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جدولة ري الذرة الرفيعه تحت صور مختلفة من التسميد النيتروجيني

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الملخص العربي

اقيمت هذه الدراسه بمحطة مركز البحوث الزراعية بالفيوم (طاميه) خلال موسمي الزراعة ٢٠٠٩/٢٠١٠ لدراسة تأثير الصور المختلفة من التسميد النتيتروجيني (الحقن بالامونيا الغازيه – اليوريا – نترات الامونيوم) بمعدل ٩٠ وحدة ن /فدان وجدوله ري الذرة الرفيعه (صنف هجين دورادو) بالمعامل (٠,٨ – ١,٠ – ١,٢) لقيم البخر التراكمي لوعاء البخر القياسي علي المحصول ومكوناته وبعض العلاقات المائيه وذلك في تصميم القطع المنشقة مرة واحدة في اربعة مكررات . واوضحت الدراسه تفوق المعامله (الحقن بالامونيا الغازيه والري عند ١,٢من بخر الوعاء التراكمي) في زيادة محصول الذرة الرفيعة ومكوناته (طول وعرض ووزن القنديل – وزن حبوب القنديل – وزن ال ١٠٠ حبة) مقارنة بباقي المعاملات . كانت اعلي قيم لمتوسط الاستهلاك المائي الموسمي (٥٧,٢٠ ، ٦٠,١٥سم) ناتجة من معامله الحقن بالامونيا الغازيه والري عند ١,٢ من بخر الوعاء التراكمي.في موسمي ٢٠٠٩ ، ٢٠١٠ علي التوالي. وقد كان معدل الاستهلاك المائي اليومي منخفضا خلال شهر يونيو وازداد حتي وصل الي اقصي استهلاك مائي في شهر اغسطس وعاود الانخفاض في شهر سبتمبر مرة اخري وذلك في الموسمين المتعاقبين . وكانت قيم معامل المحصول للمعاملة التي أعطت أعلي محصول ومكوناته (الحقن بالامونيا والري عندي ١,٢ من بخر الوعاء التراكمي) من يونيو وحتي سبتمبر هي ٠,٤٠ ، ٠,٦٩ ، ٠,٩٠ ، ٠,٣٨ علي التوالي (كمتوسط للموسمين المتعاقبين) وقد اعطت ايضا هذه المعامله اعلي متوسط لكفاءة استخدام المياه في الموسمين المتعاقبين وكانت ٠,٨٢٨ ، ٠,٨٤٨ كجم محصول /م^{3} ماء .

SCHEDULING GRAIN SORGHUM IRRIGATION UNDER DIFFERENT NITROGEN FERTILIZER FORMS

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ABSTRACT : ***The present investigation was carried out at Fayoum Agric. Res. Station (Tamia) during 2009 and 2010 seasons to study the combination effects of 90 kgNfed^{-1}. in different N-fertilizer forms i.e. F_1: Liquid ammonia gas injection, F_2: Urea and F_3: Ammonium nitrate and three irrigation scheduling coefficients, for the cumulative pan evaporation (C.P.E.), i.e. I_1: 0.8, I_2: 1.0 and I_3: 1.2. on yield and yield components and some crop - water relations of grain sorghum (Dorado hybrid). The split- plot design with four replicates was used, since the main plots were occupied with N- fertilization forms while the split ones were allocated for scheduling irrigation treatments. The obtained main results were as follows:***

1. ***Length, width and weight of panicle, grain weight /panicle, 100-grain weight and grain yield/ fed., obtained from injecting liquid ammonia gas and irrigation at 1.2 C.P.E. coefficient, surpassed significantly those obtained from the other treatments.***
2. ***Seasonal water consumptive use (ET_C) reached its maximum values 57.20 and 60.15 cm in 2009 and 2010 seasons, respectively, as sorghum crop was fertilized by liquid ammonia gas and irrigated at 1.2 C.P.E. coefficient.***
3. ***The daily ET_C rate was low during June, then increased to reach its maximum during August and then declined again during September, in both seasons. The crop coefficient K_C (as average of the two seasons) for grain sorghum yield potential were 0.40, 0.69, 0.90 and 0.38 at June, July, August and September, , respectively. The wet moisture level (1.2 C.P.E.) under injecting liquid ammonia gas exhibited the highest efficiency of water use which amounted to 0.828 and 0.848 kg grains m^{-3} in 2009 and 2010 seasons, respectively.***

Key words: ***Nitrogen forms, sorghum yield and yield components, scheduling irrigation, sorghum crop - water relations, Liquid ammonia fertilization***

INTRODUCTION

Grain sorghum (*Sorghum bicolor Monch*) is one of the most important cereal summer crops in Middle and Upper Egypt. Nowadays, irrigation management plays an effective role in the Egyptian agriculture strategy due to limited water recourses, whereas nitrogen fertilization considered one of the important factors affecting crop production especially for cereal crops. Both organic and inorganic sources of supplemental nitrogen dictate which of these sources should be used in a given situation. In addition nitrogen fertilizer sources have considerable effects on both soil pH and solubility of cations including micronutrient cations. The most important criteria in evaluating different nitrogen fertilizers includes, their effect on soil pH reaction, plant production quantitively and qualitatively.

