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Response of Nutrient Management Practices under Rice Establishment Methods

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Abstract

Field experiment was conducted at Zonal Agricultural Research Station, V.C. Farm, Mandya, University of Agricultural Sciences, Bengaluru during the *Kharif* season of 2015 to study the response of nutrient management practices under rice establishment methods. The experiment was laid out in split plot design with three replications consisting of twenty treatment combinations. Four establishment methods of rice such as Manual transplanted, Mechanized transplanted, Dibbling of seeds followed by SRI principles, and Wet direct seeded rice by broadcasting were follwed in main plots and five nutrient management practices such as 100 per cent RDF,150 per cent RDF, 75 per cent inorganic + 25 per cent Organic, LCC based N application and UASB POP recommended dose of manure and fertilizers, in sub plot. Among the different establishment methods, Dibbling of seeds followed by SRI principles significantly influenced the growth, yield attributes and yield and was on par with Mechanized transplanted. The plant height (92 cm), number of tillers / hill (25), leaf area / cm^2 / plant (1618), total dry matter (71 g), Root length (24.5 cm) at 90 DAS / T, Root weight (11.73 cm) at 90 DAS / T, Days to maturity (119), number of panicle/m^2 (451), length of panicle (20 cm), weight of 10 panicle (24.5 g), grain yield (5330 kg / ha) and straw yield (6356 kg / ha), were recorded under dibbling of seeds with SRI principlesand lowest growth, yield attributes and yield were recorded under wet direct seeded rice by broad casting during *kharif* season.

Keywords: Machine planting, rice establishment methods, nutrient management, LCC SRI method

Rice (*Oryza sativa*) is the staple food for more than half of the population of the world. The productivity and sustainability of rice-based systems are threatened by the inefficient use of inputs (fertilizer, water, and labour), increasing scarcity of resources, especially water and labour; climate variability, emerging energy crisis and rising fuel prices, rising cost of cultivation and emerging socio-economic changes such as urbanization, migration of labour, preference for non-agricultural work, and concerns about farm-related pollution. Method of establishment influences the performance of rice through its effect on growth and development. Although, transplanting has been reported to be the best establishment method, some alternatives like dry and wet direct seeding are being explored to reduce the cost of cultivation on account of high labour and water requirement. Integrated use of organic manures and chemical fertilizers has advantages over use of only organic manures or chemical fertilizers. Since sourcing of organic manure is difficult and the crop response to them during initial stages is not as spectacular, compared to the chemical fertilizers, an integrated approach of plant nutrition involving the judicious mix of organic, chemical and microbial sources could be helpful to sustain optimum yield and to restore the residual soil fertility.

Material and Methods

The investigation was carried out in the Zonal Agricultural Research Station, Vishveshwarya Canal Farm, Mandya, University of Agricultural Sciences, Bengaluru during the *Kharif* season of 2015. The experimental farm is located at an altitude of 704 m above mean sea level with the geographical location at 12º 34' North latitude and 76º 49' East longitudes comes under Southern dry zone of Karnataka (Zone-VI). The climate of the experimental field is classified as semi arid tropical with high humidity, moderate temperature and medium rainfall. The soil of the experimental plot was sandy loam in texture and well drained with acidic reaction (pH 5.1). Organic carbon content of the soil was found to be medium while available nitrogen was found to be low, phosphorous and potassium were found to be medium. The

experiment was laid out in split plot design with three replications consisted of twenty treatment combinations. Four establishment methods of rice such as manual transplanted (M_1), mechanized transplanted (M_2), dibbling of seeds with SRI principles (M_3), and wet direct seeded rice by broadcasting (M_4) were grown in main plots and five nutrient management treatments of rice such as100 per cent RDF (F_1), 150 per cent RDF (F_2),75 per cent inorganic + 25 per cent Organic (F_3), LCC based N application (F_4) and UASB POP recommended dose of manure and fertilizers (F_5), in sub plot. Treatment F_5 UAS package of practices (10 t FYM/ha + 100: 50: 50: kg NPK / ha + 20 kg ZnSo4). The variety IR-30864 was taken as test crop during *kharif*, in manual transplanted 18-20 days old seedlings are transplanted. With respect to mechanized transplanted, fourteen days old seedlings of mat nursery were transplanted with a spacing of 25 x 25 cm, dibbling of seeds with SRI principles, seeds were soaked in water for 24 hours and incubated in dark for 12 hours to induce sprouting which are placed 2-3 seeds per corners of square, marked ropes were used for square planting and for wet direct seeded rice by broadcasting, the seeds are broadcasted at 25 kg / ha seed rate to maintain optimum plant population. Intercultural operations such as gap filling, irrigation and plant protection were carried out as required. The crop was harvested at four different dates depending on the maturity of the varieties manually and grain yield was recorded at 16 per cent moisture level. Data was collected from five hills per plot and then averaged. Observations on growth and yield were recorded during harvesting. Data recorded for different growth and yield parameters was compiled and tabulated in proper form for statistical analysis. Statistical analysis was performed following the method of Gomez and Gomez (1984).

