WATER MANAGEMENT OF SUNFLOWER CROP UNDER LIQUID AMMONIA GAS FERTILIZATION

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ABSTRACT

The present investigation was carried out at Tamiea Agric. Res. Station, Fayoum Governorate during 2009 and 2010 seasons to study the effects ofammonia fertilizer levels, i.e. N_1: 15, N_2:30 and N_3:45 and N_4: 60 kg N fed^{-1},four irrigation regime i.e. irrigation at I_1: 0.6, I_2: 0.8, I_3: 1.0 and I_4: 1.2cumulative pan evaporation (C.P.E.) and their interaction on yield, yield components and some crop water relations of sunflower (Sakha 53). The strip- plot design with four replicates was used. The obtained results were as follow:

Yield and all yield components i.e. plant height, head diameter and weight, as well as seed weight head^{-1}and 100- seed weight, were obtained from applying 60 kg N fed^{-1}and irrigating sunflower at 1.2 C.P.E., surpassed significantly those obtained from the other treatments. However, the highest seed oil content were detected fromapplying 15 kg N fed^{-1} and irrigating sunflower at 1.2C.P.E.

Seasonal water evapotranspiration (ET_C) reached its maximum values (54.69 and 53.05 cm in 2009 and 2010 seasons, respectively), as sunflower crop received60 kg N fed^{-1} and irrigated at 1.2C.P.E.. The daily ETc increased by increasing the irrigationintervals from 0.6 to 0.8 to 1.0 to1.2 C.P.E.. The peak of daily ETc occurred on July. The K_C (crop coefficient) during the growing seasons were 0.42, 0.52, 0.62,0.88 and 0.51 for May, June, July, August and September months, respectively, (means of two seasons).

Applying 60 kg N fed^{-1}and irrigation at 1.2C.P.E. gave the highest water use efficiency, i.e. 0.497 and 0.480 kg seeds m^{-3} water consumed in 2009 and 2010 seasons, respectively.

Key words: Sunflower, yield and yield components, evapotranspiration,Kc and water use efficiency.

INTRODUCTION

Sunflower (*Helianthus annuus L.*) is the second oil crop after cotton in Egypt. Great emphasis has been given to increase its production per kg area. The response of sunflower plants to nitrogen fertilization at different soil types and environments must be optimized for high yield. Irrigation water management nowadays play an important role in our agricultural strategy due to the expansion in the new reclaimed area under our limited water resources. Thus irrigation development for saving water throughout agricultural treatments became a very necessary for high efficiency use of water.

Karami (1980) obtained that application of 50 kg, N ha^{-1}, increased the seed yield, plant height, head diameter and 100- seed weight and he added that higher rates of N produced no additional significant responses on yield or yield components, whereas oil percentage decreased with increasing nitrogen rate. **Mohammed and Rao (1981)** found that oil content slightly increased with 40 kg N ha-1, but decreased with 80-120 kg N ha-1. **El-Sayed *et al.* (1984)** found that plant height, stem diameter, head diameter, 1000- seed weight and seed yield were significantly increased by increasing the level of applied nitrogen up to 50 N/ fed. On the other hand, oil percentage decreased by increasing level of nitrogen. **Saleh *et al.* (1984)** indicated that increasing nitrogen application increased seed yield and its components. **Satyanarayana *et al.* (1985)** found that application of 60 kg N ha^{-1}, gave the highest seed yield.In contrasting to other outhers, **Samui *et al.* (1987)** found that application of nitrogen significantly increased the oil yield. **Tripathi and Sawhney (1989)** indicated that application of nitrogen decreased oil contentfrom 43.02% (0 kg N ha^{-1}) to 39.66% (60 kg N ha^{-1}).