Viets *et al.* (1954) found that application of nitrogen fertilizers increased the yield of corn. Hamissa *et al.* (1971) reported that total amounts of nitrogen utilized by corn plants were higher in the case of anhydrous ammonium than ammonium nitrate. Muirhead *et al.* (1985), Baldwin (1986) and Sutton *et al.* (1986) found that the yield of corn increased with nitrogen fertilization using different forms, only ammonium gas was more effective than urea. Rauan (1986) stated that the anhydrous ammonia injected before sowing gave higher yield and uptake than the other nitrogen treatments used. Darwish (1989) found a positive effect of N fertilization on grain yield, straw and whole plant of corn grown in alluvial sol. He add that the effect was in the order of ammonium gas > ammonium sulphate > ammonium nitrate > urea. El-Sayad *et al.* (1998) studied the effect of nitrogen forms (ammonium gas, ammonium sulphate, thiourea, urea and ammonium nitrate) on growth, grain yield of corn and they point out that the application of ammonium gas fertilizer gave the highest grain yield. Whereas the lowest values were obtained with the application of ammonium nitrate fertilizer. Siam et al. (2008) revealed that ammonium gas gave the highest yield and yield component for maize crop as compared with urea and ammonium sulphate.

Concerning effect of nitrogen fertilizer on crop - water relations, Ainer (1983), Sadik *et al.* (1995) and Elvio and Michele(2008) found that increasing nitrogen fertilization rate from 80kg N/ fed. too 100, 120 or 140 kg N / fed. gradually increased water consumptive use for maize crop..

Regarding, the effect of irrigation on yield and its component, Latif *et al.* (2000),with sorghum, indicated that increasing irrigation interval from 7 to 21 days significantly decreased length, width, weight of panicle, grain weight panicle^{-1}, 1000-grain weight and grain yield fed^{-1}. Mourad *et al.* (2000) pointed out that decreased number of irrigations from 5 to 2 significantly decreased grain sorghum vegetative growth attributes. Rayan and abdel-Mawly (2001) in Upper Egypt, found that decreasing irrigation interval increased sorghum grain yield and all yield components. In addition, seasonal ET_C amounted to 60.3 cm. due to irrigation at 1.0 C.P.E. and the highest WUE was recorded with irrigation at 1.0 C.P.E. Abdou (2004) stated that decreasing irrigation

interval due to irrigation at 1.2 C.P.E. significantly increased plant height, number of green leaves/ plant, comparable with irrigation at 0.6 C.P.E. In addition, yield component, grain yield/fed. , seasonal ET_C and WUE(kg grains/m^3 water consumed) were increased. The maximum daily ET_C rate occurred during August, i.e. 4.86 and 6.92 for irrigation at 0.6 and 1.2 C.P.E., respectively. The K_C values were 0.50, 0.76, 0.99, 0.68 and 0.63 for June, July, August, September and October, respectively. Ashry *et al.* (2008) concluded that the crop coefficient (K_C) for high yielding treatment (planting on ridges 60 cm width and irrigation at 1.4 C.P.E. from June to October were 0.49, 0.73, 1.035, 0.8 and 0.61, respectively, and seasonal ET_C for the same treatment amounted to 61.53 cm (as average of two seasons). The present trial aiming to find out the most proper coefficient, for pan evaporation records, to schedule the irrigation for grain sorghum crop, under different N-fertilizers forms, in order to accomplish both the yield potential and efficient water use at Fayoum Governorate conditions.

