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YIELD AND SOME CROP - WATER RELATIONSHIPS OF ONION UNDER DIFFERENT IRRIGATION REGIMES AND LIQUID AMMONIA FERTILIZATION LEVELS

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ABSTRACT

A field experiment was conducted at Tameia Agric.Res. station, Fayoum Governorate, during 2010/2011 season and repeated in 2011/2012 one, aiming at studying the effect of irrigation regimes as different available soil moisture depletion (ASMD) and N - fertilization levels as (100,120 and140 Kg.N fed^{-1} soil – injected ammonia gas) on onion bulb yield, yield components and some crop - water relations. To achieve the previous targets, N fertilization levels i.e. 100, 120 and 140 kg N/fed were combined with three irrigation regimes i.e. irrigation at 35, 55 and 75% ASMD in a strip-plot design with four replicates. The main obtained results could be summarized as follows:-

1. Onion bulbs yield and yield components were significantly affected by the adopted both N fertilization levels and irrigation regimes and their interaction as well in both seasons.
2. The highest averages of bulb weight, bulb diameter and bulbs yields (18.750 and 17.910 t fed^{-1}) were detected from applying 140 kg N fed^{-1} and irrigation at 35% ASMD interaction, whereas the lowest figures resulted from the interaction of 140 kg N fed^{-1} level and irrigation at 35% ASMD, in 2010/2011and 2011/2012 seasons.
3. Seasonal evapotranspiration (ET_C)., as a function of N -fertilization levels and irrigation regimes were 35.03 and 33.85 cm in 2010/2011 and 2011/2012 seasons, respectively. The highest ET_C values (40.32 and 39.11 cm) resulted from applying 140 kg N fed^{-1} and irrigation at 35% ASMD in the two successive seasons. Applying 100 kg N fed^{-1} and irrigation at 75% ASMD gave the lowest ET_C values which comprised 29.93 and 29.06 cm in 2010/2011 and 2011/2012 seasons, respectively.
4. The crop coefficient (K_C) values were 0.56, 0.69, 0.79, 0.94 and 0.74 for December, January, February, March and April, respectively, (two seasons average of the highest yielding interaction e.g. supplying N at 140 kg fed^{-1} rate and irrigating at 35%ASMD).
5. The highest water use efficiency values in 2010/2011 and 2011/2012 seasons (10.054 and 10.903 kg dry bulbs m^{-3} water consumed, respectively) were detected from applying 140 kg N fed^{-1} and irrigation at 35% ASMD.

Keywords: Onion yield, ammonia gas fertilization, irrigation regimes, crop - water relations.

INTRODUCTION

Onion is an important winter vegetable crop grown in Egypt. The crop plays a great economical role in the national agricultural exporting policy. In 2011 the onion bulb yield amounted to 2,304,210 tones resulted from harvested area equals 63,723 hectares (FAOSTAT,2013). The limited irrigation water resources is the main limiting factor facing the Egypt ^{s} agricultural strategy, so efficient water management is the most important issue in the agriculture sustainability. Nitrogenous fertilization is one of the most important factors positively affecting crop production and crop quality.

Nitrogen requirements for onion was investigated by many researches around the world, Thabet *et al*.(1994), Vigas and Arbe (1994), Singh (1995), Shah *et al*.(1996) and Sharma (1998), reported that high nitrogen rates had no significant effect on most onion plant parameters. On contrast, Singh *et al*. (1994), Amin *et al*. (1995) and Dixit (1997) showed that onion yield and storage quality of onion bulbs were increased as N fertilization level increased. Zedan *et al.* (2000), concluded that increasing N level to 120 unit fed^{-1} with combination of K rate of 48 unit fed^{-1} increased onion bulb yield. El- Akram (2012) at Fayoum region revealed that applying ammonium nitrate at the level of 100 Kg N/fed increased onion yield and its components.

