Indian Journal of Agricultural Sciences **80** (4): 327–8, April 2010

Yield and nitrogen-use efficiency of indica rice varieties as influenced by timing of nitrogen fertilization*

G MAHAJAN[1] and N K SEKHON[2]

Punjab Agricultural University, Ludhiana 141 004

Received: 9 July 2009; Accepted: 11 January 2010

Key words: Nitrogen use efficiency, Rice, Timing of N application

The application of nitrogen fertilizer either in excess or less than optimum rate at a particular stage of the crop affects both yield and nitrogen-use efficiency to a remarkable extent, hence proper management of crop nutrition is of immense importance. Therefore, the field experiment during 2007–08 was conducted in the rainy (*kharif*) season at research farm of University, Ludhiana to see the effect of timing and number of splits of N application on the productivity and nitrogen-use efficiency of rice cultivars having different growth duration. Ludhiana is situated (30°56′N, 75°52′E) in the Indo-Gangetic plain in north-western India. The field was used for 20 years on rice–wheat cropping system.

The field experiment was conducted in split-plot design with 3 rice cultivars of different duration ('PR 118' is of long duration of 158 days, 'PAU 201' of medium duration of 142 days and 'PR 115'of short duration of 125 days) in main plots and 4 treatments of N application (control: without N; 2 splits: at tillering and panicle initiation stages; 3 splits of N: at basal, tillering, panicle initiation stages; 3 splits of N: basal, panicle initiation, flowering stages) in sub-plots. The treatments were replicated thrice. The soil was loamy sand with *p*H 7.2, total nitrogen 0.32 g/kg, organic matter 0.28%, and Olsen P 8 mg/kg.

Thirty-day-old seedlings were planted in the puddled field in mid-June. Seedlings were planted in rows 20 cm apart and the distance between the hills in a row was 15 cm. Crop was fertilized with only nitrogen @ 120 kg N/ha applied as per treatments through urea fertilizer. Treatment-wise equal quantity of nitrogen was applied in each split. The crop was raised with the standard package of practices.

At harvest of the crop, grain yield of rice was measured at 14% grain moisture content. Five hills were selected randomly from each plot at harvest for measuring agronomic parameters including number of productive tillers/m^2, spikelet sterility% and N uptake. Agronomic efficiency of nitrogen was determined by difference in grain yield of fertilized and control plot divided by amount of N applied through fertilizer (Fageria and Baligar 1999). Standard analysis of variance procedures were used for the statistical analysis.

The stay-green cultivar 'PAU 201' registered highest yield (7.9 tonnes/ha), followed by 'PR 115' (Table 1). The long duration cultivar 'PR 118' registered lowest yield that was 8.0 and 10.9% lower than cultivars 'PR 115' and 'PAU 201', respectively. Highest yield of 'PAU 201' was also observed to be associated with highest N uptake and agronomic efficiency of nitrogen in this cultivar. Compared to 'PAU 201', N uptake was 12.6 and 20.2% lower in cultivars 'PR 115' and 'PR 118', respectively, while agronomic efficiency of nitrogen was 36.3 and 53.3% lower respectively. Higher yield of 'PAU 201' may, therefore, be attributed to greater utilization of N towards grain, particularly at the reproductive stage. Beh *et al*. (2009) reported that grain yield differences between the cultivars are due to variation in nitrogen-use efficiency among cultivars.

Application of N caused significant improvement in grain yield of all the tested cultivars. Data in Table 1 show that grain yield decreased significantly when N was applied in 2 splits instead of 3 splits. In another study, Islam *et al.* (2009) reported that 3 equal splits of N gave best results than 2 splits in view of mopho-physiological parameters and grain yield. Further, it has been noticed that grain yield of short- duration cultivar 'PR 115' decreased significantly when N was applied at the flowering stage. Application of N at flowering stage did not help in grain yield improvement as evidenced by the increased sterility (%) in cultivar 'PR 115', when N was applied at the flowering stage. The grain yield of long duration cultivar 'PR 118' and medium duration cultivar 'PAU 201' decreased significantly, when N was applied in 2 splits compared to 3 splits. With 2 splits of N in 'PR 118' and 'PAU 201', N towards sink might have decreased causing