MATERIALS AND METHODS

Two field experiments were conducted at the farm of Tamia Agric. Res. Station, Fayoum Governorate during the summer seasons of 2008 and 2009 to study the effect of nitrogen fertilizer forms and irrigation scheduling treatments on grain sorghum crop and crop- water relations. To achieve these targets three N- fertilizer forms, i.e. F_1: soil- injected liquid ammonium gas (82% N), F_2: Urea (46.5%N) and $F_{3:}$ Ammonium nitrate(33.5%N), each at 90 kgNfed^{-1} rate, in combination with three irrigation scheduling coefficients, i.e. I_1: irrigation at 0.8 cumulative pan evaporation C.P.E., $I_{2:}$ irrigation at 1.0 C.P.E., and I_3: irrigation at 1.2 C.P.E. in the split-plot design with four replications. The effect of different experimental treatments and interaction on grain yield, and yield component as well as crop -water relations was studied. Whole N-dose as liquid ammonia was soil – injected seven days before sowing, whereas, N-dose for both urea and Ammonium nitrate fertilizers, were applied in two equal portions just before both life irrigation and the next one. A basal dose of Calcium super phosphate (15.5% P_2O_5) at 150 Kg/fed rate was added during field preparation. Sorghum seeds (Dorado hybrid), at seeding rate of 15 Kg /fed, were sown in hills 25cm apart system. Application of irrigation scheduling was started at the 2nd irrigation. It is well to mention that, the traditional irrigation scheduling concept addresses only two variables: (a) timing of irrigation; and (b) amount of irrigation. While the amount of required irrigation can be easily ascertained from routine soil moisture monitoring, the ability to apply the required irrigation amount is far less controllable or understood in particular under the common surface irrigation methods. In connection, the weather elements responsible for the crop evaporative power are solar radiation, air temperature, wind velocity and air relative humidity are influencing pan evaporation in the same

manner. So irrigation was practiced as the two sides of the following formula are the same:-

Pan evaporation record, mm x Coefficient=Available soil water in the root zone (60cm depth),mm

In the present study, pan evaporation record was multiplying by 1.2, 1.0 or 0.8 coefficients to find out the proper one resulted in grain sorghum yield potential and improve water use efficiency as well.

Harvest was done on Sept. 27 in 2009 and 2010 seasons. Some of soil physical and chemical properties of the experimental plots were determined according to Klute (1986) and Page *et al.* (1982) and presented in Table (1). The monthly averages of weather factors for Fayoum Governorate during the two growing seasons are shown in Table (2). Some soil moisture constants of the experimental field (mean of the two seasons) are listed in Table (3). At harvesting time the following data were recorded for each sub-plot.

I. Yield and yield component.

1- Panicle length (cm) 2- Panicle width (cm) 3- panicle weight (g)
4- Grain weight/plant (g) 5- 100 grain weight (g) 6-Grain yield Kg/fed.

All the measurements and data collected were subjected to the statistical analysis according to Snedecor and Cochran (1980).

II. Crop water relations:

1. Seasonal consumptive use (ET_C)

On determining the crop water consumptive use (ET_C), soil samples were taken 48 hours after each irrigation and just before the next one as well as at harvest time. The crop water consumptive use between each two successive irrigations was calculated according to Israelsen and Hansen, 1962 as follows :

$$Cu\ (ET_C) = \{(Q_2 - Q_1) / 100\} \times Bd \times D \text{ ……………….. Where:}$$

Cu = crop water consumptive use (cm).
Q2= soil moisture % by weight, 48 hours after irrigation.
Q1= soil moisture% by weight just before the next irrigation.
Bd = soil bulk density (gcm^{-3}).
D = soil layer depth (cm).

2. Daily ET_C rate (mm/day).

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), using the monthly averages of climatic factors of Fayoum Governorate and the procedures of the FAO-Penman Monteith equation (Allen *et al.* 1998).

4. Crop Coefficient (K_C).

The crop coefficient was calculated as follows:

$$K_C = ET_C / ET_0$$

Where: ET_C = Actual crop evapotranspiration and ET_0 = Reference evapotranspiration.

5. Water use efficiency (WUE).

The water use efficiency as kg grains/ m^3 water consumed was calculated for different treatments as the method described by Vites(1965):

WUE = Grain yield (kg/fed.) / Seasonal crop water consumptive use "Cu"($m^3 fed^{-1}$.

Table (1): Some physical and chemical analyses of the experimental field (2009 and 2010 average)

Physical analysis				Chemical analysis	
Sand%	Silt%	Clay%	Texture classes	Organic matter%	$CaCo_3$%
38.00	21.2	40.8	Clay loam	1.68	5.18

Chemical analysis														
Soluble cations (meq/L)				Soluble anions (meq/L)				Ec dSm^{-1}	P^H 1:2.5 Extract	CEC (meq/ 100 g soil)	Exchangeable Cations (meq/100 g soil)			
Ca^{++}	Mg^{+}	Na^{+}	K^{+}	Cl^{-}	HCO_3^{-}	CO_3^{--}	SO_4^{--}				Ca^{++}	Mg^{++}	K^{+}	Na+
8.18	7.69	24.67	0.33	20.73	3.06	–	17.08	4.00	٨.١٢	٣٢.٤٧	16.29	10.29	1.2	4.05

Table (2): Monthly weather factors for Fayoum Governorate (2009 and 2010 average).

