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EFFECT OF PUDDLING PRACTICES AND CROP ESTABLISHMENT METHODS ON THE PRODUCTIVITY OF RICE (*ORYZA SATIVA.*L)

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ABSTRACT

A research trial was conducted in clay loam soils at Regional Agricultural Research Station, Maruteru, Andhra Pradesh during *rabi*, 2022-23 to assess the effects of puddling and crop establishment methods on rice productivity.The study comprised two factors: puddling practice, *viz*., power tiller (M_1), rotovator (M_2,) and roto-puddler (M_3) as main plot treatments and crop establishment method, *viz..*,drum seeding (E_1),line planting (E_2),machine planting (E_3),diagonal planting (E_4,) and Bengal planting (E_5) as sub-plot treatments.The results showed that among the puddling practices, the use of a roto-puddler registered the highest growth parameters at harvest, such as number of tillers m^{-2} (401), crop dry matter (11053 kg ha^{-1}), and yield attributes, that is, the number of panicles m^{-2} (371), total number of grains $panicle^{-1}$ (259), grain (4697 kg ha^{-1}), and straw yield (6098 kg ha^{-1}). This was statistically at par with the use of a rotovator but significantly superior to that of a power tiller. Among crop establishment methods, growth parameters at harvest, that is, number of tillers m^{-2} (416), crop dry matter (11427 kg ha^{-1}), and yield parameters, that is, the number of panicles m^{-2} (386), total number of grains $panicle^{-1}$ (257), grain (4837 kg ha^{-1}), and straw yield (6148 kg ha^{-1}) were higher with the diagonal planting method; however, it was found statistically at par with Bengal planting and drum seeding but significantly superior over machine planting and line planting.

Keywords: Bengal planting, Diagonal planting, Power tiller, Rice, Roto-puddler

INTRODUCTION

Rice is the foremost food crop of India, cultivated in an area of approximately 45.07 m ha with a production of 129.5 m t and productivity of 2798 kg ha^{-1} during 2019-2020 (Ministry of Agriculture & Farmers Welfare, 2022).Land preparation is a crucial part of rice production because puddling is required to decrease the loss of water and nutrients through excessive percolation, and it can also reduce weeds and enhance nutrient availability (Hazra *et al*., 2014; Alam *et al*., 2018).However, the long-term effects of puddling could lead to the formation of large clods in fine-textured soils, resulting in negative effects on soil characteristics, leading to a decline in rice yield.Therefore, great emphasis has been placed on the development of suitable puddling practices and machinery for wetland rice cultivation.Rotovators and roto-puddlers are new options through which puddling and levelling can be performed together.The roto-

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puddler aids in green manure inclusion in wetland areas.

Manual transplanting under puddled conditions is the regular practice of rice establishment.However, the conventional establishment of rice by transplanting is laborious, and vigorous tillage consumes more energy and water and spoils the soil structure.In transplanting, major operations such as nursery preparation and management, pulling of nursery, and transporting and distributing seedlings to the main field consume 30–40 percent of the total expenses on cultivation (Rani and Jayakiran, 2010).Alternate establishment methods can be utilized to reduce the cost of cultivation, even if the productivity remains static or increases.Rice crops are grown in many ways, depending on resource availability.The drum seeder is a simple piece of equipment thatsolves problems tremendously.Apart from monetary savings, it also has advantages such as a reduction in crop duration by 10-12 days the possibility of better weed management and fertilizer application under row seeding, which is not possible in traditional transplanting. The machine transplanting of rice has been apprised the most promising option, as it saves labour, ensures timely transplanting, and attains required plant density that contributes high productivity, saves energy, minimizes drudgery besides early crop maturity and efficient water use besides benefit:cost ratio. Diagonal planting is a new method of planting in which the number of plants is doubled compared to common line planting (Dhawan, 2018).This planting method is a variant of the line-planting system.An extra plant is often set at the center of each square.Recently, farmers have been using skilled manpower for planting with early aged seedlings, locally called the Bengal planting method, which is a standard practice throughout the Godavari region of Andhra Pradesh. This method enables stable rice yields by way of effective weed control; stimulated root growth and optimum plant stand with enhanced tillering under reduced inputs and unpredictable climatic conditions

MATERIAL AND METHODS

A field trial was conducted to study the effect of puddling and crop establishment methods on rice productivity at the Regional Agricultural Research Station, Maruteru,during *rabi*, 2022-23. The experimental soil was clay loam, slightly acidic in reaction pH (5.7), EC 0.32 dSm^{-1}, medium in organic carbon (0.54%), low in available nitrogen (220 kg ha^{-1}), medium in available phosphorus (28.4 kg ha^{-1}), and high in available potassium (312 kg ha^{-1}).The rice variety “MTU- 1121” (Sri Druthi) was used as the test variety.The experiment was designed as a split-plot with three main plots of puddling practices and five subplots of crop establishment methods with three replications.The main plots comprised three different puddling practices: power tiller (M_1), rotovator (M_2), and roto-puddler (M_3). Five crop establishment methods of rice, *viz.*, drum seeding (E_1), line planting (E_2), machine planting (E_3), diagonal planting (E_4), and Bengal planting (E_5) were assigned to sub-plots.

