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Grain Yield, Nutrient Uptake and Water Use Efficiency of Aerobic Rice (*Oryza sativa* L.) as Influenced by Varied Levels of Farmyard Manure and Irrigation Schedules

B. G. SHEKARA[1], G. B. SHIVAKUMARA[2], N. MALLIKARJUNA[2], G. K. SUDARSHAN[2]
B. MANJUNATH[2] AND B. RAVIKUMAR[2]

[1]*AICRP on Forage, Zonal Agricultural Research Station, VC Farm, Mandya, India*
[2]*Department of Plant Pathology, University of Agricultural Sciences, GKVK, Bangalore 560065, India*

Abstract

A field experiment was conducted during summer seasons of 2005 and 2006 at Mandya, Karnataka (southern dry zone-6) to study the effect of irrigation regimes in conjunction with varied levels of FYM on growth and yield of aerobic rice (*Oryza sativa* L.). The mean of two years research results revealed that application of FYM 20 t /ha recorded significantly higher grain yield (6.23 t/ha), total uptake of nitrogen (140.67 kg/ha), phosphorus (35.25 kg/ha), potassium (92.14 kg/ha) over other levels. Whereas, application of FYM 10 t/ha recorded higher net monetary returns (Rs 18,080/ha). Among irrigation schedules IW/CPE ratio of 2.5 recorded significantly higher grain yield (6.40 t/ha), total uptake of nitrogen (136.59 kg/ha), phosphorus (35.24 kg/ha), potassium (94.45 kg/ha) and net monetary returns (Rs 23,491/ha). However, irrigation schedule at IW/CPE ratio of 1.0 i.e., irrigation once in 10—12 days recorded higher water use efficiency (52.09 kg grain/ha cm).

Key words : Aerobic rice, Farmyard manure, Irrigation regimes, Nutrient uptake, Water use efficiency.

About 80% of the world's rice is grown under irrigated (55%) and rainfed lowland (25%) ecosystems, both of which depends on fresh water resources. The growing scarcity of fresh water will pose problems for rice production in future years. Hence, shifting gradually from traditional rice production system to growing rice aerobically especially in water scarce irrigated low lands can help to mitigate occurrence of water related problems. On the other hand application of FYM as organic manure improve physical properties of soil especially the structure, water holding capacity, bulk density, porosity, cation exchange capacity etc., apart from these enzymatic activities were enhanced and encouraging root development and yield of crops (1). At present not much information on optimum moisture regimes with various levels of farm yard manure for maximizing yield of rice under aerobic situation. Hence, an attempt was made to study the response of aerobic rice to varied irrigation regimes in conjunction with levels of farmyard manure for achieving maximum production.

Methods

A field experiment was conducted at Zonal Agricultural Research Station, Visweswaraiah Canal Farm, Mandya, Karnataka during the dry season of 2005 and 2006. The soil was red sandy loam in texture, near neutral in reaction (pH 6.98), medium in available N (298.0 kg/ha), P_2O_5 (26.1 kg/ha) and K_2O (149.3 kg/ha). Four irrigation schedules based on IW/CPE ratio (IW/CPE ratio of 2.5, 2.0, 1.5 and 1.0) as sub-plot and three levels of farm yard manure (M_1—No farm yard manures, M_2—FYM at 10 t/ha and M_3—FYM at 20 t/ha) as main plots were tested in a split plot design with three replications. The gross plot size was 5 m × 4 m. Over night soaked seeds of cultivar KRH-2 (Karnataka Rice Hybrid) was manually dibbled at the rate of one seed per hill with spacing of 25 cm × 25 cm as inter and intra row spacing. Crop was sown on 23 January 2005 and 2 February 2006 and harvested on 8 to 16 June 2005 and 18 to 25 June 2006. At the time of sowing farm yard manure containing 0.65% N, 0.23% P and 0.41% K was applied as per treatment. The crop was dressed with 100: 50:50 NPK kg/ha. Entire P_2O_5 and K_2O and 50% of nitrogen was applied at the time of sowing and remaining 50% N was given in 2 equal splits at 30 and 60 days after sowing. The field was irrigated immediately after sowing. The initial four ir-

Table 1. Grain yield and economics of irrigated aerobic rice as influenced by levels of farm yard manure and irrigation schedules at different at harvest.

