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Effect of Planting Geometry and Fertilizer Levels on Yield Parameters and Economics of Aerobic Rice under Drip Fertigation

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ABSTRACT

Studies on effect of planting geometry and fertilizer levels on yield parameters and economics of aerobic rice under drip fertigation was conducted during Kharif 2014 at ZARS, UAS, GKVK, Bengaluru. Experiment was laid out in a factorial concept of randomized complete block design with 13 treatments which are replicated thrice. The treatments constitutes 50 per cent of RDF through Drip fertigation (F_1), 75 per cent of RDF through Drip fertigation (F_2), 100per cent of RDF through Drip fertigation (F_3) and four planting geometry 25 cm x 10 cm, 25 cm x 15 cm, 25 cm x 20 cm and 25 cm x 25 cm, with a control i.e., planting geometry of 25 cm X 25 cm with surface irrigation and soil application of RDF. The results revealed that, 100 per cent RDF through drip fertigation has recorded significantly higher productive tillers (601.73 m^{-2}), grain (6115kg ha^{-1}) and straw yield (8792 kg ha^{-1}). Planting geometry of 25 cm x 15 cm recorded significantly higher productive tillers (516.61 m^{-2}), grain (5954 kg ha^{-1}) and straw yield (8297 kg ha^{-1}). Interaction of planting geometry of 25 cm x 15 cm with 100 per cent RDF through drip fertigation has recorded significantly higher productive tillers (719.47 m^{-2}), grain (6762 kg ha^{-1}) and straw yield (9186 kg ha^{-1}). The planting geometry of 25 cm x 15 cm with 100 per cent RDF through drip fertigation recorded higher gross, net returns and B: C ratio (₹121977, ₹75814 ha^{-1} and 2.64, respectively).

Key words: *Planting geometry, Fertigation, Drip, Aerobic rice*

INTRODUCTION

Rice is the world's most important food crop and primary source of food for more than half of the world's population; it occupies the enviable prime place among the food crops after wheat. It is grown in six continents and in more than 100 countries. It is cultivated in different ecosystems in many ways. It is the main source of carbohydrate, protein and calories for large section of population. More than 90 per cent of the world's rice is produced and consumed in Asia, where 60 per cent of the earth's population lives. In the world, rice occupies an area of 147 million hectare with a production of 525 million tonnes.

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In India, it is grown in an area of 46.19 million hectare with a production of 106.29 million tonnes and productivity of 2462 kg ha^{-1}. In Karnataka, rice is grown in an area of 1.34 million hectares with an annual production of 3.95 million tones with productivity of 3098 kg ha^{-1}[1]. Rice consumes around 4000-5000 litres of water to produce one kg grain, which is three times higher than other cereals[1]. Rice is a semi- aquatic plant and the farmers are habituated to irrigate as much water as possible through continuous land submergence based on a wrong notion that yield could be increased with increased water use. Traditional rice production system not only leads to wastage of water but also causes environmental problems and reduces fertilizer use efficiency. Attempts to increase water productivity either by reducing water consumption or by increasing the yields will automatically facilitate higher growth in agricultural production, as substantial quantity of saved water could be used to irrigate other areas[5]. Further, anaerobic condition favours the release of greenhouse gasses specially methane, contributing to climate change.The fact that rice is the only cereal which can grow in deep water does not necessarily mean rice plants must be grown only in ponded water. Now we are under pressure to develop water saving technologies in rice. Saturated soil culture, intermittent irrigation, alternate wetting and drying and aerobic rice are irrigation related technologies which save waterin rice. Rice does develop well in water, but recent developments demonstrate that rice can also be grown in dry soils under non flooded conditions called “Aerobic rice”.Fertigation is the judicious application of fertilizers through irrigation water, to increase efficient use of water and fertilizers, increase yield, protect environment and sustain irrigated agriculture. Drip and other micro-irrigation systems, which are highly efficient for water application, are ideally-suited for fertigation. Water-soluble fertilizers (WSF) at concentrations required by crops are conveyed *via* the irrigation stream to the wetted volume of soil. Thus the distribution of nutrients in the irrigation water will likely place these nutrients in the desired root zone[3]. In a drip-fertigation system uptake of N, P and K are substantially improved. In this respect per unit of fertilizer and water applied, higher yield and better quality are obtained[6]. At present, rice information on the suitability of fertigation levels and planting geometry in aerobic cultivation is meagre. Plant geometry in rice has a direct role on the grain yield, since it is an important yield parameter maintaining inadequate or excess plant population often leads to reduction in yield[4]. So finding out the optimum plant population per unit area under different levels of drip fertigation is of major importance.

