ON – FARM WATER MANAGEMENT IN RICE FIELDS AT NORTH NILE DELTA, EGYPT

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ABSTRACT

Two field experiments were conducted at the Experimental Farm of Sakha Agric. Res. Station during the summer seasons (2006 and 2007). The aim of this work is to study the influence of four field canal options (Traditional earth canal, Lined canal, Gated pipes, and Buried pipe connected with Gated pipes), two irrigation intervals (4 and 6 days) and two submerged heads (5 and 7.5 cm) on rice productivity and some irrigation efficiencies. The experiments were conducted in a split-split-plot design with four replicates. The main plots were assigned to field marwa options, the sub-plot was assigned to the irrigation intervals and sub-sub plot was allocated to the submerged heads. The obtained results could be summarized as follows:

- Irrigation by gated pipes every 6 days at 7.5 cm submerged head achieved the highest rice yield and NPK content in the two growing seasons.
- The highest values of nitrogen use efficiency were recorded when rice flooded to 7.5 cm every 6 days irrigation interval under gated pipes.
- Improved field canal by buried pipeline, gated pipes and lining saved irrigation water by 9.39, 8.14 and 4.72 %, respectively compared to traditional earth canal.
- Water productivity was increased from 0.46 to 0.58 kg/m^3 under irrigation by gated pipes.
- At the same time prolonging irrigation interval from 4 to 6 days increased water productivity.

INTRODUCTION

Worldwide, there are about 150 million hectares of rice land, which provide around 550–600 million tons of rough rice annually (Maclean *et al.,* 2002). Rice is unique among the major food crops in its ability to grow in a wide range of hydrological situations, soil types, and climates. Rice is the only cereal crop that can grow in wetland conditions. The water conservation and best use is a crucial issue that represents the keystone for agriculture extension, both horizontally and vertically. Different projects and experiments have proven that the average overall irrigation efficiency is about 50%. Most of water losses occur in mesqas, marwas and in field (Shawky and El - Kashef, 2004). Field channel efficiency is affected primarily by the method and control of operation, soil type in relation to canal losses, length of field channels, and size of the irrigation blocks and fields. Ibrahim *et al.* (1995) recommended that irrigation interval for rice should be every 6 days for approximately one month after transplanting then can be extended to 10 days until the end of the growing season without decreasing yield. Prasad et al. (1997) found that irrigation of improved rice cultivars to a depth of 7 cm at 3 days after disappearance of ponded water increased grain yield 34 % than the local ones which irrigated by farmers practices .The depth of irrigation water applied was 18- 41.3 cm for the study field and 18 – 91 cm for the control. Saied *et al.* (2007) showed that the average values of on - farm irrigation efficiency at Kafr Elsheikh and El-Behira Governorates reached to minimum state in El Naira mesqa (55.81%) when all area cultivated with rice, but reached to 80.26% in Sharf El Den mesqa when rice occupied 35.73% of the total area. The higher on-farm water losses and lower values of on–farm irrigation efficiency were obtained in the area cultivated by rice. While, on - farm water losses were decreased when the area of the other crops were increased. Moreover, a number of technologies to cope with water scarcity require good water control for individual fields. Finally, the water that continuously flows through rice fields may remove valuable (fertilizer) nutrients. Constructing separate channels to convey water to and from each field greatly improves the individual control of water and is the recommended practice in any type of irrigation system. Some researchers have reported a yield increase using available water deficit (AWD) (Wei Zhang and Song 1989, Stoop *et al.,* 2002), recent work indicates that this is the exception rather than the rule, Belder et al (2004); Cabangon *et al.* (2004) and Tabbal *et al* (2002). In 31 field experiments analyzed by Bouman and Tuong (2001), 92% of the Alternate wetting and drying (AWD) treatments resulted in yield reductions varying from just more than 0% to 70% compared with those of the flooded checks. In all these cases, however, AWD increased water productivity with respect to total water input because the reductions in water inputs were larger than the reductions in yield. The large variability in results of AWD in the analyzed data set was caused by differences in the number of days between irrigations and in soil and hydrological conditions.

