Short communication

Aerobic rice in uplands with micro sprinkler irrigation

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Abstract

A field experiment was conducted at Kerala Agricultural University campus, Thrissur, during February to June 2014 to study the response of upland aerobic rice to sprinkler irrigation. The trial was laid out in Split Plot Design with three replications. Treatments included four irrigation levels; sprinkler irrigation at 75 per cent pan evaporation, 100 per cent pan evaporation, 125 per cent pan evaporation and life saving irrigation at 5cm depth at required stages and three fertilizer doses; 90:45:45 N, P_2O_5, K_2O kg ha^{-1}, 70:35:35 N, P_2O_5, K_2O kg ha^{-1} and 60:30:30 N, P_2O_5, K_2O kg ha^{-1}. Sprinkler irrigation at 125 per cent pan evaporation resulted in significantly higher plant height, tiller number per hill, panicles per hill, grains per panicle, grain and straw yield. The highest field water use efficiency (FWUE) of 9.11 kg ha^{-1} mm^{-1} was recorded at the lower irrigation level of 75 per cent pan evaporation. The fertilizer levels failed to show significant influence on grain yield.

Keywords: Aerobic rice, Fertilizers, Micro sprinkler irrigation, Upland rice.

Rice is a profligate user of water, consuming about half of all the fresh water resources of the world (Castaneda et al., 2002). Because of continuous presence of ponded water, there is a huge loss of water through evaporation, seepage and percolation. A fundamental approach to reduce water use in rice production is to grow it like an irrigated upland crop. Aerobic rice with micro irrigation practices is said to be a suitable technology to address water scarcity. According to McCauley (1990), micro sprinkler irrigation is an alternative irrigation method which can contribute substantially to lower water consumption in rice. It may be an option in areas where water has become too scarce or expensive to grow flooded rice, and in rainfed area during summer where irrigation water is insufficient for typical flooded rice production. In view of these issues, the present study was conducted to study the response of aerobic upland rice to micro sprinkler irrigation and nutrient levels.

The study was conducted from February 2014 to May 2014 at Kerala Agricultural University campus, Thrissur, Kerala. The daily mean maximum and minimum temperatures during the cropping period were 34.97^{0}C and 24.25^{0}C. The daily mean pan evaporation varied from 3.4 mm to 5.2 mm during the season. The soil of the experimental site was sandy loam with a pH of 5.48, field capacity of 16.5 per cent and permanent wilting coefficient of 6.6 per cent and available N, P and K status of 253, 58 and 92 kg ha^{-1} respectively. The organic carbon content was 1.70 per cent and EC 0.057 dS m^{-1}.

The experiment was laid out in split plot design in view of easiness in laying irrigation lines. The main plots had irrigation levels as treatments which included irrigation at 75 per cent pan evaporation (Ep) (I_1), 100 per cent Ep (I_2), 125 per cent Ep (I_3) and life saving irrigations at 5cm depth (I_4) and the sub plot treatments included three fertilizer levels;

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90:45:45 N, P_2O_5, K_2O kg ha^{-1} (F_1), 70:35:35 N, P_2O_5, K_2O kg ha^{-1} (F_2) and 60:30:30 N, P_2O_5, K_2O kg ha^{-1} (F_3). 'Uma' (MO-16), a red kernelled, medium duration cultivar (120 days) was used. The plot size was 25 m^2 and seeds were dibbled at a spacing of 20 cm x 10 cm.

For irrigation, water was pumped through a 1HP motor and it was conveyed to the main field using 40 mm PVC pipes after filtering through sand and screen filters. From the main line, water was taken to the field through sub mains of 25 mm diameter. The diameter of main line and sub main was fixed considering the total quantity of water required for irrigation as well the head losses. From the sub main, lateral PVC pipe of 20 mm diameter was extended to the centre of each sub plot to which a 20 mm riser pipe of 1m height was connected on which the sprinkler heads were fixed, so that each sprinkler head uniformly wetted 25 m^2 plot area. At the head end of each sub main, valves were fixed to regulate the irrigation regimes. The discharge rate of micro sprinkler head used was 300 L hr^{-1} and the distribution efficiency was 80 per cent. From the first day of sowing itself sprinkler system was operated. Daily irrigation based on the evaporation values of the day was given to all plots through micro sprinklers except the plots receiving life saving irrigation and the quantity was fixed as per the treatment. Life saving irrigation was given when the plants showed incipient wilting symptom.

The volume of irrigation water required for each treatment was calculated as follows:
Volume (L) =
Pan evaporation (Ep) (mm) x Area (m^2) / 10000
Time of operation of sprinkler system to deliver the required volume of water per plot was computed based on the formula.
Time of application (h) =
Volume of water (L) / Discharge rate of sprinkler (L h^{-1})

The soil test data indicated that the soil was low in available N as well as K and medium in available P. The entire dose of phosphorus as bone meal was applied as basal and incorporated into the soil. Urea as nitrogen source and Muriate of Potash as potassium source were applied through irrigation water as foliar application with the help of a fertilizer injector. Fertilizers were applied in ten split doses at six days interval from 12 DAS to 66 DAS. In the plots receiving life saving irrigation, fertilizers were applied in three split doses (1/3rd N and K as basal, 1/3rd at maximum tillering and 1/3rd at panicle initiation).

