

Original Research Article

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Optimization of Nitrogen Fertilization Timing and Rate in Machine Transplanted Rice

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ABSTRACT

Keywords

Machine transplanted rice, Nitrogen rate and timing, Grain yield, Cost economics

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Machine transplanted rice (MTR) is an emerging production system in South India to address the labour shortage. No research has been done in this aspect on optimizing nitrogen management to produce high yield. In this study, influence of varying nitrogen rates and time of application were studied with respect to grain yield, its components and economic returns. Nitrogen was applied in two, three and four splits, besides a basal dose at the rates of 120, 160 and 200 Kg/ha. The MTR did not respond to increasing N level from 120 to 200kg/ha, though the yield levels improved substantially (11.35%) Application of nitrogen in four splits (Initial tillering (IT), tillering (T), Active tillering AT) and Panicle initiation (PI) and three splits (IT, AT and PI) significantly enhanced the grain and straw yields with better net returns over two splits (AT and PI) indicating the importance of a different fertilizer schedule for MTR over transplanted rice.

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crop and staple food of India. At the current growth rate of population (1.55%) in India, the requirement of rice by 2020 would be around 120-135 million tonnes (Raj *et al.*, 2016). Direct seeding of rice and transplanting are the two common methods of rice establishment (Kumar *et al.*, 2017). Transplanting method is more popular among farmers due to higher yield and less weed

growth as compared to direct seeded rice. However, it requires high energy and also it is labour intensive (Guru *et al.*, 2018). Machine transplanting of rice (MTR) has been considered the most promising option, as it saves labour, ensures timely transplanting and attains optimum plant density that contributes to high productivity (Negalur and Halepyati, 2017). The positive response to nitrogen application in rice has been reported but its time of application contributes significantly towards nitrogen use efficiency and rice

productivity. Nitrogen moves very rapidly in the soil and subjected to various losses mainly due to leaching, denitrification, volatilization and surface runoff resulting into reduced nitrogen use efficiency. To overcome this problem, split application of nitrogen is recommended and response per unit of nitrogen in rice was reported to be more when applied in split doses (Singh *et al.*, 2017).

The crop management practices of MTR are entirely different from those adopted in manual transplanted rice in many ways *viz.* transplanting young seedlings, maintaining very shallow water depth during early stages of crop growth, giving wider row spacing and inter cultivation with power operated weeders. Early duration rice varieties (120-125 days) normally attain the panicle initiation stage in 45-47 days after transplanting in case of manual transplanting whereas in MTR the crop attains this stage in 55-58 days extending the period of tillering in MTR significantly (Negalur and Halepyati, 2017).

Taking into consideration these, it was hypothesized that N requirement of MTR at different growth stages can be met by increasing the number of splits with varying doses of N and consequently a study was conducted in this area of research.

Materials and Methods

A field experiment was conducted during *Kharif* season of 2012 at Rice Section, ARI, Rajendranagar, Hyderabad, Telangana (17°19'N, 78°23'E, 542m above mean sea level). The soil of the experimental field was clay loam with pH 7.9, organic carbon 0.32% and the available N, P₂O₅ and K₂O were 163, 74 and 869 kg/ha respectively. The total rainfall received in 27 rainy days from transplanting (22/7/2012) to physiological maturity (2/11/2012) was 293.4 mm. The mean maximum and mean minimum

temperatures recorded were 30.3°C and 18.5°C respectively and the season was quite normal. The experiment was replicated thrice with nine treatment combinations in split plot design comprising 3 nitrogen rates as main plots (120, 160 and 200kg N/ha) and 3 nitrogen schedules as sub plots *viz.* N as three equal splits at basal (B), active tillering (AT) and panicle initiation (PI). The most popular variety, *MTU 1010* of 125 days duration was used in the experimentation.

The selected field was ploughed twice with tractor drawn cultivator in summer, later 15 days before transplanting the field was puddled with tractor drawn rotavator with 5-7 cm standing water and again two days before machine transplanting. The soil was allowed to settle for 48 hours before the transplanting machine entered the field. Seed of *MTU 1010* rice variety were soaked for 24 hours and then incubated for another 12 hours. The nursery tray (58×28cm) was filled with the mixture of 3:1 soil: FYM free from clods and pebbles and then the sprouted seed was seeded with seeding machine @ 160g seed / tray and watering was done. The trays were shifted to the nursery field and covered with straw for shading. For first three days watering was done gently with rose cans without distributing the seed masses, later the watering was given through irrigation channels. After six days, the straw was removed and nursery was exposed to sunlight. The nursery was regularly irrigated, maintained well and transplanting was done with 17 days age seedlings on 22/7/2012 with walking type 4 line kubota transplanter. The row to row spacing was 30cm and within row it was 14-16cm with 3-4 seedlings / hill. For one hectare, 175 trays were used. Entire experimental field was planted at once and then it was divided into plots of 7.2×5.0m by forming 20cm temporary bunds within the replications. In between each replication, 60 cm width irrigation channels were prepared for irrigation/drainage.

Sufficient care was taken to prevent the movement of applied nitrogen from one plot to the another. Entire phosphorus (60 kg/ha), half the dose of potassium (20 kg/ha) and nitrogen as per the designated treatments were applied basally and thereafter. At panicle initiation the remaining potassium (20kg/ha) was applied along with nitrogen. The IT, T, AT and PI stages appeared at 15, 35, 45 and 58 DAT, respectively and the fertilizers were scheduled accordingly. Data on grain yield and its components were recorded and statistically analysed. The cost economics was worked out as per the prevailing market prices.

