IMPROVING WHEAT PRODUCTION IN NEW SOILS UNDER AMMONIA FERTILIZER RATES AND WATER MANAGEMENT

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ABESTRACT

Field experiment was carried out at Demo farm of Faculty of Agriculture, Fayoum University, Egypt during 2012/2013 and 2013/2014 seasons to study the effect of ammonia gas rates, i.e., F_1: 80 and F_2: 100 kg N fed^{-1} (1 kg ammonia gas contain 82.4 % N) and irrigation regime i.e., I_1: irrigation at 40%, I_2: 60% and I_3: 80% from available soil moisture depletion (ASMD), at sandy and calcareous soils, on yield, yield components and some water relations of wheat crop (Giza 168). A split plot design with four replications was used in both seasons. The obtained results showed that using 100 kg N fed^{-1} at 40% ASMD gave the highest averages of plant height, spike number m^{-2}, 1000-garin weight, spike weight m^{-2}, straw yield fed^{-1} (2011.4 and 2334.1 kg fed^{-1}) in sandy soils (Site 1), and (2539.5 and 2716.7 kg N fed^{-1}) in calcareous soils (Site 2), and grain yield fed^{-1} (1888.4 and 2077.4 kg fed^{-1}) in Site 1 and (2209.4 and 2468 kg fed^{-1}) in Site 2, in the two successive seasons, respectively. The lowest averages of yield and its components were obtained from applying 80 kg N fed^{-1}and irrigation at 80 % ASMD, at the two sites in both seasons. Seasonal consumptive use (ET_C) averages were 44.47 and 43.95 cm in 1st season and 45.53 and 45.17 cm in 2nd season, in both sites, respectively. The highest ET_C values were recorded with the interaction (F_2I_1), whereas, the lowest values resulted from the interaction (F_1I_3) in all sites and seasons. Daily ET_C rates were low during November and December, then increased during January and February, to reach its maximum values during March and then declined again at April till harvesting. The values of daily ET_C decreased due to decreasing ammonia gas rate in the two growing season's months. The crop coefficient (K_C) values (averages of the two seasons) were 0.47, 0.54, 0.66, 0.70, 0.87, 0.67 and 0.47 in the Site 1 and 0.47, 0.55, 0.63, 0.67, 0.86, 0.67 and 0.49 in the Site 2, for, Nov., Dec., Jan., Feb., Mar., Apr. and May, respectively. The highest water use efficiency, i.e., 0.96 and 1.04 kg grains m^{-3} water consumed at the Site 1, and 1.14 and 1.24 kg grains m^{-3} water consumed at the Site 2, were obtained from (F_2I_1) treatments in first and second seasons, respectively.

Key wards: wheat yield, yield components, ammonia gas rates, irrigation regime, sandy soils, calcareous soil.

INTRODUCTION

Wheat is one of the most important cereal crops in the world. In Egypt, its production does not meet the current demand so, the Egyptian government is doing great efforts to reduce the gap between production and consumption.

Wheat production is affected by different factors such as climatic conditions, irrigation and soil fertility. The new reclaimed areas are in continuous increase and irrigation water is being the limiting factor. The interaction between fertilization and irrigation is considered one of the most important factors affecting wheat production. Adding of N fertilizers tended to produce high grain and straw yield. **Barak (1981)** stated that above ground parts, roots, dry matter and nitrogen content were increased with application of nitrogen at enhanced rate. **Lakhy (1988)** reported that nitrogen application in wheat increased the number of productive ears, grain yield and grain protein content. **Ahamad and Abolfazl (2013)** reported that increases of N fertilizer level led to increase of yield and yield components of wheat.

Concerning effect of nitrogen fertilizer on water relations, **Shaaban (2006)** tested different levels of two organic fertilizer sources (chicken manure and sunflower residue) and inorganic nitrogen and revealed that the maximum values of water use efficiency (WUE) for grains and straw yields of wheat plants was observed by increasing doses of inorganic N fertilizer and decreased by decreasing of the N fertilizer.

Regarding the irrigation scheduling effect **Doorenbos *et al.* (1979)** indicated that available soil moisture depletion (ASMD) less than 50% had a little effect on water uptake by wheat plants, whereas moderate stresses occurred at 70 ASMD and sever stress when ASMD exceeded 80%. Water requirements for high yield ranged between 45 and 65 cm, and the crop coefficient (K_C) values were 0.3-0.4, 0.7-0.8, 1.05-1.2, 0.65-0.70 and 0.2-0.25 for initial, development, mid-season, late season and harvest stages, respectively. **Meyer and Green (1980)** showed that expansive growth of wheat was reduced when soil moisture was below 33% ASMD. **Yousef and Eid (1994)** at Fayoum reported that the highest values of yield and yield components were obtained from irrigation at 30% ASMD. Increasing ASMD from 50 % to 70 % significantly decreased yield components, grain yield and straw yield. The ET_C was increased as the ASMD decreased and the highest WUE resulted from irrigation at 30% ASMD. **Yousef and Hanna (1998)** found that spike number m^{-2}, 1000-grain weight, grain and straw yields fed^{-1} were significantly decreased by increasing ASMD from 35 % to 70 %. They added that seasonal ET_C was 42.77 and 37.83 cm for irrigation at 35 and 70 ASMD, respectively. However, the Kc values were 0.4, 0.68, 0.79, 1.02, 1.00, 0.61 and 0.39 during Nov., Dec., Jan., Feb., Mar., Apr. and May months, respectively. The highest WUE was resulted from irrigation at 35 % ASMD. **Yousef and Eid (1999)** revealed that irrigation at 35% ASMD gave the highest values of spike number m^{-2}, 1000-grain weight, grain and spike yields fed^{-1}, seasonal ET_C (43.7 cm) and WUE (1.065 kg grains m^{-3} water consumed), whereas, irrigation at 80 % gave the lowest mentioned measurements. **Hussain *et al.* (2003)** indicated that irrigation wheat at 4 weeks after emergence gave the highest number of spikes m^2 (238), however, irrigation at 2 weeks after emergence gave the highest grain yield (4103 kg ha^{-1}) and biological yield (10207 kg ha^{-1}). **Yousef and Ashry (2006)** found that the highest yield and yield components were resulted from irrigation at 35% ASMD and increasing ASMD to 55 or 75 % caused significant reduction in yield components, grain and straw yields. Seasonal ET_C values were: 43.13, 40.12 and 39.05 cm for irrigation at 35, 55 and 75 % ASMD, respectively. The peak of water consumption occurred during March and April and the K_C values were; 0.53, 0.74, 0.87, 0.91, 0.99, 0.60 and 0.41 for Nov., Dec., Jan., Feb., Mar., Apr. and May months, respectively.

