Indian Journal of Agronomy **55**(1): 35–39 (March 2010)

Effect of irrigation schedules on growth and yield of aerobic rice (*Oryza sativa*) under varied levels of farmyard manure in Cauvery command area

B. G. SHEKARA, SHARNAPPA AND N. KRISHNAMURTHY

University of Agricultural Sciences, GKVK, Bengaluru, Karnataka 560 065

Received: January 2009

ABSTRACT

Field experiments were conducted during summer 2005 and 2006 at Mandya, Karnataka to study the effect of irrigation regimes in conjunction with varied levels of farmyard manure (FYM) on growth and yield of aerobic rice (*Oryza sativa* L.). The treatments consisted of 4 levels of irrigation based on IW (irrrigation water) CPE (Cumulative Pan Evaporation) ratio (2.5, 2.0, 1.5 and 1.0 with an IW of 5 cm) and three levels of FYM (0, 10 and 20 tonne/ha) was laid out in split plot design with three replications. The results revealed that application of 20 tonne FYM recorded significantly more number of productive tillers/hill, filled spikelets/panicle and thus more grain yield (6.01 and 6.44 t/ha during 2005 and 2006, respectively). However, no FYM application recorded higher B:C ratio (1.02). Irrigation scheduled at IW/CPE ratio of 2.5 recorded significantly higher yield attributes and grain yield (6.21 and 6.58 tonne/ha during 2005 and 2006, respectively) and same treatment recorded higher B:C ratio. However, irrigation scheduled at IW/CPE ratio of 1.0 recorded higher water use efficiency (52.09 kg grain/ha-cm). The N, P and K uptake was higher with application of 20 tonne FYM and with irrigation scheduled at IW/CPE ratio of 2.5.

Key words: Farmyard manure, Irrigation, Nutrient uptake, Rice, Water use

About 80% of the world's rice is grown under irrigated (55%) and rainfed lowland (25%) ecosystems depends on fresh water resources. The growing scarcity of fresh water will pose problems for rice production in coming years. Hence, farmers are gradually shifting from traditional rice production system to aerobic rice especially in water scarce irrigated low lands.

The application of FYM improves physical properties of soil especially the structure, water holding capacity, bulk density, porosity, cation exchange capacity etc., apart from these, enzymatic activities were enhanced that encourages root development and yield of crops. At present not much work has been carried out on optimum moisture regimes with varying levels of FYM for maximizing yield of aerobic rice. Therefore, an attempt was made to study the response of aerobic rice to varied irrigation regimes in conjunction with levels of FYM for achieving maximum production.

MATERIALS AND METHODS

The field experiments were conducted at Zonal Agricultural Research Station, Visweswaraiah Canal Farm, Mandya, Karnataka during dry season 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 (11.5 kg/ha) and K (124.4 kg/ha). Four irrigation schedules based on Irrigation Water/Cumulative Pan Evaporation (IW/CPE) ratio 2.5, 2.0, 1.5 and 1.0 as sub-plot and 3 levels (t/ha) of FYM (0, 10 and 20) as main plots were tested in a split plot design with three replications. The gross plot size was 5 m x 4 m. Over night soaked seeds of cultivar KRH 2 (Karnataka Rice Hybrid) was manually dibbled @ 1 seed/hill at a spacing of 25 cm x 25 cm. 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 sowing, FYM containing 0.65% N, 0.23% P and 0.41% K was applied as per treatment. The crop was fertilized with 100: 22.0: 41.7 kg N:P:K/ha. Entire P and K along with 50% of N was applied at the sowing and remaining N was given in 2 equal splits at 30 and 60 days after sowing (DAS). The field was irrigated immediately after sowing. The initial 4 irrigations from sowing to 20 DAS were given commonly to all the treatments at an interval of 5 days and subsequent irrigations were given to the plots as per treatments, applying 5 cm of water at each irrigation (IW). Irrigation was given when the CPE reached the level of 20, 25, 33.3 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 536 and 520.5 mm in 2005 and 2006, respectively. Water was

Corresponding author: (E mail: shekara_gundanaik@rediffmail.com)

measured through parshall 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 2 m space between each irrigation treatment and by laying 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 @ 0.025 kg a.i./ha at 3 DAS with spray solution of 750 litre/ha. Observations on growth, yield parameters and grain yield was recorded, data was statistically analysed. The economics was worked out with prevailing market price and water use efficiency (WUE) was worked from the yield of paddy (kg) and the total amount of water used (ha-cm) and expressed in kg/ha-cm.

