

## **IMPACT OF IRRIGATION INTERVALS AND N- LEVELS ON WATER PRODUCTIVITY, GROWTH AND YIELD OF GIZA 179 RICE VARIETY UNDER DRILL- SEEDED METHOD**

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### **ABSTRACT**

Two field experiments were conducted at the Farm of Sakha Agricultural Research Station, Sakha, Kafr- ELsheikh, Egypt during 2012 and 2013 summer seasons. The study aimed to find out the proper nitrogen levels of drill seeded rice of Giza179 rice cultivar under prolonged irrigation interval. The experiment was performed in strip-plot design with four replications. The horizontal plots were devoted to three irrigation treatments; continuous flooding (CF) every 3 days, irrigation every 6 and 9 days. The nitrogen levels Viz; 0, 110, 165 and 220 kg Nha<sup>-1</sup> were distributed in the vertical plots. The main results revealed that the growth characteristics as well as grain yield and its attributes were significantly affected by the irrigation intervals in both season of study. flag leaf area, leaf area index, chlorophyll content, plant height, number of tillers/m<sup>-2</sup>, number of paniclesm<sup>-2</sup>, number of filled grains panicle<sup>-1</sup>, 1000-grain weight, grain yield tha<sup>-1</sup> and straw yield tha<sup>-1</sup> were decreased as irrigation intervals were prolonged up 9 days in the two seasons of study. On the other hand, the period from sowing to heading was prolonged and sterility% was increased. Harvest index wasn't affected by irrigation intervals in both seasons. Both irrigation intervals of CF and 6 days were at a par regarding rice grain yield of both seasons of study while, panicles number/m<sup>-2</sup> and filled grainspanicle<sup>-1</sup> showed the same pattern in 2012 season. Water use efficiency was found to be optimum with irrigation interval of 6- days, with water save % amounted to be 6.93- 5.78..Meanwhile, prolonged irrigation interval up to 9 days gave the highest of water save %( 18.8-19.5%) and yield reduction. Increasing nitrogen level up to 220 kg Nha<sup>-1</sup> significantly increased all studied traits without significant differences with those produced by 165 kg Nha<sup>-1</sup> in most assessed traits and rice grain yield in both seasons of study. On controversy, sterility% significantly decreased as nitrogen level was increased up to 165kgNha<sup>-1</sup> while beyond the latter level the sterility% started to slightly increase. Increasing nitrogen level clearly increased water use efficiency. The interaction effect had significant effect on flag leaf area, leaf area index, plant height, number of tillersm<sup>-2</sup>, number of paniclesm<sup>-2</sup>, filled grains number/panicle, sterility%, 1000-grain weight, grain and straw yields in both seasons of study. The interaction effect had no significant effect on heading date, chlorophyll content and harvest index in both seasons. The interaction effect came to confirm that the irrigation every 6 days with 165 kg Nha<sup>-1</sup> was being to be effective in increasing water use efficiencies, water save and maintain reasonable grain yield. Under prolonged irrigation interval, increasing nitrogen level could relief the harmful of water stress.

It could be concluded that the nitrogen level of 165 kg Nha<sup>-1</sup> and irrigation every 6-day is relevant for drilled Giza 179 rice variety providing high water use efficiency with high yield and reasonable water save percentage.

**Keywords:** drill seeded rice, irrigation intervals, and Nitrogen levels

## INTRODUCTION

Irrigated rice crop is increasingly facing water scarcity. More progress has been made for water saving with more rice production. Furthermore, water efficient irrigation regimes for rice have been tested, advanced, applied and distributed in different regions in Egypt, particularly, under newly reclaimed saline soil. Because of continued population growth and economic developments, the demand for fresh water to meet industrial and domestic needs has increased in Egypt. Therefore, it is expected that, in near future, less water will be available for rice growing. Tabbal *et al.* (2002) reported that reduced water inputs and increased water productivity of rice grown just under saturated soil conditions were compared with traditional flooding rice. Khafaga *et al.* (2006) and Zayed *et al.* (2007) stated that continuous flooding and watering at 6 days intervals were comparable regarding, rice growth, yield attributing traits and grain yield, but the irrigation interval of 6 days gave the highest value of water use efficiency and water productivity. Moreover, Anbumozhi *et al.* (1998), EL-Kholy *et al.* (1999), El Refaee *et al.* (2005) and Majied. (2012) came to similar results. Khafaga *et al.* (2006) found that the percolation losses and evapotranspiration (ETa) were increased by increasing ponding water depth

Water and nutrients availability are two major constraints in rice fields in Egypt. Both stresses interact and contribute to low rice productivity. Many Egyptian farmers are shifting rice establishment method from transplanting in puddle soil to direct seeding in either puddle soil or dry soil after dry tillage because the latter requires less labour, time, drudgery and cultivation cost (El-Ekhtyar, 2004 and Farooq *et al.*, 2009 and 2011). Direct seeding requires only 34% of the total labour requirement of transplanted rice (Ho Nai-Kin and Romli 2002) and 29% of the total cost of transplanted rice production without any yield loss. Drill seeding, a variant of direct seeding, is sowing the seeds in rows at specified seed rate, depth, and covers those with soil under dry or moist condition. This method of rice establishment substantially reduces labour requirement, improves emergence of seeds, and reduces lodging to less than 10% (Bakker *et al.*, 2002). Nitrogen fertilizer management in direct-seeded rice cultivation is important and a challenging task to achieve high yield and increased N use efficiency (NUE). In general, N uptake is less than 40% of the total N applied in rice cultivation (Ladha *et al.*, 2005). The low level of N utilization is due to high N losses through volatilization, denitrification, runoff, and leaching. Application of N not synchronized with plant need leads to high N losses, low yield, and poor grain quality. Nitrogen uptake patterns over the growing season depend on the availability of soil N, timing of fertilizer application, and amount of fertilizer N available (Ladha *et al.*, 2005). Increasing nitrogen rates from 150 – 165 kg Nha<sup>-1</sup> significantly increased rice growth, yield and yield attributing characteristics of drill seeded rice (Ali *et al.*, 2012 and El-Habit Howida *et al.*, 2013). Zayed *et al.* (2006) found that NUE was higher with low nitrogen levels and was lower with increasing nitrogen level. El-Refaei *et al.* (2008) indicated that significant

amount of irrigation water can be saved was small yield reduction if rice field was irrigated every 6 days using 165 kg N ha<sup>-1</sup>.

