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SAVING IRRIGATION WATER AND IMPROVING WATER PRODUCTIVITY IN RICE CULTIVATION BY INDUCING NEW PLANTING METHOD IN NORTH NILE DELT, EGYPT

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ABSTRACT

Two field experiments were conducted at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, Egypt. The site is allocated at 31^0-07' N Latitude, 30^0-57'E Longitude with an elevation of about 6 metres above mean sea level, during the two successive seasons of 2009 and 2010. The rice cultivar was Sakha 104. The experiment was designed as a split split-plot design with four replicates. The main plots were randomly occupied by two nitrogen resources urea (F_1) and gaseous ammonia (F_2). While two planting methods treatments; traditional transplanting in flooded soil (M_1) and Transplanting in beds (M_2) were assigned to sub-plots and three irrigation depths 9, 7 and 5 cm for d_1, d_2 and d_3, respectively.

Results showed that both submerged depth of 9 and 7 cm significantly increased plant height, number of tillers/m^2,panicle weight and 1000 grain weight compared to submerged depth of 5 cm, there were no significant differences between submerged depth of 9 and 7 cm . Planting in bottom of beds significantly increased grain yield, number of tillers/hill, number of panicles/hill, panicle length, plant height, Panicle weight and 1000 grains weight by 3.45%, 6.2%, 6.7%, 19.9%, 4.9 %,0.58% and 1.6%, respectively compared with traditional planting method. There were no significant differences in grain yield between nitrogen resources, urea and gaseous ammonia. Average amounts of the applied irrigation water were 13933, and 10997 m^3/ha. for traditional planting and planting in bottom of beds respectively, i.e. method of planting in bottom of bed saved about 21% of the irrigation water applied. Productivity of irrigation water was increased significantly by 58%.

Therefore, method of planting in bottom of beds could be applied for the rice in North Delta Egypt, it enhanced WP by 67.1% and saved water by 21% without significant reduction in its yield, compared with traditional planting.

Abbreviations: Productivity of irrigation water (PIW), irrigation water applied (IWA), grain yield (GY), Straw yield (SY), nitrogen resources (F) Planting method (M), and depth of irrigation water (d).

Keywords: Rice; irrigation; water saving; water productivity

INTRODUCTION

Egypt presently has the highest average national rice yield in the world; however, the country's rice output must be increase by 20% over the next decade just to maintain current levels of consumption. This will be difficult because the yield level is already high, and because of increasing competition for water with growing water shortages that affect all sectors. Water availability is becoming progressively more limited, as an increasing population creates competing demands for this precious resource. The challenge for agricultural researchers is to find ways to reduce the water used in rice production while continue to increase yields.

Improving water productivity (WP is an important strategy for addressing future water scarcity which is driven particularly by population growth and potential changes in climate and land use. Improving WP in agriculture will reduce competition for scarce water resources, mitigate environmental degradation and enhance food security simply because by producing more food with less water rewards the saved water to other natural and human uses (Rijsberman, 2001 and Molden *et al.,* 2001).

Furrow-irrigated rice-production systems have recently begun to receive increased attention among rice producers and media outlets. Furrow-irrigation can generally saturate the soil and may be similar to flood-irrigation (Vories *et al.,* 2002). Nitrogen fertilizer application timings and rates in furrow-irrigated rice have been investigated (Bollich *et al.,* 1988; Wells *et al.,* 1991). Vories *et al.* (2002) observed a 15.6% yield reduction in furrow-irrigated rice compared to flood-irrigated rice.

Beecher *et al.* (2006) showed that rice crop water use was significantly different between the layout-irrigation treatments. The Flat, Bed 5 and Bed 15 treatments had similar input (irrigation + rainfall-surface drainage) water use (mean of 18.3 ML/ha). The water use for the Furrow treatment was 17.2 ML/ha and for the Furr/Drip treatment, 15.1 ML/ha. Input WP of the Flat treatment (0.68 t/ML) was higher than the raised bed treatments, which were all similar (mean 0.55 t/ML). This single season experiment shows that high yielding rice crops can be successfully grown on raised beds, but when beds are ponded after panicle initiation, there is no water saving compared with rice grown on a conventional flat layout.

