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Research Article

IMPACT OF DIFFERENT NITROGEN LEVELS AND TIME OF APPLICATION ON GRAIN YIELD AND YIELD ATTRIBUTES OF WET SEEDED RICE

*** A. Alagesan[1] and C. Raja Babu[2]**
[1]Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-641 003
Present Address: Krishi vigyan Kendra, Tamil Nadu Agricultural University, Tiruchirapalli-639 115
[2]Department of Crop Physiologyy, Tamil Nadu Agricultural University, Coimbatore-641003
Present Address: Regional Research Station, Tamil Nadu Agricultural University, Vridhachalam-606 001
**Author for Correspondence*

ABSTRACT
Field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore with five levels of nitrogen (40,80, 120, 160 and 200 kg N ha^{-1}) and four times of split application. The experiment was conducted during dry season (December 2005 - April 2006) and Southwest Monsoon (SWM) season (July-October 2006) for wet seeded low land rice. Application of graded levels of N significantly increased the grain yield and yield attributing characters viz., number of tillers, filled grains per panicle, percentage of unfilled grains per panicle and test weight. The effect was significant up to a level of 120 kg N ha^{-1}. Nitrogen application at 160 kg ha^{-1} did not bring any distinct effect on the yield parameters over 120 kg ha^{-1} level. Application of N in four equal splits at seedling, active tillering (AT), panicle initiation (PI) and flowering enhanced the growth and yield attributes when compared to the recommended practice of three equal splits of 1/3 each at seedling, AT and PI. In dry as well as SWM season, application of 120 kg N ha^{-1} produced higher grain yield of 5409 kg ha^{-1} and 5185 kg ha^{-1} respectively. Application of 160 kg N ha^{-1} failed to bring significant yield advantage over 120 kg N ha^{-1} level. The grain yield of wet seeded rice started declining when N was applied at 200 kg ha^{-1}.

Key Words: *Wet Seeded Rice, Nitrogen, Split application, Yield Attributes*

INTRODUCTION
Nitrogen is the kingpin in fertilizer management programme for rice as it is the key to realise the yield potential of high yielding rice varieties. Insufficient and inappropriate fertilizer nitrogen management may account for one half to two thirds of the gap between actual and potential yields. The absence of transplanting shock in wet seeded rice leads to rapid vegetative growth during the early growth period and subsequently making the crop to face a typical situation of N deficiency at the reproductive phase. Direct seeded rice in the puddled soil has the biggest potential to adsorb nitrogen rapidly from the soil and production of dry matter. The research work on nitrogen for wet seeded rice is meager. Therefore improved nitrogen management practices suitable to direct seeding should be developed, rather than relying on the spillover benefits derived from transplanted rice cultivation. Based on the current trends in research results, It is speculated that the next major break through for rising the productivity potential of rice could be achieved from direct seeded rice rather than transplanted rice. The present study was undertaken to find out the effect of different nitrogen levels and time of application of N on the yield and yield attributes of wet seeded rice

MATERIALS AND METHODS
The experiment was conducted with five levels of nitrogen (N_1:40, N_2:80, N_3:120, N_4:160 and N_5: 200 kg N ha^{-1}) and four times of split (S_1: $1/3^{rd}$, $1/3^{rd}$ and $1/3^{rd}$ of N applied during seedling stage(S), active tillering stage(AT) and panicle initiation stage, S_2: $1/ 4^{th}$, $1 /4^{th}$, $1/4^{th}$ and $1/4^{th}$ at S, AT, PI and flowering(FL) stage, S_3: $1/6^{th}$, $1/6^{th}$, $1/3^{rd}$ and $1/3^{rd}$ at S,AT,PI and FL stage and S_4: $1/ 4^{th}$, $1/ 4^{th}$, $1/6^{th}$, $1/6^{th}$ and $1/6^{th}$ at S, AT, PI, booting and FL. The field experiment was laid out in factorial randomized