More water can be saved and water productivity further increased by prolonging the periods of dry soil and imposing a slight drought stress on the plants, but this usually comes at the expense of yield loss, (Bouman and Tuong, 2001). Lampayan *et al.* (2005) concluded that the AWD fields had the same yield as continuous flooding, but saved 16–24% in water costs and 20–25% in production costs. Belder *et al.* (2007) and Cabangon *et al.* (2004) calculated that evaporation losses decreased by 2–33% compared with fully flooded conditions. Xue et al (2007) reported that yield maximal of 3.6–4.5 t ha1l with 688 mm of total water input in 2003, and 6.0 t ha/1 with 705 mm of water input in 2004. Feng Liping *et al.* (2007) obtained relatively low yields of 2.4–3.6 t ha−1 with 750–1,000 mm of total water input. It is estimated that aerobic rice systems are currently being pioneered by farmers on some 80,000 ha in northern China using supplementary irrigation (Wang Huaqi *et al.,* 2002).Abo Soliman *et al.* (2008) reported that the grain yield of wheat and soybean crops were significantly increased with gated and concrete pipes and with shorter border length and width. The lowest amount of water applied, water consumptive use (m3/fed) and water losses % and the highest values of field water use, crop water use efficiencies (kg/m3) and water application efficiency % were obtained under gated pipes, 60m border length and 12m border width.

This study compared between different practical methods of using irrigation techniques and intervals for producing rice under Egyptian Nile delta conditions, to increasing rice yield, water productivity and saving natural resources.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of Sakha Agric. Res. Station during the summer seasons (2006 and 2007). The aim of this work is to study the influence of four field canal options (Traditional earth canal, Lined canal, Gated pipes, and Buried pipe connected with Gated pipes), two irrigation intervals (4 and 6 days) and two submerged heads (5 and 7.5 cm) on rice productivity and some irrigation efficiencies. The experiments were conducted in a split-split-plot design with four replicates. The main plots were assigned to irrigation marwa options, the sub-plot was assigned to the irrigation intervals and sub-sub plot was allocated to the submerged heads.

Rice Sakha 104 variety was first broadcasted in a separate nursery and subsequently transplanted into the rice field when the seedlings were 2–3 weeks old on June, 20, 2006 and June,26, 2007. All plots received 100 Kg Ca-super phosphate /fed. during land preparation. Nitrogen fertilizer in the form of urea was broadcasted at a rate of 75 Kg N/fed., in two doses after 21 and 42 days from transplanting. Rice was harvested on October 5, 2006 and October,10, 2007. Yield and yield components were determined at harvesting in the two studied seasons.

Some soil physical and chemical properties were determined according to Klute (1986) and Page (1982) which presented in Table (1).

Table (1): Chemical and physical properties for the soil of the experimental field

Soil depth (cm)	Particle size distribution			Texture grade	Bulk density g/cm^3	O.M %	EC (dS/m)	Soil moisture characteristics		
	Sand%	Silt%	Clay%					FC%	WP%	AW%
0–15	9.14	33.75	57.11	Clayey	1.14	1.89	1.3	42.95	23.32	19.63
15–30	9.55	33.14	57.31	Clayey	1.18	1.02	1.3	40.41	22.02	18.39
30–60	8.98	38.49	52.53	Clayey	1.26	0.76	1.5	37.76	20.69	17.07
60–90	9.21	39.05	51.74	Clayey	1.26	0.45	1.5	36.25	19.7	16.55

EC=Electrical conductivity FC=Field capacity WP=Wilting point AW= Available water

Plant chemical analysis:

Grains and straw samples of rice after harvesting were dried, milled and wet digested for determination of N, P and K, according to (Chapman and Pratt, 1961).

Nitrogen fertilizer use efficiency: It was calculated as follows:
NUE = Total N uptake (kg/fed.)/ Applied N fertilizer (kg/fed) *100

Amount of water applied

* Traditional field ditch: The irrigation water applied was measured by using a set of cut-throat flume (20×90cm), Early (1975).
* Gated pipes, buried pipes and concrete pipes: The discharge through an orifice was determined from the following equation as described by (Brater and King, 1976).

$Q = CA\ (2GY)^{1/2}$

Where: Q: Discharge (m^3/sec)
C: Coefficient of discharge ranges form 0.61 to 0.65
A: Area of orifice opening (m^2)
G: Accelerating of gravity (9.81m/$sec.^2$)
Y: The head causing free flow where Y the upstream head measured from the center of the orifice opening.