MATERIALS AND METHODS

The present investigation was conducted during 2012/13 and 2013/14 seasons at Demo farm, Faculty of Agriculture, Fayoum University, Egypt. The soil physical and chemical properties of the experimental sites (Site 1: sandy soils and Site 2: calcareous soils) was determined according to **Klute (1986)** and **Page *et al.* (1982)** and presented in Tables (1 and 2). The trails aimed to study the effect of two ammonia gas fertilization rates and irrigation regimes treatments and their interaction on yield, yield components and some crop water relations. To achieve this target, two ammonia gas rates, i.e., F_1: 80 kg N fed^{-1} and F_2: 100 kg N fed^{-1} (1 kg ammonia gas contain 82.4 % N), were combined with three irrigation regime treatments, i.e., I_1: 40 %, I_2: 60 % and I_3: 80 % available soil moisture depletion (ASMD) were arranged in a split-plot design with four replications. The main plots were allocated for N fertilization rates while the split ones were occupied by the irrigation regime treatments. The sub-plots area was 42 m^2 (6 x 7 m), each plot was isolated from the others by allays 1.5 m between to avoid the lateral movement of water. The averages of climatic factors for Fayoum Governorate during the wheat crop growing seasons are recorded in Table (3). Dates of irrigation and irrigation count for different treatments tested in both seasons are listed in Table (4). Calcium super phosphate (15.5% P_2O_5) at the rate of 150 kg fed^{-1} and 20 m^3 fed^{-1} organic matter (compost) to increase the humus in upper 30 cm of soil layers were added during the field preparation. Irrigation regime treatments started from 2nd irrigation. Wheat grains of Giza 168 variety at the rate of 70 kg fed^{-1} were planted on November 15th in both seasons, whereas harvesting was done on May 3rd and 4th in the two successive seasons in the two sites, respectively. The soil moisture constants were gravimetrically determined on oven dry basis, as the technique of Water Requirements and Field Irrigation Dept., ARC, Egypt for soil layers, each of 15.0 cm from soil surface and down to 60.0 cm depth and recorded in Table (1). At harvesting time the following data were recorded for each sub-plot.

I. Yield and yield components:

Plant height (cm), spike number m^{-2}, 1000-grain weight (g), spike weight (g m^{-2}), straw yield (kg fed^{-1}) and grain yield (kg fed^{-1}).

All the collected data were subjected to the statistical analysis according to the procedures outlined by **Snedecor and Cochran (1980)** and the means were compared by L.S.D. test at 5% level.

II. Crop water relations:

1- Seasonal consumptive use (ET_C).

For determining the crop water consumptive use (ET_C), soil samples were taken from each sub-plot, just before and after 48 hours from each irrigation, as well as at harvesting time and the ET_C between each two successive irrigations was calculated according to the following equation **(Israelsen and Hansen, 1962).**

$$Cu\ (ET_C) = \{(Q_2 - Q_1) / 100\} \times Bd \times D$$

Where: Cu = crop water consumptive use (cm), Q_2= soil moisture percentage 48 hours after irrigation, Q_1= soil moisture just before irrigation, Bd = soil bulk density (gm cm^{-3}) and 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 a monthly rate (mm day^{-1}), 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). Calculated by the equation:

$$K_C = ET_C / ET_0$$

Where: ET_C = Actual crop evapotranspiration (mm/day) and ET_0 = Reference evapotranspiration (mm/day).

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):**

$$WUE = \text{Grain yield (kg fed}^{-1}) \div \text{Seasonal } ET_C\ (m^3\ fed^{-1}).$$

Table (1): Some initial physical properties of the soil sites (1 and 2) samples (as averages).

Soil types	Depth (cm)	Particle size distribution				Bulk Density g/cm³	Particle Density g/cm³	Soil moisture content at		
		Sand %	Silt %	Clay %	Texture classes			Field Capacity%	Wilting Point %	Available Water%
site (1) sandy	0-15	71.98	15.55	12.47	S.L**	1.53	2.65	20.74	11.03	9.71
	15-30	73.7	13.90	1100	S.L	1.56	2.65	19.29	10.29	9.00
	30-45	67.85	12.62	10.52	S.L	1.58	2.66	16.83	9.97	6.86
	45-60	75.88	12.99	11.13	S.L	1.60	2.66	15.65	9.19	6.46
	Mean	**74.90**	**13.72**	**11.37**	**S.L**	**1.57**	**2.66**	**18.13**	**10.12**	**8.01**
site (2) calcareous	0-15	76.91	13.22	9.87	S.L	1.53	2.65	22.31	11.63	11.68
	15-30	76.52	13.37	9.61	S.L	1.54	2.65	22.17	11.07	11.12
	30-45	77.25	13.44	9.31	S.L	1.55	2.66	22.08	11.55	10.53
	45-60	74.30	15.31	10.39	S.L	1.56	2.64	22.46	12.09	10.37
	Mean	**76.15**	**13.99**	**9.86**	**S.L**	**1.55**	**2.65**	**22.28**	**11.42**	**10.86**

