https://doi.org/10.56093/ijas.v90i7.105615

Indian Journal of Agricultural Sciences **90** (7): 1342–4, July 2020/Article

Nitrogen management practices for improving yield and nitrogen use efficiency in rice (*Oryza sativa*)

RAHUL KUMAR VERMA*, ADESH SINGH, MOHAMMAD HASANAIN, MD BASIT RAZA and RAJIV KUMAR SINGH

Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh 250 110, India

Received:15 August 2019; Accepted: 11 October 2019

ABSTRACT

A field experiment was conducted on rice (*Oryza sativa* L.) during *kharif* season of 2017 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U P) to assess the nitrogen (N) use efficiency and performance of rice under different nitrogen management practice. Management practices included N levels with modified application through leaf colour chart (LCC) and chlorophyll meter (SPAD). The study shows that treatment T_6 (LCC (50 kg N/ha) with basal N @50 kg/ha)gave highest yield and N-use efficiency which were comparable to T_9 (SPAD (67 kg N/ha) with basal N @33 kg/ha). The total biological yield (grain + straw) of rice was significantly higher in T_6 (114.4 q/ha) as compared to control (66.9 q/ha). The SPAD and LCC-treated plot showed higher N-use efficiency in rice over fixed-scheduling N treatments. Highest N content(1.88% (grain) and 0.76% (straw)) and uptake (128.14 kg/ha) was recorded in T_6 treatmentin all stages (tillering, PI and harvest) which was comparable with T_8 and T_9 treatment.

Key words: Chlorophyll meter, LCC, Nitrogen use efficiency, Rice, SPAD

India is a major rice (*Oryza sativa* L.) producer and consumer contributing around 30% of total area and 22% of the total production of the world (Carlson *et al.* 2016). Modern rice cultivars having higher potential yield are preferred over traditional varieties. These cultivars require adequate amount of essential nutrients to produce higher grain yield. Of the total 172.2 Mt fertilizer ($N+P_2O_5+K_2O$) consumed globally, 14.3 % (24.7 Mt) was used in rice during 2010–2011(Bijay-Singh and Singh 2017), while the share of nitrogen (N) was around 15.4% which was higher than the rest of the primary nutrients consumed (Heffer 2013). Data from field trials conducted around the world shows an average recovery efficiency of N (REN)to be around 46% (Ladha *et al.* 2005). This is far from reality that exists in farmers' field where balanced fertilization and good agronomic practices (GAP) are rarely carried out. Correct diagnosis of N status of plant leaves is quite important to determine the real time plant N requirement.The chlorophyll meter (SPAD) and leaf colour chart (LCC) are simple, mobile and provide a non-destructive way to measure crop N status *in-situ*for determining the time of top-dressing of N (Islam *et al.* 2009).Therefore the present study undertaken to evaluate various N management practices and their effect on yield andN-use efficiency in rice.

*Corresponding author e-mail: vermarahul820@gmail.com

MATERIALS AND METHODS

The experiment was conducted on rice (Pusa Basmati 1) in *kharif* (July-October) season of 2017 at the Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (UP) (29˚40′ N latitude and 77˚42′ E longitude). The application of N was doneas per treatments through neem coated urea (NCU): T_1= 0 kg N/ha (Control), T_2= 120 kg N/ha (3 splits, *i.e.* 50:25:25), T_3= 120 kg N/ ha (2 splits, *i.e.*50:50:0), T_4= 120 kg N / ha (3 splits, *i.e.*25:25:50), T_5= 120 kg N/ha (3 splits, *i.e.* 75:12.5:12.5), T_6= 120 kg N/ha, 50 % N through urea at basal, and rest through LCC, T_7= 120 kg N/ha, 33 % N through urea at basal, rest through LCC, T_8=120 kg N/ha, 50 % N through urea at basal, rest through SPAD and T_9= 120 kg N/ha, 33 % N through urea at basal, rest through SPAD. The required quantities of phosphorus (P) and potassium (K) were applied to the crop by single super phosphate and muriate of potash. Split application of N was done at various stages like basal, maximum tillering and panicle initiation (PI).The LCC (supplied by International Rice Research Institute, Philippines) and SPAD readings were taken at 7 days interval at a specified time.

