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Tray nursery management for machine transplanting under Mechanized System of Rice Intensification (MSRI)

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Abstract
Study on nursery management techniques during *rabi,* 2015-16 was conducted at Regional Agricultural Research Station, Tirupati, Andhra Pradesh for finding suitable bedding material and foliar nutrition to develop the mat nursery to suit for machine transplanting under Mechanized System of Rice Intensification (MSRI). The treatments include four bedding materials (soil alone, soil: farm yard manure, soil: vermicompost and soil: pressmud cake in the ratio of 70: 30) and five foliar applications (control, urea @ 0.5%, DAP @ 0.5%, 19-19-19 @ 0.5% and 13-00-45 @ 0.5%) tested in Randomized Block Design with factorial concept with three replications. At 13 and 16 Days after sowing the bedding material comprised of soil with pressmud cake in 70: 30 ratio recorded significantly more seedling vigour index, dry matter production, seedling root length and shoot length over soil with farmyard manure and soil alone as bedding materials but, comparable to soil with vermicompost and the lowest seedling vigour index was recorded with soil alone as bedding material. Foliar sprays and their interaction with bedding materials recorded non significant differences with growth parameters of rice seedlings at 13 and 16 DAS. However, better growth parameters were recorded numerically with the foliar application of urea @ 0.5% as compared to other foliar applications.

Keywords: Tray nursery, bedding material, foliar application, seedling growth and seedling vigour

Introduction
In Andhra Pradesh state, rice is the principal food crop cultivated in an area of 2.20 m ha with a production of 12.35 m t and productivity of 5.59 t ha^{-1} (Statistical Year Book, 2019) [11]. In recent years, the area under rice crop is decreasing year by year due to shortage of water and rapid urbanization, but demand for rice is growing every year and it is estimated that the requirement would be 125 million tonnes by 2025 AD (Kumar *et al*., 2009) [4]. To sustain present food self-sufficiency and to meet future food requirements at the current population growth rate of 1.5 per cent, the rice productivity has to be increased with good management practices under shrinking availability of land and water resources. Mechanization increases land and labour productivity by timely completion of farm operations and reduces the drudgery of humans and animals. Mechanization in transplanting through rice transplanter using mat nursery reduces the cost of cultivation since large area can be transplanted within a very short period (Mohanty *et al.,* 2014) [7]. Mechanized System of Rice Intensification (MSRI) is attaining wider adoptability due to machine transplanting and higher grain yield. The success of mechanical transplanting depends on the success of the nursery. Root damage during uprooting of seedlings from conventional nursery bed can be completely avoided using tray nursery since the mats are directly fed to the transplanter without separation. Raising tray nursery is necessitated with the introduction of mechanical transplanters. For machine transplanting, seedlings should be raised with special care in plastic trays. Soil is packed into it and the seeds are sown and then these are arranged on plain land and the seedlings are raised. About 3 leaf stage, 12-15 cm height seedlings are used for machine transplanting (Kitagawa *et al.,* 2004) [3]. Normally soil media is used for raising tray nursery in rice due to which seedlings are not attaining the optimum plant height to suit for machine transplanting due to lack of growth promoting nutrients in the normal soil. So, it is necessary to identify low volume, nutrient rich alternate growing media to obtain optimum plant height for easy planting with machine transplanters. Research work on alternate media for tray nursery is still in infant stage. A suitable media for raising mat tray nursery is needed to bring easiness in transportation of mat nurseries for commercial cultivation. Possibilities of using different media as an alternative to conventional soil media have been studied by research workers (Mamun *et al.,* 2013) [6].

For obtaining uniform and healthy growth of seedlings, foliar nutrition would be best option. If the quantity of soil media required in tray nursery can be reduced by identifying light weight nutrient rich materials like farm yard manure, vermi compost and pressmud cake, it would help rice growers for easy transportation and raising healthy and vigorous nursery in trays for commercial cultivation. In traditional rice system, nursery management techniques and foliar nutrition studies for paddy nursery are very well documented however, research work on tray nursery management under Mechanized system of rice intensification (MSRI) is scanty. Considering this situation field study was conducted to find out the suitable bedding material and foliar application of nutrients for tray nursery technique for mechanical transplanting of rice under MSRI.