Choudhury *et al.* (2007) indicated that Rice yields on raised beds that were kept around field capacity were 32-42% lower than under flooded transplanted conditions and, 21% lower than under flooded wet-seeded conditions. Water inputs were reduced by 32-42% compared with flooded rice, but could also be accomplished with dry seeding on flat land with the same water management. Reduced water inputs and yield reductions balanced each other, so that water productivity was comparable among most treatments.

Jagroop Kaur *et al.* (2007) studied the effects of different planting techniques on the growth, productivity and water saving in paddy. Treatments comprised: transplanting in flat puddle field with 15- or 30-day-old seedlings (33 plants m^{-2}), transplanting in furrows with 15-day-old seedlings (22 or 33 plants m^{-2}), transplanting in furrows with 30-day-old seedlings (22 or 33 plants m^{-2}), transplanting on beds with 15-day-old seedlings, transplanting on beds with 30-day-old seedlings (22 or 33 plants m^{-2}), direct sowing in rows in flat unpuddled field and direct broadcasting. They found that grain yield of rice transplanted in furrows and on beds was at par with recommended planting method of flat transplanting. The rice transplanted with 15- or 30-day-old seedlings and by using 22 or 33 plants m^{-2} produced statistically similar grain yield. The furrow and bed transplanting saved 119.5 cm (39.0%) irrigation water from puddling to harvest and 44.2 to 50.0% more water expense efficiency than the recommended practice of flat transplanting under same age (30 days) of seedlings.

Atta (2005) found that by applying the innovative planting method for cv. Sakha 104 obtained the highest grain yield per hectare, compared with traditional planting (3.4% increment). He also indicated reduction of the total water applied from 14870 m^3 ha^{-1} to 9545 m^3 ha^{-1}, this achieved water saving of 35.8% of the total water applied and increased water use efficiency from

0.66 to 1.06 kg m^{-3} (60.6% increment). Atta *et al.* (2006) showed that planting in strips of furrows 80 cm wide resulted in the highest value of grain yield (9.05 ton ha^{-1}) , followed by planting in strips of furrows 60 cm wide (9.00 ton ha^{-1}) and traditional planting (8.71 ton ha^{-1}). They also indicated that irrigation water applied was 9028.6, 10047.6, and 15628.6 m^3 ha^{-1}, respectively, and water use efficiency values were 1.0, 0.896 and 0.558 kg grain m^{-3} of water applied for planting in stripes of furrows 80 cm wide, planting in strips of furrows 60 cm wide and traditional planting, respectively. In comparison with traditional planting, saving water values were 42.23%, and 35.71% for planting in strips of furrows 80 cm, planting in stripes of furrows 60 cm wide, respectively. Choudhury *et al.* (2007) showed that Rice yields on raised beds that were kept around field capacity, were 32–42% lower than under flooded transplanted conditions and 21% lower than under flooded wet-seeded conditions. Water inputs were reduced by 32–42% compared with flooded rice, but could also be accomplished with dry seeding on flat land with the same water management. Reduced water inputs and yield reductions balanced each other so that water productivity was comparable among most treatments

The objective of this investigation was to produce more rice with less water by inducing planting methods in North Delta, Egypt.

MATERIALS AND METHODS

A field experiment was carried out during the two successive rice growing seasons of 2009 and 2010 at Crops Water Requirement Research Field, Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. The site is allocated at 31-07' N Latitude, 30-57'E Longitude with an elevation of about 6 meters above mean sea level. The site represents the conditions and circumstances of North Nile Delta region. The soil of the experimental site was clayey texture and contained 53.1% clay, 32.7% silt and 14.2% sand. The average of the electrical conductivity of soil salinity over 0-60 cm depth was 1.62 dSm^{-1}, the electrical conductivity of irrigation water was 0.50 dSm^{-1}. The preceding crop was clover in both seasons.