Month	Year	Temperature C°			Relative humidity (%)	Wind speed (m/sec)	Pan evaporation (mm/day)
		Max.	Min.	Mean			
June	2009	38.2	20.4	29.3	44	2.99	8.18
	2010	38.4	21.4	29.9	48	3.01	7.60
July	2009	38.5	22.7	30.6	47	2.58	8.41
	2010	36.3	22.4	29.3	50	2.58	8.60

August	2009	37.0	21.8	29.4	48	2.42	7.62
	2010	40.2	24.5	32.3	46	2.44	7.00
September	2009	35.2	20.7	27.9	50	2.58	6.69
	2010	36.2	21.9	29.1	50	2.60	6.10

Table (3): Some soil moisture constants and bulk density for the experimental field (average of 2009 and 2010 seasons).

Soil depth (cm)	Field capacity (%, wt)	Wilting point (%, wt)	Bulk density (g/cm^3)	Available moisture mm (depth)
٠0-15	42.56	21.16	1.41	44.8
15-30	40.76	19.84	1.43	٤٢.٦
30-45	38.32	18.65	1.31	٣٥.٥
45-60	33.59	17.34	1.39	٣٦.٢

RESULTS AND DISCUSSION

I-Yield and yield components

The analysis of variance proved that sorghum grain yield and its components were significantly affected due to N fertilizer forms and scheduling irrigation treatments as well as their interaction in 2009 and 2010 seasons.

Results in Tables (4 and 5) show that grain yield and its components were decreased significantly with either urea or ammonium nitrate as compared with liquid ammonia gas and these results were true in 2009 and 2010 seasons. The maximum panicle length(21.26 cm), panicle width(3.72 cm), panicle weight (62.90 g), grain weight/panicle(41.05 g), 100- grain weight(4.49 g) and sorghum grain yield (1760.40 kg/fed), were obtained under liquid ammonia gas 2009 season. The corresponding values in 2010 season were22.02 cm, 4.93 cm, 67.58 g, 44.56 g, 4.53 g and 1950.00 kg/fed, in the same order, respectively. It is clear that under urea and ammonium nitrate fertilizers, sorghum yield was decreased by 9.85 and 5.27%, in 2009 season and by 23.05 and 10.72% in 2010 season, respectively, comparable with liquid ammonia gas fertilizer. The superiority of liquid ammonia gas may be due to the induced reduction in soil pH, which increased nutrients availability and improved the efficiency of nutrients uptake. These results are in the line with those reported by Viets *et al.* (1954), Hamissa *et al.* (1971), Muirhead *et al.* (1985), Baldwin (1986), Sutton *et al.* (1986), Rauan (1986), Darwish (1989), El-Sayad *et al.* (1998) and Siam *et al.* (2008).

Regarding the effect of irrigation scheduling treatments, data in Tables (4 and 5) indicate that irrigation at 1.2 C.P.E., grain yield and its components

were increased significantly more than 1.0 and 0.8 C.P.E. irrigation treatments. In 2009 season, irrigating grain sorghum at 0.8 C.P.E. reduced panicle length, width and weight, grain weight/panicle, 100-grain weight and grain yield by 23.01, 22.14, 34.24, 37.05, 26.70 and 19.88%, respectively, as compared with irrigating at 1.2 C.P.E.. The corresponding values in 2010 season were 21.8, 17.70, 35.92, 38.25, 26.47 and 15.62%,in the same order, respectively. These results may referred to the effect of water deficit, resulted from the wide irrigation cycle under 0.8 C.P.E. irrigation treatment, which in turn reduced plant growth and yield component and consequently grain yield. Such results are in full agreement with those found by Latif *et al.* (2000), Mourad *et al.* (2000), Rayan and abdel-Mawly (2001) and Abdou (2004).

The interaction of N fertilizer forms and irrigation scheduling treatments on sorghum grain and its components was significant in 2009 and 2010 seasons (Tables 4 and 5). It was found that liquid ammonia gas form as interacted with irrigation at 1.2 C.P.E. resulted in the highest values of grain yield and its components, whereas, the interaction of Ammonium nitrate form and irrigation at 0.8 C.P.E. gave lowest values in 2009 and 2010 seasons.

Table (4): Effect of N fertilizer form, irrigation scheduling coefficient and interaction on grain sorghum yield and yield components in 2009 season.