Water productivity: It was calculated as follows:

WP = Yield (kg/fed.) / Amount of water applied (m^3/fed) , Michael (1978).

Statistical analysis: Data are subjected to statistical analysis according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1- Rice yield and yield components:

The obtained results in Table (2) revealed that the field canal options, irrigation intervals and submerged static head significantly affected rice grain yield and yield components in the two growing seasons. Gated pipes produced the highest grain yield, 3149.38 and 3081.80 kg/fed. in the 1st and 2nd seasons, respectively. Buried pipes connected with gated pipes came in the second order followed by lined canal, while the traditional earth canal produced the lowest rice grain yield. Rice straw yield, panicle length, total tillers, fruiting tillers, plant height and weight of 1000 grains took the same trend as the grain yield in the two studied seasons. Increasing rice grain yield and yield components under the improved field canals could be attributed to the improvement of irrigation efficiencies. Regarding to the irrigation intervals, data indicated that irrigation every 6 days resulted in the highest rice grain yield, 3042.5 and 2993.75 kg/fed. in the 1st and 2nd seasons, respectively. Straw yield, panicle length, total tillers, fruiting tillers, plant height and weight of 1000 grains were significantly increased at irrigation interval 6 days (I_2) compared to 4 days irrigation interval (I_1). The submerged static head 7.5 cm (H_2) recorded the highest grain yield 3015.63 and 2932.5 kg/fed. in the 1st and 2nd seasons, respectively. Average values of rice yield components were also higher under (H2) than under (H1) during the two growing seasons. The interaction between field canal options, irrigation intervals and submerged static head was significant for grain yield during the two growing seasons. The obtained results are in agreement with those of Wei Zhang and Song (1989); Ibrahim *et al.* (1995); Prasad *et al.* (1997); Shawky and El - Kashef (2004) and Abo Soliman *et al.* (2008)

Table (2): **Rice yield and yield components as affected by field canal options, irrigation intervals and submerged water head.**

Treatments	Grain yield, kg/fed	Straw yield, kg/fed	Panicle length, cm	Total No tillers	Fruiting tillers	Weight of 1000 grain, g	Plant height, cm	Grain yield, kg/fed	Straw yield, kg/fed	Panicle length, cm	Total tillers	Fruiting tillers	Weight of 1000 grain, g	Plant Height, cm
	2006							2007						
Field ditch														
O1	2693.13	3170.63	17.61	18.84	9.29	25.73	82.24	2691.25	3250.00	18.21	21.31	10.39	28.16	95.65
O1	2860.63	3314.38	19.44	19.74	9.74	27.81	86.15	2776.88	3403.13	19.43	24.73	10.71	29.19	97.76
O3	3149.38	3590.00	21.70	21.84	9.97	29.63	87.44	3081.80	3598.13	20.36	25.51	11.12	29.66	100.91
O4	3078.75	3456.25	20.21	20.61	9.80	29.43	86.71	2915.00	3467.50	19.86	25.04	10.93	29.57	99.83
F – test	**	**	**	**	*	**	**	**	**	**	**	**	*	**
LSD 0.01	72.93	41.65	1.39	1.25	0.55	0.81	3.72	78.51	47.56	0.39	0.62	0.52	1.48	3.10
LSD 0.05	50.79	28.99	0.97	0.87	0.38	0.57	2.59	54.64	33.10	0.27	0.43	0.36	1.03	2.16
Irrigation Intervales														
I1	2848.44	3330.94	19.40	19.48	9.52	27.66	84.05	2738.75	3361.88	18.57	23.29	10.58	28.68	97.51
I2	3042.50	3439.38	20.08	21.03	9.88	28.64	87.23	2993.75	3497.50	20.36	25.01	10.99	29.61	99.57
F – test	**	**	**	**	*	**	**	**	**	**	**	**	**	ns
LSD 0.01	63.55	36.11	0.64	0.55	0.36	0.56	2.33	39.29	14.48	0.34	0.61	0.31	0.63	3.48
LSD 0.05	45.33	25.76	0.45	0.39	0.26	0.40	1.66	28.03	10.33	0.25	0.43	0.22	0.45	2.48
Submerged static head														
H1	2875.31	3434.38	19.54	19.87	9.56	27.90	84.64	2800.00	3491.88	19.13	23.63	10.68	28.97	97.68
H2	3015.63	3355.94	19.94	20.64	9.85	28.39	86.63	2932.50	3367.50	19.80	24.68	10.90	29.32	99.40
F – test	**	**	**	**	*	**	**	**	**	**	**	*	ns	*
LSD 0.01	56.87	31.62	0.32	0.64	0.37	0.45	1.96	38.21	19.34	0.47	0.32	0.26	0.76	2.27
LSD 0.05	41.97	23.33	0.23	0.47	0.27	0.33	1.44	20.20	14.27	0.35	0.24	0.19	0.56	1.68
Interactions														
O X I	ns	ns	ns	ns	ns	ns	ns	*	**	**	ns	ns	ns	ns
O X H	*	ns	ns	ns	ns	ns	ns	ns	**	ns	*	ns	ns	ns
I X H	**	ns	ns	ns	ns	ns	ns	ns	ns	*	*	ns	ns	ns
O X I X H	*	ns	ns	ns	ns	ns	ns	*	*	ns	**	ns	ns	ns