Regarding the effect of irrigation treatment **El-Wakil and Gaafar (1986)** found that increasing available soil moisture depletion (ASMD) from 40 to 60 or 80% caused a significant decrease in head diameter of sunflower crop by 3.5 and 7.1 cm, seed yield fed^{-1}. by 174.3 kg and 276.2 kg fed^{-1}, oil percentage by 3.4 and 4.33% and oil yield fed^{-1}, by 100.2 kg and 139.8kg/fed, respectively. **Attia *et al.* (1990)** reported that irrigating sunflower plants at 25% available soil moisture significantly decreased plant height, head diameter, head weight, seed yield $plant^{-1}$, 100- seed weight and seed yield fed^{-1} by 37.2%, 41.1%, 46.5%, 40.6% , 4.1% and 43.5%, respectively compared to those irrigated at 75% available soil moisture. **Sharma (1994)** pointed out that increasing number of irrigation from one to three caused a significant increase in head diameter and seed yield by 1.7 cm and 3.9 t $ha.^{-1}$, respectively, whereas the 1000- seed weight did not increase.

El-Wakil and Gaafar (1986) showed that the seasonal crop evapotranspiration (ETc) decreased from 1492.0 to 1215.5 and 1084.0 m^3 water fed^{-1}, as the soil moisture depletion increased from 40 to 60 or 80% ASMD, respectively. They added that the highest water utilization efficiency (WUE) values were found to be; 1.24kg seeds m^{-3} water consumed which obtained from irrigation at 60% ASMD. **Attia *et al.* (1990)** reported that the water use by sunflower crop has been increased from 1611.5 to 1748.5 and 1824.1 m^3/fed, when irrigation was applied at 75%, 50% and 25% of ASMD, respectively. **Green and Read (1993)** concluded that the sunflower crop was very responsive to soil moisture stress where the decreasing available soil moisture decreased dry matter production m^{-3} water consumed. However, the total water use increased from 12.4 cm to 34.11 cm as the soil moisture increased from slightly above wilting point to the field capacity level. **Kumar *et al.* (1991)** found that oil content increased with increasing soil moisture. **Abdou *et al.* (2011)** reported that the highest sunflower yield and yield components, seasonal evapotranspiration (51.21 cm) and daily ETc were obtained from irrigation at 1.2 C.P.E (short intervals), and the crop coefficient (Kc) values of the growing season were 0.44, 0.73, 0.98 and 0.63 for June, July, August and September. The highest WUE (0.408 kg seed/m^3 water consumed) was resulted from the wet treatment (short intervals).

Salib *et al.* (1998) reported that the highest sunflower yield, yield components and seed oil content were obtained from the interaction between applying 45 kg N fed-1 and irrigating plants soon on furrows of 60 cm width. **Farrag *et al.* (2011)** found that growth, grain yield and yield components as a function of N fertilizer level (liquid ammonia gas) and scheduling irrigation treatments of maize significantly affected by the interaction, the highest values of yield i.e. 2841.88 and 2455.80 kg fed^{-1}were obtained from 130 kg N $fed^{-1}$and irrigating at 1.2 C.P.E. and the lowest ones detected from 90 kg N fed-1 and irrigating at 0.8 C.P.E. i.e. 1663.87 and 1915.13 kg fed^{-1}.

MATERIALS AND METHODS

Two field experiments were conducted at the Farm of Tameia Res. Station, Fayoum Governorate during 2009 and 2010 seasons. Thus,four liquidammonia gas (82% N) rates, i.e. N_1: 15, N_2: 30, N_3: 45 and N_4: 60 kgNfed^{-1}were combined with four scheduling irrigation treatment C.P.E., i.e.irrigation at I_1: 0.6, I_2: 0.8, I_3: 1.0 and I_4: 1.2 C.P.E. ina strip-plot design with four replications.The sub-plot area was (3×7 m) six ridges of 7m length and 0.5m width. The sub-plots were isolated from each others by dikes of 1.5m between to avoid the horizontal water seepage. Calcium super phosphate (15.5% P_2O_5) at the rate of 200 kg/fed was added during field preparation, Sunflower seeds (Sakha 53) at the rate of 5.0 kgfed^{-1} were planted in hills of 20 cm apart on May 29th and first of June in the two successive seasons, whereas harvesting was on20 and 26September in the first and second seasons, respectively. The physical and chemical analysis of the experimental plots soil were done according to **Page *et al.* (1982)** and **Klute (1986)** and presented in Table (1). The averages of Fayoum climatic factors during the two growing seasons are recorded in Table (2). The soil moisture constants of the experimental soil are shown in Table (3). The soil moisture values were gravimetrically determined on oven dry basis, for different soil layers each of 15.0 cm from the soil surface and down to 60.0 cm depth, as the technique of Water Requirements and Field Irrigation Dept., A.R.C., Egypt. Irrigation dates, intervals and count for different irrigation regime treatments are listed in Table (4). At harvesting time the following data were recorded from each sub-plot:

I. Yield and yield components

- Plant height (cm)
- Head diameter (cm)
- Head weight (g)
- Seed weight/ head (g)
-100- seed weight (g).
- Seed yield (kg fed^{-1})
- Seed oil content (%).

II. Crop water relations

1. Seasonal consumptive use (ETc).

To determine crop water evapotranspiration (ETc), soil samples were taken from each sub-plot, just before and after 48 hours irrigation, as well as at harvesting time. The ETc 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 evapotranspiration (cm)

Q_2 = soil moisture percentage (wt wt^{-1})

Q_1= Soil moisture percentage (wtwt^{-1}) just before irrigation.

Bd = Soil bulk density (gcm^{-3}).D = Soil layer depth (cm).

Calculated from the evapotranspiration value of each month, and divided by the number of days/ month.

2. Reference evapotranspiration (ET_0) in mm/ day.

ET_0 was estimated using the monthly averages of Fayoum climatic data (Table. 2) and the FAO Penman- Monteith equation. **(Allen *et al*., 1998).**

3. Crop coefficient (Kc).

The values of Kc were calculated as follows:

$K_C = ET_C / ET_0$... ……… Where

ET_C = Actual crop evapotranspiration (mm day^{-1})

ET_0 = Reference evapotranspiration (mm day^{-1}).

- Water use efficiency (WUE)

The WUE, as kg grains/ m^3 water consumed was calculated for different treatments as the equation described by **Vites (1965):**

WUE, kgm^{-3} = Grain yield (kg fed^{1}) / Seasonal ET_C ($m^3 fed^{-1}$)

Table (1). Physical and chemical analysis of the experimental field during 2009 and 2010 seasons (average of two seasons)

A. Physical analysis:

Sand%	Silt%	clay %	Texture class	orgonic matter %	Ca Co_3%
36.90	22.73	40.37	clay loam	1.15	6.91

B. Chemical analysis:

ECe ds/m	pH 1:2.5 extract	Soluble cation meg/L				Soluble anions meg/L				CEC meg/100 gm soil
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	HCo_3	Co_3	So_4	
5.93	8.15	12.37	9.18	31.71	0.79	27.91	4.88	-	31.26	39.74

Table (2). The monthly averages of climatic factors for Fayoum Governorate during 2009 and 2010 seasons.

Month	Year	Temperature (c̊)			Relative humidity%	Wind speed m/sec.	Pan* evaporation (mm/day)
		Max.	Min.	Mean			
May	2009	32.8	16.7	24.75	46	2.78	6.9
	2010	34.1	16.7	25.40	45	2.77	6.9
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

* After Fayoum meteorological station (Tameiadestrict)

Table (3). The soil moisture constants of the experimental field sits during 2009 and 2010 growing seasons (average of the two seasons)

Soil depth (cm)	Field capacity (%)	Wilting point (%)	Bulk density (g/cm^3)	Available moisture (%)
0- 15	41.99	20.19	1.40	21.80
15- 30	39.89	19.10	1.41	20.79
30- 45	35.91	16.35	1.37	19.56
45-60	34.21	16.71	1.36	17.50

Table (4). Dates of irrigation, irrigation intervals and irrigations count, as affected by irrigation treatments in 2009 and 2010 seasons