Information on nitrogen use efficiency(NUE), water use efficiency(WUE) and nitrogen ( N ) balance under intermittent irrigation management approach rice are imperative in making sound fertilizer recommendations that reduce N losses, save water and maintain potential yield of drill-seeded rice. Research findings on NUE and N balance in paired and single-row planting methods in drill-seeded rice are, however, meager.

This paper presents the results of a field study conducted to evaluate the various irrigation intervals (irrigation intermittent system) and five N management strategies on crop and water productivity and N use-efficiency.

## MATERIALS AND METHODS

Two field experiments were conducted at Sakah Agricultural Research Station Farm during summer seasons of 2012 and 2013. Soil texture of the experimental sites is classified as clay soil and its chemical analysis was presented in Table 1. New released variety Giza 179 was used in this study .The experiment was laid out in strip plot design with four replications. The horizontal plots were devoted to three irrigation intervals; continuous flooding with irrigating every 3 days (CF), irrigation intervals every 6 and 9 days. Meanwhile nitrogen levels; 0,110,165 and 220 kg N ha<sup>-1</sup> in the form of urea (46%) were allocated in the vertical plots. Soil samples were taken before land preparation at the depth of 0-30 cm from the soil surface. The soil samples were completely mixed, dried and grounded, and then physically and chemically characteristics were analyzed according to Black *et al.* (1965). Results of analysis in both seasons are shown in Table 1.

**Table 1: Physical and chemical analysis of the experimental sites.**

Character	2012	2013
Physical analysis:		
Sand (%)	16.5	15.5
Silt (%)	28.0	30.0
Clay (%)	55.5	54.5
Soil texture	Clayey	Clayey
Chemical analysis:		
E.C. (ds/m)	1.85	1.80
Organic matter (%)	1.81	1.83
pH	8.04	8.06
Available N (ppm)	28	29
P (ppm)	14	15
K (ppm)	350	360
Fe (ppm)	4.55	5.00
Zn (ppm)	0.99	1.00

The phosphorus and potassium fertilizers were applied in the forms of calcium super phosphate (15.5 % P<sub>2</sub>O<sub>5</sub>) and potassium sulphate(48%k<sub>2</sub>O ) in the rates of 37 kg P<sub>2</sub>O<sub>5</sub> and 50k<sub>2</sub>Oha<sup>-1</sup>, respectively. Nitrogen in the form of urea (46.5 % N) was added into three equal splits, 1/3 at 25, 50 and 75 days after sowing at the above nominated levels. The experimental sites were well

tillage. The seeds of 120 kg ha<sup>-1</sup> were mechanically drilled at rows of 17 cm spaces and 1 cm below soil surface on May,5 in the two seasons. The weeds were controlled chemically using Saturn 50% at 7.5 liters ha<sup>-1</sup> into 350 liter waterha<sup>-1</sup> and sprayed at four days after drilling. The drilled soil was flashy irrigated every 6 days interval after sowing for 25 days. Zinc fertilizer at the rate of 24 kg ZnSO<sub>4</sub>ha<sup>-1</sup> was mixed with sand and manually broadcasted at the beginning of flooding. Then, the irrigation treatments were applied as aforementioned. Each Irrigation treatment was tightly surrounded by deep ditches with 2 m wide and 1 m depth to isolate each other. The plot size was 15m<sup>2</sup>(3m width\* 5m length).

At heading stage, plant samples from area of 0.125m<sup>2</sup> (0.74 m length \*0.17m width) from each plot were taken to estimate days to heading, flag leaf area(cm<sup>2</sup>), leaf area index (LAI)) and chlorophyll content (SPAD value)according to Yoshida *et al.*(1972). Leaf area index is the ratio between the leaf area (cm<sup>2</sup>) of the plant divided by ground area occupied by the plants (cm<sup>2</sup>) and chlorophyll content was estimated by chlorophyll meter (Model Li 3000L)

At harvest, plant of the area of 0.125m<sup>2</sup>(74cm length x17cm width) from each plot were counted to determine number of tillers m<sup>-2</sup> and number of panicles m<sup>-2</sup> and the plant height (cm) was measured. Ten main panicles from each plot were packed to determine number of filled grains panicle<sup>-1</sup>, sterility% and 1000-grain weight (g).

The plants in the central rows of 10 m<sup>2</sup> of each plot were harvested, dried, threshed, then grain and straw yields were determined at 14 % moisture content and converted into t ha<sup>-1</sup> as well as harvest index.

The volume of irrigation water applied in each plot was measured by a calibrated water meter with water pump . The amount water before treatments application (the first 25 days period of drilled rice growth was recorded as well as water required for irrigation treatments of all experiments. Water use efficiency was calculated according to Michael (1978).

All data collected were subjected to standard statistical analysis following the proceeding described by Gomez and Gomez (1984) using the computer program (MSTAT). The treatment means were compared using Duncan's multiple range test Duncan (1955). \* and \*\* symbol used in all Tables indicate the significant at 5% and 1% levels of probability, respectively, while, NS means not significant.

