WATER USE EFFICIENCY AND RICE PRODUCTIVITY AS AFFECTED BY NEW PLANTING METHODS AT NORTHERN PART OF DELTA OF EGYPT

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Abstract

Water scarcity and soil salinity are the main constrains for rice production in Egypt while rice is big water consumer crop. A system of growing rice on raised beds, where water is applied only in the furrows between beds, is hypothesized to reduce water input for rice. For water saving with considerable rice grain yield under newly reclaimed saline soil three field experiments were conducted to innovate new rice planting technology at the experimental farm of El Sirw agriculture research station during three successive seasons of 2008, 2009 and 2010. The innovated methods of rice cultivation technology were transplanting on flat soil with watering every four days as traditional method (control treatment) up to 6 cm water depth, submergence, saturation irrigation on flat soil irrigating every 4days (1 cm water depth), drilling rice on bed with watering every four days up to 1 cm water depth, broadcasting rice with watering every four days up to 1 cm water depth and regular transplanting on bed with watering every four days up to 1 cm water depth and rice transplanting on levees with watering every four days up to 1 cm water depth. The used variety in this experiment was Giza 178 (drought and salt Egyptian rice variety). The soil was clayey with salinity level of 7.5,7.0 & 6.0 dS/m in 2008, 2009 and 2010 seasons, respectively.

The obtained findings showed that the new used rice planting and technology significantly saved water and enhanced water productivity in rice crop under such circumstances. Regular transplanting on bed gave the highest values of water productivity with saving water of 3000- 2700 and 2800 m3 /ha in the first second and third seasons, respectively and insignificant yield reduction (7%) as compared to traditional planting method. Furthermore, the regular transplanting on bed gave the highest values of water use efficiency (WUE) with values of (0.6,0.62 and 0.66) in the first, second and third seasons, respectively. The transplanting on flat soil with watering every 4 day with 6 cm water depth gave the highest grain yield (6.9, 7.0and7.51 t ha-1) and total applied water (14200, 14300 and 14350 m3 ha-1) in 2008, 2009 and 2010 seasons, respectively. Planting on levees gave the highest amount of saved water (3220 and 3250 m3 ha-1) in the second and third seasons.. Rice planting on levees intermediated the above- mentioned methods in water productivity and grain yield whereas it came in the second rank. Drilling on bed gave the lowest yields (6.13, 6.20 and 6.42 t ha-1) in the first, second and third seasons, respectively.

The lowest values of yield components were produced by drilling on bed. Furthermore, the different planting establishment methods significantly varied in their effect on yield attributing characteristics.

Key words: Rice, Water Use Efficiency, Bed planting method, Saline soils.

INTRODUCTION

Rice (*Oryza sativa* L) occupies an important place in the economy of Egypt. It not only meets the total domestic requirements of rice but also contributes a lot toward foreign exchange earning. It is grown on an area of 0.46 million hectares with an average yield of 10.0 t /ha^{-1} (Anonymous, 2009-2010). Rice crop is suffering from water shortage and salinity in Egypt than other advanced rice growing countries of the World. To solve the problem of labour shortage and water shortage, alternate methods of rice stand establishment are inevitable. Direct seeding of rice is a potential alternate, which, is a successful method in various rice growing countries of the world (Adair *et al.*, 1992). Direct seeding and bed planting of rice are considered as resource saving technologies in USA and Australia contributing a lot in reducing environmental pollution and enhancing livelihood of the farming communities through increasing profit with reduced cost of production (Awan et al., 2005, Majid *et al.*, 1996, Sharma, 1996 and Murugaboopathi *et al.*, 1991).

Aslam et al (2008) stated that the highest number of productive tillers/unit even (231.7) were noted in direct seeding followed by double zero tillage (219), bed planting (206.7) and conventional planting (200.2) respectively. Direct seeded crop produced smaller panicles that bore less number of grains (72.67) and grain weight (22.17g) which resulted lower grain yield. The crop established with double zero tillage produced the highest paddy yield (4.8 t/ha) that was statistically at par with conventionally planted crop (4.72 t/ha). The paddy yield in bed planting (4.43 t/ha) and brown manuring (4.23 t/ha) were at par and significantly higher than direct seeding (3.36 t/ha) that produced the lowest yield. Attia *et al* .(2005 and 2006), Khattak et al.(2006) , Mishra, and Saha(2007) and Waled et al.(2009) stated that rice bed planting and furrow irrigation gave high water use efficiency, high values of saved water amount with considerable grain yield. In the present investigation sex rice planting methods were tested. It is an effort to achieve the sustainability and stability in rice production systems.