N-fertilizer form	Irrigation Scheduling coefficient	Panicle Length (cm)	Panicle Width (cm)	Panicle Weight (g)	Grain Weight/ Panicle (g)	100-grain Weight (g)	Grain Yield (kg /fed)
Liquid ammonia	I_1 : 0.8	18.05	3.28	50.40	30.10	3.85	1506.20
	I_2: 1.0	20.83	3.68	63.18	41.00	4.01	1785.30
	I_3: 1.2	24.91	4.20	75.12	52.06	5.60	1989.71
	Mean	21.26	3.72	62.90	41.05	4.49	1760.40
Urea	I_1 : 0.8	16.47	2.90	45.79	28.38	3.75	1461.37
	I_2: 1.0	18.01	3.24	58.36	37.92	3.94	1511.90
	I_3: 1.2	21.16	3.83	68.47	43.40	4.88	1787.66
	Mean	18.55	3.32	57.54	36.57	4.19	1586.98
Ammonium nitrate	I_1 : 0.8	16.17	2.79	38.97	26.91	3.53	1236.45
	I_2: 1.0	17.80	3.08	52.04	34.64	3.84	1357.81
	I_3: 1.2	19.78	3.50	61.93	40.16	4.69	1469.74
	Mean	17.92	3.12	50.98	33.90	4.02	1354.67
Irrigation mean							
I_1 : 0.8		16.90	2.99	45.05	28.46	3.71	1401.34
I_2: 1.0		18.88	3.33	57.86	37.85	3.93	1551.67

I_3: 1.2	21.95	3.84	68.51	45.21	5.06	1749.04
LSD at 5%						
Fertilizer forms (F)	0.09	0.08	0.43	0.32	0.04	42.87
Irrigation scheduling (I)	0.07	0.05	0.26	0.15	0.18	19.76
F x I interaction	0.11	0.08	0.44	0.26	0.06	34.23

Table (5): Effect of N fertilizer form, irrigation scheduling coefficient and interaction on grain sorghum yield and yield components in 2010 season.

N-fertilizer form	Irrigation scheduling coefficient	Panicle Length (cm)	Panicle Width (cm)	Panicle Weight (g)	Grain Weight/ Panicle (g)	100-grain Weight (g)	Grain Yield (kg /fed)
Liquid ammonia	I_1 : 0.8	19.19	4.45	52.81	33.01	3.87	1750.20
	I_2: 1.0	21.67	4.86	66.24	43.27	4.10	1976.55
	I_3: 1.2	25.20	5.49	83.70	57.41	5.61	2141.25
	Mean	22.02	4.93	67.58	44.56	4.53	1950.00
Urea	I_1 : 0.8	17.01	3.62	48.27	30.75	3.79	1624.10
	I_2: 1.0	18.96	3.95	61.09	40.81	3.99	1847.89
	I_3: 1.2	22.43	4.12	71.78	49.26	4.95	2070.00
	Mean	19.47	3.90	60.38	40.27	4.24	1847.33
Ammonium nitrate	I_1 : 0.8	16.85	3.10	41.46	29.10	3.60	1511.90
	I_2: 1.0	18.11	3.69	58.73	37.19	3.86	1751.13
	I_3: 1.2	20.23	3.94	66.94	43.70	4.75	1860.00
	Mean	18.40	3.58	55.71	36.66	4.07	1741.01
Irrigation mean							
I_1 : 0.8 C.P.E.		17.68	3.72	47.51	30.95	3.75	1707.68
I_2: 1.0 C.P.E.		19.58	4.17	62.02	40.42	3.98	1858.52
I_3: 1.2 C.P.E.		22.62	4.52	74.14	50.12	5.10	2023.75
LSD at 5%							
Fertilizer forms (F)		0.07	0.07	0.20	0.53	0.03	30.74
Irrigation scheduling (I)		0.05	0.04	0.08	0.23	0.03	36.58
F x I interaction		0.09	0.07	0.14	0.40	0.06	32.06

II- Crop water relations

1-Seasonal consumptive use (ET_C)

The data in Table (6) indicate that the values of seasonal consumptive use (ET_C) of grain sorghum crop, as a function of N fertilizer forms and irrigation scheduling treatments, were 52.67 and 54.45 cm in 2009 and 2010 seasons, respectively. Liquid ammonia gas gave the highest seasonal ET_C values i.e. 54.85 and 56.54 cm, whereas, Ammonium nitrate resulted in the lowest values e.g. 50.84 and 52.39 cm, respectively, in 2009 and 2010 seasons. Under urea fertilizer, seasonal ET_C was reduced by 4.59 and 3.75% in 2009 and 2010 seasons, comparable with Liquid ammonia gas, respectively. These results are in full agreement with those obtained by Sadik et al. (1995) and Elvio and Michele(2008).