Number ofirrig.	Season 2009								Season 2010							
	Irrigation treatments								Irrigation treatments							
	I_1 (0.6)		I_2 (0.8)		I_3 (1.0)		I_4 (1.2)		I_1 (0.6)		I_2 (0.8)		I_3 (1.0)		I_4 (1.2)	
	Date	Days No.	Date	Days No.	Date	Days No.	Date	Days No.	Date	Days No.	Date	Days No.	Date	Days No.	Date	Days No.
Plantig	29/5	-	29/5	-	29/5	-	29/5	-	1/6	-	1/6	-	1/6	-	1/6	-
1st	12/6	14	12/6	14	12/6	14	12/6	14	15/6	14	15/6	14	15/6	14	15/6	14
2nd	9/7	27	3/7	21	27/6	15	23/6	11	10.7	25	6/7	21	30/6	15	27/6	12
3rd	3/8	25	22/7	19	11/7	14	3/7	10	31/7	21	24/7	18	14/7	14	8/7	11
4th	24/8	21	8/8	17	26/7	15	14/7	11	21/8	21	11/8	18	29/7	15	18/7	10
5th	14/9	21	24/8	18	9/8	14	27/7	13	12/9	22	30/8	18	11/8	13	28/7	10
6th	-	-	12/9	19	25/8	16	9/8	13	-	-	20/9	21	27/8	16	8/8	11
7th	-	-	-	-	11/9	17	24.8	15	-	-	-	-	12/9	16	21/8	13
8th	-	-	-	-	-	-	8/9	15	-	-	-	-	-	-	3/9	13
9th	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17/9	14
Harvest	20/9	6	20/9	8	20/9	9	20/9	12	26/9	6	26/9	7	26/9	14	26/9	9
Irrig. count	6	114	7	114	8	114	9	114	6	117	7	117	8	117	10	117

RESULTS AND DISCUSSION

1. Yield, yield components, protein and oil content of seeds

Results in Table (5) show that applying 60 kg of N fed^{-1} caused remarkable increase in seed yield and yield components than 15, 30 or 45kg. Applying 15kgN significantly reduced plant height, head diameter, head weight, seed weight head^{-1}, 100-seed weigh and seed yield 17.13, 20.28, 32.32, 30.81, 18.07 and 32.32 %, respectively, in 2009 season, season by 16.74, 21.92, 33.94, 29.04and 20 %, in 2010 season, respectively, compared with applying 60 kg. The obtained results may be due to the role of nitrogen in stimulating amino acid building and growth hormones, which in turn acts positively on cell division and enlargement caused more metabolized translocation to the plant head and seeds. These results confirm the findings of **Satyanarayana *et al*. (1985), Samui *et al*. (1987) and Farrag *et al.*(2011)**.

Regarding the effect of irrigation treatments results in table (5) show that seed yield and its components were decreased significantly with 0.6, 0.8 or 1.0C.P.E. compared with 1.2C.P.E. in both seasons. The highest averages of plant height. head diameter, head weight, seed weight head^{-1}, 100-seed weight, seed yield and seed oil content , were obtained under 1.2 C.P.E.. It is clear that under 0.8 and 1.0 C.P.E., sunflower yield was decreased by 15.73 and 7.02 %, in 2009 season, respectively, and in 2010 season by 25.89 and 8.79%, respectively, compared with 1.2C.P.E..These results may be referred to the effect of water deficit resulted from the wide irrigation cycle under 0.6 C.P.E. irrigation treatment, which in turn reduced photosynthesis, cell division, stem elongation, leaf area, leaf duration and dry matter accumulation in plant organs. The obtained results are in the same line with those reported by **El-Wakil and Gaafar (1986) and Attia *et al.* (1990).**

The data recorded in Table (5) indicate thatyield and yield components were significantly affected by the interaction between liquid ammonia gas level and scheduling irrigation treatments in both seasons. Irrigation at

Table 5

1.2 C.P.E. and applying 60 kgN fed^{-1} resulted in the highest averages of yield and its components in the two seasons. The lowest ones were obtained from irrigation at 0.6C.P.E. and applying 15 kgammonia gas fed^{-1} in both seasons. Such finding are agree with that reported by **Salib *et al.* (1998)**.

