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IRRIGATION WATER MANAGEMENT OF RICE CROP IN NORTH DELTA

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ABSTRACT

Two field experiments were conducted at El Karada; water requirements research station, Kafr El Sheikh Governorate, North Delta, Water Management Research Institute, National Water Research Center, Egypt, during the two summer seasons of 2006 and 2007. The investigation aimed to produce more rice grain yield with less water by inducing planting methods and different densities. The experimental design was a randomized complete block, replicated 3 times. Six planting methods were followed in the permanent field, they were: **T_1** (Traditional transplanting), **T_2** Transplanting of seedlings rice on flat soil at distance of 20 cm. between rows and 15 cm between hills, **T_3** Transplanting of seedlings rice on flat soil at distance of 20 cm. between rows and 12.5 cm between hills , **T_4** Transplanting of seedlings rice on flat soil at distance of 20 cm. between rows and 10 cm between hills , **T_5:** Transplanting in bottom of furrows (30 cm) and **T_6:** Transplanting in bottom of beds (35 cm).

Results showed that the total water applied were 6564, 6300, 6340, 6420, 4244 and 3878 m^3/fed. and 6597, 6551, 6593, 6617, 4490 and 4124 m^3/fed. for T_1, T_2, T_3, T_4,T_5 and T_6 treatments over both seasons, respectively. Planting in bottom of furrows and beds saved 35.34%, 33.94% and 40.92%, 39.33% of irrigation water compared with traditional planting method over the two0seasons, respectively. Maximum paddy yield (6438.00 and 6460.67 kg fed^{-1}) was produced by the treatment T_4 in the two seasons, respectively, while the rest (of transplanting methods (T_1, T_2, T_7, T_5 and T_6) produced comparatively lower grain yield. The planting method had no significant effect on (weight of 1000 grain (gm) in 2006 and 007, respectively. Maximum value of water productivity (0.80 and 0.78 $LE.m^{-3}$) was produced by the treatment T_4 in the two seasons, respectively, while the lowest value (0.34 and 0.33 $LE.m^{-3}$) was obtained by conventional transplanting T_1 during 2006 and 2007, respectively. Maximum economic efficiency (1.97 and 1.98) was achieved by the treatment T_4 this is in the two seasons, respectively, while the lowest value (0.91) was recorded by conventional transplanting T_1 during 2006 and 2007, respectively.

INTRODUCTION

To mitigate the increasing water scarcity in Egypt, new ways of growing rice need to be developed that use less water than conventional lowland rice.

In order to enhance rice productivity in water-limited environments, there is a need to adopt water-saving practices.

Raj Gupta *et al.*(2002) showed that direct seeded rice on beds saves ~40% irrigation water, saves seed (less lodging), promotes in situ conservation of rainwater, improves crop yields (larger panicles and bolder seeds), improves N use efficiency, promotes crop diversification, obviates puddling and soil cracking and facilitates management of saline or alkali soils.

Atta *et al.*(2006) showed that planting in strips of furrows 80 cm wide resulted in the highest value of grain yield (9.05 t/ha), followed by planting in strips of furrows 60 cm wide(9.00 t/ha) and traditional planting (8.71 t/ha).

Beecher *et al.*(2007) demonstrated that water productivity of the rice on the flat layout was 0.70 t/ML, compared with 0.59 t /ML in the flooded beds and 0.58 t/ML on the furrow irrigated rice.

Jagroop *et al.* (2007) revealed that the grain yield of rice transplanted on furrows and on beds was at par with recommended planting method of flat planting. The furrow and bed planting saved 119.5 cm (39%) irrigation water from puddling to harvest and 44.2 to 50.0% more water expense efficiency than the recommended practice on flat planting under same age (30 days) of seedlings

The objective of this investigation was to produce more rice grain yield with less water by inducing planting methods and different densities.