** Sandy Loam = S.L

Table (2): Some initial chemical properties of the soil sites (1 and 2) samples (as averages)

	Sandy soil					Calcareous soil				
Depth (cm)	**0-15**	**15-30**	**30-45**	**45-60**	**Mean**	**0-15**	**15-30**	**30-45**	**45-60**	**Mean**
pH	7.71	7.69	7.67	7.63	**7.67**	8.20	8.15	8.10	8.17	**8.16**
ECe	3.73	3.65	3.60	3.31	**3.55**	4.15	4.07	3.98	3.81	**4.00**
Soluble cations (meq/l)										
Ca++	12.67	12.78	12.92	10.94	**12.18**	13.24	12.35	12.47	11.71	**12.44**
Mg++	9.15	8.93	8.82	8.73	**8.90**	7.27	6.35	6.52	6.91	**6.76**
Na^+	15.11	14.73	14.19	13.71	**14.34**	20.63	20.44	20.23	20.66	**20.49**
K^+	1.20	1.18	1.17	1.01	**1.12**	1.35	1.33	1.31	1.16	**1.29**
Soluble anions (meq/l)										
Cl^-	23.00	22.91	22.73	20.45	**22.06**	25.02	24.36	24.72	23.24	**24.33**
Hco_3^-	3.79	3.51	3.12	2.94	**3.28**	2.49	4.32	4.38	3.57	**3.69**
Co_3^{--}	-	-	-	-	-	-	-	-	-	-
So_4^{--}	11.34	11.29	11.25	11.00	**11.20**	12.98	12.66	12.43	12.63	**12.68**
CEC(meq/100 g soil	11.17	11.51	11.72	11.88	**11.59**	11.00	10.91	10.72	10.54	**10.79**
Exchangeable cations (meq/ 100 g soil)										
Ca^{++}	5.81	6.01	6.25	6.22	**6.09**	5.44	5.22	5.13	4.98	**5.19**
Mg^{++}	3.71	3.56	3.48	3.59	**3.59**	4.41	4.21	4.07	3.85	**4.14**
Na^+	1.28	1.37	1.53	1.54	**1.45**	1.22	1.18	1.11	1.32	**1.21**
K^+	0.49	0.57	0.57	0.62	**0.56**	0.53	0.51	0.50	0.54	**0.52**
CaCo3 (%)	6.00	5.70	5.50	5.50	**5.67**	12.27	13.69	14.18	15.65	**13.95**
Organic Matter %	0.75	0.66	0.67	0.64	**0.69**	0.71	0.68	0.65	0.63	**0.67**

Table (3):The monthly averages of climatic factors for Fayoum Governorate during 2012/13 and 2013/14 growing seasons.

Month	**Year**	**Temperature C°**			**Relative Humidity%**	**Wind speed m sec^{-1}**	**Class A pan evaporation mm day^{-1}**
		Max	**Min**	**Mean**			
Nov.	2012	27.9	16.4	22.1	46	1.49	2.3
	2013	29.1	17.4	23.3	40	1.48	2.5
Dec.	2012	21.8	11.0	16.4	49	1.03	1.7
	2013	23.7	11.6	17.8	45	1.05	1.6
Jan.	2013	23.0	10.3	16.7	52	1.20	2.1
	2014	23.6	9.6	16.7	43	1.18	1.6
Feb.	2013	24.3	10.4	17.4	49	1.65	2.8
	2014	25.8	11.1	17.6	45	1.65	2.4
Mar.	2013	29.0	12.6	20.8	45	2.11	4.5
	2014	30.3	12.9	21.6	46	2.13	4.6
Apr.	2013	32.2	15.0	23.6	46	2.42	6.1
	2014	30.4	15.4	23.1	33	2.43	4.4
May	2013	38.5	20.8	29.7	42	2.78	7.8
	2014	37.4	21.4	29.4	41	2.77	6.4

Table (4): Dates of irrigation, irrigation, irrigation intervals for different irrigation regime treatment in 2012/3013 and 2013/2014 seasons.

Seasons	2012/2013			2013/2014		
Number of irrigation	Irrigation regimes (ASMD)			Irrigation regimes (ASMD)		
	(I_1) 40%	(I_2) 60%	(1_3) 80%	(I_1) 40%	(I_2) 60%	(1_3) 80%
	Date	Date	Date	Date	Date	Date
Planting	15/11	15/11	15/11	15/11	15/11	15/11
1st irrigation.	9/12	9/12	9/12	8/12	8/12	8/12
2nd irrigation.	29/12	3/1	8/1	29/12	2/1	8/1
3rd irrigation.	17/1	28/1	7/2	16/1	28/1	6/2
4th irrigation.	6/2	22/2	10/3	7/2	22/2	10/3
5th irrigation.	27/2	19/3	11/4	27/2	20/3	11/4
6th irrigation.	19/3	13/4	-	17/3	14/4	-
7th irrigation.	10/4	-	-	11/4	-	-
Harvesting	3/5	3/5	3/5	3/5	3/5	3/5
Irrigation count	**7**	**6**	**5**	**7**	**6**	**5**

6. Water applied:

The water quantity applied for each irrigation depletion treatment to reach the maximum water holding capacity between each two successive irrigations was added using the following weir equation **(Jensen, 1983)** as follows:

$$Q = 0.0184\ (L-0.2H)\ H^{3/2}$$

In which: Q = discharge, liters/second, L = length of crest (cm) and H = head over the weir (cm).