complete block design with three replications. The farm is geographically situated at 11°N latitude and 77°E longitude and an altitude of 426.7 m above the mean sea level (MSL). The soils of the experimental fields were moderately drained deep clay loam to clay, classified taxonomically as typic haplustalf. The soils were low in available N, medium in available P and high in available K. The organic carbon content was 0.69 and 0.73 during the periods of study respectively. The rice variety ADT 36 was used for the study. It is a short duration, erect type, having long compact panicle maturing in 105 - 110 days. The grains are medium slender and white in colour. A seed rate of 70 kg ha^{-1} was adopted. The seeds were soaked in water overnight and incubated for 24 hours. The sprouted seeds were line sown using a manually operated drum seeder with a row spacing of 20 cm. The nitrogen fertilizer in the form of prilled urea was applied as per treatment schedule. A uniform dose of 50 kg each of P and K per ha was applied to all the plots. The entire quantity of P was applied through single super phosphate as basal dose. Potassium as muriate of potash was applied in four equal splits, at 20 days after sowing, active tillering, panicle initiation and at flowering. Four one square meter areas were selected at random and panicle bearing tillers alone were counted and expressed in number per m^2. Number of filled grains in ten panicles was counted and means values were expressed as filled grains per panicle. The number of unfilled grains from the randomly selected ten panicles used for filled grains were counted and expressed as percentage of unfilled grains. One thousand filled grains were taken at harvest from each plot and their weight was recorded at 14 per cent moisture and expressed in grams. Grain moisture content was measured by using a moisture meter and was adjusted to 14 per cent moisture content. The grain yield was recorded plot wise and expressed in kg ha^{-1}.

RESULTS AND DISCUSSION

Yield attributes

The tillers m^{-2} (Table.1)was increased upto 160 kg N ha^{-1}. Beyond which there was a reduction in tiller number. N applied in four equal splits recorded more number of tillers. Bhattacharya and Singh (1992) reported that the yield attributes and grin yield were highest upto 150 kg N ha^{-1}. Jayaprakash and Wahab (1995) also reported similar trend.In both the seasons, the effect of different levels of N and varied split applications on the production of ear bearing tillers was clearly exhibited. The productive tillers m^{-2} was the lowest when no N was provided to the direct seeded rice crop (Norman *et al*, 1992). There was a positive

Table 1. Total tillers and productive tillers per m^2 of rice

Treatment	Dry season 2005 -06		South West Monsoon 2006	
	Total number of tillers/m^2	Productive tillers/m^2	Total number of tillers/m^2	Productive tillers/m^2
N_1	461	458	369	364
N_2	491	487	391	385
N_3	521	515	443	436
N_4	548	539	475	466
N_5	529	518	463	450
SEd	12	13	11	11
CD (P = 0.05)	25	25	21	21
S_1	522	514	433	424
S_2	534	530	444	436
S_3	486	480	416	409
S_4	496	490	420	412
SEd	11	11	9	9
CD (P = 0.05)	22	23	19	19

response to the applied N to the extent of 160 kg N ha^{-1}, beyond which a reduction in the ear bearing tillers per unit area was recorded (Obecemea *et al.*, 1990; Erquiza *et al.*,, 1990; Kropff *et al.*, 1993). Application of N in four equal splits each at seedling, AT, PI and flowering recorded the highest tillers per m^2 followed by three equal splits (seedling, AT and PI). Restricting the N supply at the initial stages (S_3) and increasing the number of splits to five (S_4) brought a reduction in the number of productive tillers per m^2 when compared to other splits. Levels of N and time of application manifested favourable effect on the number of filled grains per panicle during the periods of study (Table 2). Largest number of filled grains in a panicle was recorded with the application of 160 kg N ha^{-1}, while the lowest number was observed in the absence of N application. The influence of N was noticed upto 160 kg N ha^{-1} in the dry season crop and the effect was felt only upto 120 kg N ha^{-1} level in the monsoon crop. Matured grains per panicle were the highest when N was applied in four equal splits at seedling, AT, PI and flowering. The other splits failed to bring clear differences, during dry season. The rice crop seeded during monsoon season did not respond to the split applications of N in producing more number of filled grains. Varied levels of N and the split application significantly influenced the percentage of unfilled grains per panicle. The immature grain percentage was increased with added N levels. The effect was pronounced when the application rate exceeded 120 kg N ha^{-1} during dry season and 160 kg N ha^{-1} during SWM season. The highest percentage of sterile and unfilled spikelets were recorded with 200 kg N ha^{-1}. Applying higher quantity of N in the early stages (3 equal splits) produced more number of immature grains per panicle compared to the splits with late application of N beyond panicle initiation and flowering (Maskina *et al.*, 1992).

