Agricultural Research & Technology Open Access Journal
ISSN: 2471-6774

Juniper Publishers
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Research Article
Volume 20 Issue 4 - March 2019
DOI: 10.19080/ARTOAJ.2019.20.556137

Agri Res & Tech: Open Access J

Evaluation of Potential Very Early Rice Genotypes with Different Levels of Nitrogen under Aerobic Situation

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Submission: December 14, 2018; **Published:** March 25, 2019

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Abstract

Rice is an important staple food crop for majority of the world population. Aerobic rice system is a new way of growing rice that needs less water than low land rice. It is grown like an upland crop (maize, wheat, Oats etc.) in soil, which is un-puddled, non-flooded or saturated. On the other hand, optimization of applied nitrogen at critical growth stages, coinciding with the period of efficient utilization is essential to meet the nitrogen requirement of crop through-out the growing season. On the basis of this fact an experiment was conducted during kharif season of 2013 at Rice Research Station, Bankura, West Bengal, India. The soil of experimental field was sandy loam in texture with medium in fertility status. This experiment was laid out in a split-plot design with three replications and compared two factors [nitrogen levels (3) and AVT-VE rice cultures: Direct seeded (7)] to identify promising and stable genotypes under direct seeded condition in aerobic situation and study the grain yield potential, nitrogen response and use efficiency of promising AVT-2 rice cultures [AVT-VE (Direct Seeded)] grown in aerobic conditions under high and low input management in rice. Recommended fertilizer dose (RFD) was N, P_2O_5, K_2O @ 80, 40, 40kg ha^{-1} (N: 25% as basal, 50% at active tillering stage and 25% at panicle initiation stage). Three (3) levels of Nitrogen (kg ha^{-1}) [N_1 - 50% recommended nitrogen (RN) - 40, N_2 - 100% recommended nitrogen (RN) - 80, N3 - 150% recommended nitrogen (RN) - 120] were randomly allotted in the three main plots; while seven very early rice cultures [V_1 = IET 22020, V_2 = IET 22743, V_3 = IET 22744, V_4 = Anjali, V_5 = Varalu, V_6 = Vandana and V_7 = Siddhanta (Local check)] were randomly allotted in the seven sub plots of each main plot. Three rice cultures belonging to AVT VE – DS (Direct seeded) [IET 22020, IET 22743 and IET 22744] were evaluated along with Anjali, Varalu, Vandana and Siddhanta (local check) under three levels graded levels of nitrogen 50, 100 and 150% of RDN during kharif 2013. The experimental results revealed that grain yield differences among the cultivars were significant. IET cultures recorded significantly higher grain yields over standard and local check (cv. Siddhanta). IET 22020 recorded highest grain yield of 3.51t ha^{-1}. Incremental doses of nitrogen influenced the grain yield significantly. Application of 150% of RDN recorded significantly higher grain yield of 3.6t ha^{-1}. The N response was higher (34.36) at 100% RDN as compared to 150% RDN.

Keywords: Promising very early rice cultures; Nitrogen levels; Grain yield and aerobic direct seeded condition

