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Effect of establishment methods and INM practices on growth and yield of rice (*Oryza sativa* L.)

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ABSTRACT

A field study was conducted to evaluate the effect of establishment methods and integrated nutrient management practices on growth, yield attributes and yield of rice (*Oryza sativa* L.) was carried out during late samba season 2021 at the farmers field of Sadhurvedhamanagalm village, Sivagangai district. It was laid out in a factorial randomized block design, replicated thrice with two establishment methods (A_1-Direct seeded rice (DSR) and A_2-Transplanted rice (TPR)) as factor A and five INM practices (B_1-RDF-Recommended Dose of Fertilizer (120:40:40 kg NPK ha^{-1}) alone, B_2-RDF + Poultry manure compost @ 5 t ha^{-1}, B_3-RDF + Coir pith compost @ 5 t ha^{-1}, B_4-RDF+ Green manure (Daincha) @ 6.25 t ha^{-1} and B_5-RDF-Green leaf manure @ 6.25 t ha^{-1}) as a factor B. Among the establishment methods, transplanted method recorded highest growth attributes (plant height, leaf area index, number of tillers m^{-2} and dry matter production), yield attributes (number of productive tillers m^{-2}, number of filled grains $panicle^{-1}$) and yield (grain yield and straw yield) of rice. Similarly, among the different INM practices, the highest growth, yield attributes and yield were recorded under the treatment RDF+poultry manure compost @ 5 t ha^{-1}than the other treatment combination.

Key words: *Establishment methods, INM practices, Rice and yield*

Introduction

More than half of the world's population consumes rice as a staple food (USDA, 2023). At the global level, rice is grown in an area of about 165.2 million hectares with production and productivity of 510.8 MMT and 4.88 t ha^{-1}, respectively (USDA, 2022 and FAO, 2022). In India, rice is grown over an area of 38.39 million hectares with production and productivity of 150.4 MT and 4.21 t ha^{-1} respectively (USDA, 2022). The area under rice in Tamil Nadu is 21.65 lakh hectares with a production of 41.45 lakh tonnes and the productivity is 4.98 t ha^{-1}. The United Nations Food and Agriculture Organization (FAO) estimates that 513.68 million metric tons of rice were produced worldwide in 2022. The amount of net cultivable land available for crop production is unable to maintain up with the alarming rate at which the world's population is currently growing. The best approach to feed the world's growing population is by adopting suitable agronomic management practices like establishment methods and INM practices. In low-lying irrigated areas, planting rice in puddled soil is the most common and conventional technique. The common pre-planting management technique is puddling which helps to control weeds and makes transplanting easier in the field and reducing water infiltration (Dileep *et al.*,

2018). And another establishment method is direct seeded rice which is arguably the oldest crop establishment technique, is making it more and more popular for its low input requirement. It has certain benefits such as reduced labour costs, less water and drudgery requirements, early crop maturity, low production costs and improve soil physical condition for subsequent crops (Kaur and Singh, 2017). However, establishment method alone cannot boost the production up to our required level. For these fertilizers have contributed substantially to the spectacular increase in rice yield. Though, frequent use of chemical fertilisers causes soil crusts, acidifies the soil, attracts more pests and alters the soil pH. These consequences include reduced beneficial organisms, stunted plant growth and loss of humus and organic matter. The high cost of inorganic fertilizers and unstable crop production call for substituting part of the inorganic fertilizers by locally available organic sources like FYM, poultry manure, other form of compost and green manuringin an integrated manner is essential for increase the productivity of rice. A study was conducted to evaluate the effect of establishment methods and INM practices on growth and yield of rice in Sadhurvedhamanagalm village of Sivagangai district in Tamil Nadu.

Materials and Methods

The field experiment was conducted during late samba season of 2021 to find out the growth attributes, yield attributes and yield of rice under establishment methods (direct seeded rice and transplanted rice) and INM practices (RDF-Recommended Dose of Fertilizer (120:40:40 kg NPK ha^{-1}) alone, RDF + Poultry manure compost @ 5 t ha^{-1}, RDF+ Coirpith compost @ 5 t ha^{-1}, RDF+ Green manure (Daincha) @ 6.25 t ha^{-1} and RDF-Green leaf manure @ 6.25 t ha^{-1}). The experiment was laid out in a factorial randomized block design (FRBD) with establishment methods in factor A and INM practices in factor B. There were 10 treatment combinations consisting of two establishment methods *viz.*, (A_1-Direct seeded rice (DSR) and A_2-Transplanted rice (TPR)) and five INM practices (B_1-RDF-Recommended Dose of Fertilizer (120:40:40 kg NPK ha^{-1}) alone, B_2-RDF + Poultry manure compost @ 5 t ha^{-1}, B_3-RDF+ Coirpith compost @ 5 t ha^{-1}, B_4-RDF+ Green manure (Daincha) @ 6.25 t ha^{-1} and B_5-RDF-Green leaf manure @ 6.25 t ha^{-1}) and three replication (R_1, R_2 and R_3).