Results and Discussion

Effect of establishment methods and nutrients on growth parameters of rice

Dibbling of seeds followed by SRI principles significantly influenced the plant height, number of tillers, Leaf area and total dry matter production (Table I), root length, root weight and days to maturity (Table II). Dibbling of seeds followed by SRI principles recorded significantly higher growth characters. The maximum plant height (92 cm), number of tillers / hill (25), leaf area (1618), total dry matter production (71 g), root length (24.5 cm), root weight (11.7 g) and days to maturity (119) were recorded under Dibbling of seeds followed by SRI principles which was on par with Mechanized transplanted method on growth parameters like plant height (91 cm), number of tillers / hill (22), leaf area (1577) total dry matter production (68 g), root length (23.2 cm), root weight (10.8 g) and days to maturity (120) in *kharif* season. There was a progressive increase in plant height, number of tillers, leaf area and TDMP under Dibbling of seeds followed by SRI principles system of planting when compared to manual transplanted, and mechanized transplanted methods. Wet direct seeded rice by broadcasting produced lesser plant height (79 cm), number of tillers / hill (16), leaf area (1138) and total dry matter production (52 g), root length (20.6 cm), root weight (8.9 g) and days to maturity (116). Dibbling of seeds followed by SRI principles which might have established quickly in the field due to wider spacing, less competition, without transplanting and started growing at a faster might be attributed to higher plant height. The number of tillers per plant was significantly higher in Dibbling of seeds followed by SRI principles. Dibbling of seeds in square method with wider spacing might have resulted in profused tillering under Dibbling of seeds followed by SRI principles, which might have facilitated plants for better utilization of the resources. This advantage of Dibbling of seeds followed by SRI principles in enhancing tiller numbers, leaf area and total dry matter production root length, root weight may be attributed to young seedlings used for transplanting at shallow depth and wider spacing, which provided good aeration for better establishment of crop. Higher root dry weight and root length in dibbling of seeds followed by SRI principles also led to proliferation of root system by contributing to higher biomass.

Days to maturity was affected by crop establishment methods (Table II). The growth duration of manual transplanting was 7 days more than Dibbling of seeds followed by SRI principles, whereas, it was 3 days more than wet direct seeded rice by broadcasting. Kumar *et al*. (2015) also reported that manual transplanting was 7 days more and matured later by 7

TABLE I

Growth of rice as influenced by response of nutrient management practices under rice establishment methods during Kharif 2015

Treatments	Plant height (cm) at harvest	Number of tillers hill^{-1} at harvest	Lear area (cm2 plant-1) at 90 DAS/T	Total dry matter (g/hill) at harvest
Establishment techniques (M)				
M_1	89	19	1281	60
M_2	91	22	1577	68
M_3	92	25	1618	71
M_4	79	16	1138	52
S.Em±	1	1	16.0	1
C.D. at 5%	2	3	55.4	4
Nutrient management practices (S)				
F_1	87	19	1342	54
F_2	90	23	1487	71
F_3	87	19	1372	60
F_4	89	21	1438	67
F_5	87	19	1378	62
S.Em±	1	1	32	2
C.D. at 5%	2	2	91	5
Interactions				
S.Em±	1.0	2.0	63	3
C.D. at 5%	NS	NS	NS	NS

Methods of crop establishment

M_1: Manual transplanted rice

M_2: Mechanized transplanted rice

M_3: Dibbling of seeds followed by SRI principles

M_4: Wet direct seeded rice by broadcasting (DSR)

DAS/T: Days after sowing / transplanting

Subplot: Nutrient management practices

F_1: 100 % RDF; F_2: 150 % RDF

F_3: 75 % inorganic + 25 % Organic (N equivalent basis)

F_4: LCC based N application

F_5: UASB package of practices (FYM 10 t/ha + 100: 50: 50: kg NPK / ha + 20 kg $ZnSo_4$)

NS: Non significant

days compared to Dibbling of seeds followed by SRI principles which was due to older seedlings and transplanting shock as reported earlier by Rakesh Choudary *et al*. (2016).

