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Effect of crop establishment methods and irrigation scheduling on growth and yield of rice

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Abstract
Field experiment was carried out at Soil and Water Management Research Institute, kattuthottam, Thanjavur during *rabi* season of 2016-2017 to study the effect of crop establishment methods and irrigation scheduling on growth and yield of rice. The experiment was laid out in split plot design with three replication. The treatments comprised of three establishment methods *viz*., direct seeded rice, non puddled machine transplanted rice and puddled transplanted rice in main plots and seven irrigation scheduling practices in sub plots *viz.*, alternate wetting and drying at 10 cm depletion of ponded water, alternate wetting drying at 15 cm depletion of ponded water, alternate wetting and drying at 20 cm depletion of ponded water , alternate wetting and drying at 10 cm depletion of ponded water and submergence at flowering, alternate wetting and drying at 15 cm depletion of ponded water and submergence at flowering, alternate wetting and drying at 20 cm depletion of ponded water and submergence at flowering and irrigation on the day of disappearance of ponded water. It was found that direct seeded rice recorded significantly higher plant height, DMP, productive tillers m^{-2}, number of grains $panicle^{-1}$, and grain yield compared to puddled transplanted rice and non puddled transplanted rice. Among the various irrigation scheduling practices, irrigation on the day of disappearance of ponded water recorded higher growth and yield parameters and it was on par with alternate wetting and drying at 10 cm depletion of ponded water and submergence at flowering. Crop establishment method and irrigation scheduling contributed significant influence on growth and yield of rice.

Keywords: Direct seeded rice, Non puddled machine transplanted rice, AWDI irrigation, DMP, Yield

Introduction
Rice (*Oryza sativa* L.) being the staple food crop in the world. In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products. Manual transplanting requires a lot of labours besides involving drudgery and is also very expensive. Scarcity of labours is another major problem in some paddy growing areas of the country. Manual transplanting takes about 250-300 man hours/ha which is roughly about 25 per cent of the total labour requirement of the crop. Hence, less expensive, farmer friendly and labour saving method of paddy transplanting is urgently needed. Urbanisation, migration of labour from agriculture to non-agriculture sector and increased labour costs are seriously treating the cultivation of crops in general and rice in particular (Yadav *et al.*, 2014) [15]. The mechanical transplanting or sowing of paddy has been alternate and the most promising option, as it saves labour, ensures timely transplanting and attains optimum plant density that contributes to high productivity (Usha *et al.* 2015) [13]. Through mechanization, reducing the seedling age by half, cut the seed requirement by 50%, labour requirement by 60% thereby reduce the production cost by 27% and increase the profit per ha by 36% as compared to conventional transplanting was reported by Uprety (2010) [12].

Rice is grown with utmost importance but with a misconception that it requires an enormous amount of water. High seepage and percolation losses are the main reasons for the much higher water use in flooded rice than in other crops. Alternate wetting and drying (AWD) irrigation is a water saving technology that reduces the water use in rice fields. There was a reduction in the grain yield in alternate wetting and drying when compared with rice grown with standing water (Bouman and Tuong, 2001) [3]. Kulkarni (2011) [6] reported that using of field water tube for AWD is safe to limit the water use upto 25% without reduction in rice yield. Compared to famers practice of continuous flooding, safe AWD saves as much as irrigation water (30%) without any reduction in yield and increases farmers' income by 30% (Lampayan, 2013) [8].

Hence, the present investigation was taken up to study the effect of different crop establishment methods and irrigation scheduling on growth and yield of rice.

Materials and Methods

Field experiments was conducted during *rabi* season of 2016-2017 at Soil and Water Management Research Institute, kattuthottam, Thanjavur Tamil Nadu. The experimental field is situated in Cauvery Delta Zone of Tamil Nadu geographically located at 10° 45N latitude, 79 °E longitude with an altitude of 50 m above mean sea level. The soil of the experimental site was sandy clay loam in texture having neutral pH (6.47), EC (0.15) and medium organic carbon (0.58%), With regard to nutrient status, the soil was low in available nitrogen (251 kg ha^{-1}), high in phosphorus (15.8 kg ha^{-1}) and medium in potassium (198.8 kg ha^{-1}), respectively.