The field water use efficiency of the aerobic rice was calculated using the formula,
FWUE (kg ha^{-1} mm^{-1}) =
Grain yield (kg ha^{-1}) / Water used (mm)
The data were subjected to analysis of variance using the statistical package 'MSTAT-C'.

Table 1. Influence of irrigation and fertilizer levels on height (cm) and tillers of rice plant

Treatment	Plant height	No. of tillers per hill	Plant height	No. of tillers per hill	Plant height	No. of tillers per hill
	30 DAS		60 DAS		At harvest	
IrrigationI_1 (75per cent Ep)	34.06	18.32	53.09	23.21	72.64	12.11
I_2 (100per cent Ep)	35.47	18.44	57.70	24.10	77.87	14.78
I_3 (125per cent Ep)	37.66	19.65	59.97	27.22	85.46	30.89
I_4 (Life saving irrigation)	24.22	16.11	40.84	19.78	66.24	08.22
CD (0.05)	2.95	NS	2.12	1.88	6.52	1.76
FertilizerF_1 (90:45:45 N, P_2O_5, K_2O kg ha^{-1})	33.63	19.41	55.25	22.91	76.94	17.00
F_2 (70:35:35 N, P_2O_5, K_2O kg ha^{-1})	32.41	19.25	52.67	20.83	76.07	16.08
F_3 (60:30:30 N, P_2O_5, K_2O kg ha^{-1})	32.53	18.00	50.80	19.58	73.65	16.42
CD (0.05)	NS	NS	2.75	2.78	3.01	NS
Interaction (I x F)	NS	NS	NS	NS	NS	NS

Levels of irrigation significantly influenced the height of rice plant (Table 1). Throughout the growth stages, shortest plants were observed under life saving irrigation but were taller under 125 per cent Ep (I_3) irrigation. Govindan and Grace (2012) observed the influence of drip irrigation in imparting tallness in aerobic rice. The lower values of plant height under life saving irrigation might be due to reduction in soil moisture status due to the increased loss of water through evapo-transpiration and percolation and resultant moisture stress experienced by the crop. Reduction in growth parameters with increase in severity of water stress is due to anatomical changes in the plant like decrease in cell volume, cell division, cell elongation, intercellular space and thickening of cell wall as reported by Adriano et al. (2005).

At 30 DAS, number of tillers/hill was not significantly influenced by irrigation levels (Table 1). On the contrary, irrigation levels significantly affected tiller number per hill at 60 DAS and at harvest. The sprinkler irrigation given at 125 per cent Ep (I_3) registered significantly higher number of 27.22 and 30.89 tillers per hill at 60 DAS and at harvest respectively. A drastic reduction in tiller count to the tune of almost 10 numbers per hill from 60 DAS to harvest stage was observed in 75 per cent Ep (I_1) and 100 per cent Ep (I_2) irrigation. Murthy et al. (2012) also reported reduction in tiller count of rice with lower irrigation regime.

At 30 DAS plant height and tiller number were not significantly influenced by fertilizer levels. However at harvest, significant differences were observed (Table 1). However interaction between irrigation and fertilizer levels was not significant with respect to plant height of rice as well as tiller number at all stages of crop growth.

Panicles per hill and grains per panicle were significantly influenced by irrigation levels (Table 2). The increase in irrigation from 75 per cent to 125 per cent Ep resulted in 56 per cent increase in panicle number whereas increase in irrigation from 75 per cent to 100 per cent Ep resulted in only 16 per cent increase in panicle number. The grains per panicle varied from 56.22 to 78.89. The test weight of grain did not show any statistically significant variation with respect to irrigation level. Several workers like Karim et al. (2014) reported that test weight of grains do not vary greatly due to irrigation levels.

The grain and straw yield of sprinkler irrigated upland rice showed an increasing trend with increase in irrigation levels (Table 2). However the fertilizer levels failed to register any significant influence. The lowest grain and straw yield were recorded in plots which received life saving irrigation which was 36 per cent lower than yield under 125 per cent Ep (I_3) irrigation. This can be attributed to the lowest values of yield attributes registered in this treatment. Kahlown et al. (2007)

Table 2. Influence of irrigation and fertilizer levels on yield and yield attributes of rice

