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Effect of drip fertigation on growth, physiological parameters and grain yield of rice grown in Cauvery new delta zone of Tamil Nadu

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Abstract
A field experiment was conducted during *rabi* 2017-18 at Soil and Water Management Research Institute, Kattuthottam, Thanjavur, to study effect of drip fertigation on growth, physiological parameters and grain yield of rice grown in sandy loam soils. The experiment was laid out in randomized block design with three levels of drip irrigation (100%, 150% and 200% PE) and three fertigation levels (75%, 100% and 125% RDF). Surface irrigation with soil application of RDF was included as the check. The results of the study indicated that drip fertigation at 200% PE + 125% RDF recorded higher growth and physiological parameters viz., plant height(96.3 cm), LAI (5.35), Dry Matter Production (13204 kg ha^{-1}), CGR (9.3), grain and straw yield of 5964 and 7073 kg ha^{-1}, respectively. This yield increment were found as high as 46 per cent and 22 per cent over drip fertigation at 100% PE + 75% RDF and Surface irrigation with soil application 100% RDF, respectively.

Keywords: Drip fertigation, aerobic rice, surface method

Introduction
Rice (*Oryza sativa*) is the most important staple food crop over half the world's population and it provides 21% of global human per capita energy. In India, rice is widely grown as the second food crop occupying about 43 million hectares of area. In, Tamil Nadu, rice is grown in 1.84 m ha with the total production of 6.34 mt and the average productivity is 3467 kg ha^{-1}(Indiastat, 2019) [9]. Rice is cultivated by different methods and the conventional method involving wild flooding has been in vogue from time immemorial. This practice consumes a very huge amount of water. Traditional method of irrigation, which not only consumes more water, but also causes severe wastage of water and nutrients thus leads to nutrient losses under anaerobic condition (Naik *et al*., 2015) [11]. In future there is no much scope for improving water availability to agriculture as only 5.24 per cent increase is projected by 2050 because of growing competition from industrial sector and domestic activities (Dhiman *et al*., 2015) [4].
In Tamil Nadu, Cauvery Delta Zone (CDZ) is the major rice growing region which is designated as the 'Rice Bowl". It is imperative to evolve a water saving technology for rice farming in CDZ as the scarcity for irrigation water is becoming scarce. The micro irrigation methods especially drip irrigation combined with fertigation would be an appropriate option for enhancing the use efficiencies of both water and nutrients in rice. Drip fertigation permits application of nutrients directly at the site of active roots through water. Thus, it increases both water and nutrient use efficiency and reduces the nutrient losses. Hence, a field study was taken up to study the effect of different drip fertigation levels on the growth, physiological parameters and grain yield of rice.

Materials and methods
A field experiment was conducted during *rabi* 2017-18 at Soil and Water Management Research Institute, Kattuthottam, Thanjavur District, Tamil Nadu. The experimental field was located in the new ayacuts of Cauvery Delta Zone of Tamil Nadu It is geographically located at 10°45' N latitude, 79°E longitude with an altitude of 50 m above mean sea level. The soil of the experimental site was sandy loam in texture having neutral pH (6.8), EC (0.1 dS m^{-1}) and medium in organic carbon (0.60%). With regard to nutrient status, the soil was low in available nitrogen (184.0 kg ha^{-1}), high in phosphorus (23.4 kg ha^{-1}) and medium in potassium (137.7 kg ha^{-1}). The experiment comprised of ten treatments i.e Drip Fertigation at 100% PE +

75% RDF (T_1), DF at 100% PE + 100% RDF (T_2), DF at 100% PE + 125% RDF(T_3), DF at 150% PE + 75% RDF(T_4), DF at 150% PE + 100% RDF(T_5), DF at 150% PE + 125% RDF(T_6), DF at 200% PE + 75% RDF(T_7), DF at 200% PE + 100% RDF(T_8), DF at 200% PE + 125% RDF(T_9), Surface irrigation with soil application of 100% RDF(T_{10}) were evaluated in randomized block design under three replications. Surface irrigation was given based on IW: CPE ratio of 1.2 with manual application of fertilizer. Recommended dose of fertilizer (RDF) viz., 150: 50: 50 kg NPK ha^{-1} was adopted Entire quantity of P_2O_5 was applied as basal in the form of single super phosphate and for manual application, entire N and K_2O were applied in four equal splits i.e 25% each at basal, active tillering, panicle initiation and flowering. Under drip fertigation, N and K_2O supplied through water soluble fertilizer urea (N- 46%) and SOP (K-50%) at 75% (T_1, T_4, T_7), 100% (T_2, T_5, T_6) and 125% (T_3, T_6, T_9) once in three days. Raised beds were formed with a top bed width of 3.6 m and furrows with width of 30 cm. Rice variety ADT 39 taken as a test variety with spacing of 20cm x 10cm. Six laterals were laid out per bed with spacing of 60cm. Laterals had emitting point spaced at 30 cm apart with a discharge rate of 4 lph at 1 kg cm^{-2}. Proper weed management and plant protection measures were carried out at the appropriate time as per the recommendation. Growth, physiological parameters and yield were recorded as per the standard methodology. In order to evaluate the effect of different drip fertigation levels on growth, physiological parameters and yield of rice, the data were statistically analysed. The critical difference at 5% level of significance was calculated to find out the significance of different treatments over each other (Gomez and Gomez, 1984) [6].