## **RESULTS AND DISCUSSIONS**

### **Effect of irrigation intervals**

Data furnished in Table 2 revealed that the irrigation intervals significantly influenced the studied growth parameters under such conditions in both seasons. Prolonging irrigation intervals up to nine days severely declined growth of Giza 179 rice variety in 2012 and 2013 seasons, respectively. The intermittent irrigation interval of 6 days slightly affected rice growth. It is clear that the continuous flooding gave the highest means of tested rice growth characteristics, flag leaf area, leaf are index and

chlorophyll content in both seasons (Table 2). On the other hand, the prolonged irrigation interval of 9 days produced the minimum values of growth parameters in the first and second seasons, respectively. The irrigation every 9 days gave the longest period from sowing to heading. Water stress increased osmotic pressure resulted in high water potential inside plant cells, low water content, low photosynthesis rate and low metabolism process. Furthermore, the water stress might affect cell division and elongation resulted short plants, narrow leaves leading to small leaf area index and flag leaf area. Low water content of leaf induced by water stress might destroy chlorophyll pigments resulted in low chlorophyll content led to low photosynthesis and dry matter production. Water stress might increase antioxidants releasing in plant cell which damaged the cell membranes and the protein shrinking as a result of water imbalance. Under water stress, the respiration rate might be increased resulted in more water and energy losses against anabolism and ultimately induced starvation and very low growth rate. Water stress might also affect rice roots growth and its capability of nutrient and water absorption. The water stress affected plant phenology because the recovery period after each cycle of stress and watering resulted in delaying or accelerating heading date based the intensity of water stress and rice variety in self. Similar data had been reported by El-Ekhtyar (2004), Zayed *et al.* (2007), and Majid (2012).

Results of variation analysis show that measured properties of plant height, tillers number, panicles number, number of filled grains panicle-1, sterility%, and weight of 1000 grain have a significant difference in irrigation intervals. Prolonging irrigation intervals up to 9 days significantly diminished the yield attributes giving the lowest values of these properties. The continuous flooding (CF) gave the highest values of number of tillers, number of panicles, filled grains panicle-1 and 1000-grain weight without significant differences with those produced by 6-irrigation interval in the first season regarding the first two traits (Table 5&9). Meanwhile, the CF treatment gave the lowest values of sterility% in both seasons (Table 5&9). In the second season, both irrigation intervals of CF and 6-day were at the same level of significant regarding sterility %. Since water stress significantly might be restricted rice growth and other metabolism processes of rice plants as well as increasing catabolism against anabolism that resulted poor yield attributes. Similar results under drill seeded rice had been reported by El-Ekhtyar (2004) and Ali *et al.* (2012).

Data inserted in Table 13 showed that the irrigation intervals had significant effect of grain and straw yields in both seasons. On the other way, the irrigation intervals didn't show any significant effect of harvest index in the 2012 and 2013 seasons. The CF treatment gave the highest values of grain and straw yields in both seasons. Interestingly, the irrigation treatments of CF and 6-days interval were statically placed at the same group regarding the grain and straw yields in both seasons. Thereby, the irrigation interval of 6 days could be recommended under current water shortage and tolerant varieties such as Giza 179 as well as drill seeded rice. The minimum values of rice grain yield were produced when rice plants were irrigated every 9 days

in both seasons of study (Table13). Water stress significantly restricted yield components particularly, plant population/unit area, bearing tillers number m<sup>-2</sup>, and panicle characteristics involving, filled grains, weights of panicle and individual grain. Furthermore, the water stress might be affected panicle peduncle elongation, assimilates translocation due to more exertion of ABA which blocks this translocation, affecting current photosynthesis resulted in low grain filling rate. In addition, water stress might affect the root system growth and its ability of nutrient and water uptake resulted in shoot growth inhibition and ultimately declined rice grain yield. Similar results were claimed by EI-Ekhtyar(2004),Majid (2012)and Ali *et al.*( 2012).

**Table 2:Effect of irrigation intervals and nitrogen levels on heading date, flag leaf area, leaf area index and chlorophyll content of Giza 179 rice cultivar during 2012 and 2013 seasons.**

Treatments	Heading date(days)		Flag leaf area(cm <sup>2</sup> )		Leaf area index(LAI)		Leaf chlorophyll content (SPAD value)	
	2012	2013	2012	2013	2012	2013	2012	2014
A:Irrigation intervals								
Continuous flooding(CF)	91.9b 94.4a	90.6c 92.8b	24.02a 22.94b	24.28a 23.34b	6.19a 6.13a	6.36a 6.24b	33.24a 32.07b	32.56a 31.04b
Irrigation every 6 days	95.3a	94.7a	17.32c	17.43c	5.04b	5.12b	27.96c	27.23c
F. Test	*	**	**	**	**	**	**	**
B: Nitrogen levels (kg Nha <sup>-1</sup> )								
0	90.8d	88.7c	17.52c	16.99c	4.83c	4.85d	28.21c	27.82c
110	92.9c	92.1b	20.81b	21.27b	5.58b	5.76c	31.03b	29.98b
165	95.2b	94.6a	23.23a	23.84a	6.21a	6.27b	32.19a	31.27a
220	96.5a	95.4a	24.17a	24.63a	6.64a	6.73a	32.88a	32.05a
F. Test	*	*	**	**	**	**	**	**
A x B Interaction:	N.S	N.S	**	**	**	**	NS	NS

Means: followed by the same litter (s) are not significantly different, according to DMRT. \*,\*\* and N.S.: Significant at 0.05 and 0.01 levels and not significant, respectively.