The experiment was designed as a split split-plot design with four replicates. The main plots were randomly occupied by two nitrogen resources urea (F_1) and gaseous ammonia (F_2). While planting methods were in the sub plots. Planting methods were traditional transplanting on flat soil (M_1), and transplanting in bottom of bed (M_2).The sub-sub-plots were occupied by three irrigation depths(d_1) 9, (d_2) 7 and (d_3) 5 cm. The raised beds were 20 cm high x 45 cm wide with 80-cm distance from mid bed to mid another fig (1). The plots were isolated by ditches of 2.5 m in width to avoid lateral movement of water.

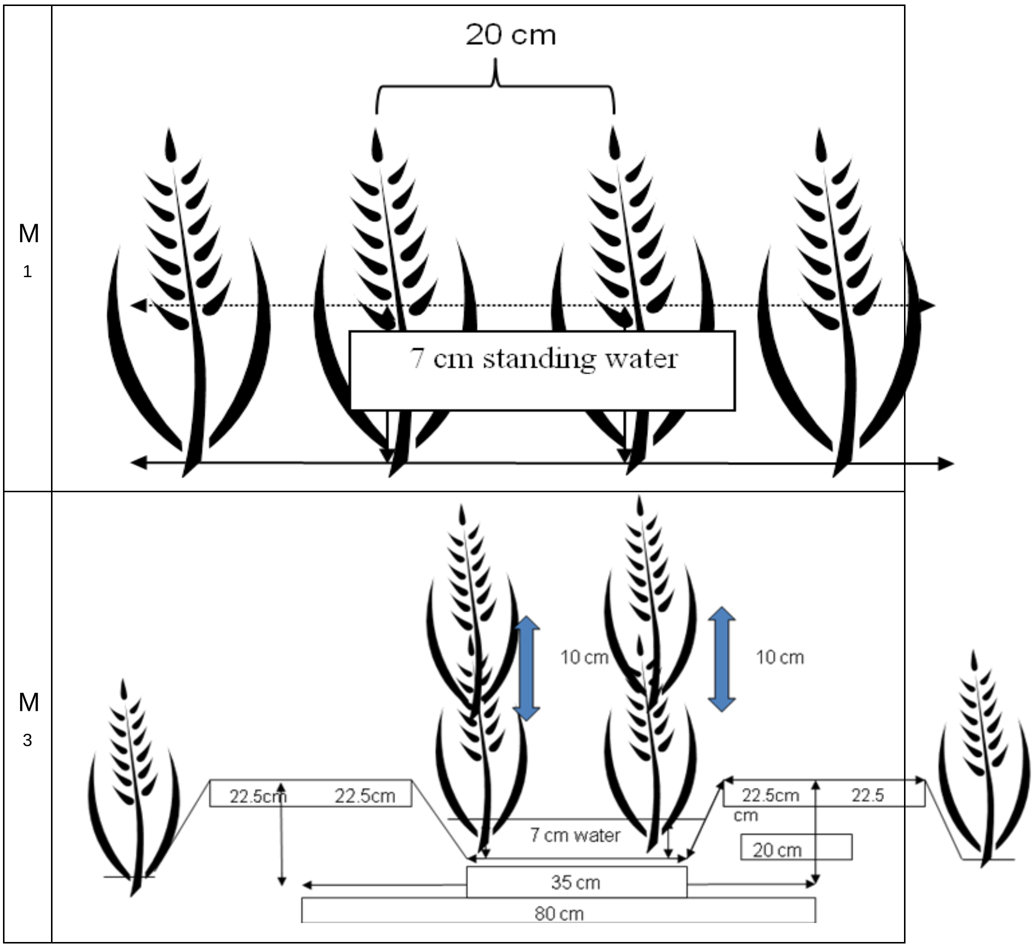

Fig (1): Planting methods

Rice cultivar was Sakha 104, On June 3rd and 5th in 2009 and 2010, respectively, twenty five days old seedlings were transplanted in hills spaced 20 by 20 cm to give 25 hills m^{-2} for traditional planting, and spaced 10 by 10 cm in the two rows in bottom of bed to keep population on 25 hills m^{-2} for beds. Cultural practices were similar to those used in the area. Rice plants were harvested at 120 days from sowing

Data collected were plant height in cm, number of tillers per hill, number of panicles per hill, panicle weight in g, 1000-grain weight in g, panicle length in cm and rice grain yield ton ha^{-1} at maturity. The grains were separated from the straw, and the grains were weighed. Grain yield was calculated based on the adjustment to grain moisture content of 140 g kg^{-1}.