The current experiment aimed to study the efficiency of bed planting method in water saving with high sustainability of rice productivity under saline soil.

MATERIALS AND METHODS

The experiments were conducted at the Rice Research and Training center, Rice program conducted at El Sirw agriculture Research Station during 2008, 2009 and 2010 seasons. The experimental field was surrounded by rice fields in a relatively flat topography. The 25 cm topsoil layer has a clay texture, and the soil is characterized under the USDA textural classification as a clayey soil. Other soil characteristics are shown in Table 1.

The innovated methods of rice cultivation technology were transplanting on flat soil with watering every four days as traditional methods (control treatment) up to 6 cm water depth, submergence, saturation irrigation on flat soil irrigating every 4days (1 cm water depth), drilling rice on bed with watering every four days up to 1 cm water depth, broadcasting rice with watering every four days up to 1 cm water depth and regular transplanting on bed with watering every four days up to 1 cm water depth and rice transplanting on levees with watering every four days up to 1 cm water depth.

The experiments were conducted in a randomized complete block design (RCBD) in four replications with plot sizes of 200 m^2(10 m width X 20 m length). The land surface (or bed) configurations consisted of conventional puddled flat fields (B0), and levees of 65 cm centre-to-centre spacing (B65) and bed130 cm spacing from center to center (B130) with furrows 35 cm wide. Thus, the bed width was 30 cm in B65 and 95 cm in B130. The bed heights were about 20–25 cm from the furrow bottom. Irrigation water is applied in flats (B0) until the water depth reaches 6 cm above the soil surface each 4 days, and in beds (B65 and B130) until it reaches 1–2 cm above the bed surface. In beds treatment, the fields were irrigated when the water depth in the furrows was 10 cm below the bed surface. The drilling treatment on bed was conducted on bed with 130 cm width from center to center, as in transplanting on bed. The row of drilling has been draw by hoe using rope and ten the seed were manually drilled at the same spacing of drilling machine.

Table 1. Some chemical characteristics of the used soil at three locations

Tested characteristics	2008	2009	2010
pH	8.2	8.13	8.0
ECe ($dS.m^{-1}$)	7.5	7.0	6.4
OM (organic matter) %	1.56	1.84	1.86
Soluble cations, $meq.l^{-1}$(soil paste):	-	-	-
Ca^{++}	14.8	12.0	10.13
Mg^{++}	8.4	5.1	5.7
K^{+}	0.30	0.5	0.6
Na^{+}	54.0	50.1	40.1
Soluble anions, $meq.l^{-1}$(soil paste):	-	-	-
CO_3^{-}	-	-	-
HCO_3^{-}	15.64	16.0	10.7
Cl^{-}	55.5	48.5	49.5
SO_4^{--}	5.33	6.5	4.5
Available micronutrients ppm	-	-	-
Fe^{++}	5.95	6.07	6.10
Zn^{++}	1.01	1.20	1.25
Mn^{++}	4.50	4.50	4.40

Experimental design and cultural practices

All main plots were surrounded by consolidated bunds and lined with plastic sheets installed to a depth of 0.4 m to minimize seepage among plots. Beds of 30 cm width (B65) and 95 cm width (B130) with furrow about 35 cm wide and 20 cm deep were formed using a bed shaper attached to a 4-wheel tractor under dry soil conditions. There were 7 beds in B130plots and 15 beds in B65 plots of 20 m length within each plot. Plots assigned as bed treatments remained dry while the flat fields were soaked 2 weeks before transplanting for puddling under wet soil conditions.

Two days before transplanting, the beds were flooded up to 10 mm, ponding water above the bed surface to facilitate transplanting. In all treatments standing water was maintained at 10–20 mm during the first 10 days after transplanting to facilitate seedling recovery. Afterwards, the ponded water layer in well water was kept between30 and 60 mm before terminal drainage at 15 days before the harvest. In the other water treatments, water application was withheld depending on the treatment.