**Table 3: Effect of the interaction between irrigation intervals and nitrogen levels on flag leaf area (cm<sup>2</sup>)of Giza 179 rice cultivar during 2012 and 2013 seasons.**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	19.12ef	19.80e	13.63g	18.49gh	19.53fg	12.94i
110	22.95cd	22.19d	17.28f	23.67de	22.79e	17.36h
165	26.68a	24.05bc	18.96ef	27.15ab	24.89cd	19.48fg
220	27.35a	25.73ab	19.42e	27.81a	26.16bc	19.32f

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**Table 4: Effect of the interaction between irrigation intervals and nitrogen levels on leaf area index(LAI) of Giza 179 rice cultivar during 2012 and 2013 seasons**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	5.23fg	5.10g	4.16i	5.26e	5.02ef	4.27g
110	6.09cd	5.97d	4.69h	6.37bc	6.18c	4.73f
165	6.46ab	6.42bc	5.57ef	6.59b	6.55bc	5.68d
220	7.17a	7.03a	5.74de	7.21a	7.19a	5.79d

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**Effect of nitrogen levels:**

Nitrogen treatments significantly influenced the growth; heading date, flag leaf area, leaf area index (LAI) and chlorophyll content of rice in the two study seasons (Table 2). The measured growth parameters significantly responded to nitrogen up to 220 kg and there were progressive improvements on growth of rice. Both nitrogen levels of 165 and 220 were put at one group of significant. The lowest values growth properties were recorded with zero nitrogen application, while the highest values were with higher nitrogen level of 220 kg Nha<sup>-1</sup>. This could be owing to low available N status of the soil and ion imbalance under drill seeded rice because high plant density. It was observed that increasing nitrogen level up to 220 kg ha<sup>-1</sup> significantly retarded heading. As seen in Table 2, none of nitrogen application shortened the period from sowing to heading giving early heading date, under current drill seeded rice. Zayed *et al.* (2005) claimed that both low nitrogen availability accelerates the heading and shortened the vegetative period resulted in less dry matter production at pre-heading that might be produced low grain yield. Similar results were indicated by El-Habet, Howida *et al.* (2013).

Plant height and number of tiller m<sup>-2</sup> were significantly increased as nitrogen levels increased up to 220 kg N ha<sup>-1</sup> (Table 5). The higher nitrogen level of 220 kg N ha<sup>-1</sup> recorded the highest values of plant height and tillers number m<sup>-2</sup>, while the lowest values of them were produced by non-nitrogen fertilizer. Nitrogen fertilizer treatments had significant and positive impact on yield attributes in both seasons (Tables 5&9). Increasing nitrogen level up to 220 kg Nha<sup>-1</sup> significantly increased panicle numbers m<sup>-2</sup> and filled grains panicle<sup>-1</sup>, but the increment in 1000- grain weight was up to 165 kg ha<sup>-1</sup>. However, increasing nitrogen rates up to 220 kg ha<sup>-1</sup> reduced 1000-grain weight without significant mean with that of 165 kg Nha<sup>-1</sup>. The rate of 220 kg ha<sup>-1</sup> failed to lower the number of unfilled grains % comparing only with its proceeding rate of 165 kg Nha<sup>-1</sup>. The latter nitrogen level of 165 kg Nha<sup>-1</sup> gave the lowest values of sterility% in both seasons (Table 9).

The zero nitrogen application exerted the highest values of sterility%. In the two season of study, the nitrogen of 220 and 165 kg Nha<sup>-1</sup> levels were at apar regarding panicles number and filled grains /panicle. At the same time, the treatment of zero nitrogen application recoded the lowest values of

yield attributes. The improvement of the yield attributes as a result of increasing nitrogen levels might due to increase translocation of photosynthesis from source to sink during grain filling as well as improving rice growth traits and grain filling. That might be due to stimulate the vigorous growth superficial roots ,increased the synthesis of cytokinins ( mainly Zeatian ) in roots, and delayed the appearance of the abseic acid (ABA) peak in both leaves and filling grains.High ratio of Zeatian /ABA enhanced the synthesis of RNA, which resulted in protein synthesis for carbon assimilation and transportation (Yang and Sun., 1992). Zayed *et al.*(2007) and El-Habat,Howida*et al.*(2013) reached similar results.

The nitrogen levels significantly improved and affected rice grain and straw yields as well as harvest index in the first and second seasons, respectively (Table13). The grain and straw yields gradually increased as nitrogen levels were increases up to 220 kgNha<sup>-1</sup>. For rice grain yield, the nitrogen level of 220kgNha<sup>-1</sup> gave the highest values of grain yield without significant differences with those released by nitrogen level of 165 kgNha<sup>-1</sup> in both seasons of study(Table13). The maximum values of straw yield were exerted by higher nitrogen level in the two seasons of study. Harvest index recorded its highest value with nitrogen level of 165kgNha<sup>-1</sup> without any significant differences with those produced by nitrogen level of 110 kg Nha<sup>-1</sup> in the first and second season(Table13). It seems that the higher nitrogen level Of 220 kg Nha<sup>-1</sup> was being ineffective in improving harvest index since it failed to produce more grain against straw. Moreover, increasing nitrogen beyond 165kgNha<sup>-1</sup> significantly reduced the harvest index in the two seasons of study (Table 13). The lowest values of yields and harvest index were recorded when rice plants didn't receive any applied nitrogen. A significant higher grain yield at the highest level of nitrogen was obtained ,might be owing to better N uptake leading to greater dry matter production and its translocation to the sink .Increased panicle numbers hill<sup>-1</sup>, filled grains panicle<sup>-1</sup> and grain weight were mainly responsible for the increased yield at this level of nitrogen. Majid (2012) and El-Habet,Howida *et al.*(2013) came to similar results.

