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Impact of Anhydrous Ammonia and Irrigation Intervals on Rice Yield under Drill Seeded Method

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ABSTRACT

Strategies of regulated irrigation and fertilization are one of the most practical ways in saving irrigation water and N-fertilizer of farmland in Egypt. Irrigation intervals and anhydrous ammonia injection were studied using Giza178 rice cultivar at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha Agriculture Research Station, Kafr El-Sheikh, Egypt, during 2017 and 2018 seasons. To compare different levels of anhydrous ammonia (82 % N) with urea and various irrigation intervals on yield and yield attributes of Giza 178 rice cultivar as well as water use efficiency (WUE). Four irrigation intervals treatments namely; W1 (continuous flooding), W2 (irrigation every 4 days), W3 (irrigation every 8 days) and W4 (irrigation every 12 days) with three rates of anhydrous ammonia; T1=195 kg N/ha (80 units/fed), T2= 165 kg N/ha (70 units/fed), T3=143 kg N /ha (60 units/fed) plus check treatment, T4= 165 kg N/ha as form urea (70 units/fed) were used. The field experimentwas laid out in strip design with four replications.The main obtained results indicated that Giza178 produced higher grain yield and its attributes under continuous flooding (W1) without any significant decrease in yield up to irrigation every 8 days (W3) and significantly decreased underirrigation every 12 days (W4) treatment in both seasons.The application of anhydrous ammonia at the rate of195kg N /ha (T1)significantly increased rice yield and relatively mitigated the undesirable effect of water stress resulted in increase the water use efficiency (WUE) and water saved %.The values of water saved were (22.99 and 22.60%) underirrigation every 8 days (W3) when combined withanhydrous ammonia at the rate of 195kg N /ha (T1) compared to continuous flooding, while,the water saved under W4 was about 25.47 and 25.43% but with reduction in grain yield (9.47 and 10.04 %) in 2017 and 2018seasons respectively.The interaction betweenanhydrous ammonia at the rate of 195 kg N /ha (T1)integrated with irrigation every 8 days (W3) treatments under drill seeded method had significant positive effect on grain yield and water savewhich can help savingirrigation water and increase the productivity.

INTRODUCTION

Overall world, rice crop is considered as one of the major important food crops. It is rated as staple food for more than half of the world population. In Egypt, rice crop is ranked as is one of the most important cereals. Rice consumes so much irrigation water as compared with other crops and most of the Egyptian rice genotypes are grown under continuous flooding with almost five cm depth of standing water during the growing season.The limitation of water resources and the remarkable increase in population should force the research workers to find different ways for saving water without significant reduction in rice yield.Releasing medium and short duration varieties saved about 30 to 33 % of irrigation water. Water input can be reduced by reducing water depth in rice field (3 cm depth), irrigate the field up to soil saturation and using different irrigation intervals (Ghanem and BadawiTantawi, 1999). The amount of water saved due to increasing irrigation intervals ranged from about 19 to 39%.

El-Wehishy and Abd El-Hafez (1998) indicated that grain yield and yield components of rice significantly decreased by increasing the irrigation intervals up to 14 days. El-Refaee *et al*. (2005) demonstrated that the grain yield was not affected by irrigation intervals when rice fields are irrigated either every 4 or 8 days without any significant difference between them.

Direct seeded rice (*Oryza sativa* L.) with emphasized on drill seeded rice is considered the future avenue and pertinent for increasing rice productivity and cropping intensity compared with highly production cost of transplanting rice. Among the biotic factors, water and nitrogen is considered the most important interactive phenomena which closely affect rice production under drill seeded method (El-Kallawy, 2018).

Dalling (1985) indicated that nitrogen is essential nutrient to the rice plant, with about 75 % of leaf N linked with chloroplasts, which are physiologically influential in dry matter accumulation out of photosynthesis. Through vegetative stage, nitrogen enhances growth and tillering, which defines the potential number of panicles (Mae, 1997). Nitrogen contributes to spikelets production during the early panicle initiation promodia and contributes to sink size by decreasing the number of degenerated spikelets and increasing hull size during the late panicle formation. Nitrogen helps carbohydrate to accumulation in culms and leaf sheaths during the booting period and in grain during the grain-filling period by being a component of photosynthesis process (Mae, 1997).

Rice plant could be defined as a plant which prefers ammonium form than nitrate form of nitrogen. Ammonium (NH_4^+) is one of the two inorganic nitrogen sources used by rice plants ($NH_4^+$and NO_3^-) under many circumstances which can improve the capacity of rice plant to tolerate water stress Guo*et al.*,(2007). Anhydrous ammonia is usually applied as a pre-plant fertilizer to supply nitrogen for cereal crops.

Anhydrous ammonia which is a raw material of nitrogen fertilizers with 82 % nitrogen content was used for fertilization as an economic ways. Ammonia gas (NH_3) is highly reactive and ionises to ammonium (NH_4^+) ions in the presence of water. Ammonium ions have a positive charge and immediately adsorbed at surfaces of clay particles and organic matter which has a negative charge. This strong attraction reduces the losses of ammonia to the atmosphere or by leaching into the soil (Hartz *et al*, 2000).

The use of anhydrous ammonia has been raised rapidly through last decade as an alternated efficient N-material (El-Mneasy, 2002). Abdel Kader (2002) reported that anhydrous ammonia is an inexpensive nitrogen fertilizer source than other commercial nitrogen sources (urea, ammonium sulphate and nitrate). Anhydrous ammonia is a squeezed gas; it must be injected in the soil to prevent losses from vaporization. When soil conditions are favorable for injection and closure of the injection channel, ammonia is an effective source of nitrogen for crops. Because anhydrous ammonia needs to go through the nitrification process, it is more resistant to losses from the soil by leaching or denitrification.

The current study aimed to compare two inorganic nitrogen sources (anhydrous ammonia and urea) and its reflection on rice grain yield of Giza178. Also, to find out the most effective irrigation intervals on rice grain yield and identify the best integrated nitrogen sourceswith irrigation intervals which save water and alleviate the hazard effect of water stress.

MATERIALS AND METHODS

A two-yeas field experiment was conducted at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha Agriculture Research Station, Kafr El-Sheikh, Egypt, during 2017 and 2018 seasons, to study the impact of different levels of anhydrous ammonia (82 % N) and various irrigation intervals on growth, yield and yield attributes of Giza 178 rice cultivar as well as water use efficiency (WUE). The treatments of irrigation intervals i.e. continuous flooding (W1), irrigation every 4 days (W2), irrigation every 8 days (W3) and irrigation every 12 days (W4) were conducted. After drilling the plots were irrigated every six - days intervals after sowing up to 30 days then the water treatments were applied according to experimental treatments.The field experiments were laid out in strip plot design with four replications. Nitrogen treatments as form of anhydrous ammonia namely; T1=195 kg N/ha (80 units/fed), T2= 165 kgN/ha (70units/fed), T3=143 kg N /ha (60 units/fed) plus check treatment, T4= 165 kg N/ha as form urea (70 units/fed) were used under drill seeded method in both seasons. Soil chemical analysis of the experimental site in the two studied seasons was as the follow:

Table1. Some mechanical and chemical characteristics of the used soil in 2017 and 2018 seasons.