RESULTS AND DISCUSSION

Significant differences were observed in plant height and dry matter production of rice crop at harvest with application of FYM and irrigation schedules. Application of 20 tonne FYM/ha recorded significantly higher plant height and dry matter accumulation in both the years (Table 1&2). This increase in plant height and dry matter production might be due to the fact that application of FYM increased the soil organic carbon, which holds more

Table 1. Effect of irrigation schedules and levels of FYM on growth and yield components in aerobic rice

Treatment	Plant height		Dry matter accumulation		Productive tillers (no./hill)		Filled spikelets/ panicle		1,000-seed weight (g)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
FYM (tonne/ha)										
0	74.0	78.6	62.01	63.11	14.36	14.71	90.8	97.6	20.04	22.69
10	81.4	90.3	83.93	93.73	21.33	24.71	110.5	114.0	21.42	23.08
20	88.6	97.0	104.65	109.14	27.74	29.14	129.5	136.2	23.68	25.89
SEm+	0.4	0.1	0.54	1.86	0.40	0.26	0.8	0.7	0.24	0.35
CD (P= 0.05)	1.3	1.2	1.60	5.53	1.19	0.77	2.4	2.1	0.71	1.04
Irrigation schedule (IW/CPE ratio)										
2.5	85.0	93.0	103.52	105.58	24.94	26.52	124.9	133.4	24.30	26.28
2.0	84.2	91.0	98.93	99.45	24.36	25.56	122.2	130.6	23.30	25.09
1.5	79.2	89.3	73.54	85.81	18.46	20.03	103.8	108.6	20.40	23.10
1.0	77.0	81.3	58.12	63.79	16.29	15.02	90.2	91.1	18.90	21.09
SEm+	0.4	0.6	1.57	2.11	1.44	0.35	1.1	1.0	0.80	0.60
CD (P= 0.05)	1.2	1.8	4.64	6.26	1.33	1.03	3.2	3.0	2.20	1.78

Table 2. Interaction effect of FYM and irrigation schedules on productive tillers and filled spikelets/panicle of aerobic rice

FYM (t/ha)	Irrigation schedule (IW/PE ratio)							
	2.5	2.0	1.5	1.0	2.5	2.0	1.5	1.0
				Productive tillers (no/hill)				
		2005				*2006*		
0	19.24	16.33	11.55	10.33	15.61	18.46	14.33	10.44
5	25.66	23.89	20.48	15.30	29.22	26.99	24.22	18.42
10	32.85	29.30	26.35	22.44	34.79	31.22	27.55	23.00
		M × I	I × M			M × I	I × M	
SEm±		0.77	0.78			0.61	0.58	
CD (P=0.05)		2.30	2.31			1.78	1.73	
				Filled spikelets/panicle				
		2005				*2006*		
0	110.0	104.3	77.0	72.0	112.0	115.3	87.7	75.3
5	119.7	119.0	113.0	90.3	124.0	127.0	112.7	92.3
10	145.0	143.3	121.3	108.3	164.3	149.3	125.3	105.7
		M × I	I × M			M × I	I × M	
SMm±		1.9	1.8			1.7	1.7	
CD (P=0.05)		5.6	5.4			5.2	4.9	

I: Irrigation Schedule; M: FYM (t/ha)

moisture in soil and creation of suitable condition for better root growth and proliferation and also opportunity to extract water from larger profile area. These results were in conformity with the findings of Rao *et al.* (2004).

Irrigation scheduled at IW/CPE ratio of 2.5 recorded significantly higher plant height and dry matter accumulation. This might be due to the fact that increased frequency of irrigation led to effective uptake of water and nutrients leading to increased plant height. The increased in dry matter production is attributed to possible reduction in transpiration rate and normal gas exchange resulted in increased production of photosynthates and translocation to sink. This was in harmony with the findings of Gowri (2005) and Kato *et al.* (2004).

