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EFFECT OF IRRIGAION INTERVALS AND NITROGEN FERTILIZER RATES ON SUMMER SQUASH (*Cucurbita pepo* L.) GROWTH, YIELD, NUTRITIONAL STATUS AND WATER USE EFFICIENCY.

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ABSTRACT

Optimal irrigation and nitrogen management remains a major challenge for improving water use efficiency, nitrogen use efficiency, and vegetables yield in Egypt. The effect of three irrigation intervals (8, 12 and 16 days, starting after first irrigation), three nitrogen fertilizer rates (60, 75 (control) and 90 kg/fed.) and their interaction on growth, fruit yield, nutritional status, water use efficiency and nitrogen use efficiency of summer squash cv. Eskandrani were studied in two experiments conducted in a clay loam soil at a private farm, Mansoura district, Dakahlia Governorate, Egypt, during the two summer seasons of 2006 and 2007. Results indicated that irrigation every 8 days throughout growing season resulted in higher foliage weight, number of leaves and leaves weight per plant, total fruit yield/fed., marketable yield/fed., mean fruit weight, seasonal applied water and agronomic efficiency of nitrogen (AEN) in both summer seasons. Early fruit yield/fed. and K concentration in leaves were highest with the intermediate interval (12 days) in both summer seasons. On the other hand, there were insignificant differences between irrigation every 8 or 12 days intervals in N, P, and K uptake by plant in both seasons. Water use efficiency (WUE) and N and P concentration in leaves were highest with irrigation interval at 16 days in both seasons. All studied characters except AEN were significantly increased with increasing "N" rates, whereas there were insignificant differences between 75 and 90 kg N/fed. in either P concentration in leaves or WUE in both seasons. AEN was significantly decreased with raising N rates in both seasons. The interaction effect between irrigation rates and "N" levels was significant for all the studied parameters in both seasons. Generally, it could be concluded that irrigation every 12 days intervals combined with application of 75 kg N/fed. to summer squash cv. Eskandrani fields might gave the chance for increasing water and nitrogen use efficiency and produce satisfactory and good marketable fruit yield with minimizing environmental impact of over-fertilization.

INTRODUCTION

Summer squash (*Cucurbita pepo* L.) is one of the most important cucurbits crops in Egypt. It responds well to the application of irrigation water and nitrogen fertilizers. Water is a critical component in the production of cucurbit crops. Schwabet *et al.* (1996) stated that proper irrigation increase efficiency of fertilizers which reflect on growth, yield and crop quality. Thus an adequate water supply is critical to produce profitable yields and to maintain marketable quality. Nitrogen fertilizers are important plant nutrient for high yield and diffecult for growers to apply the ideal rate from it.

Usually, adequate availability of water and nitrogen is important for the optimum production of cucurbit crops (Gallego *et al.*, 1993; Pier and Doerge, 1995; Pascale *et al.*, 1998; Sayed *et al.*, 1998 and Farrag and El-Nagar, 2005).

Gallego *et al.* (1993) and Pier and Doerge (1995) found that the optimum nitrogen fertilization depends upon plant water supply during the growing season. Hence, an understanding of the interaction between N fertilization and irrigation is needed for selecting management practices that optimize summer squash yield and quality, improve water and nitrogen use efficiency, and minimize N losses to the environment.

There were significant positive linear relations among irrigation water, summer squash plant water consumption, fruit traits and yield. Whereas, plants irrigated with higher amount of water generally gave lower irrigation use efficiency values than others (Ertek *et al.*, 2004; Al-Harbi *et al.*, 2005 and Al-Omran *et al.*, 2005). On cucumber, total and marketable fruit yields were increased with increasing irrigation water (Farrag and El-Nagar, 2005; Ertek *et al.*, 2006 and Nimah, 2007).

On the other hand, the effect of nitrogen fertilizer on growth, yield and water use relations of summer squash was studied by many researchers. In this respect, Mohammad (2004) found that water consumption and water use efficiency increased with increasing "N" rates that applied to squash plants. Shafshak *et al.* (1990), El-Lithy *et al.* (1992) and El-Shabrawy (1997) found that increasing nitrogen levels increased squash vegetative growth, *i.e.*, number and dry weight of leaves per plant and plant fresh weight. El-Lithy *et al.* (1992), Hamail *et al.* (1994) and El-Shabrawy (1997) found that increasing N levels up to 120 kg N/fed. increased significantly quality of early and total squash fruit yield.