Piritical size distribution	2017 season	2018 season
Sand %	26.30	27.30
Silt %	28.64	29.50
Clay %	45.06	43.20
Texture class	Clayey	Clayey
pH (1:2.5 soil water suspension)	8.10	8.00
Ece (soil paste extracted at 25 C° $dS.m^{-1}$)	3.00	3.10
OM (organic matter) %	1.65	1.55
Total carbonate %	1.65	1.78
Soluble cations, meq. l^{-1} (soil paste):		
Ca	9.5	10.00
Mg	3.94	4.50
K	1.76	2.00
Na	14.8	14.50
Soluble anions, meq. l^{-1}(soil paste)		
CO_3	8.30	7.40
HCO_3	15.7	12.90
Cl	8.10	7.50
SO_4	3.00	3.20
Total N (ppm)	556.00	460.00
Available Ammonium (ppm)	18.30	17.10
Available Nitrate (ppm)	15.40	14.20
Available P (ppm)	10.00	10.50
Available K (ppm)	230.00	243.50

The experimental sites were prepared (plowed two times and well dry leveled). The drilled plots were fertilized with phosphorus in the form of calcium mono phosphate (15% P_2O_5) was added to dry soil during land preparation according to recommended dose (36.9 kg P_2O_5/ha) while zinc fertilizer was added as ZnSO4 at the rate of 10 kg/fed by mix ZnSO4 with sand and broadcast immediately after drilling.Potassium fertilizer at the rate of 57.12 kg K_2O/ha was applied during land preparation. Clean seeds at the rate of 119 kg seeds/ha was cultivated using drilling machine with 17 cm space among the rows. Anhydrous Ammonia (AA) (82% N) was injected 5 days before planting at 20 cm depth in the soil, while nitrogen in the form of urea (46.5 % N) was added as splits, in three equal splits, 1/3 incorporated in the dry soil, 1/3 at panicle initiation stage and the last one was applied at late booting stage. Saturn 50% at the rate of 7.5 liters/ha was to control weeds. Saturn was dissolved in 350 liters of water/ha and sprayed four days after sowing.

Studies characters

Leaf area index (LAI) was calculatedas follows:Leaf area of a fixed number of hills / Ground area occupied by these hills.

Chlorophyll content (uE= uMole $m^{-2}S^{-1}$) was estimated in flag leaf at late booting period using chlorophyll meter (chlorophyll content was determined using chlorophyll fluorometer model OPT-SCIENCES OS-30) Optie-sciences, Inc. USA. Five leaves were randomly chosen and measured from the widest part of the leaf of the main culm in each plot.Five days before harvesting; number of panicles was counted using wood frame 17 x 10 cm randomly in each plot and was computed to number of panicles per m^2. Moreover, ten panicles were randomly collected, to estimate weight and length of panicle, number of filled and unfilled grains and 1000-grain weight were estimated. The grain and straw yield weight for each plot were recorded after proper sun drying and then converted into t/ha. The grain yield was adjusted at 14% moisture. All of the collected data were subjected to the standard statistical analysis and the difference among the treatment means were compared according to Duncan's Multiple Range test (M-STAT) at 0.05 levels (Gomez and Gomez, 1984).

Water Relations

Water pump provided with a calibrated water meter was used for water measurements a long rice season. Water use efficiency (WUE) was calculated as weight of grains per unit of water used (kg grain/m^3 water). According to Israelsen and Hansen (1962) as follows:

WUE = Rice grain yield (kg/ha.) / Total water used (m^3/ha.)

RESULTS AND DISCUSSION

Leaf area index (LAI), chlorophyll content of flag leaf, number of panicle (m^2) and panicle weight (g) of Giza178 rice cultivar as effected by different irrigation intervals and both anhydrous ammonia and urea are presented in Table 2.Data revealed that both leaf areaindex and chlorophyll contentreached to maximum values under continuous flooding (W1), irrigation every 4 days (W2) and irrigation every 8 days (W3) while, irrigation every 12 days (W4) significantly decreased leaf area index and chlorophyll content in 2017 and 2018 seasons. Data in the same table exhibited that the number of panicle (m^2) and panicle weight (g) reached to the greatest values under W1 and gradually decreased under W2, W3 and W4 respectively. The available water enhances nutrient availability and improved nutrients uptake by plants; in contrast, most of the physiological processes inside the plant such as protein synthesis, photosynthesis, respiration, and nucleic acid synthesis are affected negatively by water shortage. Moreover, water stress causes inhibition the activities of many enzymes and leads to changes in the ultra-structures of plant tissues. These findings agreed with those obtained by El- Refaee *et al*, (2008), Castilo *et al*., (2006), Roshan *et al*., (2013) and El-Kallawy (2018) who indicated that the water holding for 10 days gave the lowest values of estimated growth parameters of rice.

Concerning to, the effect of nitrogen treatments, data in Table 2 indicated that the application of anhydrous ammonia at the rate of 195 kg N/ ha (T1) gave the highest values of all studied characters followed by the applications of anhydrousammonia (T2) and urea (T4) at the rate of 165kg N/ ha) which, gave almost the same value. On the other side, the addition ofanhydrous ammonia at the rate of 143 kg N/ ha (T3) show the lowest values of previous studied characters in both seasons.The advantages of anhydrous ammonia injection for rice are: (a) the nitrogen stays available to the plant up to harvest; (b) residual nitrogen moves down the soil profile lightly but remains in the root zone (0-30cm). This residual N is then available for a subsequent crop because it is not lost to deep leaching or volatilization. (c) Losses of ammonia from anhydrous ammonia were very low compared to urea fertilizer that will help to increase the nitrogen use efficiency for plant (Rogers, 2016). It can be easily observed that anhydrous ammonia and urea gave the same effect on the most studied character when added at the same rate of 165kg N/ ha (T2 or T4). The interaction between irrigation intervals and anhydrous ammoniahad significant effects on leaf area index (LAI) as well as chlorophyll content in flag leaf of Giza178 in 2017 and 2018 seasons. Data revealed that combination of anhydrous ammonia at the rate of 195 kg N/ha (T1) with each of continuous flooded (W1) and irrigation every 4 days (W2) gave the highest values of LAI, while the integrated of anhydrous ammonia at the rate of 165 kg N/ha (T2) with each of W1 and W2 followed by T4 (urea) under only continuous flooding (W1).

