coir pith. The higher fraction of applied water was absorbed and held within the surface soil due to the presence of microspores in higher numbers with coir pith and water movement was facilitated by coir pith as it has higher adhesion capacity.

This is how the development and yield of aerobic rice under a trickle irrigation system (I_1), was comparatively higher than surface irrigation. Results showed that 120% PE with coir pith application worked well on the aerobic rice growth, physiological and yield parameters under trickle irrigation when compared to 100% PE and 80% PE and surface irrigation method (Mishra and Paysi, 1993).

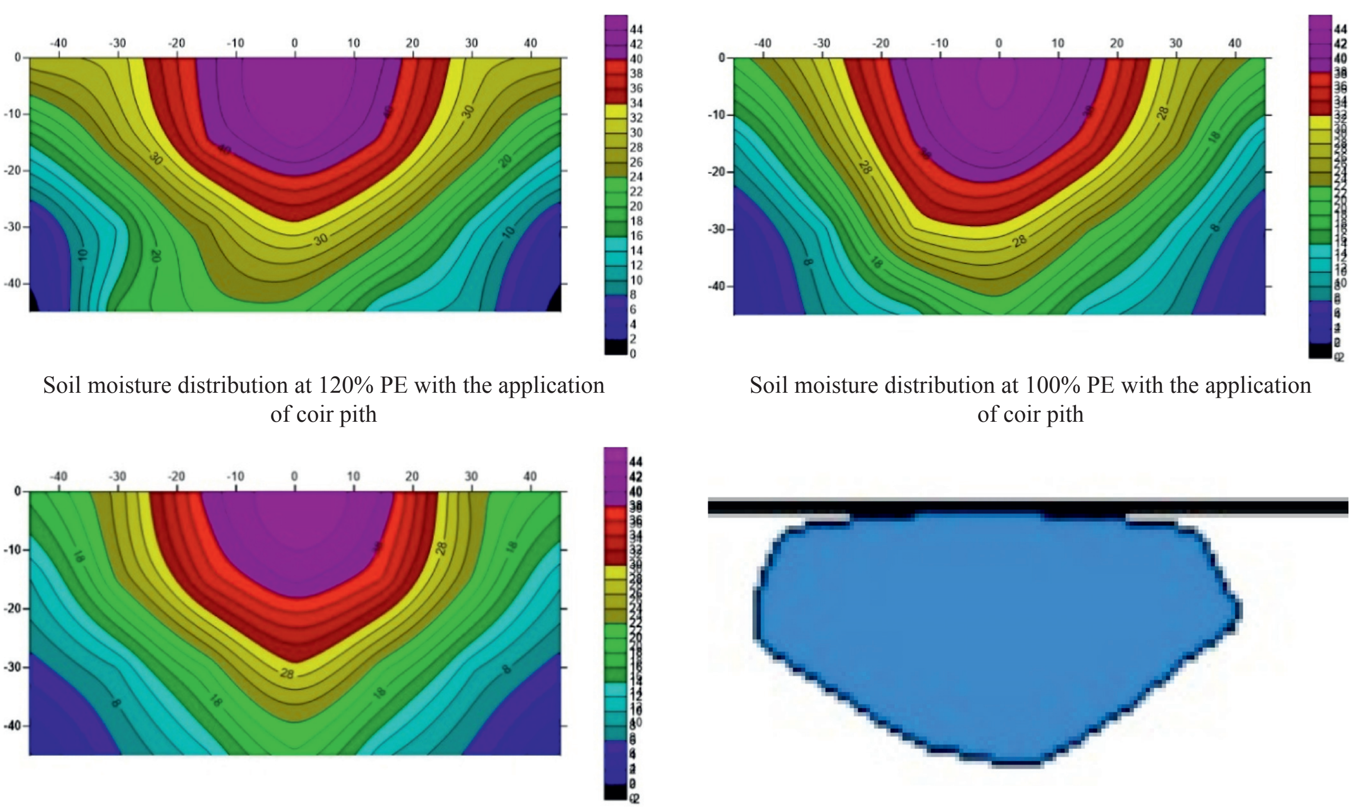
Grain yield (kg/ha)

When we compared the response of aerobic rice to trickle irrigation levels, the irrigation at 120% PE (I_1) produced the maximum grain yield (6062 kg/ha) followed by 100% PE (I_2) (5,739 kg/ha) and the lowest grain yield (4073 kg/ha) was recorded at 80% PE (I_3). The maximum grain yield obtained under 120% PE (I_1) was comparable with the yield obtained under surface irrigation (IW: CPE 1.2) and irrigation at 100% PE was on par with surface irrigation (IW: CPE 1.2) system grain yield (5,880 kg/ha).