**Table 5: Effect of irrigation intervals and nitrogen levels on plant height, number of tillersm<sup>-2</sup> and number of panicles m<sup>-2</sup> of Giza 179 rice cultivar during 2013 and 2013 seasons.**

Treatments	Plant height(cm)		Number of tillersm <sup>-2</sup>		Number of panicles m <sup>-2</sup>	
	2012	2013	2012	2013	2012	2013
A:Irrigation intervals :						
Continuous flooding(CF)	92.8a	91.7a	493a	482a	490a	487a
Irrigation every 6 days	91.2b	90.5b	478b	469b	476a	466b
Irrigation every 9 days	88.7c	87.8c	427c	418c	425b	416c
F. Test	**	**	**	**	**	**
B:Nitrogen levels (kg Nha <sup>-1</sup> ):						
0	85.7d	84.9c	392d	379c	391d	375c
110	90.3c	88.7b	465c	457b	462c	454b
165	92.5b	92.6a	496b	491a	493b	488a
220	94.9a	93.8a	512a	498a	509a	497a
F. Test	**	**	**	**	**	**
Ax B Interaction:	**	**	*	*	*	*

Means: followed by the same litter (s) are not significantly different, according to DMRT.\*,\*\* and N.S.: Significant at 0.05 and 0.01 levels and not significant, respectively.



**Table 6: Effect of the interaction between irrigation intervals and nitrogen levels on plant height (cm) of Giza 179 rice cultivar during 2012 and 2013 seasons**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	88.4g	85.4i	83.3j	87.9e	84.7g	82.1h
110	92.5de	91.3ef	87.1h	90.2d	89.6d	86.3f
165	94.3bc	92.8d	90.5f	93.4b	83.8b	90.7d
220	95.8a	95.2ab	93.7cd	95.3a	93.9b	92.2c

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**Table 7: Effect of the interaction between irrigation intervals and nitrogen levels on number of tillers/m<sup>-2</sup> of Giza 179 rice cultivar during 2012 and 2013 seasons**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	416f	397g	363h	405e	398e	334f
110	492c	482cd	421f	486b	456c	429d
165	523b	515b	448e	512a	509a	452c
220	541a	519b	476d	523a	514a	458c

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**Table 8: Effect of the interaction between irrigation intervals and nitrogen levels on number of panicles m<sup>-2</sup> of Giza 179 rice cultivar during 2012 and 2013 seasons.**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	412f	394f	367g	402e	393e	329f
110	491cd	479d	417f	481b	454c	428d
165	520ab	513bc	446e	501a	507a	449c
220	539a	517ab	471d	564a	511a	456c

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**Table 9: Some yield components of Giza 179 rice cultivar as influenced by irrigation intervals and nitrogen levels during 2012 and 2013 seasons**

Treatments	Number of filled grains/panicle		Sterility percentage		1000-grain weight (g)	
	2012	2013	2012	2013	2012	2013
	<b>A. Irrigation intervals</b>					
Continuous flooding (CF)	111.6a	108.8a	5.01b	4.79b	27.13a	27.29a
Irrigation every 6 days	110.0a	104.4b	4.83c	4.84b	26.49b	26.57b
Irrigation every 9 days	90.4b	86.8c	6.49a	6.41a	24.64c	24.84c
F. Test	**	**	**	*	**	**
<b>B. Nitrogen levels (kg Nha<sup>-1</sup>)</b>						
0	84.5d	79.2d	6.02a	5.87a	25.39c	25.65c
110	97.6c	93.5c	5.54b	5.47b	25.85b	26.02b
165	113.9b	108.8b	4.99d	4.96c	26.57a	26.68a
220	120.0a	118.3a	5.22c	5.08c	26.53a	26.59a
F. Test	**	**	**	**	**	**
A x B Interaction:	**	**	**	**	**	**

Means: followed by the same litter (s) are not significantly different, according to DMRT. \*, \*\* and N.S.: Significant at 0.05 and 0.01 levels and not significant, respectively.

**Table 10: Effect of the interaction between irrigation intervals and nitrogen levels on number of filled grains/panicle of Giza 179 rice cultivar during 2012 and 2013 seasons.**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	91.3g	88.2h	74.1j	92.4g	79.9i	65.4j
110	103.7e	105.5d	83.5i	105.4d	92.6g	82.5h
165	122.4c	121.0c	98.2f	111.6c	118.1b	96.7f
220	128.9a	125.4b	105.6d	125.6a	126.8a	102.4e

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**Table 11: Effect of the interaction between irrigation intervals and nitrogen levels on sterility percentage of Giza 179 rice cultivar during 2012 and 2013 seasons.**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	5.37e	5.68d	7.01a	5.26cd	5.52c	6.84a
110	5.10ef	5.25e	6.26bc	4.99d	5.20d	6.22b
165	4.72g	4.11h	6.14c	4.53e	4.33e	6.02b
220	4.85fg	4.29h	6.53b	4.36e	4.31e	6.57a

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**Table 12: Effect of the interaction between irrigation intervals and nitrogen levels on 1000-grain weight (g) of Giza 179 rice cultivar during 2012 and 2013 seasons**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	26.16de	25.54ef	24.47g	26.29cd	25.74de	24.92ef
110	26.89bcd	26.38cd	24.29g	27.11bc	26.49cd	24.46f
165	28.02a	26.92bc	24.76g	28.23a	27.01bc	24.80f
220	27.43ab	27.13bc	25.04fg	27.54ab	27.05bc	25.18ef