Among different nutrient management practices, significantly maximum plant height (90 cm), number of tillers / hill (23), leaf area (1487) and total dry matter production (71 g), root length (24.2 cm), Root weight (11.3 g) and days to maturity (123) were recorded with the application of 150 per cent RDF which was on par with LCC based N application [plant height (89 cm), number of tillers / hill (21), leaf area (1438), total dry matter production (67 g), root length (23.7cm) and root weight (11.0 g)] in *kharif* season. There was a progressive increase in plant height, number of tillers, leaf area and TDMP under 150 per cent RDF and LCC based N application system of planting when compared to UASB Package of practices, 100 per cent RDF and 75 per cent inorganic + 25 per cent

TABLE II

Growth of rice as influenced by response of nutrient management practices under rice establishment methods during Kharif 2015

Treatment	Root length (cm) at 90 DAS/T	Root weight (g.) at 90 DAS/T	Days to maturity
Establishment techniques (M)			
M_1	21.7	9.7	126
M_2	23.2	10.8	120
M_3	24.5	11.7	119
M_4	20.2	8.9	116
S.Em±	0.8	0.5	2
C.D. at 5%	2.8	1.8	5
Nutrient management practices (S)			
F_1	20.7	9.4	118
F_2	24.2	11.3	123
F_3	21.7	9.6	118
F_4	23.7	11.0	120
F_5	21.8	10.2	121
S.Em±	0.6	0.2	1
C.D. at 5%	1.9	0.7	3
Interactions			
S.Em±	1.3	0.5	2.00
C.D. at 5%	NS	NS	NS

Methods of crop establishment

M_1: Manual transplanted rice

M_2: Mechanized transplanted rice

M_3: Dibbling of seeds followed by SRI principles

M_4: Wet direct seeded rice by broad casting (DSR)

DAS/T: Days after sowing/transplanting

Subplot: Nutrient management practices

F_1: 100 % RDF; F_2: 150 % RDF

F_3: 75 % inorganic + 25 % Organic (N equivalent basis)

F_4: LCC based N application

F_5: UASB package of practices (FYM 10 t/ha + 100: 50: 50: kg NPK/ha + 20 kg $ZnSo_4$)

NS: Non significant

Organic. 100 per cent RDF produced lesser plant height (87 cm), number of tillers / hill (19), leaf area (1342) and total dry matter production (54 g), Root length (20.7 cm), Root weight (9.4 g) and Days to maturity (118). Application of nutrients as per crop requirement at various growth stages eventually leads to better utilization of nitrogen for growth and development (Aabid *et al*., 2016). The number of tillers per plant was significantly higher in 150 per cent RDF could attribute to more assured nutrients supply to the plants at active tillering stage. Further, tiller number and leaf size are the two important factors which influence leaf area and these, in turn, are greatly affected by soil nutrient availability. This advantage of application of 150 per cent RDF enhancing tiller numbers, leaf area and total dry matter production, root length, root weight and days to maturity may be attributed to better synchronization in supply and demand of nitrogen at all the critical growth stages. Besides, high leaf area coupled with high chlorophyll content at flowering has been reported to affect the amount of photosynthates available to the panicle (Avijit *et al*., 2011). UASB package of practices (FYM 10 t / ha + 100: 50: 50: kg NPK / ha + 20 kg $ZnSo_4$) and 75 per cent inorganic + 25 per cent Organic produced lesser plant height (87 and 87 cm),

TABLE III

Yields attributes and yield of rice as influenced by response of nutrient management practices under rice establishment methods during Kharif 2015

Treatment	Number of panicles / m^2	Panicle length (cm)	10 Panicle weight (g)	Grain yield (kg / ha)	Straw yield (kg / ha)
Establishment techniques (M)					
M_1	390	18	23.0	4910	5842
M_2	429	20	24.1	5043	6119
M_3	451	20	24.5	5317	6263
M_4	351	18	20.3	4789	5704
S.Em±	8	0	0.7	88	92
C.D. at 5%	26	1	2.5	303	320
Nutrient management practices (S)					
F_1	382	18	21.3	4698	5615
F_2	434	20	24.8	5350	6354
F_3	401	18	22.2	4758	5793
F_4	412	20	24.1	5238	6312
F_5	399	18	22.3	5029	5835
S.Em±	8	0	0.8	105	147
C.D. at 5%	23	1	2.3	302	423
Interactions					
S.Em±	16	1	1.6	209	294
C.D. at 5%	NS	NS	NS	NS	NS

