J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 2 (1): 83 - 94, 2011

EFFECT OF IRRIGATION LEVELS AND CULTIVATION METHODS ON YIELD AND CROP WATER PRODUCTIVITY Of RICE

Taha, A.A.*; M.A.M. Ibrahim; G. Labeeb* and R. Kh. Darwesh****
*** Soils Dept., Fac. Agric., Mans. Univ., Egypt**
**** Soils, Water and Environment, Res. Inst. (SWERI), A.R.C., Egypt**

ABSTRACT

A field experiment was conducted at Sakha Agricultural Research Station Farm, during the two successive growing seasons (2008 and 2009) to study the effect of watering level and planting method on yield and crop water productivity of two rice varieties, Giza 177 and Egyptian Hybrid 1.

Statistical design was split split plot; main plots were allocated to planting method (broadcasting and transplanting), while sub-plots were assigned to be rice varieties (Giza 177 and Egyptian Hybrid 1). Sub-sub plots were the watering levels; watering as traditional in the area (Trad.), 75% of traditional watering (0.75 Trad.) and watering according to Ibrahim equation,1981 (Ib. eq.).

The obtained results can be summarized as follows:

Watering level affected plant height, where watering according Ibrahim equation reduced plant height of rice plant by 5.02 % in the first season and by 6.97 % in the second one.

Decreasing watering level from traditional method to 0.75 of traditional method reduced grain yield by 49 Kg fed-1 in the first season and 33 Kg fed-1 in the second season (in both seasons the difference is not significant).

Decreasing watering level from traditional method to watering according Ibrahim equation reduced grain yield by 673.5 Kg fed-1 (14.55 % reduction) in the first season and by 630 fed-1 (13.91% reduction) in the second season (in both seasons the difference is highly significant).

Grain /Straw Ratio of variety treatment means were 0.700 for Giza 177 and 0.980 for Egyptian hybrid 1 in the first season and the corresponding values of the second season were 0.770 and 0.952 . Grain /Straw Ratio of Egyptian hybrid 1 was decreased with decreasing watering level under the study .

The means of 1000 grain weight of Giza 177 were 25.68 and 25.82 gm in the first and second season, respectively. The means of 1000 grain weight of Egyptian hybrid 1 were 24.45 and 24.88 gm in the first and second season, respectively.

watering according to 0.75 of traditional + Giza 177 assigned 3.310 gm rice grain panicle-1 compared with 3.055 and 2.685 gm panicle-1 for watering as traditional + Giza177 and watering according Ibrahim equation + Giza177 treatments, respectively. The same means for the same treatments in the second season were 3.275 gm panicle-1 compared with 2.865 and 2.890 gm panicle-1, respectively.

In the first season watering according to traditional + Egyptian hybrid 1 assigned 4.385 gm rice grain panicle-1 compared with 4.025 and 3.600 gm panicle-1 for watering as 0.75 of traditional + Egyptian hybrid 1 and watering according Ibrahim equation + Egyptian hybrid 1 treatments, respectively. The same means for the same treatments in the second season were 4.540 gm panicle-1 compared with 4.165 and 3.595 gm panicle-1, respectively.

The lower Crop water productivity values (0.747 and 0.718 kg m-3) were assigned with Giza 177 and the higher values (0.895 and 0.852 kg m-3) were assigned with the latest one (Egyptian hybrid 1).

Crop water productivity of traditional watering, 0.75 of traditional watering and watering according to Ibrahim equation treatment means were 0.705, 0.850 and 0.908 kg m-3 in the first season . Similar values for the same treatments in the same order in the second season were 0.703, 0.833 and 0820 kg m-3 .

Keywords: Watering level, planting methods, rice varieties and crop water productivity.

INTRODUCTION

Water is the most important inputs for crops production. The Egyptian water share from the main water source, River Nile, is limited by 55.5 x 10^9 m^3 $year^{-1}$. This amount of water represent 95% (approximately) from national fresh water supply (Ibrahim,2003), which is not enough to meet the demand of all sectors. About 80-85% of the River Nile water supply is used in agricultural sector. Rationalize the use of irrigation water throw maximizing water use efficiency by crops becomes a must to narrow the food gap between consumptions and production.

Rice (Oryza sativa) is not only the staple food for nearly half of the world's population (most of them live in the developing countries) but also a key source of employment and income for the rural people.

Rice is the most widely grown crop under irrigation (Guera *et al.*, 1998). In Egypt there are no real problems in rice production when irrigation water is available. Soil salinity and occasional alkalinity adverse rice cultivation to varying degrees.

Basin irrigation is the common system used for watering rice in Egypt. The method involves dividing the field into small units with a small banks. Each unit has (a nearly the same level) a water inlet and outlet. The basin is filled with water and the water is retained until it evaporates or infiltrates into the soil.