Regarding effect of irrigation water management, Doorenbos and Kassam (1986) have reported that onion yields of 35 – 45 t ha^{-1} could be obtained with 350 – 550 mm of water using furrow irrigation. They advise that soil water depletion should not be allowed to drop below 25% of available water for optimum yield. The author added that water utilization efficiency for onion bulb yield (85- 90% moisture) ranged from 8 to 10 kg m^{-3} and the crop coefficient (K_C) values are (0.4 – 0.6), (0.7- 0.8), (0.95 – 1.1), (0.85 – 0.90) and (0.75 – 0.85) for initial, crop development, mid-season, late season and harvest stages, respectively. Karim *et al* (1996) indicated that WUE for onion was 636 kg ha cm^{-1} water consumed as the crop was irrigated when 20% of available soil moisture was depleted. Gaviola *et al*. (1998) pointed out that the greater the amount of irrigation water applied, the higher the yield. Abu-Awwad (1999) found that onion ET_C was 400 mm and WUE was maximum for the intermediate water level. Koriem *et al.* (1999) found that averages of water consumptive use tended to reduce as ASMD% increased. The author added that ET_C rate gradually increased and reached peaking on March and then declined towards harvesting and the seasonal K_C was 0.66 and higher WCU was obtained by irrigation at 30% ASMD. Halim and Ener (2001) recorded that seasonal ET of onion in irrigated conditions ranged from 394 to 438 mm and from 177 to 266 mm in conditions without irrigation for a yield of 35.8 – 43.1 and 13.9 – 17.4 t ha^{-1}, respectively, under arid climatic conditions in Turkey. Kadayifci et al. (2005) reported that seasonal ET of onion in Turkey ranges from 350 – 450 mm for bulb yield of 40 t ha^{-1}. Nandi *et al.* (2002) and Abd El- Gawwad (2008) reported that growth and yield of onion were significantly affected by irrigation, but not by post life one. El-Akram (2012) revealed that onion bulb yield and ET_C were higher with frequently irrigation, i.e. irrigation at 40% ASMD, compared to irrigation at 60% and 80% ASMD. Morsy and Abd El-Latif (2012) concluded that bulb diameter and bulb weight, bulb yield were increased by increasing irrigation events from 2 to be 3, 4 or 5. Irrigating Giza 20 variety at 5 irrigations gave the highest ET_C (1320 m^3 fed^{-1}.), whereas water productivity of each m^{-3} was decreased.

The herein research trials aiming at finding out the extent to which onion bulb yield and some crop – water relationships could be affected due to combination of different N – levels and irrigation regimes to determine the most efficient interaction exhibiting higher bulb yield with proper water use under Fayoum Governorate circumstances..

MATERIALS AND METHODS

A field experiment was conducted at Tameia Agric. Res. station, Fayoum Governorate during 2010/2011 and 2011/2012 seasons. Some physical and chemical analyses of the experimental site were determined according to Klute (1986) and Page *et al*.(1982) and data are presented in Table 1. The study aiming at investigating the effect of different nitrogen fertilization levels and irrigation regimes and their interaction on onion bulb yield, yield components and some crop - water relations. To achieve these targets, three N fertilization levels i.e. 100, 120 and 140 kg N fed^{-1} (as ammonia gas, 82% N) were combined with three irrigation regimes e.g. irrigation at 35, 55 and 75% of the available soil moisture depletion (ASMD). The adopted treatments were assessed in a strip-plot design with four replicates. Calcium super phosphate (15.5% P_2O_5) and potassium sulphate (46%K_2O)at the rates of 300 and 150 kg fed^{-1} ,respectively, during the field preparation. The liquid ammonia was soil - injected seven days before onion transplanting. The sub plot area was 21 m^2 contained three wide ridges (beds of 120 cm width). Onion seedlings (Giza 20 Cv.) were transplanted in hills 10 cm apart on the both sides and in the middle of the beds. Transplanting was executed on December 15th, whereas harvesting was done on April 25th and 21st in 2010/2011 and 2011/2012 seasons, respectively.. It is worthy to mention that, in the two seasons of study, under irrigation at 35, 55 and 75% ASMD regimes, onion crop received, plus transplanting irrigation, 6, 5 and 4 irrigation events, respectively. Dates of irrigation events under different irrigation regimes in both seasons are listed in Table 2.

Table 1: Particle size distribution and some chemical analyses of the experimental site in 2010/ 2011 and 2011/2012 seasons (two seasons average).