Introduction

Rice (*Oryza sativa* L.) is most economically important food crop and grown across the world. Most people of the world depend on rice for their secured livelihood and a way of life. It is the staple food for more than 65 per cent of the people and provides employment and livelihood to 70 per cent of the Indians. There is a need to enhance the productivity of the rice to meet the growing demand under conditions of declining quantity and quality of land [1]. Rice is an important staple food crop of the world. Aerobic rice system is a new way of growing rice that needs less water than low land rice. It is grown like an upland crop (maize, wheat, Oats etc.) in soil, which is un-puddled, non-flooded or saturated. Aerobic rice system is the method of cultivation, where the rice crop is established by direct seeding (dry or water-soaked seed) in un-puddle field and non-flooded field condition [2]. The usual way of planting aerobic rice is the same as we would plant the other cereal crops like wheat, oats or maize by direct seeding. There is no need of raising of seedling in nursery bed and puddle operation in the main field [3]. Nitrogen plays an important role to promote the plant growth and ultimately in determining the yield of rice. Nitrogen is the key element in the production of rice and gives by far the largest response. It is the most essential element in determining the yield potential of rice and nitrogenous fertilizer is one of the major inputs to rice production [4]. However, recovery of applied nitrogen in rice is very low owing to various losses. Optimization of applied nitrogen at critical growth stages, coinciding with the period of efficient utilization is essential to meet the nitrogen requirement of crop throughout the growing season [5]. Almost every farmer has the tendency to apply costly N fertilizer excess to get a desirable yield of Aman rice [6], but the imbalance use of N fertilizer causes harm to the crop and decreases grain yield. It is also a fact that improper use of nitrogenous fertilizer, instead of giving yield advantage, may reduce the same. Nitrogen management is an important aspect for obtaining good yield of rice. Optimum dose and schedule of fertilizer application is necessary to achieve higher yields, minimize lodging and damage from insect pests [7]. Sangeetha and Balakrishnan [8] reported that lower grain yield of rice obtained with absolute control which did not receive organic manures and recommended NPK addition. Nitrogen fertilization and proper time of its application is the major agronomic practice that affects the yield and quality of rice crop [9]. Different varieties may have varying responses to N-fertilizer depending on their agronomic traits. Now a days the identification and release of high yielding very early rice varieties, it becomes imperative to make a comparative assessment of the growth studies and their influence on grain yield under different nutrient combination. Of the mineral nutrients, nitrogen plays a major role in utilization of absorbed light energy and photosynthetic carbon metabolism in many biochemical and physiological activities of plant [10,11]. Its deficiency or excess application may adversely affect these processes and ultimately reduces crop yield. On other hand, genetic character of a variety limits the expression of yield. Rice cultivars differ in their potential to respond to high fertility conditions. Selection of suitable varieties and their nutrient requirements have great relevance in boosting up productivity of upland rice in aerobic direct seeded situation. Selection of proper variety suitable to the specific ecological situation may prove to be a boon to the farmer. Keeping these points in view the present research was taken up. Hence this study was proposed to identify promising and stable very early rice genotypes under direct seeded condition in aerobic situation and study the grain yield potential, nitrogen response and use efficiency of promising AVT-2 rice cultures (very early) [AVT-VE (Direct Seeded)] grown in aerobic conditions of red and laterite zone of West Bengal under high and low input management in rice.

Materials and Methods

To identify promising and stable genotypes under direct seeded condition in aerobic situation and study the grain yield potential, nitrogen response and use efficiency of promising AVT-2 rice cultures/genotypes (very early) [AVT-VE (Direct Seeded)] grown in aerobic conditions of red and laterite zone of West Bengal under high and low input management in rice, a field experiment was conducted during kharif season, 2013 at Rice Research Station, Bankura, West Benagl, India. Main objectives of this experiment were to identify promising and stable genotypes under direct seeded condition in aerobic situation and study the grain yield potential of promising AVT-2 rice cultures/genotypes (very early) under high and low input management in rice (direct seeded condition). The soil of experimental field was sandy loam in texture. The experiment was laid out in a split plot design in 3 replications. Recommended fertilizer dose (RFD) was N, P_2O_5, K_2O @ 80, 40, 40kg ha^{-1} (N: 25% as basal, 50% at active tillering stage and 25% at panicle initiation stage). Three (3) levels of Nitrogen (kg ha^{-1}) [N_1 - 50% recommended nitrogen (RN) - 40, N_2 - 100% recommended nitrogen (RN) - 80, N_3 - 150% recommended nitrogen (RN) - 120] were randomly allotted in the three main plots; while seven very early rice cultures [V_1 = IET 22020, V_2 = IET 22743, V_3 = IET 22744, V_4 = Anjali, V_5 = Varalu, V_6 = Vandana and V_7 = Siddhanta (Local check)] were randomly allotted in the seven sub plots of each main plot. Three rice cultures belonging to AVT VE – DS (Direct seeded) [IET 22020, IET 22743 and IET 22744] were evaluated along with Anjali, Varalu, Vandana and Siddhanta (local check) under three graded levels of nitrogen 50, 100 and 150% of RDN during kharif 2013. The source of N, P_2O_5 and K_2O were urea, single super phosphate (S.S.P.) and muriate of potash (M.O.P.), respectively. 25% of recommended dose of N and full dose of P_2O_5 and 75% of K_2O were applied as basal. 50% of recommended dose of nitrogen was top dressed at active tillering stage and rest 25% N along with 25% K_2O were applied at panicle initiation stage. The field was drained before application of fertilizers and one week before harvest. Initial soil sample were collected and were analyzed for important properties using standard procedures. The soil was slightly acidic (pH 5.6) in nature, EC: 0.17 dsm^{-1}, organic carbon (%): 0.42, available P_2O_5 45kg ha^{-1} and K_2O 188kg ha^{-1}, respectively. Plot size was 4m × 3m, whereas the crop geometry was line (row) to line (row) 20 cm with continuous direct sowing. Pendimethalin (PE) @ 1.0kg a.i. ha^{-1} at 1 day after sowing (DAS) and 2, 4-D Na salt (80 WP) @ 0.08kg a.i. ha^{-1} at 20 DAS was applied. One hand weeding was done at 45 DAS. Observation on yield parameters and yield was recorded. Data was statistically analyzed. The $5m^2$ area in the middle of each plot was harvested for recording grain yield. Ten rice hills outside the harvested area were selected and harvested separately for recording panicle weight. The number of matured panicles per m^2 area in the middle of each plot was recorded.