MATERIALS AND METHODS

Two field experiments were conducted at El Karada, water requirements research station, Kafr El Sheikh Governorate, North Delta, Water Management Research Institute, National Water Research Center, Egypt, during the two summer seasons of 2006 and 2007. The soil of the experimental was clayey textured with pH of 8.3. The average of electric conductivity of soil over 0-60 cm depth was 2.3 dSm^{-1}. The previous crop was wheat during 2006 and during 2007 seasons. The experimental design was a randomized complete block, replicated 3 times the experimental consists of 18 plots and each plot was 320 m^2. Six planting methods were followed in the permanent field (treatments), they were: T_1 (Traditional transplanting), T_2 Transplanting of seedlings rice on flat soil at distance of 20 cm. between rows and 15 cm between hills, T_3 Transplanting of seedlings rice on flat soil at distance of 20 cm. between rows and 12.5 cm between hills, T_4 Transplanting of seedlings rice on flat soil at distance of 20 cm. between rows and 10 cm between hills, T_5: Transplanting in bottom of furrows (30 cm). and T_6: Transplanting in bottom of beds (35 cm). the raised furrow was 20 cm high x 35 cm wide with 60 cm distance from med furrow to med another, while the raised beds was 20cm high X 45 cm wide with 80 cm distance from med bed to med another. Rice cultivar Sakha 104 was transplanted on the first of June and 5^{th} june and harvested on 10^{th} and 15^{th} September for 2006 and 2007 seasons, respectively. The fertilizers requirements for the nursery were added according to the recommended doses according to Crops Research Institute, Agricultural Research Center (ARC). Nitrogen fertilizer in the form of ammonium sulphate (20.6 % N) was used at a rate of 60 kg N/fed. Phosphate fertilizer in the form of Calcium superphosphate (15.5 P_2O_5) at the rate of 30 Kg P_2O_5 per feddan was added during permanent field preparations. The complementary fertilizers such as potassium and Zinc were applied as recommended in time. All other cultural practices for rice production were followed. Yields were determined by crop-cut sampling in two diagonally opposite corners of each plot using a 1m x1 m sampling frame in experiment, and grain yields are recorded as kg/ fed. at 14 % moisture content. Ten plants were chosen at random to determine: 1000 grain weight (gm) and grain yield as kg/ fed. all obtained data were analyzed statistically using analysis of variance technique and significant means were separated using

least significance difference test (LSD) for comparing the treatment means (Steel and Torrie, 1980).

Irrigation water applied

Irrigation water was measured using water meter (in m^3). Irrigation water was transmitted through lined ditches with controlled gates, to each plot. The submerged head for each irrigation was about 5 cm at irrigation intervals every 3 days (Continuous flooding).

Grain Yield (kg/fed.):

The central 60 m^2 were harvested to determine grain yield in ton/fed as adjusted at 14% moisture content.

Economic evaluation

Economic evaluation Refers to the combinations of inputs that maximize individual or social objectives. Economic efficiency is defined in terms of two conditions necessary and sufficient. Necessary condition is met in production processes when there is producing the same amount of inputs. But the sufficient condition for efficiency encompasses individual or social goals and values (John and frank, 1987).

RESULTS AND DISCUSSIONS

Irrigation water applied:

Data for total water applied are presented in Table (1).and fig. 1. and 2. It was evident that T_1 (Traditional transplanting) received the highest amount of irrigation water (6564 and 6797 m^3/fed.) followed by T_4 (6420 and 6617 m^3/fed.) in the first and second season, respectively. While the treatment T_6 received the lowest amount of irrigation water (3878 and 4124 m^3/fed) followed by T_5 (4244 and 4490 m^3/fed.) in the first and second seasons, respectively. This difference could be attributed to climatic factors and planting patterns.

From these results we can report that planting in bottom of furrows and beds saved 35.34%, 33.94% and 40.92%, 39.33% of irrigation water compared with traditional planting method over the two seasons, respectively. These results are in accordance with those reported by Atta *et al.*(2006), Jagroop *et al.*(2007), and Meleha *et al.*(2008).

Table 1: Total water applied (m^3 fed^{-1}) and amount of water saving in (m^3 fed^{-1}) and as (%) in both 2006 and 2007 seasons.

