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EFFECT OF NITROGEN FERTILIZER SPLITTING AND WATER MANAGEMENT ON PRODUCTIVITY AND GRAIN QUALITY OF GIZA 179 RICE CULTIVAR

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ABSTRACT: A Field experiment was initiated during the 2018 and 2019 seasons at The Experimental Farm of Sakha Research Station, Kafr El-Sheikh, Egypt. The purpose of this study is to determine a more suitable nitrogen fertilization mode under water deficit for improving the grain yield and quality of Giza 179 rice cultivar. The experiment was laid out in a split-plot design with three replications. Three irrigation treatments were distributed in the main plots namely, continuous flooding (CF), irrigation every 4 and 8 days after the disappearance of ponded water (DADPW). However, the subplots were occupied by five splits of nitrogen application, i.e., T1 (all dose as basal), T2 (½ as basal + ½ top dressing at the mid tillering stage), T3 (½ as basal + ¼ top dressing at mid tillering + ¼ top dressing at panicle initiation), T4 (⅓ as basal+ ⅓ at mid tillering + ⅓ at panicle initiation), and T5 (⅔ as basal + ⅓at mid tillering). The results revealed that growth, grain yield and its components and grain quality were significantly increased under CF without significant differences with 4-DADPW compared to the 8-DADPW treatment. The T3 and T4 treatments registered higher values of growth and grain yield than other treatments. Continuous flooding consumed the highest amount of irrigation water. However, the lowest amount of water was received by 8-DADPW treatment and gave reasonable water productivity in both seasons. Generally, in the case of the shortage of irrigation water, it is possible to use irrigation as 4-DADPW with nitrogen application as T4 or T3, leading to high values of growth, grain yield and quality, and water productivity for Giza 179 cultivar.

Key words: Rice, irrigation management, nitrogen fertilizer, water productivity, grain yield.

INTRODUCTION

Rice is the essential food crop and a major food grain for more than a third of the world's population (Yoseftabar, 2013). Irrigation and fertilization are the essential practices in the rice crop. In lowland rice, traditional water management tries to maintain the fields flooded at all times. Flooded irrigation is the most common method of rice cultivation, and it uses a lot of water, around 18 % of water resources (Busari et al., 2019). Water inputs can be reduced to increase water productivity by introducing irrigation periods of none submerged conditions of several days (LaHue et al., 2016). Decreasing water availability for agriculture threatens the productivity of the irrigated rice ecosystem to save water and increase rice productivity (Ashouri, 2014). Rice receives more irrigation water than other grain crops, hence a water-saving irrigation system for rice is viewed as a critical component in any water-scarcity strategy. (Manzoor et al., 2006).

After water stress, nitrogen is the most crucial and limiting nutrient in rice growth. (Haefele et al., 2006). Nitrogen influences the number of tillers per plant, grain yield, and yield components. (Salman et al., 2012). Due to poor

assimilate formation, nitrogen deficiency causes stunted growth and chlorotic leaves. As a result, nitrogen deficiency causes premature flowering and a shorter growth cycle. The presence of too much nitrogen encourages the growth of dark green plants (high chlorophyll). (Roshan et al., 2011). Throughout the pre-heading stage, nitrogen contributes to carbohydrate accumulation in the culms and leaf sheaths, and during the rice ripening stage, nitrogen contributes to carbohydrate accumulation in the grain (Swain et al., 2010). For greater rice grain yield, the amount and timing of nitrogen treatment must be optimized. Physical, chemical, and biological processes cause significant changes in nitrogen fertilizer under flood circumstances. (Mahmud et al 2021).

The present study objective is to evaluate the effect of irrigation regimes and timing of nitrogen addition on plant growth, grain yield, grain quality, and water productivity of the Giza 179 rice cultivar.

MATERIALS AND METHODS

Experimental site:

The present experiment was conducted at The Experimental Farm of Sakha Research Station, Agricultural Research Center, Kafr El-Sheikh, Egypt- The Agricultural Farm during the 2018 and 2019 seasons. The study examined Giza 179 rice cultivar (duration about 120 days) grown under different water regimes conditions and nitrogen splitting application at different rice growth stages. The average meteorological data (from May to September) of the experimental sites were 32.8 and 31.7 ^{o}C for maximum temperature, 17.3 and 23.5 ^{o}C for minimum temperature, 82.1 and 81.4 % for relative humidity, 6.8 and 6.5 mm/day for pan evaporation in 2018 and 2019 seasons, respectively. All experiments were preceded by a barley crop (*Hordum spp*.). The results of mechanical and chemical experiments' soil properties are presented in Table 1.