Results and Discussion

The effects of various levels of nitrogen (N) and very early rice genotypes/varieties on various parameters have been presented in Tables 1 and 2.

Nitrogen levels

The yield attributes of potential very early rice genotypes/varieties were found to be differed due to applied nitrogen levels. Each increase in the N-level increased number of panicles m^{-2} and matured panicle weight resulting higher yield attributes and

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grain yield (Table 1). Thus, at 150% recommended nitrogen (RN) i.e 120kg N ha^{-1}, the yield attributes recorded maximum number of panicles m^{-2} (350), panicle weight (1.85g) and finally recorded highest grain yield (3.60t ha^{-1}) than lower fertilities. It was significantly higher than other levels (rate) of nitrogen. While, at 100% recommended nitrogen (RN) i.e 80kg N ha^{-1} the yield attributes recorded second highest number of panicles m^{-2} (337), panicle weight (1.62g) and finally recorded second highest grain yield (3.22t ha^{-1}) during investigation. While, at 50% recommended nitrogen (RN) i.e 40kg N ha^{-1} the yield attributes recorded lowest number of panicles m^{-2} (225), panicle weight (1.36g) and finally recorded lowest grain yield (1.84t ha^{-1}) during investigation. It was significantly lower than other levels (rate) of nitrogen in this experiment. The experimental results revealed that among the nitrogen levels, the highest grain yield (3.6 t ha^{-1}) was recorded with 150% recommended nitrogen (RN) i.e 120kg N ha^{-1} and it was statistically significant higher than 100% recommended nitrogen (RN) i.e 80kg N ha^{-1} (3.22t ha^{-1}) and 50% recommended nitrogen (RN) i.e 40kg N ha^{-1} (1.84t ha^{-1}), respectively. There was a significant increase in grain yield with the increase in N level from 40 to 120kg ha^{-1} and further increase in N level upto 120kg ha^{-1} could increase the grain yield significantly (Figure 1).

Table 1: Grain yield and ancillary characters of selected AVT-Very Early (Direct Seeded) cultures grown under aerobic condition at graded levels of N fertilizer doses during kharif season.

Parameters	Grain Yield (t ha^{-1})	Rank	No. of Panicle m^{-2}	Panicle wt. (g)	N res. (Kg Grain/Kg N) (Base Level 40Kg N/ha)
N Levels (kg/ha)					
N1 (40)	1.84		225	1.36	
N2 (80)	3.22		337	1.62	34.36
N3 (120)	3.6		350	1.85	21.92
CD (0.05)	0.11		5.39	0.13	
C.V. (%)	6.94		3.24	15	
Entries					
V1 (IET 22020)	3.51	1	367	1.83	23.38
V2 (IET 22743)	3.27	2	344	1.71	31.44
V3 (IET 22744)	3.1	3	333	1.63	32.21
V4 (Anjali)	2.89	4	292	1.66	31.31
V5 (Varalu)	2.45	6	260	1.44	25.52
V6 (Vandana)	2.69	5	282	1.63	28.85
V7 [Siddhanta (Local check)]	2.29	7	250	1.35	24.27
CD (0.05)	0.41		26.71	0.22	
C. V. (%)	15.02		9.22	14.12	
Expt. Mean	2.89		304	1.61	