Particle size distribution								Organic matter (%)					CaCo$_3$ (%)		
Sand %		Silt %		Clay %		Textural class									
49.90		24.03		26.07		Sandy clay loam		1.21					5.92		
Soluble cations ($meqL^{-1}$)				Soluble anions ($meqL^{-1}$)				EC (dSm^{-1})	p^H	CEC (meq/100g soil)	Exchangeable cations (meq/100g soil)				
Ca^{+2}	Mg^{+2}	Na^+	K^+	Cl^-	HCo_3^-	CO_3^{-2}	SO_4^{-2}				Ca^{+2}	Mg^{+2}	Na^+	K^+	
9.77	8.37	40.31	0.38	30.21	1.77	-	27.35	5.91	8.10	30.72	15.31	10.32	0.93	4.12	

Table 2 : Date of irrigation events and irrigation interval as affected by irrigation regimes in 2010/2011 and 2011/2012 seasons.

Irrigation event	2010/2011						2011/2012					
	Available soil moisture depletion%						Available soil moisture depletion%					
	35		55		75		35		55		75	
	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)	Date	Interval (days)
Transplanting	15/12	-	15/12	-	15/12	-	15/12	-	15/12	-	15/12	-
First	5/1	21	5/1	21	5/1	21	3/1	19	3/1	19	3/1	19
Second	23/1	18	30/1	25	2/2	28	22/1	19	27/1	24	30/1	27
Third	9/2	17	22/2	23	1/3	27	8/2	17	19/2	23	26/2	27
Fourth	25/2	16	16/3	22	26/3	26	24/2	16	12/3	22	22/3	25
Fifth	13/3	16	5/4	20	-	-	11/3	16	2/4	21	-	-
Sixth	31/3	18	-	-	-	-	28/3	16	-	-	-	-
Harvesting	25/4	25	25/4	20	25/4	30	21/4	24	21/4	20	21/4	31

Measurements and data recorded:

I. Yield and yield components:

At harvesting time twenty onion plant were chosen from each sub-plot and left for two weeks until dried to determine bulb diameter (cm) and bulb dry weight (g) yield attributes. Dry bulb yield was determine based on the entire plot area and expressed as ton fed^{-1}.

Data of the abovementioned measurements were subjected to the statistical analysis according to Snedecor and Cochran (1980) and the means were compared using LSD test at 5% level.

II. Crop - water relationships:

1- Seasonal consumptive use (Cu, ETc)

Crop water consumptive use (ET_C), was gravimetrically determined via the soil water constants values Table 3 .The soil samples were taken, in 15 cm increment system to 60 cm depth of soil profile, 48 hours after each irrigation and just before the next one, as well as at harvesting time. The crop evapotranspiration (ET_C) between each two successive irrigation events was calculated according to Israelsen and Hansen, (1962) as follows:

$$Cu\ (ET_C) = Q_2 - Q_1 / 100 \times Bd \times D$$ ……… where

Cu = crop water evapotranspiration (cm).

Q_2 = soil moisture % by weight, 48 hours after irrigation.

Q_1 = soil moisture % by weight just before the next irrigation.

Bd = soil bulk density (g cm^{-3}).

D = soil layer depth (cm).

Table 3: Some soil moisture constants and bulk density of the experimental field (average of the two seasons).

Soil depth (cm)	Field capacity (%, wt/wt)	Wilting point (%, wt/wt)	Available moisture (%, wt/wt)	Bulk density (g cm^{-3})	Available moisture (mm)
00-15	33.28	16.93	16.35	1.39	34.09
15-30	30.97	15.88	15.04	1.42	32.04
30-45	27.32	14.02	13.30	1.51	30.12
45-60	25.17	13.11	12.06	1.49	26.95
Mean	29.19	14.99	14.19	1.45	Tot., 123.20

2- Daily ET_C rate (mm day^{-1})

Calculated from the ET_C between each two successive irrigations divided by the number of days.

