EFFECT OF IRRIGATION REGIME ON WATER LAYER REPOSITION IN RICE CROP (*Oryza sativa* L.)

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ABSTRACT. In "Los Palacios" Rice Research Station, during two rainy and a poor rainy seasons, under semicontrolled conditions, a study was developed to determine the effect of water layer reposition on crop yield and water irrigation economy. Results showed that the different reposition rates of flooding did not affect yields nor its components: full grains per panicle, panicles per square meter and 1000 grain-weight. A great water economy was reached by reducing the days under irrigation.

RESUMEN. En la Estación Experimental del Arroz «Los Palacios», durante dos épocas lluviosas y una poco lluviosa, bajo condiciones semicontroladas, se desarrolló un estudio para determinar el efecto de la reposición de la lámina de agua sobre el rendimiento del cultivo y en la economía de agua de riego. Los resultados arrojaron que los distintos regímenes de reposición del aniego no afectaron los rendimientos y sus componentes: granos llenos por panícula, panícula por metro cuadrado y el peso de 1000 granos. Se alcanzó una gran economía del agua por disminuir los días bajo riego.

Key words: rice, *Oryza sativa*, crop yield, irrigation, water

Palabras clave: arroz, *Oryza sativa*, rendimiento de cultivos, riego, agua

INTRODUCTION

As a general rule, rice is cultivated under irrigation conditions and the opinion of requiring abundant water is very generalized. Rice behaves better in submerged and saturated soils than in soils at its field capacity (1, 2); however, it is outlined that it can be cultivated with the same quantity of water required by other cereals (3).

Rice production is mainly affected by the lack of water; it was proved that with adequate and good irrigation management, the current water consumption can be reduced to obtain high yields. The amount of water to achieve optimum yields is the one which satisfies evapotranspiration requirements of the crop and controls losses by filtration and others produced in its transportation and distribution (4, 5).

Some authors asserted that rice plant needs to have a given quantity of water for its development and growth; on the other hand, others outlined (6) that in the rainy season the irrigation regime can be successfully applied through water reposition (7). In heavy soils, studying alternatives in the irrigation rice regime, a better water economy was found without affecting agricultural yield (8).

In light soils, water managements were evaluated from traditional practice until soil saturation during all crop cycle (9). No significant differences were recorded in the agricultural and industrial yields nor its components, but there was a considerable water saving in saturated soil treatment (1-cm water layer). Taking into account the problems existing with irrigation, which has been insufficient to comply with crop management, this work was developed with the objective of knowing the effects of different rates of water layer replacement on the agricultural and industrial yield of grains and water irrigation economy.

MATERIALS AND METHODS

The study was conducted in "Los Palacios» Rice Research Station, on a Nodular Ferralitic Hydromorphic soil (10). The commercial variety J-104 was used under semicontrolled conditions with four treatments and four repetitions.

The experiment was performed in two rainy and a poor rainy seasons. In either case, 1-m^2-pots were used with drainage regulation. Seeds were drilled at a sowing density of 130 $kg.ha^{-1}$ and a row spacing of 5 cm.

Crop tillage followed the Technical pattern (11), except irrigation, which was accomplished from 20-25 days according to each experimental treatment, keeping them until 50 % heading when they were definitely discontinued.

The treatments studied were:

1. Flooding with permanent circulation (control).
2. Flooding with permanent reposition upon losing the established level.
3. Flooding with weekly reposition.
4. Flooding with reposition when saturation is reached.

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Dry weight at 100 % heading and straw:grain relationship at harvest time during crop cycle were determined; furthermore, samples were taken to determine full grains per panicle, fertile tillers/m^2, as well as the agricultural and industrial yield of grains and undesirable plants per m^2 40 days after germination.

The volume of water applied to each treatment was controlled using a test tube to calculate water consumption at the end.

The agricultural yield and its components were evaluated in a 1-m^2 area. Treatments were distributed according to a randomized complete design with a 10-cm water layer.

RESULTS AND DISCUSSION

Results showed significant differences ($p \leq 0.05$) with respect to agricultural and industrial grain yields, for the rainy as well as the poor rainy periods, using different reposition rates in relation to treatment 1 (control); it can be appreciated in Table I. Similar results for these same sowing seasons have been reported (8).

