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NITROGEN MANAGEMENT TO IMPROVE THE NUTRIENT UPTAKE, YIELD AND QUALITY PARAMETERS OF SCENTED RICE UNDER AEROBIC CULTURE.

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ABSTRACT : In the present study, the research results concluded that yield attributes of scented rice under aerobic culture responded up to 150 kg/ha nitrogen with four equal splits of nitrogen at ¼ basal + ¼ at active tillering + ¼ at panicle initiation and ¼ at heading. Grain and straw yields obtained higher values with highest level of nitrogen i.e. 175 kg/ha comparable with 150 kg/ha. Grain quality parameters milling percent, head rice recovery, kernel length, breadth, amylose content and protein content of rice registered significantly highest values with 150 kg N ha^{-1}. Spilt application of nitrogen at ¼ basal + ¼ at active tillering + ¼ at panicle initiation and ¼ at heading was the most suitable stages for split application of nitrogen, which record significantly higher values of all quality parameters except amylose and protein content of grain. Nutrient uptake of N, P_2O_5 and K_2O was influenced only by quantity of nitrogen applied and recorded higher with 175 kg/ha but not influenced by time of application of nitrogen except N uptake.

Key words: Aerobic culture, Vasumati, Scented rice, Nitrogen management, Nutrient Uptake, yield attributes.

INTRODUCTION

Rice is the staple food for about 50 per cent of the world's population that live in Asia. India has the largest area about 43.46 m ha and produces around 91.79 m t. Recently, there is an increasing scarcity of fresh water for agriculture particularly for rice cultivation due to decline in water levels in one hand and the demand of water to industries and other sectors on the other hand threatens the sustainability of the irrigated rice ecosystem. In this context the new system of rice growing, "Aerobic culture" gains importance. The aerobic rice is a new system of rice cultivation where fields remain unsaturated through out the season like an upland irrigated dry crop. This method of growing rice saves water by eliminating continuous seepage and percolation. Shobha Rani *et al.* (2002) focussed that 'Vasumati' scented variety is more suitable even for upland conditions, since it possesses distinct qualities and insulated with pest and disease resistance and thereby making it pesticide residue free for export. Considering grower's perspective as well as export orientation, cultivation of scented rice seems to be better option.

Nitrogen is the major nutrient that most frequently limits the rice production. Nitrogen management is essential for rice under aerobic culture as the nitrogen use efficiency is be in the range of 40 to 60 per cent. Application of nitrogen at right time is perhaps the simplest agronomic solution for improving the use efficiency of nitrogen. Hence, the present study was conducted to improve the uptake of nutrients, quality parameters of rice to different levels of nitrogen and time of application.

MATERIALS AND METHODS

A field experiment was conducted during *rabi*, 2007 at S.V.Agrilcultural College, Tirupati, Andhra Pradesh, India. The average minimum temperature during the crop growth period is 19.4ºC. The soil of the experimental site was sandy clay loam in texture neutral in reaction, non-saline, low in organic carbon and the initial nutrient status was 202, 21.4 and 205 N-P_2O_5-K_2O kg ha^{-1} respectively. The experiment was laid out in a randomized block design with factorial concept and replicated thrice. The treatments comprised of four levels of nitrogen under factor-I i.e.100, 125,150 and 175 kg N ha^{-1} and four levels of time of application of nitrogen under factor-II i.e. T_1 – ½ basal + ¼ at active tillering and ¼ at panicle initiation, T_2– ⅓ basal ⅓ + at active tillering and ⅓ at panicle initiation, T_3 – ¼ basal + ¼ at active tillering + ¼ at panicle initiation and ¼ at heading, T_4 – ¼ basal + ¼ at active tillering + ¼ at panicle initiation and ¼ at flowering. Entire dose of Phosphorus and potassium were applied basally as per the recommended dose of 50 kg each of P_2O_5 and K_2O ha^{-1} through SSP and MOP, respectively. The variety taken for study was 'vasumati' a scented rice variety. Irrigation was given to crop to maintain soil saturation only instead of flooding. All other crop management practices were followed as per the recommendations of aerobic rice culture. Grain length and breadth of brown rice (dehulled) was measured by 'Mitutoyo Micrometer" and expressed in mm. Amylose content of grain was estimated by calorimetric method (Juliano, 1971) and protein content of grain was estimated by Lowry's method (Lowry *et al*., 1951). The uptake of N, P and K at harvest was calculated by multiplying the nutrient content with the dry matter weight at harvest and expressed as kg ha^{-1}. Milling percent and Head rice recovery were calculated by following formulas.

$$\text{Milling Percentage} = \frac{\text{Total milled rice}}{\text{Total rough rice}} \times 100$$

$$\text{Head rice recovery} = \frac{\text{Total head rice}}{\text{Total rough rice}} \times 100$$

