Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 5153-5160

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-7 pp. 5153-5160**
Journal homepage: http://www.ijcmas.com

Original Research Article

Effect of Nitrogen Scheduling on Growth, Yield and Economics of Rice under Different Establishment Methods

Prakhar Kumar, S.K. Choudhary and Abhinandan Singh*

Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar -848125, India
**Corresponding author*

Keywords

Establishment methods, Nitrogen scheduling, Transplanting method, DSR-wet and Neem coated urea.

A B S T R A C T

A field experiment was carried out at the Research Farm of Dr. Rajendra Prasad Central University, Pusa, Samastipur, Bihar (India), during *kharif* season of 2015. The soil of experimental field was calcareous clay-loam alkaline in reaction with pH 8.6. The factors under study comprised of Establishment methods (3 levels) and Nitrogen scheduling (6 levels). The experiment was conducted in split plot design replicated thrice. 60 kg P_2O_5, 40 kg K_2O and 25 kg $ZnSO_4$ per hectare was used. Nitrogen was applied as per treatment. Among different rice establishment methods, transplanting method registered the maximum grain yield (39.11 q ha^{-1}) which remains comparable to DSR-wet. Under different nitrogen scheduling, LCC-4 recorded maximum grain yield (44.12 q ha^{-1}) and it was significantly superior to rest of the treatments except neem coated urea. Among different establishment methods, maximum net return (₹ 22,614 ha^{-1}) and B:C ratio (0.77) were observed in DSR-dry. Under nitrogen scheduling, maximum net return (₹ 31,468 ha^{-1}) and B:C ratio (1.03) was recorded in neem coated urea and it was comparable with LCC-4. Thus LCC based nitrogen scheduling resulted in better synchronization between crop N demand and supply

Introduction

"Rice is Life" for millions of people and staple food for more than half of the world's population. Worldwide, rice is grown on 161 million hectares, with the production of about 713.8 million tonnes with an average productivity of 4.44 tonnes/ha (IRRI, 2014). India has the largest acreage under rice of 43.95 million ha with the production of 106.54 million tonnes and an average productivity of about 2424 kg/ha (Agricultural Statistics at a Glance, 2014). Rice is traditionally grown by transplanting seedlings into puddled soil. Puddling benefits rice by reducing water percolation losses, controlling weeds, facilitating easy seedling establishment, and creating anaerobic conditions to enhance nutrient availability. But, repeated puddling adversely affects soil physical properties by destroying soil aggregates, reducing permeability in subsurface layers, and forming hard-pans at shallow depths. Traditionally, transplanting seedlings entails lot of expenditure on raising nursery, uprooting and transplanting. Scarcity of labour during peak period of transplanting and rising labour cost necessitate the search for an alternative to conventional method of transplanting. Direct seeded rice (DSR), being a cost effective, consumes less water and labour saving crop establishment method, is becoming popular. Direct seeding methods can be categorized as wet seeding (pre-germinated seeds) and dry seeding. In wet seeding, pre-germinated seeds are sown into puddled and levelled field which are free from standing water and in dry seeding; dry rice seeds are drilled or broadcast on unpuddled soil either after dry tillage or zero tillage or on a raised bed. DSR is efficient resource conservation technology which saves the labour to the extent of about 40% and water up to 60% (Nainwal *et al*., 2013).

Rice plant require sufficient N at early and mid-tillering stage to achieve an adequate yield attributes *viz*. number of panicles, grain numbers per panicle. There is need to measure N requirement of crop at different critical stages of growth. Real time corrective N management is based on periodic assessment of plant nitrogen status and the appearance of nitrogen deficiency symptoms especially on leaves. Thus, the key ingredient for real time N management is a method of rapid assessment of leaf nitrogen content that is closely related to the photosynthetic rate and biomass production and is a sensitive indicator of changes in crop nitrogen demand within a growing season. Recently, it has become possible to quickly and non-destructively quantify spectral characteristics of leaves, which can be used to diagnose plant N deficiency and in-directly, to correct N fertilization and improve N-use efficiency in rice crop. Thus, Leaf colour chart (LCC) has been found an effective, inexpensive and easy-to-use tool for monitoring the greenness of plant and providing a quick estimate of leaf N status and highly useful to synchronize fertilizer N application with crop demand (Nainwal *et al*., 2013).