Table I. Agricultural (14 % moisture) and industrial rice yields at different irrigation rates

Treat-ment	Rainy season				Poor rainy season	
	First year		Second year			
	AY	IY	AY	IY	AY	IY
1	4.20	43.11	4.60	49.45	5.78	43.40
2	4.10	42.98	4.58	48.48	5.80	43.85
3	4.36	43.51	4.59	49.32	5.79	43.80
4	4.22	45.88	4.61	48.49	5.81	43.90
SEx	0.80 ns	1.19 ns	0.51 ns	1.06 ns	0.60 ns	1.81 ns

AY - Agricultural yield (t.ha^{-1})
IY - Industrial yield (% entire grains)

In this table it is appreciated that yield is superior in the poor rainy season with respect to the rainy one; then according to the results found in IRRI, it is attributed to the presence of a longer sunlight period, which together with a longer crop cycle makes a greater photosynthesis and superior yields possible. The nonsignificant statistics in this variable, between the treatments studied, can be attributed to the fact that in all the cases soil moisture was sufficient for its normal development. Similar results were reported (13, 14) in rice cultivated under flooding. In this regard, some authors (8) indicated that this crop developes and yields are not affected when soil is kept at a moisture range between field capacity and a water layer from 10 to 15 cm high.

In Table II a similar behavior is observed with yield components, such as: full grains/panicle and infertile tillers/m^2, since no significant differences were recorded for the studied periods, a response that can be attributed to the same causes that influenced yields as a rule.

Table II. Yield components in rice cultivated at different irrigation rates

Treat-ment	Rainy season				Poor rainy season	
	First year		Second year			
	FG/P	FT/m^2	FG/P	FT/m^2	FG/P	FT/m^2
1	84.00	344	79.80	358	94.00	419
2	84.25	399	78.85	355	94.21	421
3	84.00	344	78.71	359	94.36	420
4	84.49	340	78.91	358	94.12	420
SEx	0.98 ns	6.60 ns	3.80 ns	4.40 ns	1.09 ns	3.38 ns

FG/P - Full grains/panicle
FT/m^2 - Fertile tillers/m^2

The physiological indicators that appear in Table III showed no significant differences between years and seasons, concerning dry weight and grain/straw relationship. This response can be explained by the fact that during all the period, soil moisture levels were kept from saturated soil (1-cm layer) until a 10-cm water level, results confirming others (6, 9, 16) that recorded a close relationship between crop development and yield, when soil moisture is kept between field capacity and 10 to 15-cm layer. Concordant results have been found (15) under similar experimental conditions.

Table III. Physiological indicators in rice cultivated at different irrigation rates

Treat-ment	Rainy season				Poor rainy season	
	First year		Second year			
	DM	RGS	DM	RGS	DM	RGS
1	404.75	0.98	399.75	1.17	527.75	1.17
2	407.00	1.01	400.75	1.35	531.00	1.10
3	407.00	0.98	399.00	1.30	537.00	1.07
4	406.00	0.90	402.28	1.30	540.00	1.04
SEx	3.22 ns	0.40 NS	41.36 ns	0.80 ns	52.60 ns	0.83 ns

DM - Dry matter / m^2
RGS - Grain-straw relationship

Table IV shows the occurrence of weeds per m^2. Significant differences can be noted between treatments independently of the season when crop developed; in general, the presence of weeds was greater in the rainy season (12, 16) due to higher temperatures that stimulate its germination and growth.

Table IV. Occurrence of weeds per m^2 in rice cultivated at different irrigation rates

Treatment	Rainy season		Poor rainy season
	First year	Second year	
1	15 a	10 ab	8 b
2	13 b	9 c	9 a
3	11 c	11 a	9 a
4	12 bc	9 c	8 b
VC (%)	16.2	17.6	14.3

Means with the same letters do not differ significantly

The water volumes consumed by the crop during its developing cycle are appreciated in Table V. A well differentiated trend between treatments concerning the volume of applied water is observed, the smallest consumption being for the different years studied in the treatment of flooding with reposition when achieving saturation. This is the best treatment consuming the smallest quantity of water, whereas the least favorable resulted the one in which flooding was kept with permanent circulation, varying consumption from 5700 until 12 100 $m^3.ha^{-1}$ respectively. This difference is mainly due to the reduction of days without irrigation, it coinciding with other results (9, 18) reported for similar conditions.

Table V. Water volume applied ($m^3.ha^{-1}$) to the crop during the vegetative cycle

Treatment	Rainy season		Poor rainy season
	First year	Second year	
1	10500	10450	12100
2	7800	7740	9080
3	7030	7021	8205
4	5700	5731	7525

These results permit to suggest that the treatment with water layer reposition when saturation is reached is the most favorable, either from the agricultural or economic points of view, which implies a substantial saving of water irrigation without affecting agricultural and industrial yields and its components.

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