Table (5): The values of discharge through contracted rectangular weirs under different widths and operating heads.

Head over weir, cm	Width of weir	
	30 cm	40 cm
5.0	5.97	8.0
5.5	6.9	9.3
6.0	7.8	10.5
6.5	8.4	11.8
7.0	9.7	13.2
7.5	10.7	14.5
8.0	11.8	16.0
8.5	12.9	17.6
9.0	14.0	19.0
9.5	15.2	20.7
10.0	16.3	22.2
10.5	17.5	23.7
11.0	18.7	25.3
11.5	19.9	27.1
12.0	21.3	29.0

RESULTS AND DISCUSSION

I-Yield and yield components

1-Yield components

The results in Tables (6 and 7) show that N fertilizer rates significantly affected wheat yield components in the two sites, in both seasons. Applying 100 kg N fed^{-1} gave the highest averages of plant height, spike number m^{-2}, 1000-garin weight and spike weight m^{-2}. Decreasing ammonia gas rate from 100 to 80 kg N fed^{-1} caused significant decreases in plant height, spike number m^{-2}, 1000-garin weight and spike weight m^{-2} in 2012/13 by 0.88, 1.90, 1.69 and 1.85% and by 2.07, 4.46, 0.91 and 1.81% in 2013/14 season, respectively, in Site 1. Similarly in Site 2 increasing ammonia gas rate from 80 to 100 kg N fed^{-1} caused increases in the previous measurements by 2.12, 1.56, 8.02 and 9.40 % in 2012/13 season and by 4.85, 8.67, 2.37 and 11.52 % in 2013/14 season, respectively. These increments may be due to the role of nitrogen for stimulating amino acid building and growth hormones, which in turn acts positively cell division and enlargement. These results are in harmony with those reported by **Lakhy (1988), Shaaban (2006)** and **Ahamad and Abolfazl (2013).**

Regarding the effect of irrigation regime treatments, the data recorded in Tables (6 and 7) show that irrigation regime treatments significantly affected the wheat yield components in the two successive seasons, in both sites. In the site 1, increasing the available soil moisture depletion (ASMD) from 40 to 60 % significantly decreased plant height, spike number m^{-2}, 1000-garin weight and spike weight m^{-2} by 3.07, 17.20, 4.55 and 4.29 %, respectively , in the 1st season and by 3.45, 13.41, 9.20 and 5.25 %, respectively, in the 2nd season. By the same way in site 2, the previous measured decreased 6.59, 17.89, 6.26 and 7.37 %, respectively, in the 1st season and by 5.14, 11.48, 8.07 and 5.68 %, respectively, in the second one. These results may be referred to the effect of moisture stress on reducing photosynthesis, cell division, stem elongation, leaf area, leaf duration, tillering and dry matter accumulation in plant organs. The obtained results are in the same line with those reported by **Meyer and Green (1980), Yousef and Eid (1994), Yousef and Hanna (1998), Yousef and Eid (1999), Hussain *et al.*, (2003)**, **Yousef and Ashry (2006)** and **Abdou *et al.*, (2011).**

Data in Tables (6 and 7) indicate that the yield components in wheat were significantly affected due to interaction of ammonia gas rates and available soil moisture depletion (ASMD) treatments in the two successive seasons, in both sites. The highest averages of plant height, spike number m^{-2}, 1000-garin weight and spike weight m^{-2} were detected from applying 100 kg N fed^{-1} and irrigation at 40 % ASMD in both sites over the two seasons,. On contrast, the lowest averages of yield components resulted from applying 80 kg N fed^{-1} and irrigation at 80 % ASMD.

2-Straw yield and grain yield

The obtained results in Tables (6 and 7) reveal that the averages of straw and grain yields were significantly decreased due to decreasing of ammonia gas rate from 100 to 80 kg N fed^{-1} in the two successive seasons, in the both sites. Appling 100 kg N fed^{-1} gave the higher straw yields, i.e., 1699.9 and 1900.7 kg fed^{-1} in 2012/13 and 2013/14 seasons, respectively, in Site 1. Likewise, in Site 2, the higher straw yields, i.e., 2319.6 and 2511.0 kg fed^{-1} respectively, in both seasons. Applying 80 kg N fed^{-1} in Site 1 decreased straw and grain yields by 8.96 and 3.56 %, respectively, in 2012/13 season, and by 7.19 and 5.18 %, in 2013/14, as well as, in Site 2 by 3.32 and 3.80 % in 2012/13 and by 7.68 and 12.67 % in 2013/14 season, respectively. These results may be attributed to that the superior of high addition of N rate. These results are in harmony with those obtained by **Barak (1981)**, **Lakhy (1988), Shaaban (2006)** and **Ahamad and Abolfazl (2013).**

