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Research Article

EFFECT OF WATER SOLUBLE FERTILIZERS ON GROWTH AND YIELD OF DRIP IRRIGATED AEROBIC RICE

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Abstract- Experiment was laid out to know the effect of water soluble fertilizers on drip irrigated aerobic rice at Zonal Agricultural Research Station, Bengaluru during *Kharif* 2012. Drip fertigation at 1.5 PE up to maturity with 100 % RDF through WSF registered significantly higher plant height (53.6 cm), leaf area (3529 cm^2), total dry matter (118.4 g $hill^{-1}$), productive tillers (27.77 $hill^{-1}$), panicle weight (4.23 g) total grains $panicle^{-1}$ (170.80) which resulted in higher grain yield (6598 kg ha^{-1}) and accounted 90.3 % increase in grain yield over surface irrigation with 100 % RDF. The same treatment also recorded higher water productivity of 78.2 kg-ha cm^{-1} by using only 844.4 mm of water. Hence, it is concluded that drip fertigation at 1.5 PE up to maturity with 100 % RDF through WSF found optimum for higher yield with reduced water use over surface irrigation.

Keywords- Aerobic rice, Drip Irrigation, Water Soluble Fertilizers, Water productivity.

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Introduction

Rice being an important staple food crop in Asia and it occupies the enviable prime place among the food crops after wheat. As a world's most important wetland crop, it is having prime role among cereals. Out of total rice produced, 85 per cent diverts for human consumption [2].

Rice and rice based systems are predominant in Indian agriculture. Rapid degradation of rice ecologies due to imbalanced use of fertilizers and unscientific water management has put tremendous pressure on the rice growers to make rice farming economically viable and ecologically sustainable. Fertilizer application in wetland rice farming is currently done manually through the soil application in split doses. The present method of fertilizer application is imprecise which leads to problems such as fluctuating nutrient supply because of its uneven fertilizer spread [5].

Rice consumes around 5000 liters of water to produce one kg of grain, which is three times higher than other cereals [3]. 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. 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. One of such attempts to apply fertilizers judiciously with less water use and sustained growth and yield of crop is drip fertigation.

Information is scanty on growing aerobic rice under drip fertigation. Hence this experiment is pioneer to assess the performance of aerobic rice by applying water soluble fertilizers along with drip irrigation.

Materials and Methods

The field experiment was conducted at the Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka during *Kharif* 2012. The soil was red sandy clay loam in nature and near neutral in reaction (pH: 6.9) and organic carbon content was high (0.60 %). The soil test results of the experimental site reveal that soil is medium in nitrogen, phosphorus and potassium, respectively. The average annual rainfall of site is around 926 mm. The field experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. In this literature, parts of the experimental results are presented as of convenience to draw conclusions.

Treatment details are as follows:

T_1:	Surface irrigation with soil application of RDF
T_2:	Drip irrigation (1.5 PE) with soil application of RDF
T_3:	Drip irrigation (1.0+1.5 PE) with soil application of RDF
T_4:	Drip fertigation (1.5 PE) with 100 % RDF through WSF
T_5:	Drip fertigation (1.5 PE) with 75 % RDF through WSF
T_6:	Drip fertigation (1.5 PE) with 50 % RDF through WSF
T_7:	Drip fertigation (1.0+1.5 PE) with 100 % RDF through WSF
T_8:	Drip fertigation (1.0+1.5 PE) with 75 % RDF through WSF
T_9:	Drip fertigation (1.0+1.5 PE) with 50 % RDF through WSF

RDF: Recommended dose of fertilizers, PE: Pan Evaporation WSF: Water soluble fertilizers, 1.5 PE: 1.5 PE up to maturity, 1.0+1.5 PE: 1.0 PE up to tillering and 1.5 PE tillering to maturity

The irrigation was given through PVC pipe after filtering through the screen filter by 7.5 HP motor from the bore well. The pressure maintained in the system was 1.2 kg cm^{-2}. From the sub main in-line laterals of 16 mm were laid at a spacing of 0.5 m with 4 lph discharge rate emitters positioned at a distance of 40 cm. Drip irrigation was scheduled based on the open pan evaporation as per the treatment requirement after subtracting effective rainfall for that period. However, surface irrigation was scheduled based on recommended package of practices.