Nutrient use efficiency expressed in terms of agronomic efficiency (AE) and apparent nitrogen recovery efficiency(ANR) and which were worked out as:

$$AE = \Delta \text{ kg grain/kg N applied}$$

$$ANR = (\Delta \text{ kg N uptake/kg N applied}) \times 100$$

Table 1 Effect of nitrogen management practices on yield attributes and yield of rice

Treatment	Panicle length (cm)	No. of panicles per meter row length	No. of grains per panicle	Test weight (g)	Yield (q/ha)		
					Grain	Straw	Total biological yield
T1	19.2	41	116	17.8	19.4	47.5	66.9
T2	22.6	60	125	19.7	29.8	70.2	100.0
T3	23.7	61	126	20.1	31.9	71.7	103.6
T4	22.4	59	125	19.5	28.4	70.0	98.4
T5	21.5	57	124	19.2	27.7	69.6	97.3
T6	29.3	69	133	23.5	36.8	77.6	114.4
T7	26.2	66	130	22.5	34.2	74.8	109.0
T8	25.1	65	128	21.0	33.9	73.6	107.5
T9	27.8	67	131	23.0	35.6	75.9	111.5
SEm±	1.1	1	2	1.1	5.0	0.7	0.9
CD (P=0.05)	3.5	4	5	3.3	1.5	2.2	2.9

T1= 0 kg N/ha (Control), T2= 120 kg N/ha (3 splits, i.e. 50:25:25), T3= 120 kg N/ ha (2 splits i.e. 50:50:0), T4= 120 kg N /ha (3 splits, i.e. 25:25:50), T5= 120 kg N/ha (3 splits, i.e.75:12.5:12.5), T6= 120 kg N/ha, 50 % N through urea at basal, and rest through LCC, T7= 120 kg N/ha, 33 % N through urea at basal, rest through LCC, T8=120 kg N/ha, 50 % N through urea at basal, rest through SPAD and T9= 120 kg N/ha, 33 % N through urea at basal, rest through SPAD, SEm= Standard error of mean, CD= critical difference at 5% level of significance

Table 2 Effect of nitrogen management practiceson nitrogen content, uptake and N use efficiency at different stages of rice crop

Treatment	Nitrogen content (%)				Total N uptake (kg/ha)	N use efficiency	
	Tillering stage	PI	At harvest			Agronomic efficiency (kg grain/kg N applied)	Apparent N recovery efficiency (%)
			Grain	Straw			
T1	1.93	1.42	1.61	0.39	49.84	_	_
T2	2.12	1.78	1.82	0.68	102.33	8.63	40.00
T3	2.17	1.80	1.83	0.69	107.95	10.37	44.69
T4	2.12	1.74	1.78	0.66	98.93	7.47	37.17
T5	2.12	1.72	1.77	0.69	98.20	6.87	36.56
T6	2.23	1.84	1.88	0.76	128.14	14.43	61.52
T7	2.18	1.81	1.84	0.72	116.62	12.30	51.92
T8	2.19	1.80	1.83	0.71	114.28	12.03	49.95
T9	2.21	1.82	1.86	0.74	122.38	13.47	56.71
SEm±	0.02	0.02	0.02	0.01	2.15	0.41	1.79
CD (P=0.05)	0.06	0.07	0.06	0.04	6.24	1.18	5.20

Details of treatments are given in Table 1.

Δ is the difference between treated plot and control plot.

Various yield attributes such as panicle length, number of panicles per metre row length, number of grains per panicle, test weight of grain were recorded at crop maturity stage. All the data recorded during the course of investigation were subjected to statistical analysis as outlined by Gomez and Gomez (1984) using analysis of variance technique (ANOVA) for randomized block design.

Maximum yield contributing traits, viz. panicle length, number of panicle per meter row length, number of grains per panicle and test weight were observed under T_6 where 50% N was applied based on LCC and rest was applied as basal, while minimum were recorded under control (Table 1). The longest panicle (29.3cm) and maximum number of panicles per metre row length (69) were recorded in T_6 which was statistically *at par* with T_7 and T_9 treatments, and significantly higher than rest of the treatments. The treatments comprising of LCC and SPAD (T_6, T_7, T_8 and T_9) showed a significantly higher test weight and number of grains per panicle over other treatments. The increase in yield contributing traits under the treatments comprising of LCC and SPAD might be due to better supply of nutrients besides increase in photosynthetic area and more translocation of photosynthates towards sink. The results were in conformity with earlier findingsof Bharadwaj *et al.* (2008).Total yield (grain + straw) of rice under various treatments ranged from 66.9 to 114.4 q/ha (Table 1). Highest grain and straw yield of 36.8 and 77.6 q/ha respectively, was recorded under T_6 treatment which was at par with T_9 and significantly higher over rest of the treatments.Higher yield under T_6 and T_9 treatments may be attributed to N scheduling where application of N at maximum tillering stage lead to production of new meristematic tissue by better growth performance and favorable source sink relationship (Coventry *et al.* 2011).