Moreover, seasonal water consumption of watermelon plants increased with decreasing irrigation intervals and increasing nitrogen application (Pascale *et al.*, 1998). Muskmelon yield response to nitrogen rate was quadratic and differed with the level of irrigation (Higgs *et al.*, 2005).

The aim of this work was to study the effect of interaction between irrigation intervals and nitrogen fertilizer rates on summer squash growth, yield, nutritional status, water use efficiency and nitrogen use efficiency.

MATERIALS AND METHODS

Two field experiments were performed at a private farm in Shoha village, Mansoura district, Dakahlia Governorate, Egypt, during the two summer seasons of 2006 and 2007, on squash cv. Eskandrani.

Physical and chemical properties of the experimental soil were determined according to the standard procedures as described by Page (1982) and Klute (1986), and are presented in Tables (1 and 2).

A split plot design with three replicates was used. The main plots were assigned to three irrigation intervals (8, 12 and 16 days). Sub plots were devoted to the three rates of nitrogen fertilizer (60, 75 (control) and 90 kg N/fed.). Each sub plot area was 16 m^2 and contained 4 rows; 80 cm wide and 5 m long. Each treatment was separated by two guard ridges. Squash seeds " cv. Eskandrani" were sown on one side of the ridges with 40 cm between hills on 18 and 20 March in both summer seasons, respectively.

Table (1): Some physical and chemical properties of the experimental soil surface layer (at the depth of 0-30) before planting during summer 2006 and 2007 seasons

Properties	Values		Properties	Values	
	2006	2007		2006	2007
Sand (%)	27.6	27.7	pH* values	7.9	7.7
Silt (%)	31.3	31.6	EC (dSm^{-1})	0.9	0.8
Clay (%)	41.1	40.7	Total N (%)	0.13	0.14
Texture class	Clay-loam	Clay-loam	Available P (ppm)	11.1	11.4
$CaCO_3$	3.2	3.4	Exchangeable K		
OM (%)	2.3	2.4	(ppm)	304	293

* pH: (1:2.5 soil extract).

Table (2): The soil moisture constants (% by weight) and bulk density of the experimental soil during summer 2006 and 2007 seasons

Constants depth (cm)	Field capacity %		Wilting point %		Available water (%)		Bulk density gm/cm^3	
	2006	2007	2006	2007	2006	2007	2006	2007
0 – 15	44.27	43.51	24.06	23.48	20.21	20.03	1.21	1.25
15 – 30	41.85	41.63	22.72	22.32	19.13	19.31	1.27	1.29
30 - 45	40.38	40.45	21.86	21.27	18.52	19.18	1.37	1.36

Three irrigation treatments were applied at 8, 12, 16 days after the first irrigation which was 10 days after seed sowing. The number of irrigation events was 11, 7 and 5 for the irrigation treatments (8, 12 and 16 days) respectively.

Nitrogen treatments in the form of ammonium sulfate (20.6% N), calcium super phosphate (16% P_2O_5) at rate of 40 kg P_2O_5/fed. and potassium sulfate (48% K_2O) at rate of 48 kg K_2O/fed. were divided in two equal portions. The first portion of calcium super phosphate was added during seed bed preparation and the second portion was added with the first portion of N and K fertilizers which added at the fourth week after seeds sowing, and the second portion of N and K fertilizers was added at the eighth week after seeds sowing. Other agricultural practices were conducted according to recommendations.

Five plants from each sub plot were randomly taken after 50 days from planting for measuring the vegetative growth parameters, *i.e.*, foliage weight, leaves fresh weight and number of leaves per plant. Leaves dry mater was analyzed for total nitrogen, phosphorus and potassium percentage. Total nitrogen was determined with micro-kjeldahl method according to Chapman and Pratt (1961). Phosphorus was colorimetrically determined following Jackson (1973). Potassium was determined using a flame photometer as described by Jackson (1973).

During the harvesting period, fruits of each plot were harvested by hand every 2–3 days, and were classified as marketable fruits (3-4 cm in diameter and 13–16 cm in length) and non-marketable fruits (misshapen large and small fruits) in each harvest, thereafter, marketable and total fruit yield were determined as ton/fed.. The first six harvests were considered as the early yield. Also, mean fruit weight was determined by dividing the total weight of the harvested fruits by the total number of fruits.

