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SOURCE AND TIMES OF SPLITS OF NITROGEN ON N UPTAKE AND ITS EFFICIENCY ON IRRIGATED LOWLAND RICE

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ABSTRACT

Effect of green manure in combination with different times of N splits as urea nitrogen on growth, nitrogen uptake and its efficiency was studied in irrigated lowland rice. There was slow but steady accumulation of N in the leaves when basal manuring was done through green leaf manure (GLM). There was loss in the total N uptake, when 40 kg N was applied at AT, which resulted in profuse tiller production. A starter dose of 20 kg N at AT was found essential to improve the N uptake when GLM was basal applied. Split application of N 40 kg each as basal and at PI with 20 kg each at AT. one week after AT and again at heading resulted in better N uptake with better nitrogen use efficiency (NUE). Agronomic efficiency (AE) was higher with urea N basal compared to GLM.

KEY WORDS: Nitrogen, Uptake, Split application, Green leaf manure, Urea-N, NUE, AE

The concept of integrated nutrient management seeks to sustain soil fertility through integration of different nutrient sources and their application that will produce maximum crop yield per unit input use (De Datta *et al.*, 1990). Though there are number of works on partial substitution fertiliser N with green manure under integrated nitrogen management on yield, the substitution of fertiliser N with green leaf manure is rather limited. It is essential to understand the effect of the sources of N on nitrogen uptake in order to get a better nitrogen response. Hence, field experiments were conducted to find out effect of green leaf manure or urea N as basal in combination with different times of urea-N splits on N as basal in combination with different times of urea - N splits on N uptake and their efficiency on grain yield.

MATERIALS AND METHODS

Field experiments were conducted using cv. IR72 under irrigated lowland conditions of wetland, Coimbatore, India, during November 1995 to September, 1996. The soil of experimental field was medium in available N(320 and 336 kg/ha), and P (12.4 and 12.3 kg/ha), high in available K (540 and 560 kg/ha), with a pH of 7.7 and 7.6 and the organic carbon content of 0.50 and 0.51 percent in Expt 1 and Expt 2 respectively. The experiments were laid out in a randomized block design with three replications. There were nine treatments including a control (no N application). In the Expt 1, the other eight treatments were two sources on N to supply 40 kg N/ha as basal (urea, and GLM- *Sesbania rostrata*) and in combination 40-40-0, 0-40-40, 20-40-20 and 40-40-30 kg N/ha applied at active tillering, panicle initiation and at heading stages respectively. Based on the results of 1995, treatments were reconstituted in 1996. Nitrogen at AT was reduced from 40 to 20 kg N/ha. Accordingly, for the two sources of N, 20-40-20, 20-40-30; 20-40-40 and 20-20-40-20 were the combinations. In the last combination during 1996, 20 kg was applied one week after active tillering stage (30 DAT). All the treatments received 60 kg each of P_2O_5 was applied as basal and K_2O was applied in three equal splits as basal, PI, and heading stages along with urea. Fifty days old *Sesbania rostrata* was applied on equal N basis, two days before transplanting. Irrigation was given by maintaining 5 cm depth of water till panicle initiation (PI), then 5 cm depth only after disappearance of ponded water. Samples were collected from the field with an interval of 10 days and week for Expt 1 and Expt 2 respectively. Agronomic efficiency (AE) and physiological efficiency (PE) were calculated as suggested by Yoshida (1981). The N content was determined as per Humphries (1956) and statistical analysis as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The N content of leaves was increasing with age till heading stage and then sharply declined towards maturity. The dilution of N concentration during pre-heading stage had no effect on the total content because of continued production of new leaf biomass. A record of 88 kg N accumulated during heading stage in Expt 1 of green manure applied plots. withholding N at AT had reflected during PI stage. The reduction of N content, which is remobilized ranged between 61 to 71 percent.

During the early stages of crop growth, inorganic basal N had higher N in the leaves, obviously due to immediate availability of ammonia nitrogen (Dickmann *et al.*, 1993). Green leaf manuring had slow accumulation rates during early vegetative period but the difference got narrowed down, beginning Pi stage. The accumulation of N in the leaves was steady for the split doses applied, one week after active tillering (T_4 and T_8 of Expt 2) and at flowering. Ultimately those plots recorded significantly higher N content two weeks before maturity.

Table 1. Source & times nitrogen application on N content of rice (kg/ha)

a) Experiment 1 (Nov 95 - Apr 96)

Treatment	N kg ha^{-1}				Green leaf			Total			NUE	
	B	AT	PI	H	PI	F	H	PI	F	H	AE	PE
T1	40	20	40	20	36.1	75.0	13.2	68.8	172.5	178.0	17.7	27.5
T2	40	40	40	0	36.9	75.4	15.2	78.2	165.4	163.2	8.0	15.5
T3	40	0	40	40	41.9	66.9	14.4	87.3	151.0	159.2	11.7	24.4
T4	40	40	40	30	33.0	75.2	16.1	72.3	177.7	173.6	8.9	21.1
T5	40*	20	40	20	36.6	72.5	14.2	73.6	186.3	199.2	15.8	22.1
T6	40*	40	40	0	33.4	71.8	13.8	65.6	182.4	180.1	11.7	23.0
T7	40*	0	40	40	29.3	58.5	11.9	58.2	160.8	170.9	8.7	13.8
T8	40*	40	40	30	36.2	88.8	21.9	66.9	184.2	187.4	9.5	21.4
T9	0	0	0	0	24.7	40.8	3.2	47.4	96.8	93.4		
SEd					1.3	2.7	1.0	2.4	6.0	9.7		
CD (P=0.05)						2.7	5.7	2.0	5.1	12.7	19.9	

b) Experiment 2 (Jun. 96 - Sep. 96)

