Effect of Nutrient Management on Grain Yield of Aerobic Rice Under Irrigated Condition During Pre-Kharif Season

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Abstract— *A field experiment on 'Effect of nutrient management on grain yield of aerobic rice under irrigated condition during Pre-kharif season' was conducted at Rice Research Station, Bankura, West Bengal, India during 2011 and 2012, respectively in upland situation of red and laterite areas of West Bengal. The experimental result revealed that grain yield of rice in aerobic situation was not significantly influenced by the irrigation schedules during pre-kharif season. Among the levels of nutrient management practices, highest grain yield (4.42 t ha-1) of aerobic rice [variety: Puspa (IET 17509)] was obtained from the treatment N2 [N1 (N, P2O5, K2O @ 80, 40, 40 kg ha-1) + Vermicompost @ 2.5 t ha-1]. It is the most promising approaches for saving water and labour. This is eco-friendly and environmentally safety. Rice production in aerobically is an important tool to mitigating the global warming i.e. climate change scenario.*

Keywords— Aerobic rice, nutrient management, irrigated condition, pre-kharif and eco-safety system

I. INTRODUCTION

Rice (Oryza sativa L.) is an important staple food and grown across the world. It is the second most widely consumed cereal in the World next to wheat (Kumari et al., 2014). But Rice cultivation is a water intensive enterprise. Rice consumes more than 50% of the water used for irrigation in Asia (Barker et al., 1999). On the other hand by the end of 21st Century, the earth's climate is predicted to warm by an average of 2-40C (IPCC, 2007). Now days water becoming scarcity for agriculture purposes. Therefore there is need to develop an alternative system for rice cultivation, which saves water. Aerobic rice system is the method of rice cultivation, where the rice crop is established by direct seeding (dry or water-soaked seed) in un-puddle field. There is no need of raising of seedling in nursery bed and puddle operation in the main field (Jana, 2012). Aerobic rice cultivation can reduce the irrigation by about 40-50 percent when compared to transplanted rice. Compared with flooded lowland rice, aerobic rice requires 30-50% less water (Bouman et al., 2005). Supplementary irrigation is applied in aerobic rice system of cultivation as and when required (Bouman and Tuong, 2001; Wang et al., 2002). Aerobic rice system in un-puddle situation during boro season by using short duration rice varieties (namely cv. puspa, annada etc.) is possible through good management practices and it is the future rice (Jana, 2013a and Jana, 2013b).

Information of nutrient management with varying levels of irrigation schedules for maximizing grain yield of rice under aerobic situation are scanty. Therefore, an attempt was made for achieving maximum production of rice in red and laterite areas of West Bengal, India under changed climate. The objective of the present study was to study the effect of nutrient management practices and irrigation schedule on grain yield of aerobic rice system. Keeping the above facts in mind this present study was conducted with the objective to study the effect of nutrient management on grain yield of aerobic rice under irrigated condition during kharif season.

II. MATERIALS AND METHODS

The research-based information on the nutrient management practices and levels of irrigation schedules of aerobic rice system during pre-kharif season is very meager. So, on the basis of this fact, a field experiment on "Effect of nutrient management on grain yield of aerobic rice under irrigated condition during Pre-kharif season' was conducted during 2011 and 2012, respectively at Rice Research Station, Bankura, West Bengal, India on sandy loam soil. This experiment was laid out in split plot design in three replications with three levels of irrigation schedules (I1 = Irrigation at germination, tillering, panicle initiation and grain filling stages; I2 = Irrigation at germination, tillering, flowering and grain filling stages and I3 = Irrigation at germination, tillering, panicle initiation, flowering and grain filling stages) randomly allotted in the three main plots; while three levels of nutrient management [N1 = N, P2O5, K2O @ 80, 40, 40 kg ha-1; N2 = N1 + Vermicompost @ 2.5 t ha-1 and N3 = N1 + FYM @ 5 t ha-1] were randomly allotted in the three sub plots of each main plot. The plot size was 4 X 3 m. The rice variety was Puspa (IET 17509). This is a drought tolerant, short duration (105 days) rice variety released from Rice Research Station, Bankura, West Bengal. The direct sowing in un-puddled field was done with 20 X 15 cm spacing on 15.05.2011 and 14.05.2012, respectively as pre-kharif rice. Direct seeding of water soaked seed treated with carbendazim @ 2g per kg seed was done in the main field with ideal moisture condition. The required cultural practices and plant protection measures were followed as per recommended package.