At the seventh harvest, samples of five fruits were taken at random from each sub plot and were dried at 70°C till constant weight to determine dry matter. Dried samples were ground in a Wiley mill to pass through a 20-mesh screen and analyzed for N, P and K percentage.

At the final harvest (twenty-second harvest), four plants per plot were separated into roots, stems and leaves for biomass determination and subsequently ground for N, P and K using the same methods reported for mineral analysis of leaves and fruits. The uptake of N, P and K was calculated by multiplying the biomass of each plant organ (leaves, stems, fruits and roots) by its nutrient concentration. All nutrient amount of plant organs were then summed to get the nutrient uptake of the whole plants.

Water consumptive use computed as the difference in the soil moisture content before and after irrigation according to the following equation by Israelson and Hansen (1962): $Cu = D \times Bd \times 4200 \times (\theta_2 - \theta_1)/100$, Where Cu is the water consumptive use m^3/fed., D is the soil depth, Bd is the soil bulk density (g cm^{-3}), θ_1 is the soil moisture content before irrigation (% by weight), θ_2 is the soil moisture content after irrigation or after 48 hours (% by weight).

Seasonal applied water is the sum of the figures computed for each irrigation application.

Water use efficiency was computed for the different treatments by dividing the fresh marketable fruit yield (kg/fed.) by seasonal applied water (m^3/fed.) (Stanhill, 1986).

For calculation of agronomic efficiency of nitrogen (AEN), fresh fruit marketable yield (kg/fed.) was divided by the amount of nitrogen in Kg/fed. applied in different treatments (Aujla *et al.*, 2007). This AEN has been reported as kg fruit yield per kg nitrogen applied.

The data were statistically analyzed as split plot design according to Snedecor and Cochran (1982). Comparisons among means of treatments were tested using LSD values at 5% level.

RESULTS AND DISCUSSION

1. Vegetative growth:

Data presented in Table (3) reveal that decreasing irrigation intervals caused significant increases in foliage weight, number of leaves and leaves weight per plant in both summer seasons. These results are in agreement with those obtained by Farrag and El-Nagar (2005) who found that cucumber vegetative growth values were significantly increased with increasing irrigation levels.

Moreover, it is evident from the data in Table (3) in both summer seasons that the growth parameters of summer squash plants were significantly increased with increasing "N" rates. These results might be due to the deficiency of "N" and organic matter in the experimental soil (Table 1) which magnified the effect of additional doses of nitrogen, which is one of the most important components of cytoplasm, nucleic acids and chlorophyll, therefore, increasing nitrogen levels enhances amount of metabolites necessary for building plant organs (Purekar *et al.,* 1992). Similar results were obtained by Shafshak *et al.* (1990), El-Lithy *et al.* (1992), Ibrahim (1995) and El-Shabrawy (1997).

The interaction between irrigation intervals and "N" rates had significant effects on all vegetable growth parameters in both summer seasons (Table 3). The highest values were obtained from 8 days irrigation intervals within 90 kg N/fed., whereas the lowest values were obtained from 16 days irrigation intervals within 60 kg N/fed. in comparison with other treatments in both seasons. In the same line, Pascale *et al.* (1998) reported that watermelon plant growth was significantly increased by the higher "N" rate combined with more frequent irrigation.

Table (3): Effect of irrigation intervals, nitrogen rates and their interactions on summer squash vegetative growth characters during summer 2006 and 2007 seasons

Treatments		Foliage weight per plant (g)		No. leaves per plant		Leaves weight per plant (g)	
Irrigation intervals (days)	Nitrogen rates (kg /fed.)	2006	2007	2006	2007	2006	2007
8		1368	1408	33.08	33.74	998	1029
12		1279	1331	32.40	33.08	947	983
16		1176	1205	31.69	32.31	892	927
LSD (5%)		65	57	0.34	0.27	30	21
	60	1115	1164	30.99	31.56	875	908
	75	1290	1344	32.52	33.18	950	986
	90	1418	1439	33.66	34.39	1014	1046
LSD (5%)		91	68	0.49	0.31	41	30
8	60	1253	1291	31.75	32.37	931	957
	75	1370	1411	33.17	33.88	998	1031
	90	1480	1523	34.32	34.97	1064	1100
12	60	1116	1164	31.00	31.59	877	913
	75	1294	1345	32.54	33.21	950	986
	90	1428	1483	33.66	34.43	1013	1050
16	60	977	1036	30.22	30.71	818	855
	75	1206	1269	31.85	32.44	901	940
	90	1345	1310	33.01	33.78	957	989
LSD (5%)		120	96	0.60	0.47	52	45

