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Enhancement of Mat Nursery Management and Planting Pattern (Using Rolling Markers) in System of Rice Intensification (SRI) Technique

P. Veeramani

Department of Agronomy, Agricultural College and Research Institute,
Tamil Nadu Agricultural University, Madurai

Abstract: Nursery and field experiments were conducted at Madurai from July to November 2006 to evaluate the response of hybrid rice in modified mat nursery and transplanting single seedling in different planting patterns in main field (using rolling markers) under System of Rice Intensification (SRI) technique. Rice seedlings grown from seeds fortified with 1% KCl + 6 g m^{-2} *Pseudomonas* + DAP 50 g m^{-2} powdered DAP + 0.5% DAP drenching on 9th day + 20 g m^{-2} *Azophos* + 50 g m^{-2} VAM + 0.5 kg m^{-2} vermicompost exhibited the best seedling characteristics AND it was found suitable for mat nursery at 14 days producing seedlings with more root length (12.9 cm), seedling height (21.7 cm), chlorophyll meter (SPAD) value (32.9), seedling dry weight (18.1 g) and seedling vigour index (15.8). Grain yield was influenced by manuring. Higher plant height, more number of tillers hill^{-1}, greater quantity of dry matter production, higher leaf area index AND root characters were observed at all growth stages with oblong pattern of planting (30 x 25 cm). The results of the study indicated the potential benefits of integrated approach to raising seedlings in mat nursery (organic, inorganic, biofertiliser) which includes seed fortification with 1% KCl + 6 g m^{-2} *Pseudomonas* + 50 g m^{-2} powdered DAP + 0.5% DAP drenching on 9th day + 20 g m^{-2} *Azophos* + 50 g m^{-2} VAM + 0.5 kg m^{-2} vermicompost along with zig zag pattern of planting adopted by using triangular rolling markers was found to be the best option for getting higher productivity in hybrid rice under System of Rice Intensification technique.

Key words: Hybrid rice % Mat nursery % Chlorophyll meter (SPAD)

INTRODUCTION

Rice is a staple food crop of India, providing 43 per cent of calorie requirement for more than 70 per cent of India's population. The area of rice grown in India (44 million ha) is the largest among all the rice growing countries with an annual production of around 89 million tonnes. To meet the demands of increasing population and maintain this self-sufficiency, this present production level needs to be increased to 120 million tonnes by 2020. This increase in production has to be achieved in the backdrop of declining and deteriorating resource base such as land, water, labour and other inputs and without adversely affecting the quality of environment [1]. The System of Rice Intensification (SRI) has its own methodologies *viz.*, transplanting of young seedlings usually 8-12 days old, transplanting single seedling per hill at wider spacing in a square geometry, use of mechanical weeder which permitting greater root growth and tillering and provides other favorable conditions for better growth [2]. The manuring of seed bed produces early and deep rooted seedlings which will therefore have a greater resistance to setbacks. Any achievement in yield increase will depend on the nursery techniques and standard to be followed for the preparation of the super seedlings. In this context, the application of appropriate levels of nitrogen and phosphorus to nursery has also got a great impact on the growth of seedlings. Nitrogen nourishment induces vegetative growth. Phosphorus application to rice nursery influenced rooting and promoted early root strike in the soil [3].

In system of rice cultivation (SRI), proper spacing in the planting of seedlings is one of the essential principles. A spacing of 25 x 25 cm in a uniform square pattern is the recommended practice. However practical adaptability of planting single seedling in square method becomes very tedious under field conditions and farmers find it difficult to mark the recommended spacing with the conventional method of using rope as marker.

Corresponding Author: P. Veeramani, Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai

This led to the development of a handy implement, the rolling marker overcoming the constraints of rope. The marker when rolled on wet paddy field makes uniform square impressions. Lately, the adoption of zig zag and Oblong pattern of planting under SRI has been tried instead of square planting. Focusing these points, the present study was undertaken to evaluate the response of hybrid rice in modified mat nursery and to different planting pattern in main field (using rolling markers) under SRI principles.

MATERIALS AND METHODS

The field experiment was conducted at Agricultural College and Research Institute, Madurai from July to November 2006. The soil type was sandy clay loam with a pH of 7.3. It was low in available N, medium in P and high in available K. The organic carbon content was 0.31 per cent. The hybrid rice CORH 3 was used, the seeds of CORH 3 were obtained from Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in a Factorial Randomized Block Design (FRBD) replicated thrice. The treatments tried were five nursery treatments viz.