Table 2. Leaf area index (LAI), chlorophyll content (uE) of flag leaf, number of panicle/m^2 and panicle weight (g) of Giza178 rice cultivar as affected by irrigation intervals and nitrogen fertilizer treatments in2017and 2018 seasons

Treatments	2017 season				2018 season			
	Leaf area index (LAI)	Chlorophyll content (uE)	No. of panicle /m^2	Panicle weight /g	Leaf areaindex(LAI)	Chlorophyll content (uE)	No. of panicle /m^2	Panicle weight/g
Irrigation (A)								
W1	5.82a	0.819a	582.10a	1.823a	6.18a	0.820a	586.80a	2.07a
W2	5.64a	0.795a	575.05b	1.79b	5.87ab	0.788ab	579.15b	2.02ab
W3	5.23ab	0.736b	567.87c	1.77b	5.47b	0.737ab	572.93c	1.92bc
W4	4.41b	0.707b	560.65d	1.66c	4.64c	0.707b	555.32d	1.87c
F. Test	*	*	**	**	*	*	**	**
Nitrogen fertilizers (B)								
(T_1)	6.10a	0.805a	594.57a	1.96a	6.34a	0.814a	599.77a	2.19a
(T_2)	5.12b	0.773b	571.95b	1.74b	5.37bc	0.767b	574.73b	1.93b
(T_3)	4.83b	0.716c	544.50c	1.58c	5.00c	0.715c	539.85c	1.82c
(T_4)	5.03b	0.776b	574.65b	1.75b	5.46b	0.775b	579.85b	1.94b
F. Test	**	**	**	**	**	**	**	**
Interaction: AXB	*	*	*	*	*	*	*	*

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of urea, W1= continuous flooding W2= Irrigation every 4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

It is clear from the results that the highest rate of anhydrous ammonia produced the greatest value of LAI when combined with all the irrigation treatments compared with tested nitrogen treatments. The increase of the leaf area index of tested rice cultivar could be attributed to adequate amount of water and nitrogen around roots zoon increased nitrogen uptake resulted in cell division, elongation and consequently increases the plant growth.

As for, the effect of the interaction of irrigation intervals with nitrogen treatments on chlorophyll content in flag leaf of Giza178 rice cultivar are exhibited in Table 3.

Data indicated that the highest values of chlorophyll content was found when anhydrous ammonia (T1) combined with each of W1, W2 and W3 followed by both T2 and T4 when integrated with W1 and W2 in both seasons. The lowest values of chlorophyll content were observed when applied 143kg N/ ha (T3) as formof anhydrous ammonia under irrigation every 12 days (W4).

The increase in chlorophyll content may be due to the addation of anhydrous ammonia or urea increased the availability of nitrogen that increase the absorption of nitrogen and consequently, increase chlorophyll formation.

Regarding to, number of panicles/m^{2}and panicle weight (g) of Giza 178 rice cultivar as affected by the interaction between irrigation intervals and nitrogen fertilizer treatments are presented in Table 4. Data demonstrated that integration of T1 with each of all irrigation treatments surpassed the other fertilizer treatments when combined with the same irrigation treatments under study in both seasons. The highest values of number of panicles were observed when T1 combined with W1, W2 and W3. In contrast, the lowest value in number of panicles/m^{2}was found when T3 was combined with each of irrigation treatments without any significant differences among them. It can be easily noticed that application of 165 kg N/ ha (T2) as form of either anhydrous or urea gave nearly the same values of number of panicles whenapplied under all the irrigation intervals under study and came in the second rank after T1 when combined with each the same irrigation treatments. The increase in number of panicles could be attributed toadequate amounts of water and nutrients uptake especially nitrogen. The absorption ofnitrogen always increases the uptake of both phosphorus and potassium that enhance the nods and buds to emerge more tillers and panicles as a result to increase in cell division and elongation.On the other side,the irrigation every 12 days (water stress) caused a reduction of required amount of water with inadequate amount of nitrogen that cause decrease in nutrients availability and uptake, which led toreduction in number of panicles during panicle initiation (Howida El-habet., 2018).

Osman, *et al*., (2013) and Ismail, *et al*., (2013) indicated that rice and wheat growth and yield increase by application of nitrogen fertilizer due to that nitrogen is main constituent of nucleotides, proteins, chlorophyll and enzymes. They also reported that nitrogen is involved in different metabolic pathways that have forthright effect on both vegetative and reproductive phases of plants.

Regarding to,the weight of panicle data in Table 4 stated that combination of T1 with all tested irrigation intervals surpassed the other nitrogentreatments and produced the greatest weight of panicle and came in the first rank, followed by T2 and T4 which gave nearly the same values in the weight of panicle, while T3 came in the least rank when integrated with the same tested irrigation treatments.The increase in panicle weight (g) could be attributed to the presence of required amount of nitrogen whether added to anhydrous ammonia or urea which led to improve the viability ofleaves and late its senescence resulted in increase in photosynthesis and its products (assimilates). These assimilates translocate from source to the sink of plant, consequently increase the panicle weight. The interaction effects confirmed that applying of anhydrous ammonia at the rate of 195 kg N /hacan alleviates the hazardous effect of water deficit on number of panicles/m^{2}and panicle weight of rice. Motavalli *et al*, (2008) indicated that anhydrous ammonia has profitable impacts on soil microbes, nitrifying bacteria and worms. Moreover, anhydrous ammonia enhances nitrogen detention in the soil, constriction nitrate leaching, and give rise to increasing nitrogen use efficiency.

Table 3. Leaf area index (LAI) and chlorophyll content (Eu) of Giza178 rice cultivar as affected by the interaction between irrigation intervals and nitrogen fertilizer treatmentsin 2017 and 2018 seasons

Nitrogen treatments	2017 Season							
Irrigation	Leaf area index (LAI)				Chlorophyll content (uE)			
Intervals	T1	T2	T3	T4	T1	T2	T3	T4
W1	6.60a	5.67a-c	5.23cd	5.81a-c	0.853a	0.842ab	0.739de	0.843ab
W2	6.53ab	5.59a-c	5.48bc	4.96cd	0.838ab	0.796ac	0.748d	0.800ac
W3	5.88a-c	5.06cd	4.88c-e	5.13cd	0.800ac	0.739de	0.714g	0.743d
W4	5.41c	4.17de	3.86e	4.22de	0.730ef	0.716g	0.663h	0.719fg
	2018 Season							
W1	6.84a	5.90b-e	5.59c-e	6.40a-c	0.861a	0.844a	0.736d-f	0.842ab
W2	6.77ab	5.82c-e	5.20d-g	5.72c-e	0.833ab	0.803bc	0.748d-f	0.803bc
W3	6.12a-d	5.37d-f	5.12e-g	5.29d-g	0.830ab	0.739d-f	0.711f	0.741d-f
W4	5.65c-e	4.40gh	4.09h	4.45f-h	0.732d-f	0.716ef	0.666g	0.717ef