Materials and Methods

A field experiment was conducted at Research Farm of Dr. Rajendra Prasad Central University, Pusa, Samastipur, Bihar (India) situated on the southern bank of the river *Burhi Gandak* in Samastipur district at 25.59º North latitude and 84.40º East longitudes with an altitude of 52.3 m above the mean sea level, during *kharif* season of 2015. The soil of experimental field was calcareous clay-loam alkaline in reaction with pH 8.6. It was moderately fertile being low in organic carbon (0.36%), available nitrogen (212 kg N ha^{-1}), phosphorous (17 kg P_2O_5 ha^{-1}) and potassium (103 kg K_2O ha^{-1}). The factors under study comprised of (A) Establishment methods (3 levels): M_1- Transplanting, M_2- DSR-dry and M_3- DSR-wet in main plot and (B) Nitrogen Scheduling (6 levels): N_1- LCC-3, N_2- LCC-4, N_3- LCC-5, N_4- RDN (120 kg N ha^{-1}) (50% B + 25% AT + 25% PI), N_5- Neem coated urea (100 % B) and N_6- Control in sub plot. The experiment was conducted in split plot design replicated thrice. 'Rajendra Suwasani' was taken as a test crop. 60 kg P_2O_5, 40 kg K_2O and 25 kg $ZnSO_4$ per hectare was used. Nitrogen was applied as per treatment. Whereas, full dose of P_2O_5 and $ZnSO_4$ was applied as basal at the time sowing/transplanting. K_2O was applied in two splits 75% as basal and 25% at panicle initiation stage.

Results and Discussion

Growth

Various growth characters like plant height and number of tillers m^{-2} are show in Table 1 which is directly or indirectly responsible for modifying the yield contributory characters and finally the grain yield. In present study, plant growth was studied with respect to plant height, number of tillers m^{-2}, dry matter production m^{-2} and crop growth rate at different growth stages.

Different establishment methods influenced the plant height at various growth stages. Maximum plant height was observed with M_2- DSR-dry; this might be due to avoidance of root injury and transplanting shock over M_1-Transplanting method, while M_3- DSR-wet has recorded comparable plant height with M_2- DSR-dry, due to better utilization of moisture and nutrient and lesser weed completion in puddled condition. These observations are in agreement with those of Jaiswal and Singh (2001).

Nitrogen scheduling affected the plant height up to significant level at successive growth stages. Plant height increased with variation in N-levels in different nitrogen schedules, and at harvest maximum plant height was recorded with N_3- LCC-5 due to more availability of nitrogen which might have encouraged higher protein synthesis and higher LCC values means more chlorophyll content leading to higher photosynthesis. These resulted in to rapid cell elongation and enlargement and ultimately higher plant height. These results are in the conformity with the findings of Chopra and Chopra (2004).

Periodical observations on numbers of tillers m^{-2} revealed that numbers of tillers m^{-2} increase up to 60 DAS and there after a declining trend was observed irrespective of treatments. At 30 DAS maximum numbers of tillers m^{-2} was recorded with M_3- DSR-wet due to better availability of moisture, nutrients and absence of transplanting shock as in case of transplanted rice. However, at successive growth stages numbers of tillers m^{-2} was maximum with M_1-Transplanting. This may be due to lesser competition for light, moisture, space, nutrient and other edaphic and climatic factors among the tillers. This finding is in conformity with the results of Balasubramaniyam (2004).

Nitrogen helps in the development of auxin, promoting growth of lateral buds which ultimately led to the formation of tillers. Higher numbers of tillers m^{-2} was recorded with N_4- RDN (50% B + 25% AI + 25% PI) at 30 DAS but at later stages it recorded maximum in N_2-LCC-4, it might be due to steady supply of nitrogen during the crop duration. The findings are in agreement with the results of Budhar (2005).

The photosynthetic activities of the plant are well reflected in their dry matter production. The dry matter production m^{-2} increased progressively with the crop growth in all the methods of establishment and it was maximum at harvest. At 30 DAS maximum dry matter production m^{-2} was noted under M_3- DSR-wet due to early establishment, and better moisture and nutrient supply. On successive growth stages, maximum dry matter production m^{-2} was recorded with M_1- Transplanting due to soft seedbed, lesser completion for light, space, nutrient and avoidance of overcrowding. Similar results were also notified by Singh *et al.*, (2010).