The mean values of Sakha agro-meteorological data during 2009 and 2010 seasons were presented in Table (1), and the mean values of some soil Physical, chemical properties and some water constants of the experimental site before cultivation were presented in Table (2).

Table (1): Sakha agro-meteorological data, (31° 07' N Latitude, 30° 05' E Longitude), during 2009 and 2010 seasons.

Season	Months	Air temperature		Relative humidity		Wind speed	Solar radiation	Pan evaporation
		Max	Min.	Max	Min.	Mean	Mean	Mean
		C°		%		km d^{-1}	MJm-^{2}	mm d^{-1}
2009	May	29.5	13.0	57.5	38.6	111.0	22.6	6.8
	June	31.7	17.7	64.6	47.0	109.0	28.1	7.8
	July	32.2	19.0	70.2	52.6	89.5	23.4	7.3
	Aug.	32.4	19.4	70.7	53.0	77.0	21.2	6.8
	Sept.	31.1	17.7	70.5	53.5	78.2	17.8	6.4
	Oct.	29.1	13.4	64.2	52.1	91.5	12.0	4.6
2010	May	28.5	11.6	62.2	45.0	111.0	22.8	7.3
	June	31.7	17.0	64.2	47.0	117.0	23.0	8.3
	July	31.3	17.5	71.6	58.0	78.0	20.4	7.1
	Aug.	33.0	18.6	75.3	59.0	65.0	22.3	6.5
	Sept.	33.0	16.8	70.5	52.0	76.0	20.3	5.9
	Oct.	29.0	13.4	62.8	49.5	70.0	15.2	4.7

Irrigation water applied (IWA)

The irrigation water was applied to the experimental plots until reaching the end of the plot length. This was measured and delivered by a constant rectangular weir with steel gates for each plot. The rate of discharge was 0.01654 m^3/sec at effective head of 10 cm. The amount of applied water for each plot of the studied treatments was calculated by the equation;

Q = q × t…………………………………………… (1)

Where:

Q is the volume of water delivered to the plot (m^3),
q is the discharge of the weir (m^3/ min) and
t is the time of irrigation (min).

Productivity of irrigation water (PIW)

Productivity of irrigation water (PIW) was calculated according to (Ali *et al.,* 2007)

PIW= GY/I …………………………………………(2)

Where PIW in (kg m^{-3}), GY is grain yield (kg ha^{-1}) and I is the amount of applied water in m^{-3} ha^{-1}.

The obtained data were statistically analyzed by analysis of variance. The data of the two seasons showed nearly the same trend, Thus, combined analysis was done according to Gomez and Gomez (1984) .Means of the treatment were compared by the least significant difference (LSD) at 5% level of significance which developed by Waller and Duncan (1969).

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RESULTS AND DISCUSSION

Grain yield and its attributes

Results in Table (3) show that insignificant increase was detected in the number of grains/panicle, panicle weight, panicle length, and yields of grain between F_1 and F_2 treatments. Planting in bottom of beds significantly increased grain yield, number of tillers/hill, number of panicles/hill, panicle length, plant height, Panicle weight and 1000 grains weight by 3.45%, 6.2%, 6.7%, 19.9%, 4.9 %,0.58% and 1.6% respectively, compared with traditional planting method**,** M_1 treatment. No significant differences in plant height and the number of tillers/hill between F_1 and F_2. These results coincided with those obtained by Atta (2005), Atta *et al.* (2006), Khattak, *et al.* (2006), Mishra and Saha (2007) and Jagroop *et al.* (2007) who mentioned that GY of rice transplanted in bed produced high GY. As for the effect of the deficit irrigation treatments on the studied characters, the obtained results showed that treatment of d_1 and d_2 had the highest values of GY and its components. No significant differences in plant height and the number of tillers/hill between d_1 and d_2. Treatment of d_1 significantly increased plant height by 10%, number of grains/panicle by 23%, panicle weight by 29%, panicle length by 17%, GY by 45%, SY and 38% compared to d_3. The higher Grain yield of d_1 treatment than that of d_3 could be attributed to the high yield components such as the number of grains per panicle, panicle weight, and panicle length of treatment d_1, as shown in Table (3). Treatment d_1 produced the highest GY and yield components, followed by treatments d_2, and d_3, respectively.