Concerning the effect of irrigation water regime, the results presented in Tables (6 and 7) indicate that irrigation treatments had a significant effect on wheat straw and grain yields in both seasons and in the two sites. Irrigation at 40 % ASMD gave the highest averages of straw yield in sandy soil, i.e., 1970.8 and 2251.2 kg fed^{-1}, and grain yield, i.e., 1849.7 and 2024.9 kg fed^{-1}, respectively, in 1st and 2nd seasons. Also, in Site 2, the straw yield, i.e., 2479.8 and 2618.2 kg fed^{-1} and grain yield, i.e., 2157.5 and 2334.7 kg fed^{-1}, respectively, in the two successive seasons, were detected from irrigation at 40% ASMD. Straw and grain yields were reduced in sandy soil by 10.78 and 22.65 % in 2012/13 season, respectively, and by 11.61 and 21.90 % in 2013/14 season, respectively. The same trend was found in calcareous soil, where the corresponding values were 15.66 and 18.35 %, in the first season and 17.13 and 16.74 % in the second one, respectively, as increasing available soil moisture depletion from 40 to 80 % ASMD, such finding may be revered to the effect of water stress on reducing growth attributes, i.e., plant height, spike number m^{-2}, 1000-garin weight and spike weight m$^{-2.}$. These results are in agreement with those **Meyer and Green (1980), Yousef and Eid (1994), Yousef and Hanna (1998), Yousef and Eid (1999), Hussain *et al.*, (2003)**, **Yousef and Ashry (2006)** and **Abdou *et al.*, (2011).**

Results in Tables (6 and 7) show that wheat straw and grain yields significantly affected by the interaction between ammonia gas rates and irrigation regime treatments. Applying 100 kg N fed^{-1} and irrigation at 40 % ASMD gave the highest straw yield, i.e., 20114 and 2334.1 kg fed^{-1} and grain yield, i.e., 1888.4 and 2077.4 in Site 1. The highest straw yield, i.e., 2539.5 and 2716.7 kg fed^{-1} and grain yield, i.e., 2209.4 and 2468.0 kg fed^{-1} were also obtained in site 2.

Table(6)

Table(7)

II-Crop water relation

1-seasonal consumptive use (ET_C)

The results in Table (8) show that seasonal consumptive use or evapotranspiration (ET_C) of wheat crop, as a function of N fertilizer rates and irrigation regime treatments were 44.47 and 45.53 cm in 2012/2013 and 2013/2014 seasons, respectively, in Site 1. Furthermore, in Site 2 the ET_C values were 43.95 and 45.17 cm in the two successive seasons, respectively. The differences may be due to the variation in climate factors of the two seasons (Table 3). Applying 100 kg N fed^{-1} gave the high values of wheat ET, i.e., 44.91 and 46.09 cm in Site 1, as well as, 44.52 and 45.75 cm in Site 2, in the two successive seasons, respectively. Decreasing N fertilizer rate from 100 to 80 kg N fed^{-1} decreased seasonal ET_C in sandy and calcareous soil by 1.98 and 2.60 %, respectively in the 1^{st} season, and by 2.54 and 2.58%, respectively in the 2^{nd} season. These results may be referred to the reduction in vegetative growth and yield.

Regarding the effect of irrigation regime treatments data recorded in Table (8) reveal that irrigation wheat at 40 % ASMD produced the highest values of ET_C in site1 and 2 in 2012/13 season, i.e., 46.39 and 45.79 cm, respectively, and in 2013/14 season, i.e., 47.50 and 46.91 cm, respectively. On the other hand, irrigation at 60 % ASMD decreased ETc in Site 1 by 4.86 and 4.72 % in the 1^{st} and 2^{nd} seasons, respectively, and in Site 2 by 4.50 and 3.76 %, in the two successive seasons, respectively. It could be concluded that increasing the available soil moisture in the root zone of wheat plants caused increase in ET_C throughout the season. These results may be due to the high transpiration rates from plants and high evaporative demands from soil under high available moisture, conversely, under water stress, the transpiration from plants may decreased as a result of poor vegetative growth, also the evaporation decreased from dry soil surface. These results are in accordance with those reported by **Doorenbos *et al.*, (1979), Yousef and Hanna (1998), Yousef and Ashry (2006) and Abdou *et al.*, (2011).**

The data listed in Table (8) indicate that applying 100 kg N fed^{-1} and irrigation at 40 % ASMD gave the highest values of ETc in site 1 and Site 2 in 2012/2013, i.e., 46.76 and 46.18 cm and in 2013/2014 season, i.e., 48.02 and 47.42 cm, respectively. However, the lowest ETC values in 2012/2013, i.e., 42.18 and 41.35 cm and in 2013/2014 season, i.e., 43.27 and 42.81 cm were detected from applying 80 kg N/fed and irrigation at 80 % ASMD.

Table (8): Effect of N fertilizer rates and irrigation regime on seasonal consumptive use of wheat crop (ET_C) in cm in site1 and site 2.

Sites	Fertilizer rates	2012/2013						2013/2014	
		Irrigation regimes treatments (ASMD)						Irrigation regimes treatments (ASMD)	
		(I_1) 40%	(I_2) 60%	(I_3) 80%	Mean	(I_1) 40%	(I_2) 60%	(I_3) 80%	Mean
Site 1 Sandy	F_1	46.02	43.92	42.18	**44.04**	46.98	44.61	43.27	**44.95**
	F_2	46.76	44.56	43.41	**44.91**	48.02	46.11	44.16	**46.09**
	Mean	**46.39**	**44.24**	**42.79**	**44.47**	**47.50**	**45.36**	**43.71**	**45.53**
Site 2 Calcareous soils	F_1	45.40	43.44	41.35	**43.39**	46.40	44.59	42.81	**44.60**
	F_2	46.18	44.20	43.18	**44.52**	47.42	45.83	44.00	**45.75**
	Mean	**45.79**	**43.82**	**42.26**	**43.95**	**46.91**	**45.21**	**43.40**	**45.17**

2-Daily ET_C (mm/day)

The results presented in Tables (9 and 10) show that the daily ETc rates as influenced by different treatments tested in both seasons, in both sites were started with low values during Nov. and decreased more during Dec., then increased again during Jan., Feb., to reach its maximum during March, thereafter, it decreased during April and May (plant harvesting).