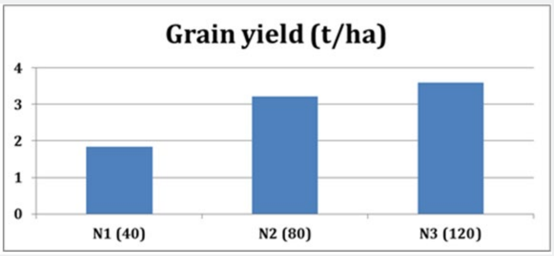

Figure 1: Effect of different N levels on grain yield of very early rice genotypes under aerobic situation.

The improvement in yield attributing traits may be ascribed to the improved vegetative growth due to nitrogen fertilization, facilitating photosynthesis, thereby increasing translocation of organic food materials towards the reproductive organs; which enhanced the formation of panicles with fertile grains. The improvement in yield components due to increased nitrogen levels also have been reported by many workers Shukla *et al.* [12], Pandey *et al.* [13] and Singh *et al.* [14]. The productivity i.e. grain yield of aerobic direct seeded rice was found to be differed with different level of nitrogen during investigation. This might be due to better growth and appreciable improvement in yield attributing characters. This could be attributed to the fact that higher dose of nitrogen being constituent of enzymes and protein enhanced cell expansion and various metabolic processes. Grain yield production increased significantly with incremental levels of N up to 120kg ha^{-1}. This could be attributed to the higher nitrogen application which might have increased the chlorophyll formation and improved photosynthesis and thereby increased the plant growth, number of panicles per unit area and panicle weight leading to the production of high grain yield. Similar results have also evinced by Liukhan *et al.* [15] and Sabir *et al.* [16].

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Varieties

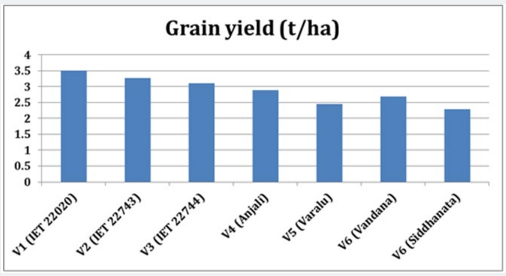

Figure 2: Grain yield as influenced by very early rice genotypes under aerobic situation.

There were significant differences among the potential very early rice genotypes/varieties in plant growth, yield attributes and grain yield. All yield attributing characters (number of panicle/m^2 and panicle weight) were remained differed with different varieties. Among the seven genotypes/varieties, IET 22020 (very early rice genotype) recorded maximum number of panicles m^{-2} (367), panicle weight (1.83g) and finally recorded highest grain yield (3.51t ha^{-1}). It was statistically at par with IET 22743 and IET 22744 (very early rice genotypes) with respect to grain yield (3.27 and 3.10t ha^{-1}, respectively). IET 22743 recorded 344 numbers of panicles m^{-2} and panicle weight was 1.71g. IET 22744 recorded 333 numbers of panicles m^{-2} and panicle weight was 1.63g. While, IET 22020 was remained closed to IET 22743 and IET 22744 with respect in grain yield under aerobic direct seeded situation during investigation. Experimental results revealed that among the potential very early rice genotypes/varieties, IET 22020 recorded the highest grain yield (3.51t ha^{-1}), which was significantly higher to that of Anjali (2.89t ha^{-1}), Varalu (2.45t ha^{-1}), Vandana (2.69t ha^{-1}) and Siddhanta (2.29t ha^{-1}) (local check) (Table 1). However, IET 22743 exerted second promising yield attributing characters and grain yield during investigation (Figure 2).