The dry matter production is the cumulative effect of all the growth characters *viz.* plant height and number of tillers which are the indicator of higher chlorophilic area resulted in higher dry matter production per unit area (Terashima and Evans, 1988). Maximum dry matter production was recorded under N_2- LCC-4, because of more split application of nitrogen which might have lead to rapid cell division and elongation. However, it was comparable to N_5- NCU (100% B) because of slow release of neem coated urea for longer period of crop growth cycle. These results were also confirmed by Devi *et al.*, (2012) .

Crop growth rate (CGR) increased rapidly up to 30-60 days after sowing there after decreased with crop age. Similar results were also reported by Rehman *et al.,* (2013).

Yield

Yield is the ultimate outcome of the crop efficiency as influenced by various management practices is show in Table 2. Environment and input act on the plants which ultimately produce the desirable economic product. This is because of total dry matter production as well as the efficiency of its conversion is amenable to various management practices and processes. The final yield of rice is the result of the successful completion of growth and development activities which in turn depends on the genetic potential of the genotype, the environmental conditions to which it is exposed during the course of its life cycle and agronomic management efficiencies.

The higher grain yield was recorded in transplanted method which was comparable to wet direct seeding. This might be ascribed to the availability of more nutrients, light, space, moisture as puddling also restrict percolation losses. Lesser plant competition within row might be also the reason. This impact has made it possible to record more number of tillers m^{-2} with heavier panicles contributing to higher grain yield with transplanting method. Higher grain yield under transplanting method were also reported by Mallareddy and Padmaja (2013).

The poor yield in dry direct seeded rice was because of higher loss of water by the way of seepage and percolation along with the leeching of nitrogen with percolating water resulting in poor growth. These results are in accordance with the findings of Ram *et al.,* (2006).

Application of nitrogen in split doses with LCC-4 up to late growth stages registered higher grain yield, however it was at par with grain yield with neem coated urea. The increased availability of nitrogen at distinct physiological phases would have supported for better assimilation of photosynthates towards grain and also due to the favourable effect of accelerating the yield attributes. Similar finding have been reported by Sen *et al.,* (2011).

Straw yield is the amount of photosynthates not converted to economic yield. Like grain yield, straw yield also differed significantly due to different establishment methods. Transplanting method recorded higher straw yield. This might be due to increased production of tillers m^{-2}, plant height and length of panicle which ultimately contributed to increased straw yield. Similar results were found by Mhaskar *et al.,* (2005).

In case of nitrogen scheduling higher straw yield was recorded with LCC-4 and it was comparable to neem coated urea due to its slowly and steady supply of nitrogen upto late growth phases. These results were in accordance with the results of Mahajan *et al.,* (2011).

Economics

The gross return calculated on the basis of price of grain and straw yield of rice as per market price were subjected to statistical analysis and presented in Table 2. The results clearly exhibited that there was a significant variation in gross return due to different establishment methods of rice. The maximum gross return was recorded under M_1 – Transplanting (₹ 55,445 ha^{-1}) which was significantly superior over M_2 – DSR-dry (₹ 50,669 ha^{-1}) and M_3 DSR-wet (₹ 51,818 ha^{-1}).

Table.1 Effect of nitrogen scheduling on growth of rice under different establishment methods