These results are referred to that at the initial growth stage, most of the water loss was due to evaporation from the bare soil (germination and seeding stages) and the reduction in the ET_C rate during Dec., was due to the decrease in evaporative demands (temperature and radiation). Thereafter, as the plant cover and temperature increased, evaporation increased and transpiration took place beside it, then transpiration and evaporation reached maximum values during heading and grain filling stages (March), whereas at maturity stage the plants tended to be dry and the ET_C rate decreased again during April and May (harvesting). The results in Tables (9 and 10) indicate that the higher values of ET_C during all months of the two growing seasons duration (Nov. – May) were resulted from applying 100 kg N fed^{-1}. Whereas, applying 80 kg N fed^{-1} gave the lower averages in both seasons and in both sites. It could be revealed that decreasing ammonia gas rate from 100 to 80 kg N fed^{-1} resulted in decreasing daily ET_C rate of wheat during all months of the growing seasons. The daily ETc rates of wheat during the growing seasons months (Nov. – May.) of both seasons, in both sites were increased by irrigation at 40% ASMD. It is obvious that increasing the available moisture in wheat root zone resulted in increasing ET_C rate during the growing season duration months. These results are in the same line of those reported by **Yousef and Hanna (1998), Yousef and Ashry (2006) and Abdou *et al.*, (2011).**

Table(9)

Table(10)

3-Reference evapotranspiration

Reference evapotranspiration rate (ET_0) in mm/day during the months of wheat growing seasons, i.e., 2012/13 and 2013/14, estimated using the **FAO Penman- Monteith method** and the meteorological data of Fayoum Governorate are listed in Table (9). The obtained data indicated that the ET_0 rate values were somewhat high during Nov., and then decreased during Dec. and Jan. months. Thereafter, the daily rates of ET_0 increased from Feb. till May, in both seasons.

These results may be attributed to the variation in climatic factors from one month to another. **Allen *et al.*, (1998)** reported that the reference ET values depend mainly on the evaporative power of the air at each area, i.e., temperature, radiation, relative humidity and wind speed.

4-Crop coefficient (K_C)

The crop coefficient reflects the crop cover percentage and soil conditions on the ET_0 values. The K_C values were estimated from the daily ET_C rates and the daily ET_0 rates during the two growing seasons, in both sites. The results in Tables (11 and 12) reveal that the K_C values, as a function of the interaction between ammonia gas rates and irrigation regimes treatments (as over all mean) were low during Nov. and Dec. months, then increased during Jan. (0.66 and 0.65) and (0.63 and 0.63) and Feb. (0.70 and 0.69) and (0.68 and 0.66) as the vegetative growth increased to booting stage.

The K_C values reached its maximum values (0.93 and 0.81) and (0.89 and 0.81) during March (heading – grain filling stage). The K_C values decreased again during Apr. (0.66 and 0.68) and (0.67 and 0.66), as plants started maturity and reached minimum values on May (0.49 and 0.45) and (0.50 and 0.47) at harvesting, in both seasons, in both sites, respectively. These results may be attributed to the large diffusion resistance of bare soil during the initial growth stage (germination and seedling stages), which decreased gradually with increasing the crop cover until heading and grain filling stages. At maturity stage (Apr.) the transpiration decreased, as a result of leaves and stem drying causing the low values of K_C during Apr. and May months. The data recorded in Tables (11 and 12) reveal that reduced ammonia gas applying from 100 to 80 kg N/fed decreased the K_C values during the months of the two growing seasons, in both sites. On the other hands, increasing the ASMD from 40 to 60 or 80% caused reduction in K_C values in all the months of the two growing seasons duration, in both sites. Irrigation at 40% ASMD gave the highest K_C values during all months of the growing seasons duration, whereas, the lowest ones were detected from irrigation at 80% ASMD in both seasons, in both sites. The K_C values of wheat, as a function of different treatments were 0.47, 0.54, 0.66, 0.70, 0.87, 0.67 and 0.47 in Site 1 and 0.47, 0.55, 0.63, 0.67, 0.86 and 0.49 in Site 2, for Nov., Dec., Jan., Feb., March, Apr. and May, respectively, (average of the two seasons). Such findings are in the same line of those reported by **Doorenbos *et al.*, (1979), Yousef and Hanna (1998) Yousef and Ashry (2006) and Abdou *et al.* (2011).**

5-Water use efficiency (WUE)

Results in Table (13) show that the WUE values as affected by fertilizer rates and irrigation regime treatments were 0.89 and 0.96 kg grain m^{-3} water consumed in Site 1 and 1.078 and 1.18 kg grains m^{-3} water consumed in Site 2 in 2012/13 and 2013/14 seasons, respectively. The higher water use efficiency values were 0.90 and 0.98 kg grains m^{-3} water consumed in Site 1 and 1.08 and 1.19 kg grains m^{-3} water consumed in Site 2 in 1^{st} and 2^{nd} seasons, respectively, were detected from applying 100 kg N fed^{-1}.

Table (11): Effect of N fertilizer rates and irrigation regime on crop oefficient (K_C) of wheat in Site 1.