The climatic condition and genetic makeup of variety had better interaction under which could be enhanced growth and development of panicles. The photoperiodic responses and genetic potentiality on variation of yield attributes of improved varieties have also been reported by Lar *et al.* [17]. Productivity of crop is collectively determined by vegetative growth coupled with higher yield attributes resulting in higher grain yield. Increased in grain yield through greater partitioning of assimilates from shoot to grain. The increased in grain yield by the varieties due to overall respective performance in growth and appreciable improvement in the yield attributing characters. Significant variations in grain yield of rice varieties have also been reported by many workers [17-19].

Table 2: Interaction effect between nitrogen levels (rate) and rice genotypes/varieties on grain yield and ancillary characters of selected AVT-Very Early (Direct Seeded) cultures grown under Aerobic condition at graded levels of N fertilizer doses during kharif season.

N- Levels	Entries	Grain Yield (t ha^{-1})	Rank	No. of Panicle m^{-2}	Panicle wt. (g)	N res. (Kg Grain/Kg N) (Base Level 40Kg N/ha)
N_1	V_1	2.63	14	263	1.61	
	V_2	2.11	16	247	1.42	
	V_3	1.92	17	238	1.31	
	V_4	1.73	18	218	1.36	
	V_5	1.49	20	198	1.25	
	V_6	1.63	19	214	1.39	
	V_7	1.39	21	196	1.19	
N_2	V_1	3.75	4	410	1.87	27.92
	V_2	3.68	5	388	1.76	39.25
	V_3	3.53	7	374	1.67	40.25
	V_4	3.26	9	320	1.69	38.25
	V_5	2.68	13	285	1.41	29.75
	V_6	3.07	11	310	1.56	36
	V_7	2.55	15	272	1.35	29.08
N_3	V_1	4.14	1	429	2.02	18.83
	V_2	4	2	398	1.93	23.63
	V_3	3.85	3	387	1.91	24.17
	V_4	3.68	6	337	1.93	24.38
	V_5	3.19	10	296	1.66	21.29
	V_6	3.37	8	322	1.94	21.71
	V_7	2.94	12	283	1.53	19.46
CD (0.05)						
N at same V		NS	--	NS	NS	--
V at same N		NS	--	NS	NS	--

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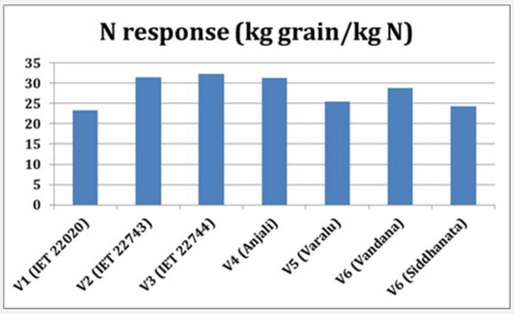

Figure 3: N response (kg grain/kg N) [base level 40kg N/ha] of very early rice genotypes under aerobic situation.

The experimental results revealed that grain yield differences among the cultivars were significant. IET cultures recorded significantly higher grain yields over standard and local check (Siddhanta). IET 22020 recorded highest grain yield of 3.51t ha^{-1}. Incremental doses of nitrogen influenced the grain yield significantly. Application of 150% of RDN recorded significantly higher grain yield of 3.6t ha^{-1}. The N response was higher (34.36) at 100% RDN as compared to 150% RDN. Regarding interaction effect, combination of N3 X V1 i.e 150% recommended nitrogen (RN) i.e 120kg N ha^{-1} and IET 22020 (very early rice culture) recorded highest grain yield of 4.14t ha^{-1} [20] (Table 2) (Figure 3).

Conclusion

From the present study, it may be concluded that among the potential very early rice genotypes/varieties IET 22020 proved most impressive by recording the highest grain yield and IET 22743 exerted second promising very early rice genotype under aerobic direct seeded situation of red and laterite zone of West Bengal. IET 22020 has the potential to be an alternative/replacement as very early rice genotype for Siddhanta in upland areas under aerobic direct seeded condition with 150% recommended nitrogen (RN) i.e 120kg N ha^{-1}.

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