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Study of Different Nitrogen Levels and Nitrogen Scheduling on Production and Profitability of Aerobic Rice

S. K. Bhagat, B. Tigga, Akhilesh Lakra, Pradeep Kumar Dewangan, D. P. Singh, Yogesh Kumar Sahu, Narendra Kumawat

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Abstract The field experiment was carried out during *kharif* season of 2013. Two nitrogen level viz. 120 kg N ha^{-1} (N_1) and 150 kg N ha^{-1} (N_2) and six nitrogen scheduling viz. two splits (F_1-1/2 as basal + 1/2 at panicle initiation), two splits (F_2-1/2 at 10–12 days after emergence + 1/2 at panicle initiation), three splits (F_3-1/3 as basal +1/3 at AT +1/3 at panicle initiation), three splits (F_4-1/3 at 10-12 days after emergence + 1/3 at AT +1/3 at panicle initiation), four splits (F_5-1/4 as basal + 1/4 at AT + 1/4 at panicle initiation + 1/4 at flowering) and four splits (F_6-1/4 at 10-12 days after emergence + 1/4 at anthesis time + 1/4 at PI + 1/4 at flowering) were laid out in factorial randomized block design with three replication. The results revealed the application of 150 kg N ha^{-1} produced significantly higher grain yield (43.36 q ha^{-1}), straw yield (74.55 q ha^{-1}), harvest index (36.66), gross return (Rs 64,250 ha^{-1}), net return (Rs 42, 456 ha^{-1}) and B : C ratio (1.94) as compared to 120 kg N ha^{-1}. Similarly among the nitrogen scheduling application of three splits (1/3 at 10 -12 DAE + 1/3 at AT + 1/3 at PI) registered the higher grain yield (50.25 q ha^{-1}), straw yield (83.84 q ha^{-1}), harvest index (37.46), gross return (Rs 74,207 ha^{-1}), net return (Rs 52597 ha^{-1}) and B : C ratio (2.43).

Keywords Nitrogen levels, Scheduling, Aerobic rice, Yields, Economics.

S. K. Bhagat
Department of Agronomy, College of Agriculture,
IGKV, Raipur, Chhattisgarh, India

B. Tigga
Indira Gandhi Krishi Vishwavidyalaya,
Raipur 492012, Chhattisgarh, India

Akhilesh Lakra
M. G. Chitrakoot Gramodya Vishwavidyalaya,
Chitrakoot, Satna 485334, MP, India

Pradeep Kumar Dewangan, D. P. Singh, Yogesh Kumar Sahu, Narendra Kumawat*
AICRP on Maize-Zonal Agricultural Research Station,
Jhabua 457661, MP, India
e-mail : kumawatandy@gmail.com
*Correspondence

Introduction

Rice (*Oryza sativa* L.) is the most important and extensively cultivated staple crop which provides half of the daily food for one of every three persons on earth. Food security in Asia depends on irrigated rice eco system. Rice consumes about 90 % of the fresh water resources in Asia used for agriculture. However, the increasing scarcity of fresh water threatens the sustainability of the irrigated rice ecosystem. The demand for rice in the country is expected to increase because population is increasing at the rate of 1.6% every year and area under rice is also expected to be reduced to about 40 m ha in the next 15-20 years. Nevertheless, with these growth trends the country will have to feed about 1.3 billion people by the year 2025, requiring food grains of 380 mt. To meet the demand and supply, production has to come primarily through increase in yield and productivity which will be major thrust in coming decades to feed the burgeoning population. This has to be achieved with judicious use of inputs in order to sustain the production. In world, rice has occupied an area of 157.7 m ha with a total production of 650.2 mt. The total rice area in India was 42.56 m ha and 105.31 mt was produced with an average productivity of 2393 kg ha^{-1} [1]. Chhattisgarh is popularly known as rice bowl of India because maximum area is covered under rice during *kharif* and contribute major share in national rice production. In Chhattisgarh, 5.48 mt rice was obtained from 3.61 m ha with an average productivity of 1517 kg ha^{-1} [2].

The International Rice Research Institute developed the aerobic rice technology to address the water crises in tropical agriculture. In aerobic rice system, where in the crop is established in non-puddled, non-flooded fields [3,4] and rice is grown like an upland crop (unsaturated condition) with adequate inputs and supplementary irrigation when rainfall is insufficient. In context Chhattisgarh, aerobic rice cultivation seems to be very promising therefore its suitability needs to be asses for increasing the productivity and sustainability of rice production.