Results and Discussion

In machine transplanted rice, the yield attributes were not significantly influenced by the nitrogen levels and their scheduling. Interaction effect between nitrogen rate and timing was not found significant with respect to plant height, yield attributes and yield. Maximum plant height (100.0cm) was recorded with 160 kg N/ha followed by 200kg N/ha (98.8 cm) and 120kg N/ha (95.8cm). Of the different N schedules, more split applications (S_3) recorded better plant height (99.0cm). The tillers as well as panicle number increased with increase in nitrogen level from 120 to 200kg/ha by 8.2 and 10.9 %, respectively. Nitrogen split application from three to four / five numerically improved the yield attributes viz., tillers and panicles. The maximum number of panicles ($417/m^2$) was recorded when nitrogen was applied at B, IT, AT, T and PI indicating that higher split applications ensured N supply at critical growth stages of the crop.

Increasing the N rates had no significant influence on grain and straw yield of MTR,

where as more number of split applications exhibited considerable impact on grain yield. Enhancement of N from 120 to 200 kg/ha increased the grain yields from 6398 to 7262 kg/ha (13.5 % improvement) but not reached the level of significance. Fageria and Baligar (2001) reported that rice grain yield increased with increase N supply but up to certain limit only as was observed in the present study. Highest grain yield (7209 kg/ha) was obtained when N was applied in 5 equal splits (S_3) and it was at par with N application in 4 equal splits (S_2 -781kg/ha), however it is interesting to note that these two schedules significantly recorded higher grain yield over 3 equal splits (S_1 -6171 kg/ha). This was primarily due to higher N use efficiency and reduction in N losses (denitrifications and leaching) on account of N application in four / three splits than in two splits (Mahajan *et al.*, 2011). Similar trend was also observed in case of straw yield.

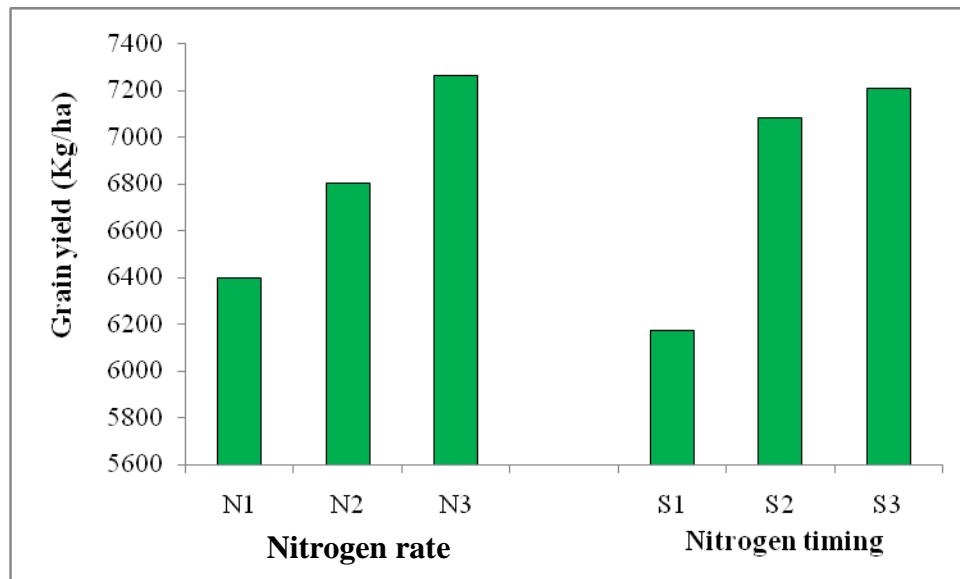
Economic analysis of the different nitrogen rates and schedules indicated that higher net return (Rs.57406/ha) as well as returns per rupee invested (1.55) were associated with higher nitrogen level (200 kg/ha) and these values were low *i.e.*, Rs.47174/ha and 1.31 respectively with 120kg/ha. N in five splits at B, IT, T, AT and PI resulted in net returns of RS. 56717/ha with a return of 1.53 rupees per every rupee invested, whereas with three split applications. (B, AT and PI) the net income was only Rs.44262/ha (-12455/ha) and return per every rupee invested was only 1.23 (-0.3).

For MTR, nitrogen scheduling as IT, AT, T and PI besides basal application recommended for higher grain and straw yields. The net returns as well as returns per rupee invested were also higher with this practice (Fig. 1 and Table 1).

Table.1 Plant height, yield attributes, yield and economics as influenced by nitrogen rates and timing in machine transplanted rice

Treatment	Plant height (cm)	Tillers / sq.m	Panicles / sq.m	Grain yield (kg/ha)	Straw yield (kg/ha)	Net returns (Rs./ha)	Net returns (Rs./Re.)
Nitrogen rate							
N₁-120 kg/ha	95.8	415	380	6398	7038	47174	1.31
N₂-160 kg/ha	100.0	437	405	6805	7494	51965	1.42
N₃-200 kg/ha	98.8	449	416	7262	8015	57406	1.55
SEd+	1.21	15.8	13.7	384	421	-	-
C.D.(p=0.05)	NS	NS	NS	NS	NS	-	-
Nitrogen timing							
S₁-‘N’ 3 equal splits at basal (B), active tillering AT) and Panicle initiation (PI)	97.6	414	380	6174	6809	44262	1.23
S₂ – ‘N’ 4 equal splits at B, initial tillering (IT), AT and PI	98.0	437	405	7081	7718	55553	1.52
S₂ – ‘N’ 5 equal splits at B, IT, AT, Tillering and PI	99.0	450	417	7209	8021	56717	1.53
SE d+	1.14	19.3	18.2	258	298	-	-
C.D. (p=0.05)	NS	NS	NS	NS	NS	-	-

Fig.1 Yield of Machine transplanted rice as influenced by Nitrogen rates and timing



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