Treatment	N kg ha^{-1}					Green leaf			Total			NUE	
	B	AT	WA	PI	H	PI	F	H	PI	F	H	AE	PE
T1	40	20	0	40	20	37.5	64.4	17.7	88.6	170.5	196.5	15.6	21.3
T2	40	20	0	40	30	34.0	71.9	18.9	86.2	186.8	213.3	9.6	11.9
T3	40	20	0	40	40	32.2	62.9	15.8	82.4	169.6	202.6	15.6	23.2
T4	40	20	20	40	20	38.6	75.3	21.7	90.6	195.3	251.2	18.0	19.8
T5	40*	20	0	40	20	35.5	61.8	16.2	81.9	167.2	184.6	12.3	19.3
T6	40*	20	0	40	30	39.4	66.4	18.3	76.7	170.3	202.2	14.7	22.3
T7	40*	20	0	40	40	31.3	71.3	19.6	74.1	176.8	217.5	10.3	13.2
T8	40*	20	20	40	20	47.0	83.1	21.7	100.8	211.2	239.3	16.1	17.3
T9	0	0	0	0	0	20.4	39.5	9.0	55.9	103.9	108.3		
SEd						1.3	2.5	0.9	3.1	6.3	5.3		
CD (P=0.05)						2.7	5.2	1.8	9.4	13.1	11.2		

B - basal ; AT - active tillering ; WA - week after AT ; PI - panicle initiation ; F - flowering, H - heading, NUE - nitrogen use efficiency, AE - agronomic efficiency, PE - physiological efficiency

* N as *Sesbania rostrata*

Application N at heading exerted a perceptible difference in the functional leaves (green leaves) N content. Forty kg N ha^{-1} at heading maintained significantly higher N content at maturity. Besides, it was also recorded that with an additional split of 20 kg N one week after At, and 20 kg ha^{-1} at heading was sufficient to maintain the N content. Nitrogen applied at heading retained more leaf N content probably by large green leaf biomass, a compensatory mechanism to balance, which all made good the dilution of N concentration in green leaves. Crop raised during June to September had relatively higher green leaf biomass than the first season (November to April).

Total N uptake

Nitrogen uptake was increasing in all plots as growth advanced. There was reduction in the N uptake compared to its previous stage in certain cases. This has happened only in Expt 1, where 40 kg N was applied at AT which resulted in profuse tillering. The N uptake was gradual and positive till maturity when the N application at AT was restricted to 20 kg (Expt 2). The loss might be due to the degeneration of some of the tillers produced during course of time. This could not be argued that the higher biomass production which was associated with higher fertiliser N application alone responsible for the loss of N which is stored earlier in the hill. The N loss through tiller mortality is inevitable in rice, since tiller is an independent plant (Yoshida, 1981), and any loss of tiller, results in the loss of N uptake. The stored energy lost through tiller mortality is permanent. It may be traced in the soil but not in a sister tiller as usually happening through translocation or remobilization from aged plat parts.

A starter dose, if GLM was basal applied or split reduced from 40 to 20 kg ha^{-1} or at the maximum withholding it at AT if urea N was applied as basal, resulted in gradual build up of N, may be through a process of checking formation of unproductive tillers. The total N uptake was not only positive but it was gradual and steady, and higher in those plots, whose N uptake was not only positive but it was gradual and steady, and higher in those plots, whose N was split applied at 20 kg each at At, one week after AT and at heading, besides 40 kg each at basal and at PL stages. The higher N uptake might be due to controlled tiller production. The normal happening of tiller loss, may be well within the addition of assimilates and thus the uptake was positive till maturity.

The nitrogen use efficiency (NUE) studied through agronomic efficiency and physiological efficiency were affected by higher N levels or higher doses of N application at AT and at heading stages. The higher efficiencies (16-18 kg grain kg^{-1} N) were seen associated with N splits of 20 kg per ha each at AT, a week after At and at heading. The poor efficiency (9.6 kg grain kg^{-1} N) recorded were mainly because of higher biomass or assimilated carbohydrates and starch left under utilized in the culm at maturity (Ramasamy et al. 1997), or may be due to poor translocation from source to sink.

SUMMARY AND CONCLUSION

Nitrogen content in the leaves was increasing up to pre-heading period and then declined sharply. There was slow but steady accumulation of N in the leaves when basal manuring was done through GLM. There was loss in the total N uptake, when 40 kg N ha^{-1} was applied at AT, which resulted in profuse tiller production. A starter dose of 20 kg N ha^{-1} at At was found essential to improve the N uptake when GLM was basal applied. Split application of 40 kg N each as basal and at PI with 20 kg each at At, one week after AT and again at heading was found more useful to have positive N uptake with better NUE. Agronomic efficiency was higher with urea -N basal compared to GLM basal.

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