Experimental design and land preparation:

The experiment was laid out in a split-plot design with three replications in each season. Three irrigation treatments were used, namely, continuous flooding (CF) and irrigation at 4- and 8- days after the disappearance of ponded water (DADPW) were allocated at the main plot. However, the subplots were occupied by five split of nitrogen application nitrogen i.e., all dose as basal denoted at T1, ½ as basal + ½ top dressing at mid tillering stage dented in T2, ½ as basal + ¼ top dressing at mid tillering + ¼ top dressing at panicle initiation dented at T3, ⅓ as basal- ⅓ at mid tillering + ⅓ at panicle initiation dented at T4 and ⅔ as basal + ⅓at mid tillering dented at T5.

Table 1: Mechanical and chemical analysis of the experiments soil

Soil analysis	2018	2019
Soil texture (%)	clayey	clayed
pH	8.05	8.20
EC (dS m^{-1})	2.00	2.05
Available NH_4 mg kg^{-1}	13.50	12.60
Available NO_3 mg kg^{-1}	10.00	11.80
Available P mg kg^{-1}	14.00	12.00
Available K mg kg^{-1}	366	350
Available Zn mg kg^{-1}	1.13	1.15

Seeds of Giza 179 rice cultivar at the rate of 144 kg ha^{-1} were soaked in sufficient water for 24 hours and incubated for another 48 hours to enhance germination. The nursery was well plowed and leveled. Fertilizer treatments, as well as all other cultural practices, were applied as recommended to the nursery. Pre-germinated seeds were broadcasted in the presence of water after puddling the nursery on the 10^{th} and 13th of May in the first and second seasons, respectively. For the permanent field, phosphorus fertilizer at the rate of 35.5 kg P_2O_5 ha^{-1} was basally applied to the soil during the land preparation. Potassium fertilizer was added at 57 kg K_2O ha^{-1} as a basal dose and incorporated into dry soil. According to the treatments, the recommended dose of nitrogen fertilizer (165 kg N/ha, using urea 46.5 % N) was applied. With an area of 30 m^2 (5 x 6 m) each, all plots were transplanted with three to four thirty-day-old seedlings at 20 cm distance among hills and rows. To avoid lateral irrigation water movement and for more water control, each main plot was lightly separated by two-meter-wide ditches.

Data recorded:

At the booting stage (75 days from sowing), plants of five hills were randomly taken from subplots of each treatment to estimate dry matter production and leaf area index (LAI). Days to 50% of heading were recorded in each subplot. At harvest, plant height was estimated. The total number of panicles of ten random hills was counted and then converted into numbers/m^2. Ten random panicles were collected from each plot to estimate panicle length, the total number of grains/panicle, unfilled grain percentage, sink capacity (grains number per unit area), panicle weight, and 1000-grain weight. Grain and straw yields were randomly measured from an inerr-area of 12 m^2 (3 x 4 m), and grain yield was adjusted to 14 % moisture content. Milling recovery (hulling, milling, and head rice %) was measured according to the method described by Khush (1978). According to Hafez and Mikkelsen, (1981), the Orange G. method was used to determine the nitrogen content in rice grains and then multiplied by the factor of 5.95 to estimate the crude protein in rough grains.

Water management:

A water pump provided with a calibrated water meter was used for all water measurements. Water productivity was calculated as the weight of grain yield per unit of water (kg grain/m^3 water).

Statistical Analysis

Data collected were statistically analyzed using the analysis of variance technique according to Gomez and Gomez (1984). Duncan's Multiple Range Test was used to compare the treatment means (Duncan 1955). All statistical analyses were accomplished using the analysis of variance technique using the "COSTAT" statistical software package.

RESULTS AND DISCUSSION

1-Growth attributes:

The values of leaf area index and dry matter production were the highest one in CF without any significant differences with 4-DADPW compared to 8-DADPW treatment (Table 2). Prolonging irrigation intervals from continuous flooding up to 8-DADPW treatment decreased LAI, DM, and plant height. The tallest plants were obtained when plants were irrigated with continuous flooding in two seasons. The water availability might be due to root growth and high mobility of nutrients in soil solution and nutrients absorption by plant roots that increased the

physiological processes inside the plant such as protein synthesis and photosynthesis. The results agree with the findings of Hossain et al., (2020). In contrast, prolonged irrigation interval during early stages from tiller development causes inhibition of the activities of many enzymes leading to changes in the structures of plant tissues. The results agree with the findings of Alhassan et al., (2017) and Hameed et al., (2019).