Material and Methods

This study was conducted in F.No. 18 of Regional Agricultural Research station, Tirupati, Andhra Pradesh situated at an altitude of 182.9 m above mean sea level at $13^0$5' N latitude and 79^o5' E longitude in Southern agro climatic zone of Andhra Pradesh during *rabi*, 2015-16. The components of growing media *viz*. soil, farmyard manure, vermicompost and pressmud cake as well as the different combinations of growing media were air dried and passed through 2 mm sieve. Bedding materials were prepared by mixing Soil and Farm yard manure, vermicompost, pressmud cake in 70:30 ratio on volume basis. Rice seedlings were raised in 60cm x 30cm sized trays after filling with desired beding material. Nursery management experiment was conducted in Randomized Block Design with factorial concept replicated thrice with four bedding materials [B_1- soil alone (SA), B_2- soil:farmyard manure in 70:30 (SFYM), B_3-soil: vermicompost in 70:30 (SVC) andB_4-soil: pressmud cake in 70:30 (SPMC)] and five foliar applications (F_1: Control,F_2:foliar application of urea @ 0.5%, F_3:foliar application of DAP @ 0.5%, F_4: foliar application of 19-19-19 @ 0.5%,F_5: foliar application of 13-00-45 @ 0.5%). Foliar application of nutrients were imposed at 10 DAS. Biometric observations on seedling establishment percentage, seedling shoot length, root length and dry matter production were recorded at 7,10, 13 and 16 DAS. The number of days taken to germinate 50% seeds in the tray was considered as the mean germination time. The observation was recorded on per sq. cm basis. Measured quantity of seed is sown in marked area of 100 sq. cm randomly at two places in the tray and the number of seedlings emerged in that area were recorded and the mean is expressed in establishment percentage. The length from the collar region to tip of the seedling leaf was measured as shoot length and the length from collar region to the tip of the root was measured as root length and mean value of 10 seedlings was expressed in cm. Ten seedlings were taken at random from the trays along with the roots as per treatment at 7, 10, 13 and 16 DAS for dry matter production and the mean values are expressed in g. Seedling vigour index **(SVI)** was calculated by adopting the formula suggested by Abdul-Baki and Anderson (1973) [1]. SVI = Establishment percentage × (Root length + Shoot length).

Results and Discussion

Bedding materials had no significant effect on germination and establishment. Bedding materials and foliar applications had no significant effect on growth parameters like shoot length, root length and dry matter production During initial stages at 7 and 10 DAS. Mean germination time for different bedding materials was five days and germination percentage was 96 to 97 irrespective of the bedding material used.

Effect on growth and development of seedlings

Seedling vigour index (SVI)

Pressmud cake with soil (B_4) recorded highest seedling vigour index (2480) followed by soil with vermicompost (2399) and soil with farmyard manure (2180). soil alone as bedding material recorded lowest SVI of 1901. Higher seedling vigour index with pressmud cake (B_4) or vermicompost (B_3) is due to high water holding and nutrient retaining abilities of these bedding materials leading to optimum growth of seedlings compared to soil alone. These results are in confirmation with the findings of Dhananchezhiyan *et al.* (2013) [2] and Mamun *et al.* (2013) [6]. Higher SVI was recorded with foliar application of urea @ 0.5% followed by DAP @ 0.5%.

Shoot length

Seedling shoot length significantly varied due to bedding materials. Among the different bedding materials, soil with pressmud cake (SPMC) (11.33 and 14.57 cm) followed by soil with vermicompost (SVC) (12.01 and 14.93 cm) resulted in significantly higher shoot length over soil with farmyard manure (SFYM) (10.41 and 13.25 cm)and soil alone (8.85 and 11.65 cm) at 13 and 16 DAS, respectively. Non significant differences among bedding materials were recorded at 7 DAS, where as SPMC 9.51 cm), SVC (9.28 cm) and SFYM (9.11 cm) recorded statistically at par shoot length but, superior over soil alone (8.25 cm) at 10 DAS. There were no statistically measurable differences in shoot length due to foliar applications at different growth stages. However, higher shoot length was with foliar application of urea @ 0.5% (11.02 and 13.97 cm) followed by DAP @ 0.5% (10.84 and 13.70cm) and shortest shoot length was in control (No foliar application) (10.27 and 12.97cm) at 13 and 16 DAS, respectively. The interaction of bedding materials and foliar applications had no significant influence on seedling shoot length at all the growth stages (7, 10, 13 and 16 DAS).