Treatments	Plant height (cm)				Number of tillers m^{-2}				Dry matter production ($g\ m^{-2}$)				Crop growth rate (CGR) ($g\ day^{-1}\ m^{-2}$)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	0-30 DAS	30-60 DAS	60-90 DAS	At harvest
Establishment methods																
M_1 – Transplanting	26.43	75.43	98.92	100.15	79	367	289	250	50	392	704	963	1.63	11.43	10.40	8.63
M_2 – DSR-Dry	28.41	77.04	102.98	104.37	184	319	275	239	79	371	653	905	2.63	9.73	9.43	8.40
M_3 – DSR-Wet	27.82	76.17	101.22	102.79	206	330	281	241	85	380	664	925	2.90	9.86	9.46	8.53
SEm ±	0.59	1.59	1.80	1.66	4.53	6.99	5.42	6.58	1.66	7.32	14.18	21.11	0.35	0.33	0.31	0.23
CD $_{(P=0.05)}$	1.76	NS	NS	NS	13.53	21.05	NS	NS	4.93	NS	43.11	NS	1.07	0.97	0.92	NS
Nitrogen scheduling																
N_1 – LCC-3	27.31	79.25	99.31	100.47	147	314	260	227	68	385	656	921	2.30	10.53	9.03	8.83
N_2 – LCC-4	27.46	81.22	107.11	108.8	172	378	310	271	74	410	717	985	2.50	11.17	10.23	8.93
N_3 – LCC-5	27.06	78.35	110.81	112.51	170	340	290	250	78	386	696	961	2.63	10.23	9.33	8.23
N_4 – RDN	29.39	79.84	109.23	110.76	174	344	298	253	80	398	707	969	2.70	10.56	10.30	8.73
N_5 – NCU	28.42	77.75	99.90	101.15	179	371	300	255	76	400	714	977	2.57	10.83	10.46	8.76
N_6 – Control	25.67	60.88	79.86	81.44	97	285	233	201	54	307	546	779	1.87	8.37	7.96	7.76
SEm ±	0.56	1.52	1.74	1.69	4.41	6.51	6.05	6.21	1.59	7.99	13.75	20.19	0.27	0.31	0.30	0.22
CD $_{(P=0.05)}$	1.65	4.49	5.07	5.06	12.94	19.36	17.65	18.32	4.67	23.14	41.16	59.38	0.79	0.91	0.89	0.64

Table.2 Effect of nitrogen scheduling on Yield and Economics in rice under different establishment methods

Treatments	Straw yield ($q\ ha^{-1}$)	Grain yield ($q\ ha^{-1}$)	Cost of Cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B: C ratio
Establishment methods						
M_1 – Transplanting	52.48	39.11	34,871	55,445	20,574	0.58
M_2 - DSR-Dry	47.46	35.79	28,594	50,669	22,075	0.77
M_3 - DSR-Wet	48.94	36.56	29,204	51,818	22,614	0.77
SEm ±	0.90	0.98	-	932	526	0.04
CD $_{(P=0.05)}$	2.73	2.94	-	2807	1573	0.12
Nitrogen scheduling						
N_1 – LCC-3	45.29	33.37	30,907	47,894	16,987	0.56
N_2 – LCC-4	58.27	44.12	31,608	62,430	30,821	0.98
N_3 – LCC-5	52.81	38.82	32,135	55,126	22,991	0.72
N_4 – RDN	54.41	41.11	30,966	58,188	27,192	0.89
N_5 – NCU	58.00	43.94	30,707	62,175	31,468	1.03
N_6 – Control	28.97	21.14	30,051	30,051	1,066	0.05
SEm ±	0.89	0.95	-	831	507	0.03
CD $_{(P=0.05)}$	2.67	2.80	-	2477	1465	0.09

As regards the nitrogen scheduling the highest gross return was found under N_2 – LCC-4 (₹ 62,430 ha^{-1}) which was significantly superior over rest of the treatments except N_5 – NCU (100% B) (₹ 62,175 ha^{-1}).

A critical study of data of net return revealed that different rice establishment methods produce significant variation, maximum net return was found under M_3 – DSR-wet (₹ 22,614 ha^{-1}) which was significantly superior over M_1 – Transplanting (₹ 20,574 ha^{-1}) and remained statistically at par with M_2 – DSR-dry (₹ 22,075 ha^{-1}).

Data regarding the effect of nitrogen scheduling cause the significant effect on net return. Maximum net return was recorded under N_5 – NCU (100% B) (₹ 31,468 ha^{-1}) which was statistically at par with N_2 – LCC-4 (₹ 30,821 ha^{-1}) while significantly superior over rest of the treatments.

An appraisal of mean data revealed that different rice establishment methods indicated significant effect on benefit cost ratio. Higher benefit cost ratio was found under M_2 – DSR-dry (0.77) and M_3 - DSR-wet (0.77) which was significantly superior over M_1 – Transplanting (0.58).

Nitrogen scheduling also indicated significant variation in benefit cost ratio. The highest B:C ratio was recorded under N_5 – NCU (100% B) (1.03) which was significantly superior over rest of the treatments except N_2 – LCC-4 (0.98).