Treatment	Panicles per hill	Number of grains per panicle	1000 grain weight (g)	Grain yield (Mg ha^{-1})	Straw yield (Mg ha^{-1})	Harvest Index
Irrigation						
I_1 (75per cent Ep)	11.66	62.22	21.61	2.78	3.39	0.45
I_2 (100per cent Ep)	13.55	68.67	21.34	2.84	3.97	0.42
I_3 (125per cent Ep)	18.23	78.89	21.67	3.20	4.74	0.40
I_4 (Life saving irrigation)	08.12	56.22	21.21	2.04	2.25	0.47
CD (0.05)	0.93	9.71	NS	0.04	0.11	0.01
Fertilizer						
F_1 (90:45:45 N, P_2O_5, K_2O kg ha^{-1})	13.16	68.25	1.58	2.73	3.62	0.42
F_2 (70:35:35 N, P_2O_5, K_2O kg ha^{-1})	12.83	66.17	21.31	2.72	3.59	0.43
F_3 (60:30:30 N, P_2O_5, K_2O kg ha^{-1})	12.67	65.08	21.48	2.70	3.57	0.43
CD (0.05)	NS	NS	NS	NS	NS	NS
Interaction (I x F)	NS	NS	NS	NS	NS	NS

also reported decrease in grain and straw yield of aerobic rice under lower level of irrigation water supplied through sprinkler or drip. The harvest index was 0.40 under 125 per cent Ep which was below the standard value under favourable condition. Low grain yield compared to straw yield was the main reason for low harvest index. Hence, it can be assumed that the moisture supply was sufficient for vegetative growth and at later phases the plant experienced stress which affected the grain yield.

Interaction between irrigation and fertilizer levels were not significant with respect to yield and yield attributes of rice. The soil of the experimental plot was high in organic carbon as well as available phosphorus. This may be a reason for lack of response to applied fertilizers. Poor response of upland rice to applied nutrients is reported elsewhere. The stress factor also might have affected the plant response to nutrients.

Irrigation at 75 per cent Ep registered the highest field water use efficiency (FWUE) and the lowest field water use efficiency of 3.39 kg ha^{-1} mm^{-1} was registered for crop grown under life saving irrigation (Fig.1). As the irrigation level increased from 75 per cent Ep to 125 per cent Ep the FWUE decreased, probably due to the loss of applied water through evaporation and percolation. Decrease in WUE with increase in levels of irrigation was also reported by Tuong et al. (2004). It was observed that the overhead irrigation favoured the incidence of sheath blight disease which also adversely affected the yield of crop at higher irrigation levels and resulted in low water use efficiency. FWUE was not significantly influenced by fertilizer levels and the interaction between irrigation and fertilizer levels was also not significant.

The results of the study indicate that upland rice can be raised with over head irrigation through micro sprinkler. All the growth and yield parameters were influenced by irrigation levels and higher values were recorded when quantity of irrigation water supplied was at 125 per cent pan evaporation. However there is need to standardize the irrigation level as the crop experienced stress and did not record the yield attainable under conducive growing environment. The nutrient levels also need to be standardized under optimum irrigation level.

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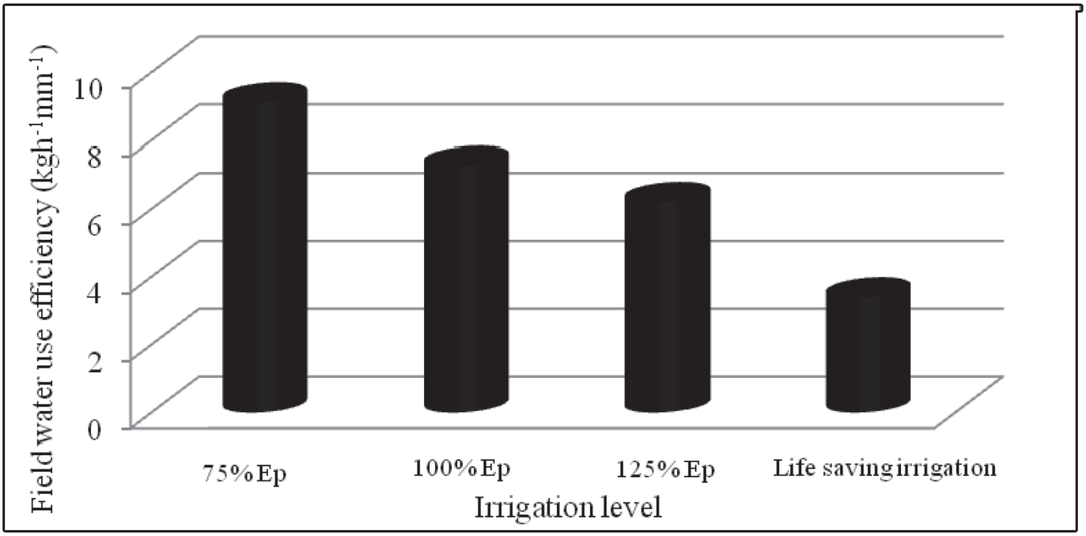

Figure 1. Field water use efficiency of aerobic upland rice as influenced by irrigation levels

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