The recommended fertilizer application rates for N, P and K were used. The rate of nitrogen application was 165 kg ha^{-1}, Phosphorus at rate of 35 kg ha^{-1}, and potassium at 54kg ha^{-1} Zinc was applied at 24 kg ha^{-1} in both seasons. P, K and Zn were applied as basal dressings and incorporated in individual plots 1 day before transplanting. The cultivar used was Giza 178 in all seasons. Seedlings were grown in a seedling nursery for approximately 25 days. Transplanting was carried out by placing 2–3 plants per hill at a spacing of 20 cm × 20 cm in flats. In beds the row spacing was set at 15 cm, resulting in 7 rows in B130 (95 cm bed width + 35 cm furrow width) and 3 rows in B65 (30 cm bed width + 35 cm furrow width). At direct seeded methods, the seed had been sown at the same day of nursery establishment for transplanting method. The hill spacing along the rows was 21 cm in B130 and 18 cm in B65 to maintain a similar plant population (25 hills m^{-2}) among the bed treatments, and no plants were grown in the furrows.

Each plot was irrigated separately. The volume of irrigation water applied in each plot was measured by a flow meter. The depth of irrigation water applied (measured in mm) over the plot surface was then computed from the volume of water applied and the area of the plot.

Data collected were plant height in cm, number of panicles per hill, panicle weight in g, panicle length in cm and rice grain yield t 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 (≈ 14 %).

Water use efficiency (WUE):

Water use efficiency was calculated according to Michael (1978).

The data of each season were imposed to the statistical analysis of variance and differences among treatments means of the studied traits were judged by LSD at P ≤0.05% level of significance according to Gomez and Gomez .(1984).

RESULTS AND DISCUSSION

Yield attributes

Tested cultivation method significantly affected all studied yield attributing characteristics during three seasons (Tables 2, 3and 4). As for plant height, broadcasting treatment gave the tallest plant in three seasons without any significant differences with those produced by the control treatment of flat cultivation method. The shortest plants were recorded when rice was cultivated on levees methods. Regarding panicles number $hill^{-1}$, the control treatment in the terms of traditional gave the highest values of panicles number $hill^{-1}$ in the three seasons of study without any significant differences with those obtained by broadcasting and transplanting on bed methods. The lowest value of panicles number $hill^{-1}$ was recorded when rice was cultivated by drilling method and when it was cultivated by flat soil with saturation watering. As previously mentioned the experiment was conducted under salt stress thereby, drilling and saturation irrigation regime didn't receive enough water to get ride off salinity around root growth zone resulted in lower panicles number $hill^{-1}$.

Table 2. Plant height and panicle number hill-1 of Giza 178 rice variety as affected by rice planting under saline soil.

Trait / Treatment	Plant height (cm)			Number of panicles (hill)		
	2008	2008	2010	2008	2009	2010
Watering every 4 d*on flat soil	89.9a	90.8a	90.5a	14.8a	16.1a	16.3a
Saturation watering every 4d Drilling rice on	86.9b	88.3b	89.6b	12.4bc	13.6c	14.0c
bed	87.4b	88.6b	89.1b	11.63c	13.1c	13.9c
Broadcasting rice (B)	90.6a	90.9a	90.9a	13.6abc	15.3ab	15.5ab
Transplanting on bed	87.6b	87.9b	87.9b	14.3ab	15.4ab	15.7ab
Levees	85.6b	85.9c	87.3c	13.8a	14.6b	15.0b
LSD0.05	1.9	1.5	1.1	1.70	0.92	0.71

*=days

Table 3. Panicle length and panicle weight of Giza 178 rice variety as affected by rice planting under saline soil.

