Original Research Article

Productivity of aerobic rice under different lateral arrangement and nutrient management

Abstract

A title experiment to asses the **“Productivity and economic feasibility of lateral arrangement and nutrient management in aerobic rice”** was conducted at the Instructional-cum-Research Farm, I.G.K.V, Raipur, (C.G.) during *kharif* season of 2018. The soil of experimental field was clayey (*Vertisols*) in texture. The trial was laid out in strip plot design *viz.*, horizontal strips consist 3 lateral arrangements and vertical strips consist 4 nutrient management with 12 treatment combinations. The treatments consisted of 3 lateral arrangement M_1- lateral at 25 cm (1 LPH/0.3 metre spacing), M_2- lateral at 50 cm (2 LPH/0.3 metre spacing) and M_3- conventional practice and 4 nutrient management of N_1- 50 % RDF, N_2 - 100 % RDF, N_3 - 150 % RDF and N_4 - STCR- based fertilizer recommendation. Aerobic rice variety Indira aerobic -1 was used for trial. The sowing was done on 20th June, 2018 at 20 cm of spacing and harvesting of crop was done on 7th October, 2018.

The results of trial revealed that the growth parameters like plant height (cm), number of leaves hill^{-1}, dry matter accumulation hill^{-1} (g), number of tillers (m^{-2}) and grain yield (t ha^{-1}) were significantly higher under lateral arrangement at 25 cm (M_1). However, lowest value of all these parameters were obtained in conventional practice (M_3). Similarly, all these characters were also higher among nutrient management with application of STCR based fertilizer (N_4). Remarkably, lowest values were obtained with application of 50 % RDF (N_1).

Keywords: Aerobic rice; STCR; Conventional; Yield; Test weight

Introduction

Rice (*Oryza sativa* L.) crop is the most important staple cereal crop of more than 65% population in Asia and it comes in second position among the food crops after wheat. This grain crop provides 20 percent of world's dietry energy supply, while maize and wheat crops supplies 5 and 19 percent, respectively. In Asia, more than 2 billion peoples are consuming about 60-70 % of their energy requirement and derived products from rice crop (Geethalakshmi *et al*., 2011). It cover more than 85 per cent of total production that is consumed by human being however, it deserves a prime place among cereals as world's most important wetland crop.

The scarcity of water resources and competition with other sectors, the contribution of water for irrigation purpose is decreased by 10 to 15 per cent in the next 2 decennium. Over the past decade, In globally we are suffering for water scarcity and competition for water. As the water demand for municipal, domestic, environmental and industrial purposes rises in the near future, thus water availability for agriculture sector gets affected. Water status for agriculture purpose is estimated about 83.3 per cent of total water used today, will shrink to 71.6 per cent in 2025 and to 64.6 per cent in 2050 (Yadav, 2002). Rice is a high water requirement crop which requires 3000- 5000 litres of water to produce one kg of grain which is almost 2 to 3 times higher than any other cereal crops like wheat, maize (Cantrell and Hettel, 2004). In this case, One of the ways that we need to increase water use efficiency. Several techniques of water saving have been developed for rice crop such as, saturated soil culture, alternate wetting and drying method (Tabbal *et al.* 2002), system of rice intensification and raised bed system to lower the water requirements of the rice crop. Basically, Rice prefer in more water and flooded condition, but recent technologies and developments demonstrate showing that rice can be also grown in dry soils under less water conditions which is called aerobic rice. The water productivity of rice under aerobic conditions was 32-88% higher than under flooded conditions. Aerobic rice is defined as a production system in which, direct seeding of high yielding and input responsive rice cultivars with aerobic adaptation grown in non-puddle, non-flooded and non-saturated soil during the entire growing cycle.

Drip irrigation, also known as trickle irrigation is an irrigation method that applies water slowly to the root zone of plants, through a network of valves, pipes, tubes and emitters. The goal is to optimize water and input usage. Application of water-soluble fertilizers (WSF) through irrigation as a carrier improving nutrient use efficiency. Thus nutrients in the irrigation water will likely placed directly to the root zone of crop (Clark *et al.* 1991). Fertigation is the precise application of water soluble fertilizer through sprinkler and drip irrigation. It is an efficient and agronomically sound method of providing soluble plant nutrients directly to the active plant root zone. Fertigation is a new agricultural technique, which supplies water and fertilizer simultaneously (Castellanos *et al.* 2012; Mahajan and Singh, 2006). It can supply fertilizer and water at right time and right place thus, improve water-use efficiency and uptake of nutrients.