3- Reference evapotranspiration (ET_0)

Estimated as (mm day^{-1}) based on the monthly averages of weather factors of Fayoum Governorate Table 4 and the procedures of FAO-Penman Monteith equation **(Allen *et al*. 1998).**

Table 4 : Monthly averages of weather factors for Fayoum Governorate during 2010/2011 and 2011/2012 seasons

Month	Season	Temperature C°			Relative humidity (%)	Wind speed (m sec^{-1})	Class A pan evaporation (mm day^{-1})
		Max.	Min.	Mean			
December	2010	21.9	7.6	14.80	53	1.18	1.8
	2011	26.5	12.6	19.5	53	1.16	2.8
January	2011	24.4	8.2	16.30	49	1.65	2.8
	2012	23.6	7.7	15.51	46	1.66	2.6
February	2011	27.5	11.4	19.50	50	2.13	4.3
	2012	27.00	10.8	18.4	51	2.15	4.4
March	2011	31.8	14.3	23.0	46	2.43	5.9
	2012	25.4	11.8	18.6	52	2.42	5.8
April	2011	28.5	13.7	21.1	47	2.42	4.9
	2012	29.1	13.6	21.3	49	2.49	5.6

4- Crop coefficient (K_C)

The crop coefficient (Kc) was calculated as follows:

$$Kc = ET_C / ET_0$$

Where

ET_C = actual evapotranspiration, mm ET_0 =reference evapotranspiration, mm

5- Water use efficiency (WUE)

The water use efficiency or water productivity, as kg onion bulb yield per the cubic meter of water consumed was calculated as out lined by Smith (2002) as follows :-

WUE, kg onion bulbm^{-3} = crop yield, kg onion bulb fed^{-1} / actual crop evapotranspiration (ET_C, m^3 fed^{-1})

RESULTS AND DISCUSSION

I. Yield and yield components

The results in Table 5 show that onion yield and its components were significantly affected by nitrogen fertilization levels in both seasons. The highest averages of bulb yield and yield attributes e.g. bulb weight and bulb diameter in 2010/2011 and 2011/2012 seasons, respectively, were detected from applying 140 kg N fed^{-1}. On the contrary, the lowest averages were recorded due to applying 100 kg N fed^{-1} in both seasons. Increasing N - fertilization rate resulted in significant increases in bulb yield. reached to 10.67 and 8.91% and to 24.24 and 23.91% as N –rate increased to be 120 or 140kg N fed^{-1}, comparing with 100 kg N fed^{-1} one, respectively, in 2010/2011 and 2011/2012 seasons. Furthermore, the yield attributes were positively responded to increasing N- rate, where increasing N – rate from 100 to 120 or 140 kg N fed^{-1} increased bulb weight by (10.58 and 10.37%) and by (25.18 and 24.45%) in 2010/2011 and 2011/2012 seasons, respectively, comparable with 100 kg N fed^{-1}. The corresponding increase values in bulb diameter comprised(20.05 and 18.18%) and (31.50 and 29.98%) under 120 and 140 kg N fed^{-1} levels in 2010/2011 and 2011/2012 seasons, respectively, comparing with 100 kg N fed^{-1} level. These results may be attributed to the role of nitrogen element in increasing growth and yield attributes and consequently bulb yield. The obtained results are in agreement with those reported by Singh *et al* (1994), Amin *et al* (1995), Dixit (1997) and Zedan *et al* (2000).

Table 5: Effect of N – level, irrigation regime and interaction on onion bulbs yield and its components in 2010/2011 and 2011/2012 seasons

Treatments		2010/2011 season			2011/2012 season		
Nitrogen level (kg N fed^{-1})	Irrigation regime	Dry bulb Weight (g)	Bulb diameter (cm)	Dry bulbs Yield (t fed^{-1})	Dry bulb weight (g)	Bulb diameter (cm)	Dry bulbs yield (t fed^{-1})
100	35% (ASMD)	82.15	4.62	14.07	79.20	4.52	13.78
	55% (ASMD)	74.65	4.11	13.17	70.42	4.07	12.89
	75% (ASMD)	66.92	3.86	12.13	62.65	3.62	11.73
Mean		74.57	4.19	13.12	70.75	4.07	12.80
120	35% (ASMD)	90.95	5.68	15.94	86.91	5.51	15.23
	55% (ASMD)	81.68	4.92	14.65	77.78	4.75	14.07
	75% (ASMD)	74.75	4.51	13.07	69.51	4.18	12.54
Mean		82.46	5.03	14.52	78.09	4.81	13.94
140	35% (ASMD)	103.85	6.12	18.57	97.75	5.98	17.19
	55% (ASMD)	92.60	5.45	16.12	86.90	5.11	15.82
	75% (ASMD)	83.62	4.97	14.22	79.50	4.79	13.86
Mean		93.35	5.51	16.30	88.05	5.29	15.86
Means of irrigation 35% (ASMD)		92.32	5.47	16.19	87.95	5.34	15.64
55% (ASMD)		82.98	4.83	14.65	78.37	4.64	14.26
75% (ASMD)		75.10	4.45	13.14	70.55	4.20	12.71
LSD, 5%	nitrogen levels (F)	1.92	0.45	0.08	2.50	0.23	0.24
	Irrigation regimes (I)	0.83	0.17	0.11	0.92	0.20	0.14
	F × I	1.44	N.S	0.19	N.S	N.S	0.24

