SAVING IRRIGATION WATER AND IMPROVING WATER PRODUCTIVITY IN RICE CULTIVATION BY INDUCING GOOD LAND LEVELING AND NEW PLANTING METHOD IN NORTH NILE DELTA, EGYPT

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ABSTRACT

Two field experiments were conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt. during the two successive seasons of 2012 and 2013. The rice cultivar was Sakha 104. The experiment was designed as a split split-plot design with four replicates. Results showed that both submerged depth of 9 and 7cm significantly increased grain yield, plant height, number of panicles/hill, number of tillers/hill, panicle length, panicle weight, 1000 grains weight and seasonal applied irrigation water compared to submerged depth of 5cm (d_3), there were no significant differences between submerged depth of d_1 and d_2. Planting in bottom of beds (M_3) significantly increased grain yield by 8.48%, plant height by 4.38%, number of panicles/hill by 8.34%, number of tillers/hill by 10.58%, panicle length by 16.9%, Panicle weight by 6.62% and 1000 grains weight by 6.83%, compared to M_1. The highest mean values of grain yield (12.51 ton ha^{-1}), plant height (113cm), No. of panicles/hill (31), No. of tillers/hill (32), panicle length (28cm), panicle weight (2.98 gm) and 1000 grain weight (30.91 gm) were obtained from interaction between (L_2 x M_3 x d_2). Average amounts of the applied irrigation water were 13885, 11519 and 8919 m^3/ha^{-1}, for (M_1), (M_2) and (M_3), respectively. According the highest mean values of productivity of irrigation water (PIW) (1.480 kg grain m^{-3}) was obtained from combination between (L_2 x M_3 x d_3), So, method of (M_3) saved about 35.8% of the irrigation water applied and increased productivity of irrigation water (PIW) by 13% compared to (M_1).Therefore, method of planting in bottom of beds could be recommended for planting rice crop under laser leveling in North Delta Egypt.

Abbreviations: Productivity of irrigation water (PIW), land leveling (L), Planting method (M) and irrigation water depth (d).

Keywords: rice; irrigation; water saving; water productivity

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INTRODUCTION

Egypt presently has the highest average rice yield in the world; however, the country's rice yield must be increased by 20% over the next decade just to maintain current levels of consumption **(El-Atawy, 2012).**

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 makes competing demands for this precious resource. The challenge for agricultural researchers is to find ways to reduce the water consumption 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). Vories *et al.* (2002**) observed a 15.6% yield reduction in furrow-irrigated rice compared to flood-irrigated rice.

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 that reduction of the total water applied from 14870 m^3 ha^{-1} to 9545 m^3 ha^{-1}, resulted in 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}, 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 strips of furrows 60 cm wide, respectively.

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 showed 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) showed that rice yields on raised beds that were kept around field capacity, 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. 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.

El-Atawy (2012) obtained 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 irrigation water depth 7cm (d_2) x transplanting in beds (M_2). Method of transplanting at bottom of beds (M_2) increased productivity of irrigation water (PIW) by 45% than traditional method **(**M_1). Therefore, transplanting rice in beds only and keeping it under continuous irrigation (d_1 x M_2) could be applied by the farmers because it increased (PIW) by 53% and saved water by 33% compared to d_1 x M_1 in North Delta, Egypt.

The objective of this investigation was to produce more rice with less water under matching planting methods with precision land leveling in North Delta, Egypt.

MATERIALS AND METHODS

A field experiment was carried out during the two successive rice growing seasons of 2012 and 2013 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 47.1% clay, 25.6% silt and 27.3% sand. The average of the electrical conductivity of soil salinity over 0-60 cm depth was 1.63 dSm^{-1}, the electrical conductivity of irrigation water was 0.54 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 land leveling, normal land leveling (L_1) and laser land leveling with 0.1% slop (L_2). While three planting methods treatments were in the sub plots, traditional transplanting in flooded soil (M_1), transplanting in furrow (M_2) and transplanting in beds (M_3), and three irrigation depths 9, 7 and 5cm for d_1, d_2 and d_3, respectively were assigned to sub-sub plots.

The raised rows were 60 cm distance from mid row to mid another while, the raised beds were 20 cm high x 45 cm wide with 80-cm distance from mid bed to mid another. The plots were isolated by ditches of 2.5 m in width to avoid lateral movement of water.

Rice cultivar was Sakha 104, on may 15th and 20th in 2012 and 2013, respectively, twenty five days old seedlings were transplanted in hills spaced 20 by 20 cm to give 25 hills m^{-2} for traditional planting, while transplanted in hills spaced 13.3 cm apart on two sides of furrow in bottom to give 25 hills m^{-2} 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 length in cm, panicle weight in g, 1000-grain weight in g, 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 some soil Physical, chemical properties and some water constants of the experimental site before cultivation were presented in Table (1).