Results and Discussion

Growth parameters

Plant height

The rice establishment methods and INM practices influenced the plant height (Table 1) at all the growth stages especially at harvest stage. The tallest plant height of 96.97 cm was noticed in transplanted rice (A_2) at harvest stage. Taller plants were produced by the transplanted establishment technique due to less weed competition compared to DSR techniques. The present observations are in concomitant with reports of Bhandari *et al.* (2020). The shortest plant heigh of 94.26 cm at harvest stage were noticed in direct seeded rice (A_1). Among the INM practices, RDF + poultry manure compost @ 5 t ha^{-1} (B_2) recorded highest plant height of 104.27 cmat harvest stage. This might be due to chemical fertilizers provide nutrients that are quickly soluble in soil solutions, making them available to plants right away. Microbial activity and better physical conditions of the soil are the reasons behind the availability of nutrients from organic sources. The rapid growth brought on by an adequate supply of nutrients to the crops led to an increase in various metabolic processes and better mobilisation of synthesised carbohydrates in amino acids and proteins, which in turn produced a higher growth rate when both organic and inorganic fertilizers were used together. This in turn stimulated the rapid cell division and cell elongation, thus allowing the plant to grow faster (Kumar *et al*., 2021). The lowest plant height of 86.01 cm ever recorded in RDF alone may have resulted from inadequate nutrient availability, which hampered growth and nutrient mobilisation (Tomar *et al.,* 2018).

LAI

Leaf area index influenced significantly by different rice establishment methods and INM practices (Table 1). Among the establishment methods, maximum leaf area index occurred in transplanted rice (4.86) at flowering stage and lowest leaf area index was noticed in direct seeded method (4.71) at flowering stage. Among the INM practices, RDF + poultry manure compost @ 5 t ha^{-1} recorded higher LAI of (5.37) at flowering stage. The application of poultry manure may have resulted in an increase in rice growth because the manure contains uric acids, which accelerate the release of nutrients and may

have led to more consistent and extensive root development, a more responsive crop to available nutrients, and a quicker conversion of synthesised photosynthates into protein to form more protoplasm, which in turn increased the number and size of cells and potentially the number of tillers and the leaf area index (Hussainey *et al.,* 2019). The RDF alone treatment recorded lowest LAI (4.10) at flowering stage.

Number of tillers hill^{-1}

The total number of tillers hill^{-1} was influenced significantly by different rice establishment methods and INM practices (Table 1). The maximum number of tillers hill^{-1} of 11.09 at maximum tillering stage were noticed in transplanted method (A_2). However, the lowest number of tillers hill^{-1} of 10.72 at maximum tillering stage were noticed in direct seeded method of establishment (A_1). With respect to INM practices, the highest number of tillers hill^{-1} of 12.06 at maximum tillering stage were recorded in RDF+ poultry manure compost @ 5 t ha^{-1}(B_2). The efficient use of nutrients during the active tillering stage and the availability of enough light, water and other resources in a relatively larger net area for offshoot production may be the cause of enhanced tillering in transplanting techniques. These results were concomitant with the finding of Awan *et al.* (2011). The lowest number of tillers hill^{-1} of 9.39 at maximum tillering stage were registered in RDF alone (B_1).

Dry matter production

The total dry matter production varied significantly in both rice establishment methods and INM practices. The maximum increment in dry matter accumulation of 12231 kg ha^{-1}recorded in transplanted method, might be due to increased amount of photosynthate accumulation, nutrient availability and soil moisture. Similar result was reported by Thapliyal *et al.* (2020). However, the minimum dry matter accumulation was noticed in direct seeded rice (11725kg ha^{-1}). Among the INM practices,the highest dry matter of 13665 kg ha^{-1} were registered under the treatment RDF+ poultry manure compost @ 5 t ha^{-1} (B_2). The combined application of organics and RDF may have led to a significant increase in growth characters, which in turn may have increased photosynthate production and photosynthesis, ultimately resulting in a higher accumulation of dry matter. The results of Rani and Sukumari (2013) corroborate these conclusions. The lowest dry matter production of 9970 kg ha^{-1}was recorded in RDF alone treatment (B_1).