MATERIAL AND METHODS

The experiment was conducted at Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bengaluru situated in the Eastern Dry Zone of Karnataka (Zone -5). The experimental site was located between 12º 51' N latitude and 77º 35' E longitude at an altitude of 930 m above mean sea level (MSL) to know the Effect of planting geometry and fertilizer levels on growth parameters of aerobic rice under drip fertigation.The experiment was laid out in a factorial concept of randomized complete block design with 13 treatments which are replicated thrice. The treatments constitutes 50 per cent of RDF through Drip fertigation (F_1), 75 per centof RDF through Drip fertigation (F_2), 100per cent of RDF through Drip fertigation (F_3) and four planting geometry 25 cm x 10 cm, 25 cm x 15 cm, 25 cm x 20 cm and 25 cm x 25 cm, with a control i.e., planting geometry of 25 cm X 25 cm with surface irrigation and soil application of RDF. The soil of the experimental site was red sandy clay loam with neutral in reaction (pH 7.1) and medium in available nitrogen (356.3 kg ha^{-1}), available phosphorus (23.8 kg ha^{-1}) and available potassium (256.4 kg ha^{-1}) with a gross plot 4.5 m X 6.0 m = 27.0 m^2 and net plot: 3.5 m X 3.0 m = 10.50 m^2. The recommended dose of fertilizer 100:50:50 kg NPK ha^{-1}.

RESULT AND DISCUSSION

The results of the study entitled "Effect of planting geometry and fertilizer levels on yield parameters of aerobic rice under drip fertigation" conducted at ZARS, University of Agricultural Sciences, GKVK, Bengaluru during *Kharif* 2014 are as follows

Yield parameters:

The application of fertilizer in different levels through drip fertigation showed the significant differences in yield parameters viz. The 100 per cent RDF through drip fertigation recorded significantly higher number of productive tillers (601.73 m^{-2}), grain yield (31.72 g hill^{-1}), panicle weight (3.03 g), 1000 grain weight (23.11 g), grain yield (6155 kg ha^{-1}) and straw yield (8792 kg ha^{-1}) and significantly lower number of productive tillers (330.5 m^{-2}), grain yield (15.66 g hill^{-1}), panicle weight (2.39 g), 1000 grain weight (20.63 g), grain yield (4823 kg ha^{-1}) and straw yield (6927 kg ha^{-1}) was recorded in 50 per cent RDF through drip fertigation (Table 1).Planting geometry of 25 cm x 15 cm recorded significantly higher productive tillers (516.61 m^{-2}), grain yield (5924 kg ha^{-1}), straw yield (8297 kg ha^{-1}) and total dry matter production (2663.6 g m^{-2}) as compared to planting geometry of 25 cm x 25 cm (2031.5 g m^{-2}). The planting geometry of 25 cm x 15 cm and 25 cm x 10 cm and 25 cm x 20 cm were found statistically on par with each other (2663.6, 2316.8 and 2356.4 g m^{-2}, respectively).Significant difference in yield parameters was observed due to interaction of planting geometry and fertilizer levels. Planting geometry of 25 cm x 15 cm with 100 per cent RDF through drip fertigation has recorded significantly higher productive tillers (719.47), straw yield (9186 kg ha^{-1}) and grain yield (6762 kg ha^{-1}) which is on par with 25 cm x 10 cm with 100 per cent RDF (8914 kg ha^{-1}), 25 cm x 20 cm with 100 per cent RDF (8671 kg ha^{-1}) and 25 cm x 25 cm with 100 per cent RDF (8389 kg ha^{-1}). Significantly lower yield (6356 kg ha^{-1}) was observed in control i.e. 25 cm x 25 cm with surface irrigation and soil application of RDF which was on par with 25 cm x 10 cm with 50 per cent RDF (6475 kg ha^{-1}). The planting geometry of 25 cm x 25 cm with 100 per cent RDF has recorded higher panicle weight (3.17 g panicle^{-1}), test weight (23.98 g) and grain yield (34.75 g hill^{-1}) compared other treatments. Economic yield is expressed as a function of number of grains per panicle, grain weight per panicle, 1000 grain weight, and number of panicles meter square. Planting geometry of 25 cm x 15 cm has recorded significantly higher grain yield (5954 kg ha^{-1}) as compare to 25 cm x 25 cm (5168 kg ha^{-1}). The higher grain yield with rectangular planting geometry might be due to number of panicles per meter square (516.61), Total dry matter per meter square, number of tillers per meter square followed by 25 cm x 25 cm. Planting geometry of 25 cm x 15 cm will accommodate more number of plants per unit area than 25 cm x 25 cm and provide optimum space for light interception, nutrient absorption and weed suppression. Hence the higher yield is observed in case of planting geometry of 25 cm x 15 cm. These results are in accordance with the findings of Ray *et al*.[7] and Sultana *et al*[8]. The grain yield is dependent on photosynthetic source, which could build up a sound source in terms of plant height and number of tillers and hold the leaves for longer period and to increase total dry mater and later leading to higher grain yield. Yield parameters differed significantly in different planting geometry. The plant spacing of 25 cm x 25 cm recorded higher Panicle weight (2.84 g panicle^{-1}), test weight (22.01g) and grain yield (27.12