Table (1): The mean values of some soil Physical, chemical properties and some water constants of the experimental site before cultivation

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_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
27.3	25.6	47.1	Clay	47.0	25.3	21.7	1.19	1.63	8.15	0.30	0.10	0.76	0.02	-	0.55	0.21	0.42

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;

$Q = q \times t$…………………………………………… (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 treatments were compared by the least significant difference (LSD) at 5% level of significance which developed by **Waller and Duncan (1969)**.

RESULTS AND DISCUSSION

Grain yield and its attributes

Results in Table (2) show that significant increase was detected in grain yield, plant height, No. of panicles/hill, No. of tillers/hill, panicle length, panicle weight and 1000 grain weight between L_1 and L_2 treatments. Laser land leveling (L_2) significantly increased grain yield, number of tillers/hill, number of panicles/hill, panicle length, plant height, Panicle weight and 1000 grains weight by 10.31%, 9.38%, 14.21%, 10.07%, 7.84%, 4.43% and 5.42%, respectively, compared with normal land leveling (L_1**).**

Planting in bottom of beds (M_3), significantly increased grain yield by 8.48%, number of tillers/hill by 10.58%, number of panicles/hill by 8.34%, panicle length by 16.9%, plant height by 4.38%, panicle weight by 6.62% and 1000 grains weight by 6.83%, compared with traditional planting method (flat land) (M_1**).** These results coincided with those obtained by **Khattak, *et al.* (2006), Mishra and Saha (2007), Jagroop *et al.* (2007) a**nd **El-Atawy (2012)** who mentioned that grain yield of rice transplanted in bed produced high grain yield.

Table (2): Average values of grain yield, plant height, number of panicles/hill, number of tillers/hill, panicle length, panicle weight and 1000-grain weight as influenced by land leveling, planting methods and irrigation depth.

Land leveling	Plant method	Irrig. Depth (cm)	Grain yield (kg/ha.)	Plant height, (cm)	No. of panicles/ hill	No. of tillers/ hill	Panicle length, (cm)	Panicle Weight (g)	1000 grain Weight (g)
(L_1)	Tradi-tional (M_1)	9 (d_1)	11.05 a	107 a	25 a	27 a	21.5 a	2.70 a	27.89 a
		7 (d_2)	11.00 a	105 b	25 a	26 a	22 a	2.62 a	27.29 b
		5 (d_3)	7.82 b	104 b	20 b	22 b	18.5 b	2.23 b	24.14 c
	Furrow (M_2)	9 (d_1)	11.71 a	110 a	26 a	28 a	22.5 ab	2.79 a	28.04 a
		7 (d_2)	11.58 a	112 a	27 a	28 a	23.5 a	2.75 a	28.40 a
		5 (d_3)	8.18 b	107 b	21 b	24 b	20.51 b	2.31 b	25.74a
	Bed (M_3)	9 (d_1)	11.85 a	112 a	27 a	29 a	24 ab	2.87 a	28.81 a
		7 (d_2)	11.89 a	114 a	28 a	30 a	25 a	2.79 a	29.45 a
		5 (d_3)	8.30 b	109 b	22 b	25 b	21.5 b	2.35 b	26.02 b
Mean (L_1)			10.37	108.9	24.6	26.6	22.1	2.60	27.25
(L_2)	Tradi-tional (M_1)	9 (d_1)	11.31a	109 a	28 a	29 a	22.5 b	2.81 a	28.10 b
		7 (d_2)	11.23 a	110 a	28 a	28 a	23.5 a	2.77 a	28.50 a
		5 (d_3)	9.55 b	105 b	25 b	26 b	19.5 c	2.31 b	26.66 c
	Furrow (M_2)	9 (d_1)	11.91 a	111 a	29 a	30 a	26.5 a	2.88 a	29.05 a
		7 (d_2)	12.33 a	112 a	30 a	30 a	26 a	2.86 a	29.22 a
		5 (d_3)	10.47 a	107 b	26 b	27 b	22.5 b	2.39 b	27.09 a
	Bed (M_3)	9 (d_1)	11.97a	112 a	30 a	31 a	27 a	2.95 a	30.78 a
		7 (d_2)	12.51 a	113 a	31 a	32 a	28 a	2.98 a	30.91 a
		5 (d_3)	10.67 a	108 b	27 b	28 b	23.5 b	2.51 b	28.23 a
Mean (L_2)			11.33	109.70	28.2	29.0	24.34	2.72	28.73
LSD at 0.05			1.3	0.016	0.9	0.9	1.0	0.0095	0.049
Means values of Planting methods		(M_1)	10.32 b	106.67b	25.17b	26.3b	21.25 b	27.10 b	27.10 b
		(M_2)	11.03 a	109.83a	26.50a	27.8a	23.85 a	27.92 a	27.92 a
		M_3)	11.20 a	111.33a	27.50a	29.2a	24.84 a	28.95 a	28.95 a
LSD at 0.05			1.2	0.015	0.6	0.7	0.9	0.0084	0.053
Means values of irrigation depth		9 (d_1)	11.65a	110.17a	27.50a	29.0a	24.00 a	28.78 a	28.78 a
		7 (d_2)	11.76a	111.00a	28.17a	29.0a	24.67a	28.88 a	28.88 a
		5 (d_3)	9.17b	106.67b	23.50b	25.3b	21.50 b	26.32 b	26.32 b
LSD at 0.05			1.3	0.015	0.7	1.2	0.8	0.0095	0.050
L x season			ns	ns	ns	ns	ns	ns	ns
M x season			ns	ns	ns	ns	ns	ns	ns
d x season			ns	ns	ns	ns	ns	ns	ns
L x M			**	**	**	**	**	**	**
L x d			**	**	**	**	**	**	**
M x d			**	**	**	**	**	**	**
L x M x d			**	**	**	**	**	**	**