Nursery Treatments:

N_1 : Water soaked seed (24 hours) + 25 g mG^2 powdered DAP + 0.5% urea drenching on 9th day.

N_2 : Seed fortification with 1% KCl + 6 g mG^1 Pseudomonas + 50 g mG^2 powdered DAP + 0.5% urea drenching on 9th day.

N3 : Seed fortification with 1% KCl + 6 g mG^2 Pseudomonas + 50 g mG^2 VAM + 0.5 kg mG^2 ermicompost + 0.5 % DAP drenching on 9th day.

N4 : N_2 +20 g mG^2 Azophos + 50 gmG^2 VAM + 0.5 Kg mG^2vermicompost.

N5 : N_3 + 20 g mG^2 Azophos + 50 g mG^2 VAM + 0.5 kg mG^2 ermicompost.

Main Field Treatments:

M_1 : Square planting (25 x 25 cm).

M_2 : Zig zag planting (25 x 25 cm).

M_3 : Oblong planting (30 x 25 cm).

Modified Rice Mat Nursery Preparation: The purpose of raising modified rice mat nursery is for easy handling of younger seedlings without any root damage and increasing the tillering in main field. Raised beds @ 20 No. haG^1 were formed with a dimension of 5 x 1 m with 2 cm height. Over this, polythene sheets were spread on puddled soil and enriched soil with DAP was put over the polythene sheet to a height of 2 cm. Treated and sprouted seeds were broadcast uniformly in the beds at 75 g mG^2 on dry weight basis and then the seeds were covered with thin layer of sand. Watering was done through the shallow channel provided around the bed. Excess water was drained through the drainage channel. After sprouting of seeds, the water level was maintained just to immerse the bed. For the first three days, the beds were covered with paddy straw to maintain high humidity for uniform germination and establishment of seeds. The nursery was watered 2-3 times a day up to five days after sowing (DAS). After the 5th day water was let into irrigation channel between the nursery beds to keep the beds soaked. The seedlings were maintained in the nursery beds up to 14 days from the date of sowing.

The cost of inputs, labour charges and prevailing market rates of farm produce were taken into consideration for working out gross and net returns per hectare using the following formula.

Benefit cost ratio = Gross return (Rs.)/Total cost of cultivation (Rs.).

The benefit cost ratio was worked out for various treatments by dividing the gross returns by cost of cultivation.

RESULTS AND DISCUSSIONS

Seedling Growth Characters in Mat Nursery: Rice seedlings grown with seed fortification with 1% KCl + 6 g mG^2 Pseudomonas + 50 g mG^2 powdered DAP + 0.5% DAP drenching on 9th day + 20 g mG^2 Azophos + 50 g mG^2 VAM + vermicompost 0.5 kg mG^2 exhibited the best seedlings characteristics, with seedling height, root length, number of leaves, seedling dry weight and seedling vigour index (Table 1). Seedling height, production of leaves, biomass and root number in rice were significantly influenced by seed fortification. Singh [4] stated that the seedlings raised with DAP application weighed 25 times more than those grown without DAP. Fertilized seedlings attained greater height and produced more foliage and biomass and became autotrophic earlier than unfertilized ones. This indicates application of insufficient inorganic fertilizers is not suitable for mat nursery. Organic manures are mostly used for mat nursery, must be fully decomposed and mixed well with the soil, if poorly decomposed manure are used, seedlings will turn yellow and die due to toxicity in the medium [5]. The longest root length recorded s eed fortified with 1% KCl + 6 g mG^2 Pseudomonas + 50 g mG^2

Table 1: Seedling growth characters in modified rice mat nursery on 14th DAS

Treatments	Seedling height (cm)	Root length (cm)	No. of leaves	Seedling dry weight (g)	Chlorophyll meter (SPAD) value	Root number	Seedling vigour index
N1	16.7	11.0	4.1	11.5	28.8	9.8	9.8
N2	18.0	10.7	4.7	13.1	28.6	10.8	11.5
N3	18.6	10.2	5.5	15.6	30.4	11.6	14.3
N4	20.0	10.7	6.1	16.7	30.2	12.2	15.0
N5	21.7	12.9	7.2	18.1	32.9	12.9	15.8
SE_d	02	0.3	0.2	0.3	1.1	0.3	0.3
CD(P=0.05)	0.4	0.7	0.6	0.8	2.5	0.7	0.7

N1 : Water soaked seed (24 hours) + 25 g m^{-2} powdered DAP+ 0.5% urea drenching on 9th day