Treatments		2013/2014							2012/2013						
Fert. rate	**ASMD**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May.**
Reference ET_0 mm/day		**3.2**	**2.6**	**2.8**	**3.3**	**4.2**	**5.8**	**6.2**	**3.4**	**2.5**	**2.9**	**3.5**	**4.8**	**6.1**	**6.7**
	40%	0.48	0.55	0.68	0.72	0.94	0.70	0.51	0.46	0.58	0.68	0.72	0.83	0.68	0.46
F_1	**60%**	0.48	0.51	0.62	0.69	0.91	0.68	0.47	0.46	0.52	0.63	0.67	0.79	0.66	0.45
	80%	0.48	0.49	0.58	0.65	0.88	0.66	0.46	0.46	0.50	0.59	0.65	0.76	0.65	0.44
Mean		**0.48**	**0.52**	**0.63**	**0.69**	**0.91**	**0.68**	**0.48**	**0.46**	**0.53**	**0.63**	**0.68**	**0.79**	**0.66**	**0.45**
	40%	0.48	0.56	0.70	0.74	0.95	0.71	0.50	0.46	0.59	0.71	0.75	0.84	0.68	0.48
F_1	**60%**	0.48	0.52	0.63	0.70	0.93	0.68	0.49	0.46	0.55	0.67	0.70	0.83	0.66	0.46
	80%	0.48	0.50	0.59	0.68	0.90	0.67	0.48	0.46	0.52	0.62	0.66	0.79	0.64	0.43
Mean		**0.48**	**0.53**	**0.64**	**0.71**	**0.93**	**0.69**	**0.49**	**0.46**	**0.46**	**0.67**	**0.70**	**0.82**	**0.66**	**0.46**
Mean of irrig.															
40%		0.48	0.56	0.69	0.73	0.95	0.71	0.51	0.46	0.59	0.69	0.74	0.84	0.68	0.47
60%		0.48	0.52	0.63	0.70	0.92	0.68	0.48	0.46	0.65	0.65	0.68	0.81	0.66	0.45
80%		0.48	0.50	0.59	0.67	0.89	0.67	0.47	0.46	0.61	0.61	0.66	0.78	0.65	0.43
Over all mean		**0.48**	**0.53**	**0.66**	**0.70**	**0.93**	**0.66**	**0.49**	**0.46**	**0.55**	**0.65**	**0.69**	**0.81**	**0.68**	**0.45**

Table (12): Effect of N fertilizer rates and irrigation regime on crop oefficient (K_C) of wheat in Site 2.

Treatments		2013/2014							2012/2013						
Fert. rate	**ASMD**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May.**
Reference ET_0 mm/day		**3.2**	**2.6**	**2.8**	**3.3**	**4.2**	**5.8**	**6.2**	**3.4**	**2.5**	**2.9**	**3.5**	**4.8**	**6.1**	**6.7**
F_1 80 unit	**40%**	0.48	0.55	0.66	0.71	0.92	0.69	0.50	0.46	0.58	0.66	0.68	0.85	0.67	0.48
	60%	0.48	0.53	0.62	0.67	0.89	0.66	0.49	0.46	0.54	0.62	0.65	0.80	0.65	0.46
	80%	0.48	0.49	0.59	0.62	0.85	0.64	0.46	0.46	0.51	0.57	0.61	0.77	0.64	0.45
Mean		**0.48**	**0.52**	**0.62**	**0.67**	**0.89**	**0.66**	**0.48**	**0.46**	**0.54**	**0.63**	**0.65**	**0.81**	**0.65**	**0.46**
F_1	**40%**	0.48	0.57	0.68	0.73	0.94	0.69	0.51	0.46	0.60	0.67	0.70	0.85	0.68	0.48
100	**60%**	0.48	0.54	0.64	0.68	0.90	0.67	0.50	0.46	0.58	0.64	0.67	0.82	0.66	0.47
unit	**80%**	0.48	0.52	0.61	0.66	0.88	0.66	0.49	0.46	0.54	0.60	0.64	0.79	0.64	0.46
Mean		**0.48**	**0.54**	**0.64**	**0.69**	**0.91**	**0.67**	**0.50**	**0.46**	**0.57**	**0.64**	**0.67**	**0.83**	**0.66**	**0.47**
Mean of irrig.															
40%		0.48	0.56	0.67	0.72	0.93	0.69	0.51	0.46	0.59	0.67	0.69	0.85	0.68	0.48
60%		0.48	0.54	0.63	0.68	0.90	0.67	0.50	0.46	0.56	0.63	0.66	0.81	0.66	0.47
80%		0.48	0.51	0.60	0.64	0.84	0.65	0.48	0.46	0.53	0.59	0.63	0.78	0.64	0.46
Over all mean		**0.48**	**0.54**	**0.63**	**0.68**	**0.89**	**0.67**	**0.50**	**0.46**	**0.56**	**0.63**	**0.66**	**0.81**	**0.66**	**0.47**

Data listed in Table (13) indicate that irrigation wheat crop at 40% ASMD gave the highest WUE values, i.e., 0.95 and 1.02 in Site 1, and 1.12 and 1.235 kg grains m^{-3} water consumed in Site 2 in 2012/13 and 2013/14 seasons, respectively. Irrigation at 60 % ASMD decreased the values in the 1st season by 6.74 and 3.70 % for site 1 and site 2 and in the 2nd seasons by 4.08 and 5.08 %, respectively. It could be noticed that WUE decreased as ASMD increased. Such findings are in harmony with the results found by **Yousef and Hanna (1998) Yousef and Ashry (2006).**

Table (13): Effect of N fertilizer rates and irrigation regime on water use fficiency (WUE) in cm in Sites 1 and 2.