Treat.	2006			2007		
	Total water applied (m^3 fed^{-1})	water saving (m^3 fed^{-1})	Water saving (%)	Total water applied (m^3 fed^{-1})	water saving (m^3 fed^{-1})	Water saving (%)
T_1	6564	-	-	6797	-	-
T_2	6300	264	4.02	6551	246	3.62
T_3	6340	224	3.41	6593	204	3.00
T_4	6420	144	2.19	6617	180	2.65
T_5.	4244	2320	35.34	4490	2307	33.94
T_6	3878	2686	40.92	4124	2673	39.33

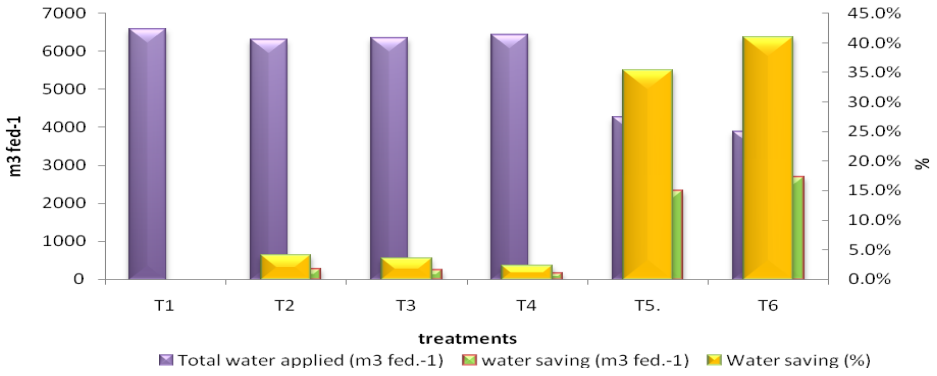

Fig. 1: Total water applied (m^3 fed^{-1}) and amount of water saving in (m^3 fed^{-1}) or as (%) in 2006 season.

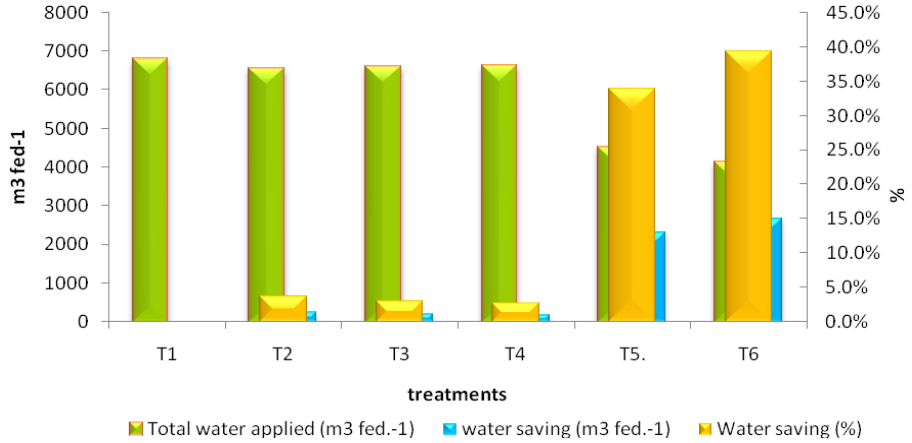

Fig. 2: Total water applied (m^3 fed^{-1}) and amount of water saving in (m^3 fed^{-1}) as (%) in 2007 season.

Grain Yield (kg/fed.):

Data in table 2 show that the maximum rice grain yield (6438.00 and 6460.67 kg $fed.^{-1}$) was produced by the treatment of T_4 this in the two seasons, respectively, while the rest of transplanting methods (T_1, T_2, T_3, T_5 and T_6) produced comparatively lower, grain yield each of 3883.33, 5120.00, 5509.33, 3897.00 and 3907.00 kg.fed^{-1} and 3898.33, 5158.50, 5431.00, 3994.67 and 4065.00 kg.fed^{-1} during 2006 and 2007, respectively.

Table 2: Rice Productivity (kg fed^{-1}) and weight of 1000 grain (gm) as affected by different planting methods during 2006 and 2007 summer seasons.