N2 : Seed fortification with 1% KCl + 6 g m^{-2} Pseudomonas + 50 g m^{-2} powdered DAP + 0.5% urea drenching on 9th day

N3 : Seed fortification with 1% KCl + 6 g m^{-2} Pseudomonas + 50 g m^{-2} VAM + 0.5 kg m^{-2} vermicompost + 0.5 % DAP drenching on 9th day

N4 : N_2 +20 g m^{-2} Azophos + 50 gm^{-2} VAM + 0.5 Kg m^{-2} vermicompost

N5 : N_3 + 20 g m^{-2} Azophos + 50 g m^{-2} VAM + 0.5 kg m^{-2} vermicompost

powdered DAP + 0.5% DAP drenching on 9th day + 20 g m^{-2} Azophos + 50 g m^{-2} VAM + vermicompost 0.5 kg m^{-2} treatment might be due to the supply of N and P through fertilizer sources which would have resulted in better root development.

Seedling height, production of leaves, biomass and root number in rice were significantly influenced by seed fortification. Application of high level of N, P_2O_5; K_2O in nursery, obtained tall growth, dark green foliage and thicker stem. Generally, rice hybrids are sensitive to the age of seedlings at the time of transplanting. Fifteen days old seedlings gave 16-20 per cent higher yield than the rice crop planted with 25 days old seedling of traditional wet nursery. Adequate nutrition to nursery is important factor to get healthy rice seedlings.

Crop Growth Attributes in Main Field: Higher plant height, more number of tillers $hill^{-1}$, greater quantity of dry matter production, more leaf area index, growth analysis and root characters were observed at all growth stages which is highly influenced by nursery treatment seed fortification with 1% KCl + 6 g m^{-2} Pseudomonas + 50 g m^{-2} powdered DAP + 0.5% DAP drenching on 9th day + 20 g m^{-2} Azophos + 50 g m^{-2} VAM + vermicompost 0.5 kg m^{-2}. The combinations of nutrient sources were organic, inorganic and biofertilizer resulted in increased seedling growth as compared to less fertilizer treatments.

The interaction between nursery management and planting pattern was not significant, but the growth attributes viz., plant height, number of tiller per hill, root characters, growth analysis and dry matter production and yield attributes viz., grain and straw yield were significantly influenced by nursery management and planting pattern. Higher tiller production was recorded by combined nursery management and planting pattern due to steady supply of nutrients at early stages of seedling under wider spacing found greater production of panicles. Adequate spacing also promoted higher panicle weight with more number of filled grains per panicle.

Planting pattern had significant influence on growth parameters of rice. Among different planting patterns, oblong pattern (30 x 25 cm) resulted in maximum plant height, leaf area index, total tillers per plant and dry matter accumulation. This is because of wider spacing which influenced the vegetative growth in a better way than closer spacing by increasing the nutrient absorption by plants and resulted in better dry matter production (DMP) [6].

Effect of Planting Density: Significantly higher grain yield was recorded with the spacing of 25 x 25 cm zig zag planting pattern over 30 x 25 cm oblong planting pattern. These findings are in accordance with the earlier work by Narasa Reddy and Bharathi [7]. Significantly higher number of filled grains per panicles, test weight and lower spikelet sterility percentage were obtained at a wider spacing of 30 x 25 cm oblong pattern of planting (Table 2). The marked increase in above yield components might not be sufficient to influence the yield considerably as compared to the number of tillers m^{-2} at closer spacing of 25 x 25 cm zig zag pattern of planting. However the higher grain and straw yield was recorded at 25 x 25 cm zig zag pattern of planting might be due to significant increase in tillers m^{-2} compared to 30 x 25 cm oblong method of planting.

Yield Attributes: Oblong pattern of planting (30 x 25 cm) influenced significantly the yield attributes like panicle length, panicle weight, thousand grain weights and filled grains $panicle^{-1}$, but its wider nature of spacing reduced

Table 2: Effect of growth characters and yield characters due to mat nursery and planting pattern