Results and discussion

Growth and physiological parameters

Plant height (cm)

The plant height of rice was progressively increased with increasing water and fertilizer levels (Table. 1). At harvest stage, taller plant height of rice was recorded with drip fertigation at 200% PE + 125% RDF (96.3 cm) however this was at par with drip fertigation at 150% PE + 120% RDF and drip fertigation at 200% PE + 100% RDF. Shorter plant was recorded under Drip fertigation at 100% PE + 75% RDF (78.7 cm). Taller plant height observed under aerobic rice with drip irrigation might be due to continuous availability of required moisture near the crop root zone which might have resulted in higher nutrient uptake resulting in greater cell division and elongation. Similar results were also reported by Pushpa *et al*. (2007) [12], Govindan and Grace (2012) [7].

LAI

LAI is an important indicator of total photosynthetic surface area available to the plant for the production of photosynthates which accumulate in the developing sink (Table. 1). Higher LAI was recorded under drip fertigation at 200% PE + 125% RDF (5.35) which were on par with drip fertigation at 150% PE + 125% RDF and drip fertigation at 200% PE + 100% RDF. Lower LAI was recorded under drip fertigation at 100% PE + 75% RDF (3.01). The photosynthetic activity of plant largely depends upon leaf area. In the present study, the LAI was enhanced with increase of water and also constant supply of nutrients which resulted in better translocation of photosynthates and more carbohydrate synthesis contributing to favorable plant water balance. This was perhaps due to the higher production of number of leaves with enhancement of leaf area and more number of branches, which was in conformity with the findings of Kumar *et al*. (2009) [10], Vijaykumar (2009) [15], Vanitha and Mohandass (2014) [14].

Dry matter production (kg ha^{-1})

Dry matter production is the product of the influence of the growth characters like number of tillers, LAI and efficiencies of the crop to capture available resources (Table. 1). The dry matter accumulation was significantly higher under drip fertigation at 200% PE + 125% RDF (13204 kg ha^{-1}) however it was found to be comparable with drip fertigation at 150% PE + 125% RDF (12718 kg ha^{-1}) and drip fertigation at 200% PE + 100% RDF (12530 kg ha^{-1}). The minimum dry matter accumulation was recorded under drip fertigation at 100% PE + 75% RDF (13204 kg ha^{-1}). The increased dry matter accumulation in these treatments may be due to production of higher number of tillers and leaves because of higher uptake of moisture and nutrients due to frequent fertigation and use of water soluble fertilizers. Similar results were obtained by Vijaykumar (2009) [15] and Rekha *et al*. (2015) [13]

Crop Growth Rate (g m^{-2} day^{-1})

Crop growth rate is representing photosynthetic efficiency of a plant, which depends upon the dry matter production of rice crop (Table. 1). Significantly higher CGR was recorded with drip fertigation at 200% PE + 125% RDF (9.3 g m^{-2} day^{-1}) however it was found comparable to drip fertigation at 150% PE + 125% RDF and drip fertigation at 200% PE + 100% RDF. The lower CGR was recorded under drip fertigation at 100% PE + 75% RDF (5.2 g m^{-2} day^{-1}). The higher CGR in drip fertigation was due to higher dry matter production at different growth stages due to favorable soil water and nutrient environment throughout the crop growth stages. Similar results were reported by Anusha (2015) [1] and Kombali *et al*. (2017) [8]

Relative growth rate (mg g^{-1} day^{-1})

Relative growth rate (RGR) measures the increase in dry matter with a given amount of assimilatory material at a given point of time. Drip fertigation at 200% PE + 125% RDF registered higher RGR of 4.24 mg g^{-1} day^{-1} at par with Drip fertigation at 150% PE + 120% RDF (4.00 mg g^{-1} day^{-1}) lower RGR recorded under drip fertigation at 100% PE + 75% RDF (3.37 mg g^{-1} day^{-1}). The reason for increased RGR among the treatments could be the frequent application of irrigation with WSF fertilizers through drip which provided well aerated condition at root zone with adequate soil moisture content leads to sufficient concentration of nutrients that did not fluctuate between wet and dry extremes contributes to optimum growth. This result was in accordance with the findings of Badr *et al.*, 2010 [3].