2. Plant elemental content

Data in Table (3) showed that the improved field canals resulted in increasing the concentrations of the nutrients in rice plant compared to the traditional earth canal. Irrigation by gated pipes resulted in the highest NPK concentrations in grains 1.47, 0.47 and 0 .35 %, respectively in the 1st season and 1.57, 0.3 and 0.5 %, respectively in the 2nd season. While the corresponding average values in rice straw were 0.31, 0.14 and 1.17%, respectively in the 1st season and 0.27, 0.16 and 0.98 %, respectively in the 2^{nd} season. Buried pipes connected with gated pipes and lined canal followed by gated pipes increased rice NPK content.

Irrigation every 6 days under the different field canal options resulted in the highest NPK contents compared to 4 days during the two growing seasons. The highest average values of NPK contents in grains 1.49, 0.47 and 0.35 %, respectively in the 1st season and 1.60, 0.30 and 0.49 %, respectively in the 2^{n} season were obtained at irrigation every 6 days under gated pipes. The corresponding average values of NPK content in straw were 0.30, 0.14 and 1.18%, respectively in the 1st season and 0.26, 0.16 and 0.99%, respectively in the 2^{nd} season .Regarding the effect of submerged static head, data revealed that irrigation of rice using gated pipes to water depth 7.5 cm at 6 days interval recorded the highest values of plant NPK content in the two studied seasons. These results are in agreement with those obtained by Wei Zhang and Song (1989) and Stoop et al. (2002)

Table (3): NPK contents in rice grains and straw as affected by field canal options, irrigation intervals and submerged water head.