Farm yard manure was applied before experimentation at the rate of 10 tonnes ha^{-1} to all the plots uniformly. Fertilizers were supplied to each plot as per treatment requirement. The soil application was done as per the recommendation. Out of total nutrients, 50 per cent nitrogen and the entire dose of phosphorus and potassium were applied as basal and remaining 50 per cent N in two equal splits at 30 and 60 DAS, respectively. However, drip fertigation was given in eight equal splits at eight days interval as per treatment requirement. The fertilizers used for fertigation are Urea, Di-ammonium phosphate, Muriate of potash, Calcium nitrate and 19:19:19.

The direct sowing was done in 5 cm depth with 25x25 cm spacing. The experiment was maintained as per the standard package of practice of aerobic rice cultivation [1].

Observations were made for growth and yield attributing characters from five randomly selected plants in the middle of the plot to overcome the border effect. The data obtained were subjected to statistical analysis and were tested at five per cent level of significance to interpret the treatment differences.

Water productivity was worked out from following formula:

Water Productivity = Grain yield (kg ha^{-1})/ Quantity of total water applied (cm)

Results and Discussion

Growth and yield attributes

The results from the study [Table-1] reveal that the higher plant height, leaf area hill^{-1} and total dry matter production hill^{-1} were recorded under drip fertigation at 1.5 PE up to maturity with 100 per cent RDF through water soluble fertilizers (53.6 cm, 3529 cm^2 and 118.4 g gill^{-1}, respectively) which was on par with drip fertigation at 1.5 PE up to maturity with 75 per cent RDF through water soluble fertilizers (53.4 cm, 3453 cm^2 and 114.9 g gill^{-1}, respectively) and drip fertigation at 1.0 PE up to tillering and 1.5 PE from tillering to maturity with 75 per cent RDF through water soluble fertilizers (52.1 cm, 3423 cm^2 and 113.48 g gill^{-1}, respectively). However, surface irrigation with soil application of RDF recorded significantly least plant height (47.2 cm), leaf area (1698 cm^2 hill^{-1}) and total dry matter (81.3 g hill^{-1}). 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 [4, 7].

Table-1 *Growth and yield attributes of aerobic rice under drip fertigation.*

Treatments	Plant height (cm)	Leaf area (cm^2 hill^{-1})	TDM (g hill^{-1})	Productive tillers hill^{-1}	Panicle weight (g)	Total grains panicle^{-1}	Grain yield (kg ha^{-1})	% increase in yield
Surface irrigation with soil application of RDF	47.2	1698	81.30	17.63	3.00	135.23	3467	-
Drip irrigation (1.5 PE) with soil application of RDF	48.5	2847	88.10	23.73	3.28	156.19	4567	37.83
Drip irrigation (1.0+1.5 PE) with soil application of RDF	47.5	2637	84.54	17.87	3.20	144.10	4319	26.17
Drip fertigation (1.5 PE) with 100 % RDF through WSF	53.6	3529	118.40	27.77	4.23	170.80	6598	90.30
Drip fertigation (1.5 PE) with 75 % RDF through WSF	53.4	3453	114.90	26.97	4.04	165.09	5470	60.41
Drip fertigation (1.5 PE) with 50 % RDF through WSF	50.7	3189	111.60	23.97	3.88	158.51	4917	45.85
Drip fertigation (1.0+1.5 PE) with 100 % RDF through WSF	52.1	3423	113.48	26.30	4.00	163.37	5365	60.00
Drip fertigation (1.0+1.5 PE) with 75 % RDF through WSF	51.6	3102	111.38	22.27	3.74	159.84	5131	51.45
Drip fertigation (1.0+1.5 PE) with 50 % RDF through WSF	51.0	3027	109.80	21.87	3.42	156.16	4731	42.96
S. Em±	0.57	67.73	1.85	0.90	0.06	3.03	456	NA
CD @ 5 %	1.79	206.0	5.55	2.47	0.25	9.10	1367	NA