Data in Table 5 indicate that the adopted irrigation regimes significantly influenced bulb yield and yield attributes. The highest averages of bulb yields and yield attributes of bulb weigh and bulb diameter were recorded under irrigation at 35% ASMD in the two seasons of study. Increasing soil moisture depletion% resulted in lower values of bulb yield and yield attributes, where under 55% ASMD regime, bulb yield were reduced by 9.51 and 8.82% in 2010/2011and 2011/2012 seasons, comparable with 35%

ASMD, respectively. Further increase in ASMD% to be 75% was accompanied with bulb yield reduction amounted to 17.23 and 18.73% in 2010/2011 and 2011/2012 seasons, respectively, comparing with 35% ASMD regime. The bulb weigh and bulb diameter yield attributes exhibited the same trend, where bulb weight figures were reduced by (10.12 and 10.89%) and by (18.65 and 19.78%) under 55 and 75% ASMD regimes in 2010/2011 and 2011/2012 seasons, respectively, as compared with 35% ASMD regime. The corresponding reduction values in bulb diameter amounted to (11.70 and 13.11%) and (18.65 and 21.35%) under 55 and 75% ASMD regimes in 2010/2011 and 2011/2012 seasons, respectively, compared with 35%ASMD regime. These results may be due to the negative effect of soil moisture deficits on cell division, vegetative growth and dry matter accumulation in reproductive stage (bulb formation). The obtained results are in harmony with those of Halim and Ener (2001), Kumar et al.(2007) and Enciso et al. (2009) and Peji et al.(2011) who found that irrigation was highly affected the total onion yield, yield components and morphological characteristics of onion bulbs. Moreover, under the Egyptian conditions, Koriem et al. (1999), Abd El-Gawwad (2008), El Akram (2012) and Morsy and Abd El- Latif (2012) recorded similar trends.

Data in Table 5 show that onion bulb yield was significantly affected due to the interaction of N levels and irrigation regimes in both seasons. Injecting ammonia gas at 140 kg N fed^{-1} rate and irrigation at 35% ASMD exhibited the highest bulbs yield fed^{-1} which comprised 18.570 and 17.190 t fed^{-1} in 2010/2011 and 2011/2012, respectively. On the other hand, 100 kg N fed^{-1} rate and irrigation at 75% ASMD interaction gave the lowest averages of bulbs yield fed^{-1} reached 12.130 and 11.730 t fed^{-1}, respectively, in 2010/2011 and 2011/2012 seasons. In addition, the highest figures for the yield attributes of bulb weight and bulb diameter were recorded as 140 kg N fed^{-1} rate was interacted with irrigation at 35% ASMD regime and such findings were true in the two seasons of study.

II. Crops water relationships:

1. Seasonal evapotranspiration (ET_C)

The results in Table 6 show that seasonal ET_C of onion, as a function of N - fertilization level and irrigation regime treatments were 35.03 and 33.85 cm in 2010/2011 and 2011/2012 seasons, respectively. The difference between the two seasons may be due to the weather factors variation and onion growth, performance and yield in the two seasons of study. Application of 140 kg N fed^{-1} gave the highest values of ET_C which amounted to 36.96 and 35.90 cm in 2010/2011 and 2011/2012 seasons. Decreasing N - level from 140 to 120 or 100 kg N fed^{-1} was accompanied with lower ETc reached 4.67 and 12.61%, in 2010/2011 and 4.79 and 14.40% in 2011/2012 season, respectively.. It is obvious that increasing N - levels exhibited higher ETc for onion crop. These results may be due to higher yield and yield attributes resulted from increasing N-level. These results are agree with those reported by Gaviola el al. (1998) and Zedan et al. (2000) .