RESULTS AND DISCUSSION

In the present investigation, application of nitrogen from 100 to 175 kg/ha greatly influence all the yield attributes like number of panicles m^{-2}, number of total grains, filled grains panicle $^{-1}$ and test weight of grains. Highest values of all yield attributes recorded with the highest level of nitrogen 175 Kg ha^{-1} which was comparable with 150 Kg ha^{-1} but significantly higher with 125 and 100 Kg ha^{-1} (Table 1). The lowest stature of yield attributing characters with 100 kg N ha^{-1} might be due to insufficient supply of nitrogen for better growth and development of crop. Similar results have been reported by Parmeet Singh *et al.* (2008). Application of nitrogen at different stages of crop growth also significantly influence the yield attributes. Application of nitrogen in four splits, (T_3) – ¼ basal + ¼ at active tillering + ¼ at panicle initiation and ¼ at heading which were in parity with (T_4) – ¼ basal + ¼ at active tillering + ¼ at panicle initiation and ¼ at flowering and significantly superior to other two split application schedules. The lowest number of total and filled grains panicle^{-1} was noticed with (T_1) – ½ basal + ¼ at active tillering and ¼ at panicle initiation, which was on par with (T_2)– ⅓ basal ⅓ + at active tillering and ⅓ at panicle initiation. Split dose of nitrogen at heading stage of rice is more beneficial to the crop rather than flowering. The results are in line with findings of Dhiman *et al.* (1999).

The highest grain yield of vasumati under aerobic culture was produced with the 150 kg N ha^{-1} (N_3), which was however, comparable with 175 kg N ha^{-1} (N_4), but significantly higher than with 125 kg N ha^{-1} (N_2) (Table 1).

Table 1: Effect of levels and time of application of nitrogen on Yield attributes and yield of scented rice under aerobic culture.

Treatment	Effective tillers (m-2)	Total No. of grains panicle-1	No. of filled grains panicle-1	1000-grain weight (g)	Grain yield (Kg/ha)	Straw yield (Kg/ha)	B: C ratio
Nitrogen level (kg ha-1)							
N1-100	246	62	37	21.8	1495	2552	3.62
N2-125	253	63	38	22.0	1542	2630	3.64
N3-150	270	66	42	23.3	1636	2771	3.78
N4-175	262	65	41	22.9	1599	2862	3.61
SE ±	6	1	1	0.2	29	76	-
CD at 5%	13	2	2	0.5	58	156	--
Time of application							
T1-½ B + ¼ AT + ¼ Pl	220	61	38	21.6	1488	2437	3.47
T2 – 1/3 B + 1/3 AT + 1/3 Pl	222	62	39	21.7	1538	2583	3.59
T3 – ¼ B + ¼ AT + ¼ Pl + ¼ H	239	65	41	22.3	1645	2974	3.84
T4 – ¼ B + ¼ AT + ¼ Pl + ¼ F	237	64	40	21.9	1601	2822	3.73
SE ±	6	1	1	0.2	29	76	-
CD at 5%	13	2	2	0.5	58	156	-

B- Basal, AT- Active tillering, PI- Panicle initiation, H- Heading, F- Flowering.

The reason is that over dose of nitrogen of 175 kg ha^{-1} produced profuse tillering, which led to competition among them resulting in conversion of lesser number of tillers in to productive tillers and reduced the quantity of photosynthates from source to sink, which would have resulted in more number of ill filled grains there by finally reduced the grain yields. Jadhav *et al.* (2004) noticed that significant increase in grain and straw yield of Basmati rice with higher levels of nitrogen at 120 kg ha^{-1} under upland condition. The highest straw yield was recorded with175 kg N ha^{-1} (N_4), which was on par with the application of 150 kg N ha^{-1}(N_3), but significantly superior to 125 kg N ha^{-1} (N_2). Application of 100 kg N ha^{-1} (N_1) produced the lowest grain and straw yields. These results are in accordance with the findings of Bouman *et al.* (2002). Regarding time of application of nitrogen the highest grain and straw yields were recorded with (T_3) – ¼ basal + ¼ at active tillering + ¼ at panicle initiation and ¼ at heading which was comparable to (T_4) – ¼ basal + ¼ at active tillering + ¼ at panicle initiation and ¼ at flowering and significantly superior to other two split application schedules. This might be due to the application of nitrogen in splits according to crop requirement caused not only reduction in loss of nitrogen but also increased the nitrogen absorption, consequently better utilization of applied nitrogen leads to higher yield attributes and finally resulted in higher grain and straw yields. This was in accordance with findings of Balasubramanian (2002).

Among the grain quality parameters milling percent, head rice recovery, kernel length, breadth, amylose content and protein content of rice registered highest values with 150 kg N ha^{-1} (N_3), which was significantly superior to 125 kg N ha^{-1} (N_2), but on par with175 kg N ha^{-1} (Table 2). The lowest milling percent was recorded with the 100 kg N ha^{-1} (N_1). Singh *et al.* (1997) concluded that protein content, kernel length, breadth and percent recovery of head rice significantly increased with increasing levels of nitrogen. With regard to time of application milling percent, head rice recovery, kernel length, breadth recorded significantly higher values with (T_3) which was comparable to (T_4) and significantly superior to other two split application schedules. Amylose and protein content of grain could not influenced by time of application of nitrogen at different stages of crop growth but only due to quantity of nitrogen applied. Increased protein content with increased level of nitrogen applied is due to the fact that nitrogen forms the principal constituent of protein and indisputably protein content would be always in direct proportion with the dose of applied nitrogen. Findings of the present investigation are in agreement with those of Jadhav *et al.* (2003) and Singh *et al.* (2007).