RESULTS AND DISCUSSION

Crop Growth Parameters

Plant growth parameters, such as the number of tillers and crop dry matter accumulation (kg ha^{-1}), were studied during the experiment (Table 1).All growth parameters were significantly influenced by both puddling practices and crop establishment methods, but not due to their interaction.Among the puddling practices, significantly higher values of growth parameters were observed in the Roto-puddler (M_3), which was at par with the Rotovator (M_2).Significantly lower values of growth parameters were observed with the power tiller

(M_1).Higher tiller count per m^{-2} (401) and higher dry matter accumulation (11053 kg ha^{-1}) were observed with the roto-puddler, which was due to enhanced and prolific rice growth under puddled tillage using a roto-puddler, which provided adequate soil physical characteristics and balanced nutrient availability throughout crucial phenophases, which might have resulted in a greater number of tillers and greater dry matter accumulation with biomass.Similar results were observed by Dewanti and Mandang (2022), and Srinivas *et al*. (2023).The lower tiller number and less dry matter accumulation with the power tiller treatment was due to greater hill mortality and bulk density of soil leading to lesser root growth. These results are in accordance with the findings of Srinivas *et al*. (2023).

In terms of crop establishment methods, the diagonal planting method had the paramount tiller number m^{-2} (416) and higher drymatter accumulation (11427 kg ha^{-1}) at harvesting stage and it was equal to bengal planting and drum seeding but it was significantly superior over machine planting and line planting.This was due to more plant population due to an extra plant set in the centre of each square, which doubles the plant population under diagonal planting as confirmed by Dhawan (2018*)* as well as transplanting under puddled conditions, which lowers weed density of competition

Table1. Growth parameters of rice as influenced by puddling practices and crop establishment methods during *rabi*, 2022-23

Treatments	Number of tillers(m^{-2})	Dry matter accumulation(kg ha^{-1})
Puddling Practices (3)		
M_1- Power tiller	340	9607
M_2- Rotovator	375	10585
M_3- Roto-puddler	401	11053
SEm +	10.71	263.53
CD (P=0.05)	42.06	1034.75
CV (%)	11.15	9.80
Establishment Methods (5)		
E_1- Drum Seeding	386	10309
E_2- Line Planting	343	9964
E_3- Machine Planting	326	9541
E_4- Diagonal Planting	416	11427
E_5- Bengal Planting	391	10835
SEm +	11.41	412.90
CD (P=0.05)	33.30	1205.16
CV (%)	9.20	11.89
Interaction	NS	NS

(interference) and improves the nutrient uptake by crop, that prevalentfavourable conditions for crop growth. Similar results were registered by Srinivas *et al*. (2023) which shows that increased number of tillers m^{-2} (416) and higher drymatter accumulation (11427 kg ha^{-1}) registered under diagonal planting. Whereas, bengal planting and drum seeding recorded next best in case of tiller number m^{-2} (391 and 386) and higher drymatter production (10835 and 10309 kg ha^{-1}) respectively was observed due to adequate spacing. There is an improvement in tillering ability and root development due to maximum use of the input because of wider plant spacing in bengal planting (E_5). These results are in accord with the results of Duraisamy *et al*. (2011) who reported the same that there is hike in rice growth and grain yield due to wider plant spacing.

Despite the higher tiller count, Bengal planting and drum seeding were also noticed on par with diagonal planting because its early aged and sprouted seedlings on puddled soil resulted in less competition of weed density, improved nutrient uptake, and increased number of tillers with great vigor, thereby improving dry matter accumulation.Similar results were reported by Rao *et al.* (2020), Choudhary *et al.* (2021), and Srinivas *et al*. (2023).

A lower number of tillers m^{-2} (326) was observed under machine planting, which is possibly a result of underlying factors such as less space between hills, leading to more competition for nutrients, inadequate supply of nutrients and moisture during the post-rainy season, and also planting by machine, which ensures only 1 to 2 seedlings per hill, resulting in a lower number of tillers m^{-2}(326) and less dry matter accumulation (9541 kg ha^{-1}).