Trait / Treatment	Panicle length cm			Panicle weight g		
	2008	2008	2010	2008	2009	2010
Watering every 4 d*.on flat soil	21.93a	22.45a	22.40a	2.30a	2.39a	2.48a
Saturation watering every 4d.	19.18c	19.88c	20.00d	2.28a	2.27ab	2.38ab
Drilling rice on bed	19.15c	19.75c	20.40cd	1.89b	2.07c	2.28b
Broadcasting rice (B)	19.63c	21.05b	20.95bc	2.01b	2.17bc	2.36ab
Transplanting on bed	20.90b	21.33b	21.40b	2.29a	2.47a	2.48a
Levees	20.7b	21.03b	21.05bc	2.22a	2.34ab	2.41ab
LSD0.05	0.9	0.80	0.73	0.17	0.16	0.12

Table 4. Filled grains panicle^{-1} and unfilled grains panicle^{-1} of Giza 178 rice variety as affected by rice planting under saline soil

Character	Filled grains			Unfilled grains		
	2008	2009	2010	2008	2009	2010
Watering every4 d*. on flat soil	124.8a	131.8a	133.0a	4.3d	3.50d	2.93c
Saturation watering every 4d.	120.0b	121.b	124.0b	6.00c	5.55c	4.65c
Drilling rice on bed	106.5d	117.3c	119.0c	13.70a	10.50a	8.43a
Broadcasting rice (B)	112.3c	123.8b	121.8b	10.33b	6.63b	6.25b
Transplanting on bed	122.5a	130.3a	130.8a	5.80d	4.5d	3.43c
Levees	118.0b	119.0b	125.1b	7.25c	5.75bc	4.15c
LSD0.05	3.3	3.8	3.3	1.5	1.1	1.3

*=days

Interestingly, The longest and heaviest panicles, and filled grains panicle^{-1} were produced by the control treatment in the terms of traditional cultivation method gave the highest values of panicle number hill^{-1} in the three seasons of study without any significant differences with those obtained by transplanting on bed method except panicle length(Tables 3 and 4). On the other hand, the lowest values of aforementioned traits were obtained by drilling. Both drilling method and the treatment of water as saturation system on flat soil were at par regarding Panicle length cm. In the concern of Panicle weight g, traditional cultivation method, treatment of water as saturation system on flat soil transplanting on bed and levees planting methods were at a par. As for, filled grains panicle^{-1} in the three seasons of study, Saturation with watering every 4days and levees planting methods were comparable in this traits. Levees planting method came at medium rank regarding the aforementioned trait. The lowest values of unfilled grains panicle^{-1} were given by planting on flat soil with watering ever four days without any significant differences with those obtained by produced by transplanting on bed. Meanwhile, the maximum values of unfilled grains /panicle were produced by drilling planting method followed by broadcasting planting method in the three seasons of study. Similar finding had been reported by Attia *et al.*(2005 and 2006), Aslam et al.(2008) and El-khoby *et al.*(2009).

Grain yield t/ha

The tested planting methods had significant differences on grain yield of Giza 178 rice variety in the three seasons of current study (Table 5). The control treatment in the terms of cultivation on flat soil with watering every four days produced the highest rice grain yield without any significant differences with those produced by method of transplanting on bed that was fact in the three years of study. On the other hand, the lowest values of rice grain yield were produced by drilling planting method. It is worthy to mention that both of planting methods of drilling and broadcasting were comparable regarding rice grain yield in the three seasons (Table 5).It was observed that the planting method on flat soil with watering every 4 days gave the highest values of main yield components resulted in higher grain yield followed by transplanting on bed for the same reasons. Planting on flat soil with watering every 4 days might be effective in removing salt from such kind of saline soil resulted in improving rice growth leading to high grain yield. At the time drilling planting method is not relevant under salt stress because secondary salinization. Using bed planting method might improve soil drainage with giving one to two flooding irrigation for salt leaching. The current findings are in a good agreement with those indicated by Attia et al.(2005 and 2006), Aslam et al.(2008) and El-khoby et al.(2009)

Table 5. Grain yield t ha-1 and Total applied water m3 ha-1 of Giza 178 rice variety as affected by rice planting under saline soil