*Short note

[1]Agronomist (Rice) (e mail: mahajangulshan@rediffmail.com), Department of Plant Breeding and Genetics, [2]Senior Plant Physiologist (e mail: nksekhon52@yahoo.co.in), Department of Soils

Table 1 Gain yield (tonnes/ha), panicles/m^2, sterility (%), N uptake and agronomic nitrogen-use efficiency under different nitrogen treatment (pooled mean)

Cultivar	Timing of N application				
	Control (without N)	Basal, MT, PI	Basal, PI, flowering	MT, PI	Mean
		Grain yield (tonnes/ha)			
'PR 115'	6.9	8.2	7.6	8.0	7.7
'PR 118'	6.5	7.4	7.4	6.9	7.0
'PAU 201'	6.7	8.4	8.4	8.0	7.9
Mean	6.7	8.0	7.8	7.7	
LSD: Cultivars: 0.2; Timing of fertilization : 0.1; cultivars × timing of fertilization: 0.3					
		Panicles/m^2			
'PR 115'	266	295	302	334	299
'PR 118'	274	320	313	319	306
'PAU 201'	269	338	333	337	319
Mean	270	317	316	330	
LSD: Cultivars: NS; Timing of fertilization : 14.2; cultivars × timing of fertilization: NS					
		Sterility (%)			
'PR 115'	20.1	15.7	19.8	15.6	17.8
'PR 118'	22.4	16.9	17.3	21.5	19.5
'PAU 201'	20.2	16.7	15.4	15.3	16.9
Mean	20.9	16.4	17.5	17.5	
LSD: Cultivars: 1.7; Timing of fertilization : 2.1; cultivars × timing of fertilization: NS					
		N uptake (kg/ha)			
'PR 115'	117.9	157.6	145.3	156.6	144.3
'PR 118'	111.6	146.2	149.0	134.1	135.2
'PAU 201'	124.1	176.7	180.7	168.3	162.5
Mean	117.8	160.2	158.4	153.0	
LSD: Cultivars: 7.86; Timing of fertilization : 5.3; cultivars × timing of fertilization: 9.1					
		Agronomic efficiency of nitrogen (kg/kg N applied)			
'PR 115'		10.6	5.6	9.7	8.6
'PR 118'		7.5	7.9	3.4	6.3
'PAU 201'		14.4	14.6	11.6	13.5
Mean		10.8	9.37	8.2	
LSD: Cultivars: 3.5; Timing of fertilization : 1.3; cultivars × timing of fertilization: 2.3					

MT: Maximum tillering; PI: panicle initiation; Control: without nitrogen application

higher sterility (%) and thus resulting in decreased grain yield. Agronomic N efficiency of 'PR 118' and 'PAU 201' was less when N was applied in 2 splits instead of 3 splits. Qi Jing *et al.* (2007) attributed that application of N during critical stages may optimize leaf N distribution, thereby maintaining high canopy photosynthesis, especially during grain-filling stages.

SUMMARY

For short-duration cultivar 'PR 115', grain yield remained same when N was applied in either 2 (at tillering and panicle initiation) or 3 splits (basal, at tillering and panicle initiation). However, with 3 splits including N applied at flowering stage resulted in 7.3% reduction in grain yield. In medium and longer duration cultivars, N application in 3 splits resulted in more grain yield than 2 splits. So, for medium and longer duration cultivars, if N application is omitted at tillering stage, the same yield can be obtained by applying that amount at flowering stage.

REFERENCES

Bah A, Syed S R S, Anwar A R and Husni M H A. 2009. Critical time of N application during panicle initiation on the yield of two Malaysian rice cultivars. Pertanika *Journal of Tropical Agricultural Science* **32** (2): 317–22.

Fageria N K and V C Baligar. 1999. Yield and yield components of lowland rice as influenced by timing of nitrogen fertilization. *Journal of Plant Nutrition* **22**(1): 23–32.

Islam M S, Hasanuzzaman, Rokonuzzaman and K Nahar. 2009. Effect of split application of N fertilizer on morpho-physiological parameters of rice genotypes. *International Journal of Plant Production* **3** (1): 51–62.

Qijang T, Jiang Y, Zhy and Cao W. 2007. Spatial distribution of LAI and leaf N content in relation to grain yield and N uptake in rice. *Plant Production Science* **10**(1): 136–45.