Materials and Methods

The field experiment was conducted at the Research Cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG) during *kharif* 2013. The soil of experiment field was inceptisols, textually sandy loam and locally known as Matasi. The experiment was laid out in factorial randomized block design with three replications. The treatment consisted of two N levels 120 kg N ha^{-1} (N_1) and 150 kg N ha^{-1} (N_2) and six nitrogen scheduling viz. two splits (F_1-1/2 as basal + 1/2 at panicle initiation), two splits (F_2-1/2 at 10-12 days after emergence + 1/2 at panicle initiation), three splits (F_3-1/3 as basal +1/3 at AT + 1/3 at panicle initiation), three splits (F_4-1/3 at 10-12 days after emergence + 1/3 at AT + 1/3 at panicle initiation), four splits (F_5-1/4 as basal + 1/4 at AT + 1/4 at panicle initiation + 1/4 at flowering) and four splits (F_6–1/4 at 10-12 days after emergence +1/4 anthesis time +1/4 at PI +1/4 at flowering). Sowing was performed on 26th June, 2013 by seed drill after basal application of fertilizer in rows using seed rate of 80 kg ha^{-1}. However 60kg P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1} were applied through single super-phosphate and muriate of potash, respectively. The whole amount of phosphorus and potassium were applied as basal whereas nitrogen was given in splits as per treatments. Manual weeding was done at 25 and 40 DAS to remove the weeds from experimental plots. Harvesting was done manually from net plot area when the grains become hard and turned light straw color. The plants were left in the plot for five days to dry in the sun and thereafter making bundles and the bundles weight per plot was recorded. Subsequently, threshing was done

Table 1. Effect of niitrogen level and scheduling on grain yield, straw yield harvest index and test weight of aerobic rice.

Treatments	Grain yield (q.ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Text weight (g)
Nitrogen levels (kg ha^{-1})				
120	40.16	70.54	36.14	24.22
150	43.36	74.55	36.66	24.46
SEm±	0.35	0.27	0.17	0.13
CD (p=0.05)	1.03	0.79	0.51	NS
Nitrogen scheduling				
Two splits (1/2 as B + 1/2 at PI)	30.60	57.11	34.88	23.50
Two splits (1/2 at 10-12 DAE + 1/2 at PI)	37.07	67.36	35.47	23.83
Three splits (1/3 as B + 1/3 at AT + 1/3 at PI)	43.96	75.93	36.67	24.03
Three splits (1/3 at 10-12 DAE + 1/3 at AT + 1/3 at PI)	50.25	83.84	37.46	25.00
Four splits (1/4 as B + 1/4 at AT + 1/4 at PI + 1/4 at F)	42.22	73.50	36.45	24.48
Four splits (1/4 at 10-12 DAE + 1/4 at AT + 1/4 at PI + 1/4 at F)	46.47	77.54	37.45	25.18
SEm±	0.61	0.47	0.30	0.22
CD (p=0.05)	1.80	1.37	0.88	0.66

by pedal thresher and after manual winnowing grain yield per plot was noted and converted in to per hectare.

Results and Discussion

Data revealed that there was significant difference between grain yield of rice due to nitrogen levels and its scheduling under aerobic condition (Table 1). Application of nitrogen @ 150 kg ha^{-1} produced the highest grain yield (43.36 q ha^{-1}) which was significantly superior over the application of 120 kg ha^{-1}. (43.36 q ha^{-1}) Similarly, nitrogen scheduling revealed that nitrogen applied in three splits (1/3 at 10-12 days after emergence + 1/3 at anthesis time + 1/3 at panicle initiation) significantly produced higher grain yield (50.25 q ha^{-1}) as compared to other split doses of nitrogen. Application of nitrogen in three equal splits at 10-12 DAE, active tillering and panicle initiation increased growth attributes, dry matter accumulations which lead to increase in the number of effective tillers, fertile grains panicle and decrease in the sterility percentage resultant in higher grain yield. Similar findings were also reported earlier [5].