Higher shoot length was recorded with bedding material of soil with pressmud cake was due to higher uptake of nutrients by the seedlings leading to cell enlargement, triggering of young tissues or meristamatic growth (Kumar and Chopra, 2016) [5]. Dhananchezhiyan *et al.* (2013) [2] reported that seedling height can be considered as an indicator of the healthy nursery. Vermicompost contains relatively lower nutrients compared to pressmud cake. Mamun *et al.* (2013) [6] reported optimum seedling growth (12 cm) within 16 days for mechanical transplanting in rice.

Root length

Adequate root length is required for good anchorage and establishment of seedlings after transplanting in the main field. Root length differed significantly due to different bedding materials at 10, 13 and 16 DAS. At 10 DAS, soil with pressmud cake produced longer root length of 9.37 cm which was comparable with SVC (9.23 cm) and superior over SFYM (8.91 cm) and soil alone (8.27 cm). Soil with pressmud cake (SPMC) recorded higher seedling root length (10.44 and 10.61 cm) which was at par with SVC (10.070 and 10.38 cm) and superior over SFYM (9.03 and 9.25 cm) and soil alone (8.25 and 8.32 cm) at 13 and 16 DAS, respectively and significantly shortest root length was due to soil as bedding material. There were no statistically measurable differences in root length due to foliar applications at different growth stages. However, higher root length was with foliar application of urea @ 0.5% (9.60 and 9.77 cm) followed by

DAP @ 0.5% (9.52 and 9.67 cm) and shortest root length (9.26 and 9.52 cm) with no foliar application at 13 and 16 DAS, respectively. The interaction of bedding materials and foliar applications on seedling root length was not significant at all the seedling growth stages. Longest roots due to bedding material of SPMC and SVC might be due to improvement in soil physical properties as compared with farm yard manure and soil alone. This might have helped the roots to proliferate deep into the soil. The results are in confirmation with the reports of Rajendran*et al.* (2005) [9] and Kumar and Chopra (2016) [5].

Seedling dry matter production

Dry matter produced by rice seedlings varied significantly due to bedding materials at 10, 13 and 16 DAS. Among the bedding materials, soil with pressmud cake (SPMC) recorded higher seedling dry matter production (0.644 and 0.948 g) followed by soil with vermicompost (SVC) (0.614 and 0.930 g). These were significantly superior over soil with farmyard manure (SFYM) (0.567 and 0.839 g) and soil alone (0.479 and 0.732 g) at 13 and 16 DAS, respectively. Bedding material has no significant influence on seedling dry matter at 7 DAS, where as SPMC(0.347 g), SVC (0.338g) and SFYM (0.325 g) produced statistically comparable dry matter but, superior over soil alone (0.297 g) at 10 DAS. Foliar applications had no significant influence on dry matter production at different nursery growth stages. However, higher dry matter was recorded with foliar application of urea @ 0.5% (0.595 and 0.887 g) followed by DAP @ 0.5% (0.588and 0.872 g) and shortest shoot length was recorded with no foliar application (0.544 and 0.842 g) at 13 and 16 DAS, respectively. Interaction of bedding materials and foliar applications on seedling dry matter production was found to be non significant at all the seedling growth stages (7, 10, 13 and 16 DAS). Growth media comprised of soil with pressmud cake produced the highest dry matter followed by soil with vermicompost over soil with farmyard manure and soil alone at 13 and 16 DAS as the above growth media has produced higher shoot and root length by supplying more nutrients to the rice seedlings which resulted in higher dry matter production. Similar results were reported by Rajendran *et al.* (2005) [9] who recorded increase in biomass production with mat nursery comprising of soil + pressmud cake mixture (1:1).