Yield attributes and yields of rice

Highest yield attributes *viz.,* number of productive tillers m^{-2}, number of filled grains panicle^{-1}, grain and straw yield differed significantly among the different rice establishment methods and INM practices (Fig. 1 & 2). The maximum number of productive tillers of 329m^{-2}, number of filled grains of 124.28 panicle^{-1}, grain yield of 5769 kg ha^{-1}and straw yield of 7974 kg ha^{-1}were registered under the treatment transplanted method (A_1). This might be due to quality of rice seedling in nursery before transplanting into rice fields is commonly good; plants that have already developed roots and other systems are stronger, making them less vulnerable to outside condition. These results were concomitant with the findings of (Hindersah *et al*., 2022). Direct

Table 1. Effect of establishment methods and INM practices on growth attributes of rice

Treatments	Plant height (cm)	LAI	Number of tillers hill^{-1}	DMP (kg ha^{-1})
A_1- Direct seeded rice (DSR)	94.26	4.71	11.49	11725
A_2- Transplanted rice (TPR)	96.97	4.86	11.94	12231
S.Ed.	0.58	0.03	0.11	116
CD (P=0.05)	1.22	0.07	0.24	244
B_1- RDF-Recommended Dose of Fertilizer (120:40:40 kg NPK ha^{-1}) alone	86.01	4.10	9.82	9970
B_2- RDF + Poultry manure compost @ 5 t ha^{-1}	104.27	5.37	13.24	13665
B_3- RDF+ Coirpith compost @ 5 t ha^{-1}	91.74	4.54	11.12	11312
B_4- RDF+ Green manure (Daincha) @ 6.25 t ha^{-1}	98.65	4.98	12.23	12541
B_5- RDF-Green leaf manure @ 6.25 t ha^{-1}	97.40	4.94	12.18	12405
S.Ed.	0.92	0.05	0.18	184
CD(p=0.05)	1.93	0.11	0.38	386

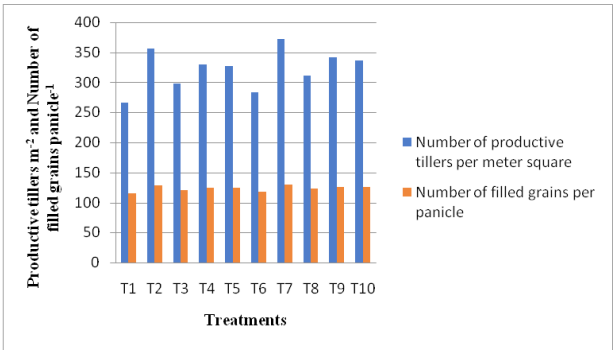

Fig. 1. Effect of establishment methods and INM practices on number of productive tillers m^{-2} and number of filled grains $panicle^{-1}$

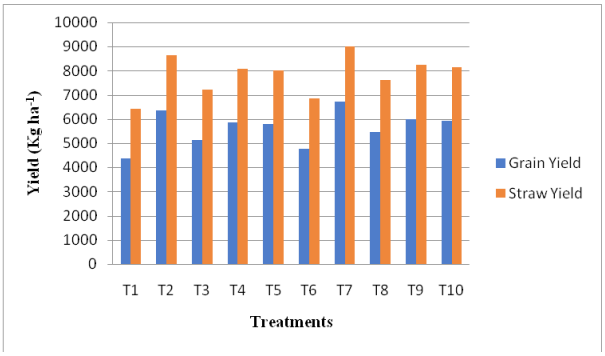

Fig. 2. Effect of establishment methods and INM practices on grain yield and straw yield of rice

seeding method of rice establishment yield was 12% lower than that of TPR (Transplanted rice)mainly due to fewer spikelet per panicle. Among INM practices, RDF + poultry manure compost recorded the highest number of productive tillers of $364m^{-2}$, number of filled grains $panicle^{-1}$of 129.00, grain yield of 6530 kg $ha^{-1}$and straw yield of 8824kg ha^{-1}. The integrated effects of fertilizer and organic manure were noted to be more beneficial than the use of chemical fertilizer alone. Additional increase in yield attributes and yield was registered due to better translocation of photosynthetic products from source to sink due to higher uptake of NPK which are responsible for quick and easy translocation of photosynthetic products. The better vegetative growth coupled with high yield attributes resulted in higher grain and straw yield of rice. The results are in agreement with the observation of Kumar *et al.* (2019). The lowest number of productive tillers m^{-2}, number of filled grains $panicle^{-1}$, grain and straw yield were recorded under RDF alone treatment (B_1).

Conclusion

It can be concluded that among the establishment methods transplanted method recorded highest growth, yield attributes and yield of rice. The yield mainly depends on dry matter production, number of productive tillers m^{-2}, number of filled grains $panicle^{-1}$ transplanted method improved these parameters and reduce the weed population. The lowest number of effective tillers were recorded under DSR. One of the reasons for lower yields under direct seeding is attributed to excessively higher competition with weeds and dense population per unit area. Therefore, it can be concluded that transplanted method of establishment performs well under RDF+ poultry manure compost @ 5 t ha^{-1} treatment.

Conflict of Interest: None

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