Treatments Nursery management (N)	Plant height (cm)	Number of tillers m^{-2}	Dry matter production (kg ha^{-1})	Panicles (hill^{-1})	Panicles (m^{-2})	Panicle weight (g)	Test grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kgha^{-1})
N1	84.3	545.3	11740	25.0	354.2	2.34	20.62	7787	9256
N2	86.0	573.4	12237	26.5	392.4	2.52	20.85	8724	10179
N3	87.5	621.2	12485	28.0	414.5	2.60	21.14	9591	11020
N4	90.4	654.6	12709	29.8	437.7	2.71	21.28	10294	11916
N5	92.4	698.0	12893	31.0	459.8	2.81	21.56	10920	12425
SE_d	0.3	4.7	160.3	0.6	21.1	0.03	0.08	128.0	191.4
CD(P=0.05)0.7	9.7	328.5	1.2	43.3	0.06	0.18	262.20	392.2	
Planting pattern (M)									
M1- Square planting	84.3	498.8	11957	20.6	345.9	2.48	20.56	7244	89350
M2 - Zig zag planting	87.4	683.9	12417	29.5	437.3	2.60	21.13	10598	11935
M3- Oblong planting	92.6	672.7	12864	34.0	451.9	2.71	21.58	10548	12009
SE_d	0.2	3.6	124.2	0.4	16.3	0.02	0.06	99.10	148.3
CD(P=0.05)	0.5	7.5	254.4	0.9	33.5	0.04	0.13	203.1	303.8
Interaction (N x M)									
SE_d	0.5	8.2	277.7	1.0	36.6	0.05	0.1	221.7	331.6
CD(P=0.05)	1.2	16.9	NS	NS	NS	NS	0.3	454.2	679.4

the plant population per unit area and yield attributes like number of panicle per unit area. Hence, it directly affected the grain and straw yield. Addition of organic and inorganic fertilizer in nursery along with SRI practices recorded significantly higher yield than farmers practice [8]. Planting single seedling with more crop geometry gave a good plant growth and yield responses.

The grain and straw yield were increased with the maintenance of proper plant population per unit area, yield attributes like number of panicle m^{-2} increased in zig zag pattern of planting compared with seed fortification with 1% KCl + 6 g m^{-2} Pseudomonas + 50 g m^{-2} powdered DAP + 0.5% DAP drenching on 9th day + 20 g m^{-2} Azophos + 50 g m^{-2} VAM + vermicompost 0.5 kg m^{-2} significantly enhanced grain and straw yield (Table 2) [9] reported that use of healthy and vigorous nursery seedlings is beneficial for achieving higher productivity of hybrid rice. It might be due to wider spacing with continuous availability of nutrients and better source sink relationship, which might have helped with higher carbohydrate synthesis and translocation to the yield attributing points. These results are accordance with the results of Narasa Reddy and Bharathi [7], who has recorded significantly higher number of filled grains per panicle, test weight at a wider spacing and in above yield components might not be sufficient to influence the yield considerably as compared to the number of panicles m^{-2} at closer spacing.

Economics: The highest net return was obtained with the combination of seed fortification with 1% KCl + Pseudomonas 6 g m^{-2} + powdered DAP 50 g m^{-2} + 0.5% DAP drenching on 9th day + Azophos 20 g m^{-2} + VAM 50 g m^{-2} + vermicompost 0.5 kg m^{-2}, with moderate spacing in zig zag pattern (Rs.38,036). Mat nursery reduced the cost on seed, fertilizer, labour and water. There was an overall cost saving due to mat nursery. Thus fertilizing the nursery is essential for getting robust seedlings and more seedlings out put which ultimately gives higher income in rice. The economic analysis of the results showed the maximum B: C ratio was obtained by seed fortification with 1% KCl + 6 g m^{-2} Pseudomonas + 50 g m^{-2} powdered DAP + 0.5% DAP drenching on 9th day + 20 g m^{-2} Azophos + 50 g m^{-2} VAM + vermicompost 0.5 kg m^{-2}, with moderate spacing in zig zag pattern (25 x 25 cm). All these factors favour maximum B: C ratio, because of higher efficiency in the utilization of resources. The harvest index of seedling under nursery management with seed fortification using 1% KCl + Pseudomonas 6 g m^{-2} + powdered DAP 50 g m^{-2} + 0.5% DAP drenching on 9th day + Azophos 20 g m^{-2} + VAM 50 g m^{-2} + vermicompost @ 0.5 kg m^{-2} (N_5) along with zig zag pattern of planting (25 x 25 cm) was maximum which might be due to the maintenance of good source sink relationship.

CONCLUSIONS

Based on the experimental results, it was concluded that an integrated approach of nursery treatment like seed fortification with 1% KCl + 6 g m^{-2} Pseudomonas + 50 g m^{-2} powdered DAP + 0.5% DAP drenching on 9th day + 20 g m^{-2} Azophos + 50 g m^{-2} VAM + vermicompost 0.5 kg m^{-2} and transplanting in zig zag pattern (25 x 25 cm) by marking impressions with triangular rolling marker was the best agronomic option for getting higher yield in hybrid rice under SRI technique.

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