Traits / Treatments	Grain yield t/ha			Total applied water		
	2008	2009	2010	2008	2009	2010
watering every 4 d*.on flat soil	7.48	7.65	8.23	14200	14300	14350
Saturation watering every 4d.	6.90	7.00	7.51	13100	13105	13140
Drilling rice on bed	6.13	6.20	6.42	10850	11800	11830
Broadcasting rice (B)	6.21	6.70	6.81	11800	11650	11600
Transplanting on bed	7.10	7.20	7.64	11800	11650	11670
Levees	6.50	6.80	7.00	11300	11080	11100
LSD0.05	0.45	0.50	0.6	-	--	

*=days

Water measurements

Regarding water measurements, the traditional planting method gave the highest values of total applied water (14200, 14300 and 14350 $m^3 ha^{-1}$) in 2008, 2009 and 2010 seasons, respectively, followed by the planting on flat soil under saturation condition in the three seasons of study. On the other hand , planting on levees gave the lowest values of total applied water(11080 and 11100 m^3 ha^{-1}) in the second and third seasons, respectively, and subsequently the highest amount of water save in the last two seasons of current trail. Meanwhile, in the first season, the drilling planting method gave the lowest values of total applied and highest value of water save (3220 and 3250 m^3 ha^{-1}) in the first and second seasons, respectively. The treatment of planting on flat soil with saturation irrigation gave the minimum value of water save in the three seasons of study. Both methods of broadcasting and transplanting on bed occupied medium rank concerning total applied water and amount of saved water in 2008, 2009 and 2010 seasons. As for, water use efficiency (WUE), the planting method of transplanting on bed gave the maximum values of water use efficiency under present trail)(0.6,0.62 and 0.66) in the first, second and third seasons, respectively, followed by the planting on levees. Meanwhile, the lowest values of water use efficiency were recorded at saturation irrigation under flat soil (0.53, 0.53 and 0.54) in 2008, 2009 and 2010 seasons, respectively. Similar results had been indicated by Aslam *et al.*(2008) and Waled *et al.*(2009).

Table 6. water productivity of rice as influenced by bed planting methods in saline soil.

Traits / Treatments	WUE** kg rice /m3			Water saved m^3		
	2008	2009	2010	2008	2009	2010
Watering every 4 d*. on flat soil	0.53	0.54	0.57	-	-	-
Saturation. Water. Every 4d.	0.53	0.53	0.54	1100	1195	1210
Drilling rice on bed	0.57	0.57	0.54	3350	2500	2520
Broadcasting rice(B)	0.54	057	0.59	2700	2650	2680
Transplanting on bed	0.60	0.62	0.66	2700	2650	2750
Levees	0.57	0.61	0.63	2900	3220	3250

*=days,** = water use efficiency

REFERENCES

1. Adair, C. R.,. Beachell H.M., Jodon N. E., David L. L. and Jones. J. W. 1992. Comparative yields of transplanted and direct sown rice, J. Amer. Soc. Agron. 34(2): 129-127.
2. Anonymous, 2009-2010 .Economic scoter, Egyptian agriculture ministry.
3. Aslam M., Hussain S. Ramzan , M. and Akhter M. 2008. Effect of different stand establishment technique on rice yield and its attributes. J. Anim. Pl. Sci. 18(2-3):80-82.
4. Atta, Y.I.M. 2005. Strip planting of rice: A new method for increasing water use efficiency under splitting of nitrogen fertilizer. Egypt. J. of Appl. Sci, 20 (10B): 501-511.
5. Atta, Y. I. M.,. Meleha M.E, Tallet A. and Gawish U.M. 2006. Improving water productivity in rice cultivation with high potential for water saving. The 3rd Arab World Region Conference, Cairo, 4-11 December.
6. Awan, T. H., Ali I. , Anwar C. M., Sarwar G. M.,. Ahmad C. M,. Manzoor Z and Yaqub M. 2005. Economic Effect of Different Plant Establishment Techniques on Rice Production. In Proc. Int. Seminar on Rice Crop, RRI, KSK, Lahore, Punjab – Pakistan. 2-3, October 2005. pp: 226-231.
7. Gomez, K.A.& Gomez, A.A. 1984. Statistical procedures for agricultural research .2nd .ed, John wiley and Sons, USA.
8. Khattak, S. I., Usman K. , Khan Q. and Qayyum A. 2006. Impact of various planting techniques on yield and yield components of rice. Indus Journal of Plant Sciences. 5(1): 753-756.
9. Majid, A., Kahan A. S., Ahmad S. I. and Zaid. M. A. 1996. Water consumption of Different Rice Production Techniques. AMA, Agricultural Mechanization Asia, Africa and Latin America 27(1): 37-40 (Rice Absts., 19(4): 2457, 1996).
10. Michael, A.M. 1978. Irrigation theory and practices. Vikas Publishing House PUTLTD New Delhi, Bombay.
11. Mishra, V. and R. Saha.2007. Effect of raised sunken bed system on inter-plot water harvesting and productivity of rice and French bean in Meghalaya. Indian J. of Agric. Sci. 77 (2): 73-78.
12. Murugaboopathi, C., M. Tomita, E. Yamaji and S. Koide. 1991. Prospect of large sized paddy field using direct seeding supported by surface irrigation system. Transaction of the ASAE. 34(5):2040-2046.
13. Sharma, A. R. 1996. Direct seeding and transplanting for rice production under flood prone lowland conditions. Field Crop Res. 44(2-3): 129-137.
14. El-khoby W. M., Abd Allah A. Abd Allah, Okasha E. M. and A. Z. El-Bably. 2009. Rationalization of Irrigation Water Use in Some Rice Cultivars Using Different Planting Methods in North Delta, Egypt. J. of plant and environment science 2 . 2009. 79-85.