Insignificant effect of irrigation depth and season interaction was obtained from all traits. Such results indicated that irrigation depth treatments showed similar effect from season to season. The interaction between irrigation depth and planting method was significant on plant height, the number of tillers/hill, the number of grains /panicle, GY and SY. All traits were not significantly affected by the interaction between irrigation depth x planting methods x season, as shown in Table (3).

Data in Table (3) show that the average values of plant height, the number of tillers/hill, the number of grains/panicle, GY and SY were significantly affected by the interaction between irrigation depth treatments and planting methods, over both seasons. It is obvious form Table (3) that the highest mean values of the number of tillers/hill, the number of grains /panicle, GY and SY were obtained from d_1 x M_2 and d_2 x M_2, whereas, plant height trait was higher with d_2 x M_2. The lowest value of the number of tillers/hill, the number of grains /panicle, GY and SY was obtained from d_2 x M_1, while plant height was lower with d_3 x M_1. These results could be attributed to the exchangeable effect on irrigation depth and transplanting methods differences.

Impact of irrigation depth on GY and yield components under different planting methods was in descending order M_2 >M_1. This indicates that irrigation depth was more influential on M_2 (bed) than on the other planting methods

Table (3): Average values of grain yield, number of tillers/hill, number of panicles/hill, panicle length, plant high, panicle weight and 1000-grain weight, as influenced by nitrogen resource, planting methods and irrigation depth in combined analysis of 2009 and 2010 seasons

Nitrogen resource	Plant method	Irrig. depth	Grain yield kg/ha.	No. tillers/ hill	No. panicles/ hill	Panicle length, cm	Plant height, cm	Panicle weight (g)	1000 grain weight(g)
Urea(F_1)	Traditional (M_1)	9cm	10,200	27	24	22 a	109.0a	2.8a	28.87a
		7cm	9,990	27	25	21 b	107.0b	2.7 a	28.07a
		5cm	7,050	22	18	15 c	100.0c	2.2b	25.50 b
	Mean		9,080	25.3	22.3	19.3	105.3	2.57	27.48
	Bed (M_2)	9cm	10,500	29	26	23a	111.0 a	2.9 a	28.94a
		7cm	10,450	27	25	24a	114.0a	2.7a	28.63a
		5cm	7,340	24	20	20c	107.0 b	2.1b	26.50b
	Mean		9,430	26.7	23.6	22.3	110.7	2,6	28.0
Mean			9,255	26.0	22.3	20.8	108.0	2.58	27.74
Ammonia (F_2)	Traditional (M_1)	9cm	10,200	27	24	18c	108.0ab	2.9 a	29.65 a
		7cm	10,000	26	25	22 a	107.0 b	2.8 a	28.56 a
		5cm	7,100	22	18	18c	105.0 b	2.2 b	24.96 b
	Mean		9,100	24.3	22.3	19.3	106.7	2.6	27.7
	Bed (M_2)	9cm	10,600	29	26	26 a	115.0 a	2.9a	29.94 a
		7cm	10,400	27	26	26 a	112.0 a	2.7a	28.93a
		5cm	7,300	24	20	20 c	108.0ab	2.1 b	25.50 b
	Mean		9,400	26.0	24.0	24.0	111.7	2.6	28.1
Mean			9.250	25.15	23.15	21.65	109.2	2.6	27.6
Fertilizer (F) x season			ns	ns	ns	ns	ns	ns	ns
Method (M) x season			*	ns	ns	ns	ns	ns	ns
Depth (D) x season			**	**	ns	ns	**	**	**
F x M			**	ns	ns	**	ns	ns	ns
F x D			**	**	**	**	**	**	**
M x D			**	**	**	**	ns	**	**
F x M x D			**	**	**	**	**	**	**

Irrigation water applied (IWA)