The N content was highest at tillering stage in all the treatments and after that it showed a gradual reduction up to harvesting stage (Table 2). At tillering stage, the N content was found to be higher in T_6 (2.23%) which was statistically at par with T_7, T_8 and T_9 treatments and significantly higher than the remaining treatments. At PI stage, the N content was comparatively lower and it ranged from 1.42% (control) to 1.84% N (T_6). The increased N content in T_6 might be due to better utilization of N from soil with well-developed root system owing to steady N supply throughout the crop growth stages, which might have resulted in adequate availability of N causing higher N content in plant at all the stages of crop growth. The total N uptake varied from 49.84to 128.14 kg/ha (Table 2). The N uptake by rice (grain + straw) followed similar trend as that of N content. This was mainly due to higher N content and yield in both the treatments (Dwivedi *et al.* 2015).

In general the N use efficiency in India is low as against global data. Maximum AE and ANR was recorded to be 14.43 (kg grain/kg N) and 61.52%, respectively, in T_6 which was at par with T_9 and significantly higher than the rest of the treatments (Table 2). Higher N use efficiency and more recovery of applied nitrogen in T_9 may be due to reduced N losses through volatilization and denitrification from added NCU which releases nitrogen slowly.

ACKNOWLEDGEMENT

The authors sincerely acknowledge the necessary services and supplies received from the Department of Soil Science and Agricultural Chemistry, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, India for successful conduct of this research work.

REFERENCES

Bharadwaj A K, Mahapatra B S, Singh A P, Chaubey A K, Singh N and Singh D. 2008. Productivity of rice wheat cropping system as influenced by site specific nutrient management treatments. *Journal of Farming Systems Research and Development* **14**(1): 102–4.

Bijay-Singh and Singh V K. 2017. Fertilizer management in rice. (In) *Rice Production Worldwide, pp* 217–253. Springer, Cham.

Carlson K M, Gerber J S, Mueller N D, Herrero M, MacDonald G K, Brauman K A, Havlik P, O'Connell C S, Johnson J A, Saatchi Sand West P C. 2017. Greenhouse gas emissions intensity of global croplands. *Nature Climate Change* **7**(1): 63.

Coventry D R, Yadav A, Poswal R S, Sharma, R K, Gupta R K, Chhokar R S, Gill S C,Kumar V, Kumar A, Mehta A and Kleemann S G L. 2011. Irrigation and nitrogen scheduling as a requirement for optimising wheat yield and quality in Haryana, India. *Field Crops Research* **123**(2): 80–8.

Dwivedi A, Singh A, Kumar V, Naresh R K, Tomar S S and Dev I. 2015. Population studies, phenology and quality of mashbean and maize as influenced by planting geometry and nutrient management under intercropping system. *Progressive Agriculture* **15**(1): 95–8.

Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research*. 2 edn, p 680, John Wiley & Sons, New York.

Heffer P. 2013. Assessment of fertilizer use by crop at the global level, 2010–2010/11. International Fertilizer Industry Association (IFA), Paris.

Islam M S, Bhuiya M S U, Rahman S and Hussain M M. 2009. Evaluation of SPAD and LCC based nitrogen management in rice (*Oryza sativa* L.). *Bangladesh Journal of Agricultural Research* **34**(4): 661–72.

Ladha J K, Pathak H, Krupnik T J, Six J and van Kessel C. 2005. Efficiency of fertilizer nitrogen in cereal production: retrospects and prospects. *Advances in agronomy* **87**: 85–156.

Tayefe M, Gerayzade A, Amir E and Nasrollah Z A. 2011. Effect of nitrogen fertilizer on nitrogen uptake, nitrogen use efficiency of rice (*Oryza sativa* L.). *International Conference on Biology, Environment and Chemistry* **24**.