Straw yield (kg/ha)

The highest straw yield (7,957 kg/ha) was recorded under 120% PE based irrigation (I_1) followed by 100% PE based irrigation (I_2) (7604 kg/ha) and was on par with surface irrigation (IW: CPE 1.20) (7,768 kg/ha). The lowest straw yield was recorded at 80% PE (I_3) (5674 kg/ha) (Table 2).

Among different trickle irrigation regimes the irrigation at 120% PE (I_1) recorded significantly higher grain and straw yield as compared to other levels owing to better availability of moisture and nutrients throughout crop growth stages leading to better uptake of nutrients, production of higher dry-matter and in turn economic yield. This also indicates that increased solubility of nutrients resulted in improved uptake with lesser losses, even when lower



Soil moisture distribution at 120% PE with the application of coir pith

Soil moisture distribution at 100% PE with the application of coir pith

Soil moisture distribution at 80% PE with the application of coir pith

Normal moisture distribution in clay soil

Fig. 2. Dimensional view of soil moisture distribution under trickle irrigation of aerobic rice cultivation.

Table 2. Effect of coir pith application on grain and straw yield of aerobic rice under soil moisture-based trickle irrigation system

Treatment	Grain yield (kg/ha)			Straw yield (kg/ha)		
I_1, 120% PE	6,062	5,894	5,318	7,957	7,695	7,098
I_2, 100% PE	5,739	5,645	4,067	7,604	7,414	5,713
I_3, 80% PE	4,073	3,521	3,213	5,674	5,099	4,736
SEd	129.96	61.56	93.96	113.40	107.28	111.24
CD (P=0.05)	361.00	171.00	261.00	315.00	298.00	309.00
IW: CPE 1.20	5,880	5,833	5,716	7,768	7,570	7,491

Table 3. Effect of coir pith application on the economics of aerobic rice under soil moisture-based trickle irrigation system

Treatment	Cost of cultivation (₹)	Drip cost (₹)	C-POM cost (₹)	Total cost of cultivation (₹)	Gross return (₹)	Net return (₹)	Benefit cost ratio
$I_{1,}$ 120% PE	33,303	2,594	3,000	38,897	84,680	45,783	2.18
I_2, 100% PE	33,303	2,594	3,000	38,897	80,274	41,377	2.06
I_3, 80% PE	33,303	2,594	3,000	38,897	57,387	18,490	1.48
IW: CPE 1.20	31,979	0	0	31,979	79,551	47,572	2.49

doses of nutrients are applied as compared to higher levels under a trickle irrigation system (Sudhir *et al.,* 2011).

A well-maintained micro-irrigation system may have a life span of 7 years, hence for the present study a life span of 7 years was considered for trickle irrigation system for computation. The total cost of cultivation of aerobic rice per hectare including annualized trickle irrigation system cost is given in Table 3. Economic analysis of the present investigation revealed that the cost of cultivation of rice under a trickle irrigation system was higher than surface irrigation irrespective of water-soluble fertilizers. The cost of cultivation was recorded ₹38,897/ha at 120, 100 and 80% of PE respectively as included common water-soluble fertilizers under trickle fertigation system including of C-POM cost, as compared to surface irrigation (IW: CPE 1.20) (₹31979/ha) included conventional fertilizer.

Gross return (₹/ha), Net return (₹/ha) and benefit cost (B:C) ratio

Among the trickle irrigation regimes, 120% PE based irrigation earned the highest gross return, net return and B: C ratio of ₹84680, ₹45783 and 2.18 respectively followed by irrigation at 100% PE (I_2). Whereas surface irrigation (IW CPE 1.20) earned the gross return, net return and B:C ratio of ₹79551, ₹47572 and 2.49 respectively owing to less cost of convention fertilizer as compared to the water-soluble fertilizer. Simultaneously, the conventional fertilizer loss was more in soil than the water-soluble fertilizer. Among different trickle irrigation regimes, irrigation at 120% PE recorded higher economic return owing to the application of coir pith which maintained the field capacity level of moisture at the root zone to enhance the absorption of nutrients and their use efficiency led to produce more dry matter production ultimately better yield. These results are in line with the study of Soman (2012).

The trickle irrigation at 120% PE once in 3 days coupled with coir pith application improved the growth and yield of aerobic rice in comparison to surface water systems (IW: CPE 1.20). Coir pith has favourable hydrological properties with a positive degree of actual physical properties, which makes it the best water-holding and spreading medium for raised bed formation of aerobic rice cultivation under a trickle irrigation system.

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