(75 kg N /fed.= control)

2. Nutritional status:

2.1. N, P and K concentrations in leaves:

Data listed in Table (4) show that the irrigation intervals had significant effects on N, P and K concentrations in leaves. Increasing irrigation intervals from 8 up to 16 days led to mark increase in N and P percentage whereas, means of K% were significantly increased by increasing irrigation intervals from 8 up to 12 days and decreased at irrigation interval of 16 days. These results were true in both seasons. The same trend was found by Farrag and El-Nagar (2005) on cucumber.

Table (4): Effect of irrigation intervals, nitrogen rates and their interactions on N, P and K concentrations in summer squash leaves during summer 2006 and 2007 seasons

Treatments		N%		P%		K%	
Irrigation intervals (days)	Nitrogen rates (kg /fed.)	2006	2007	2006	2007	2006	2007
8		3.40	3.27	0.22	0.22	3.70	3.61
12		4.10	3.93	0.26	0.26	3.97	3.87
16		4.69	4.48	0.29	0.28	3.34	3.30
LSD (5%)		0.14	0.12	0.02	0.02	0.13	0.11
	60	3.82	3.66	0.24	0.23	3.43	3.37
	75	4.10	3.93	0.27	0.26	3.69	3.61
	90	4.27	4.09	0.27	0.27	3.89	3.80
LSD (5%)		0.16	0.16	0.02	0.02	0.16	0.15
8	60	3.11	3.00	0.20	0.19	3.43	3.36
	75	3.43	3.30	0.23	0.23	3.72	3.63
	90	3.66	3.51	0.24	0.24	3.95	3.85
12	60	3.85	3.68	0.24	0.23	3.75	3.66
	75	4.11	3.94	0.27	0.27	3.98	3.87
	90	4.34	4.16	0.28	0.27	4.19	4.08
16	60	4.50	4.28	0.27	0.26	3.11	3.09
	75	4.76	4.55	0.30	0.29	3.38	3.34
	90	4.82	4.61	0.30	0.30	3.54	3.48
LSD (5%)		0.22	0.26	0.03	0.03	0.21	0.21

(75 kg N /fed.= control)

Concerning the effect of nitrogen rates on the percentage of N, P and K in leaves, data of Table (4) show that there were significant differences in both seasons. Increasing "N" rates increased significantly N, P and K concentrations in leaves in both seasons, but no significant differences were detected between 75 and 90 kg N /fed. in P%. it is worthy to note that Ibrahim (1995) found increases of N, P and K % in squash leaves with the increase of "N" level applied up to 80 kg N /fed., whereas, El-Shabrawy (1997) found that N % in squash leaves was increased by increasing nitrogen levels from 60 to 120 kg N/fed., while P and K % were not affected by N-levels.

The interaction between irrigation intervals and "N" rates had significant effects on N, P and K concentrations in both summer seasons (Table 4). Increasing irrigation intervals enhances N, P and K percentage in response to N fertilization, especially when high "N" rates are applied. These results may be due to the effect of "N" on the efficiency of plants to use water and fertilizer nutrients, besides, the effect of water in a dilution effect.

2.2. N, P and K uptake by plant:

Data presented in Table (5) show that the irrigation intervals had significant effects on N, P and K uptake by summer squash plant in both seasons. The highest values were obtained from 12 and 8 days irrigation intervals, while the lowest values were recorded with 16 days irrigation intervals in both summer seasons. In this respect, Frank and Viets (1967) stated that growing plants in fertile soil can meet its needs for more nutrients when water conditions are more favorable.

Also, it is evident from the data in Table (5) that the effect of different nitrogen rates on N, P and K uptake by squash plant cv. Eskandrani was significant in both seasons. The highest values of N, P and K uptake were obtained from adding 90 kg N/fed., while the lowest values were obtained from adding 60 kg N/fed.. These results may be attributed to the high capacity of the plants supplied with 90 kg N/fed. in building metabolites, which reflected on more growth and total yield (Tables 3 and 6), in turn to contribute much to the increase of N, P and K uptake.