Table 2: Effect of levels and time of application of nitrogen on quality parameters of scented rice under aerobic culture.

Treatment	Milling percent (%)	Head rice recovery (%)	Kernel length (mm)	Kernel breadth (mm)	Amylose content (%)	Protein content (%)
Nitrogen level (kg ha-1)						
N1-100	71.5	48.5	6.77	1.63	20.9	8.0
N2-125	72.0	48.6	6.79	1.66	21.8	8.2
N3-150	74.2	48.9	6.92	1.75	24.2	9.0
N4-175	73.6	48.8	6.83	1.72	23.1	8.8
SE ±	0.75	0.50	0.052	0.018	0.68	0.13
CD at 5%	1.5	NS	0.10	0.04	1.4	0.3
Time of application						
T1-½ B + ¼ AT + ¼ PI	71.5	48.7	6.72	1.61	22.1	8.5
T2 – 1/3 B + 1/3 AT + 1/3 PI	72.4	49.0	6.79	1.63	22.2	8.6
T3 – ¼ B + ¼ AT + ¼ PI + ¼ H	74.2	50.8	6.96	1.68	22.6	8.7
T4 – ¼ B + ¼ AT + ¼ PI + ¼ F	73.1	49.9	6.83	1.65	22.3	8.5
SE ±	0.75	0.50	0.052	0.018	0.68	0.13
CD at 5%	1.5	1.0	0.10	0.04	NS	NS

Table 3: Uptake of nutrients (kg ha^{-1}) by scented rice as influenced by levels and time of nitrogen application under aerobic culture.

Treatment	**Nitrogen uptake (Kg ha-1)**	**Phosphorus uptake (Kg ha-1)**	**Potassium uptake (Kg ha-1)**
Nitrogen levels (kg ha-1)			
N1 – 100	88.1	11.7	106.5
N2 – 125	93.0	12.6	112.6
N3 – 150	109.7	18.0	121.0
N4 – 175	112.6	16.9	116.0
SEm ±	2.45	0.56	3.94
CD (P=0.05)	5.0	1.2	8.1
Time of application			
T1 – ½ B + ¼ AT + ¼ PI	94.5	14.2	110.0
T2 – 1/3 B+ 1/3 AT+1/3 PI	96.0	14.5	111.2
T3 – ¼ B+¼ AT+¼ PI + ¼ H	102.7	14.9	117.3
T4 – ¼ B+ ¼ AT +¼ PI + ¼ F	102.3	14.8	114.7
SEm ±	2.45	0.56	3.94
CD (P=0.05)	5.0	NS	NS

Different levels and time of nitrogen application considerably influenced the N uptake by scented rice grown under aerobic culture (Table 3). The highest N uptake by the rice crop was recorded with the application of 175 kg N ha^{-1}, which was on par with 150 kg N ha^{-1} and significantly superior to 125 kg N ha^{-1}. The lowest N uptake was noticed with 100 kg N ha^{-1} (N_1), which was however, comparable with 125 kg N ha^{-1}. Application of N at four equal splits at ¼ B + ¼ AT + ¼ PI + ¼ H (T_3) resulted in the highest N uptake, which was on par with ¼ B + ¼ AT + ¼ PI + ¼ F (T_4). The lowest N uptake was recorded with ½ B + ¼ AT + ¼ PI (T_1), which was on par with $^1/_3$ B + $^1/_3$ AT + $^1/_3$ PI (T_2).

The beneficial effect of increasing nitrogen levels on the nitrogen uptake was earlier reported by Saradeep Kour *et al.* (2005). Where as uptake of phosphorus and potassium by scented rice significantly influenced only by different levels of nitrogen management practices tried, while time of N application did not exert any significant influence. The highest phosphorus and potassium uptake was recorded with the 150 kg N ha^{-1} which was however, comparable with 175 kg N ha^{-1} and significantly higher than with 125 kg N ha^{-1} and lowest with 100 kg N ha^{-1}. Increasing N application stimulated more vegetative growth and increased foraging capacity of roots which in turn increased the uptake of P and K. Similar results were observed by Rammohan *et al.* (1999)

The highest B: C ratio was recorded with 150 kg N ha^{-1} (N_3), which was significantly higher than with all other three levels of N tried. Among time of application highest B-C ratio was registered with (T_3), which was comparable with (T_4) and significantly higher than (T_2) (Table 1). The experimental results concluded that scented rice variety 'vasumati' could better managed by application of 150 kg N ha^{-1} with four splits of application of nitrogen at ¼ Basal + ¼ Active tillering + ¼ Panicle initiation + ¼ Heading (T_3) for higher yields.

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