Sites	Fertilizer rates	2012/2013 Irrigation regimes treatments (ASMD)				2013/2014 Irrigation regimes treatments (ASMD)			
		(I_1) 40%	(I_2) 60%	(I_3) 80%	Mean	(I_1) 40%	(I_2) 60%	(I_3) 80%	Mean
Site 1 Sandy	F_1	0.94	0.88	0.84	**0.89**	1.00	0.98	0.8	**0.93**
	F_2	0.96	0.90	0.84	**0.90**	1.04	0.99	0.92	**0.98**
	Mean	**0.95**	**0.89**	**0.84**	**0.89**	**1.02**	**0.98**	**0.89**	**0.96**
Site 2 Calcareous soils	F_1	1.10	1.08	1.02	**1.07**	1.23	1.17	1.11	**1.17**
	F_2	1.14	1.07	1.04	**1.08**	1.24	1.19	1.14	**1.19**
	Mean	**1.12**	**1.08**	**1.03**	**1.075**	**1.24**	**1.18**	**1.13**	**1.18**

Conclusion

Under the present experimentation and from the results of this study it could be concluded that the highest values of straw and grain yields were obtained from applying 100 kg N fed^{-1} and irrigation at 40 % ASMD (i.e., 1990 m^3 water consumed in sandy soils and 1965 m^3 water consumed in calcareous soils).

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تحسين انتاجية القمح في الاراضي الجديده تحت معدلات مختلفه من التسميد بالامونيا الغازيه وادارة مياه الري

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اقيمت التجربة الحقلية في مزرعة كلية الزراعة بالفيوم (دمو) – محافظة الفيوم مصر . خلال موسمي ٢٠١٢/ ٢٠١٣ ، ٢٠١٣ / ٢٠١٤ لدراسة تأثير التسميد بمعدلات الامونيا الغازية وهي (F_1) : التسميد بمعدل ٨٠ كجم ن/فدان ، (F_2) ١٠٠ كجم ن /فدان (١ كجم من غازالامونيا يحتوى على ٨٢.٤ % نيتروجين) مع ثلاث معاملات للري وهي (I_1): الري عند استنزاف ٤٠% ، (I_2): ٦٠% ، (I_3): ٨٠% من الرطوبة الارضية الميسرة في موقعين الاول اراضي رملية والثاني اراضي جيرية وذلك علي المحصول ومكوناته وبعض العلاقات المائية لمحصول القمح (جيزه ١٦٨) في تصميم القطع المنشقة مرة واحدة في أربعة مكررات وفيما يلي أهم النتائج المتحصل عليها:-

*إضافة ١٠٠ كجم ن /ف والري عند استنزاف ٤٠% من الرطوبة الارضية الميسرة أعطي أعلي متوسطات من ارتفاع النبات، عدد السنابل /م٢،وزن ال١٠٠٠ حبة، وزن السنابل /م٢ ، محصول القش (٢٠١١,٤ ، ٢٣٣٤,١ كجم/فدان) في الموقع الاول و (٢٥٣٩,٥ ، ٢٧١٦,٧ كجم/فدان) في الموقع الثاني في الموسمين المتعاقبين علي الترتيب ولمحصول الحبوب (١٨٨٨,٤ ، ٢٠٧٧,٤كجم/ف) للموقع الاول وللموقع الثاني (٢٢٠٩,٤ ،٢٤٦٨ كجم/ف) فى الموسمين على الترتيب. وكانت أقل المتوسطات المتحصل عليها هي عند اضافة ٨٠ كجم ن /فدان والري عند استنزاف ٨٠% من الرطوبة الارضيه الميسرة في الموسمين المتعاقبين في كلا الموقعين علي الترتيب.

*كان متوسط الاستهلاك المائي الموسمي للمعاملات المختلفة (٤٣,٩٥،٤٤,٤٧سم) في الموسم الاول للموقعين علي الترتيب بينما كان في الموسم الثاني للموقعين علي الترتيب هو (٤٥,٥٣، ٤٥,١٧ سم) وكانت أعلي متوسطات الاستهلاك المائي تم التحصل عليها من التفاعل (F_2I_1) بينما أقل المتوسطات للموسمين المتعاقبين لكلا الموقعين قد نتجت من التفاعل (F_1I_3).

*بدأ معدل الاستهلاك المائي اليومي بقيم منخفضة خلال نوفمبر وديسمبر ثم إزداد خلال يناير وفبراير ليصل الي اقصي قيمه له خلال مارس ثم عاود الانخفاض مرة اخري خلال ابريل وحتي الحصاد في مايو في الموسمين، وكانت قيم ثابت المحصول ٠,٤٧ ، ٠,٥٤ ، ٠,٦٦، ٠,٧٠، ٠,٨٧، ٠,٦٧ و ٠,٤٧ (متوسط الموسمين) للموقع الاول وكانت للموقع الثاني ٠,٤٧ ، ٠,٥٥ ، ٠,٦٣، ٠,٦٧، ٠,٨٦، ٠,٦٧ و ٠,٤٩ (متوسط الموسمين) للشهور نوفمبر، ديسمبر، يناير، فبراير، مارس ، ابريل ،مايو علي الترتيب.

*كانت أعلي قيم لكفاءة الاستهلاك المائي فى الموقع الأول (٠,٩٦ ، ١,٠٤ كجم حبوب/ م٣ ماء مستهلك) وفي الموقع الثاني (١,١٤ ، ١,٢٤ كجم حبوب/م٣ ماء مستهلك) تم الحصول عليها من التفاعل (F_2I_1) في الموسمين المتعاقبين.

*كانت أعلي قيم لكفاءة استخدام المياه كجم / م٣ماء مضاف عند إضافة ١٠٠ كجم ن/ فدان مع الري عند استنزاف ٤٠% من الرطوبة الارضية في كلا الموسمين لكلا الموقعين.