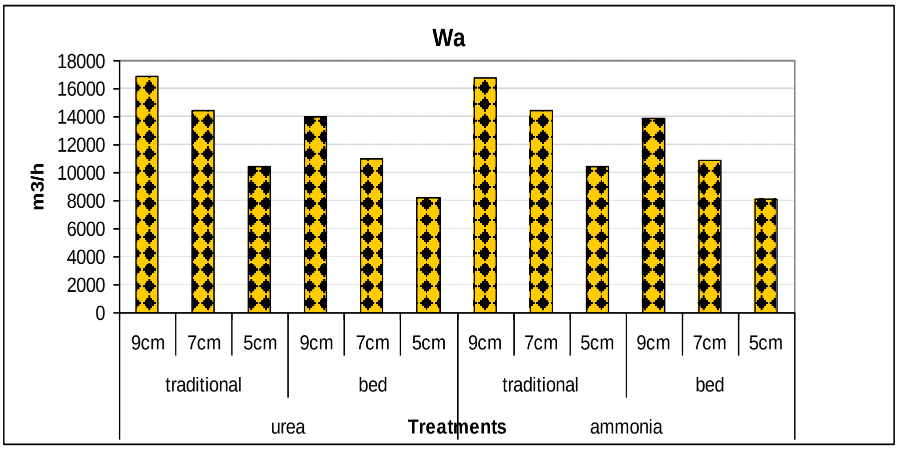
The amount of irrigation water, which was used, is presented in Table 4 and illustrated in fig (2). It was clear that the total amount of water applied are 15435.00, 12726.00 and 9333.50 m^3 ha^{-1} resulted from irrigation of d_1, d_2 and d_3 respectively, under fertilizer by urea (F_1), while it were 15335.00, 12706.00 and 9253.5.00 m^3 ha^{-1} for fertilizer by gaseous Ammonia. Regarding planting methods, it was evident that traditional plant method (M_1) received the highest amount of irrigation water 13966.33 and 13899.67 m^3 ha^{-1} as compared to bed planting method (M_2) which were 11030.00 and 10963.33 m^3 ha^{-1} respectively. It means that M_2 is feasible on rice with a 21% saving of irrigation water comparable to M_1. Meleha *et al*. (2008), Atta *et al.* (2006) and Atta (2005) found that the method of planting at the bottom of beds saved water by 37.9%, compared to traditional planting. It is obvious that the amount of irrigation water applied was gradually increased as a result of the growing up of a vegetative growth that required high amount of irrigation water to meet its water requirements, and then it decreased again. These findings may be attributed to growth stage and weather conditions accompanying growth stage.

Table (4): Seasonal water applied as affected by irrigation treatments in combined analysis of 2009 and 2010 seasons

Treatments		M_1	M_2	D mean	Diff.
F_1	d_1	16910 a	13960 a	15435.00	2950
	d_2	14492 b	10960 b	12726.00	3532
	d_3	10497 c	8170 c	9333.50	2327
		13966.33	11030.00	12498.17	
F_2	d_1	16800 a	13870 a	15335.00	2930
	d_2	14492 b	10920 b	12706.00	3572
	d_3	10407 c	8100 c	9253.5.00	2307
		13899.67	10963.33	12431.50	
F x M		ns	ns		
Depthx season		**	**		
F x D		**	**		
M x D		**	**		
F x M x D		**	**		

In a column means followed by common letter are not significantly different at 5% level by DMRT

Comparison	S.E.D	L.S.D (5%)	L.S.D (1%)
2-rows means at each column	172.2	365.1	503



Fig(2): Seasonal water applied as affected by irrigation treatments in combined analysis of 2009 and 2010 seasons.

Productivity of irrigation water (PIW)

Mean values of PIW of rice (kg grain m^{-3}) as affected by irrigation depth and planting methods are presented in Table 5 and illustrated in fig (3). Results showed that M_2 treatment increased PIW by 32.3 more than M_1 treatments. Similar results were reported by Vethaiya *et al.* (2003), Atta (2005), Atta *et al.* (2006) and Choudhury *et al.* (2007).