On the other hand, it was found that the rice plants with well-watered spent the least days to attain 50 % flowering, while plants watered at 8-DADPW had the most extended duration to attain 50 % flowering. water stress greatly influences the root size, elongation and the division of cells. Influences physiological functions contribute to delays flowering these results are supported by the findings of Wang, (2020). Maximum values of studied growth traits of LAI, DM, days to 50 % heading and plant height were noted in plants treated with T4 without significant differences from those produced by T3. Meanwhile, the minimum values of such traits were obtained by applying T1 treatment in both seasons (Table 2). The available nutrients supply at different growth stages helped increase the plant's physiological processes such as photosynthesis, enhancing leaf area, more dry matter accumulation and help for cell elongation to increase the plant height. These results are supported by the findings of Jiang et al., (2106), Ullah et al., (2019) and Santiago-Arenas et al. (2020).

Table 2: Leaf area index (LAI), dry matter, days to heading and plant height of Giza 179 rice cultivar as affected by irrigation regimes and split of N application during 2018 and 2019 seasons.

Treatment	LAI		Dry matter (g/m^2)		Days to 50% heading		Plant height (cm)	
	2018	2019	2018	2019	2018	2019	2018	2019
Irrigation regime (I):								
CF	5.33a	5.88a	1136.8a	1217.5a	91.2b	91.6c	99.4a	101.5a
4- DADPW	5.06a	5.49a	1108.8a	1189.4a	96.6a	93.8b	96.6b	98.7b
8- DADPW	3.46b	3.76b	864.0b	942.2b	93.0a	95.3a	88.0c	89.3c
F. test	*	**	**	**	**	**	**	**
Fertilizer treatment (N):								
T1	2.45c	2.86c	946.6c	1022.9c	90.3c	91.6c	92.7c	94.5c
T2	4.12b	4.62b	1013.8b	1090.1b	91.7b	93.0b	94.1b	65.9b
T3	5.74a	6.15a	1084.4a	1167.4a	93.3a	94.6a	95.8a	97.6a
T4	6.22a	6.63a	1101.2a	1184.2a	93.8a	95.1a	96.2a	98.0a
T5	4.54b	4.95b	1036.8b	1117.3b	92.1b	93.4b	94.6b	96.4b
F .test	**	**	**	**	**	**	**	**
Interaction								
I X N	NS	NS	NS	NS	NS	NS	NS	NS

*** = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant. According to CF = continuous flooding, 4-8 days after the disappearance of ponded water, T1= (all N dose as basal), T2= (½ as basal + ½ at mid tillering), T3= (½ as basal + ¼ at mid tillering + ¼ at panicle initiation), T4= (⅓as basal + ⅓at mid tillering + ⅓ at panicle initiation) and T5= (⅔as basal + ⅓ at mid tillering).**

2- Grain yield and its attributes:

In both seasons, continuous flooding treatment significantly registered the maximum values of all grain yield attributes (number of panicles, total number of grains/panicle, panicle length, sink capacity, panicle weight and 1000-grain weight) without any significant difference with 4-DADPW treatment in most above mentioned traits, except for unfilled grains percentage, which respects to the highest value under 8-DADPW irrigation treatment (Table 3). These results are in accordance with those reported by Sudhakara et al., (2017) who indicated that water stress caused an increase in the percentage of unfilled grains.

On the other hand, the watering at 8days after the disappearance of ponded water up to eight days gave the minimum values of all traits in both seasons. The highest values of grain yield were recorded by CF (11.35 and 11.72 t/ha), followed by 4-DADPW (10.94 and 10.39 t/ha). However, the lowest values (8.10 and 8.43 t/ha) were obtained by 8-DADPW. Such results might be because available water enhanced the production and transportation of the dry matter content to panicles for new tillers. Consequently, the number of tillers bearing panicles and the total number of grains/ panicles increased. As a result, grain filling and weight and higher grain yield have increased too. The results indicated that exposing rice plants to water stress reduced the number of plants within the unit area due to the tillers' death caused by drought stress. Also, a decrease in sink capacity was associated with decreasing total grains/panicle and panicle weight. These findings agree with those obtained by Alhassan et al., (2017), Materu et al., (2018) and Hossain et al., (2020).