Drip fertigation permits application of nutrients directly at the site of high on centration of active roots. Since nutrients are applied to a limited soil volume, the fertilizer use efficiency is also high. Adoption of micro irrigation might help in increasing the irrigated area, productivity of crops, water use efficiency and also achieve more weed control efficiency (83 %) by making non-availability of irrigation water to the weeds (Sivanappan, 2004). On the other hand, conventional fertilization especially on light soils may cause huge nutrient losses through leaching, percolation and volatilization.

Material and Methods

The field experiment was conducted during *kharif season* from 20 June 2018 to 7th October 2018 at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The experimental site is situated at between at 21^{o}4' N latitude and 81^{o}35' E longitude at the height of 290.20 m above the mean sea lined (MSL). According to data aerobic rice crop received 964.5 mm rainfall during the crop period from 20th June 2018 to 7th October 2018 and maximum temperature was varied from 31.2°C to 37.24 °C, while minimum temperature varied from 24.53 °C to 27.13°C. Relative humidity throughout the crop season during 2018 was varied between 70 to 95 percent. The open pan evaporation mean values ranged from 21.50 to 28.0 mm day^{-1} whereas, average sunshine hours varied from 1.8 to 8.36 hours day^{-1}. The average wind velocity varied from 0.88 to 8.01 km hr^{-1} of crop season during 2018 for different weeks. Soil type of the experimental field is texturally clay, *Vertisols* and locally known as *"kanhar"*. Indira aerobic-1 variety of aerobic rice maturing in about 115-120 days was sown with a spacing of 20 cm in rows. The experiment was consist 12 treatments with three replications. The treatments were divided into horizontal and vertical strip with strip plot design. The horizontal strips were divided into two lateral arrangement and one conventional method of irrigation and vertical strip was further divided into four fertigation levels. Horizontal strips consists viz., M_1- Lateral at 25 cm (1 LPH/0.3 Meter spacing), M_2- Lateral at 50 cm (2 LPH/0.3 Meter spacing), M_3- conventional practice (surface irrigation) and Vertical strips consists N_1- 50 % RDF, N_2 - 100 % RDF (100:60:40) kg ha^{-1} ($N:P_2O_5:K_2O$), N_3- 150 % RDF, N_4- STCR based fertilizer recommendation (for 7 tonnes). The sowing was taken up on June 20th, 2018 by maintaining the intra and inter row spacing of 20 cm with seed rate of 80 kg ha^{-1}. Immediately after sowing the seeds are covered with soil with the help of planking. Water soluble fertilizers used were Urea, Phosphoric acid (PA) and Murate of potash (MOP) as N, P and K sources, respectively. The experimental data recorded were subjected to analysis by using Fisher's method of Analysis of Variance (ANOVA). The levels of significance used in F and t test was a p=0.05.

Results and Discussion

Growth attributes

The growth attributes of aerobic rice influenced by lateral arrangement and nutrient management and are presented in (Table 3). Among lateral arrangement, lateral at 25 cm (1 LPH/0.3 meter distance, M_1) recorded higher plant height, number of tillers m^{-2}, total dry matter production hill^{-1}, number of leaves hill^{-1}, Leaf area hill^{-1}, Leaf area index, Plant population (114.58 cm, 495.83 m^{-2} and 44.13 g hill^{-1}, 40.50, 1094.67, 5.47, 80.83 respectively). This is might be due to application of water and nutrients through drip fertigation directly to the root zone make them easily available and also maintaining moist condition around root zone, which creates favourable environment for roots to grow and absorb water and nutrients more effectively help in increasing number of tillers, leaves, total dry matter production and increasing plant height. These results are in conformity with the findings of (Hebbar *et al.*, 2004) and (Gururaj, K. 2013). Among nutrient management significantly higher plant height, number of tillers m^{-2}, total dry matter production hill^{-1} number of leaves hill^{-1}, Leaf area hill^{-1} and Plant population were observed with the application of STCR based fertilizer recommendation (N_4) (113.56 cm, 519.33 m^{-2}, 45.58 g hill^{-1}, 42.89, 1108.48, 80.0 respectively). This is mainly because application of fertlizers through drip irrigation resulted in continuous supply of nutrients besides maintaining optimum water availability which leads to higher uptake of nutrients which in turn recorded higher growth attributes. (Gururaj, K. 2013). Further, significantly higher plant height, number of tillers m^{-2}, total dry matter production $hill^{-1}$, number of leaves $hill^{-1}$, Leaf area $hill^{-1}$, Leaf area index and Plant population in fertigation treatments over surface irrigation resulted in the production of higher plant biomass that could be attributed for higher plant growth parameters under drip fertigation treatments. Such finding is in conformity with the findings of (Hebbar *et al.*, 2004) in tomato; (Vijaykumar 2009) in rice and (Soman, P. 2012) in rice. However, low values of these parameters observed under conventional practices (M_3) and application of 50 % RDF.