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of urea, W1= continuous flooding, W2=Irrigation every 4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

Table 4. Number of panicle (m^2) and panicle weight (g) of Giza178 rice cultivar at harvest as affected by the interaction between irrigation intervals nitrogen fertilizer treatments inboth seasons

Nitrogen treatments	2017 season							
Irrigation	Number of panicle /m^2				panicle weight (g)			
Intervals	T1	T2	T3	T4	T1	T2	T3	T4
W1	605.40a	585.00d	546.00g	592.00c	2.04a	1.79b-d	1.66de	1.80b-d
W2	602.20ab	575.40e	544.00g	578.60d	2.00a	1.76c-e	1.62d-f	1.78b-d
W3	597.40bc	564.70f	544.00g	565.40f	1.94ab	1.76c-e	1.59ef	1.79b-d
W4	573.30e	562.70f	544.00g	562.60f	1.88a-c	1.65de	1.47f	1.65de
	2018 Season							
W1	610.60a	587.60cd	551.80g	597.20bc	2.27a	2.01b-e	1.97c-f	2.03b-d
W2	607.40ab	576.20d-f	549.20g	583.80d	2.23a	2.02b-e	1.82fg	2.02b-e
W3	602.60ab	569.33ef	549.20g	570.60ef	2.17ab	1.86d-g	1.79g	1.88d-g
W4	578.50de	565.80f	509.20h	567.80ef	2.11a-c	1.84e-g	1.710g	1.85d-g

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of urea, W1= continuous flooding W2= irrigation every 4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

Panicle length (cm), number of filled grain, number of unfilled grain per panicle and 1000- grain weight (g) of Giza178 rice cultivar as affected by the irrigation intervals andnitrogen treatments are presented in Table 5. Data revealed that length of panicle reached to maximum value under W1, W2 and W3 respectively, compared with W4 which gave the lowest value.Data in the same table showed that W1 produced the greatest number of filled grain followed by W2.In contrast; water stress under irrigation every 12 days gave the lowest values of panicle length in both seasons. Results also, indicated that W1 produced the greatest number of filled grains/panicle followed by W2 while, W4 (irrigation every 12 days) gave the opposite results in two studied seasons. Regarding to, 1000 grain weight data in the same table indicated that the highest values of 1000 grain weight was recorded under W4 followed by W3 and W2 respectively in both seasons.

As for nitrogen fertilizer treatments data in Table 5 also, revealed that the highest values of panicle length (cm) and number of filled grain/panicle were obtained by the application ofanhydrous ammonia at the rate of 195 kg N /ha (T1) followed by urea (T4) in both seasons. Whereas, the highest valueof unfilled grain/panicle was recorded under T2 treatment.Data indicated also, that the values of 1000 grains weight (g) tended to decrease as fertilizer levels increased.

Panicle length (cm) and number of filled grain per panicle of Giza178 rice cultivar as affect by the interaction between irrigation intervals and nitrogen treatments in 2017 and 2018 seasons are presented in Table 6. Data showed that the combination of T1 with each of the irrigation intervals gave the highest length of panicle and came in the first rank followed by T4 and T2 under the same irrigation treatments while, application anhydrous ammonia at the level 143kg N/ha with all irrigation treatments gave the lowest values ofpanicle length and number of filled grain per panicle in both seasons.It could be attributed to the application of anhydrous ammonia at the rate of 195 kg N /ha (T1) helps rice plant to water stress tolerant. Motavalli *et al* (2008) indicated that nitrate leaching percentage was decreased by 56% by application of anhydrous ammonia a compared to urea and thus, nitrogen use efficiency was increased. It can be observed that the application of T1 with all irrigation treatments under study produced the greatest length of panicle without anysignificant difference among them in both seasons.It could be attributed to the application of anhydrous ammoniacaused increase in the cell division and its elongation in the panicle of Giza178 rice cultivar.Moreover, the combination of T4 with each W1, W2 and W3 gave almost the same value ofpanicle length.Data also, in same tableshowed that T1 combined with all the tested irrigation intervals produced the greatest number of filled grain per panicle followed by 165 kg N /ha either added as form of anhydrous ammonia (T2) or as form of urea (T4) when combined with W1 only while, T2 integrated with all irrigation treatments gave the lowest number of filled grain per panicle in both seasons.It might be due to anhydrous ammonia which improves the viability of leaves and late its senescence which led to increase photosynthesis and its products (assimilates). These assimilates translocate from source to the sink of plant consequently increase the filling of grains (Naeem, 2006). These results are in harmony with those obtained by Abd El-Megeed (2017) who found thatthe application of anhydrous ammoniain rice soil before flooded gave the maximum number of filled grain per panicle compared with urea.

Table 5. Panicle length (cm), number of filled, number unfilled grain/panicle and 1000- grain weight (g) of Giza178 rice cultivar as affected by irrigation intervals and nitrogen treatments in 2017 and 2018 seasons

Treatments	2017 season				2018 season			
	Panicle length (cm)	number of filled grain/ panicle	number of unfilled spikelet's	1000-grain weight (g)	Panicle length (cm)	number of filled grains/ panicle	number of unfilled spikelet's	1000-grain weight (g)
Irrigation (A)								
W1	18.73a	120.60a	3.69b	24.58c	21.24a	125.70a	5.02b	24.92c
W2	18.34ab	117.07b	3.54b	25.41b	20.81ab	122.38b	4.87b	25.76b
W3	18.03ab	113.92c	3.90ab	25.42b	20.49ab	118.87c	5.23ab	25.75b
W4	17.71b	109.82d	4.88a	26.37a	20.17b	114.92d	6.21a	26.71a
F. Test	*	*	*	*	*	*	*	*
Nitrogen fertilizers(B)								
T_1	19.60a	122.05a	4.05ab	24.75c	22.00a	127.27a	5.38ab	25.09c
T_2	18.08b	115.03b	4.93a	25.71ab	20.55b	120.06	6.26a	26.05ab
T_3	16.64c	108.00c	3.19b	26.17a	19.22c	113.22c	4.52b	26.50a
T_4	18.49ab	116.35b	3.84b	25.16bc	20.94b	121.32b	5.17b	25.50bc
F. Test	**	**	Ns	*	**	**	**	*
Interaction: AXB	*	*	Ns	*	*	*	*	*

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of urea, W1= continuous flooding W2=Irrigation every 4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

Table 6. Panicle length (cm) and number of filled grain/panicle of Giza178 rice cultivar as affected by irrigation intervals and nitrogen treatments in 2017 and 2018 seasons