Potential water saving induced by using short-season duration is 13%, FAO (2003), but the necessity to increase this value still hold. So, this work aimed to increase the potential water saving through studying the irrigation level effect on rice (tow short season verities) yield to determine the lowest level of irrigation water which do not negatively affect the grain yield .

MATERIALS AND METHODS

A field experiment was conducted at Sakha (The site lies at Kafr EL Sheikh Governorate, Middle North of the Nile Delta.) Agricultural Research Station Farm, during the two growing seasons 2008 and 2009 to study the watering level and planting method on yield and crop water productivity of two rice varieties, Giza 177 and Egyptian Hybrid 1.

Surface soil samples (20cm depth) before cultivation were taken from the experimental site, air dried and grained (2 mm-sieve), mixed to form composite sample and analyzed by using methods of Black (1965) and Jackson (1967). The experimental soil is characterized by clayey (12.2 % sand, 33.3 % silt and 54.5 % clay) soil with an EC value of 4.8 dSm^{-1} (in soil paste extract)and pH value of 8.17 (in soil paste) .

Nile water with an EC value of 0.64 dSm^{-1} was used permanently for Irrigation.

Two cultivation methods, (broadcasting and transplanting), two Short duration varieties of rice (sakha 177 and Egyptian Hybrid 1) and three irrigation water levels (Traditional watering, 7.5 cm water head above the soil, irrigation with 0.75 of the traditional watering and irrigation according to Ibrahim equation,1981.

The studied factors were arranged to form 12 treatments in split split plot design with three replicates. The experiment area was divided into 36 plots, each plot was 52.5 m2 (7.5 X 7) = (1/80 fed.), and isolated from the other to prevent horizontal water movement.

Field preparation and nursery practices were performed according to the traditional local management. Table 1 shows practices time. Weeds were chemically controlled in the first stages of plant life and manually at the latest stages.

Table 1: Date of cultural practices in the two growing seasons.

Season	Practices / Variety	Broadcasting		Transplanting		
		Sowing	Harvesting	Sowing	Transplanting	Harvesting
2008	Giza 177	May, 22	September,15	May, 22	June, 20	September,22
	Egyptian Hybrid 1	May, 22	September,23	May, 22	June, 20	September,30
2009	Giza 177	May, 15	September,7	May, 15	June, 12	September,15
	Egyptian Hybrid 1	May, 15	September,18	May, 15	June, 12	September,25

Up to 18 days old of broadcasting rice water was added as needed with accounted amount in both seasons (1945.5 and 1984.6 m^3 fed^{-1} in the first and second seasons, respectively) then watering treatments were applied.

Up to 42 days old (two weeks after transplanting) of transplanting rice water was added as needed with accounted amount in both seasons (1872 and 2263 m^3 fed^{-1} in the first and second seasons, respectively) then watering treatments were applied.

Data of Table 2 show the seasonal applied water of rice crop.

Table 2: Seasonal applied water of rice crop (m^{-3} fed.) .

Cultivation methods	Varieties		Irrigation water applied (m^3/ fed.)			Season duration	Water duty (m^3/ fed./day)		
			Trad.	0.75 trad.	Ib. eq.		Trad.	0.75 trad.	Ib. eq.
Broadcasting	Giza 177	2008	6853	5612	4643	115	59.6	48.8	40.4
	Egyptian H.1		7210	5876	4803	123	58.6	47.8	39.1
Transplanting	Giza 177		5972	4943	3961	122	48.9	40.5	32.5
	Egyptian H.1		6289	5181	4113	130	48.4	39.9	31.6
Broadcasting	Giza 177	2009	6826	5607	4914	115	59.4	48.8	31.7
	Egyptian H.1		7103	5815	5106	125	56.8	46.5	40.8
Transplanting	Giza 177		5845	4961	4443	122	47.9	40.6	36.4
	Egyptian H.1		6136	5181	4624	132	46.5	39.3	35.0

Watering or so-called irrigation interval was the same for all the studied treatments, every 6 days.

Ibrahim equation is as follows :-

$$ET\ c = ET\ p * K\ c \quad \& \quad ET\ p = 0.1642 + 0.8\ Ep$$

where: ETp = potential evapotranspiration (cm day^{-1}) ,
Ep = pan evaporation (cm day^{-1}) : ETc = crop evapotranspiration (cm day^{-1}).
Kc = crop coefficient .

Crop water productivity (C.W.P) was calculated according to Doorenbos and Pruitt (1977) as follows:
C.W.P = Grain yield (kg fed^{-1})/ Irrigation water applied (m^3 fed^{-1}).