II. Crop water relations

1. **Seasonal crop evapotranspiration**

The results presented in Table (6) show that the of seasonal evapotranspirationvalues of sunflower (ETc), as a function of ammonia gas fertilization levels, irrigation regimes and their interactions were 46.10 and 45.07 cm in 2009 and 2010 seasons, respectively.

The data illustrated in Table (6) reveal that the seasonal ETc values of sunflower were increased as liquidammonia gas fertilizer level applied increased. Increasing N fertilization level applied from 30 or 45to60kgfed^{-1} resulted in increasing ETc in 2009 season by 12.61 and 7.16 %, respectively, and in 2010 season by 12.82 and 6.03%, respectively. Applying 15kg N fed^{-1} gave the lowest values of ETc, i.e. 41.96 and 40.84 cm in the two successive seasons,

Irrigation at 1.2C.P.E. gave the highest values of ETc, i.e.50.31 and 48.98 cm in the two successive seasons, whereas the lowest values of ETc. i.e. 42.29 and 41.18 cm were obtained from irrigation at 0.6 C.P.E. (dry treatment) in 2009 and 2010 seasons, respectively. Decreasing the C.P.E. from 1.2 to 1.0 or 0.8 decreased the ETc of sunflower in 2009 season by 5.78 and 11.55%, respectively, and in 2010 season by 4.84 and 11.15% respectively. These results may be attributed to that increasing the available soil moisture depletion may reduce the evaporation from soil surface and the transportation from plants as a result of the reduction in vegetative growth caused by irrigation at long intervals. These results are in agreement with those reported by **El- Wakil and Gaafar (1986) and Attia *et al.* (1990).**

Regarding the effect of the interactions betweenammonia fertilization levels and irrigation regime treatments on seasonal ETc, results in Table (6) indicate that the highest ETc values, i.e. 54.69 and 53.05 cm were resulted fromapplying 60kg N fed^{-1}and irrigating sunflower plants at 1.2 C.P.E. (wet treatment) and in 2009 and 2010 seasons, respectively.Applying 15kg N fed^{-1}andirrigation at 0.6C.P.E. gave the lowest ETc values, i.e. 37.25 and 36.56 cm (N_1I_1 treatment) in the two successive seasons.whereas the highest ones, i.e. 50.83 and 49.60 cm were detected from applying 60 kg N fed^{-1}.These results may be referred to that increasing N fertilization level to 60 kg N fed^{-1} gave vigorous vegetative growth, as higher availability of nitrogen, which in turn increased plant transpiration. These results are in harmony with those found by **El- Sayed *et al.* (1984) and Saleh *et al.* (1984).**

Table (6).Effect of ammonia gas levels, scheduling irrigation treatments and their interaction on seasonal evapotranspiration (ET_C) of sunflower crop in 2009 and 2010 seasons.

Seasons	2009					2010				
Ammonia Levels U. fed^{-1}	Irrigation treatments C.P.E.					Irrigation treatments C.P.E.				
	I_1 (0.6)	I_2 (0.8)	I_3 (1.0)	I_4 (1.2)	Mean	I_1 (0.6)	I_2 (0.8)	I_3 (1.0)	I_4 (1.2)	Mean
N_1	37.25	40.74	43.56	46.29	41.96	36.56	39.18	42.84	44.78	40.84
N_2	40.94	42.18	45.92	48.66	44.43	39.22	41.87	44.75	47.11	43.24
N_3	43.22	45.46	48.46	51.61	47.19	42.84	44.93	47.69	50.98	46.61
N_4	47.74	49.24	51.66	54.69	50.83	46.08	48.12	51.16	53.05	49.60
Mean	42.29	44.50	47.40	50.31	46.12	41.18	43.52	46.61	48.98	45.07

