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Effect of deficit irrigation practices on growth and yield of transplanted rice (*Oryza sativa* L.)

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Abstract
A field trial was conducted on transplanted rice on clay soils of the Agricultural College Farm, Bapatla to study the effect of growth and yield of rice under deficit irrigation during *kharif*, 2017-18. The experiment was laid out in randomized block design with seven treatments and three replications. Continuous submergence of 5 cm throughout the growth period (T_1) resulted in increasing growth, yield attributes and yield of transplanted rice as compared to deficit irrigation treatments; however, AWD irrigation with 5 cm submergence till 5 cm depth of water receded below ground level in field water tubes (T_6) was found to be suitable without considerable reduction in yield simultaneously reducing the water use by 26 % compared to that of continuous submergence.

Keywords: Rice, alternate wetting and drying (AWD), growth and yield

Introduction
Rice is the staple food of more than a half of the world population especially the Asian countries. The demand for rice is increasing with population growth, but the growing scarcity of fresh water may pose the problems for rice production in the years to come. The area under rice production in India (43.99 m ha) is the largest among all the rice growing countries with an annual production of 109.69 million tonnes and productivity of 2.49 t/ha (www.indiastat.com). Generally, rice demands higher water inputs than other cereal crops. Water required to produce 1.0 kg of rice is about 3000- 5000 liters (Geethalakshmi *et al.*, 2011) [3]. It is estimated that, by 2025, about 2 million ha of Asia's irrigated dry season rice and 13 million ha of irrigated wet season rice are going to be experiencing water scarcity (Tuong and Bouman., 2003). Meanwhile rapid population growth demands more rice production; so, need of the hour is to produce rice with less water (deficit irrigation) while increasing both land and water productivity.

Alternate Wetting and Drying (AWD) method of irrigation has been evolved as one of the water saving options where instead of full irrigation, deficit irrigation is being practiced. Here alternate cycles of saturated and unsaturated conditions are maintained and irrigation water is applied to obtain flooded conditions after a certain number of days have elapsed after the disappearance of ponded water. So, the present study was carried out to study the effect of deficit irrigation on growth and yield of transplanted rice.

Material and methods
A field experiment was conducted during *kharif*, 2017-18 of the Agricultural college farm, Bapatla. The soil of the experimental field was clayey in texture, moderately alkaline (pH-8.5) in reaction, low available nitrogen (188 kg ha^{-1}), medium in available phosphorus (15 kg ha^{-1}) and available potassium (187 kg ha^{-1}). The experiment was laid out in randomized block design with seven treatments and three replications. The treatments included continuous submergence of 3-5 cm depth from transplanting to maturity (T_1), irrigation with ponded water depth of 3 cm at weekly interval from 15 DAT to maturity (T_2), irrigation with ponded water depth of 5 cm at weekly interval from 15 DAT to maturity (T_3), AWD with 3 cm submergence till 5 cm depth of water receded below ground level (BGL) in field water tubes from 15 DAT to maturity (T_4), AWD with 3 cm submergence till 10 cm depth of water receded BGL in field water tubes from 15 DAT to maturity (T_5), AWD with 5 cm submergence till 5 cm depth of water receded BGL in field water tubes from 15 DAT to maturity (T_6), AWD with 5 cm

submergence till 10 cm depth of water receded below ground level in field water tubes from 15 DAT to maturity (T_7). In the four AWD treatments *viz*., T_4, T_5, T_6 and T_7, field water tubes were installed for monitoring of water level and application of required quantity of water. Amount of water applied to each treatment was measured with the help of Parshall flume. Continuous submergence of 5 cm was maintained upto 15 DAT in all the treatments. The irrigation treatments were imposed from15 DAT. The growth and yield parameters were recorded and analyzed statistically using ANOVA.

Results and discussion

Growth parameters

Plant height did not differ significantly among different irrigation schedules during 30, 60 and 90 DAT but during harvesting significant differences were noticed. Continuous submergence (T_1) was observed with significantly taller plants than all other treatments; however, it was found on a par with those of T_5 and T_6 (Table 1). There was significant difference in tiller count at all the stages of crop growth except at harvesting. A significant increase in tiller number was found under T_1 but without any significant differences with those of T_4, T_5 and T_6. Irrigation schedules did not affect the production of dry matter at early stages of crop growth (30 DAT and 60 DAT) whereas, at 90 DAT and at harvest, significant differences were observed among the treatments. Continuous submergence resulted in significantly higher amount of drymatter production over all other treatments except T_4, T_5 and T_6 at harvest. AWD irrigation through field water tubes (T_4, T_5, T_6 and T_7) and irrigation of 5 cm at weekly interval (T_3) were found on a par with each other.

