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Research Communication

Nitrogen and zinc scheduling for productivity and profitability in direct-seeded rice (*Oryza sativa*)

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 2014 at Varanasi, Uttar Pradesh, to study the effect of nitrogen levels and zinc application on yield and zinc content of direct-seeded (*Oryza sativa* L.) rice (DSR). Among the different nitrogen levels, the application of 150 kg N/ha recorded the highest yield attributes, viz. effective tillers at harvesting (77 running /m), panicle length (24.75 cm), grains/panicle (205), test weight (22.47 g) and panicle weight (2.4 g), which resulted in the highest grain (4.34 t/ha) and biological yield (10.08 t/ha). Among different zinc schedules; the application of 0.3% $ZnSO_4.H_2O$ spray at anthesis recorded the highest yield attributes, viz. effective tillers at harvesting (72 running/ m), panicle length (24.11 cm), grains/panicle (202), test weight (21.48 g) and panicle weight (2.73 g), resulting in highest grain (4.36 t/ha) and biological yield (10.27 t/ha). Harvest index was also influenced by nitrogen levels but not by zinc scheduling, although it was found non-significant. However, the highest net returns (₹ 41.27 × 10^3/ha) and benefit: cost ratio (1.04) were recorded with the application of 150 kg N/ha, while in case of zinc scheduling the maximum net returns (₹ 43.27 × 10^3/ha) and benefit: cost ratio (1.10) were reported with the application of 0.3% $ZnSO_4.H_2O$ spray at anthesis. Combine application of 150 kg N/ha and 0.3% $ZnSO_4.H_2O$ spray at anthesis was found optimum for grain yield (5.58 t/ha) of direct-seeded rice.

Key words **:** Direct-seeded rice, Grain yield, Nitrogen and zinc interaction, Nitrogen and zinc scheduling, Yield attributes

Currently, direct-seeded rice in Asia occupies about 29 million ha which is approximately 21% of the total rice area in the region (Pandey and Velasco, 2002). Mostly puddled transplanted rice is grown which is more water demanding, laborious, cumbersome, time-consuming and more CH_4 emitting, and also entail a lot of expenditure on raising nursery, uprooting, and transplanting.The scarcity of labour during the peak period of transplanting, the uncertain supply of irrigation water, depletion of groundwater and increasing production cost necessitate the search for an alternative to the conventional puddled transplanting of rice. Direct-seeded rice (DSR) provides an opportunity to combat all problems of puddled transplanted rice.

Nitrogen plays a vital role in growth and development by involving in many biosynthesis processes in plant system and influences vigorous growth which finally contributes to yield (Fageria and Baligar, 2005). It is a major component of chlorophyll, an amino acid which is stimulates the root growth and crop development as well as uptake of the other nutrients. Zn deficiency is now considered the most widespread nutrient disorder in rice (Quijano-Guerta *et al.,* 2002). It can be corrected by zinc application in soil or on plant as foliar spray. Zinc fertilization through foliar spray is a good strategic option to quick plant response and economic point of view. Keeping in view the possible N × Zn interactions, present study was aimed to identify optimum doses of N and Zn for higher grain yields and net returns of DSR.

A field experiment was conducted at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, during the rainy (*kharif*) season of 2014. It is located in the South Eastern part of Varanasi at 25° 18' N, 83° 03' E and at an altitude of 75.7 m above the mean sea-level in the North-

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ern Gangetic alluvial plains. The climate is typically subtropical with temperature range from 5 to 40.6°C and rainfall during crop period was 563.6 mm. The soil of the experimental site was sandy clay loam (52.20, 21.15 and 26.64% sand, silt and clay, respectively), organic carbon 0.45%, *p*H 7.4, available N, P, K 197.6, 21.22, 220.21 kg/ha, respectively and available zinc 0.51 ppm. The seed of rice cultivar 'HUR 105' was sown directly under unpuddled condition with 20 cm plant-to-plant spacing. The field experiment was conducted in factorial randomized block design, with 3 replications, having 4 nitrogen levels (0, 90, 120, 150 kg/ha) and 4 zinc scheduling (0, 0.3% $ZnSO_4.H_2O$ spray at anthesis, at early milking and at dough stage), with the constant level of phosphorus and potassium at 60 and 60 kg/ha respectively. Nitrogen and zinc were applied in the form of urea and zinc sulphate respectively. Nitrogen applied in 2 split doses–first at the time of sowing and the second dose at 40 days after sowing (DAS). The data were statistically analysed as per standard statistical procedure.