Table 1: Seedling establishment percentage and vigour index and Dry matter production (g) of rice seedling as influenced by bedding materials and foliar applications

Treatments	Seedling establishment (%)	Seedling vigour index	Dry matter production (g)			
Bedding materials			7 DAS	10 DAS	13 DAS	16 DAS
B_1: Soil Alone (SA)	95.2	1901	0.239	0.297	0.479	0.732
B_2: Soil and FYM in 70: 30 (SFYM)	96.9	2180	0.242	0.325	0.567	0.839
B_3: Soil and Vermicompost in 70: 30 (SVC)	97.2	2399	0.250	0.338	0.614	0.930
B_4: Soil and Pressmud cake in 70: 30 (SPMC)	97.1	2480	0.252	0.347	0.644	0.948
SEm±			0.008	0.010	0.019	0.037
CD (P=0.05)			NS	0.023	0.039	0.075
Foliar applications						
F_1: Control (No foliar application of nutrients)	96.8	2178	0.238	0.317	0.544	0.842
F_2: Foliar application of urea @ 0.5%	97.2	2307	0.248	0.330	0.595	0.887
F_3: Foliar application of DAP @ 0.5%	97.1	2269	0.251	0.334	0.588	0.872
F_4: Foliar application of 19-19-19 @ 0.5%	96.9	2258	0.247	0.329	0.572	0.861
F_5: Foliar application of 13-00-45 @ 0.5%	97.0	2192	0.244	0.324	0.570	0.851
SEm±			0.009	0.013	0.022	0.042
CD (P=0.05)			NS	NS	NS	NS
Bedding materials × Foliar applications						
SEm±			0.018	0.257	0.435	0.083
CD (P=0.05)			NS			

Table 2: Seedling shoot length and root length (cm) of rice at different growth stages as influenced by bedding materials and foliar applications.

Treatments	Seedling shoot length (cm)				Seedling root length (cm)			
Bedding materials	**7 DAS**	**10 DAS**	**13 DAS**	**16 DAS**	**7 DAS**	**10 DAS**	**13 DAS**	**16 DAS**
B_1:Soil Alone (SA)	6.39	8.25	8.85	11.65	7.91	8.27	8.25	8.32
B_2: Soil and FYM in 70: 30(SFYM)	6.50	9.11	10.41	13.25	8.11	8.91	9.03	9.25
B_3: Soil and Vermicompost in 70: 30(SVC)	6.51	9.28	11.39	14.31	8.40	9.23	10.07	10.38
B_4:Soil and Pressmud cake in 70: 30(SPMC)	6.52	9.51	12.01	14.93	8.37	9.37	10.44	10.61
SEm±	0.20	0.23	0.31	0.49	0.27	0.30	0.34	0.34
CD (P=0.05)	NS	0.46	0.65	0.99	NS	0.63	0.69	0.69
Foliar applications								
F_1: Control (No foliar application of nutrients)	6.46	8.90	10.27	12.97	8.20	8.81	9.26	9.52
F_2: Foliar application of urea @ 0.5%	6.57	9.11	11.02	13.97	8.22	9.01	9.60	9.77
F_3: Foliar application of DAP @ 0.5%	6.41	9.13	10.84	13.70	8.21	8.89	9.52	9.67
F_4: Foliar application of 19-19-19 @ 0.5%	6.37	9.02	10.67	13.60	8.15	9.11	9.54	9.70
F_5: Foliar application of 13-00-45 @ 0.5%	6.58	9.02	10.51	13.42	8.22	8.90	9.32	9.53
SEm±	0.22	0.26	0.36	0.55	0.31	0.35	0.38	0.38
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Bedding materials × Foliar applications								
SEm±	0.44	0.51	0.72	1.10	0.61	0.70	0.77	0.76
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Conclusion

The study conducted on Standardization of bedding material and foliar application of nutrients for tray nursery revealed that, bedding material comprised of either soil with pressmud cake or soil with vermicompost in 70:30 ratio can be recommended as media for tray nursery raising for Mechanized System of Rice Intensification (MSRI) as they were comparable in growth parameters and were significantly better over soil with farmyard manure (70:30) and soil alone. Although non significant differences were observed in seedling growth and development, foliar application of urea @ 0.5% at 10 DAS can be suggested for tray nursery as it has recorded numerically better growth parameters compared to other foliar applications studied.

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