2. Reference evapotranspiration (ET_0)

The daily ET_0 rates (mm/day) during sunflower growing seasons of 2009 and 2010 are shown in Table (7). The daily ET_o values were estimated using the daily meteorological data of Fayoum Governorate (Table, 2) and the FAO-Penman- Monteith equation from May to September in both seasons. The results showed that the daily ET_0 rates were started with low values during May then increased during June month and slowly declined during July with continuous decrease during August and September in the two seasons. These results may be referred to the changes in climatic factors from month to another. With respect to these results, **Allen *et al.* (1998)** reported that the values of reference evapotranspiration are mainly depended on the evaporative power of the air, i.e. temperature degrees, relative humidity, wind speed and solar radiation.

3. Crop coefficient

The crop coefficient (Kc) values reflect the crop cover percentage over the reference evapotranspiration values during the period of estimation. The Kc values were calculated from the daily ETc rates and the daily ET_0 values (Table, 7) during the months of the two growing seasons duration. The results presented in Table (7) reveal that the Kc values, as a function of N fertilization levels, irrigation regimes and their interactions (over all means) were low during May and June months (germination and seedling growth stages). The Kc values thereafter increased during July to reach its maximum values in August (vegetative growth and anthesis stages), then the Kc values redecreased again to reached its minimum values during September (physiolcal maturity and harvesting stage). These results were found to be true in the two growing seasons 2009 and 2010. Such findings may be due to the high diffusive resistance of the bare soil during May and June (initial growth period), which decreased by increasing the crop cover until maximum growth and anthesis stage (mid-July to mid-August). However, at seed filling (late season) transpiration rates decreased, as most plant leaves became dry.

Table (7). Reference evapotranspiration (ET_0), daily ET_C (mm day^{-1}) and crop coefficient (K_C) values of sunflower for the highest yielding treatment, i.e. N_4I_4 during 2009 and 2010 growing seasons.

Seasons	2009			2010		
	ET_0 (mm day^{-1})	ETC (mm day^{-1})	K_C	ET_0 (mm day^{-1})	ET_C (mm day^{-1})	K_C
May	6.1	2.81	0.42	-	-	-
June	8.1	4.46	0.55	8.1	3.92	0.49
July	7.7	4.85	0.63	7.6	4.56	0.60
August	7.0	6.23	0.89	7.1	6.11	0.86
September	6.0	3.06	0.51	6.2	3.16	0.51

5. Water use efficiency (WUE)

The water use efficiency expressed as the productivity of seeds in kg, detected from each cubic meter evapotranspiration by the crop (kg seeds/ m^3 water) are listed in Table (8).

Regardingthe effect of N fertilization levels on W.U.E. values, the obtained results in Table (8) reveal that applying 60 kg N fed^{-1} to sunflower plants gave the highest W.U.E. values, i.e. 0.446 and 0.424 kg seeds m^{-3} water consumed in 2009 and 2010 seasons, respectively. Whereas the lowest W.U.E. values, i.e. 0.368 and 0.358 kg seeds m^{-3} water consumed were detected from applying 15 kg N fed^{-1}i.e 368 and 358 kg seeds m^{-3} water consumed in the two successive seasons, respectively. The results are in the same trend of those reported by **Saleh *et al.* (1984) and Samui *et al.*, (1987).**

The data recorded in Table (8) show that the W.U.E. values, as a function of, N fertilization levels,irrigation regimes and their interactions in 2009 and 2010 seasons were 0.409 and 0.394 kg seeds m^{-3} water consumed, respectively. Irrigation at 1.2C.P.E. gave the highest W.U.E. values, i.e. 0.424 and 0.416 kg seeds m^{-3} water consumed in 2009 and 2010 seasons, respectively. However, the lowest ones, i.e. 0.386 and 0.368 kg seeds m^{-3} water consumed in the two successive seasons, were observed from irrigation at 0.6 C.P.E. (dry treatment). These results may be due to that in the case of dry treatment the reduction in seed yield was much more that the decrease in seasonal evapotranspiration detected from this treatment,when compared with those of irrigation at 1.2 C.P.E.. These results are in accordance with the results found by **Attia *et al,* (1990).**

Table (8). Effect of Ammonia gas levels, scheduling irrigation treatments and their interaction on water use efficiency (kg seeds m^{-3} water consumed) of sunflower crop in 2009 and 2010 seasons.