Treatments	2006		2007	
	Rice productivity (kg.fed^{-1})	Weight of 1000 grain (gm)	Rice productivity (kg.fed^{-1})	Weight of 1000 grain (gm)
T_1	*3883.33*	28.63	*3898.33*	28.84
T_2	*5120.00*	28.70	*5158.50*	28.92
T_3	*5509.33*	28.27	*5431.00*	28.55
T_4	*6438.00*	28.40	*6460.67*	28.64
T_5.	*3897.00*	28.75	*3994.67*	28.80
T_6	*3907.00*	28.95	*4065.00*	28.99
F test	**	N.S	**	N.S
L.S.D 0.01	82.61	-	**186.03**	-
L.S.D 0.05	58.08	-	**130.78**	-

Weight of 1000 grain (gm)

Data presented in Table 2 indicated that the different methods of planting had insignificant effect on weight of 1000 grain (gm) in both seasons of study. Weight of 1000 grain values were 28.63, 28.70, 28.27, 28.40, 28.75 and 28.95 gm and 28.84, 28.92, 28.55, 28.64, 28.80 and 28.99 gm in 2006 and 2007, for T_1, T_2, T_3, T_4, T_5 and T_6 in 2006 and 2007, respectively.

The highest values were obtained with T_6 in both seasons, while the lowest values were found with T_3 treatment in both seasons.

Economic evaluation

Table 3 and 4 and fig. 3 show values of rice grain productivity (kg fed^{-1}), total income (LE fed.$^{-1}$), net profit (LE fed^{-1}), water applied (m^{3}fed.$^{-1}$), water productivity (LE.m^{-3}) and economic efficiency as affected by different planting methods during 2006 and 2007 summer seasons, respectively.

Results indicated that the maximum values of total income (LE fed.$^{-1}$), net profit (LE fed^{-1}), and water applied (m^{3}fed.$^{-1}$), water productivity (LE.m^{-3}) and economic efficiency were obtained under T_4 in 2006 and 2007 seasons.

Table 3: Values of productivity (kg fed^{-1}), total income (LE fed^{-1}), net profit (LE fed^{-1}), water applied (m^{3}fed.$^{-1}$), water productivity (LE.m^{-3}) and economic efficiency as affected by different planting methods during 2006 summer season

Treat.	Productivity (kg.fed^{-1})	Total income (LE fed^{-1})	Costs (LE.Fed^{-1})			Net profit (LE. Fed^{-1})	Water applied (m^3 fed^{-1})	Water productivity (LE.m^{-3})	Economic efficiency
			variable	fixed	total				
T_1	3883.33	4660.00	1045	1400	2445	2215.00	6564	0.34	0.91
T_2	5120.00	6144.00	1185	1400	2585	3559.00	6300	0.56	1.38
T_3	5509.33	6611.20	1185	1400	2585	4026.20	6340	0.64	1.56
T_4	6438.00	7725.60	1200	1400	2600	5125.60	6420	0.80	1.97
T_5	3897.00	4676.40	940	1400	2340	2336.40	4244	0.55	1.00
T_6	3907.00	4688.40	940	1400	2340	2348.40	3878	0.61	1.00

Table 4: Values of rice grain productivity (kg fed^{-1}), total income (LE fed^{-1}), net profit (LE fed^{-1}), water applied (m^{3}fed.$^{-1}$), water productivity (LE.m^{-3}) and economic efficiency as affected by different planting methods during 2007 summer season

Treat.	Rice produc. (kg.fed^{-1})	Total income (LE. fed^{-1})	Costs (LE.Fed^{-1})			Net profit (LE. Fed^{-1})	Water applied (m^3 fed^{-1})	Water produc. (LE.m^{-3})	Economic efficiency
			variable	fixed	total				
T_1	3898.33	4678.00	1045	1400	2445	2233.00	6797	0.33	0.91
T_2	5158.5	6190.20	1185	1400	2585	3605.20	6551	0.55	1.39
T_3	5431	6517.20	1185	1400	2585	3932.20	6593	0.60	1.52
T_4	6460.67	7752.80	1200	1400	2600	5152.80	6617	0.78	1.98
T_5	3994.67	4793.60	940	1400	2340	2453.60	4490	0.55	1.05
T_6	4065	4878.00	940	1400	2340	2538.00	4124	0.62	1.08

