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DETERMINING THE EFFECT OF VARIOUS IRRIGATION DEPTHS FOR MAXIMIZING RICE PRODUCTION

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A research study was conducted at the University of Agriculture, Faisalabad to provide empirical evidence for optimizing water use for maximum net returns form rice production. The level of use of all production inputs other than irrigation was kept similar. Four irrigation levels i.e. 6.25, 7.50, 8.75 and 10.00 cm were applied in a triplicated randomized complete block design. Relatively higher net field benefit was obtained in case of 7.50 cm depth of water, while in case of 8.75 and 10.00 cm depth of water, low net returns were obtained which could be ascribed to excessive water use causing crop lodging, resultant higher respective cost of water applied and consequent lower yields. Seven and a half centimeter depth of water was thus found to be an economical alternative for rice production at the farm level.

Key words: irrigation depths, rice production

INTRODUCTION

The rice plant usually takes 3-6 months from germination to maturity depending on the variety and the environment under which it is grown. Because rice plant is sensitive to its prevailing environmental conditions and because man has succeeded in modifying that environment, rice can now be grown in many different locations and under a variety of climates. Rice is normally transplanted at random with an optimum spacing varying between 0.15 x 0.15 m and 0.30 x 0.30 m. Water losses occur from irrigated rice during the crop season through transpiration, evaporation, and deep percolation. Water losses through percolation are the most variable. Therefore, heavier soils are preferred due to low percolation losses. On an average about 180-300 mm water/month is needed to produce a reasonably good crop of rice (Youshida, 1981). Adequate water during the total growing period is needed for vigorous growth and high yield because plants have to recover from transplanting and for formation of the roots, thus adequate water supply just following transplanting is important. The most sensitive periods to water deficit are flowering and head development (Doorenboss and Kassam, 1979). Water stress is a constraint to the production of rice in the major rain-fed areas of Asia and other parts of the world (O'Toole and Chang, 1979). However, the degree by which water stress imposes a productivity constraint depends on the interaction of seasonal and annual rainfall with the soil and crop rooting characteristics (Hsiao *et al.,* 1980). The rice crop response to water stress at vegetative stage has been reported primarily in terms of reduced height, tillers and leaf area (IRRI, 1975), while at more sensitive reproductive stage like flowering, high spikelet sterility resulted in the greatest reduction in grain yield. However, current knowledge is quite limited in terms of linking water stress-induced physiological alterations to growth and yield (Matsushima, 1986). The average rice yields in rice growing countries range from less than 1 to more than 6 tons per hectare (Youshida, 1981). Generally, the farmers do not make optimum use of the allocated irrigation water and irrigate their lands without giving much consideration to the fact that water is a scarce input. Rather, they almost flood the fields without taking into account its effect on crop production. The farmers are unaware of the advantage of properly combining the irrigation input with other inputs for maximizing crop production. The major objective of the study was to determine the effect of various irrigation depths for maximizing rice production.

EXPERIMENTAL PROCEDURE

The experiment was conducted at the Postgraduate Agricultural Research Station, University of Agriculture, Faisalabad. Four irrigation levels I_1 = 6.25 cm, I_2 = 7.50 cm, I_3 = 8.75 cm and I_4=10.00 cm and recommended dose of fertilizers per hectare (nitrogen> 115 kg, phosphorus= 90 kg and potassium = 30 kg) was applied in complete randomized block design with three replications. For individual plot measuring 7.25m x 33.5m, the fertilizer requirement was calculated to be N=2.90 kg, P=2.25 kg and K=0.75 kg. The crop was transplanted in 23 cm apart rows. The variety grown was Basmati-385. The fertilizer dose and time of application was kept the same in each plot. However, fertilizer was applied in two doses. Total amount of phosphorus, potassium and half dose of nitrogen were applied to the individual plot just before transplanting, whereas the remaining half dose of nitrogen was applied at the time of ear formation. Zinc sulphate @ 25 kg per hectare was also applied to fulfil the zinc deficiency in the soil. Insecticides were applied to check the attack of termites and leaf roller. All the agricultural operations done at the experimental field were recorded by participant observation method. Cost incurred on each input was recorded and finally income earned from the harvest was worked out.