Nitrogen applied @ 150 kg ha^{-1} found to be significantly superior over 120 kg ha^{-1} for straw yield (Table 1). This could be ascribed due to efficient utilization of nitrogen and better partitioning of dry matter may be assigned as the reason for superiority of straw yield. The results also corroborated with earlier findings [6]. Concerning to nitrogen scheduling, straw yield was significantly increased due to the application of nitrogen in three splits (1/3 at 10-12 DAE + 1/3 at AT + 1/3 at PI). The lowest straw yield was observed under the application on nitrogen in two splits (1/2 as B + 1/2 at PI) which was significantly inferior to other split application of nitrogen. More leaf area and dry matter accumulation provide a source for generating more carbohydrates resulted in higher straw yield. Sathiya and Ramesh [7] also showed that similar findings.

The harvest index was significantly higher under the application of 150 kg N ha^{-1} than that of 120 kg N ha^{-1}. As regards to nitrogen scheduling, highest harvest index was obtained under the three splits of

Table 2. Effect of nitrogen level and scheduling on total cost, grass return, net return and B : C ratio aerobic rice.

Treatments	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B : C ratio
Nitrogen level (kg ha^{-1})				
120	21425	59666	38240	1.78
150	21794	64250	42456	1.94
Nitrogen scheduling				
Two splits (1/2 as B + 1/2 at PI)	21244	45790	24546	1.15
Two splits (1/2 at 10-12 DAE + 1/2 at PI)	21244	55290	34047	1.60
Three splits (1/3 as B + 1/3 at At + 1/3 at PI)	21610	65182	43572	2.01
Three splits (1/3 at 10-12 DAE + 1/3 at AT + 1/3 at PI)	21610	74207	52597	2.43
Four splits (1/4 as B + 1/4 at AT + 1/4 at PI + 1/4 at F)	21976	62651	40676	1.85
Four splits (1/4 at 10-12 DAE + 1/4 at AT + 1/4 at PI + 1/4 at F)	21976	68625	46649	2.12
SEm±	-	-	-	-
CD (p=0.05)	-	-	-	-

nitrogen as 1/3 at 10-12 DAE + 1/3 at AT + 1/3 at PI but remained on par with application of nitrogen in three splits as 1/3 as B + 1/3 at AT + 1/3 at PI and four splits as 1/4 at10-12 DAE + 1/4 at AT + 1/4 at PI + at F. Application of nitrogen in two splits (1/2 as B + 1/2 at PI or 1/2 at 10-12 DAE + 1/2 at PI) found to be comparable and inferior to rest of other split application of nitrogen. More number of tillers, leaf area, dry matter accumulation and translocation of photosynthates towards reproductive parts might have increased the economic yield. Similar results were also reported earlier [8].

The influence of nitrogen levels on test weight was not found significant (Table 1). As regards to nitrogen scheduling, test weight was significantly higher due to application of nitrogen in four splits (1/4 at 10-12 DAE + 1/4 at AT + 1/4 at PI + 1/4 F) but remained on par with three splits (1/3 at 10-12 DAE + 1/3 at AT + 1/3 at PI). The lowest test weight was recorded under the application of nitrogen in two splits (1/2 as B + 1/2 at PI) which was comparable with the treatments when nitrogen was given in two splits as 1/2 at 10-12 DAE + 1/2 at PI and three splits 1/3 as B + 1/3 at AT + 1/3 at PI. This might be due to more supply of carbohydrates from post anthesis photosynthesis might have increased the grain filling rate consequently increased the test weight. Zhang et al. [5] also showed that similar results. The data related to cost of cultivation, gross return, net return and B : C ratio have been presented in Table 2. The maximum gross return (Rs 64,250 ha^{-1}), net return (Rs 42,455 ha^{-1}) and B : C ratio (1.94) was obtained with the application of nitrogen @ 150 kg ha^{-1}. This is obviously due to higher grain and straw yield was incurred with application of 150 kg N ha^{-1}.

With respect to nitrogen scheduling, nitrogen applied in three splits as (1/3 at 10-12 DAE + 1/3 at AT + 1/3 at PI) received higher gross return (Rs 74,207 ha^{-1}), net return (Rs 52,597 ha^{-1}) and B : C ratio (2.43) as compared to other treatments. It is due to more productivity in comparison to less cost. This is in accordance with the earlier findings.

Conclusion

On the basis of there findings it may be concluded that application of nitrogen @ 150 kg ha^{-1} and three split scheduling of nitrogen at 1/3 at 10-12 days after emergence, 1/3 at anthesis time and 1/3 at panicle initiation was found more promising for higher production and profitability of aerobic rice.

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