Grain yield (kg ha^{-1})

The drip fertigation levels had profound influence on the grain yield of rice (Table. 2). Higher grain yields were recorded with drip fertigation at 200% PE + 125% RDF (5964 kg ha^{-1}) which were comparable to drip fertigation at 150% PE + 125% RDF (5737 kg ha^{-1}) and drip fertigation at 200% PE + 100% RDF (5661 kg ha^{-1}). The grain yields were lower under drip fertigation at 100% PE + 75% RDF (3203 kg ha^{-1}). This was mainly attributed that higher number of tillers and leaf area index 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) [15], Rekha *et al*. (2015) [13], Anusha *et al*. (2015) [2]

Straw yield (kg ha^{-1})

Different drip fertigation level had significantly influenced the straw yields. The highest straw yields were recorded under drip fertigation at 200% PE + 125% RDF (7073 kg ha^{-1}) and it was on par with drip fertigation at 150% PE + 125% RDF (6786 kg ha^{-1}) and drip fertigation at 200% PE + 100% RDF (6677 kg ha^{-1}). The lower straw yield was registered under drip fertigation at 100% PE + 75% RDF (3895 kg ha^{-1}). Lower straw yield might be due to relatively lesser leaf area which might have caused reduction in growth parameters resulting in lesser dry matter production with reduced total straw yield. Similar findings were reported with Fanish *et al*. (2011) [5] and Anusha (2015) [1].

Harvest index

There was no significance difference in harvest index among the treatments. Surface irrigation with soil application of 100% RDF recorded the highest value of harvest index (0.46).

Table 1: Effect of drip fertigation on Plant height (cm), LAI, DMP (kg ha^{-1}), CGR (g m^{-2} day^{-1}) and RGR (mg g^{-1} day^{-1}) of rice in Cauvery new ayacut of Tamil Nadu

Treatment	Plant height (cm)	LAI	DMP (kg ha^{-1})	CGR (g m^{-2} day^{-1})	RGR (mg g^{-1} day^{-1})
T_1- DF at 100% PE + 75% RDF	78.7	3.01	7304	5.2	3.37
T_2- DF at 100% PE + 100% RDF	86.3	3.54	8748	6.2	3.48
T_3- DF at 100% PE + 125% RDF	94.9	4.41	10888	7.7	3.73
T_4- DF at 150% PE + 75% RDF	79.3	3.82	9436	6.9	3.53
T_5- DF at 150% PE + 100% RDF	89.3	3.95	9759	7.0	3.76
T_6- DF at 150% PE + 125% RDF	95.6	5.15	12718	9.1	4.00
T_7- DF at 200% PE + 75% RDF	79.9	3.99	9848	6.9	3.82
T_8- DF at 200% PE + 100% RDF	89.8	5.08	12530	9.1	3.90
T_9- DF at 200% PE + 125% RDF	96.3	5.35	13204	9.3	4.24
T_{10}- Surface irrigation with soil application 100% RDF	87.9	4.21	10398	7.9	3.65
SEd	3.4	0.21	520	0.3	0.19
CD (p=0.05)	7.1	0.44	1092	0.6	0.40

Table 2: Effect of drip fertigation on grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index of rice in Cauvery new ayacut of Tamil Nadu

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
T_1- DF at 100% PE + 75% RDF	3203	3895	0.451
T_2- DF at 100% PE + 100% RDF	3850	4728	0.449
T_3- DF at 100% PE + 125% RDF	4860	5841	0.454
T_4- DF at 150% PE + 75% RDF	4168	5087	0.450
T_5- DF at 150% PE + 100% RDF	4316	5202	0.453
T_6- DF at 150% PE + 125% RDF	5737	6786	0.458
T_7- DF at 200% PE + 75% RDF	4331	5282	0.451
T_8- DF at 200% PE + 100% RDF	5661	6689	0.458
T_9- DF at 200% PE + 125% RDF	5964	7073	0.457
T_{10}- Surface irrigation with soil application 100% RDF	4679	5507	0.459
SEd	147	278	0.02
CD (p=0.05)	308	584	NS

Conclusion

The results of the experiment revealed that the growth and physiological parameters viz., plant height, LAI and dry matter production were influenced positively by the drip fertigation levels and higher grain yield was obtained with drip fertigation at 200% PE + 125% RDF which was on a par with drip irrigation at 200% PE + 100% RDF and drip fertigation at 150% PE + 125% RDF in rice grown in light soil tracts of Cauvery command during *rabi* season.

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