Increased growth under continuous submergence might be due to effective uptake of water and nutrients under higher moisture condition resulting in increase in plant height, tiller number and drymatter accumulation. The results are in conformity with the findings of Maheswari *et al*. (2008) [6], Marimuthu *et al*. (2010) [7] and Shekara *et al.* (2010) [9].

Yield parameters

Result of the experiment (Table 2) revealed that a significant increase in number of productive tillers were observed with continuous submergence of 5 cm (T_1) over irrigation given at weekly interval (T_2 and T_3); however, it was found statistically on a par with AWD irrigation through field water tubes (T_4, T_5, T_6 and T_7). There was no significant difference in total number of grains per panicle but number of filled grains per panicle differed significantly among various irrigation treatments. Continuous submergence resulted in significantly more number of filled grains over other treatments. It was followed by treatment T_6 which was found on a par with T_5 and was significantly superior over rest of the treatments. Test weight being genetically governed character, did not differ significantly among the irrigation treatments. Similar results were also shown by Diproshan *et al*. (2015) [2].

Plants with continuous submergence of 5 cm throughout the growth period produced maximum grain yield and was found statistically superior over other treatments. T_6 was reported to be the next best treatment over other but it was on a par with that of T_5. Among the 7 irrigation schedules, T_2 recorded significantly lower yield than other treatments; however, the difference was not statistically significant when compared with T_3, T_4 and T_7. Continuous submergence might have provided a conducive rhizosphere condition for better uptake of nutrients and in turn helped the plants to boost their growth leading to development of yield attributing characters through supply of more photosynthates towards reproductive sink resulting in higher grain yield. The results are in accordance with the findings of Ramakrishna *et al*. (2007) [8] and Carrijo *et al*. (2017) [1].

Continuous submergence (T_1) resulted in significantly higher straw yield than all other treatments; however, it was on a par with those obtained under T_6, T_5 and T_4. There was no significant differences in harvest index under various irrigation treatments; however, the highest HI was found under T_1 and T_6 whereas, the lowest was recorded with T_2 and T_3. Jha *et al*. (2007) [5] also reported similar finding in low land rice.

Table 1: Effect of deficit irrigation practices on growth parameters of transplanted rice

Treatments	Plant height (cm)	Number of Tillers m $^{-2}$	Dry matter production (g m^{-2})
T_1 continuous submergence of 3-5 cm depth from transplanting to maturity	101.8	314.4	2173.7
T_2 Irrigation with ponded water depth of 3 cm at weekly interval from 15 DAT to maturity	99.7	242.8	1591.1
T_3 Irrigation with ponded water depth of 5 cm at weekly interval from 15 DAT to maturity	100.4	270.7	1826.3
T_4 AWD with 3 cm sub. till 5 cm depth of water receded BGL in field water tubes from 15 DAT to maturity	100.6	287.9	1826.7
T_5 AWD with 3 cm sub. till 5 cm depth of water receded BGL in field water tubes from 15 DAT to maturity	101.0	298.0	1986.7
T_6 AWD with 5 cm sub. till 5 cm depth of water receded BGL in field water tubes from 15 DAT to maturity	102.2	299.6	2111.5
T_7 AWD with 5 cm sub. till 10 cm depth of water receded BGL in field water tubes from 15 DAT to maturity	100.6	284.6	1930.4
SEm±	0.46	15.82	105.78
CD(p=0.05)	1.4	NS	326

Table 2: Effect of deficit irrigation practices on yield and yield parameters of transplanted rice

Treatments	productive tillers m $^{-2}$	Total number of grains	Number of filled grains	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	HI
T_1	288.2	247.4	228.5	5573	6204	0.48
T_2	236.5	210.7	194.3	4348	5021	0.46
T_3	244.2	217.5	201.9	4453	5113	0.46
T_4	266.4	225.5	204.8	4674	5510	0.47
T_5	270.2	229.1	213.5	4910	5563	0.47
T_6	273.3	237.6	218.9	5092	6189	0.48
T_7	262.2	219.1	204.2	4664	5180	0.47
SEm±	14.00	11.97	2.95	113.40	255.23	0.03
CD(p=0.05)	29.6	NS	9.1	349.5	786.5	NS

Conclusions

Overall, it can be concluded that continuous submergence of 5 cm (T_1) performed better in increasing growth and yield of transplanted rice; however, under deficit water conditions, AWD irrigation of 5 cm submergence with 5 cm water drop below ground level in field water tubes (T_6) found suitable without considerable reduction in yield.

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