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**The interaction effect:**

Variation analysis of data indicated that the interaction between irrigation intervals and nitrogen levels had significant effect on flag leaf area and leaf area index in both seasons. The combinations of CF with N level of 220 kg Nha<sup>-1</sup> gave the highest values of both mentioned traits. Contrary, the lowest values of them were with the combination of zero nitrogen application and irrigation intervals of 9 days in both seasons (Tables 3 and 4). The three combinations of CF with 165 kg Nha<sup>-1</sup>, CF with 220 kg Nha<sup>-1</sup> and 6 days with

220 kg were at the same level of significant in the first season, while, in the second season, the couple combinations of CF with 220 kg  $Nha^{-1}$  and 6 days with 220 kg showed similar pattern in both traits (Table3). Moreover, under long irrigation interval of 9 days the higher nitrogen level of 220kg  $Nha^{-1}$  was being effective in relieving the effect of water stress on plant growth. Furthermore, nitrogen application at the higher rate could ameliorate the undesirable effect of water stress of prolonged irrigation interval of 9 days by developing extensive root growth, large leaf area, more dry matter production and considerable net photosynthesis. The well root growth induced by higher nitrogen level under prolonged irrigation interval of 9 days enable stressed rice plants to take an adequate water and nutrient keeping health growth. At the same time supplying plant by an adequate nitrogen could delay early aging in the terms of senescence happened by water stress ensuring optimum growth and yield even with water stress.

Data listed in Tables 6&7 indicated that the interaction between irrigation intervals and nitrogen levels had significant effect on plant height and tillers number in both seasons. The combination of nitrogen level of 220 kg  $Nha^{-1}$  and continuous flooding produced the highest values of plant height and tillers number  $hill^{-1}$  in both seasons without any significant differences with those produced by the same nitrogen level with irrigation interval of 6 day in 2012 and 2013, respectively. The lowest means of plant height and tillers number were recorded when rice plant irrigated every 9 days under zero nitrogen level in both seasons of study. That means increasing nitrogen could alleviate the stress effect of water on growth (Majid, 2012)

The interaction between irrigation intervals and nitrogen level had significant effect on number of panicle  $m^{-2}$ , number of filled grains panicle $^{-1}$ , sterility%, and 1000-grain weight in both seasons of study. The combination of CF and nitrogen level of 220 kg  $Nha^{-1}$  produced the highest value of panicles number without significant differences with those produced by the same nitrogen level under 6-day interval (Tables8). The worst combination was zero nitrogen level with 9-days interval. As for, filled grains panicle $^{-1}$ , the lowest values of filled grains panicle $^{-1}$  were obtained by the combination of zero nitrogen level and 9-days interval in both seasons (Table10). The combination of higher nitrogen level of 220 kg  $Nha^{-1}$  with CF and 6-days interval gave the highest values of filled grains panicle $^{-1}$  in the first and second seasons, respectively. The lowest mean of sterility% was recorded with the combination of higher nitrogen level of 220 kg  $Nha^{-1}$  with CF, while the maximum values of sterility% was recorded when rice plants didn't receive any nitrogen under the irrigation interval of 9 days (Table11). Regarding 1000-grain weight, the highest means of 1000-grain weight was recorded when rice plants were fertilized by the nitrogen level of 165 kg  $Nha^{-1}$  under continuous flooding in both seasons (Table12). The last combination statically came at the same group with the combination of 220 kg  $Nha^{-1}$  under continuous flooding. The lowest means of 1000-grain weight were produced by the combination of zero nitrogen level and interval of 9 days in both seasons of study (Table12). Majid (2012) reported similar findings.

The interaction between irrigation intervals and nitrogen level had significant effect on grain and straw yields in 2012 and 2013 seasons, respectively (Table14). The combination of CF irrigation treatment and nitrogen level of 165 kg Nha<sup>-1</sup> gave the highest values of grain yield in both seasons (Tables 14), while, the combination of 220 kg Nha<sup>-1</sup> and 6 days interval gave the highest value of straw yield in the two seasons of study (Table15). Data analysis variation indicated that the combinations of CF with 165 and 220kgNha<sup>-1</sup>, and 6-days interval with the same two levels were placed at the same category of significant. The rice straw yield recorded its highest value at the combination of 220kgNha<sup>-1</sup> and 6-days interval in both seasons (Table14&15). Grain and straw yields recorded their lowest means at the combination of zero nitrogen application and 9-days interval in the two seasons of study. From current deliberations, the increasing nitrogen level up to 220 kg could combat the harmful of water stress induced by prolonged irrigation interval of 9 days. Similar data had been claimed by Majid (2012).

**Table 13: Effect of irrigation intervals and nitrogen levels on grain yield, straw yield and harvest index of Giza 179 during 2012 and 2013 seasons.**

Treatments	Grain yield (tha <sup>-1</sup> )		Straw yield (tha <sup>-1</sup> )		Harvest index (HI)	
	2012	2013	2012	2013	2012	2013
A. Irrigation intervals						
Continuous flooding	8.79a	8.86a	11.99a	12.13a	42.26	42.12
Irrigation every 6 days	8.56a	8.67a	12.08a	12.27a	41.19	41.22
Irrigation every 9 days	6.29b	6.35b	9.27b	9.48b	40.13	39.83
F. Test	**	**	**	**	NS	NS
B. Nitrogen levels (kg Nha <sup>-1</sup> ):						
Control	5.18c	5.23c	7.72d	7.83d	39.92c	40.01c
110	7.95b	8.01b	11.06c	11.29c	41.71a	41.39a
165	9.02a	9.14a	12.27b	12.41b	42.19a	41.96a
220	9.36a	9.45a	13.38a	13.64a	40.97b	40.86b
F. Test	**	**	**	**	**	**
Ax B Interaction:	**	**	*	*	NS	NS

Means: followed by the same litter (s) are not significantly different, according to DMRT. \*,\*\* and N.S.: Significant at 0.05 and 0.01 levels and not significant, respectively.