Application of 20 tonne FYM/ha recorded significantly more productive tillers/hill, filled spikelets, 1,000 grain weight which cumulatively lead to higher grain yield (6.01 and 6.44 tonne/ha in 2005 and 2006, respectively) than 5 t and no FYM application (Table 3). 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 improved synthesis and translocation of metabolites to various reproductive structures of the plant. Apart from dry matter accumulation the better translocation of it into reproductive parts resulted in higher grain yield.

Irrigation scheduled at IW/CPE ratio 2.5 recorded significantly more number of productive tillers/hill, filled spikelets 1,000-grain weight and grain yield (6.21 and 6.58 t/ha during 2005 and 2006) (Table 3). This could be attributed to increase in growth characters with adequate moisture availability throughout crop growth period. These results were in conformity with the findings of Guled (1993) and Avil Kumar *et al.* (2006).

Higher net B:C ratio (1.02) was obtained with no FYM application followed by application of 10 tonne FYM/ha (0.81) and lowest was obtained with application of 20 tonne FYM/ha (0.66). This might be due to higher cost of cultivation in higher levels of FYM (Table 4). Irrigation scheduled at 2.5 IW/CPE recorded higher net B: C ratio (0.99). This might be due to higher grain yield with higher irrigation level. The similar results were reported by Thomas *et al*. (2003).

Based on 2 years mean, irrigation scheduled at IW/CPE ratio of 2.5 required more water (154.8 cm) leading to lower WUE (41.31 kg/ha-cm). Whereas, irrigation scheduled at IW/CPE ratio of 1.0 needing lowest total water (91.84 cm) had higher WUE (52.09 kg/ha-cm) (Table 5). Irrigation scheduled at IW/CPE ratio of 1.5 and 1.0 are 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 (Table 3) when compared with irrigation scheduled at IW/CPE ratio of 2.5 (2 years mean). These results were in conformity with

Table 3. Grain yield (tonne/ha) of aerobic rice as influenced by FYM (M)and irrigation schedule (I).

IW/CPE ratio	2005 FYM (tonne/ha)			Mean	2006 FYM (tonne/ha)			Mean
	0	10	20		0	10	20	
2.5	5.23	6.34	7.05	6.21	5.68	6.71	7.36	6.58
2.0	5.10	6.17	6.81	6.03	5.47	6.57	7.22	6.42
1.5	4.38	4.83	5.30	4.84	4.94	5.33	5.79	5.35
1.0	4.18	4.51	4.89	4.53	4.73	4.99	5.38	5.03
Mean	4.72	5.46	6.01		5.21	5.90	6.44	
	M	I	M × I	I × M	M	I	M × I	I × M
SEm±	0.07	0.06	0.12	0.13	0.08	0.06	0.11	0.12
CD (P=0.05)	0.23	0.20	0.37	0.38	0.24	0.19	0.32	0.36

Table 4. Economics as influenced by levels of FYM and irrigation schedules in aerobic rice

IW/CPE ratio	Cost of cultivation (Rs/ha) FYM (tonne/ha)			Mean	Net B:C ratio FYM (tonne/ha)			Mean
	0	10	20		0	10	20	
2.5	15,919	19,919	23,919	19,919	1.14	1.00	0.85	0.99
2.0	15,441	19,439	23,439	19,440	1.12	1.00	0.84	0.97
1.5	14,599	18,559	22,599	18,566	0.94	0.66	0.51	0.70
1.0	14,119	18,119	22,119	18,119	0.89	0.59	0.43	0.64
Mean	15,020	19,009	23,019		1.02	0.81	0.66	

Table 5. Effect of irrigation schedules on total water use (cm), consumptive use (CU), and water use efficiency (WUE) in aerobic rice

IW/CPE ratio	No. of irrigation	Irrigation water used (cm)	Effective rain fall (cm)	CU (cm)	Total water use (cm)	WUE (kg grain/ha-cm)
			2005-06			
2.5	27	125.75	14.32	111.50	150.07	41.38
2.0	22	104.87	17.96	82.49	133.83	45.07
1.5	16	74.86	21.10	52.94	105.97	45.68
1.0	12	55.82	22.10	62.60	87.92	51.52
SEm ±						0.69
CD (P=0.05)						2.05
			2006-07			
2.5	29	134.33	15.19	104.27	159.52	41.24
2.0	25	115.87	16.87	82.97	142.65	45.01
1.5	18	85.93	20.15	56.30	116.08	46.11
1.0	13	63.89	21.86	40.12	95.75	52.62
SEm ±						0.89
CD (P=0.05)						2.63