The data in Table (6) reveal that irrigation at 1.2 C.P.E. gave the highest ET_C values which reached 54.81 and 56.62 cm, whereas, irrigation at 0.8 C.P.E. gave the lowest values e.g. 50.58 and 52.14 cm, respectively in 2009 and 2010 seasons. Increasing the irrigation coefficient from 0.8 to 1.0 or 1.2 C.P.E. increased seasonal ET_C by 3.90 and 7.72% in 2009 season and by 3.37 and 8.93% in 2010 season, respectively. These results may be due to the high transpiration rate from plants and high evaporative demands from soil surface under higher available soil moisture, whereas, under soil water deficit, the transpiration rate tended to decrease due to poor vegetative growth besides lower evaporation from the dry soil surface. These results are in accordance with those reported by Rayan and abdel-Mawly (2001) and Abdou (2004).

The results in Table (6) show clearly that under liquid ammonia gas and irrigation at 1.2 C.P.E., the highest seasonal ET_C values were recorded i.e. 57.20 and 60.15 cm, whereas, under Ammonium nitrate and irrigation at 0.8 C.P.E. the lowest values were obtained and amounted to 48.61 and 50.11 cm in 2009 and 2010 seasons, respectively.

Table (6): Effect of N- fertilizer form, irrigation scheduling coefficient and their interaction on seasonal consumptive use of grain sorghum crop (ET_C, cm) in 2009 and 2010 seasons

N fertilizer forms	2009 season			Mean	2010 season			Mean
	Irrigation scheduling coefficient				Irrigation scheduling coefficient			
	0.8	1.0	1.2		0.8	1.0	1.2	
Liquid ammonia gas	52.76	54.60	57.20	54.85	54.09	55.37	60.15	56.54

Urea	**50.38**	**52.25**	**54.36**	**52.33**	**52.21**	**54.13**	**56.91**	**54.42**
Ammonium nitrate	**48.61**	**51.03**	**52.87**	**50.84**	**50.11**	**52.37**	**54.70**	**52.39**
Mean	**50.58**	**52.63**	**54.81**	**52.67**	**52.14**	**53.96**	**57.25**	**54.45**

2- Daily ET_C rate (mm/day)

The data in Table (7) indicate, generally, that the daily ET_C rate, as a mean of the adopted treatments under study started with low values during June comprised 3.34 and 3.35 mm/day in 2009 and 2010 seasons, respectively. Thereafter, the daily ET_C rate increased during July (5.5 and 5.20 mm/day) and reached its maximum values during August (6.22 and 6.89 mm/day) and decline again at harvesting in September (2.37 and 2.67 mm/day) in 2009 and 2010 seasons. Such findings may be attributed to that during June most of water losses was due to evaporation from the bare soil (germination and seedling stages). Thereafter, as the crop cover increased the daily ET_C increased because transpiration took place besides soil surface evaporation and reached the peak rate at flowering and grain filling stages. The ET_C rate re-decreased during September as a result of lower leaves drying and low transpiration rate.

Table (7): Effect of N fertilizer form, irrigation scheduling coefficient and their interaction on daily water consumption use (mm/day) in 2009 and 2010 seasons.

season		2009				2010			
N -fertilizer forms	Irrigation scheduling coefficient	June	July	August	Sep.	June	July	August	Sep.
Liquid ammonia gas	0.8	3.32	5.45	6.28	2.39	3.38	5.23	6.85	2.41
	1.0	3.33	5.77	6.45	2.50	3.39	5.45	6.94	2.58
	1.2	3.39	5.82	6.96	2.74	3.40	5.59	7.49	2.78
	Mean	3.35	5.68	6.56	2.54	3.39	5.42	7.09	2.57
Urea	0.8	3.30	5.17	5.91	2.27	3.31	5.03	6.58	2.33
	1.0	3.32	5.53	6.10	2.31	3.33	5.22	6.86	2.48
	1.2	3.37	5.72	6.65	2.44	3.37	5.36	7.41	2.70
	Mean	3.33	5.47	6.22	2.34	3.34	5.20	6.95	2.50
Ammoniu m Nitrate	0.8	3.30	4.96	5.62	2.18	3.30	4.68	6.33	2.25
	1.0	3.30	5.45	5.88	2.22	3.31	5.06	6.55	2.38
	1.2	3.37	5.66	6.12	2.31	3.34	5.16	7.04	2.53

(F_3)	Mean	3.32	5.36	5.87	2.24	3.32	4.97	6.64	2.39
Mean of irrigation									
0.8 C.P.E.		3.31	5.19	5.94	2.28	3.33	4.98	6.59	2.33
1.0 C.P.E.		3.32	5.58	6.14	2.34	3.34	5.24	6.78	2.46
1.2 C.P.E.		3.31	5.19	5.94	2.28	3.33	4.98	6.59	2.33
Over all mean		3.34	5.50	6.22	2.37	3.35	5.20	6.89	2.67

Results in Table (7) show that liquid ammonia fertilizer form seemed to increase the daily ET_C rate, while both Urea and Ammonium nitrate ones seemed to decrease it during the entire growing season of grain sorghum crop and such finding was true in 2009 and 2010 seasons. Such findings could be attributed to higher values for growth traits, grain yield and yield components under liquid ammonia fertilizer form.