The results manifested that there was a positive relationship between different nitrogen levels and zinc scheduling on yield attributes, yield and net returns of direct-seeded rice (Table 1). The yield attributes and yield of DSR increased with the increasing levels of nitrogen from control to 150 N/ha. The highest yield attributes, viz. effective tillers at harvesting (running/m), panicle length (cm), grains/panicle, test weight (g) and panicle weight (g), resulting in the maximum grain and biological yield, were obtained with the application of 150 ha N/ha, which was significantly higher than all remaining nitrogen levels. Application of 90 and 120 kg N/ha also resulted in significantly higher yield attributes and yields than the control. The increase of yield attributes and yields of DSR might be owing to involvement of N in many metabolic reactions, viz. proteins, nucleic acids and chlorophyll formation and of zinc in N-metabolism of the plant. Similar findings were also reported by Puteh and Mondal (2014). The data of zinc scheduling revealed that, the zinc application at early growth stages significantly contributed more in growth and development of plant than later growth stages and the highest yield attributes, grain and biological yield of DSR were recorded with the application of 0.3% $ZnSO_4.H_2O$ spray at anthesis. However, the zinc application at later growth stages viz. 0.3% $ZnSO_4.H_2O$ spray at early milking and at dough stage, also found superior to the control. Grain yield of DSR increased up to 29.95% and 37.84% by independent application of 150 kg N/ha and 0.3% $ZnSO_4.H_2O$ spray at anthesis, respectively than the control. Harvest index was also influenced by an increase in nitrogen levels, but not by zinc scheduling, although it was found non-significant. Economic analysis revealed that significantly maximum net returns and benefit: cost ratio were obtained with the application of 150 kg N/ha which was significantly higher than all remaining treatments; however application of 90 and 120 kg N/ha was also found significantly higher to the control. Application of 0.3% $ZnSO_4.H_2O$ spray at anthesis recorded the highest net returns and benefit: cost ratio of DSR, which was significantly higher than all remaining treatments.

The interaction between the nitrogen levels and zinc scheduling differed significantly (Table 2). The data of

Table 1. Effect of nitrogen levels and zinc scheduling on yield attributes, yields and economics of direct-seeded rice

Treatment	Yield attributes					Yields			Economics	
	Effective tillers at harvest/ running m	Panicle length (cm)	Grains/ panicle	Test weight (g)	Panicle weight (g)	Grain yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	Net returns ($\times 10^3$ ₹/ha)	Benefit : cost ratio
N (kg/ha)										
0 (Control)	54	18.86	173	16.69	1.89	3.04	7.62	40.21	21.17	0.56
90	62	21.30	176	18.73	2.47	3.62	8.68	41.71	29.71	0.77
120	71	22.63	185	20.88	2.65	3.95	9.35	42.48	35.05	0.89
150	77	24.75	205	22.47	2.94	4.34	10.08	43.03	41.27	1.04
Zinc scheduling										
0 (Control)	56	19.43	172	17.51	2.05	2.71	6.63	41.04	13.17	0.34
0.3% $ZnSO_4$ spray at anthesis	72	24.11	202	21.48	2.73	4.36	10.27	42.63	43.00	1.10
0.3% $ZnSO_4$ spray at early milking	70	22.08	187	20.58	2.61	4.02	9.53	42.37	36.82	0.94
0.3% $ZnSO_4$ spray at dough stage	65	21.92	180	19.18	2.58	3.85	9.30	41.40	34.21	0.88
SEm±	1.96	0.62	5.53	0.55	0.07	0.098	0.266	1.16	1.73	0.04
CD (P=0.05)	5.66	1.80	15.98	1.58	0.21	0.285	0.770	3.35	5.02	0.13
N × Z	*	*	NS	NS	*	*	NS	NS	NS	NS

*P=0.05; NS, Not significant

Table 2. Interaction effect of nitrogen × zinc on grain yield of direct-seeded rice

Treatment	Grain yield (t/ha)			
	N (kg/ha)			
	0 (Control)	90	120	150
Zn-scheduling				
0 (Control)	2.27	2.75	2.86	2.98
0.3% $ZnSO_4$ spray at anthesis	3.52	4.00	4.36	5.58
0.3% $ZnSO_4$ spray at early milking	3.30	3.87	4.32	4.60
0.3% $ZnSO_4$ spray at dough stage	3.08	3.86	4.26	4.19
SEm±	0.19			
CD (P=0.05) of N × Zn	0.57			

nitrogen and zinc interaction showed that the maximum grain yield (5.58 t/ha) of DSR was obtained with the combine application of 150 kg N/ha and 0.3% $ZnSO_4.H_2O$ spray at anthesis which was significantly higher than all remaining treatments. This may be owing to the fulfilment of the requirement of nitrogen and zinc nutrition and a positive interaction between nitrogen and zinc. Our results support the finding of Shivay and Prasad (2008).

It may be concluded that the application 150 kg N/ha and 0.3% $ZnSO_4.H_2O$ spray at anthesis were found to be optimum for enhancement of yield attributes, yield and net return of DSR. Combined application of 150 kg N/ha and 0.3% $ZnSO_4.H_2O$ spray at anthesis was proved highly effective nitrogen level and zinc scheduling for grain yield of DSR.

REFERENCES

Fageria, N.K. and Baligar, V.C. 2005. Enhancing nitrogen-use efficiency in crop plants. *Advances in Agronomy* **88**: 97–185.

Pandey, S. and Velasco, L. 2002. Economics of direct seeding in Asia: Pattern of adoption and research priorities. International Rice Research Institute, Los Banos, Philippines, pp. 3–14.

Puteh, A.B. and Mondal, M.A. 2014. Growth and yield performance of rice as affected by nitrogen rate. *Life Science Journal* **11**(8): 653–655.

Quijano-Guerta, C., Kirk, G.J.D., Portugal, A.M., Bartolome, V.I. and McLaren G.C. 2002. Tolerance of rice germplasm to zinc deficiency. *Field Crops Research* **76**: 123–130.

Shivay, Y.S. and Prasad, R. 2012. Zinc-coated urea improves productivity and quality of basmati rice (*Oryza sativa* L.) under zinc stress condition. *Journal of Plant Nutrition* **35**(6): 928–951.