Treatments	Grain yield (t/ha)			Mean of two years		
	2005	2006	Pooled	Gross returns (Rs/ha)	Net returns (Rs/ha)	B : C ratio
Farm Yard Manure (M)						
M_1—NO FYM	4.72	5.20	4.96	30408	17849	2.42
M_2—FYM (10t/ha)	5.46	5.90	5.68	34639	18080	2.09
M_3—FYM (20 t/ha)	6.01	6.44	6.23	38357	17798	2.01
SE ±	0.07	0.08	0.07	198	198	0.01
CD (P = 0.05)	0.23	0.24	0.22	588	NS	0.03
Irrigation Schedules (I)						
IW/CPE—2.5	6.21	6.58	6.40	39401	23491	2.47
IW/CPE—2.0	6.03	6.42	6.22	38212	22773	2.46
IW/CPE—1.5	4.84	5.35	5.10	31145	16546	2.13
IW/CPE—1.0	4.53	5.04	4.78	29132	15013	2.06
SE ±	0.06	0.06	0.06	304	303	0.02
CD (P = 0.05)	0.20	0.19	0.20	902	902	0.06
Interaction	*	*	*	*	*	*

rigations from sowing to 20 days after sowing were given commonly to all the treatments at an interval of five days and subsequent irrigations were given to the plots based on the treatments schedule, applying 5 cm depth of water at each irrigation. Irrigation was given when the cumulative pan evaporations (CPE) reached the level of 20, 25, 33.33 and 50 mm in the case of IW/CPE ratio of 2.5, 2.0, 1.5 and 1.0 respectively. The total evaporation during cropping period was 535.95 mm and 520.45 mm in 2005 and 2006 respectively. Water was measured through par shall flume of 7.5 cm throat size set up at the experimental field and by multiplying the depth of irrigation and area of the plot, the volume of water required for each plot was arrived. Care has been taken to avoid seepage from one plot to other by providing two-meter space between each irrigation treatment and embedded with polythene sheet around each plot and maintaining buffer irrigation channels. The required cultural practices and plant protection measures were followed as per recommended package and weeds were controlled by application of pre- emergence herbicide pyrazo sulfuron-ethyl at 0.025 kg a.i./ha at 3 days after sowing with spray solution of 750 liters/ha. Observations on growth, yield parameters and grain yield was recorded, data was statistically analyzed. The economics was worked out with prevailing market price and water use efficiency was worked from the yield of paddy and the total amount of water used and expressed in kg ha/cm (2).

WUE = Grain yield (kg/ha)/Total quantity of water used (cm)

Results and Discussion

Effect on Grain Yield

Application of FYM 20 t/ha significantly recorded higher grain yield (6.23 t/ha) over other levels (4.96 to 5.98 t/ha). It could be attributed to adequate supply of nutrients, higher uptake and recovery of applied nutrients with application of FYM, which in turn must have increased morphological characters of plant and improved synthesis and translocation of metabolites to various reproductive structures of the plant. Apart from dry matter accumulation increased coupled with better distribution in to grain resulted in higher grain yield (Table 1). These results are in conformity with the findings of Guled (3) and Avil Kumar et al. (4). Irrigation schedule at IW/CPE ratio of 2.5 recorded significantly higher grain yield (6.40 t/ha) which was on par with IW/CPE ratio of 2.0 (6.22 t/ha). This could be attributed to increase in growth character with

Table 2. Uptake of total nitrogen, phosphorus and potassium (kg/ha) in irrigated aerobic rice as influenced by levels of farm yard manure and irrigation schedules at harvest.

Treatments	Total nitrogen (kg/ha)			Total phosphorus (kg/ha)			Total potassium (kg/ha)		
	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled
Farm Yard Manure (M)									
NO FYM	86.16	92.41	89.29	24.17	25.29	24.73	60.87	67.37	64.12
FYM (10 t/ha)	102.51	112.40	107.46	28.46	29.70	29.08	70.15	77.70	73.92
FYM (20 t/ha)	133.72	147.63	140.67	34.36	36.14	35.25	86.74	97.55	92.14
SE ±	1.31	0.93	1.08	0.96	0.76	0.45	0.76	0.79	0.72
CD (P = 0.05)	3.89	2.76	3.21	2.85	2.26	1.34	2.26	2.35	2.14
Irrigation Schedules (I)									
IW/CPE—2.5	131.77	140.45	136.59	34.41	36.07	35.24	90.60	98.31	94.45
IW/CPE—2.0	122.03	134.47	127.80	32.54	34.12	33.33	82.04	93.51	87.77
IW/CPE—1.5	94.45	103.78	99.12	26.23	27.39	26.81	62.73	69.79	66.26
IW/CPE—1.0	81.60	91.22	86.41	22.83	23.92	23.38	54.98	61.88	58.43
SE ±	1.56	1.28	1.30	1.07	0.42	0.32	1.13	1.44	1.03
CD (P = 0.05)	4.62	3.80	3.87	3.18	1.23	0.95	3.35	4.28	3.07
Interaction	NS	*	NS	NS	NS	NS	NS	NS	NS

adequate moisture availability throughout crop growth period (Table 1). The interaction between treatments found significant.