RESULTS AND DISCUSSION

A. Economic Analysis of Rice Experiment for 1994: The data in this respect have been given in Table 1. In case of li, depth of irrigation water applied was kept at 6.25 cm for each of the 12 irrigations resulting in 187.50 cm of water per hectare. The cost of irrigation per centimeter estimated on the basis of opportunity cost was Rs. 14.00 and thus the total cost of water per hectare applied amounted to Rs. 2625.00. The level of use of all other production inputs was kept constant resulting in uniform cost of Rs. 9077.50 per hectare for each of the treatments. The total cost of production of one hectare of rice, hence came to be Rs. 11702.50 for IJ, The gross output in the case of 11 was recorded as 2775 kg per hectare of rice paddy, valued at Rs. 12126.75 per hectare. In case of the treatments Iz, band 14 the cost of total amount of water applied was Rs. 3150.00, 3675.00 and 4200.00 per hectare respectively. The total cost of production per hectare was thus worked out to be Rs. 12227.50 12752.50 and 13277.50 in the same order. The recorded yield levels were 3332, 3162 and 2802 kg per hectare, valued at Rs. 175 per 40 kg, respectively. Gross benefits of Rs. 14560.84, 13817.94 and 12244.74 were obtained from Iz, 13 and 14 treatments respectively. It was noted that net benefits per hectare in case of It, Is, 13 and 14 treatments were +424.25, +2334.34, +1065.44 and -1032.76 respectively. However, since the total cost for the treatment 14 was higher, the net benefit for this treatment was negative.

B. Economic Analysis of Rice Experiment for 1995: In case of It, depth of irrigation water applied was kept at 6.25 centimeter for each of the 12 irrigations resulting in 187.50 cm of water per hectare. The cost of irrigation per centimeter estimated on the basis of opportunity cost was Rs. 16.00 and thus the total cost of water applied in case Of I1 was calculated to be Rs. 3000.00. The level of use of all other production inputs was kept similar resulting in uniform cost of Rs. 9437.50 per hectare for each of the treatments. The total cost of production of one hectare of rice, hence came to be Rs. 12437.50 for It. The gross output in case of It was recorded as 2830 kg of rice paddy per hectare, valued at Rs. 14150.00 (@ Rs. *200/40kg)*. The resulting net field benefit was Rs. 1712.50 per hectare. In case of the treatments, 12, 13 and 14, the total amount of water

Table 1. Cost of production per hectare of paddy rice (1994)

	Treatments			
Particulars	It	h	la	14
Total number of irrigations applied	12	12	12	12
Depth of each irrigation (cm)	6.25	7.50	8.75	10.00
Total water applied (cmlhectare)	187.50	225.00	262.50	300.00
Cost of one centimeter of water (Rs.)	14.00	14.00	14.00	14.00
Total cost of water applied (Rs.)	2625.00	3150.00	3675.00	4200.00
Cost of production per hectare (Rs.) except water	9077.50	9077.50	9077.50	9077.50
Total cost of production (Rs.)	11702.50	12227.50	12752.50	13277.50
Rice paddy production per hectare (kg)	2775.00	3332.00	3162.00	2802.00
Rice paddy price (Rs./kg)	4.37	4.37	4.37	4.37
Gross benefits per hectare (Rs.)	12126.75	14560.84	13817.94	12244.74
Net benefits per hectare (Rs.)	+424.25	+2334.34	+1065.44	-1032.76

Table 2. Cost of production per hectare of paddy rice (1995)

Particulars	Treatments			
	h	Iz	13	14
Total number of irrigations applied	12	12	12	12
Depth of each irrigation (cm)	6.25	7.50	8.75	10.00
Total water applied (cm)	187.50	225.00	262.50	300.00
Cost of one centimeter of water (Rs.)	16.00	16.00	16.00	16.00
Total cost of water applied (Rs.)	3000.00	3600.00	4200.00	4800.00
Total cost of production per hectare (Rs.) except water	9437.50	9437.50	9437.50	9437.50
Total cost of production (Rs.)	12437.50	13037.50	13637.50	14237.00
Rice paddy production per hectare (kg)	2830.00	3367.50	3175.00	2860.00
Rice paddy price (Rs./kg)	5	5	5	5
Gross benefits per hectares (Rs.)	14150.00	16837.50	15875.00	14300.00
Net benefits per hectare (Rs.)	+1725.50	+3800.00	+2237.50	+62.50

applied was 225.00, 262.50 and 300.00 cm respectively. The total respective cost of water in these treatments was Rs. 3600.00, 4200.00 and 4800.00 per hectare. Thus the total cost of production per hectare was calculated to be Rs. 13037.50, 13637.50 and 14237.00 in the same order. The recorded yield levels were 3367.50, 3175.00 and 2860.00 kg per hectare, valued at Rs. 200 per 40 kg, respectively.

Gross benefits per hectare of Rs. 16837.50, 15875.00 and 14300.00 were obtained from Iz, Is and 14 treatments, respectively. It was noted that net benefits per hectare in case of Ii.Iz, Is and 14 treatments were Rs. 1725.50, 3800.00, 2237.50' and 62.50 respectively. On the basis of these results, it may be stated that the low net benefits in case of (13 and 14) treatments can be attributed to the high respective total costs of water applied and relatively lower yields due to crop lodging on account of excessive water application. Treatment Iz with 7.5 cm depth of irrigation for rice is thus found to be an economical and a suitable alternative at the farm level.

Results reported earlier also support the present findings (Anonymous, 1986). Mather (1974) reported that excessive irrigation water application does not bring out optimum yield level of rice crop. Evidence also exists that excessive use of irrigation water resulted in decreased yield (Anonymous, 1975).

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