Irrigation intervals	2017 season							
Nitrogen	panicle length (cm)				number of filled grain/panicle			
treatments	T1	T2	T3	T4	T1	T2	T3	T4
W1	20.22a	18.77a-d	16.90d-f	19.03a-c	124.90a	121.00a-c	114.00ef	122.50ab
W2	19.60ab	18.30a-e	16.83d-f	18.63a-d	122.30ab	117.00c-e	110.30gf	118.70b-d
W3	19.57ab	17.77b-f	16.50f	18.30a-e	122.00ab	114.00e	105.00hi	114.70d-f
W4	19.03a-c	17.50c-f	16.33f	18.00b-f	119.00b-d	108.10gh	102.70i	109.50g
2018 Season								
W1	22.45a	21.22b-d	19.82f-g	21.48a-c	130.20a	126.00a-c	119.30ef	127.30ab
W2	22.04ab	20.75c-f	19.35g-i	21.08b-e	127.60ab	122.33c-e	115.60fg	124.00b-d
W3	22.02ab	20.22d-g	18.95hi	20.75e-f	127.00ab	118.50ef	110.00hi	120.00d-f
W4	21.48ac	20.00e-g	18.75i	20.45c-f	124.30b-d	113.40gh	108.00i	114.00gh

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of urea, W1= continuous flooding W2= irrigationevery4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

One thousand grain weight of Giza178 rice cultivar as affected by the interaction between irrigation intervals and nitrogen fertilizer treatmentsin 2017 and 2018 seasons is presented inTable 7. Data revealed that the 1000 grains weight (g) tended to decrease as fertilizer levels increased and prolonging irrigation intervals. The combination of T3 with all tested irrigation treatments gave the highest valueof 1000 grain weightand came the first rank followed by T2 when combined with the same irrigation treatments and came the second rank while, T4 and T1 came in the last rank respectively,when combined with all tested irrigation treatments in both seasons.It can be easily noticed that the addition of nitrogen at low level combined with prolonged irrigation intervals led to decrease in the plant growth which causes a reduction in number of spikelets per panicle, so the little amount of metabolites is enough for completely fill these spikelets resulted in heavy weight of grains.

Table 7. 1000-grain weight of Giza178 rice cultivar as affected by the interaction between irrigation intervals and nitrogen treatments in 2017 and 2018 seasons

Nitrogen treatments Irrigation Intervals	1000-grain weight (g)			
	Season 2017			
	T1	T2	T3	T4
W1	24.00d	24.67bd	25.33a-d	24.33cd
W2	24.33c-d	26.00ab	26.00ab	25.33a-d
W3	24.67b-d	25.67a-c	26.67a	24.67b-d
W4	26.00ab	26.50a	26.67a	26.33a
	Season 2018			
W1	24.34d	25.00b-d	25.67a-d	24.67cd
W2	24.67cd	26.34ab	26.34ab	25.67a-d
W3	25.00b-d	26.00a-c	27.00a	25.00b-d
W4	26.34ab	26.84a	27.00a	26.67a

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of ureaW1= continuous flooding W2= irrigation every 4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

Significant differences in grain and straw yield of Giza178 cultivar were observed when treated with both irrigation intervals and nitrogen fertilizer treatments in 2017 and 2018 seasons (Table 8). Grain yield reached to the maximum value under continuous flooding (W1) and irrigation every 4 days (W2) followed by irrigation every 8 days (W3) while, irrigation every 12 days (W4) significantly reduced grain yield in 2017 and 2018 seasons. Also, straw yield perform the same trend as grain yield in both seasons.

Table 8. Grain yield and straw yield (t/ha) of Giza178 rice cultivar as affected by the interaction between irrigation intervals and nitrogen treatments in 2017 and 2018 seasons

Treatments	Grain yield (t/ha)		Straw yield (t/ha)	
	2017	2018	2017	2018
W1	9.60a	9.87a	11.46a	11.87a
W2	9.23ab	9.49b	10.95b	11.39b
W3	9.10b	9.40b	11.19b	11.21b
W4	8.47c	8.80c	10.50c	10.86c
F. Test	*	*	*	*
Nitrogen fertilizers(B)				
T_1	9.70a	10.06a	11.70a	12.13a
T_2	9.15b	9.34b	10.95b	11.13b
T_3	8.19c	8.62c	10.34c	10.77c
T_4	9.36ab	9.53b	11.11b	11.29b
F. Test	*	*	*	*
Interaction : AXB	*	*	*	*

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of urea,W1= Continuous flooding W2= irrigation every 4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

Grain and straw yield of Giza178 rice cultivar as affected by the interaction between irrigation intervals and nitrogen fertilizer treatments in 2017 and 2018 seasons are presented in Table 9. Data indicated that grain yield reached to maximum value when the highest levels of nitrogen as form of anhydrous ammonia (T1) combined with each continuousflooding (W1), irrigation every 4 days (W2) and irrigation every 8 days (W3) without any significant difference among them followed by T4 and T2 when combined with W1 only. While, the application of 143 kg N /ha (T3) as form of anhydrous ammonia with all irrigation treatments produced the lowest value of grain yield in 2017 and 2018 seasons.These results are harmony with those obtained by Mahmoud, (2015) who found that rice gave the highest values of grain and straw yield under irrigation intervals every 8 days with anhydrous ammonia injection at the rate of 100 kg N/ha.Finally, it can be concluded that the application of anhydrous ammonia with irrigation intervalsunder drill seeded method is better than urea. It is clear from the results that the straw yield was taken the same trend of grain yield in two studied seasons.The increase in grain yield when 195 kg N /haas form of anhydrous ammonia (T1) combined with irrigation starting from continuous flooding (W1) up to W3 might be due to continuous supply the plant by nitrogen through different stages of growthbecause itmake as slow release nitrogen fertilizer, also it increase the tolerance of tested rice plant to shortage water even under irrigation every 12 days (W4)which produced 9.03 and 9.38 kg/hagrain yield in two studied season, respectively. When compared anhydrous ammonia with urea, anhydrous ammonia enhanced the microbial diversity for both bacteria and fungi in the soil. The microbial diversity in the soil are involved an important process such as soil decomposition of organic matter, cycling of carbon, nitrogen, phosphorus and sulphur (Garbeva *et al*, 2004). It is clear from the results that the application of anhydrous ammonia (T1) increases plant tolerance to water stress. It might be due to anhydrous ammonia improves the viability of leaves especially flag leaf and late its senescence which led to increase photosynthesis and its products (metabolits). The huge amounts of metabolits translocation from flag leafand other viable leaves to the panicle and completely fill most of spikelets consequently, increase grain yield.