Data were statistically analyzed according to Snedecor and Cochran (1967). Mean values were compared at 5 % level of significance by using LSD.

RESULTS AND DISCUSSION

Data of Table 3 show that, each of planting method, planting method-variety interaction, planting method – watering interaction, watering variety interaction and planting method – variety - watering interaction did not significantly affect plant height under this study in both seasons.

No significant differences were also found between verities because both of the used varieties are short dwarf .

In both seasons watering level affects plant height, where a significant effect was found due to applying traditional irrigation method compared with the two other watering levels. Plant height of watering level treatment means were 99.6, 94.7 and 94.6 cm in the first season for traditional watering, Irrigation with 0.75 of the traditional watering and irrigation according to Ibrahim equation, respectively. In the second season similar values were 100.5, 96.1 and 93.5.

Table 3: Effect of watering levels, planting methods, varieties and their interactions on plant height (cm.).

Planting methods	varieties	2008						2009					
		Watering level											
		Trad.		0.75 trad.		Ib. eq.		Trad.		0.75 trad.		Ib. eq.	
Broadcasting	Giza 177	96.3		91		91		95.3		94.6		93	
	EgyptianH.1	101		95.3		95		102.6		97.3		92.3	
Transplanting	Giza 177	99		95.6		94		103		96.3		93.3	
	EgyptianH.1	102		97		98.3		101		96.3		95.3	
F test		P NS	V NS	W *	PV NS	PW NS	WV NS	P NS	V NS	W *	PV NS	PW NS	WV NS
LSD at 5%		-	-	4.12	-	-	-	-	-	4.09	-	-	-

Planting method – variety – watering level interaction did not have any significant effect.
Trad:- traditional watering **0.75 Trad:- 0.75 traditional watering**
Ib. eq. watering according to Ibrahim equation **P:- planting methods**
V:- varieties **W:- watering levels**
PV :- planting methods – varieties interaction .
PW:- planting methods – watering levels interaction
WV:- watering levels – variety interaction

Numerical data showed that watering according Ibrahim equation reduced plant height of rice plant by 5.02 % in the first season and by 6.97 % in the second season.

Data also pointed out that Egyptian hybrid 1 variety under any conditions has the highest mean of plant height than that of Giza 177 .

Transplanting method mostly recorded a highest mean of plant height than that of broadcasting method .

Data of Table 4 illustrate plant method - variety -watering level treatment means of rice grain yield.

Rice grain yield significantly differed according to variety, watering level and watering level – variety interaction in both seasons.

Giza 177 recorded 3880 and 3825 Kg grains fed^{-1} in the first and second season, respectively. Egyptian hybrid 1 recorded 4888 and 4796 Kg grains fed^{-1} in the first and second season, respectively (25% and 24.41% increase than that of Giza 177).

Decreasing watering level from traditional watering to 0.75 of traditional watering reduced grain yield from 4625 to 4576 Kg fed-1 (49 kg decrease) in the first season and from 4532 to 4499 Kg fed-1 (33 kg decrease) in the second season (in both seasons the difference is not significant). These results are in agreement with that of Saied *et al.* (1995).They studied water regime effects on rice plant and concluded that water submersion depth over 5 cm is a waste water.

Table 4: Effect of watering levels, planting methods, varieties and their interactions on rice grain yield (kg fed^{-1}.).

Planting methods	varieties	2008			2009		
		Watering level					
		Trad.	0.75 trad.	Ib. eq.	Trad.	0.75 trad.	Ib. eq.
Broadcasting	Giza 177	3760	3960	3533	3771	3971	3533
	EgyptianH.1	5110	4760	4060	5040	4648	3990
Transplanting	Giza 177	3960	4333	3733	3743	4266	3666
	EgyptianH.1	5670	5250	4480	5573	5110	4420

F test	P	V	W	PV	PW	WV	P	V	W	PV	PW	WV
	*	**	**	NS	NS	**	NS	**	**	NS	NS	**
LSD at 5%	285.8	233.4	246.4	-	-	384.4	-	213.1	279.1	-	-	394.7

Planting method – variety – watering level interaction did not have any significant effect.
Trad:- traditional watering **0.75 Trad:- 0.75 traditional watering**
Ib. eq. watering according to Ibrahim equation **P:- planting methods**
V:- varieties **W:- watering levels**
PV :- planting methods – varieties interaction .
PW:- planting methods – watering levels interaction
WV:- watering levels – variety interaction

Decreasing watering level from traditional method to watering according Ibrahim equation reduced grain yield by 673.5 Kg (14.55 % reduction) in the first season and by 630 Kg (13.91% reduction) in the second season (in both seasons the difference is highly significant). These results are in agreement with that of El-Bably *et al*. (2007). They outlined that both submerged depths of 10 and 7 cm significantly increased grain yield compared to submerged depth of 4 cm.