The treatment of ⅓ basal + ⅓ mid tillering + ⅓ panicle initiation recorded the highest values of all grain yield attributes without any significant differences with those obtained by T3 treatment. Meanwhile, T1 (all N applied as basal) obtained the minimum values of such traits in both seasons (Table 3). Except for unfilled grains percentage, which respects the highest value under T1 (all as basal) treatment in both seasons. By fertilizer treatment, nitrogen fertilizer had a positive effect on the photosynthetic rate, which improved the grain filling and reduced sterility leading to higher grain number and most grain yield components. The application of N at different growth stages may increase the availability of soil nitrogen assimilate products, which might increase the absorption and the translocation of nutrients to the rice grain. A similar finding was reported by Jagathjoth et al., (2012). Also, nitrogen fertilizer had a positive and direct effect on grain filling reduced sterility, leading to higher grain weight. The increase of nitrogen level improved photosynthetic efficiency and translocation assimilates which reflected the increase in most grain yield components. A similar finding was reported by Ullah et al., (2019).

The interaction between irrigation regime and fertilizer treatment significantly affected the total number of grains/ panicles in both seasons (Table 4). The highest value of the total number of grains/ panicles was produced by the continuous flooding and applied N fertilizer, with three equal doses at ⅓ basal + ⅓ mid tillering + ⅓ panicle initiation a par with ½ basal + ¼ mid tillering + ¼ panicle initiation under the same irrigation regime. However, the lowest number of grains/ panicles was produced by irrigation 8-DADPW when all N doses were applied as basal treatment in both seasons.

Table 3: Grain yield and its attributes of Giza 179 rice cultivar as affected by irrigation regimes and split of N application during 2018 and 2019 seasons.

Treatment	No. of panicles /m^2		Total number of grains/ panicle		Unfilled grain (%)		Panicle length (cm)		Panicle weight (g)		1000-grain weight (g)		Grain yield (t/ha)		Straw yield (t/ha)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
CF	531.4a	545.3a	170.5a	177.2a	9.35b	10.65b	22.26a	22.94a	4.28a	4.42a	24.77a	25.03a	11.35a	11.72a	12.82a	13.41a
4- DADPW	503.8a	519.7a	165.0a	171.1a	11.51b	12.77b	21.59a	22.05a	4.15a	4.23a	24.36a	24.68a	10.94a	11.37a	12.24a	12.68a
8- DADPW	436.2b	459.4b	130.3b	139.8b	14.41a	16.41a	19.38b	19.79b	3.58b	3.84b	22.99b	23.37b	8.10b	8.43b	10.35b	10.83b
F. test	*	**	**	**	**	**	**	**	*	**	*	**	**	**	**	**
T1	413.5c	431.1c	149.4c	146.8c	14.02a	15.54a	18.91c	19.63c	2.77c	3.18c	22.08c	22.40c	8.42c	8.80c	9.64c	10.14c
T2	456.7b	474.3b	149.2b	156.6b	12.16b	13.68b	20.58b	21.05b	3.44b	3.79b	23.49b	23.81b	9.58b	9.96b	11.31b	11.81b
T3	538.8a	556.4a	163.6a	171.0a	10.43c	11.95c	22.20a	22.67a	4.73a	4.72a	25.11a	25.43a	11.04a	11.41a	12.93a	13.43a
T4	560.3a	578.0a	168.9a	176.3a	10.09c	11.61c	22.68a	23.14a	5.15a	4.94a	25.59a	25.91a	11.38a	11.76a	13.40a	13.91a
T5	483.1b	500.7b	155.4b	162.8b	12.06b	13.58b	21.00b	21.47b	3.93b	4.20b	23.91b	24.23b	10.21b	10.59b	11.31b	12.23b
F .test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
I X N	NS	NS	*	*	NS	NS	NS	NS	*	*	NS	NS	*	*	NS	NS

* = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant. According to CF = continuous flooding, 4-8 days after the disappearance of ponded water, T1= (all N dose as basal), T2=(½ as basal + ½ at mid tillering), T3= (½ as basal + ¼ at mid tillering + ¼ at panicle initiation), T4= (⅓as basal + ⅓at mid tillering + ⅓ at panicle initiation) and T5= (⅔as basal + ⅓ at mid tillering).