Field Canal options	Irrigation interval ,days	Submerged Static head ,cm	Grain						Straw					
			2006			2007			2006			2007		
			N	P	K	N	P	K	N	P	K	N	P	K
Traditional	I_1	H_1	1.05	0.31	0.22	1.13	0.2	0.32	0.26	0.1	1.12	0.22	0.11	0.94
		H_2	1.16	0.27	0.21	1.25	0.17	0.3	0.22	0.1	1.1	0.19	0.11	0.93
		Mean	1.11	0.29	0.22	1.19	0.19	0.31	0.24	0.1	1.11	0.21	0.11	0.94
	I_2	H_1	1.18	0.38	0.25	1.26	0.24	0.36	0.29	0.1	1.08	0.26	0.12	0.91
		H_2	1.13	0.34	0.24	1.22	0.22	0.34	0.27	0.11	1.06	0.23	0.12	0.9
		Mean	1.16	0.36	0.25	1.24	0.23	0.35	0.28	0.11	1.07	0.25	0.12	0.91
	Mean		1.13	0.33	[illegible]	[illegible]	0.21	[illegible]	[illegible]	[illegible]	1.09	[illegible]	0.12	[illegible]
Lined canal	I_1	H_1	1.33	0.41	0.28	1.43	0.26	0.4	0.27	0.11	1.14	0.23	0.12	0.96
		H_2	1.32	0.36	0.24	1.41	0.23	0.34	0.23	0.12	1.13	0.2	0.13	0.95
		Mean	1.33	0.39	0.26	1.42	0.25	0.37	0.25	0.12	1.14	0.22	0.13	0.96
	I_2	H_1	1.32	0.44	0.27	1.41	0.28	0.38	0.3	0.12	1.16	0.26	0.13	0.98
		H_2	1.37	0.42	0.25	1.47	0.26	0.36	0.29	0.13	1.14	0.25	0.14	0.96
		Mean	1.35	0.43	0.26	1.44	0.27	0.37	0.3	0.13	1.15	0.26	0.14	0.97
	Mean		1.34	0.41	0.26	1.43	0.26	0.37	0.27	0.12	1.14	0.24	0.13	0.96
Gated pipes	I_1	H_1	1.5	0.42	0.36	1.61	0.27	0.52	0.34	0.14	1.17	0.24	0.15	0.98
		H_2	1.39	0.5	0.34	1.49	0.31	0.48	0.3	0.14	1.15	0.3	0.16	0.97
		Mean	1.45	0.46	0.35	1.55	0.29	0.5	0.32	0.14	1.16	0.27	0.16	0.98
	I_2	H_1	1.53	0.47	0.34	1.64	0.3	0.48	0.3	0.14	1.19	0.26	0.15	1
		H_2	1.44	0.47	0.35	1.55	0.3	0.5	0.3	0.14	1.17	0.26	0.16	0.98
		Mean	1.49	0.47	0.35	1.6	0.3	0.49	0.3	0.14	1.18	0.26	0.16	0.99
	Mean		1.47	0.47	0.35	1.57	0.3	0.5	0.31	0.14	1.17	0.27	0.16	0.98
Buried pipes	I_1	H_1	1.39	.45	0.34	1.49	0.28	0.46	0.3	0.13	1.16	0.25	0.14	0.98
		H_2	1.29	0.42	0.32	1.38	0.28	0.48	0.29	0.14	1.14	0.26	0.15	0.96
		Mean	1.34	0.42	0.33	1.44	0.28	0.47	0.3	0.14	1.15	0.26	0.15	0.97
	I_2	H_1	1.43	0.46	0.35	1.53	0.27	0.46	0.32	0.14	1.18	0.26	0.15	0.99
		H_2	1.3	0.44	0.36	1.4	0.29	0.5	0.39	0.14	1.16	0.28	0.15	0.98
		Mean	1.37	0.45	0.36	1.47	0.28	0.48	0.36	0.14	1.17	0.27	0.15	0.99
	Mean		1.35	0.44	0.34	1.45	0.28	0.48	0.33	0.14	1.16	0.26	0.15	0.98

3. Uptake of NPK:

The obtained results in Table (4) showed that the field canal options significantly affected the uptake of NPK by rice plant during the two growing seasons. The improved field canals increased the uptake of NPK due to the good water control, rice growth and decreased water and nutrients losses,(Wei Zhang and Song 1989, Stoop et al 2002). Irrigation by Gated pipes resulted in the highest NPK uptake by grains 46.12, 14.66 and 10.94 kg/fed., respectively in the 1st season and 48.46, 9.10 and 15.25 kg/fed., respectively in the 2nd season. The corresponding average values of NPK uptake by straw were 11.28, 5.0 and 42.22 kg/fed., respectively in the 1st season and 9.38, 5.31 and 35.18 kg/fed., respectively in the 2nd season. Irrigation of rice every 6 days interval resulted in the highest average values of NPK uptake by grains 40.85, 13.11 and 9.26 kg/fed., respectively in the 1st season and 43.12, 8.11 and 12.48 kg/fed., respectively in the 2nd season. The corresponding average values of NPK uptake by rice straw were 10.16, 4.54 and 39.36 kg/fed., respectively in the 1st season and 9.07, 4.96 and 33.71 kg/fed., respectively in the 2nd season. Irrigation interval treatments significantly affected the uptake of NPK by rice plant during the two growing seasons. Irrigation of rice at 7.5 cm submerged water head recorded the highest average values of NPK uptake by grains 40.85, 13.11 and 9.26 kg/fed., respectively in the 1st season and 43.12, 8.11 and 12.48 kg/fed., respectively in the 2nd season. The corresponding average values of NPK uptake by straw were 10.16, 4.54 and 39.36 kg/fed., respectively in the 1st season and 9.07, 4.96 and 33.71 kg/fed., respectively in the 2nd season. Submerged static head treatments significantly affected the uptake of NPK by rice plant except for K uptake by grains and P uptake by straw during the two growing seasons. Irrigation of rice at 7.5 cm submerged water head recorded the highest NPK uptake under the different irrigation intervals and field canal options during the two growing seasons. A significance responses of NPK uptake were recorded due to the interactions, O X I , O X H and O X I X H in the two growing seasons.