Watering according to 0.75 of traditional – Giza 177 treatment means were 4147 and 4119 Kg grain fed^{-1} in the first and second season, respectively. Watering according to traditional method – Egyptian hybrid 1 treatment means were 5390 and 5307 Kg grain fed^{-1} in the first and second season, respectively.

Planting method showed a significant effect in the first season only where transplanting method recorded the highest mean regarding to grain yield (8.91% and 7.34% increase for the first and second season , respectively)

Data of Table 5 reveal that planting method, planting method-variety interaction, planting method-watering level interaction, watering level – variety interaction and planting method – variety – watering level interaction did not significantly affect rice straw yield.

Rice straw yield significantly differed according to watering level. The highest means of rice straw were obtained from traditional watering application (5340 and 5253 Kgfed^{-1}).

Reducing watering level from traditional to 0.75 of traditional caused a decrease in rice straw amounted by 258 and 182 Kg fed^{-1} in the first and in the second season, respectively. Watering according to Ibrahim equation reduced rice straw yield of rice by 608 Kg fed^{-1}

Both of the studied varieties showed the same trend of response due to application of the studied factors, where non significant difference was found in rice straw between varieties.

The highest straw yield was obtained with the treatment of transplanting method-traditional watering – Egyptian hybrid 1, 5426 kg fed^{-1} in the first season and 5380 kg fed $^{-1}$ in the second season.

Table 5: Effect of watering levels, planting methods, varieties and their interactions on rice straw yield (kg fed^{-1}.)

Planting methods	varieties	2008						2009					
		Watering level											
		Trad.		0.75 trad.		Ib. eq.		Trad.		0.75 trad.		Ib. eq.	
Broadcasting	Giza 177	5222		5116		4762		5192		5082		4663	
	EgyptianH.1	5320		5282		4766		5320		5188		4796	
Transplanting	Giza 177	5390		4735		4620		5120		4793		4550	
	EgyptianH.1	5426		5193		4780		5380		5222		4690	
F test		P Ns	V Ns	W *	PV NS	PW NS	WV Ns	P NS	V Ns	W *	PV NS	PW NS	WV Ns
LSD at 5%		-	-	440.1	-	-	-	-	-	435.4	-	-	-

Planting method – variety – watering level interaction did not have any significant effect.
Trad:- traditional watering **0.75 Trad:- 0.75 traditional watering**
Ib. eq. watering according to Ibrahim equation **P:- planting methods**
V:- varieties **W:- watering levels**
PV :- planting methods – varieties interaction .
PW:- planting methods – watering levels interaction
WV:- watering levels – variety interaction

Data presented in Table 6 reveal the values of grain / straw ratio as affected by treatments under the study. Non of the studied factors and their interactions significantly affect Grain /Straw Ratio except for variety factor.

Grain /Straw Ratio of variety treatment means were 0.700 for Giza 177 and 0.980 for Egyptian hybrid 1 in the first season and the corresponding values of the second season were 0.770 and 0.952 .

Two seasons mean of Grain /Straw Ratio for Giza 177 is 0.735 and for Egyptian hybrid 1 is 0.966 .

In the time where no significant effect was found for watering level on Grain /Straw Ratio of varieties we must mention that; Grain /Straw Ratio of Giza 177 was increased with decreasing watering level from traditional to 0.75 of traditional watering in both season for both planting methods.

Grain /Straw Ratio of Egyptian hybrid 1 was decreased with decreasing watering level under the study .

The highest grain / straw ratio was obtained with the treatment of transplanting method -traditional watering – Egyptian hybrid 1 , 1.09 in the first season and 1.06 in the second season.

Table 6: Effect of watering levels, planting methods, varieties and their interactions on grain/ straw ratio.

Planting methods	varieties	2008						2009					
		Watering level											
		Trad.		0.75 trad.		Ib. eq.		Trad.		0.75 trad.		Ib. eq.	
Broadcasting	Giza 177	0.74		0.77		0.66		0.74		0.79		0.76	
	EgyptianH.1	0.98		0.96		0.88		0.94		0.91		0.83	
Transplanting	Giza 177	0.67		0.70		0.66		0.70		0.82		0.81	
	EgyptianH.1	1.09		1.03		0.94		1.06		1.03		0.94	
F test		P Ns	V **	W NS	PV NS	PW NS	WV Ns	P NS	V **	W NS	PV NS	PW NS	WV Ns
LSD at 5%		-	0.102	-	-	-	-	-	0.082	-	-	-	-

Planting method – variety – watering level interaction did not have any significant effect.
Trad:- traditional watering **0.75 Trad:- 0.75 traditional watering**
Ib. eq. watering according to Ibrahim equation **P:- planting methods**
V:- varieties **W:- watering levels**
PV :- planting methods – varieties interaction .
PW:- planting methods – watering levels interaction
WV:- watering levels – variety interaction

Data of Table 7 show that planting method, planting method-variety interaction, planting method-watering level interaction, watering level – variety interaction and planting method – variety – watering level interaction did not significantly affect 1000 grain weight of rice.