Table 4: Total number of grains / panicles, panicle weight and grain yield of Giza 179 rice cultivar rice as influenced by the interaction between irrigation regimes and nitrogen fertilizer treatments.

Fertilizer treatment	2018			2019		
	Irrigation regime					
	CF	4-DADPW	8-DADPW	CF	4-DADPW	8-DADPW
	Total number of grains/ panicle					
T1	1657.10d	151.65d	109.37g	163.74cd	157.74d	118.89g
T2	1672.65cd	159.47cd	125.57f	169.29c	165.56c	135.09f
T3	179.09a	171.82b	139.87e	185.73a	177.91b	149.39e
T4	184.52a	177.78ab	144.37e	190.16a	183.87ab	153.89de
T5	169.35bc	164.40c	132.32f	175.99bc	170.49bc	141.84f
F .test	*			*		
	Panicle weight (g)					
T1	3.08a	2.70e	2.53e	3.53d	3.21d	2.79e
T2	3.66d	3.40de	3.26de	3.96c	3.89cd	3.52d
T3	4.89b	5.05ab	4.25c	4.87ab	4.78ab	4.51b
T4	5.61a	5.55a	4.30c	5.17a	5.08a	4.56b
T5	4.17cd	4.03cd	3.58de	4.57b	4.19c	3.84cd
F .test	*			*		
	Grain yield (t/ha)					
T1	10.21d	9.32e	5.74h	10.58c	9.75d	6.07g
T2	10.79c	10.27d	7.68g	11.16bc	10.70c	8.01f
T3	12.02ab	11.92a	9.17e	12.39a	12.35a	9.50d
T4	12.40a	12.29a	9.46e	12.77a	12.72a	9.79d
T5	11.30b	10.90bc	8.44f	11.67b	11.33b	8.77e
F .test	*			*		

*** = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant.. CF = continuous flooding, 4-8 days after the disappearance of ponded water, T1= (al as basal recommended nitrogen), T2 = (½ basal + ½mid tillering), T3= (½basal + ¼ mid tillering + ¼panicle initiation), T4 = (⅓basall + ⅓ mid tillering + ⅓panicle initiation) and T5= (⅔basal + ⅓ mid tillering).**

The data in Table 4 indicated that the continuous flooding treatment with T4 (⅓ basal + ⅓ mid tillering + ⅓panicle initiation) significantly registered the maximum values of panicle weight without any significant differences from 4-DADPW treatment in both seasons. On the other hand, the water regime of 8-DADPW the water regime of gave the minimum values of the trait mentioned above under T1fertilizer treatment.

Results in Table (4) showed that the interactions between fertilizer treatments and irrigation regime on grain yield were significant in 2018 and 2019easons. The highest grain yield values were obtained by combining CF treatment or 4-DADPW with ⅓ basal + ⅓ mid tillering + ⅓ panicle initiation or ½ basal + ¼ mid tillering + ¼

panicle initiation without any significant difference between the above combination. However, treatment of T1 under 8-DADPW irrigation treatment gave the minimum values of grain yield.

3- Some traits of grain quality:

Results in Table 5 showed that the effect of irrigation regimes on milling characters and protein content of rice grains was significant in both seasons. Increasing the period of non-irrigation from delaying irrigation as in the scheme of 8DADPW treatment significantly decreased hulling, milling, head rice percentage, and protein content. Drought stress might have led to the reduction in the total milling recovery. A similar result was found by Rao et al. (2013), Ibrahim et al. (2017) and Gewaily et al. (2019). The reduction in protein content might be due to increased grain yield and a comparative increase in nitrogen uptake, which is attributed to better availability of nutrients due to efficient water management. El-Refaee, (2012) observed similar findings.

In both seasons, when N fertilizer was applied in the pattern of ⅓ basal + ⅓ mid tillering + ⅓ panicle initiation and ½ basal + ¼ mid tillering + ¼ panicle initiation exhibited the highest means of milling characters (hulling, milling, and head rice percentage) and protein content without any significant differences between each other. Meanwhile, the minimum values of such traits were obtained by applying the recommended N in one dose as a basal application. The current finding is in harmony with those reported by Ibrahim et al., (2017), Zhang et al., (2020) and Hanling et al., (2021).

Table 5: Milling recovery and protein content of Giza 179 rice cultivar as affected by irrigation regime and nitrogen fertilizer treatment in 2018 and 2019 seasons.