The data in Table (7) reveal that irrigating grain sorghum at 1.2 C.P.E (frequent irrigation) increased the daily ET_C rate entire the growing season, , whereas, irrigation at 0.8 C.P.E gave the lowest figures. These results may be attributed to the high available soil moisture in the root zone resulted from (short irrigation cycle under irrigation at 1.2 C.P.E.) which in turn increased the evapotranspiration rate. Similar results were obtained by Abdou (2004) with the same both of crop and environment.

3- Reference evapotranspiration (ET_0)

The daily ET_0 rate during grain sorghum growing season in 2009 and 2010 seasons are presented in Table (8). The daily ET_0 values (mm/day) were calculated using the FAO-Penman-Monteith equation and meteorological data of Fayoum Governorate (Table, 2). From June to September in both growing seasons. The obtained results in Table (8) indicate that the daily ET_0 rates started with high values during June and slowly decreased during July with continuous decrease during August and September, in both seasons. These results are attributed to the changes in weather factors from month to the other. In this connection, Allen *et al.* (1998), reported that the values of ET_0 are depending mainly on the evaporative power of the air such as temperature, humidity and wind speed.

4- Crop coefficient (K_C)

The K_C values during grain sorghum growing season from planting (June) till harvesting (September) in 2009 and 2010 are recorded in Table (8). The results reveal that the K_C values, as a function of the adopted different treatments and interaction (over all mean) were low during June (initial growth stage). Then increased during July (vegetative growth stage) and reached its maximum values during August (flowering-head formation stage). Thereafter, the K_C values redecreased again during September (grain-filling-

maturity and harvesting stages). These results were true in 2009 and 2010 seasons. Such finding may be due to the large diffusive resistance of bare soil at the initial growth stage, which decreased by the increase in crop cover percentage until maximum growth (flowering and grain formation). However, at maturity (late season) transpiration rates decreased as most plant leaves dried.

Table (8): Reference evapotranspiration, ET_0 (mm/day) and effect of N fertilizer form and irrigation scheduling coefficient and their interaction on K_C for grain sorghum crop in2009 and 2010 seasons

Season		2009				2010			
N- fertilizer forms	Irrigation scheduling coefficient	June	July	August	Sept.	June	July	August	Sept.
Reference ET_0 mm/day		8.5	7.90	7.20	6.40	8.30	7.80	7.40	6.50
Liquid ammonia gas(F_1)	0.8	0.39	0.69	0.87	0.37	0.41	0.67	0.93	0.37
	1.0	0.39	0.73	0.90	0.39	0.41	0.70	0.94	0.39
	1.2	0.40	0.74	0.97	0.43	0.41	0.72	1.09	0.43
	Mean	0.39	0.72	0.91	0.40	0.41	0.70	0.99	0.40
Urea(F_2)	0.8	0.39	0.65	0.82	0.35	0.40	0.64	0.89	0.36
	1.0	0.39	0.70	0.85	0.36	0.40	0.67	0.93	0.38
	1.2	0.40	0.72	0.89	0.38	0.41	0.69	1.00	0.42
	Mean	0.39	0.69	0.85	0.36	0.40	0.67	0.94	0.39
Ammonium nitrate(F_3)	0.8	0.39	0.63	0.78	0.34	0.40	0.60	0.86	0.35
	1.0	0.39	0.69	0.82	0.35	0.40	0.65	0.89	0.37
	1.2	0.40	0.72	0.85	0.36	0.40	0.66	0.95	0.39
	Mean	0.39	0.68	0.82	0.35	0.40	0.64	0.90	0.37
Mean of irrigation									
0.8		0.39	0.66	0.82	0.35	0.40	0.64	0.89	0.36
1.0		0.39	0.71	0.86	0.37	0.40	0.67	0.92	0.38
1.2		0.40	0.73	0.90	0.39	0.41	0.69	1.01	0.41
Over all mean		0.39	0.70	0.86	0.37	0.40	0.67	0.94	0.39

5- Water use efficiency (WUE).