**Table 14: Effect of the interaction between irrigation intervals and nitrogen levels on grain yield (tha<sup>-1</sup>) of Giza 179 rice cultivar during 2012 and 2013 seasons.**

Nitrogen levels (kg Nha <sup>-1</sup> )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	5.44ef	5.24f	4.88f	5.60ef	5.31fg	4.79g
110	9.15b	8.71b	5.97e	9.12b	8.77b	6.13de
165	10.43a	9.96a	6.68d	10.55a	10.13a	6.74d
220	10.14a	10.32a	7.63c	10.18a	10.45a	7.72c

Means: followed by the same litter (s) are not significantly different, according to DMRT.

**Table 15: Effect of the interaction between irrigation intervals and nitrogen levels on straw yield ( $\text{tha}^{-1}$ ) of Giza 179 rice cultivar during 2012 and 2013 seasons.**

Nitrogen levels (kg $\text{Nha}^{-1}$ )	Irrigation intervals					
	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
0	7.86h	7.92h	7.39h	7.97f	8.03f	7.49f
110	12.37d	12.16d	8.64g	12.43c	12.31c	9.13e
165	13.74bc	13.32c	9.76f	13.86b	13.59b	9.78e
220	13.98b	14.87a	11.28e	14.24b	15.16a	11.52d

Means: followed by the same litter (s) are not significantly different, according to DMRT.

### Water relations

Data listed in Table 17 refer that irrigation intervals had marked variation in total applied water, water save% and water use efficiency in both seasons. The continuous flooding (CF) had the highest values of total applied water, while the prolonged irrigation interval of 9 days recorded the minimum values of total applied water. The irrigation interval of 9 days gave the maximum amount of water save and the CF treatment gave the least amount of water save. The intermittent irrigation interval of 6 days clearly mediated the two irrigation treatment intervals in amount of water save. Interestingly, the highest mean of water use efficiency was obviously recorded by the irrigation interval every 6 days with slightly yield reduction. The prolonging irrigation interval every 9 days gave the highest value of yield reduction and water save%, but it gave the lowest values of water use efficiency. Therefore, irrigation interval every 6 days could be recommended under drill seeded rice based on water use efficiency and other water relations (Tables 16 and 17). Similar data had been reported by Zayed *et al.* (2007) and Majid (2012).

Data in Table 18 showed that the tested nitrogen levels markedly varied in their effect of water use efficiency in both seasons. The lowest values of water use efficiency were produced by zero nitrogen level, while the highest values of water use efficiency were produced by the highest nitrogen level of 220 kg  $\text{Nha}^{-1}$ . It was observed that the combination of nitrogen level of 220 kg  $\text{Nha}^{-1}$  and irrigation interval of 6 day gave the highest values of water use efficiency in both seasons (Table 18). Furthermore, under both irrigation intervals of 6 and 9 days, increasing nitrogen level linearly increased water use efficiency up to 220 kg  $\text{Nha}^{-1}$ . At the same time, under continuous flooding the increasing water use efficiency was recorded up to only 165 kg  $\text{Nha}^{-1}$  and the water use efficiency was decreased with high nitrogen level of 220 kg  $\text{Nha}^{-1}$ . Similar data was claimed by Majid (2012).

From going discussion, it could be concluded that application of nitrogen at the rate of 165 and/or 220 kg  $\text{Nha}^{-1}$  was found to be optimum for rice growth; yield and water use efficiency as well as water save allied with 6 days irrigation intervals for drilled Giza 179 rice variety. The increasing nitrogen level up to 220 kg  $\text{Nha}^{-1}$  showed ability to relief the undesirable effect of water shortage under prolonged irrigation interval keeping high yield and reasonable WUS as well as water save even with water stress plus the others drill-seeded rice's advantages.

**Table 16: Water use for 25 days before starting irrigation treatments  $m^3ha^{-1}$ , water use through irrigation treatments  $m^3ha^{-1}$  and total water used  $m^3ha^{-1}$  during 2012 and 2013 seasons.**

Irrigation treatments	Water used before treatments		Water used through treatments ( $m^3ha^{-1}$ )		Total water used ( $m^3ha^{-1}$ )	
	2012	2013	2012	2013	2012	2013
Continuous flooding (CF)	2886.5	2795.8	9518.7	9424.6	12405.2	12220.4
Irrigation every 6 days			8658.4	8718.3	11544.9	11514.1
Irrigation every 9 days			7186.5	7041.8	10073.0	9837.6

**Table 17: Some water relations of Giza 179 cultivar as affected by irrigation intervals under drill-seeded rice during 2012 and 2013 seasons.**

Irrigation treatments	Total water ( $m^3ha^{-1}$ )		Grain yield ( $tha^{-1}$ )		Yield reduction (%)		Water saved (%)		Water use efficiency (WUE $kgm^{-3}$ )	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Continuous flooding (CF)	12405.2	12220.4	8.79a	8.86a	-	-	-	-	0.709	0.7025
Irrigation every 6 days	11544.9	11514.1	8.56a	8.67a	2.62	2.14	6.93	5.78	0.741	0.753
Irrigation every 9 days	10073.0	9837.6	6.29b	6.35b	28.44	28.33	18.80	19.50	0.624	0.645

**Table 18: Effect of the interaction between irrigation intervals and nitrogen levels on water use efficiency during 2012 and 2013**

Nitrogen levels (kg $Nha^{-1}$ )	2012			2013		
	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days	Continuous flooding	Irrigation every 6 days	Irrigation every 9 days
Control	0.439	0.454	0.484	0.458	0.461	0.487
110	0.738	0.754	0.593	0.746	0.762	0.623
165	0.841	0.863	0.663	0.863	0.880	0.685
220	0.817	0.894	0.757	0.833	0.908	0.785

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## تأثير فترات الري و معدلات النتروجين علي إنتاجية المياه ، نمو و محصول الأرز للصنف جيزة ١٧٩ تحت طريقة الزراعة بالتسطير

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مركز البحوث و التدريب في الأرز-سحا كفر الشيخ- معهد بحوث المحاصيل الحقلية -مركز البحوث الزراعية-مصر.