Significant difference on number of tillers m^{-2} (at harvest) was observed due to interaction of lateral arrangement and nutrient management and data are presented in Table 2. Lateral at 25 cm (1 LPH/0.3 meter distance, M_1) with the application of 150 % RDF (N_3) has recorded significantly higher number of tillers, which was statistically at par with Lateral at 25 cm (1 LPH/0.3 meter distance, M_1) with the application of STCR based fertilizer (N_4) and Lateral at 50 cm (2 LPH/0.3 meter distance, M_2) with N_3 and N_4 treatment. This is might be due to application of water and nutrients directly to the root zone make them easily available and also maintaining moist condition around root zone, which creates favourable environment for roots to grow and absorb water and nutrients more effectively help in increasing number of tillers and significantly lower number of tillers was observed under conventional practices (M_3) with the application of 50 % RDF (N_1).

Yield and Yield parameters

Yield contributing characters of aerobic rice *viz.*-, total no. of panicles m^{-2}, total number of grains $panicle^{-1}$, Test weight (1000 grain weight in gm) were found significantly higher except test weight influenced by nutrient management (Table 3). The yield revealed that the significant result was found in grain yield of aerobic rice (Table 4). Among lateral arrangement, lateral at 25 cm (1 LPH/0.3 meter distance, M_1) recorded higher grain yield (6.35 t ha^{-1}). It is 28% higher than conventional practice and lower values of grain yield was found in conventional practices (M_3). Drip fertigation in aerobic rice improved the availability of nutrients in the root zone for plant uptake leading to better growth and development of plants and dry matter accumulation. The improved dry matter production enhanced grain yield in drip fertigation treatments. Under Closer lateral spacing better prevalence of soil moisture and nutrients are more easily available to plant than broader lateral spacing. Hence, better availability of nutrients under M_1 led to more uptake and better growth and development of plants which resulted in remarkably higher grain yield of aerobic rice.

Among nutrient management, Higher grain yield (6.19 t ha^{-1}) was found with the application of STCR based fertilizer (N_4) which is 24% higher than application of 50% RDF (N_1). Higher grain yield may be due to its superiority in producing higher productive tillers $hill^{-1}$, No. of panicles $hill^{-1}$, 1000-seed weight and total number of filled grains $panicle^{-1}$ with lower values of sterility percentage than the other treatment. The lower values of grain yield were registered with the application of 50 % RDF (N_1). The highest yield and yield attributes in STCR might be due to the fact that soil testing helps the farmers to use fertilizers according to needs of crop. Fertilizer use for targeted yield is an approach, which takes into account the crop needs and nutrients present in the soil. The treatment with STCR based fertilizer application realized the target yield and closely accorded with those reported by (Ray *et al.,* 2000), (Meena *et al.,* 2001) and (Ramesh and Chandrashekaran, 2007).

Significant difference on test weight (gm) was observed due to interaction of lateral arrangement and nutrient management and data are presented in Table 1. Lateral at 25 cm (1 LPH/0.3 meter distance, M_1)

with the application of STCR based fertilizer (N_4) was recorded significantly highest test weight, which was statistically at par with all combination of treatment except Lateral at 50 cm (2 LPH/0.3 meter distance, M_2) with (N_1), (N_2) and conventional practices (M_3) with (N_1) treatments. The lower test weight was observed under conventional practices (M_3) with the application of 50 % RDF (N_1).

Table 1: Interaction between lateral arrangement and nutrient management on Test weight (g) of aerobic rice.

Lateral arrangement	Nutrient management				
	N_1	**N_2**	**N_3**	**N_4**	**Mean**
M_1 : Lateral at 25 cm	20.56	23.28	23.62	23.85	22.83
M_2 : Lateral at 50 cm	20.14	20.24	22.13	23.48	21.50
M_3 : Conventional practice	19.68	20.60	21.69	22.06	21.01
Mean	20.13	21.37	22.48	23.13	
				SEm±	**CD (P=0.05)**
Two horizontal strip means at the same level of vertical strip				**0.42**	**1.43**
Two vertical strip means at the same level of horizontal strip				**1.02**	**3.49**

Table 2: Interaction between lateral arrangement and nutrient management on No. of tillers m^{-2} (At harvest) of aerobic rice.