There is no any significant difference between the studied varieties treatment means (Giza177 and Egyptian hybrid 1) was found. The means of 1000 grain weight of Giza 177 were 25.68 and 25.82 gm in the first and second season, respectively. The means of 1000 grain weight of Egyptian hybrid 1 were 24.45 and 24.88 gm in the first and second season, respectively.

Watering level significantly affected 1000 grain weight of rice as shown in Table 7 but the difference between traditional watering treatment mean and 0.75 of traditional watering treatment mean in both seasons is not significant. Watering level according to Ibrahim equation significantly reduced 1000 grain weight of rice compared with other watering level treatments.

Traditional watering recorded 25.675 and 26.0 gm as 1000 grain weight in the first and second season . watering with 0.75 of traditional recorded 26.225 and 26.650 gm as 1000 grain weight in the first and second season. Watering according Ibrahim equation recorded 23.300 and 23.400 gm as 1000 grain weight in the first and second season. These results are in agreement with that of El-Bably *et al.* (2007). They outlined both submerged depths of 10 and 7 cm significantly increased 1000-grain weight compared to submerged depth of 4 cm.

The highest 1000grain weight of rice (27.6) was obtained with the treatment of transplanting method – 0.75 of traditional watering – Giza 177, in the second season.

Table (7): Effect of watering levels, planting methods, varieties and their interactions on 1000grain weight of rice

Planting methods	varieties	2008						2009					
		Watering level											
		Trad.		0.75 trad.		Ib. eq.		Trad.		0.75 trad.		Ib. eq.	
Broadcasting	Giza 177	27.2		28.9		22.2		26.5		27.6		22.1	
	EgyptianH.1	26.2		25.7		24.9		26.8		26.7		22.7	
Transplanting	Giza 177	25		26.2		24.6		26		27.6		25.1	
	EgyptianH.1	24.3		24.1		21.5		24.7		24.7		23.7	
F test		P Ns	V Ns	W *	PV NS	PW NS	WV Ns	P Ns	V Ns	W *	PV NS	PW NS	WV Ns
LSD at 5%		-	-	1.91	-	-	-	-	-	1.62	-	-	-

Planting method – variety – watering level interaction did not have any significant effect.
Trad:- traditional watering **0.75 Trad:- 0.75 traditional watering**
Ib. eq. watering according to Ibrahim equation **P:- planting methods**
V:- varieties **W:- watering levels**
PV :- planting methods – varieties interaction .
PW:- planting methods – watering levels interaction
WV:- watering levels – variety interaction

As shown in Table 8 grain weight per panicle significantly differed according to varieties, watering level and their interaction. Egyptian hybrid 1 recorded the highest mean in both seasons (4.003 and 4.100 gm panicle^{-1}) and Giza 177 recorded the lowest mean in both season (3.017 and 3.010gm panicle^{-1}).

A slight difference was noticed due to watering level decrease from traditional level to 0.75 of traditional level in both seasons (from 3.720 to 3.668 gm panicle^{-1} in the first season and from 3.703 to 3.720 gm panicle^{-1} in the second season).

Sharp decrease was noticed due to decrease watering level from traditional level or 0.75 of traditional level to watering level according Ibrahim equation in both seasons.

Watering level according Ibrahim equation treatment assigned 3.143 and 3.243 gm panicle^{-1} in the first and second season, respectively

Regarding to variety –watering level interaction, in the first season, watering according to 0.75 of traditional + Giza 177 assigned 3.310 gm panicle^{-1}) compared with 3.055 and 2.685 gm panicle^{-1} for watering as traditional + Giza177 and watering according Ibrahim equation + Giza177 treatments, respectively. The same means for the same treatments in the second season were 3.275 gm panicle-1 compared with 2.865 and 2.890 gm panicle^{-1}, respectively.

In the first season watering according to traditional + Egyptian hybrid 1 assigned 4.385 gm panicle^{-1} compared with 4.025 and 3.600 gm panicle^{-1} for watering as 0.75 of traditional + Egyptian hybrid 1 and watering according Ibrahim equation + Egyptian hybrid 1 treatments, respectively. The same means for the same treatments in the second season were 4.540 gm panicle-1 compared with 4.165 and 3.595 gm panicle^{-1}, respectively.

The highest weight of grain rice panicle^{-1} (4.65) was obtained with the treatment of broadcasting method –traditional watering – Egyptian hybrid 1, in the second season.