Table 6. Total nutrient uptake (kg/ha) as influenced by levels of FYM and irrigation schedules in aerobic rice at harvest

Treatment	N		P		K	
	2005	2006	2005	2006	2005	2006
FYM (tonne/ha)						
0	86.2	92.4	24.2	25.3	60.9	67.4
10	102.5	112.4	28.5	29.7	70.2	77.7
20	133.7	147.6	34.4	36.1	86.7	97.6
SEm±	1.3	0.9	1.0	0.8	0.8	0.8
CD (P= 0.05)	3.9	2.8	2.9	2.3	2.3	2.4
Irrigation schedule (IW/CPE ratio)						
2.5	131.8	140.5	34.4	36.1	90.6	98.3
2.0	122.0	134.5	32.5	34.1	82.0	93.5
1.5	94.5	103.8	26.2	27.4	62.7	69.8
1.0	81.6	91.2	22.8	23.9	55.0	61.9
SEm±	1.6	1.3	1.1	0.4	1.1	1.4
CD (P= 0.05)	4.6	3.8	3.2	1.2	3.4	4.3

findings of Guled (1993) and Singh *et al.* (2003).

Application of 20 tonne FYM/ha recorded significantly higher nutrient uptake (NPK) than 5 t and no FYM application during both the years (Table 6). This was attributed to the added advantage that FYM application increased soil physical, chemical and biological properties resulting in creation of condition suitable for better root growth and proliferation. This helped in higher absorption of water and nutrients. These results were in conformity with findings of Sudha (1990).

Irrigation scheduled at 2.5 IW/CPE ratio recorded higher N, P and K uptake than the lower levels of IW/CPE ratio. This might be on account of increased growth and development of crop at this moisture level. The interaction between treatments was found non-significant.

The present study revealed that application of 20 tonne FYM/ha and irrigating aerobic rice crop once in 4 to 5 day or 5 to 6 days (IW/CPE ratio of 2.5 or 2.0) during summer was 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 at 10 FYM/ha was promising.

REFERENCES

Avil Kumar, K., Reddy, M.D., Reddy, N.V. and Sadasiva Rao, K. 2006. Effect of irrigation scheduling on performance of summer rice. *Oryza* **43**(2): 97–100.

Gowri, S. 2005. Physiological studies on aerobic rice (*Oryza sativa* L.). M. Sc. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Guled, M.B. 1993. Investigation on performance of rice varieties and the water requirement of rice based cropping system in Krishnaraja Sagara Command Area. Ph D (Agri) Thesis, University of Agricultural Sciences, Bangalore.

Kato, Y., Hayashi, S., Kamoshita, A., Urasaki, K. and Yamagishi, J. 2004. Enhancing grain yield of rice (*Oryza sativa* L.) under upland conditions in Japan. In: *Proceedings of the 4th Inter-*

national Crop Science Congress, 26 September - 1 October, Brisbane, Australia. pp.160–166.

Rao, U.V., Ramu, Y.R., Kumara, C.R. and Reddy, C.R. 2004. Effect of organic and inorganic sources of nitrogen on growth, yield, nitrogen uptake and economics of low land rice. *Madras Agricultural Journal* **91**(7): 289–293.

Singh, B.P., Khokhar, R.P.S., Yadav, D.D. and Verma, S.N. 2003. Water economy in paddy. *Indian Farming* pp. 27–30.

Sudha, H.S. 1990. Effect of spacing and fertilizer levels on the growth and yield of short and medium duration rice (*Oryza sativa* L.) varieties. M.Sc. (Agri.) Thesis, University Agriculture Sciences, Bangalore.

Thomas, U.C., Varughese, K. and Thomas, A. 2003. Influence of irrigation, nutrient management and seed priming on yield and attributes of upland rice. *International Rice Research Institute Newsletter* **28**(2): 39–40.