No significant differences in all studied characters between irrigation depth 9cm (d_1) treatment and irrigation depth 7cm (d_2). As for the effect of the deficit irrigation treatments on the studied characters, the obtained results showed that irrigation depth 7cm (d_2) significantly increased grain yield by 28.32%, number of tillers/hill by 13.69%, number of panicles/hill by 19.28%, panicle length by 17.5%, plant height by 3.83%, panicle weight by 18.94% and 1000 grains weight by 9.73%, compared to irrigation depth 5cm (d_3). The higher grain yield of d_1 and d_2 treatments 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 and d_2, as shown in Table (2). These results coincided with those obtained by **Atta *et al.* (2006), Khattak, *et al.* (2006), Mishra and Saha (2007), Jagroop *et al.* (2007) and El-Atawy (2012).**

Insignificant effect of planting method and season interaction was obtained from all traits. Such results indicated that irrigation depth treatments showed similar effect from season to season. Data in Table (2) show that the average values of grain yield, plant height, No. of panicles/hill, No. of tillers/hill, panicle length, panicle weight and 1000 grain weight were high significantly affected by the interaction between land leveling treatments(L), planting methods (M) and irrigation depth (d). It is obvious from Table (2) that the highest mean values of grain yield, plant height, No. of panicles/hill, No. of tillers/hill, panicle length, panicle weight and 1000 grain weight were obtained from L_2 x M_3 x d_2, whereas, the lowest value of all studied characters were obtained from L_1 x M_1 x d_3. These results could be attributed to the interaction effect between precision land leveling, irrigation depth and transplanting methods. Impact of irrigation depth on yield and its components under different planting methods was in descending order $M_3 > M_2 > M_1$. This indicates that irrigation depth was more influential on M_3 (bed) than on the other planting methods. These results are in agreement with those obtained by **Atta *et al.* (2006), Mishra and Saha (2007) and El-Atawy (2012).**

Irrigation water applied (IWA)

Seasonal water applied in m^3 ha^{-1} as affected by land leveling, planting methods and irrigation depth, is presented in Table 3. There are significant differences in total amounts of water applied between irrigation depths 9, 7 and 5 cm (d_1, d_2 and d_3) in all planting method (M_1, M_2 and M_3) and both land leveling (L_1 and L_2).

Table (3): 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 land leveling, planting methods and irrigation depth in combined analysis of 2012 and 2013 seasons.