Table 6: Effect of nitrogen level, irrigation regime and their interaction on seasonal evapotranspiration (ET_C) of onion in cm in 2010/2011 and 2011/2012 seasons

Nitrogen level (kg N fed^{-1})	2010/2011 season				2011/2012 season			
	Irrigation regime (ASMD%)				Irrigation regime (ASMD%)			
	35	55	75	Mean	35	55	75	Mean
100	35.74	32.81	29.93	32.82	34.16	30.92	29.06	31.38
120	38.61	36.02	31.32	35.31	37.21	35.33	30.25	34.26
140	40.32	37.47	33.09	36.96	39.11	36.62	31.97	35.90
Mean	38.22	35.43	31.45	35.03	36.83	34.29	30.43	33.85

Regarding the effect of irrigation regime treatments, data in Table 6 indicate that irrigation at 35% ASMD (more applied irrigation events) gave the highest ET_C values which reached to 38.22 and 36.83 cm in 2010/2011 and 2011/2012 seasons, respectively. On the contrary, the lowest ET_C values, i.e. 31.45 and 30.43 cm were detected from irrigating onion crop at 75% ASMD (less applied irrigation events) in 2010/2011 and 2011/2012 seasons, respectively. Data also indicate that irrigation at 55 or 75% ASMD regimes resulted in lower ET_C values comprised 7.30 and 6.90% and 17.71 and 17.74% in 2010/2011 and 2011/2012 seasons, respectively, respectively, less than that under 35% ASMD regime. In connection, Abu-Awwad (1999) and Kadayifci et al.(2005) stated that increasing applied irrigation water significantly increased evapotranspiration and/or transpiration for onion crop.

It is evident that increasing the available soil moisture depletion in the root zone during the crop growing season resulted in low both transpiration from the plant canopy and evaporation from soil surface which resulted in lower ETc values. These results are in accordance with those found by Koriem *et al.*(1999), Nandi *et al.* (2002) and Abd El- Gawwad (2008).

Data in Table 6 indicate that 140 kg N fed^{-1} rate and irrigation at 35% ASMD regime interaction gave the highest ET_C values which comprised 40.32 and 39.11 cm in 2010/2011 and 2011/2012 seasons, respectively. Whereas, the lowest ET_C values i.e. 29.93 and 29.06 cm in 2010/2011 and 2011/2012 seasons, respectively, were attained from applying 100 kg Nfed^{-1} and irrigation at 75% ASMD (extended irrigation intervals).

2. Reference evapotranspiration (ET_0)

Monthly ET_0 value (mm day^{-1}) during onion growing season which extended from December to April of 2010/2011 and 2011/2012 seasons are recorded in Table 7. Data indicate that the daily ET_O values started with low values during December and January, then increased gradually from February to reach its maximum values during April. These results are mainly referred to the changes in weather elements during the growing season.

3. Crops coefficient (K_C)

In the present study K_C values for onion crop were estimated from the daily ET_C (mm day^{-1}) under the interaction which exhibited the highest bulb yield values e.g. applying 140 kg N fed^{-1} and irrigation at 35% ASMD regime. The results in Table 7 show that the K_C values was low during December, after onion transplanting, as a results of the large diffusive resistance of bare soil at the early seedling growth stage. Thereafter, the K_C tended to increase during January and February, as the percentage of crop cover increased to reach its maximum values during March (rapid growth of bulbs in diameter and weight). The K_C values decreased again during April due to late season and onion bulbs maturity. These results are in the same trend of those reported by Abu-Awwad (1999), Koriem *et al.* (1999) and El-Akram (2012).