Moreover, the interaction between irrigation intervals and "N" rates had significant effects on N, P and K uptake by summer squash plant in both seasons (Table 5). Plants watered every 8 or 12 days intervals and received 90 kg N/fed. gave the highest values for these traits, while the lowest values were noticed with the treatment of 16 days irrigation intervals within 60 kg N/fed. in both summer seasons. Such results may be explain that N, P and K uptake are generally decided by the amount of water and nitrogen applied to the crop. Reduction in N, P and K uptake with 16 days irrigation intervals at low applied nitrogen (60 kg N/fed.) can be due to the inability of the roots to absorb ions and translocate them to the plant top under low soil water (Frank and Viets, 1967).

Table (5): Effect of irrigation intervals, nitrogen rates and their interactions on N, P and K uptake by summer squash plant during summer 2006 and 2007 seasons

Treatments		N uptake (mg/plant)		P uptake (mg/plant)		K uptake (mg/plant)	
Irrigation intervals (days)	Nitrogen rates (kg /fed.)	2006	2007	2006	2007	2006	2007
8		3334	3453	0.760	0.850	3551	3698
12		3373	3516	0.809	0.955	3544	3647
16		2978	3136	0.532	0.666	3268	3369
LSD (5%)		91	104	0.112	0.108	109	118
	60	2674	2852	0.520	0.653	3107	3221
	75	3338	3514	0.726	0.838	3514	3625
	90	3673	3739	0.856	0.981	3742	3867
LSD (5%)		162	170	0.126	0.130	178	183
8	60	3019	3123	0.626	0.761	3374	3512
	75	3335	3505	0.784	0.806	3576	3695
	90	3648	3731	0.871	0.984	3702	3887
12	60	2772	2926	0.585	0.758	3207	3308
	75	3546	3652	0.853	1.005	3603	3716
	90	3801	3969	0.990	1.103	3821	3917
16	60	2231	2507	0.348	0.440	2740	2844
	75	3133	3384	0.542	0.702	3362	3465
	90	3570	3518	0.707	0.855	3703	3798
LSD (5%)		267	271	0.183	0.192	281	296

(75 kg N /fed.= control)

3. Yield and its components:

Data in Table (6) indicate that increasing irrigation intervals from 8 up to 16 days caused significant decreases in total fruit yield and marketable yield/fed. and average fruit weight in the two summer seasons. These findings are in agreement with those of Ertek *et al.* (2004), Al-Harbi *et al.* (2005), Al- Omran *et al.* (2005), Farrag and El-Nagar (2005), Ertek *et al.* (2006) and Nimah (2007). On the other hand, increasing irrigation intervals from 8 up to 12 days caused significant increase in early yield/fed., whereas, further irrigation intervals increase up to 16 days caused significant decreases in both seasons. The same trend was found by Ertek *et al.* (2004) who found that the medium level of irrigation was better than excessive or inadequate irrigation for early squash harvests.

Table (6): Effect of irrigation intervals, nitrogen rates and their interactions on early, total and marketable squash yield and fruit weight during summer 2006 and 2007 seasons

Treatments		Early yield (ton/fed.)		Total yield (ton/fed.)		Marketable yield (ton/fed.)		Mean fruit weight (g)	
Irrigation intervals (days)	Nitrogen rates (kg /fed)	2006	2007	2006	2007	2006	2007	2006	2007
8		5.06	5.35	18.43	18.89	17.85	18.15	136	140
12		5.36	5.65	17.98	18.40	17.29	17.58	131	136
16		4.69	4.91	16.52	16.84	14.68	14.96	118	122
LSD (5%)		0.16	0.14	0.44	0.41	0.46	0.38	4	4
	60	4.61	4.90	16.43	16.83	15.20	15.53	118	123
	75	5.08	5.34	17.79	18.22	16.93	17.23	128	133
	90	5.43	5.67	18.71	19.08	17.69	17.93	138	141
LSD (5%)		0.24	0.20	0.58	0.47	0.59	0.43	6	6
8	60	4.66	4.94	17.39	17.83	16.32	16.75	127	132
	75	5.07	5.39	18.66	19.15	18.43	18.76	136	139
	90	5.45	5.72	19.25	19.68	18.79	18.98	145	148
12	60	5.03	5.38	16.63	17.09	15.77	16.10	121	126
	75	5.46	5.70	18.23	18.67	17.66	17.92	131	137
	90	5.60	5.88	19.08	19.43	18.45	18.69	140	144
16	60	4.14	4.39	15.26	15.57	13.51	13.77	107	110
	75	4.71	4.93	16.48	16.84	14.70	14.98	118	123
	90	5.23	5.41	17.81	18.12	15.84	16.13	129	132
LSD (5%)		0.32	0.34	0.79	0.66	0.80	0.78	10	10