g hill^{-1}) as compared to 25 cm x 15 cm and 25cm x 10 cm spacing's. This was because of efficient utilization of growth resources, less intra plant competition coupled with higher availability of nutrients. Similar findings were opined by Baloch *et al*.[2] and Umair Ashraf *et al*.[9]. The wider spacing adopted appears to be an advantageous factor for better development of panicles, hence more panicle weight, test weight and grain yield per hill is observed. However, the plant geometry 25 cm x 15 cm shown maximum number of tillers and higher total dry matter. The straw and grain yields were significantly higher in 25 cm x 15 cm . This might be due to cumulative influence of higher plant population, more leaf area index, more of light interception and higher number of effective tillers per meter square and higher total dry matter per meter square, resulting in increased grain and straw yield. Similar results were in accordance with Sultana *et al*[8].

Economics

The data on economics of drip fertigated aerobic rice as influenced by planting geometry and fertilizer levels treatments under study are presented in Table 2.The treatments with 100 per cent RDF through drip fertigation with normal fertilizer under different planting geometries i.e. 25 cm x 10 cm, 25 cm x 15 cm, 25 cm x 20 cm and 25 cm x 25 cm has registered higher cost of cultivation (₹ 46293, 46163, 46106 and 46068 ha^{-1}, respectively), followed by drip fertigation with 75 per cent RDF under different planting geometries i.e. 25 cm x 10 cm, 25 cm x 15 cm, 25 cm x 20 cm and 25 cm x 25 cm (₹ 45291, 45161, 45104 and 45066 ha^{-1},respectively) and lower cost of cultivation was observed in drip fertigation with 50 per cent RDF under different planting geometries i.e. 25 cm x 10 cm, 25 cm x 15 cm , 25 cm x 20 cm and 25 cm x 25 cm (₹ 44288, 44158, 44101 and 44063 ha^{-1}, respectively). However, the cost of cultivation was found least under 25 cm x 25 cm with surface irrigation and soil application of RDF (₹ 36468 ha^{-1}).Gross returns were ultimately the result of grain yield and straw yield of different treatments. Planting geometry of 25 cm x 15 cm with 100 per cent RDF through drip fertigation has higher gross returns (₹ 121977) fallowed by 25 cm x 10 cm with 100 per cent RDF (₹ 111057) However, least gross returns were obtained in 25 cm x 25 cm with surface irrigation with soil application of RDF (₹ 73983ha^{-1}).Application of 100 per cent RDF with planting geometry of 25 cm x 15 cm in which had given higher net returns of ₹75814 ha^{-1} followed by 100 per cent RDF with planting geometry of 25 cm x 10 cm (₹ 64764 ha^{-1}) and 100 per cent RDF with planting geometry of 25 cm x 20 cm (₹ 62815 ha^{-1}). Generally the treatments with 100 per cent RDF through drip fertigation recorded higher net returns as compared to treatments with 75 per cent and 50 per cent RDF through drip fertigation. However, least net returns were obtained in planting geometry of 25 cm x 25 cm with surface irrigation with soil application of RDF (₹ 37515 ha^{-1}).The treatment planting geometry of 25 cm x 15 cm with 100 per cent RDF through drip fertigation recorded higher B:C ratio of 2.64, followed by planting geometry of 25 cm x 10 cm with 100 per cent RDF(2.40) and 25 cm x 20 cm with 100 per cent RDF (2.36). Generally the treatments with 100 per cent RDF had given higher B:C ratio as compared to other treatments and planting geometry of 25 cm x 15 cm has recorded higher B:C ratio compare to other planting geometries under different levels of fertilizers. However, least B:C ratio was obtained in planting geometry of 25 cm x 10 cm with 50 per cent of RDF through drip fertigation (1.84).