Effect on Nutrient Uptake

Application of FYM 20 t/ha significantly recorded higher uptake of total nitrogen (140.67 kg/ha), phosphorus (35.25 kg/ha) and potassium (92.14 kg/ha) over other levels (Table 2). This was attributed due to added advantage of FYM application that improve soil physical, chemical and biological properties resulting in creation of suitable condition for better root growth and proliferation. This helped higher absorption of water and nutrients. These results were in conformity with findings of Sudha (5). Irrigation schedule at IW/CPE ratio of 2.5 recorded higher uptake of total nitrogen (136.59 kg/ha), phosphorus (35.24 kg/ha) and potassium (94.45 kg/ha) in pooled analysis (Table 2). This might be an account of increased growth and development of crop at this moisture level. These results are in conformity with findings of Krishna Kumar (6). The interaction between treatments found non-significant.

Economic Analysis

Higher net B:C ratio (2.49) was obtained with no application of farm yard manure followed by application of farm yard manure 10 t/ha (2.09) and lowest was obtained with application of farm yard manure 20 t/ha (2.01). This might be due to higher cost of cultivation in higher levels of FYM (Table 1). Irrigation schedule at 2.5 recorded higher net benefit : cost ratio (2.47). This might be due to higher grain yield with higher irrigation level. The similar results are reported by Thomas et al. (7). The interaction between treatments found significant.

Water Use Efficiency

Irrigation schedule at IW/CPE ratio of 2.5-recorded higher total water use 154.79 cm with lower water use efficiency (41.31 kg grain/ha cm). Whereas, irrigation schedule at IW/CPE ratio of 1.0 recorded lower total water use (91.84 cm) with higher water use efficiency (52.09 kg grain/ha cm) in pooled data (Table 3). Irrigation schedule at IW/CPE ratio of 1.5 and IW/CPE ratio of 1.0 is not economical and practically not feasible as they found more detrimental to the crop by way of causing nearly 26 and 34% reduction in grain yield respectively as compared to irrigation schedule at IW/CPE ratio of 2.5 in 2 years mean. These results were in conformity with findings of Guled (3) and Singh et al. (8).

Table 3. Effect of farm yard manure and irrigation schedules on total water used (cm),seasonal consumptive use (cm) and water use efficiency (kg grains/ha cm) in aerobic rice. NA : Not analyzed statistically.

Irrigation schedules	No. of irrigation	Irrigation water used (cm)	Effective rain fall (cm)	Seasonal consumptive use (cm)	Total water used (cm)	Water use efficiency (kg grain/ha cm)
2005-06						
IW/CPE—2.5	27	125.75	14.32	111.5	150.07	41.38
IW/CPE—2.0	22	104.87	17.96	82.49	133.83	45.07
IW/CPE—1.5	16	74.86	21.1	52.94	105.97	45.68
IW/CPE—1.0	12	55.82	22.10	62.60	87.92	51.52
SE ±	NA	NA	NA	NA	NA	0.69
CD (P = 0.05)	NA	NA	NA	NA	NA	2.05
2006-07						
IW/CPE—2.5	29	134.33	15.19	104.27	159.52	41.24
IW/CPE—2.0	25	115.87	16.87	82.97	142.65	45.01
IW/CPE—1.5	18	85.93	20.15	56.30	116.08	46.11
IW/CPE—1.0	13	63.89	21.86	40.12	95.75	52.62
SE ±	NA	NA	NA	NA	NA	0.89
CD (P = 0.05)	NA	NA	NA	NA	NA	2.63
Pooled						
IW/CPE—2.5	28	130.04	14.75	107.93	154.79	41.31
IW/CPE—2.0	24	110.87	17.37	82.73	138.24	45.04
IW/CPE—1.5	17	80.39	20.63	54.62	111.02	45.91
IW/CPE—1.0	13	59.86	21.98	41.36	91.84	52.09
SE ±	NA	NA	NA	NA	NA	0.58
CD (P = 0.05)	NA	NA	NA	NA	NA	1.72

The present study revealed that application of farmyard manure at 20 t/ha resulted higher grain yield and irrigation water savings in water scarcity situation. Irrigating crop once in 4 to 5 day or 5 to 6 days (IW/CPE ratio of 2.5 or 2.0) during summer season found optimum, efficient and economical. In tail end area of irrigated command where irrigation water is available at once in 5 to 6 days, application of farmyard manure at 10 t/ha was given significantly higher yield over frequent irrigation.

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