Table 7: Crop coefficient (K_C) values for onion crop under the highest yielding interaction* in 2010/2011and 2011/2012 growing seasons

Season	2010/2011					2011/2012				
Month	Dec.	Jan.	Feb.	Mar.	Apr.	Dec.	Jan.	Feb.	Mar.	Apr.
ET_0(mm day^{-1})	2.14	2.19	3.21	4.51	5.3	2.10	2.80	3.52	4.5	5.43
ET_C(mm day^{-1})	1.24	1.62	2.72	4.37	4.01	1.16	1.79	2.57	4.05	3.86
K_C	0.58	0.74	0.85	0.97	0.76	0.55	0.64	0.73	0.90	0.71

*** Applying 140 kg N fed^{-1} and irrigation at 35% ASMD regime**

4. Water use efficiency (WUE)

Results in Table 8 show that average WUE values, as a function of N - fertilization levels and irrigation regimes were 9.939 and 9.972 kg dry bulbs m^{-3} water consumed in 2010/2011 and 2011/2012, respectively. The highest WUE values (10.479 and 10.503 kg dry bulbs m^{-3} water consumed) in the two successive seasons, were obtained with 140 kg N fed^{-1} rate. Furthermore, reducing N - level to be 120 or 100 kg N fed^{-1} resulted in slightly lowered WUE values (6.3 and 6.3%) in 2010/2011 and (7.7 and 7.5%) in 2011/2012 seasons, respectively, comparable with 140 kg N fed^{-1} rate.

Data in Table 8 indicate that irrigating onion at 35% ASMD produced the highest values of WUE which amounted to 10.045 and 10.085 kg dry bulbs m^{-3} water consumed in 2010/2011 and 2011/2012 seasons, respectively. Irrigation at 55% or 75% ASMD slightly decreased WUE for onion crop by 2.3 and 1.19% in 2010/2011 season and by 1.9% and 1.52% in 2011/2012 season, respectively, than irrigation at 35% ASMD. In this sense, El-Akram (2012) reported that increasing available soil moisture depletion to be 60 or 80% ASMD resulted in lower WUE values which comprised 8.22 and 11.43% (two seasons mean), respectively, comparable with 40% ASMD. Such differences in WUE reduction values may be attributed to differed experimentation circumstances. In general, Arnon (1975) pointed out that crop yield depends on the rate of water use, and that all factors increasing yield and decreasing water used for ET are favorably affect the water use efficiency.

The results in Table 8 show that the highest WUE values for onion crop (10.965 and 10.903 kg dry bulbs m^{-3} water) resulted from applying 140 kg N fed^{-1} as soil – injected liquid ammonia gas and irrigation at 35% ASMD in 2010/2011 and 2011/2012 seasons, respectively.

According to the obtained WUE for onion as affected the adopted N-rates and irrigation regimes, data reveal that reducing N-rate to be 120 or 100 kg N fed^{-1} exhibited slightly lowered WUE reached 7.0 and 6.9% (two seasons mean), respectively, comparable with 140 kg N fed^{-1}. In addition, increasing soil moisture depletion to be 55 or 75% ASMD resulted in negligible reductions in WUE values, comparing with 35% ASMD . Thus, on producing onion with less costs and/or conserving the limited irrigation resources as well it is advisable to supply N – fertilizer (as soil – injected liquid ammonia) at 100 or 120 kg N fed^{-1} rates and irrigating as not less than 55- 75% of available soil moisture was depleted under Fayoum Governorate conditions.

Table 8: Effect of N - level, irrigation regime treatments and their interaction on water use efficiency (kg bulb yield m^{-3} water consumed) in 2010/2011 and 2011/2012 seasons

Nitrogen level (kg N fed^{-1})	2010/2011 season				2011/2012 season			
	Irrigation regimes (ASMD %)				Irrigation regimes (ASMD %)			
	35	55	75	Mean	35	55	75	Mean
100	9.370	9.560	9.645	9.525	9.607	9.925	9.610	9.714
120	9.829	9.683	9.932	9.814	9.745	9.482	9.870	9.699
140	10.965	10.243	10.231	10.479	10.903	10.285	10.322	10.503
Mean	10.054	9.828	9.936	9.939	10.085	9.897	9.934	9.972

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المحصول والعلاقات المائية للبصل تحت معاملات مختلفة من استنفاذ الرطوبة الأرضية والتسميد بالامونيا الغازية