Treatment	Hulling (%)		Milling (%)		Head rice (%)		Protein content	
	2018	2019	2018	2019	2018	2019	2018	2019
Irrigation regime (I):								
CF	77.11a	78.35a	69.59a	70.83a	62.57a	64.00a	7.35a	7.65a
4-DADPW	76.44a	78.04a	68.92a	70.23a	61.90a	63.33a	7.07a	7.24b
8- DADPW	74.99b	76.24b	67.47b	68.46b	60.58b	61.59b	6.33b	6.76c
F. test	**	**	**	**	**	**	**	**
Treatment fertilizer (N):								
T1	74.01c	75.36c	66.49c	67.66c	59.52c	60.81c	5.68c	5.98c
T2	75.69b	77.12b	68.17b	69.41b	61.19b	62.48b	6.35b	6.65
T3	77.31a	78.65a	69.79a	70.95a	62.81a	64.10a	7.64a	7.94a
T4	77.78a	79.13a	70.26a	71.42a	63.28a	64.57a	8.06a	8.36a
T5	76.11b	77.45b	68.59b	69.75b	61.61b	62.90b	6.84b	7.14b
F .test	**	**	**	**	**	**	**	**
Interaction I X N	NS	NS	NS	NS	NS	NS	NS	NS

*** = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant. CF = continuous flooding, 4-8 days after the disappearance of ponded water, T1= (all as basal recommended nitrogen), T2= (½basal +½mid tillering), T3= (½basal + ¼ mid tillering + ¼panicle initiation), T4= (⅓basal + ⅓ mid tillering +⅓panicle initiation) and T5= (⅔basal + ⅓mid tillering.**

4- Water management strategies to reduce water input:

By comparing the different irrigation treatments, it was observed that increasing the period between irrigation from continuous flooding up to 4 and 8 days after the disappearance of ponded water tended to decrease the amount of water used (Table 6). The result revealed that CF received the highest amounts of total applied water throughout the season (12652 and 12164 m3/ha) followed by 4-DADPW treatment (10573 and 10267 m^3/ha). Meanwhile, the lowest amounts were received by 8-DADPW treatment (8427 and 8241 m^3/ha) in the 2018 and 2019 seasons, respectively. There were no significant variations in the irrigation water input due to the stable conditions, such as temperature, relative humidity, and evaporation rates in both seasons. The water-saving percentage was found to be 10.23 and 10.10 % when rice plants were irrigated as 4-DADPW treatment. At the same time, the water-saving percentage under 8-DADPW treatment was 20.97 and 20.48 % compared to CF treatment in the 2018 and 2019 seasons, respectively.

Among different irrigation regimes, treatments of 4 days after the disappearance of ponded water recorded the highest water productivity value and were considered the best WP, followed by CF treatment. Moreover, irrigation at the 8-DADPW treatment had the lowest WP value. In the treatment of 4-DADPW treatment, the highest values of WP were caused by the remarkably high grain yield and low water inputs in this treatment compared to other treatments. These results are in line with the findings of Ashouri, (2014), Ibrahim et al., (2017) and Djaman et al., (2018).

Table 6: Total water used, water saved and water productivity (WP) as affected by irrigation intervals during the 2018 and 2019 seasons.

Irrigation interval	Total water use (m^3ha^{-1})			Water saved (%)			WP (kg m^{-3})		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
CF	12652	12164	12408	-	-	-	0.897	0.963	0.926
4-DADPW	10573	10267	10402	16.43	15.60	16.34	1.035	1.107	1.071
8-DADPW	8427	8241	44589	33.39	32.25	33.08	0.961	1.023	0.992

CF = continuous flooding, 4-8 days after disappearance of ponded water, WP= water productivity.

Table 7: Water productivity (kg/m^3) as affected by irrigation intervals and Fertilizer treatments in 2017 and 2018 seasons.

Fertilizer treatment	Irrigation regimes							
	2018				2019			
	CF	4-DADPW	8-DADPW	Average	CF	4-DADPW	8-DADPW	Average
T1	0.807	0.881	0.681	0.788	0.870	0.950	0.737	0.852
T2	0.853	0.971	0.911	0.910	0.917	1.042	0.972	0.977
T3	0.950	1.127	1.088	1.053	1.019	1.203	1.153	1.125
T4	0.980	1.162	1.123	1.086	1.050	1.239	1.188	1.159
T5	0.893	1.031	1.002	0.973	0.959	1.104	1.064	1.042
Average	0.897	1.035	0.961		0.963	1.107	1.023	

CF = continuous flooding, 4-8 days after the disappearance of ponded water, T1= (all as basal recommended nitrogen), T2= (½basal + ½mid tillering), T3= (½basal + ¼ mid tillering + ¼panicle initiation), T4= (⅓basal + ⅓ mid tillering + ⅓panicle initiation) and T5= (⅔basal + ⅓mid tillering.