Table (8): Effect of watering levels, planting methods, varieties and their interactions on rice grain weight (gm per panicle) .

Planting methods	varieties	2008						2009					
		Watering level											
		Trad.		0.75 trad.		Ib. eq.		Trad.		0.75 trad.		Ib. eq.	
Broadcasting	Giza 177	3.00		3.15		2.62		2.82		3.10		2.99	
	EgyptianH.1	4.43		3.95		3.46		4.65		4.17		3.39	
Transplanting	Giza 177	3.11		3. 47		2.75		2.91		3.45		2.79	
	EgyptianH.1	4.34		4.10		3.74		4.43		4.16		3.80	
F test		P NS	V **	W *	PV NS	PW NS	WV **	P Ns	V **	W *	PV NS	PW NS	WV **
LSD at 5%		0.495	0.040	0.0.29	-	-	0.453	-	0.046	0.340	-	-	0.481

Planting method – variety – watering level interaction did not have any significant effect.
Trad:- traditional watering **0.75 Trad:- 0.75 traditional watering**
Ib. eq. watering according to Ibrahim equation **P:- planting methods**
V:- varieties **W:- watering levels**
PV :- planting methods – varieties interaction .
PW:- planting methods – watering levels interaction
WV:- watering levels – variety interaction

Data of Table 9 illustrate that factors under the study significantly affected crop water productively but their interactions did not significantly affect the same trait .

Broadcasting method in both season assigned lower (.728 and 0.713 kg m-3) values than that of transplanting method (0.913 and 0.857 kg m-3), where the amount of water applied is dependant on planting method to a large extent (a lower amount was applied with transplanting method) so the same method of planting positively affects crop performance and increases the grain yield. These results are in a disagreement trend with that of Gill(2006). Who stated that water productivity in direct-seeded rice as kg grain m-3 was higher than that of transplanting method.

A significant difference between variety means was found regarding to crop water productivity in both season. The lower values (0.747 and 0.718 kg m^{-3}) were assigned with Giza 177 and the higher values (0.895 and 0.852 kg m^{-3}) were assigned with Egyptian hybrid 1.

In the first season crop water productivity of traditional watering, 0.75 of traditional watering and watering according to Ibrahim equation treatments were 0.705, 0.850 and 0.908 kg m^{-3} . Similar values for the same treatments in the same order were 0.703, 0.833 and 0820 kg m-3 . These results are in agreement with that of Mehla *et al.* (2006). They found that water use efficiency in terms of grain yield m-3 was highest with the treatment of irrigation three days after disappearance of standing water compared with the other treatments (irrigation one day after disappearance of standing water and continuous submergence).

The highest value of crop water productivity (1.09) was obtained with the treatment of transplanting method–irrigation according Ibrahim equation– Egyptian hybrid 1, in the first season.

Table 9: Effect of watering levels, planting methods, varieties and their interactions on rice crop water productivity(kg m^{-3}).

Planting methods	varieties	2008						2009					
		Watering level											
		Trad.		0.75 trad.		Ib. eq.		Trad.		0.75 trad.		Ib. eq.	
Broadcasting	Giza 177	0.55		0.70		0.75		0.55		0.72		0.72	
	EgyptianH.1	0.71		0.81		0.85		0.71		0.80		0.78	
Transplanting	Giza 177	0.66		0.88		0.94		0.64		0.85		0.83	
	EgyptianH.1	0.90		1.01		1.09		0.91		0.96		0.95	
F test		P **	V **	W **	PV NS	PW NS	WV Ns	P **	V **	W **	PV NS	PW NS	WV Ns
LSD at 5%		0.046	0.022	0.044	-	-	-	0.050	0.034	0.089	-	-	-

Planting method – variety – watering level interaction did not have any significant effect.
Trad:- traditional watering **0.75 Trad:- 0.75 traditional watering**
Ib. eq. watering according to Ibrahim equation **P:- planting methods**
V:- varieties **W:- watering levels**
PV :- planting methods – varieties interaction .
PW:- planting methods – watering levels interaction
V:- watering levels – variety interaction

Conclusion

It can be concluded that watering level of 0.75 of traditional did not reduce rice grain yield more than 50 Kg fed^{-1} for both studied varieties, in the same time it saves not less than 21 % of irrigation water under broadcasting method. The saved water enable to produce 830 and 976 Kg rice grain of Giza 177 and Egyptian hybrid 1, respectively. Under transplanting conditions the saved water (amounted by not less than 18 %) enable to produce 673 and 945 Kg rice grain of Giza 177 and Egyptian hybrid 1, respectively.

Using Egyptian hybrid 1 enable to produce more grain yield m^{-3} of irrigation water than that of Giza 177.