Experiment was laid out in split plot design with three replication. The treatments comprised of three establishment methos *viz*., direct seeded rice (M_1), non-puddled machine transplanted rice (M_2) and puddled transplanted rice (M_3), respectively in main plots and seven method of irrigation scheduling in sub plots *viz.*, alternate wetting and drying irrigation at 10 cm depletion of ponded water (I_1), alternate wetting and drying irrigation at 15 cm depletion of ponded water (I_2), alternate wetting and drying irrigation at 20 cm depletion of ponded water (I_3), alternate wetting and drying irrigation at 10 cm depletion of ponded water and submergence at flowering (I_4), alternate wetting and drying irrigation at 15cm depletion of ponded water and submergence at flowering, alternate wetting and drying irrigation at 20 cm depletion of ponded water and submergence at flowering and irrigation on the day of disappearance of ponded water. Each individual plot was separated with buffer cannels for proper maintenance of the treatments. The irrigation water was measured with the parshall flume. In order to evaluate the effect of crop establishment methods and irrigation scheduling on growth characters, yield characters and yield, the data were statistically analyzed using "Analysis of variance test". 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) [5].

Result and Discussion

Growth characters of rice

Direct dry seeded rice recorded significantly higher plant height of 107.1 cm and dry matter production (12593 kg^{-1}) and it was followed by puddled transplanted rice. Invariably, shorter plant height and less DMP was observed under non-puddled machine transplanted rice. Irrigation on the day of disappearance of ponded water produced taller plants (110.7 cm), dry matter production (13441 kg^{-1}) and tillers m^{-2} (371) and it was on par with alternate wetting and drying irrigation at 10 cm and submergence at flowering compared to other treatments. The results were in agreement with the findings of Kumar *et al.* (2008) [7] and Aslam *et al.* (2008) [1].

Table 1: Effect of crop establishment methods and irrigation scheduling on plant height and dry matter production of rice

Treatments	Plant height				Dry matter production			
	DSR	NPMT	PT	Mean	DSR	NPMT	PT	Mean
I_1	106.2	88.9	96.8	97.3	12837	9825	11431	11364
I_2	101.8	84.4	92.6	92.9	11119	9683	10749	10517
I_3	96.4	78.3	85.9	86.9	10247	9119	9983	9783
I_4	115.0	99.8	111.3	108.7	15060	11288	13645	13331
I_5	111.5	92.6	101.8	102.0	12899	10486	12145	11843
I_6	98.9	80.3	89.5	89.5	10610	9348	10639	10199
I_7	119.7	102.7	109.8	110.7	15381	11575	13367	13441
Mean	107.1	89.6	98.2		12593	10189	11708	
	M	I	M at I	I at M	M	I	M at I	I at M
SEd	1.5	2.7	4.6	4.7	185	323	551	561
CD (p=0.05)	4.2	5.5	NS	NS	514	657	1165	1137

Yield parameters of rice

Crop establishment methods, direct dry seeded rice produced more number of productive tillers (341) and number of grains $panicle^{-1}$ (242). It was followed by puddled transplanted rice and non-puddled machine transplanted rice. Among the irrigation scheduling, more number of productive tillers m^{-2} (365) and number of grains $panicle^{-1}$ (262) was registered under Irrigation on the day of disappearance of ponded water. It was on par with alternate wetting and drying irrigation at 10 cm depletion of ponded water and submergence at flowering. Lesser number of productive tillers m^{-2}, panicle length and number of grains $panicle^{-1}$ was noticed under alternate wetting and drying irrigation at 20 cm depletion of ponded water. Similar trends was observed by Patel (2000) [10], Baloch *et al.* (2006) [2] and Paul *et al.* (2013) [11].