Regarding the effect of rice fertilizer treatment on water productivity, it was observed that the treatment of nitrogen splitting into three equal dose as ⅓ basal + ⅓ mid tillering + ⅓ panicle initiation and ½ basal + ¼ mid tillering + ¼ panicle initiation recorded higher Water productivity than all as basal recommended nitrogen treatment in both seasons. On the other hand, high WP could be increased to reach its maximum values under 4-DADPW treatment with ½ basal + ¼ mid tillering + ¼ panicle initiation in the two respective seasons (Table 7).

Conclusion

Under the same conditions, the irrigation at four days after the disappearance of ponded water with nitrogen application as ⅓ basal + ⅓ mid tillering + ⅓ panicle initiation or ½ basal + ¼ mid tillering + ¼ panicle initiation for could be recommended the highest grain yield, high grain quality, and acceptable water productivity of rice (Giza 179 cultivar).

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تأثير تجزئة السماد النيتروجيني ونظم الري على إنتاجية وجودة حبوب صنف الأرز جيزة 179

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الملخص العربي

أجريت تجربة حقلية بالمزرعة البحثة لمحطة البحوث الزراعية بسخا محافظة كفر الشيخ، جمهورية مصر العربية خلال موسمي 2018 و2019 م وذلك بهدف دراسة استجابة محصول الحبوب و جودة الحبوب لمحصول الأرز صنف جيزة 179 لإضافة التسميد النيتروجيني في مراحل النمو المختلفة و ذلك تحت نظم ري مختلفة. Iاستخدام تصميم القطع المنشقة مرة واحدة في ثلاث مكررات بحيث احتوت القطع الرئيسية على ثلاث معاملات للري (الغمر المستمر طول الموسم و الري بعد 4 و 8 أيام من اختفاء مياه الري من سطح التربة) في حين تضمنت القطع الشقية على خمس معاملات للتسميد T1(اضافه كميه السماد الموصي به من النيتروجين على الشراقى مع خلطها بالتربة الجافه) ,T2 (الكمية على الشراقى + ½ في مرحلة التفريع المتوسط) ,T3(½ الكمية على الشراقى +¼ في مرحلة التفريع المتوسط + ¼ في مرحلة بزوع الدالية) ,T4(1 /3 على الكمية الشراقى + ⅓ في مرحلة التفريع المتوسط + ⅓ في مرحلة بزوغ الدالية) ,T5(⅔ الكمية على الشراقى + ⅓ في مرحلة التفريع المتوسط). هذا وقد اظهرت النتائج الرئيسية زيادة معنوية في النمو ومحصول الحبوب ومكوناته بالإضافة لصفات الجودة في معاملة الغمر المستمر ومعامله الري بعد أربعة أيام من اختفاء الماء السطحي وذلك مقارنة مع معاملة الري كل ثمانية أيام من اختفاء المياه السطحية. سجلت معاملة التسميد T3 و T4 أعلى القيم لصفات النمو ومحصول الحبوب و صفات جودة الحبوب و ذلك بالمقارنة بمعاملات التسميد الأخرى. استهلكت معاملة الغمر المستمر أكبر كمية من مياه الري بينما سجلت معاملة الري بعد ثمانية أيام من اختفاء المياه السطحية أقل كمية مياه مستهلكة.

بصفة عامة، في حالة نقص مياه الري، يمكن استخدام معاملة الري بعد 4 أيام من اختفاء مياه الري السطحية مع إضافة السماد النيتروجيني بمعدل ½ الكمية على الشراقى +¼ في مرحلة التفريع المتوسط + ¼ في مرحلة بزوع الدالية أو ⅓ الكمية على الشراقى + ⅓ في مرحلة التفريع المتوسط + ⅓ في مرحلة بزوغ الدالية للحصول على قيم عالية لصفات النمو والإنتاجية وصفات الجودة وإنتاجية المياه لمحصول الأرز صنف جيزة 179.

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