It is concluded that keeping in view the limitations of present investigation the following broad conclusion can be drawn.

Among different method of rice establishment, transplanting method recorded the maximum grain (39.11 q ha^{-1}) and straw yield (52.48 q ha^{-1}) while remained comparable to wet direct seeding.

Leaf colour chart (LCC) critical value 4 registered significantly maximum grain yield (44.12 q ha^{-1}), indicating better utilization of applied nitrogen compared with the other nitrogen management practices.

Considering the variability in existing indigenous soil nitrogen supply and dynamic crop nitrogen demand at various growth stages, synchronizing the nitrogen application with crop demand through LCC resulted in maximum grain yield than to other nitrogen management practices.

Amongst different establishment methods, DSR-wet recorded maximum net return and B:C ratio and it was at par with DSR-dry. Leaf Colour Chart critical value 4 recorded higher gross return. However, net return and B:C ratio were higher in neem coated urea but it was at par with LCC-4.

References

Agricultural statistics at a glance. 2014. Ministry of Agriculture, Government of India.

Balasubramaniyam, P. 2004. Yield potential of fine grain rice (*Oryza sativa* L.) under integrated nutrient management. *Indian Journal of Agronomy* 49(3): 157-159.

Budhar, M.N. 2005. Leaf colour based nitrogen management in direct seeded puddled rice. *Fertilizer News* 50(3): 41-44.

Chopra, N.K. and Chopra, N. 2004. Seed yield and quality of 'Pusa 44' rice as influenced by nitrogen fertilizer and row spacing. *Indian Journal of Agriculture Sciences* 74(3): 144-146.

Devi, M.G., Reddy, S.T., Sumathi, V.,

Reddy, S. and Aruna, A. 2012. Influence of level and time of N application on yield, nutrient uptake and post-harvest nitrogen status of soil in aerobic rice. *Current Botenica* 6(1): 98-102.

IRRI. 2014. World rice statistics. http://ricestat.irri.org:8080/wrsv3/entrypoint.htm

Jaiswal, V.P. and Singh, G.R. 2001. Effect of planting methods, source and level of nitrogen on the growth and yield of rice (*Oryza sativa* L.) and on succeeding wheat (*Triticum aestivum* L.). *Indian Journal of Agronomy* 46(1): 5-11.

Mahajan, G., Chauhan, B.S. and Gill, M.S. 2011. Optimal nitrogen fertilization timing and rate in dry-direct seeded rice in north-west India. *Agronomy Journal* 103(6): 1676-1682.

Mallareddy, M. and Padmaja, B. 2013. Response of rice (*Oryza sativa*) varieties to nitrogen under aerobic and flooded conditions. *Indian Journal of Agronomy* 58(4): 500-555.

Mhaskar, N.V., Dongale, J.H., Datemal, A.A. and Khanvilkar, S.A. 2005. Performance of scented rice variety under different nitrogen levels in lateritic soil of Konkan. *Oryza* 42(4): 323-326.

Nainwal, K. and Verma, O. 2013. Resource conserving technologies (RCT) in rice-wheat cropping system. *Indian Farmer's digest* 46(10): 7-9.

Ram, M., Hari, O., Dhiman, S.D. and Nandal, D.P. 2006. Productivity and economics of rice-wheat cropping system as affected establishment method and tillage practices. *Indian Journal of Agronomy* 51(2): 177-180.

Rehman, U.R., Bashra, M.A. and Wahid, A. 2013. Optimising nitrogen-split application time to improve dry matter accumulation and yield in direct seeded rice. *International Journal of Agriculture and Biology* 15(1): 41-47.

Sen, A., Srivastava, V.K., Singh, M.K., Singh, R.K. and Kumar, S. 2011. Leaf colour chart vis-à-vis nitrogen management in different rice genotypes. *American Journal of Plant Sciences* 2: 223-226.

Singh, Y.V., Sharma, S.K., and Meena, D.S. 2010. Effect of integrated nutrient management on yield and seed quality in rice. *Oryza* 47(3): 215-220.

Terashima, I. and Evans, J.R. 1988. Effect of light and nitrogen nutrition on the organization of the photosynthetic apparatus in spinach. *Plant Cell Physiology* 29: 143-155.