Data in Table 10 shows that the total water input (m^3/ha), water saved (%) and water use efficiency as affected by irrigation intervals and nitrogen fertilizer treatments in 2017 and 2018 seasons.Comparing the different irrigation intervals and fertilizer treatments, it was observed that T1 gave the highest grain yield under continuous flooding (10.03 and 10.43 t/ha) followed by W2 (9.88 and 10.23 t/ha) and W3 (9.88 and 10.33 t/ha) in both seasons respectively.In the same time the total water input was so high and reach to (14090.50 and 14150.20 m^3 /ha) in 2017 and 2018 seasons respectively, under continuous flooding (W1), While WUE was very low (0.77 and 0.76 kg/m^3) for Giza178 rice cultivar in both seasons. Regarding to, irrigation every 8 days (W3) under T1 there were slight decrease in grain yield with yield reduction about (1.49 and 2.03 %), water saving about (22.99 and 22.60 %) and water useefficiency (0.91 and 0.93) compared with continuous flooding in both seasons respectively. Data in Table 10 showed also that irrigation every 12 days (W4) decreases grain yield with low WUE in both seasons. According to the data in Table 10 using Giza178 which appear reasonable tolerance to water stress without significant decrease in grain yield with irrigation intervals every 8 days (W3) and fertilized by anhydrous ammonia at the rate of 195 kg N/ha (T1) with water saving 22.99 and 22.60 % in both seasons respectively. It means that Giza178 cultivars should be used under water shortage with anhydrous ammonia compared with urea.

Table 9. Grain and straw yield of Giza178 rice cultivar as affected by the interaction between irrigation intervals and nitrogen treatments in 2017 and 2018 seasons

Nitrogen Treatments / Irrigation Intervals	Grain weight (t/ha) T1	T2	T3	T4	Straw weight (t/ha) T1	T2	T3	T4
2017 season								
W1	10.03a	9.74a-c	8.75fg	9.88ab	12.03a	11.33cd	10.75ef	11.73a-c
W2	9.88ab	9.26de	8.34gh	9.45b-d	11.87ab	10.81ef	10.34fg	10.81ef
W3	9.88ab	9.12d-f	8.08hi	9.33cd	11.88ab	11.23de	10.22g	11.45b-d
W4	9.03def	8.48gh	7.60i	8.80e-g	11.03de	10.45fg	10.06g	10.48fg
2018 Season								
W1	10.43a	9.89bc	9.09e-f	10.07ab	12.43a	11.72b	11.18c-e	12.16a
W2	10.23ab	9.45c-e	8.69gh	9.600cd	12.32a	11.24cd	10.78e-g	11.25ed
W3	10.22ab	9.33d-f	8.51hi	9.56c-e	12.31a	10.88d-g	10.66f-g	10.99d-f
W4	9.38de	8.71gh	8.00i	8.90fh	11.47bc	10.71fg	10.49g	10.78e-g

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of urea, W1= continuous flooding W2= irrigation every4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

Table10. Total water input (m^3/ha), water saved (%) and water use efficiency as affected by irrigation intervals and nitrogen fertilizer treatmentsin 2017 and 2018 seasons

Treatments		Total water input m^3/ha	Grain yield (t/ha)	Grain yield Reduction (%)	Water saved %	Water use efficiency (kg/m^3)	Total water input m^3/ha	Grain yield (t/ha)	Grain yield Reduction (%)	Water saved %	Water use efficiency (kg/m^3)
		2017 Season					**2018 Season**				
W1	T1	14090.50	10.03	-	-	0.71	14150.20	10.43	-	-	0.73
	T2	14150.50	9.74	-	-	0.68	14250.30	9.89	-	-	0.69
	T3	14202.90	8.75	-	-	0.61	14400.30	9.09	-	-	0.63
	T4	14300.50	9.88	-	-	0.68	14255.30	10.07	-	-	0.70
Mean		14186.50	9.58	-	-	0.67	14264.02	9.87	-	-	0.68
W2	T1	12100.20	9.88	1.49	14.12	0.81	12350.30	10.23	1.91	12.71	0.82
	T2	12250.60	9.26	4.92	13.42	0.75	12500.50	9.45	4.44	12.27	0.75
	T3	12050.50	8.34	4.70	15.15	0.69	12140.50	8.69	4.40	15.69	0.71
	T4	12350.90	9.45	4.35	13.63	0.76	12500.50	9.60	4.66	12.30	0.76
Mean		12288.05	9.23	3.86	14.08	0.75	12372.95	9.49	3.85	13.24	0.76
W3	T1	10850.60	9.88	1.49	22.99	0.91	10950.90	10.22	2.03	22.60	0.93
	T2	11075.50	9.12	6.35	21.72	0.82	11010.50	9.33	5.66	22.73	0.84
	T3	11600.70	8.08	7.65	18.32	0.69	11350.30	8.51	6.38	21.18	0.74
	T4	11550.60	9.33	5.56	19.22	0.80	11190.40	9.56	5.06	21.50	0.85
Mean		11319.35	9.10	5.26	20.56	0.80	11125.52	9.40	4.78	22.00	0.84
W4	T1	10500.70	9.03	9.97	25.47	0.85	10550.50	9.38	10.05	25.43	0.88
	T2	10650.50	8.48	12.93	24.73	0.79	10750.50	8.71	11.93	24.56	0.84
	T3	10690.60	7.60	13.14	24.70	0.74	10890.50	8.00	11.88	24.37	0.78
	T4	10850.50	8.80	10.93	24.10	0.84	10930.40	8.90	11.61	23.30	0.85
Mean		10263.07	8.15	11.74	25.97	0.80	10417.9	8.80	11.36	26.83	0.83

T1= 195, T2= 165, T3= 143 kg N/ha as form of anhydrous ammonia and T4= 165 kg N /ha as form of urea, W1= continuous flooding W2= irrigation every 4 days, W3= irrigation every 8 days, W4= irrigation every 12 days

Economic Study:

From an economic analysis(Table 11 to 18) the highest income was recorded when anhydrous ammonia was applied at the rate of 195 kg N /ha (T1) whether, irrigated with continuous flooding or irrigated every 4 days (W2) and irrigated every 8 days (W3) compared with urea under drill seeded method in 2017 and 2018 seasons.