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أقيمت تجربة حقلية بمحطة البحوث الزراعية بطامية/محافظة الفيوم خلال موسمي الزراعة ٢٠١١/٢٠١٠ – ٢٠١٢/٢٠١١. يهدف هذا البحث إلى دراسة تأثير معاملات الري (الري عند فقد نسب مختلفة من الرطوبة الميسرة بالتربة) ومستويات التسميد النيتروجيني (الحقن بالامونيا الغازية) علي محصول البصل ومكوناته وبعض العلاقات المائية للمحصول . لتحقيق هذه الأهداف توافقت ثلاث معاملات من مستويات التسميد النيتروجيني وهي ١٠٠ ، ١٢٠ ، ١٤٠ كجم ن/ ف (امونيا غازيه) مع ثلاث معاملات للري وهي الري عند فقد ٣٥ ، ٥٥ ، ٧٥% من رطوبة التربة الميسرة وذلك في تصميم الشرائح المتعامده في أربع مكررات وكانت أهم النتائج المتحصل عليها كما يلي:

١. تأثرت مكونات المحصول ومحصول الأبصال (طن/ف) معنويا بمستويات التسميد النيتروجيني ومعاملات الري والتفاعل بينهما في كلا الموسمين
٢. كانت أعلي المتوسطات لوزن البصلة وقطر البصلة ومحصول الأبصال (١٨,٧٥٠ ، ١٧,٩١٠ طن /ف) في موسمي ٢٠١١/٢٠١٠ ، ٢٠١٢/٢٠١١ علي الترتيب قد نتجت من إضافة ١٤٠ كجم ن/ف والري عند فقد ٣٥% من رطوبة التربة الميسرة. أدي نقص النيتروجين من ١٤٠ إلي ١٠٠ كجم ن /ف وزيادة الإجهاد الرطوبي من ٣٥ إلي ٧٥% من فقد الماء الميسر بالتربة إلي نقص في وزن البصل ، قطر البصلة، محصول الأبصال/ف في ٢٠١١/٢٠١٠ بنسبة ٥٥,١٨ ، ٥٨,٥٥، ٥٣,١٥% علي الترتيب وفي موسم ٢٠١٢/٢٠١١ بنسبة ٥٦,٠٢\ ، ٦٥,١٩ ، ٥٢,٦٨% علي الترتيب.
٣. الاستهلاك المائي الموسمي كنتيجة لتفاعل معاملات التسميد النيتروجيني ومعاملات الري كان ٣٥,٠٣، ٣٣,٨٥ سم خلال موسمي ٢٠١١/٢٠١٠ ، ٢٠١٢/٢٠١١ علي الترتيب وكانت أعلي قيم للاستهلاك المائي الموسمي هي ٤٠,٣٢ ، ٣٩,١١ سم قد نتجت من إضافة ١٤٠ كجم ن/ف والري عند فقد ٣٥% من ماء التربة الميسر في الموسمين المتعاقبين. بينما أدي إضافة١٠٠ كجم ن /ف (امونيا غازية) والري عند فقد ٧٥% من ماء التربة الميسرة للحصول علي اقل قيم للاستهلاك المائي الموسمي وهي ٢٩,٩٣ ، ٢٩,٠٦ سم خلال ٢٠١١/٢٠١٠ ، ٢٠١٢/٢٠١١ علي الترتيب.
٤. كانت قيم معامل المحصول (K_C) هي ٠,٥٦ ، ٠,٦٩ ، ٠,٧٩ ، ٠,٩٤ ، ٠,٧٤، خلال شهور ديسمبر ، يناير، فبراير، مارس وابريل علي الترتيب (متوسط موسمين).
٥. اعلي قيم لكفاءة استهلاك الماء في موسم ٢٠١١/٢٠١٠ وهي(١٠,٠٥٤ كجم أبصال جافة/ م^3 ماء مستهلك) ، وفي ٢٠١٢/٢٠١١ (١٠,٩٠٣ كجم أبصال جافة / م^3 ماء مستهلك) من إضافة ١٤٠ كجم ن /ف والري عند فقد ٣٥% من رطوبة التربة الميسرة .

قام بتحكيم البحث

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