أقيمت تجربتان حقليتان بمحطة بحوث سحا الزراعية بكفر الشيخ -مصر خلال موسمي ٢٠١٢ و ٢٠١٣ وتهدف الى تحديد معدلات النتروجين المثلي للأرز بالتسطير تحت فترات ري مختلفة باستخدام الصنف جيزة ١٧٩ وكذلك دور النتروجين في تخفيف الأثر الضار لنقص مياه الري. أقيمت التجارب في تصميم الشرائح المتعامدة في اربعة مكبرات . وزعت فترات الري و هي الري كل ٣ ( الغمر المستمر)، ٦ و ٩ ايام في الشرائح الأفقية اما الشرائح الراسية وزعت بها معدلات النتروجين و هي صفر، ١١٠، ١٦٥ و ٢٢٠ كجم نتروجين /هكتار. و يمكن تلخيص النتائج كما يلي ، وجد ان صفات النمو و المحصول ومكوناته تأثرت معنويا بفترات الري في موسمي الدراسة. مساحة ورقة العلم ودليل مساحة الورقة و محتوى الكلورفيل و طول النبات و عدد الأفرع و السنابل /المتر المربع و عدد الحبوب الممتلئة/السنبل و وزن الألف حبة و محصول الحبوب طن/ الهكتار و القش طن / الهكتار نقصت بزيادة طول فترات الري حتى ٩ ايام. اما عدد الأيام من الزراعة حتى الطرد و النسبة المئوية للحبوب الفارغة قد زادت معنويا مع فترة الري كل ٩ ايام. دليل الحصاد لم يتأثر معنويا بفترات الري في موسمي الدراسة . وقد وجد ان المعاملة الغمر المستمر و الري كل ٦ ايام كان علي نفس الدرجة من المعنوية بدون فرق معنوي خصوصا في محصول الحبوب بينما أ ظهرت صفتي عدد السنابل /م<sup>٢</sup> و عدد الحبوب الممتلئة/السنبل نفس المستوى من المعنوية خلال موسم ٢٠١٢. اعطت معاملة الري كل ٦ ايام اعلي كفاءة استخدام مياهة مع توفير كمية من مياه الري ترواحت من ٦.٩٣ - ٥.٧٨ % على الرغم من ان المعاملة كل ٩ ايام اعطت اكبر قدر من توفير المياه ( ١٨.٨ الي ١٩.٥ %) الا انها سجلت اعلي قدر من نقص المحصول و لذا اعطت اقل كفاءة في استخدام المياه. وجد ان جميع الصفات المدروسة تأثرت معنويا بمعدلات النتروجين و زادت بزيادة معدلات النتروجين حتي اعلي معدل نتروجين وهو ٢٢٠ كجم نتروجين/هكتار بدون فرق معنوي مع المعدل ١٦٥ كجم نتروجين /هكتار في كلا الموسمين. وجد ايضا ان النسبة المئوية للحبوب الفارغة قلت معنويا مع زيادة معدلات النتروجين حتي ١٦٥ كجم/هكتار و لكن بدأت تزيد عند اعلي معدل بدون فرق معنوي مع المعدل المذكور سابقا. وجد ايضا ان كفاءة استخدام المياه قد زادت بزيادة معدلات النتروجين. وجد ان التفاعل بين عوامل الدراسة اثر معنوي علي مساحة ورقة العلم و دليل مساحة الأوراق و طول النبات و عدد الأفرع و السنابل م-٢ و عدد الحبوب الممتلئة بالسنبل و النسبة المئوية للحبوب الفارغة و وزن الألف حبة و محصول الحبوب و القش في كلا موسمي الدراسة بينما لم تتأثر صفة عدد الأيام من الزراعة حتي الطرد ،محتوى الكلورفيل و دليل الحصاد بالتفاعل بين عوامل الدراسة في كلا الموسمين. و جاءت نتائج التفاعل لتؤكد افضلية الري كل ٦ ايام مع ١٦٥ كجم نيتروجين هكتار<sup>١</sup>، حيث اعطت اعلي كفاءة في استخدام مياه الري و دون نقص في محصول الحبوب. كان لزيادة معدلات الأزوت تحت فترات الري الطويلة اثرا معنويا في تخفيف الأثر الضار الناتج من نقص المياه علي نمو و محصول الأرز بالتسطير و كفاءة استخدام المياه.

يمكن التوصية بالري كل سنة ايام و اضافة معدل النتروجين ١٦٥ كجم هكتار<sup>١</sup> للحصول علي اعلي قدر من توفير المياه و معدل اعالي من كفاءة استخدام المياه. و ايضا في حالة تطويل فترات الري الي ٩ ايام كما هو سائد في نهايات الترع يمكن زيادة معدلات النتروجين لتكون ٢٢٠ كجم هكتار<sup>١</sup> مع الأرز بالتسطير لضمان محصول اعالي و اعلي عائد من وحدة الأرض و المياه.