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PRODUCTIVITY OF RICE IN RELATION TO NITROGEN MANAGEMENT

Grain production which is the final product of growth and development of rice is controlled by its potential ability to utilize the source towards efficient photosynthesis and the capacity to accept the photosynthates towards the development of sink. Application of fertilizers especially nitrogen at a time to best meet the demand for the development of the source is important in maintaining a favourable source-sink relationship towards high productivity. Deep placement of N has been reported to give better efficiency (Shioiri, 1941; Flinn *et al.*, 1984; John *et al.*, 1989). But deep placement of N is generally recommended only for basal application. John (1987) observed greater use efficiency and consequently higher yield due to N deep placed in two splits. However, the role of N in the pathway of yield increase remains to be studied. This necessitated further research to establish the relationship between differential timing of placement of N during rice growth and its influence on yield attributes and yield.

Studies were conducted during the first (April-September) and second (September-December) crop seasons in the Instructional Farm, College of Horticulture, Thrissur in CRD with four replications. Sandy loam soil (pH 5.4, total N 0.06%, available P 30 kg ha , exchangeable K 120 kg ha^{-1}) was air-dried, sifted through 2 mm sieve and filled to 30 cm height of 40 x 40 x 45 cm^3 mud pots and kept submerged for one month. One seedling each from a 14-day-old dapog nursery of variety Annapurna was planted at 10 x 10 cm spacing. The treatments consisted of a no nitrogen control, basal placement of N at full (125 kg N ha^{-1}) and half (62,5 kg N ha^{-1}) dose, split placement of N such as half at basal and other half at 15, 10 or 5 DBPI (days before panicle initiation) and 15, 10 or 5 DAPI (days after panicle initiation) and at PI (panicle initiation). Half a gram of prilled urea packed in single layer tissue paper was placed 5 cm deep in four locations in alternate rows and columns so that four centre hills in the pot had equal access to the fertilizer. In single placement treatments, two and one fertilizer packs were placed in each location to give full and half dose of N, respectively. In all other treatments one pack was placed in each location for basal and second split applications; P_2O_5 and K_2O were applied at 45 kg ha^{-1} through superphosphate and muriate of potash, respectively. A water level of 5 cm above the soil was maintained in the pot throughout the experiment. The soil was not disturbed after planting. Weeds and other pests were controlled by chemicals. To get a precise estimate, the four centre hills leaving the outer rows were individually considered for the determination of yield attributes.

Among the four components of yield (Table 1), the productive tillers per plant were not significantly influenced by either N application, its dose or differential timing of N application during rice growth. However, the other three parameters determining the yield were significantly influenced by N application treatments. The mean increase over two seasons in the spikelets per panicle due to placement of the entire quantity of N as basal dose over no nitrogen control was 28 per cent. The spikelet numbers associated with the placement of the second split of N at 15 DAPI were decreased by 21 per cent as that of 15 DBPI. The corresponding decrease with 10 DAPI was found to be 11 per cent as that of 10 DBPI. However, it could be seen that the placement from 15 DBPI to PI did not cause any significant effect. This indicated that the favourable increase in spikelet number is caused by an increased uptake of N during vegetative to early PI stage of rice resulting in differentiation and growth of new tissues.

Table 1. Yield attributes of rice as influenced by differential timings of N application during growth period

	Productive tillers/hill		Spikelets/ panicle		Per cent fertility		1000 grain weight (g)	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Seanson 2
No nitrogen	3	3	53	56	85	90	20	22
Full basal	4	4	69	71	81	88	22	24
1/2 B (half basal)	4	4	60	65	82	78	21	23
1/2 B+ 1/2 15 DBPI	4	4	76	80	80	85	24	26
1/2 B+ 1/2 10 DBPI	4	4	74	78	82	85	24	26
1/2 B+ 1/2 5 DBPI	4	4	74	70	79	85	23	25
1/2 B + 1/2 PI	4	4	75	77	73	81	23	24
1/2 B+ 1/2 5 DAPI	4	4	71	76	74	75	22	24
1/2 B+ 1/2 10 DAPI	4	4	66	71	73	77	22	23
1/2 B+ 1/2 15 DAPI	4	4	62	67	73	76	22	23
LSD (0.05)	NS	NS	6	7	6	5	1	1
CV (%)	12	13	7	5	5	3	5	3

Table 2. Productivity and N recovery by grain as influenced by differential timings of N application during growth period

	Grain yield, g/pot		Straw yield, g/pot		Per cent grain N		Per cent straw N		Per cent N recovery by grain	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Nitrogen	11.6	12.4	12.4	12.8	0.9	1.0	0.40	0.44	-	-
Full basal	19.6	25.2	20.0	25.6	1.1	1.2	0.60	0.65	61	63
1/2 B(half basal)	16.4	20.8	16.4	21.2	1.0	1.1	0.60	0.60	55	61
1/2 B+ 1/2 15 DBPI	24.8	29.2	25.2	29.6	1.3	1.3	0.65	0.70	66	63
1/2 B+ 1/2 10 DBPI	23.6	28.0	24.0	27.2	1.2	1.3	0.68	0.70	62	65
1/2 B+ 1/2 5 DBPI	22.8	26.8	22.8	27.6	1.2	1.3	0.70	0.70	61	63
1/2 B + 1/2 PI	20.4	24.4	20.8	24.8	1.2	1.3	0.75	0.75	57	60
1/2 B+ 1/2 5 DAPI	18.0	20.4	19.6	23.2	1.1	1.1	0.85	0.80	44	45
1/2 B+ 1/2 10 DAPI	17.2	18.8	19.2	24.4	1.1	1.1	0.85	0.85	43	38
1/2 B+ 1/2 15 DAPI	15.6	18.4	18.8	24.8	1.1	1.1	0.85	0.85	38	36
LSD (0.05)	2.2	2.0	1.9	1.6	0.1	0.1	0.08	0.07	8	7
CV (%)	6	5	6	5.0	5	6	5	5	9	11

The fertility of spikelets was very much affected by delaying the second split. The N availability and steady uptake of N after PI resulted in greater growth of plants, naturally expressed by a higher leaf area. This might result in mutual shading which affects photosynthesis. The reduced carbohydrate production resulted in chaffy and half filled grains. Fagade and De Datta (1971) reported increased spikelet number and a high LAI with high N rates, but the filled spikelets decreased. Similarly, the test weight of grain also was affected by the delayed split placement of N after PI and resulted in almost equal grain weight with that observed when only half of the N was applied as a single basal dose.

The mean grain yield over two seasons of the treatments received either half or full dose placed only at planting was lower by 45 and 21 per cent than in the treatment received deep placed N in two equal splits at planting and 15 DBPI (Table 2). Delaying the second split after PI was found to reduce the yield and N content of grain and to increase production and N content of straw, significantly. It also changed the grain : straw ratio from a favourable 1 to 0.9-0.8. The reduction in yield is due to the unfavourable make-up of the yield attributes except the productive tiller (panicle) production. John (1987) also reported the benefit of placement of nitrogen 10-15 days before PI from studies where urea supergranules were used as N source. The per cent N recovery by grain was found to be significantly higher with placement done at PI or before PI. The delayed placement did not satisfy the objective of N fertilization to rice crop since the N taken up was used mainly towards increasing yield of straw and its N content.

College of Horticulture
Vellanikkara 680 654, Trichur

P.S.John
Mercy George
A. Latha

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