As that of growth parameters, drip fertigation at 1.5 PE up to maturity with 100 per cent RDF through water soluble fertilizers resulted in significantly more productive tillers, panicle weight , total grains per panicle and grain yield (27.77 hill^{-1}, 4.23 g, 170.8. and 6598 kg ha^{-1}, respectively) which were on par with drip fertigation at 1.5 up to maturity with 75 per cent RDF through water soluble fertilizers (26.97 hill^{-1}, 4.04 g, 165.09 and 5470 kg ha^{-1}, respectively) and drip fertigation at 1.0 PE up to tillering and 1.5 PE from tillering to maturity with 75 per cent RDF through water soluble fertilizers (26.30 hill^{-1}, 4.0 g, 163.37. and 5365 kg ha^{-1}, respectively). This yield increment was up to 90.3 per cent as that of surface irrigation with soil application of fertilizers [Table-1]. Significantly least grain yield was recorded in surface irrigation with soil application of fertilizers (3467 kg ha^{-1}). The increase in the yield is related to higher leaf area index and crop growth rate which are contributed for assimilation of more photosynthates and resulted in superior yield attributes and yield [8-10].

Water use and Water productivity

Depending upon the varied amount of irrigation water applied in different treatments, irrigation water use, total water need of crop and water productivity also shown greater variation. Drip fertigation at 1.5 PE up to maturity with 100 % RDF through WSF recorded higher water productivity of 78.2 kg ha-cm^{-1} besides saving 39 per cent of water as compared to surface irrigation [Table-2]. Higher water use was registered with surface irrigation method (1288 mm) followed by treatments having irrigation levels at 1.5 PE up to maturity (844.4 mm) and least total water used was with 1.0 PE up to tillering and 1.5 PE up to maturity (766.4 mm).

Table-2 *Irrigation water use, total water use and water productivity of aerobic rice under drip fertigation,*

Treatments	Irrigation water use (mm)	Total water use (mm)	Water productivity (kg- ha cm^{-1})	% water saved
Surface irrigation with soil application of RDF	1150	1288.0	26.9	-
Drip irrigation (1.5 PE) with soil application of RDF	706	844.4	54.1	38.6
Drip irrigation (1.0+1.5 PE) with soil application of RDF	628	766.4	56.4	45.4
Drip fertigation (1.5 PE) with 100 % RDF through WSF	706	844.4	78.2	38.6
Drip fertigation (1.5 PE) with 75 % RDF through WSF	706	844.4	64.8	38.6
Drip fertigation (1.5 PE) with 50 % RDF through WSF	706	844.4	58.2	38.6
Drip fertigation (1.0+1.5 PE) with 100 % RDF through WSF	628	766.4	70.0	45.4
Drip fertigation (1.0+1.5 PE) with 75 % RDF through WSF	628	766.4	66.9	45.4
Drip fertigation (1.0+1.5 PE) with 50 % RDF through WSF	628	766.4	61.7	45.4
S. Em±	NA	NA	3.5	NA
CD @ 5 %	NA	NA	10.2	NA

The increase in water productivity in all drip irrigated treatments over surface irrigation was mainly due to considerable saving of irrigation water, greater increase in yield of crop and higher nutrient use efficiency [6].

Conclusion

Adoption of drip fertigation in aerobic rice could help to achieve 60 to 90 per cent higher grain yield by saving 38 to 45 per cent of irrigation water.

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Author Contributions

Gururaj Kombali: Researcher in the Department of Agronomy, UAS, GKVK, Bengaluru

Nagaraju, Sheshadri T., Thimmegowda M. N. and Mallikarjuna G. B: Advisory committee for conducting research

Abbreviations

RDF: Recommended dose of fertilizer, WSF: Water soluble fertilizer, PE: Pan evaporation, g; Gram, kg; Kilo gram, ha: Hectare, cm: Centi meter, m: Meter, %: Per cent, PVC: Poly vinyl chloride, HP: Horse power, lph: Liters per hour, mm: Mili meter, DAS: Days after sowing.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest: None declared

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