Table 1: Yield parameters of aerobic rice as influenced by planting geometry and fertilizer levels under drip fertigation at maturity

Treatments	No. of Productive Tillers (No. m^{-2})	Grain yield (g $hill^{-1}$)	panicle weight (g)	1000 grain weight	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Fertilizer levels (F)						
F_1	330.55	15.66	2.39	20.63	4823	6927
F_2	424.69	24.54	2.71	21.18	5538	7811
F_3	601.73	31.72	3.03	23.11	6155	8792
S.Em ±	12.45	1.31	0.019	0.08	226	243
CD at 5 %	36.35	3.82	0.055	0.233	661	708
Planting geometry (S)						
S_1	447.7	20.94	2.59	21.24	5416	7750
S_2	516.61	23.07	2.73	21.63	5954	8297
S_3	450.84	24.77	2.67	21.68	5482	7863
S_4	394.13	27.12	2.84	22.01	5168	7463
S.Em±	14.38	1.51	0.022	0.092	261	280
CD at 5 %	41.97	4.41	0.063	0.269	762	817
Interactions (F x S)						
F_1S_1	283.84	11.63	2.32	20.5	4487	6475
F_1S_2	377.67	14.99	2.37	20.53	5349	7370
F_1S_3	342.93	16.85	2.39	20.77	4966	7268
F_1S_4	317.76	19.16	2.48	20.73	4489	6596
F_2S_1	432.6	22.01	2.51	21	5656	7861
F_2S_2	452.69	23.87	2.68	21.17	5753	8336
F_2S_3	411.73	24.83	2.77	21.23	5487	7651
F_2S_4	401.73	27.44	2.88	21.3	5254	7394
F_3S_1	626.67	29.16	2.9	22.2	6105	8914
F_3S_2	719.47	30.35	2.94	23.1	6762	9186
F_3S_3	597.87	32.63	3.1	23.17	5994	8671
F_3S_4	462.91	34.75	3.17	23.98	5759	8398
Control	248.8	10.25	2.29	19.6	4028	6356
S.Em±	24.91	2.61	0.037	0.159	452	485
CD at 5 %	72.7	7.63	0.109	0.465	1321	1416
CV (%)	9.11	11.25	4.36	5.45	12.42	10.03

Note: Fertilizer levels **(F)**: **F_1**: 50 per cent RDF, **F_2**: 75 per cent RDF, **F_3**: 100 per cent RDF.
Planting geometry **(S): S_1**: 25 cm x 10 cm, **S_2**: 25 cm x 15 cm, **S_3**: 25 cm x 20 cm, **S_4**: 25 cm x 25 cm.
RDF- Recommended dose of fertilizers (100:50:50 kg NPK ha^{-1}.