REFERENCES

Black, C. A. (1965). Methods of Soil and Water Analysis. Part 2 : Madison, Wisconsin, USA.

Doorenbos, J. and W.O. Pruitt (1977). Guidelines for predicting crop water requirements . FAO Irrig. Drain. pp. 24.

El-Bably, A.Z; A.A. Abd-Allah and M.I Meleha (2007). Influence of field submergence depths on rice productivity in North Delta, Egypt. Alexandria-Journal-of-Agricultural-Research, 52(2): 29-35.

FAO (2003). Rice Irrigation in the Near East: Current Situation and Prospects for Improvement. FAO Regional Office for the Near East Cairo, Egypt. pp 36.

Gill M.S.; Ashwani-Kumar and Pardeep-Kumar (2006). Growth and yield of rice (Oryza sativa) cultivars under various methods and times of sowing. Indian Journal of Agronomy. 51(2): 123-127.

Guerra L.C.; S.I. Bhuiyan; T.P. Tuong and R. Barker (1998). Producing More Rice with Less Water from Irrigated Systems. SWIM Paper 5, International Rice Research Institute (IRRI) – International Water Management Institute (IWMI).

Ibrahim, M.A.M. (1981). Evaluation of different methods for calculating potential evapotranspiration in North Delta Region. Ph.D. thesis, Soil& Water Sci., Fac. Of Agric., Alex. Univ.

Ibrahim, M.(2003). Rice Irrigation in Egypt. FAO Regional Office for the Near East.

Jackson, M. T. (1967). Soil Chemical Analysis, Printic Hall of India. Pivate, NewYork. USA.

Mehla D.S.; J.P. Singh and K.K. Bhardwaj (2006). Effect of nitrogen and water management practices on the yield and nutrient uptake by rice crop. Haryana-Journal-of-Agronomy. 22(1): 52-55.

Saied, M.M.; M.S.M. Abo Soliman; S.M. El-Barbary and S.A. Abd El-Hafez. (1995). Influence of water regimes on the growth, yield and water utilization efficiency of rice crop. J. Agric. Sic. Mansoura univ., 20(1): 543-551.

Snedecor, G.W. and W.G. Corchran (1972). "Statistical Methods" 6th Ed. Iowa State Univ., Ames. Iowa.

تأثير مستوي مياه الري وطريقة الزراعة علي محصول وإنتاجية وحدة المياه لمحصول الأرز.

أحمد عبد القادر طه*، محمد عبد الفتاح محمد إبراهيم، جمعه لبيب * و رضا خالد درويش****

*** قسم الأراضى - كلية الزراعه - جامعة المنصوره**

**** معهد بحوث الأراضي والمياه والبيئه- مركز البحوث الزراعيه**

أقيمت تجربه حقلية بمحطة البحوث الزراعية بسخا- كفرالشيخ خلال موسمي ٢٠٠٨ و٢٠٠٩ وذلك لدراسة تأثير مستويات الري و طرق الزراعة ا لمختلفة على المحصول و بعض العلاقات المائية لبعض أصناف الأرز ، وذلك بهدف تحديد أنسب مستوى ماء رى يحقق أقصى كفاءة استعمال للمياه دون التأثير المعنوى على المحصول وذلك باستخدام تصميم تجريبى فى قطع منشقة مرتين .

مستويات الرى المستخدمة هى الري التقليدي (٧.٥ سم أو٣ بوصه) و الري بـ ٧٥% من التقليدي و الري طبقا لمعادلة ابراهيم (١٩٨١). طرق الزراعة المستخدمة هى الزراعه البدار و الزراعه الشتل . الأصناف المستخدمة هى جيزه ١٧٧ و هجين مصري ١

وكان أهم النتائج مايلى :-

- أثرت مستويات الري علي صفة طول النبات بشكل واضح . وحققت معاملة الري طبقا لمعادلة أبراهيم نقصا واضحا في طول نبات الارز قدر ب ٥.٠٢ % في الموسم الاول و ٦.٩٧% في الموسم الثاني
- نقص كيات مياه الري من الطريقه المعتاده الي ٠.٧٥ من الطريقه المعتاده ادي الي نقص في محصول الحبوب قدره ٤٩ كجم في الموسم الاول و٣٣ كجم في الموسم الثاني وهذا النقص غير معنوي في كلا الموسمين
- الري طبقا لمعادلة ابراهيم ادي الي نقص محصول الحبوب في الموسم الاول بما يعادل ٦٧٣.٥ كجم / فدان (١٤.٥٥ %) وفي الموسم الثاني ٦٣٠ كجم (١٣.٩١%) هذا النقص في كلا الموسمين معنوي جدا
- نسبة الحبوب الي القش كمتوسطات لمعاملات الاصناف كانت ٠.٧ للصنف جيزه ١٧٧ و٠.٩٨٠ للصنف هجين مصري ١ في الموسم الاول بينما كانت القيم المناظره للسابقه في الموسم الثاني

٠.٧٧ و٠.٩٥٢ علي الترتيب . ولقد لوحظ انخفاض نسبة الحبوب الي القش للصنف هجين مصري ١ بنقص مستويات المياه المضافه.