The results in Table (9) show clearly that the mean values of WUE, as a function of different tested treatments and interaction were 0.706 and 0.802kg grains/m^3 water consumed in 2009 and 2010 seasons, respectively. Liquid ammonia gas form exhibited the highest WUE values in2009 and 2010 seasons e.g. 0.762 and 0.823 kg grains/m^3 water consumed, respectively, whereas, either Urea or Ammonium nitrate fertilizer forms tended to decrease the figure by 5.38 and 16.80 % in 2009 season and by 1.94 and 5.83% in 2010 season, respectively,. The obtained results are in harmony with those reported by Sadik *et al.* (1995) and Elvio and Michele(2008).

Data in Table (9) show that irrigation at 1.2 C.P.E. gave the highest WUE values i.e. 0.758 and 0.841 kg grains/m^3 water consumed in 2009 and 2010 seasons, respectively. On the other hand, the lowest values, i.e. 0.659 and 0.743 kg grains/m^3 water consumed, respectively, resulted from irrigation at 0.8 C.P.E. (wide irrigation cycle) in2009 and 2010 seasons. It is obvious that increasing irrigation coefficient from 0.8 to 1.2 C.P.E. increased WUE for grain sorghum crop. Theses results are in the same line of those found by Rayan and abdel-Mawly (2001), Abdou (2004) and Ashry *et al.* (2008).

Table (9): Effect of N- fertilizer form, irrigation scheduling coefficient and their interaction on Water Use Efficiency of grain sorghum in 2009 and 2010 seasons

Treatments	2009				2010			
N fertilizer forms	Irrigation scheduling coefficient				Irrigation scheduling coefficient			
	0.8	1.0	1.2	Mean	0.8	1.0	1.2	Mean
Liquid ammonia gas	0.680	0.779	0.828	0.762	0.770	0.850	0.848	0.823
Urea	0.691	0.689	0.783	0.721	0.741	0.813	0.866	0.807
Ammonium nitrate	0.606	0.634	0.662	0.634	0.718	0.796	0.810	0.775
Mean	0.659	0.701	0.758	0.706	0.743	0.820	0.841	0.802

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جدولة ري الذرة الرفيعه تحت صور مختلفة من التسميد النيتروجيني

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الملخص العربي

اقيمت هذه الدراسه بمحطة مركز البحوث الزراعية بالفيوم (طاميه) خلال موسمي الزراعة ٢٠٠٩/٢٠١٠ لدراسة تأثير الصور المختلفة من التسميد النتيتروجيني (الحقن بالامونيا الغازيه – اليوريا – نترات الامونيوم) بمعدل ٩٠ وحدة ن /فدان وجدوله ري الذرة الرفيعه (صنف هجين دورادو) بالمعامل (٠,٨ – ١,٠ – ١,٢) لقيم البخر التراكمي لوعاء البخر القياسي علي المحصول ومكوناته وبعض العلاقات المائيه وذلك في تصميم القطع المنشقة مرة واحدة في اربعة مكررات . واوضحت الدراسه تفوق المعامله (الحقن بالامونيا الغازيه والري عند ١,٢من بخر الوعاء التراكمي) في زيادة محصول الذرة الرفيعة ومكوناته (طول وعرض ووزن القنديل – وزن حبوب القنديل – وزن ال ١٠٠ حبة) مقارنة بباقي المعاملات . كانت اعلي قيم لمتوسط الاستهلاك المائي الموسمي (٥٧,٢٠ ، ٦٠,١٥سم) ناتجة من معامله الحقن بالامونيا الغازيه والري عند ١,٢ من بخر الوعاء التراكمي.في موسمي ٢٠٠٩ ، ٢٠١٠ علي التوالي. وقد كان معدل الاستهلاك المائي اليومي منخفضا خلال شهر يونيو وازداد حتي وصل الي اقصي استهلاك مائي في شهر اغسطس وعاود الانخفاض في شهر سبتمبر مرة اخري وذلك في الموسمين المتعاقبين . وكانت قيم معامل المحصول للمعاملة التي أعطت أعلي محصول ومكوناته (الحقن بالامونيا والري عندي ١,٢ من بخر الوعاء التراكمي) من يونيو وحتي سبتمبر هي ٠,٤٠ ، ٠,٦٩ ، ٠,٩٠ ، ٠,٣٨ علي التوالي (كمتوسط للموسمين المتعاقبين) وقد اعطت ايضا هذه

المعاملـه اعلـي متوسـط لكفـاءة اسـتخدام الميـاه فـي الموسـمين المتعـاقبين وكانـت ٠,٨٢٨ ، ٠,٨٤٨ كجم محصول /م^{٣} ماء .