Table 11. Effect of anhydrous ammonia and urea treatments under W1 (flooded conditions) on farmer income by LE in 2017 season

Treatment	Yield (t/ha)	Price of rice/ton	Yield (price/ha)	urea (cost)	Anhydrous Ammonia (cost)	Labor (cost)	Profit
	2017 season						
T1	10.03	2500	25075.00	0	1190	0	23885
T2	9.74	2500	24350.00	0	1040	0	23310
T3	8.75	2500	21875.00	0	895	0	20980
T4	9.88	2500	24700.00	1963.50	0	100	22636.5

Table 12. Effect of anhydrous ammonia and urea treatments under W2 (irrigation every 4 days) on farmer income by LE in 2017 season

Treatment	2017 season						
	Yield (t/ha)	Price of rice/ton	Yield (price/ha)	urea (cost)	Anhydrous Ammonia (cost)	Labor (cost)	Profit
T1	9.88	2500	24700.00	0	1190	0	23510
T2	9.26	2500	23150.00	0	1040	0	22110
T3	8.34	2500	20850.00	0	895	0	19955
T4	9.45	2500	23625.00	1963.50	0	100	21561.5

Table 13. Effect of anhydrous ammonia and urea treatments under W3 (irrigation every 8 days) on farmer income by LE in 2017 season

Treatment	2017 season						
	Yield (t/ha)	Price of rice/ton	Yield (price/ha)	urea (cost)	Anhydrous Ammonia (cost)	Labor (cost)	Profit
T1	9.88	2500	24700.00	0	1190	0	23510
T2	9.12	2500	22800.00	0	1040	0	21760
T3	8.08	2500	20200.00	0	895	0	19305
T4	9.33	2500	23325.00	1963.50	0	100	21261.5

Table 14. Effect of anhydrous ammonia and urea treatments under W4 (irrigation every 12 days) on farmer income by LE in 2017 season

Treatments	2017 season						
	Yield (t/ha)	Price of rice/ton	Yield (price/ha)	urea (cost)	Anhydrous Ammonia (cost)	Labor (cost)	Profit
T1	9.03	2500	22575.00	0	1190	0	21385
T2	8.48	2500	21200.00	0	1040	0	20160
T3	7.60	2500	19000	0	895	0	18105
T4	8.80	2500	22000.00	1963.50	0	100	19936.5

Table 15. Effect of anhydrous ammonia and urea treatments under W1 (flooded conditions) on farmer income by LE in 2018 season

Treatment	2018 season						
	Yield (t/ha)	Price of rice/ton	Yield (price/ha)	urea (cost)	Anhydrous Ammonia (cost)	Labor (cost)	Profit
T1	10.43	3700	38591	0	1428	0	35345
T2	9.89	3700	36593	0	1248	0	32718
T3	9.09	3700	33633	0	1074	0	32559
T4	10.07	3700	37259	2142	0	100	35017

Table 16. Effect of anhydrous ammonia and urea treatments under W2 (irrigation every 4 days) on farmer incomet by LE in 2018 season

Treatment	2018 season						
	Yield (t/ha)	Price of rice/ton	Yield (price/ha)	urea (cost)	Anhydrous Ammonia (cost)	Labor (cost)	Profit
T1	10.23	3700	37851	0	1428	0	36423
T2	9.45	3700	34965	0	1248	0	33717
T3	8.69	3700	32153	0	1074	0	31079
T4	9.60	3700	35520	2142	0	100	33278

Table 17. Effect of anhydrous ammonia and urea treatments under W3 (irrigation every 8 days) on farmer income by LE in 2018 season

Treatments	2018 season						
	Yield (t/ha)	Price of rice/ton	Yield (price/ha)	urea (cost)	Anhydrous Ammonia (cost)	Labor (cost)	Profit
T1	10.22	3700	37814	0	1428	0	36386
T2	9.33	3700	34521	0	1248	0	33273
T3	8.51	3700	31487	0	1074	0	30413
T4	9.56	3700	35372	2142	0	100	33130

Table 18. Effect of anhydrous ammonia and urea treatments under W4 (irrigation every 12 days) on farmer income by LE in 2018 season

Treatment	2018 season						
	Yield (t/ha)	Price of rice/ton	Yield (price/ha)	urea (cost)	Anhydrous Ammonia (cost)	Labor (cost)	Profit
T1	9.38	3700	34706	0	1428	0	33278
T2	8.71	3700	32227	0	1248	0	30979
T3	8.00	3700	29600	0	1074	0	28526
T4	8.90	3700	32930	2142	0	100	30688

CONCLUSION

It can be concluded that using Giza178 rice cultivar which are fertilized by anhydrous ammonia at the rate of 195 kg N /ha (T1) and irrigated every 8 days (W3) under drill seeded method produced high grain yield (10.03 and 10.43 t/ha) which equal about 4.35 t/fed and save water about 22.99 and 22.60 % with WUE 0.91 and 0.93 kg/m^3 in 2017 and 2018 seasons respectively. Also, the water inputs were 10850.60and 10950.90 m^3/ha which equal about 4.60thousand m^3/fed compared with the national average 6.50 thousand m^3/fed (El- Refaee., 2012).

REFERENCES

Abd El Megeed, T. M. 2017. Effect of Urea and Anhydrous Ammonia Fertilizer on Yield and Yield Component of Rice Plants. J. Plant Production, Mansoura Univ., and Vol. 8(3):425 -434, 2017.

Abdel Kader-Mona G. 2002. Response of growth and yield of wheat "cv Seds 7" to Fe and Zn application under ammonia injection. Ph. D. Thesis, Fac. of Agric. Moshtohor,Zagazig, Univ.

Ashouri, M. 2012. The effect of water saving irrigation and nitrogen fertilizer on rice production in paddy fields of Iran. International Journal of Bioscience, Biochemistry and Bioinformatics. 2(1): 56-59.

Castillo, E. G., T. P. Tuong, U. Singh, K. Inubushi and J. Padilla .2006. Drought response of dry seeded-rice to water stress timing and N-fertilizer rates and sources. Soil Science and Plant Nutrition, 52:496–508.

Dalling, M. J. 1985. The physiological basis of nitrogen redistribution during filling in cereals. P. 55-71. In J.E Harper *et al*. (ed) Exploitation of physiological and genetic variability to enhance crop productivity. Am Soc. of plant physiologists, Rockville, (MD).

El- Refaee, I. S., Al-Khtyar A. M., & El-Gohary, A. A. 2008. Improving rice productivity under irrigation intervals and nitrogen fertilizer. Proceedings (the second field crops conference), FCRI, ARC, Giza, Egypt, 14-16. Oct.

El- Refaee. I. S. 2006. The interaction effect between water regimes and potassium levels on growth, grain yield and water productivity in rice. Egyptian Journal of Agriculture Research. 85 (4): 1399.

El- Refaee. I. S. E.E. Gewaily, E. S. Naeem and B. A. Zayed. 2011. Water balance and economic evaluation of some Egyptian rice cultivars. J. Agric. Res. Kafer El-Sheikh Univ., 37 (1).

El- Refaee. I. S., R.N. Gorgy and T. F. Metwally. 2012. Response of some rice cultivars to plant spacing for improving grain yield and water productivity under different irrigation intervals. Alex. J. Agric. Res. 57. (1): 1-14.

El-Kallawy. W. H. M. 2018. Impact of nitrogen sources and irrigation withholding at identified growth stages of hybrid rice under drill seeded method. Menouffia J. plant Prod., Vol.3 February (2018): 85-104.