Table (4): Rice NPK uptake (kg/fed.) as affected by field canal options, irrigation intervals and submerged water head.

	Grain						Straw					
Treatments	2006			2007			2006			2007		
	N	P	K	N	P	K	N	P	K	N	P	K
Marwa options												
O_1	30.48	8.77	6.21	32.75	5.61	8.34	8.26	3.33	34.55	7.36	3.80	29.90
O_2	38.06	11.73	7.42	39.73	7.22	10.32	9.05	3.98	37.87	8.05	4.42	32.77
O_3	46.12	14.66	10.94	48.46	9.10	15.25	11.28	5.00	42.22	9.38	5.31	35.18
O_4	41.59	13.62	10.55	42.25	8.30	13.86	10.38	4.84	40.45	9.28	5.46	34.08
F - test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.01	0.73	0.94	0.23	0.94	0.34	1.39	0.12	0.05	0.47	0.15	0.15	0.46
LSD 0.05	0.54	0.65	0.16	0.65	0.23	0.97	0.08	0.04	0.33	0.10	0.11	0.32
Irrigation intervals												
I_1	37.28	11.28	8.30	38.48	7.00	11.40	9.32	4.13	38.19	7.97	4.54	32.25
I_2	40.85	13.11	9.26	43.12	8.11	12.48	10.16	4.45	39.36	9.07	4.96	33.71
F - test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.01	0.38	0.31	0.19	0.46	0.19	0.91	0.10	0.04	0.40	0.06	0.10	0.41
LSD 0.05	0.27	0.22	1.32	0.33	0.14	0.65	0.07	0.03	0.29	0.04	0.07	0.10
Submerged static head												
H_1	38.82	12.10	8.75	40.51	7.46	11.95	10.25	4.27	39.54	8.62	4.74	33.82
H_2	39.31	12.29	8.81	41.09	7.65	11.93	9.23	4.30	38.01	8.42	4.76	32.15
F - test	**	**	ns	**	*	ns	**	ns	**	**	ns	**
LSD 0.01	0.32	0.17	0.19	0.57	0.20	0.77	0.09	0.04	0.37	0.06	0.09	0.19
LSD 0.05	0.24	0.13	0.14	0.42	0.15	0.57	0.07	0.03	0.27	0.05	0.07	0.14
Interactions												
OXI	**	**	**	**	**	*	**	**	**	**	*	**
OXH	**	**	**	**	**	*	ns	**	ns	**	*	**
IXH	**	**	ns	ns	ns	ns	**	*	ns	ns	**	ns
OXIXH	**	**	*	**	**	ns	**	**	ns	**	ns	**

4. Nitrogen fertilizer use efficiency:

Data in Table (5) revealed that improved field canals increased the total N uptake by rice plant due to the good water control and consequently decreasing water and nutrients losses. The highest average values of total N uptake 57.41 and 57.85 kg/fed. In the 1st and 2nd seasons, respectively were recorded under gated pipes treatment. Irrigation interval every 6 days resulted in increasing the total N uptake under the different field canal options in the two growing seasons Data also showed that irrigation at submerged water head 7.5 cm increased the total N uptake comparing with 5 cm water head under the different treatments.

Regarding the nitrogen fertilizer use efficiency data in Table (5) showec that improved field canals increased the N use efficiency due to the good water control and consequently decreasing water and nutrients losses. The highest average values of N use efficiency 83.20 and 83.84 %. in the 1st and 2nd seasons , respectively were recorded under gated pipes treatment. Irrigation interval every 6 days resulted in increasing N use efficiency under the different field canal options in the two growing seasons. Data also showed that irrigation at submerged head 7.5 cm increased N use efficiency comparing with 5 cm water head under the different treatments. The highest values of N use efficiency 88.76 and 88.82 % in the 1st and 2nd seasons respectively were found when rice irrigated at 7.5 cm water head every 6 days interval under gated pipes treatment.