Table 2: Economics of aerobic rice as influenced by planting geometry and fertilizer levels under drip fertigation

Treatments	Cost of cultivation (₹ha^{-1})	Gross returns (₹ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
T_1: S_1 - 25 cm X 10 cm + (F_1) 50 % of RDF through Drip fertigation.	44288	81499	37211	1.84
T_2: S_1 - 25 cm X 10 cm + (F_2) 75 % of RDF through Drip fertigation.	45291	102304	57013	2.26
T_3: S_1 - 25 cm X 10 cm + (F_3) 100 % of RDF through Drip fertigation.	46293	111057	64764	2.40
T_4 :S_2 - 25 cm X 15 cm + (F_1) 50 % of RDF through Drip fertigation.	44158	96641	52483	2.19
T_5 :S_2 - 25 cm X 15 cm + (F_2) 75 % of RDF through Drip fertigation.	45161	104556	59395	2.32
T_6 :S_2 - 25 cm X 15 cm + (F_3) 100 % of RDF through Drip fertigation.	46163	121977	75814	2.64
T_7 :S_3 - 25 cm X 20 cm + (F_1) 50 % of RDF through Drip fertigation.	44101	90374	46273	2.05
T_8 :S_3 - 25 cm X 20 cm + (F_2) 75 % of RDF through Drip fertigation.	45104	99274	54170	2.20
T_9 : S_3 - 25 cm X 20 cm + (F_3) 100 % of RDF through Drip fertigation	46106	108921	62815	2.36
T_{10}: S_4 - 25 cm X 25 cm + (F_1) 50 % of RDF through Drip fertigation.	44063	81729	37666	1.85
T_{11}: S_4 - 25 cm X 25 cm + (F_2) 75 % of RDF through Drip fertigation.	45066	95169	50103	2.11
T_{12}: S_4 - 25 cm X 25 cm + (F_3) 100 % of RDF through Drip fertigation.	46068	104743	58675	2.27
T_{13}: Control i.e., Spacing of 25 cm X 25 cm with surface irrigation.	36468	73983	37515	2.03

Note: Fertilizer levels **(F)**: **F_1**: 50 per cent RDF, **F_2**: 75 per cent RDF, **F_3**: 100 per cent RDF. **RDF**: Recommended dose of fertilizers (100:50:50 kg NPK ha^{-1}).
Planting geometry **(S): S_1**: 25 cm x 10 cm **S_2**: 25 cm x 15 cm, **S_3**: 25 cm x 20 cm, **S_4**: 25 cm x 25 cm. **B:C-** Benefit cost ratio.

CONCLUSION

This study conducted field experiment at Zonal agricultural research station, GKVK, Bengaluru using four different planting geometry and fertilizer level treatments. Experimental results shows that Application of 100 per cent RDF through drip fertigation recorded significantly higher grain and straw yield (6115 and 8792 kg ha^{-1}) .Planting geometry significantly influences the grain and straw yield, significantly higher grain and straw yield (5954 and 8297 kg ha^{-1}) was noticed in 25 cm x 15 cm and significantly lower grain and straw yield (5168 and 7463 kg ha^{-1}) observed in 25 cm x 25 cm spacing. Planting geometry of 25 cm x 15 cm with 100 per cent RDF through drip fertigation recorded significantly higher grain and straw yield of aerobic rice (6762 and 9186 kg ha^{-1}, respectively). The planting geometry of 25 cm x 15 cm with 100 per cent RDF through drip fertigation recorded higher gross, net returns and B:C ratio (₹121977, ₹75814 ha^{-1} and 2.64, respectively) and lowest was recorded in control i.e. planting geometry of 25 cm x 25 cm with surface irrigation with soil application of RDF (₹ 73983, ₹37515 ha^{-1} and 2.03). Hence the planting geometry of 25 cm x 15 cm with 100 per cent RDF through drip fertigation in aerobic rice can be recommended for farmers to obtain higher yield and higher returns by utilizing the resource efficiently.

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