Table 2: Effect of crop establishment methods and irrigation scheduling on productive tillers m^{-2}, panicle length (cm) and number of filled grains $panicle^{-1}$ of rice

Treatments	Productive tillers m^{-2}				Number of grains $panicle^{-1}$			
	DSR	NPMT	PT	Mean	DSR	NPMT	PT	Mean
I_1	346	268	310	308	250	193	226	223
I_2	298	261	288	283	217	194	210	207
I_3	270	242	266	259	196	189	191	192
I_4	409	302	368	360	272	218	267	252
I_5	351	282	331	321	257	202	245	234
I_6	292	253	286	277	215	193	206	205
I_7	418	316	362	365	287	236	262	262
Mean	341	275	316		242	204	230	
	M	I	M at I	I at M	M	I	M at I	I at M

SEd	5	8	15	15	4	6	11	11
CD (p=0.05)	14	17	31	31	10	13	23	22

Grain and straw yield

Among the three crop establishment methods, direct seeded rice recorded higher grain yield of 5671 kg ha^{-1}. However, it was comparable with puddled transplanted rice. Whereas, non puddled machine transplanted rice recorded significantly lesser grain of 4579 kg ha^{-1} kg ha^{-1}. Direct seeded rice recorded 6.57% higher yield than puddled transplanted rice and 19.2% higher yield over machine transplanted rice.

Irrigation scheduling practices greatly influenced the rice grain yield. Among the irrigation scheduling practices, irrigation on the day of disappearance of ponded water (I_7) recorded higher grain and straw yield (6104 kg ha^{-1} and 7177 kg ha^{-1}, respectively) and it was on par with alternate wetting and drying irrigation at 10 cm and submergence at flowering. Whereas, alternate wetting and drying irrigation at 20 cm depletion of ponded water registered lower grain and straw yield of 4317 kg ha^{-1} and 5042 kg ha^{-1} respectively. The increased yields might be due to favourable growing condition and nutrient supply with increased uptake of nutrients under irrigation on the day of disappearance of ponded water without any stress resulted in higher source to sink conversion, which consecutively resulted in higher grain and straw yield. These findings are in agreement with Geethalakshmi *et al*. (2009) [4] and Majeed *et al.* (2017) [9].

Table 2: Effect of crop establishment methods and irrigation scheduling on Grain yield (kg ha^{-1}) and Straw yield (kg ha^{-1}) of rice

Treatments	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})			
	DSR	NPMT	PTR	Mean	DSR	NPMT	PTR	Mean
I_1	5762	4465	5195	5141	6770	5148	6109	6009
I_2	4965	4352	4850	4722	5879	5127	5733	5579
I_3	4503	4025	4423	4317	5336	4762	5029	5042
I_4	6810	5035	6170	6005	8056	5977	7318	7117
I_5	5840	4698	5573	5370	6804	5534	6426	6255
I_6	4862	4210	4784	4619	5504	4921	5676	5367
I_7	6954	5265	6094	6104	8247	6076	7209	7177
Mean	5671	4579	5298		6657	5363	6214	
	M	I	M at I	I at M	M	I	M at I	I at M
SEd	83	146	249	253	99	172	293	298
CD (p=0.05)	232	296	525	513	275	349	619	604

Interaction effect was found to exist between crop establishment methods and irrigation scheduling with respect to rice grain and straw yields. Direct dry seeded rice with irrigation on the day of disappearance of ponded water registered higher straw yield. However, it was on par with direct seeded rice with alternate wetting and drying irrigation at 10 cm depletion of ponded water and submergence at flowering. Invariably, lowest straw yield was recorded under non puddled machine transplanted rice with alternate wetting and drying irrigation at 20 cm depletion of ponded water.

Conclusion

Among the crop establishment methods and irrigation scheduling, direct seeded rice with irrigation on the day of disappearance of ponded water recorded higher growth and yield attributes grain and straw yield. This was followed by puddled transplanted rice and non-puddled machine transplanted rice. Direct seeded rice is a sustainable and very feasible alternative to puddled transplanted rice which skips nursery and transplanting and saves cost of production.

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