كفاءة استخدام المياه و إنتاجية الأرز متأثرة بطرق زراعة جديدة بأراضي شمال الدلتا بمصر

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ندرة المياه و ملوحة التربة هما العائق الرئيسي لإنتاجية الأرز في مصر حيث أن الأرز من ابكر المحاصيل استهلاكا للمياه في موسم الصيف . نظام زراعة الأرز علي خطوط أو مصاطب حيث يضاف الماء فقط في بطون الخط (القنوات) بين المصاطب أو الخطوط ربما يمكن ان توفر المياة . اقيمت تجربة لدراسة إمكانية توفير الميا ة من خلال تلك الطرق المذكورة اعلاة و ذلك في ثلاث مواسم متتالية ٢٠٠٨و ٢٠٠٩و ٢٠١٠بمحطة بحوث السرو الزراعية بدمياط . و كانت اهم الطرق : طريقة الزراعة الشتل العادية و الري العادي، معاملة الري بالتشبع، التسطير علي مصاطب ١٢٠ سم من وسط الخط إلي وسط الخط،، البدار علي مصاطب بنفس مواصفات التسطير، الشتل علي مصاطب ، الشتل المنظم وغير المنتظم علي خطوط ٧٠ سم من نصف الخط الي نصف الخط . وكان الصنف المستخدم في هذة الطريقة هو جيزة ١٧٨ و مستوي الملوحة 7.5، 7.0 و 6 مللموز / سم. في ٢٠٠٨و٢٠٠٩و٢٠١٠.

ويمكن تلخيص أهم النتائج في الأتي.أثرت طرق الزراعة المختلفة معنويا علي المحصول و مكوناته و كذلك علي قياسات المياه (كفاءة استخدام المياه). الشتل المنظم علي مصاطب أعطي اعلي قيم لكفاءة استخدام المياه في سنوات الدراسة بنقص محصولي حوالي ٧% فقط مقارنة بالطرق التقليدية . الشتل العادي علي ارض مستوية أعطي اعلي محصول(,7.48 , 7.65 , 8.23 طن هكتار-١) ومكوناته و كذلك اعلي كمية مياه مضافة في سنوات الدراسة الثلاث (١٤٢٠٠ و ١٤٣٠٠ و ١٤٥٠٠ م٣ هكتار-١) علي التوالي . الزراعة التسطير علي مصاطب أعطت اعلي كمية مياه موفرة في السنة الأولي فقط بينما الزراعة علي خطوط شتل أعطت اعلي كمية مياه موفرة في السنتين الأخريين(٣٢٢٠ و ٣٢٥٠ م٣ هكتار-١) علي التوالي . ووجد ان الزراعة تسطير علي مصاطب قد أعطت اقل محصول. و علية لتوفير المياة يمكن التوصية بزراعة الأرز شتلا علي خطوط او مصاطب .