TABLE 1
GRAIN YIELD AND ANCILLARY CHARACTERS OF RICE IN AEROBIC SITUATION AS INFLUENCED BY NUTRIENT MANAGEMENT UNDER IRRIGATED CONDITION DUING PRE-KHARIF SEASON (POOLED DATA OF 2 YEARS)

Levels of irrigation schedule (I)	Levels of Nutrient management (N)	Plant height (cm)	No. of matured panicles m^{-2}	Panicle weight (g)	Length of panicle (cm)	Grain yield (t ha^{-1})
I_1	N_1	119.6	289.3	2.16	23.6	3.70
	N_2	128.7	362.0	2.48	24.4	4.36
	N_3	124.4	340.3	2.23	26.3	4.23
I_2	N_1	123.0	291.3	2.15	23.4	3.69
	N_2	131.0	361.6	2.63	24.2	4.33
	N_3	123.6	339.6	2.31	25.7	4.13
I_3	N_1	121.3	294.5	2.28	24.5	3.83
	N_2	130.3	365.7	2.83	25.7	4.57
	N_3	126.3	342.7	2.42	26.8	4.28
I at same N						
S.Em (±)		8.97	18.77	0.50	1.35	0.51
CD (P = 0.05)		NS	55.36	NS	NS	NS
N at same of different I						
S.Em (±)		8.20	16.26	0.43	1.18	0.45
CD (P = 0.05)		NS	48.32	NS	NS	NS
Levels of Irrigation schedules (I)						
I_1		123.9	330.5	2.29	24.7	4.09
I_2		126.5	330.8	2.36	24.4	4.05
I_3		131.4	334.3	2.51	25.6	4.22
S.Em (±)		2.61	0.41	0.023	0.38	0.28
CD (P = 0.05)		NS	1.61	NS	NS	NS
Levels of nutrient management (N)						
N_1		125.6	291.7	2.20	23.8	3.74
N_2		128.0	363.1	2.65	24.8	4.42
N_3		126.3	340.9	2.32	26.3	4.22
S.Em (±)		5.18	10.83	0.29	0.88	0.21
CD (P = 0.05)		NS	32.19	NS	NS	0.64

I_1 = Irrigation at germination, tillering, panicle initiation and grain filling stages
I_2 = Irrigation at germination, tillering, flowering and grain filling stages
I_3 = Irrigation at germination, tillering, panicle initiation, flowering and grain filling stages
N_1 = N, P_2O_5, K_2O @ 80, 40, 40 kg ha^{-1}
N_2 = N_1 + Vermicompost @ 2.5 t ha^{-1}
N_3 = N_1 + FYM @ 5 t ha^{-1}

2.1 Fertilizer Management: The recommended dose was N, P2O5, K2O @ 80, 40, 40 kg ha-1. 25% of recommended dose of nitrogen, full dose of phosphorus, 75% of potash and ZnSO4 @ 25 kg ha-1 were applied as basal. Remaining dose of N in two splits was applied. 50% N at active tillering stage and 25% N along with 25% Potash at Panicle initiation stage were applied.

2.2 Weed Management: Pendimethalin (PE) @ 1.0 kg a.i./ha at 2 days after sowing and 2,4-D Na salt (80 WP) @ 0.06 kg a.i./ha at 20 DAS were applied. Two hands weeding were done at 40 and 60 DAS.

2.3 Water Management: Irrigation water was applied according to critical growth stages of rice crop as per with treatment specification. Water management was done to keep soil moist alternate wetting and drying. Maintain water at just soil saturation level by intermittent light irrigation coinciding with appearance of hair line cracks or when see the visual condition (sign or symptoms) of the rice plant in general. Provide sufficient drainage channels to drain the excess water from the field.

2.4 Plant height (from ground level to the tip of the flag leaf) was taken at ripening stage based on randomly selected ten plants. Observation on yield parameters, viz. number of matured panicles m-2, length of panicle, panicle weight and grain yield was recorded. Data was statistically analysed. The 5 m2 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 and length. The number of matured panicles per m2 area in the middle of each plot was recorded. The characteristics of red and laterite soils are poor in organic matter content, available phosphate and in bases. The upland soils are mostly eroded with a very low water holding capacity. Crust formation in the upland soils is serious problem. This experiment was conducted in upland. The texture of experimental soil was sandy loam with slightly acidic in nature (pH: 5.6), 0.14 ds m-1 EC, medium in organic carbon 0.64 %, available P2O5 88 kg ha-1 and available K2O 245 kg ha-1. Harvesting was done on 26.08.2011 and 25.08.12, respectively. This experiment was conducted in upland condition. The upland soils are mostly eroded red-gravelly with a very low water holding capacity. Crust formation in the upland soils is serious problem. The characteristics of red and laterite soils are poor in calcium, organic matter content, available phosphate and in bases. Land is undulating and has many tiny rivulets.