Table 2. Number of filled grains per panicle, Percentage of unfilled grains and Test weight (g) of rice

Treatment	Dry season 2005-06			South-West Monsoon 2006		
	Number of filled grains / panicle	Percentage of unfilled grains	Test weight (g)	Number of filled grains / panicle	Percentage of sunfilled grains	Test weight (g)
N_1	68.4	16.8	21.3	60.6	15.9	20.5
N_2	74.7	16.6	21.5	70.1	15.7	21.3
N_3	82.5	16.4	22.2	86.2	15.9	21.5
N_4	88.8	17.8	21.8	88.3	16.2	21.9
N_5	86.9	19.3	21.6	86.2	17.3	22.0
SEd	*1.7*	*0.4*	*1.1*	*2.1*	*0.4*	*0.2*
CD (P = 0.05)	*3.5*	*0.9*	*NS*	*4.1*	*0.8*	*0.5*
S_1	80.6	18.3	21.9	80.0	16.8	21.3
S_2	82.7	16.8	21.9	82.4	16.1	21.3
S_3	78.1	17.3	21.2	80.1	16.0	21.1
S_4	79.7	17.2	21.7	81.8	16.0	21.4
SEd	*1.6*	*0.4*	*0.5*	*1.8*	*0.4*	*0.2*
CD (P = 0.05)	*3.2*	*0.8*	*NS*	*NS*	*0.7*	*NS*

NS: Non significant

Grain yield of rice

In dry season as well as South West Monsoon season, grain yield of the wet seeded rice was significantly influenced by the levels of N, time and split application (Table.3). Among the different N levels tried, application of 160 kg N ha^{-1} resulted in the highest grain yield in both the seasons. However, there was no significance difference between120 kg and 160 kg N ha^{-1}. The grain yield started declining beyond 160 kg ha^{-1}. The rate of increase in grain yield proceeded at a higher magnitude with increased N levels from 40 to 120 kg ha $^{-1}$ (Prasad *et al*.,1992; Saravanapandian and Raniperumal, 1994). The mean grain yield increase of the two seasons was to the tune of 16.9 , 11.8 and 7.1 per cent with the application of 40, 80 and 120 kg N ha^{-1} over control. Thereafter the yield increase was marginal. Application of 200 kg N ha^{-1} reduced the grain yield by 9.5 per cent over 160 kg N ha^{-1}.

Table 3. Grain yield of rice (kg ha^{-1})

DRY SEASON 2005-06

Treatments	S_1	S_2	S_3	S_4	Mean
N_1	4517	4650	4395	4546	4527
N_2	5312	5486	4691	4834	5081
N_3	5488	5722	5110	5317	5409
N_4	5635	5934	5191	5365	5531
N_5	5059	5595	5120	5318	5273
Mean	5202	5477	4901	5076	
			SEd	*CD (P=0.05)*	
	N		*130*	*263*	
	S		*116*	*235*	
	N x S		*260*	*NS*	

SOUTH WEST MONSOON 2006

Treatments	S1	S2	S3	S4	Mean
N_1	4471	4343	4226	4258	4325
N_2	5071	5140	4438	4621	4817
N_3	5304	5662	4662	5111	5185
N_4	5338	5611	4734	5370	5263
N_5	4853	5108	4631	5328	4980
Mean	4957	5173	4538	4938	
			SEd	*CD (P=0.05)*	
	N		*121*	*244*	
	S		*108*	*218*	
	N x S		*242*	*NS*	

The data on the effect of different split applications of N revealed that applying N in four equal splits (25 per cent each at seedling, active tillering, panicle initiation and flowering stages) was found to be the best time of application for obtaining higher yields in wet seeded rice. Resorting N application in three equal splits at seedling, AT and PI stages of rice was found to be the next best. Increasing the number of splits and supplying N at booting and flowering stages in addition to the early growth phases produced effects similar to that of three equal splits. The grain yield was the lowest when the quantity of N supply was restricted in the early stages and increased after panicle initiation (Akita, 1989; Vijayalakshmi *et al*., 1992). The trend of grain yield for the N levels and split application was similar in both dry season and SWM seasons, but with varied magnitude.

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