El-Masry, A. A. Gohar, M. N. and El-Akabawy, M. A. (2006).The influence of nitrogenous fertilizer sources and some soil amendments on Hull-less Barley under alkli soil. Egypt J. Appl. Sci.21 (11): 247-256.

El-Mneasy, A. I. A. 2002.Increasing the efficiency of some fertilizers. Ph. D. Thesis, Fac. of Agric. Zagazig Univ. Egypt.

El-Refaee, I. S. H., M. E. Mosalem and F. A. Sorour 2005. Effect of irrigation regimes on productivity of Giza 178 and Sakha 102 rice cultivars under broadcasting method. Egypt. J. Agric. Res., 83(5B):377-391.

El-Wehishy, M. M. and A. G. Abd El-Hafez. 1998. Response of flooded rice to water deficit. J. Agric. Res. Tanta Univ., Egypt, 23:273-288.

Fageria, N.K., Baligar, V.C., Jones, C.A., 1997.Growth and Mineral Nutrition of Field Crops; 2nd Ed; Marcel Dekker: New York.

Garbeva, P. J. A. 2004. Microbial diversity in soil: selection of microbial populations by plant and soil type and implications for disease suppressiveness. Annu. Rev. Phytopathol, 42: 243-270.

Gately., T.F. and Kelly. D. 1987. Sources of nitrogen for spring barley. Soils and Grassland Production Research Report, pp 27–8. Dublin. An Foras Taluntais.

Ghanem S.A and TantawiBadawi A. 1999. Water use efficiency in rice culture. In: Chataigner J. (ed.). Future of water management for rice in Mediterranean climate areas: Proceedings of the Workshops. Montpellier: CIHEAM, 39-45 (Cahiers Options Méditerranéennes; n. 40.

Gomes, A.K and A.A Gomes. 1984. Statistical procedures of Agricultural Research.2 and ed. Jahn Wiley Sons, New York.

Guo SW, Chen G, Zhou Y and Shen QR. (2007).Ammonium nutrition increases photosynthesis rate under water stress at early development stage of rice (*Oryza sativa* L). *Plant & Soil* 296 115-124.

Hartz, T., W. Bendixen, and L. Wierdsma. 2000. The value of pre-sidedress soil nitrate testing as a nitrogen management tool in irrigated vegetable production. Hort Science. 35(4): p. 651-656.

Howida B. El-Habet. 2014.Irrigation regime and potassium levels effects on yield of some rice genotypes, water use Efficiency (wue) and economic returns. J. Plant Production, Mansoura Univ., Vol. 5 (3): 383-399.

Howida B. El-Habet. 2018. Effect of Organic and Inorganic Fertilizers on Rice and Some Nutrients Availability under Different Water Regimes. Journal of Agricultural Science and Food Research.Volume 9.Issue 4.1000247.

Ismail, A. O. A.*; F. A. Farag; A. H. A. Hassanein and A. H. Abd-Elrahman. 2013. Effect of Soil Amendments and Anhydrous Ammonia Application and Their Interactions on Some Soil Properties and Wheat Productivity under Salt Affected Soil conditions. J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 4 (10): 1085 - 1100, 2013.

Israelsen, B.O. and V.E. Hansen (1962). .Irrigation Principles and Practices 3rd Edit. John Wiley and Sons Inc, New York.

Mae, T. 1997. Physiological nitrogen efficiency in rice: nitrogen utilization, photosynthesis and yield potential. Plant Soil 196: 201-210.

Mahmoud, M.A. (2015).Yield and irrigation water productivity of rice on raised beds, irrigation intervals and ammonia gas injection at north Nile delta. J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 6 (11): 1377 – 1388.

Motavalli, P.P., K.W. Goyne, and R.P. Udawatta.2008. Environmental Impacts of Enhanced-Efficiency Nitrogen Fertilizers. Crop Management, 7(1).

Naeem .S.S. (2006) Availability of Some Nutrient Elements in Flooded Rice Soils Fertilized with Organic and Mineral Nitrogen Fertilizers.Mansoura Univeristy.

Osman E. A. M., A. A. EL- Masry and K. A. Khatab (2013). Effect of nitrogen fertilizer sources and foliar spray of humic and/or fluvic acids on yield and quality of rice plants. Pelagia Research Library Advances in Applied Science Research, 2013, 4(4):174-183.

Rogers, G. (2016).The use of anhydrous ammonia on baby leaf spinach, Cowra NSW. Applied Horticultural Research www.ahr.co.au.

Roshan, N. M., M. Moradi, E. Azarpour and H. R. Bozorgi (2013). Irrigation withholding time management in four rice varieties at Guilan paddy fields (North Iran). African J. Agric. Res., 8(20):2371-2375.

تاثير استخدام الامونيا اللامائية معفترات الرى على انتاجية محصول الارز تحت طريقة الزراعة بالتسطير

هويدا بيومى الهابط ، طاهر محمد عبد المجيد و ابراهيم محمد هاشم
قسم بحوث الارز، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية. (٣٣٧١٧ سخا - كفرالشيخ- مصر)

تم اجراء تجربة بمزرعة محطة البحوث الزراعية بسخا كفر الشيخ لدرسة التفاعل بين الرى المتقطع على فترات مع اضافة النتروجين فى صور (الامونيا اللامائية واليوريا) مع استخدام صنف الارزجيزة ١٧٨ خلال موسمى ٢٠١٧ و٢٠١٨. استخدم اربع معاملات لنظم الرى وهى الغمر المستمر- الرى كل ٤ ايام- الرى كل ٨ ايام- الرى كل١٢ ايام واستخدمت ٣ مستويات من الامونيا اللامائية وهى ١٩٥ كجمنيتروجين/هكتار- ١٦٥ كجم نيتروجين/هكتار- ١٤٣كجم نيتروجين/هكتارمقارنة مع التوصية السمادية الموصى بها من اليوريا وهى ١٦٥ كجم نيتروجين /هكتار. ولقد اوضحت اهم النتائج ان الرى المستمر اعطى اعلى انتاجية للمحصول بدون فروق معنوية مع الرى كل ٤ ايام و الرى كل ٨ ايام تحت استخدام معاملة التسميد ١٩٥ كجم نيتروجين/هكتار بالمقارنة مع اليوريا عند نفس معاملة الرى. حيث ان استخدام الامونيا اللامائية عند هذا المستوى ادى الى تقليل الاثر الضار من نقص المياه كما ادى الى زيادة كفاءة استخدام النتروجين و زيادة الحفاظ على المياة بنسبة لا تقل عن (٢٢.٦٠- ٢٢.٩٩%) مع انخفاض غير معنوى لمحصول الحبوب بالمقارنة تحت ظروف الغمر خلال موسمى ٢٠١٧ و٢٠١٨.