Yield Attributes and Yield

The number of panicles m^{-2}, total grain number $panicle^{-1}$, and grain and straw yield (kg ha^{-1}) were significantly influenced by the different puddling practices and crop establishment methods during *rabi*, 2022-23. Regarding number of panicles m^{-2} and grain yield, the significant interaction was found among puddling practices and crop establishment methods. 1000 grain weight (g) did not influence by puddling practices and crop establishment methods (Table 2).

Yield assigning characters *i.e.* the number of panicles (371), total number of grains panicle(259), grain yield (4697 kg ha^{-1}) and straw yield (6098 kg ha^{-1}) of rice at harvest were significantly higher in roto-puddler and it was found on par with rotovator but significantly superior over power tiller treatment.This could be attributed to the fact that puddling with a roto-puddler provided good land levelling and better friable conditions in soil by incorporation of weeds and straw into the soil, which reduced crop weed competition and improved soil physical and chemical properties, leading to better tillering ability and conversion of total number of tillers to productive tillers, increasing the number of panicles m^{-2} and, in turn, increasing grain yield.Srinivas *et al*. (2023) also observed an improvement in yield attributes, grain yield and straw yield by puddling using a roto-puddler under transplanted conditions with uniform plant spacing.

Similarly, with the crop establishment treatments, significantly higher values of yield attributing characters, that is, the number of panicles m^{-2} (386), total number of grains $panicle^{-1}$ (257), grain yield (4837 kg ha^{-1}), and straw yield (6148 kg ha^{-1}) were recorded with the diagonal planting method, which was at par with Bengal planting and drum seeding but was significantly superior to machine planting and line planting (Table 2).This was due to the increased tiller number and greater dry matter accumulation, including better environmental conditions, characterized by less crop-weed competition for moisture and light and better availability of nutrients for proper accumulation of plant dry matter and yield attributing characters, such as productive tillers and filled grains per panicle, thereby increasing grain and straw yields under these treatments. However, the machine planting (E_3) treatment registered the lowest grain yield, which might be due to wider row spacing during *the rabi* season and planting using machines, which ensures only 1-2 seedlings per hill, leading to a lower plant population and a lower number of tillers, thereby resulting in decreased grain and straw yields. Similar to the number of panicles, an interaction effect between puddling practices and crop establishment methods was also detected for grain yield.

The interaction effect between puddling and crop establishment methods was found to be significant with respect to the number of panicles m^{-2} and grain yield (kg ha^{-1}).The highest number (417) panicles m^{-2} (Table 3) and the highest grain yield (5252 kg ha^{-1}) were

Table 2. Yield attributes and yield of rice as influenced by puddling practices and crop establishment methods during *rabi*, 2022-23

Treatments	No. of panicles m^{-2}	No. of grains $panicle^{-1}$	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Puddling practices (3)					
M_1- Power tiller	325	233	20.52	4192	5400
M_2- Rotovator	355	243	20.79	4531	5834
M_3- Roto-puddler	371	259	20.71	4697	6098
SEm +	6.78	4.43	0.41	96.71	133.22
CD (P=0.05)	26.61	17.40	NS	379.7	523
CV (%)	7.49	7.02	7.59	8.37	8.93
Establishment Methods (5)					
E_1- Drum Seeding	358	248	20.13	4495	5720
E_2- Line Planting	332	237	20.67	4305	5635
E_3-MachinePlanting	306	231	20.17	4134	5375
E_4-DiagonalPlanting	386	257	20.71	4837	6148
E_5- Bengal Planting	368	250	20.26	4595	6009
SEm +	11.87	5.95	0.45	123.48	165.99
CD (P=0.05)	34.65	17.38	NS	360.4	485
CV (%)	10.17	7.30	6.61	8.28	8.62
Interaction					
MXE	60.62	NS	NS	624.24	NS
E X M	59.57	NS	NS	669.61	NS

Table 3. Panicles m^{-2} of rice as influenced by puddling practices and establishment methods

Puddling practices/Crop establishment methods	Drum seeding (E_1)	Line planting (E_2)	Machine planting (E_3)	Diagonal planting (E_4)	Bengal Planting (E_5)	Mean
M_1-Power tiller	341	334	251	363	337	325
M_2- Rotovator	357	354	289	377	396	354
M_3-Roto-puddler	376	309	377	417	373	370
Mean	358	332	306	386	369	
			SEm +CD(P=0.05)			
Sub at same level of main				20.56		60.02
Main at same level of sub				19.60		59.57