Table (5): Total N uptake by rice and N fertilizer use efficiency as affected by field canal options, irrigation intervals and submerged water head

Field canal options	Irrigation intervals, days	N uptake (grain + straw), kg/fed.						N fertilizer use efficiency					
		Submerged static head, cm						Submerged static head, cm					
		2006			2007			2006			2007		
		H_1	H_2	I mean	H_1	H_2	I mean	H_1	H_2	I mean	H_1	H_2	I mean
O_1	I_1	34.47	38.19	36.33	35.29	38.90	37.10	49.95	55.35	52.65	51.15	56.31	53.73
	I_2	41.72	40.60	41.16	43.62	42.70	43.16	60.46	58.83	59.65	63.22	61.87	62.55
	H mean	38.10	39.40	38.75	39.46	40.80	40.13	55.21	57.09	56.15	57.19	59.09	58.14
O_2	I_1	45.88	66.60	56.24	45.67	43.00	44.34	66.49	64.63	65.56	66.19	62.34	64.2
	I_2	50.38	47.60	48.99	49.31	52.50	50.91	73.01	68.98	71.00	71.46	76.11	73.79
	H mean	48.13	57.10	52.62	47.49	47.75	47.62	69.75	66.81	68.28	68.83	69.23	69.03
O_3	I_1	57.22	53.74	55.48	55.17	53.70	54.44	82.93	77.88	80.41	79.96	77.80	78.88
	I_2	60.18	58.49	59.34	61.24	61.30	61.27	87.22	84.77	86.00	88.76	88.82	88.79
	H mean	58.70	56.12	57.41	58.21	57.50	57.85	85.08	81.33	83.20	84.36	83.31	83.84
O_4	I_1	48.29	50.43	49.36	49.54	49.70	49.62	69.99	73.09	71.54	71.80	72.07	71.94
	I_2	56.84	52.32	54.58	53.58	54.70	54.14	82.37	75.83	79.10	77.65	79.24	78.45
	H mean	52.57	51.38	51.97	51.56	52.20	51.88	76.18	74.46	75.32	74.73	75.66	75.19

5. Applied water and water productivity:

The amount of applied water and water productivity during the two growing seasons are presented in Table (6).The obtained results cleared that improved field canals decreased the water applied to rice and increased water productivity due to the good water control and consequently decreasing water losses by seepage .Water applied decreased from 5812.2 and 5991.0 m^3 /fed. under traditional earth canal to 5266.65 and 5395.75m^3 / fed. under buried piped treatment in the 1st and 2nd seasons, respectively. On the other hand irrigation water productivity increased from 0.46 and 0.45 % under traditional earth canal to 0.59 and 0.57 % under gated pipes treatment in the 1st and 2nd seasons, respectively. Data also showed that prolonging irrigation interval from 4 days to 6 days resulted in decreasing water applied and increasing water productivity under the different canal options during the two studied seasons. Increasing the submerged static head from 5 cm to 7.5 cm increased the applied water under the different treatments. These results are in agreement with those obtained by Shawky and El - Kashef (2004) , Ibrahim *et al.* (1995) and Saied *et al.* (2007).

Table (6): Irrigation water use efficiency as affected by different treatments in 2006 and 2007 growing seasons.