TABLE 2
SOIL HEALTH STATUS OF THAT EXPERIMENTAL FIELD (POOLED DATA OF 2 YEARS)

Soil properties	pH	EC dsm^{-1}	Organic carbon (%)	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Before experiment	5.6 (SA)	0.14 (N)	0.64 (M)	88 (M)	245 (L)
Post harvest soil data with reference to treatments					
$R_1 I_1N_1$	5.8 (SA)	0.12 (N)	0.64 (M)	10 (L)	242 (M)
$R_1I_2N_2$	5.9 (SA)	0.18 (N)	0.72 (M)	10 (L)	188 (M)
$R_1I_3N_3$	5.4 (A)	0.13 (N)	0.79 (M)	09 (L)	259 (M)
$R_2I_1N_1$	5.7(SA)	0.13 (N)	0.64 (M)	09 (L)	282 (M)
$R_2I_2N_2$	5.7 (SA)	0.16 (N)	0.71 (M)	10 (L)	228 (M)
$R_2I_3N_3$	5.3 (A)	0.16 (N)	0.74 (M)	10 (L)	255 (M)

I_1 = Irrigation at germination, tillering, panicle initiation and grain filling stages
I_2 = Irrigation at germination, tillering, flowering and grain filling stages
I_3 = Irrigation at germination, tillering, panicle initiation, flowering and grain filling stages
N_1 = N, P_2O_5, K_2O @ 80, 40, 40 kg ha^{-1}
N_2 = N_1 + Vermicompost @ 2.5 t ha^{-1}
N_3 = N_1 + FYM @ 5 t ha^{-1}
R = Replication, SA = Slightly acidic, A = Acidic, N = Normal, M = Medium, L = Low

III. RESULTS AND DISCUSSION

Regarding panicle weight, it was not significantly influenced by both the levels of irrigation schedule and nutrient management. But, the number of matured panicles m-2 was statistically significant by the nutrient management practices. It was noticed that more number of matured panicles m-2 was recorded with the treatment N2 [N1 (N, P2O5, K2O @ 80, 40, 40 kg ha-1) + Vermicompost @ 2.5 t ha-1] which reflected on the achieving maximum aerobic rice grain yield. This was agreed with the findings of Jana, 2013b. The experimental results revealed that grain yield of rice in aerobic situation were not significantly influenced by the irrigation schedules during pre-kharif season of 2011 and 2012, respectively. But, two irrigations were most important for raising the rice plant in aerobic condition during pre-kharif season, as direct seeding was done in the middle of May (Anon., 2012). 1st and 2nd irrigation were applied at germination and tillering stage of rice crop. This was agreed with Bouman and Tuong, (2001). However, the higher grain yield (4.22 t ha-1) of aerobic rice was obtained from the treatment I3, where irrigation was applied at germination, tillering, panicle initiation, flowering and grain filling stages, respectively. Among the levels of nutrient management practices, highest grain yield (4.42 t ha-1) was obtained from the treatment N2 [N1 (N, P2O5, K2O @ 80, 40, 40 kg ha-1) + Vermicompost @ 2.5 t ha-1] and it was statistically at par with grain yield (4.22 t ha-1) obtained with the treatment N3 [N1 (N, P2O5, K2O @ 80, 40, 40 kg ha-1) + FYM @ 5 t ha-1]. Best nutrient management practices have synergistic influence on grain yield of directed seeded aerobic rice. This was agreed with Sing et al., 2014, especially in case of directed seeded rice (DSR). The lowest grain yield (3.74 kg ha-1) of aerobic rice was obtained from the treatment N1 (N, P2O5, K2O @ 80, 40, 40 kg ha-1) (Table 1). This could be attributed as a result of higher uptake and recovery of applied nutrients. This might be due to better root growth and proliferation and also opportunity to extract water and nutrients both from larger soil profile area, which in turn must have improved synthesis and translocation of metabolites to various reproductive structures of rice plant and better distribution of it into grain would always results in higher grain yield. This result corroborated with the findings of Jana, 2012. The nutrient management practices like, the treatment N2 [N1 (N, P2O5, K2O @ 80, 40, 40 kg ha-1) + Vermicompost @ 2.5 t ha-1] and treatment N3 [N1 (N, P2O5,

K_2O @ 80, 40, 40 kg ha-1) + FYM @ 5 t ha-1] also improved the rice soil health status specifically with respect to organic carbon percentage (Table 2) (Anon., 2012). From the present study it may be decided that N, P_2O_5, K_2O @ 80, 40, 40 kg ha-1 + Vermicompost @ 2.5 t ha-1 can improved grain yield of aerobic rice system during pre-kharif season under red and laterite zone of West Bengal, India.

IV. CONCLUSION

From the present study, it can be concluded that nutrient management practices like, the treatment N2 [N1 (N, P_2O_5, K_2O @ 80, 40, 40 kg ha-1) + Vermicompost @ 2.5 t ha-1] and treatment N3 [N1 (N, P_2O_5, K_2O @ 80, 40, 40 kg ha-1) + FYM @ 5 t ha-1] were promising for realizing best aerobic rice grain yield and improved the rice soil health status. Aerobic rice system may be recommended in upland situation of red and laterite areas. In recent years, uneven distribution, erratic pattern and irregular rains due to climate change (global warming) has limited rice cultivation. Aerobic rice cultivation is a sustainable rice production methodology for immediate future to address water scarcity and environmental safety arising due to global warming. Aerobic rice is the rice for the future.

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