Lateral arrangement	Nutrient management				
	N_1	**N_2**	**N_3**	**N_4**	**Mean**
M_1 : Lateral at 25 cm	437.67	451.00	559.33	535.33	495.83
M_2 : Lateral at 50 cm	412.67	443.00	526.67	535.33	479.42
M_3 : Conventional practice	399.67	431.33	432.67	487.33	437.75
Mean	416.67	441.78	506.22	519.33	
				SEm±	**CD (P=0.05)**
Two horizontal strip means at the same level of vertical strip				**18.63**	**65.8**
Two vertical strip means at the same level of horizontal strip				**14.39**	**46.0**

Fig. 1. A general view experimental site of aerobic rice as influenced by lateral arrangement and nutrient management.

Fig 1: A view of experimental field of aerobic rice

Table 3: Growth attributes of aerobic rice influenced by lateral arrangement and nutrient management

Treatment	Plant height (cm) at harvest	No. of tillers (m^{-2}) at harvest	Total dry matter production ($hill^{-1}$) at harvest	No. of leaves $hill^{-1}$ at harvest	Leaf area $hill^{-1}$ (cm^2) at 90 DAS	Leaf area index at 90 DAS	Plant population (m^{-2})
Lateral Arrangement							
M_1: Lateral at 25 cm (1LPH/0.3 MD)	114.58	495.83	44.13	40.50	1094.67	5.47	80.83
M_2: Lateral at 50 cm (2LPH/0.3 MD)	109.50	479.42	38.58	37.33	1032.11	5.16	75.58
M_3: Conventional practice	104.25	437.75	31.83	33.08	950.01	4.75	74.00
SEm ±	**1.86**	**13.68**	**0.70**	**0.55**	**25.69**	**0.12**	**1.29**
CD (P=0.05)	**7.30**	**53.73**	**2.75**	**2.19**	**100.89**	**0.50**	**NS**
Nutrient Management							
N_1: 50 % RDF	103.44	416.67	28.04	26.00	904.82	4.52	73.00
N_2: 100% RDF	107.22	441.78	37.18	37.67	975.15	4.88	75.22
N_3: 150 % RDF	113.56	506.22	41.91	41.33	1113.94	5.57	79.00
N_4: STCR based (for 7 tonnes)	113.56	519.33	45.58	42.89	1108.48	5.54	80.00
SEm ±	**2.07**	**8.07**	**0.75**	**1.89**	**27.96**	**0.14**	**0.90**
CD (P=0.05)	**7.16**	**27.93**	**2.58**	**6.53**	**96.77**	**0.48**	**NS**
Int (WXN)	**S**	**S**	**S**	**S**	**S**	**S**	**NS**

*MD = Distance of emitter (in meter)

Table 4: Yield and Yield Parameters of aerobic rice influenced by lateral arrangement and nutrient management

Treatment	Grain yield (t ha^{-1})	No. of panicles m^{-2}	No. of grains panicle^{-1}	Test weight (g)	Sterility (%)
Lateral Arrangement					
M_1: Lateral at 25 cm (1LPH/0.3 MD)	6.35	314.58	177.58	22.83	14.02
M_2: Lateral at 50 cm (2LPH/0.3 MD)	5.96	265.83	163.25	21.50	15.28
M_3: Conventional practice	4.93	226.08	134.00	21.01	13.73
SEm ±	**0.09**	**13.42**	**1.71**	**0.26**	**0.60**
CD (P=0.05)	**0.38**	**52.70**	**6.75**	**1.04**	**NS**
Nutrient Management					
N_1: 50 % RDF	4.97	199.44	125.22	20.13	16.56
N_2: 100% RDF	5.68	231.22	139.56	21.37	15.10
N_3: 150 % RDF	6.14	300.89	173.89	22.48	12.49
N_4: STCR based (for 7 tonnes)	6.19	343.78	194.44	23.13	13.22
SEm ±	**0.11**	**11.81**	**3.27**	**0.97**	**0.84**
CD (P=0.05)	**0.40**	**40.86**	**11.33**	**NS**	**2.90**
Int (WXN)	**S**	**S**	**S**	**S**	**S**

*MD = Distance of emitter (in mete

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