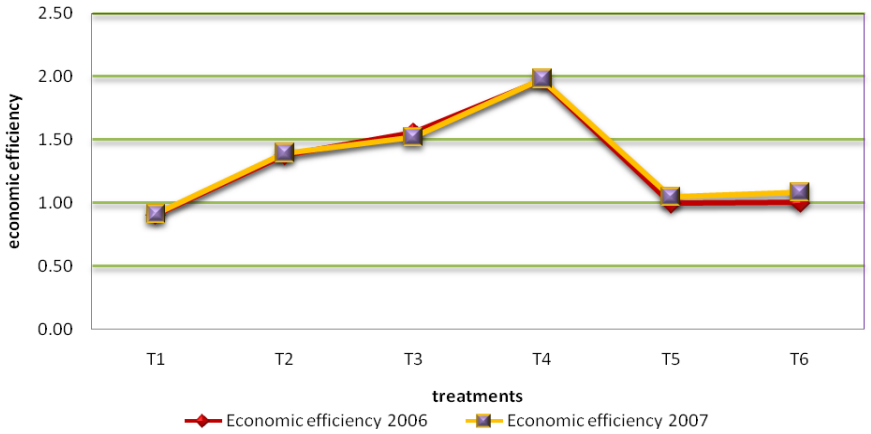

Fig. 3: Economic efficiency as affected by different planting methods during 2006 and 2007 summer seasons.

Recommendation:

Using beds 80 cm wide (T_6) as a method of rice transplanting is potentially high for water saving as approximately 40.13 % will be saved as average, and 2.44 % increase in grain yield/fed. at the same time, seedling rice can be transplanted on flat soil at distance of 20 cm. between rows and 10 cm. between hills to achieve the highest water productivity at North Delta.

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إدارة مياه الري لمحصول الأرز في شمال الدلتا

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تم إجراء تجربة بحثية في محطة تجارب المقننات المائية بالقرضا – محافظة كفر الشيخ التابعة لمعهد بحوث ادارة المياه – المركز القومي لبحوث المياه – مصر ويهدف البحث الى الحصول على اقصى محصول من الارز باقل كميات من المياه من خلال ايجاد طرق زراعة جديدة وقد أستخدم تصميم القطاعات كاملة العشوائية في ثلاث مكررات حيث كانت المعاملات كالآتي: الشتل بالطريقة العادية، (**T_1**)،.زراعة الشتلات في صفوف المسافة بينها 20 سم والمسافة بين الجور 15 سم (**T_2**)، زراعة الشتلات في صفوف المسافة بينها 20 سم والمسافة بين الجور 12.5 سم (**T_3**)، زراعة الشتلات في صفوف المسافة بينها 20 سم والمسافة بين الجور 10 سم (**T_4**)، الشتل في خطوط عرض الخط 60 سم (**T_5**) و الشتل في مصاطب عرض المصطبة 80 سم (**T_6**). وقد أظهرت النتائج ان إجمالي كميات المياه المضافة قد بلغت 6564، 6300، 6340، 6420، 4244 و3878 م3/فدان و 6597، 6551، 6593، 6617، 4244 و 3878 م3/فدان بالنسبة للمعاملات T_1، T_2، T_3، T_4، T_5 وT_6 على التوالي وذلك خلال موسمي الزراعة 2006 و 2007 على الترتيب. كميات المياه التي تم توفيرها من معاملتي الشتل في خطوط والشتل في مصاطب هي 35.34% و33.94 %و40.92% و 39.33% علي الترتيب مقارنة بالطريقة العادية خلال موسمي الزراعة 2006 و 2007 على الترتيب. تم تحقيق اعلى انتاجية (6438 و 6460.67 كجم/فدان) وذلك مع المعاملة T_4 في موسمي الزراعة2006 و 2007 على التوالي.بالمقارنة مع باقي المعاملات (T_1, T_2, T_3, T_5, T_6). لم يكن لطرق الزراعة الجديدة اي تاثير معنوي على وزن الالف حبة خلال موسمي الزراعة 2006 و 2007 على التوالي. سجلت اعلى قيمة لانتاجية المياه (0.80 و 0.70 جنيه/م3) مع المعاملة T_4.بينما سجلت المعاملة T_1 اقل القيم (0.34 و 0.33 جنيه/م3) خلال موسمي الزراعة 2006 و 2007 على التوالي. وبالمثل الكفاءة الاقتصادية حيث كانت اعلى القيم (1.97 و 1.98) واقل القيم (0.91) كانت مع المعاملة T_1 خلال موسمي الزراعة 2006 و 2007 على التوالي.