As for the effect of irrigation depth treatments on the PIW values, the obtained results indicated that the highest values of PIW were recorded from d_2 treatment (0.95 kg grain m^{-3}), whereas the lowest one was obtained from d_1 (0.6 kg grain m^{-3}). The higher values of PIW of d_2 treatment proved the superiority over d_3 and d_1, treatments by 3%, and 15% respectively, as shown in Table 5. These results could be attributed to the significant differences among GY, and to the irrigation water applied values. Values of GY of d_1 treatment was much higher than that of d_2 and d_3 treatments and the irrigation water applied of $d_2$and d_3 treatments were less than that of d_1 treatment (see Tables 3 and 4).

The interaction between irrigation depth treatments and planting methods (Table 5) showed that the highest PIW was 0.95 kg grain m^{-3} resulted from d_2 x M_2. On the contrary, the lowest one was 0.6 kg grain yield m^{-3} of water applied resulted from d_1 x M_1. This means that irrigation depth of d_2 and planting method of M_2 could be applied for saving irrigation water by 24.5% without grain reduction, which gave higher PIW by 58% compared to irrigation depth of d_1 x M_1 under the condition of the studied area.

Table (5): Grain yield (Kg ha^{-1}), seasonal water applied (Wa in m^3 ha^{-1}) and Productivity of irrigation water (PIW) Kg m^{-3}) as affected by irrigation treatments in combined analysis of 2009 and 2010 seasons.

nitrogen resource	Plant method	Irrigation depth	Grain yield kg ha^{-1}	Wa m^3 ha^{-1}	PIW Kg m^{-3}
urea	traditional	9cm	10,200	16910	0.60
		7cm	9,990	14492	0.69
		5cm	7,050	10497	0.67
	Mean		9,080	13966	0.65
	bed	9cm	10,500	13960	0.75
		7cm	10,450	10960	0.95
		5cm	7,340	8170	0.90
	Mean		9,430	11030	0.85
Mean			9,255	12498	0.74
ammonia	traditional	9cm	10,200	16800	0.61
		7cm	10,000	14492	0.69
		5cm	7,100	10407	0.68
	Mean		9,100	13900	0.65
	bed	9cm	10,600	13870	0.76
		7cm	10,400	10920	0.95
		5cm	7,300	8100	0.90
	Mean		9,433	10963	0.86
Mean			9.267	12432	0.75

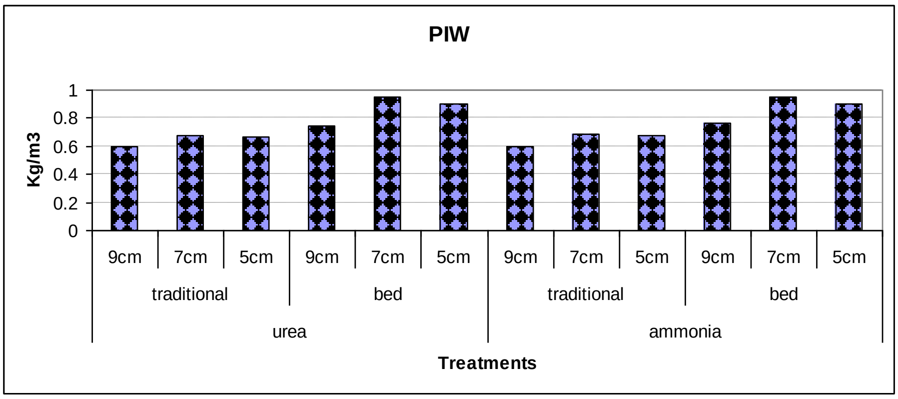


Fig (3): Productivity of irrigation water (PIW) (Kg m^{-3}) as affected by irrigation treatments in combined analysis of 2009 and 2010 seasons.

CONCLUSIONS

As a result of the increasing demand for irrigation water and the high cost of developing new water resources for irrigation, irrigation water productivity of rice production should be improved. It is necessary to produce more rice with less water by using new planting methods and deficit irrigation. The obtained results of the current study indicate that irrigation water applied in rice fields could be significantly reduced without sacrificing rice yield or without increasing the production cost by using the treatment d_2 x M_2. Method of transplanting at bottom of beds (M_2) increased PIW by 32.3% than M_1. Therefore, transplanting rice in beds only and keeping it under continuous irrigation (d_2 x M_2) could be applied by the farmers because it increased PIW by 58% and saved water by 21% compared to d_1 x M_1 in North Delta, Egypt.