Table 4. Grain yield (kg ha^{-1}) of rice as influenced by puddling practices and establishment methods

Puddling practices/Crop establishment methods	Drum seeding (E_1)	Line planting (E_2)	Machine planting (E_3)	Diagonal planting (E_4)	Bengal Planting (E_5)	Mean
M_1-Power tiller	4372	4268	3957	4213	4148	4191
M_2- Rotovator	4635	3835	4397	5045	4741	4530
M_3-Roto-puddler	4478	4811	4048	5252	4897	4697
Mean	4494	4304	4134	4837	4595	
				SEm +		**CD (P=0.05)**
Sub at same level of main				213.87		624.24
Main at same level of sub				214.35		669.61

observed (Table 4) in diagonal planting on puddling with a roto-puddler 4). This could be attributed to the increased plant population under diagonal planting, which resulted in a greater number of tillers and panicles, as well as puddling withroto-puddler, resulting in improved soil physical conditions and improved nutrient uptake thereby resulting in higher yield attributes and yield. These findings are in accordance with those of Srinivas *et al*. (2023).

CONCLUSION

The present study demonstrated that growth parameters, yield characteristics and rice yield were significantly affected by the puddling techniques and crop establishment methods. The findings clearly showed that using a roto-puddler for puddling, combined with a diagonal planting method, proved more effective, as evidenced by enhanced growth, yield characteristics and rice yields.

REFERENCES

Alam, M.J., Humphreys, E., Sarkar and M. A. R., Sudhir-Yadav. 2018. Comparison of dry seeded and puddled transplanted rainy season rice on the High Ganges River Floodplain of Bangladesh. European Journal of Agronomy, 96: 120-130.

Choudhary, K., Srivastava, V.K., Singh, U. P., Devedee, A.K and Meena, A.K. 2021. Impact of water management and crop establishment methods on growth and qualitative characteristics of rice (*Oryza sativa* L.).Biological Forum – An International Journal, 13 (2): 120-124

Dewanti, A.N. and Mandang, T. 2022. Analysis of soil puddling method and the effect to soil physical properties and rice plant growth. In *IOP* Conference Series: Earth and Environmental Science, 1038: 1-11.

Dhawan, SS. 2018. In practical Manual-Horticulture and Agroforestry System; IGNOU, New Delhi, India. 5-7.

Duraisamy, V. M., Senthilkumar, T. and Subbulakhsmi, S. 2011. Studies on the standardization of spacing and transplanting depth for a self-propelled rice transplanter. Agricultural Mechanization in Asia, Africa and Latin America, 42 (1): 42-44.

Hazra, K. K., Venkatesh, M. S., Ghosh, P. K., Ganesha Murthy, A. N., Kumar, N., Nadarajan, N and Singh, A. B. 2014. Long-term effect of pulse crops inclusion on soil plant nutrient dynamics in puddled rice-wheatcropping system on an Inceptisol of Indo-Gangetic plain zone of India. Nutrient Cycling in Agroecosystems, 100: 95-110.

Ministry of Agriculture & Farmers Welfare, 2022. Agricultural Statistics at a Glance 2021, Government of India, Ministry of Agriculture & Farmers Welfare, Department of Agriculture & Farmers Welfare, Directorate of Economics & Statistics.

Rani, T. S. and Jayakiran, K. 2010. Evaluation of different planting techniques for economic feasibility in rice. Electronic Journal of Environmental, Agricultural and Food Chemistry,9(1): 150-153.

Rao, A.U., Murthy, K.R., Kumar, K.M., Visalakashmi, V., Satyanarayana, N.H and Rao, S.G. 2020. Alternate crop establishment methods for water-saving and high rice productivity in north coastal Andhra Pradesh. Current Agriculture Research Journal, 8 (3): 219-223.

Srinivas, M., Rajashekara Reddy L., Dakshina Murthy, K.M., Anusha B., Ramabhadra Raju, M and Jogi Naidu, G. 2023. Productivity of rice-rice cropping system influenced by puddling practices and planting techniques. 2nd Indian Rice Congress *2023*. ICAR – NRRI Cuttack 11-14 Feb. 2023. 238-240.

Srinivas, M., Dakshina Murthy, K., M., Sreenivas, Ch., Anusha, B. and Bharathalakshmi, M. 2025. Effect of puddling practices and crop establishment methods on the productivity of Rice (O*ryza sativa*. L). The Journal of Research ANGRAU,53(5): 122-128