Seasons	2009					2010				
Ammonia	Irrigation treatments C.P.E.					Irrigation treatments C.P.E.				
Levels U. fed^{-1}	I_1 (0.6)	I_2 (0.8)	I_3 (1.0)	I_4 (1.2)	Mean	I_1 (0.6)	I_2 (0.8)	I_3 (1.0)	I_4 (1.2)	Mean
N_1	0.372	0.375	0.366	0.359	0.368	0.332	0.371	0.363	0.364	0.358
N_2	0.385	0.400	0.408	0.406	0.400	0.376	0.391	0.386	0.400	0.388
N_3	0.392	0.421	0.440	0.434	0.422	0.385	0.418	0.410	0.419	0.408
N_4	0.396	0.430	0.462	0.497	0.446	0.378	0.402	0.438	0.480	0.424
Mean	0.386	0.406	0.419	0.424	0.409	0.368	0.396	0.399	0.416	0.394

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إدارة المياه لمحصول عباد الشمس تحت التسميد بالامونيا الغازية

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أقيمت تجربتان حقليتان في محطة البحوث الزراعية بطامية – محافظة الفيوم خلال موسمي الزراعة ٢٠٠٩ / ٢٠١٠ لدراسة تأثير مستويات مختلفة من التسميد بالامونيا الغازية (N_1 : ١٥ ، N_2:٣٠ ، N_3 : ٤٥ ، N_4 :٦٠ كجم ن فدان[-١]) وجدولة الري (I_1 : ٠,٦ ، I_2 :٠,٨ ، I_3 : ١,٠ ، I_4:١,٢ من بخر الوعاء التراكمي) والتفاعل بينهما علي محصول عباد الشمس (سخا ٥٣) ومكونات المحصول وبعض العلاقات المائية في تصميم الشرائح المتعامدة في أربعة مكررات وكانت النتائج كالتالي:

١- تأثر المحصول ومكوناته (طول النبات – قطر القرص – وزن القرص – وزن بذور القرص – وزن ال١٠٠ بذرة) حيث تم الحصول عليها من التسميد ب ٦٠ كجم ن فدان[-١] والري عند ١,٢ من بخر الوعاء التراكمي مقارنة بباقي المعاملات. ومع ذلك فإن أعلي محتوي بذور من الزيت تم الحصول عليها من التسميد ب ١٥ كجم ن فدان[-١] والري عند ١,٢ من بخر الوعاء.

٢- كان أقصي استهلاك مائي موسمي (٥٤,٦٩ ، ٥٣,٠٥ سم) تم الحصول عليها في موسمي الزراعة ٢٠٠٩ ، ٢٠١٠ علي الترتيب من إضافة ٦٠ كجم ن ف[-١] والري عند معامل بخر تراكمي ١,٢.

٣- البخر نتح اليومي زاد بتقصير فترات الري من ٠,٦ ، ٠,٨ ، ١,٠ ، ١,٢ من بخر الوعاء التراكمي، وكانت أقصي استهلاك مائي يومي في شهر يوليو، معامل المحصول كمتوسطات أثناء موسمي النمو ٠,٤٢ ، ٠,٥٢ ، ٠,٦٢ ، ٠,٨٨ ، ٠,٥١ لشهور مايو ويونيو ويوليو وأغسطس وسبتمبر علي الترتيب.

٤- إضافة ٦٠ كجم ن فدان[-١] والري عند ١,٢ من بخر الوعاء التراكمي أعطي أعلي المتوسطات لكفاءة إستهلاك المياه (٠,٤٩٧ ، ٠,٤٨٠ كجم بذور م[-٣] ماء مستهلك) خلال موسمي ٢٠٠٩ / ٢٠١٠ علي الترتيب.