- متوسط وزن ال١٠٠٠ حبه للصنف جيزه ١٧٧ كانت ٢٥.٦٨ و ٢٥.٨٢ جرام في الموسم الاول والثاني علي الترتيب . أما متوسط وزن ال١٠٠٠ حبه للصنف هجين مصري ١ فهي ٢٤.٤٥ و ٢٤.٨٨ جرام في الموسم الاول والثاني علي الترتيب
- الري ب ٠.٧٥ من المعتاد مع الصنف جيزه ١٧٧ حقق ٣.٣١ جرام كوزن حبوب للسنبله الواحده مقارنتة ب ٣.٠٥٥ و ٢.٦٨٥ جرام / السنبله لمعاملات الري المعتاد مع جيزه ١٧٧ و الري طبقا لمعادلة ابراهيم مع جيزه ١٧٧ علي التوالي في الموسم الاول والقيم المناظره لذات المعاملات في الموسم الثاني كانت ٣.٢٧٥ و٢.٨٦٥ و ٢.٨٩٠ جرام حبوب/ للسنبله
- الري المعتاد مع الصنف هجين مصري ١ حقق وزن حبوب للسنبله ٤.٣٨٥ جرام مقارنة بـ ٤.٠٢٥ و ٣.٦٠٠ جرام للسنبلة لمعاملات الرى ٠.٧٥ من المعتاد مع هجين مصرى ١ ومعادلى الرى طبقا لمعادلة ابراهيم مع هجين مصرى ١ على الترتيب فى الموسم الأول والقيم المناظرة للقيم السابقة فى الموسم الثانى هى ٤.٤٥٠ و ٤.١٦٥ و ٣.٥٩٥ جرام للسنبلة على التوالى .
- أقل قيم للإنتاجية المحصولية من وحدة الماء (٠.٧٤٧ و ٠.٧١٨ كجم م) حققها الصنف جيزه ١٧٧ والقيم الأعلى (٠.٨٩٥ و ٠.٨٥٢ كجم م $^{-٣}$) حققها الصنف هجين مصرى ١ للموسمين الأول والثانى على الترتيب .
- متوسط الإنتاجية المحصولية لوحدة المياه لمعاملات الرى المعتاد و ٠.٧٥ من الرى المعتاد والرى طبقا لمعادلة ابراهيم هى ٠.٧٠٥ و ٠.٨٥٠ و ٠.٩٠٨ كجم م $^{-٣}$ فى الموسم الأول والقيم المناظرة لنفس المعاملات بنفس الترتيب فى الموسم الثانى هى ٠.٧٠٣ و ٠.٨٣٣ و ٠.٨٢٠ كجم م $^{-٣}$

من النتائج المتحصل عليها يمكن التوصية بالآتى

- الرى بما يعادل ٠.٧٥ من الكميات المعتادة (٥.٦ سم كإرتفاع لمياه الرى فوق سطح التربه وتكرار ذلك كل ٦ أيام) أدى إلى نقص قدره لايتجاوز ٥٠ كجم حبوب للفدان وفى ذات الوقت أدى إلى توفير ما لا يقل عن ٢١ % من كميات المضافة عند الزراعة البدار وهذه الكمية من المياه يمكن أن تنتج مالا يقل عن ٨٣٠ كجم من الحبوب للصنف جيزه ١٧٧ و ٩٧٦ كجم تقريبا من الصنف هجين مصرى ١ . واستخدام نفس معاملة الرى عند الزراعة بالشتل أدت إلى توفير ما لا يقل عن ١٨ % وهى ماتكفى لأنتاج ٦٧٣ كجم للصنف جيزه١٧٧ و ٩٤٥ كجم للصنف هجين مصرى ١ .
- فى حالة توفر فرصة الإختيار بين الصنفين جيزه ١٧٧ و هجين مصرى ١ ينصح باستخدام الصنف هجين مصرى ١ لأنه يحقق أعلى انتاجية بالنسبة لوحدة المياه مقارنة بالصنف جيزه ١٧٧ .

قام بتحكيم البحث

أ.د / السيد محمود فوزي الحديدي — **كلية الزراعة – جامعة المنصورة**

أ.د / ماهر محمد السيد كساب — **مركز البحوث الزراعية**