Field canal options	Irrigation intervals, days	Submerged static head, cm	2006 Grain Yield ,kg/fed.	2006 Water applied, m3/fed.	2006 Irrigation water use efficiency	2007 Grain yield ,kg/fed.	2007 Water applied, m3/fed.	2007 Irrigation water use efficiency
O1	I1	H1	2492.50	5540.90	0.45	2470.00	5777.00	0.43
		H2	2712.50	5848.10	0.46	2625.00	6077.00	0.43
		Mean	2602.50	5694.50	0.46	2547.50	5927.00	0.43
	I2	H1	2740.00	5760.30	0.48	2782.50	5890.00	0.47
		H2	2827.50	6099.50	0.46	2887.50	6220.00	0.46
		Mean	2783.75	5929.90	0.47	2835.00	6055.00	0.47
	Mean		2693.13	5812.20	0.46	2691.25	5991.00	0.45
O2	I1	H1	2782.50	5249.30	0.53	2550.00	5503.00	0.46
		H2	2835.00	5664.10	0.50	2730.00	5783.00	0.47
		Mean	2808.75	5456.70	0.52	2640.00	5643.00	0.47
	I2	H1	2887.50	5533.20	0.52	2835.00	5741.00	0.49
		H2	2937.50	5706.00	0.51	2992.00	5956.00	0.50
		Mean	2912.50	5619.60	0.52	[illegible]	5848.50	0.50
	Mean		2860.63	5538.15	0.52	2776.75	5745.75	0.48
O3	I1	H1	2987.50	5117.20	0.58	2887.50	5287.00	0.55
		H2	3097.50	5339.60	0.58	2992.5.0	5496.00	0.55
		Mean	3042.50	5228.40	0.58	2887.50	5391.50	0.55
	I2	H1	3202.50	5343.60	0.60	3152.50	5452.00	0.58
		H2	3257.50	5556.10	0.59	3295.00	5671.00	0.58
		Mean	3230.00	5449.85	0.60	3223.75	5561.50	0.58
	Mean		3136.25	5339.13	0.59	3089.25	5476.50	0.57
O4	I1	H1	[illegible]	5080.50	0.54	[illegible]	[illegible]	0.53
		H2	3175.00	5245.40	[illegible]	2887.50	5301.00	0.55
		Mean	2952.50	5162.95	0.58	2827.50	5249.00	0.54
	I2	H1	3180.00	5289.20	0.60	2955.00	5473.00	0.54
		H2	3255.00	5451.50	0.60	3050.00	5612.00	0.54
		Mean	3217.50	5370.35	0.60	3002.50	5542.50	0.54
	Mean		3085.00	5266.65	0.59	2915.00	5395.75	0.54

CONCLUSION

Results obtained from this study indicated that using gated and buried pipes connected with gated pipes combined with 6 days irrigation interval at 7.5 cm submerged head increased rice productivity under old land conditions in comparison with the other study treatments. This will benefit the rice farmers in the old lands by increasing rice yield and water productivity.

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إدارة الري في حقول الأرز في منطقة شمال دلتا النيل- مصر

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* معهد بحوث الاراضى و المياة والبيئة ** المعمل المركزي للمناخ الزراعي

أجريت تجربتين حقليتين في مزرعة محطة البحوث الزراعية بسخا إثناء الموسمين الزراعيين ٢٠٠٦/٢٠٠٧ و كان الهدف هو دراسة تأثير أربعة بدائل من المراوي (مروى ترابية تقليدية ، مروى مبطنة ، مواسير مبوبة و مواسير مدفونة متصلة بالمواسير المبوبة) و دراسة فترات الري كل ٤ و ٦ أيام و تأثير عمقين لغمر المياه ٥ و ٧,٥ سم على إنتاجية محصول الأرز و بعض كفاءات الري. صممت التجربة بنظام القطع المشقة مرتين حيث وضعت بدائل المراوي في القطع الرئيسية ، فترات الري في القطع المنشقة مرة واحدة و أعماق الغمر في القطع المنشقة مرتين.و يمكن تلخيص النتائج المتحصل عليها فيما يلي :-

أدى التفاعل بين الري بالمواسير المبوبة كل ٦ أيام و بعمق ٧,٥ سم إلى تحقيق اعلي إنتاجية لمحصول الأرز و أعلى محتوى للنتروجين و الفسفور و البوتاسيوم في موسمي الدراسة.

أيضا أدى الري بالمواسير المبوبة كل ٦ أيام و بعمق ٧,٥ سم إلى الحصول على أعلى القيم لكفاءة استخدام النتروجين.

أدت المراوي المطورة بالمواسير المدفونة و المواسير المبوبة و المراوي المبطنة إلى توفير ٩,٣٦ ، ٨,١٤ ، ٤,٧٢ % من مياه الري المضافة على الترتيب بالمقارنة بالمراوي الترابية.

أدى الري بالمواسير المبوبة إلى زيادة كفاءة استخدام مياه الري من ٠,٤٦ إلى ٠,٥٨ كجم / م٣ و في نفس الوقت فان طول فترة الري من ٤ إلى ٦ أيام أدى إلى زيادة هذه الكفاءة.