Transplanting rice in beds only (M_2) was better than the other methods because there is no significant difference between M_1 and M_2 in GY and gave the highest PIW.

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توفير مياه الري وتحسين إنتاجيتها لمحصول الأرز باستخدام طريقة زراعة جديدة في شمال دلتا النيل، مصر

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أجريت تجربتان حقليتان في محطة البحوث الزراعية بسخا –محافظة كفرالشيخ وهذا الموقع يقع على خط عرض 07 31^{5} وخط طول 57 30 ^{5} وأعلى من مستوى سطح البحر بستة أمتار خلال موسمي الزراعة 2009 و 2010 وكان صنف الأرز المنزرع سخا 104.

صممت التجربة باستخدام القطع المنشقة مرتين وكانت المعاملات الرئيسية هي مصادر التسميد النتروجينى: التسميد باليوريا (F_1) والتسميد بالأمونيا الغازية (F_2) وكانت المعاملات الشقية الأولى هي طريقة الزراعة: الزراعه العادية (M_1) والزراعة على مصاطب (M_2)، بينما كانت المعاملات الشقية الثانية هي عمق الرى: 9سم و7سم و 5سم (d_1 ، d_2 وd_3) على التوالى.

أوضحت النتائج أن كلا عمقي الري 7سم و9سم حققت زيادة معنوية في طول النبات، عدد الفروع في المتر المربع ، وزن السنبلة ووزن الألف حبة بالمقارنة بالعمق 5سم، وأن الزراعة في بطن المصطبة حققت زيادة في وزن محصول الحبوب، عدد الفروع في الجورة، عدد السنابل في الجورة ، طول السنبلة ، طول النبات ، وزن السنبلة ووزن الألف حبة بـ 3.45% ؛ 6.2% ؛ 6.7% ؛ 19.9% ؛ 4.9% ؛ 0.58% و1.6% على التوالي بالمقارنة بالزراعة العادية.

لا يوجد فروق معنوية بين التسميد باليوريا والتسميد بالأمونيا الغازية.

متوسط المياه المضافة كان 13933 م^3 للهكتار و10997م^3 للهكتار في الزراعة العادية والزراعة على مصاطب على التوالي ، ويعني هذا أن الزراعة على مصاطب وفرت 21% من مياه الري كما زادت إنتاجية مياه الري زيادة معنوية بمقدار 58%.

لهذا يمكن التوصية بالزراعة على مصاطب في شمال دلتا النيل لأنها ترفع كفاءة إنتاجية مياه الري إلى 67.1% وتوفر مياه الري بنسبة 21% دون أي انخفاض في المحصول بالمقارنة بالزراعة العادية.

قام بتحكيم البحث

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Table (2): The mean values of some soil Physical, chemical properties and some water constants of the experimental site before cultivation

Soil depth (cm)	Particle size distribution%			Texture class	F.C %	P.W.P %	Available Water%	Bulk density, Mg/m^3	EC, dSm^{-1}	pH	Soluble ions $MeqL^{-1}$							
	Sand	Silt	Clay								Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Co^{2-}_3	Hco^{-}_3	Cl^{-}	So^{2-}_4
0-15	26.0	28.0	46.0	Clay	47.0	25.3	21.7	1.19	1.5	8.15	0.30	0.10	0.76	0.02	-	0.55	0.21	0.42
15-30	29.0	23.0	48.0	Clay	39.0	21.8	17.2	1.16	1.57	8.00	0.31	0.10	0.79	0.02	-	0.57	0.22	0.43
30-45	26.5	26.0	47.5	Clay	38.0	21.9	16.1	1.30	1.65	8.00	0.34	0.10	0.89	0.02	-	0.65	0.23	0.47
45-60	27.5	25.5	47.0	Clay	38.5	20.8	17.7	1.20	2.78	7.90	0.84	0.27	1.25	0.03	-	0.45	0.23	1.71