Methods of crop establishment

M_1: Manual transplanted rice

M_2: Mechanized transplanted rice

M_3: Dibbling of seeds followed by SRI principles

M_4: Wet direct seeded rice by broad casting (DSR)

DAS/T: Days after sowing/transplanting

Subplot: Nutrient management practices (05)

F_1: 100 % RDF, F_2: 150 % RDF

F_3: 75 % inorganic + 25 % Organic (N equivalent basis)

F_4: LCC based N application

F_5: UASB package of practices (FYM 10 t/ha + 100: 50: 50: kg NPK/ha + 20 kg $ZnSo_4$)

NS: Non significant

number of tillers / hill (19 and 19), leaf area (1378 and 1372) and total dry matter production (62 and 60 g), root length (21.8 and 21.7 cm), root weight (10.2 and 9.6 g) and days to maturity (121 and 118).

Effect of establishment methods and nutrients on yield attributes and yield of rice

Among the different establishment methods Dibbling of seeds followed by SRI principles significantly influenced the yield attributes and yield like number of panicles / m^2, panicle length, Panicle weight, grain yield and straw yield and recorded significantly higher seed yield (5317 kg / ha) and straw yield (6263 kg / ha) (Table III) which was attributed to higher values of yield components *viz.,* number of panicles / m^2 (451), 10 panicle weight (24.5 g), panicle length (20 cm), which was on par with Mechanized transplanted method [seed yield (5043 kg / ha) and straw yield (6119 kg / ha), number of panicles / m^2 (429), 10 panicle weight (25 g), panicle length (20 cm)]. Optimum plant population and geometry under SRI system of planting led to availability of more resources to the plants that resulted in increased plant height and more number of tillers. This advantage of SRI method in enhancing tiller numbers, leaf area and dry matter production has been reported earlier byJayadeva and Prabhakar Setty (2011) and Senthil Kumar (2016). Wet direct seeded rice by broadcasting

produced lesser seed yield (4789 kg / ha) and straw yield (5704 kg / ha), number of panicles / m^2 (351), 10 panicle weight (20.3 g), panicle length (18 cm), which was mainly due to closer spacing of rice seedlings in broadcasting has shown intra-plant competition for same resources resulted in poor growth and yield components.

Among different nutrient management practices, significantly higher seed yield (5350 kg / ha) and straw yield (6354 kg / ha) was recorded in 150 per cent RDFwhich was attributed to higher values of yield components *viz.,* number of panicles / m^2 (434), 10 panicle weight (24 g), panicle length (20 cm), which was on par with LCC based N application on yield and yield attributes [seed yield (5238 kg / ha) and straw yield (6312 kg / ha), number of panicles / m^2 (412), 10 Panicle weight (24.1 g), Panicle length (20 cm)]. There was a progressive increase in yield and yield attributes under 150 per cent RDF and LCC based N application system of planting when compared to UASB Package of practices, 100 per cent RDF and 75 per cent inorganic + 25 per cent Organic. This shows that the supply of nutrients in 150 per cent RDF and LCC based N application matched more effectively with the crop nutrient demand. Improving the synchronization between crop nutrients demand and the available nutrients supply is an important key to improve NUE. Nitrogen losses from soil-plant system are large thereby leading to low fertilizer NUE when nutrients application is not synchronized with crop demand. The results confirm the findings of Gupta *et al*. (2011) and (Avijit *et al*., 2011) and UASB package of practices (FYM 10 t / ha + 100: 50: 50: kg NPK / ha + 20 kg $ZnSo_4$) and 75 per cent inorganic + 25 per cent Organic produced lesser yield and yield attributes seed yield (5029 and 4758 kg / ha) and straw yield (5835 and 5793 kg / ha), number of panicles / m^2 (399 and 401), 10 panicle weight (22.3 and 22.2 g), panicle length (18 and 18 cm). This amply clarifies that the existing recommendation approach of lower rate of nutrients applications at specified growth stages is not adequate to synchronize nutrient supply with actual crop nitrogen demand due to poor NUE and variations in crop N demand and also loss of N results in lower yield and yield attributes.

Thus, the study revealed that after taking into account the overall results of all the observed parameters among different establishment methods of rice, Dibbling of seeds followed by SRI principles and mechanized transplanted are the best adjudged treatments and nutrient management treatments for rice do not match with the crop demand. Hence, 150 per cent RDF recorded significantly higher grain yield but remained on par with LCC based N application. Hence, 150 per cent RDF or LCC based N application is one of the best tool for nutrient management in order to increase grain yield and N-use efficiency of rice for the Southern dry zone of Karnataka.

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