Land leveling	Plant method	Irrig. depth	Grain yield kg/ha.	Water applied	PIW (Kg m^{-3})
(L_1)	Tradi-tional (M_1)	9 (d_1)	11.09 a	17008 a	0.652 c
		7 (d_2)	11.03 a	15093 b	0.731 a
		5 (d_3)	7.84 b	11413 c	0.687 b
	Furrow (M_2)	9 (d_1)	11.73 a	13825 a	0.848 a
		7 (d_2)	11.60 a	12205 b	0.950 a
		5 (d_3)	8.19 b	9822 c	0.834 a
	Bed (M_3)	9 (d_1)	11.86 a	10439 a	1.136 a
		7 (d_2)	11.92 a	9202 b	1.295 a
		5 (d_3)	8.30 b	7389 c	1.123 a
Mean (L_1)			10.40	11822	0.880
(L_2)	Tradi-tional (M_1)	9 (d_1)	11.32 a	15483 a	0.731 c
		7 (d_2)	11.24 a	13626 b	0.825 b
		5 (d_3)	9.56 b	10689 c	0.894 a
	Furrow (M_2)	9 (d_1)	11.92 a	13049 a	0.913 a
		7 (d_2)	12.34 a	11631 b	1.061 a
		5 (d_3)	10.48 a	9182 c	1.141 a
	Bed (M_3)	9 (d_1)	11.98 a	10174 a	1.178 a
		7 (d_2)	12.52 a	9104 b	1.375 a
		5 (d_3)	10.69 a	7209 c	1.483
Mean (L_2)			11.34	11127	1.019
LSD 0.05			1.3	79.5	0.0058
Means values of Planting methods		(M_1)	10.32 b	13885 a	0.743 c
		(M_2)	11.03 a	11619 b	0.949 b
		M_3)	11.20 a	8919 c	1.256 a
LSD 0.05			1.2	86.4	0.0042
Means values of irrigation depth		9 (d_1)	11.65 a	13330 a	0.874 b
		7 (d_2)	11.76 a	11810 b	0.996 a
		5 (d_3)	9.17 b	9284 c	0.988 a
LSD 0.05			1.3	81.6	0.0048
L x season			ns	Ns	ns
M x season			ns	Ns	ns
d x season			ns	Ns	ns
L x M			**	**	**
L x d			**	**	**
M x d			**	**	**
L x M x d			**	**	**

It is clear that the highest total amount of water applied are 17008 m^3 ha-^{1}, resulted from irrigation depth 9 cm (d_1) under traditional planting method (M_1) and normal land leveling (L_1), while the lowest total amount of water applied are 7209 m^3 ha-^{1}, result from irrigation depth 5 cm (d_3) in beds planting method (M_3) and laser land leveling (L_2). These results declare that the laser land leveling saved irrigation water by 57.6 %, compared to normal land leveling. On the other hand the beds planting method (M_3) saves irrigation water by 35.8% compared to (M_1), while, irrigation depth 5 cm (d_3) saves irrigation water by 30.4%, compared to irrigation depth 9 cm (d_1). Generally, the treatment L_2 x M_3 x d_3 saved irrigation water by 57.6%, compared to treatment L_1 x M_1 x d_1, but it decreases grain yield by 3.6%.

It is obvious that the amount of irrigation water applied was gradually increased as a result of the growing up to 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. These results are in agreement with those obtained by **Atta *et al.* (2006), Mishra and Saha (2007), Meleha *et al*. (2008) and El-Atawy (2012).**

Productivity of irrigation water (PIW)

Mean values of PIW of rice (kg grain m^{-3}) as affected by land leveling, planting methods and irrigation depth in combined analysis of 2012 and 2013 seasons, are presented in Table 3. Results showed that no significant differences in productivity of irrigation water (PIW) between irrigation depths 9cm (d_1), 7cm (d_2) and 5cm (d_3) under transplanting in furrow (M_2) and transplanting in beds (M_3), while with traditional planting method (M_1) there are significant differences in (PIW) values between irrigation depths. Results showed that M_3 treatment increased PIW by 13% more than M_1 treatments. Similar results were reported by **Vethaiya *et al.* (2003), Atta (2005), Atta *et al.* (2006), Choudhury *et al.* (2007), and El-Atawy (2012).**

The interaction between treatments of land leveling (L), planting methods (M) and irrigation depth (d) (Table 3) shows that the highest PIW are 1.483 kg grain m^{-3}, resulted from irrigation depth 5 cm (d_3) under beds planting method (M_3) and laser land leveling (L_2). while the lowest values of PIW were 0.652 kg grain m^-, resulted from irrigation depth 9 cm (d_1) under traditional planting method (M_1) and normal land leveling (L_1). These results could be attributed to the significant differences among grain yield, and to the irrigation water applied values. Values of grain yield 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 Table 3). Similar results were reported by **Vethaiya *et al.* (2003), Atta (2005), Atta *et al.* (2006), Choudhury *et al.* (2007), and El-Atawy (2012).**

CONCLUSION

It is necessary to produce more rice with less water by using new planting methods and less submerged head of irrigation water. 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_3 x M_3 x L_2. Method of transplanting at bottom of beds (M_3) increased PIW by 13% than M_1. Therefore, transplanting rice in beds under laser land leveling and keeping it under continuous irrigation (d_1 x M_2 x L_2) could be applied by the farmers because it increased PIW by 13% and saved irrigation water by 35.8% compared to d_1 x M_1 x L_2 in North Delta, Egypt. Transplanting rice in beds (M_3) and laser leveling (L_2) only was better than the other methods because there is no significant difference between M_1 and M_3 in grain yield and gave the highest PIW.

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الملخص العربي

توفير مياه الري وتحسين إنتاجيتها لمحصول الأرز باستخدام التسوية الجيدة للتربة وطرق زراعة جديدة في شمال دلتا النيل

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أجريت تجربتان حقليتان في محطة البحوث الزراعية بسخا –محافظة كفرالشيخ، وهذا الموقع يقع على خط عرض ٠٧ ٣١° وخط طول ٥٧ ٣٠ ° ، وأعلى من مستوى سطح البحر بستة أمتار، خلال موسمي الزراعة ٢٠١٢ و ٢٠١٣م ،وكان صنف الأرز المنزرع سخا ١٠٤.

صممت التجربة باستخدام القطع المنشقة مرتين، وكانت المعاملات الرئيسية هي تسوية عادية (L_1) والتسوية بالليزر(L_2)، وكانت المعاملات الشقية الأولى هي طرق الزراعة: الزراعة العادية (M1) والزراعة على خطوط (M2) والزراعة على مصاطب (M3)، بحيث تكون كثافة الشتل في كل الحالات ٢٥ جورة في المتر المكعب، بينما كانت المعاملات الشقية الثانية هي عمق الري: ٩سم و٧سم و ٥سم (d_1 ، d_2 وd_3) على التوالي.

أوضحت النتائج أن كلاً من عمقي الري ٧سم و٩سم حققت زيادة معنوية في كلٍ من محصول الحبوب، طول النبات، عدد السنابل في الجورة، عدد الأشطاء في الجورة، طول السنبلة، وزن السنبلة ، وزن الألف حبة وكمية مياه الري السنوية المضافة بالمقارنة بالعمق ٥سم، كما اتضح أنه لا توجد فروق معنوية بين عمقي الري ٧سم و٩سم ، وقد حققت الزراعة في قاع المصطبة (M_3) زيادة معنوية في وزن محصول الحبوب بنسبة ٨,٤٨%، طول النبات بنسبة ٤,٣٨%، عدد السنابل في الجورة بنسبة ٨,٣٤%، عدد الأشطاء في الجورة بنسبة ١٠,٥٨%، طول السنبلة بنسبة ١٦,٩%، وزن السنبلة بنسبة ٦,٦٢% ووزن الألف حبة بنسبة ٦,٨٣% بالمقارنة بالزراعة العادية (M_1).

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[2] **معهد بحوث الأراضي والمياه والبيئة- مركز البحوث الزراعية – الجيزة**

كانت أعلى المتوسطات لقيم كل من محصول الحبوب(١٢,٥١ طن للهكتار)، طول النبات(١١٣سم)، عدد السنابل في الجورة(٣١ سنبلة)، عدد الأشطاء في الجورة(٣٢ فرع)، طول السنبلة(٢٨سم)، وزن السنبلة(٢,٩٨ جم) ووزن الألف حبة(٣٠,٩١ جم) نتجت من معاملة التسوية بالليزر مع الزراعة على مصاطب والري بعمق ٧سم (d_2 x M_3 x L_2).
كانت متوسطات مياه الري المضافة ١٣٨٨٥، ١١٥١٩ و٨٩١٩ م^٣ للهكتار لكل من الزراعة العادية والزراعة على خطوط والزراعة على مصاطب على التوالي، ويعني هذا أن الزراعة على مصاطب (M_3) وفرت حوالي ٣٥,٨% من مياه الري المضافة، وكانت أعلى كفاءة لاستخدام مياه الري ١,٤٨ كجم حبوب للمتر المكعب من مياه الري قد نتجت من معاملة الري بعمق ٥سم والزراعة على مصاطب مع التسوية بالليزر (L_2 x M_3 x d_3)، وقد أدت الزراعة على مصاطب (M_3) إلى زيادة كفاءة إنتاجية مياه الري زيادة معنوية بمقدار ١٣% بالمقارنة بالزراعة العادية (M_1).
لهذا يمكن التوصية بزراعة شتلات الأرز على مصاطب في شمال دلتا النيل لأنها ترفع كفاءة إنتاجية مياه الري، وتوفر مياه الري بنسبة ٣٥,٨%.