(75 kg N /fed.= control)

Data in Table (6) indicate that increasing "N" application up to 90 kg N/fed caused significant increases in mean fruit weight and early yield, total yield and marketable yield/fed. in both seasons. These results are in harmony with those of El-Lithy *et al.* (1992), Hamail *et al.* (1994) and El-Shabrawy (1997).

Moreover, the interaction between irrigation intervals within "N" rates had significant effects on early yield/fed., total yield/fed., marketable yield/fed. and mean fruit weight in both seasons (Table 6). Plants watered every 8 or 12 days and received 90 or 75 kg N/fed. gave the highest values for these traits, while the lowest values were noticed with the treatment of 16 days irrigation intervals and 60 kg N/fed. in comparison with other treatments in both summer seasons. The increases in these traits might be resulted from high growth parameters at the same treatments (Table 3), in turn, enhanced photosynthetic assimilation and absorption of various nutrients, and resulted in the increasing of yield and its components. There was a positive coefficient of correlation between seasonal applied water and marketable yield/fed. (it was 0.79), this may be due to the less watered treatments formed more misshapen fruits. These results also suggested that squash fruits quality is sensitive to excessive watering.

These results are in harmony with Pier and Doerge (1995) who found that the interaction between water and nitrogen had significant pronounced positive effects on the marketable watermelon yield. In addition, muskmelon plants grown under highest levels of water treatment and received higher amount of N (120 kg N/ha) produced significantly higher fruit yield and mean fruit weight than the deficit irrigation treatments (Higgs *et al.*, 2005).

4. Seasonal applied water (SAW):

Data presented in Table (7) indicate that SAW to summer squash plants was significantly increased as irrigation intervals decreased in both summer seasons. This may be due to the fact that frequently watered plants (8 and 12 days irrigation intervals) used more water because they found it much more easily without suffering from water deficit. Israelson and Hansen (1962) stated that if other conditions were equal, roots of plants in wet soil will extract more water than the roots of plants growing in dried soil. Ertek *et al.* (2004) also found similar findings. Moreover, positive Seasonal applied water response to nitrogen rates was observed in both seasons (Table 7). These results are in agreement with those obtained by Mohammad (2004).

There were significant interactions between irrigation intervals and "N" rates for SAW in both summer seasons (Table 7). Seasonal use of water by summer squash plants was increased with increasing frequent irrigation and nitrogen application. These results are in the same line with those obtained by Pascale *et al.* (1998).

5. Water use efficiency (WUE):

Results in Table (7) show that the values of WUE were significantly increased with decreasing frequent irrigation in both seasons. Treatments with higher amount of seasonal consumptive use of water had generally lower WUE values. Gallego *et al.* (1993), Ertek *et al.* (2004), Al-Harbi *et al.* (2005) and Al-Omran *et al.* (2005) came to similar results.

Data in Table (7) also reveal that increasing nitrogen fertilizer rates from 60 up to 75 kg N fed^{-1} increased WUE significantly, whereas, further nitrogen increase up to 90 kg N/fed. did not cause any significant effects in both seasons. These results generally agreed with the observations that "N" fertilizer increases WUE of N-deficient soils where water is adequate (Mohammad, 2004).

There was a significant interaction between irrigation intervals and "N" rates for WUE in both summer seasons (Table 7). Results of WUE in plants treated with the same "N" rate under different irrigation treatments were increased with increasing irrigation intervals. Also, WUE did not show significant increases to any increase in "N" rate above 75 kg N/fed. under all three irrigation treatments. This trend may be due to proportionally lesser loss of water than corresponding increase in marketable yield.

6. Agronomic efficiency of nitrogen (AEN):

Data collected in Table (7) indicate that decreasing irrigation intervals caused significant increases in AEN values in both seasons. The increases in AEN may be due to that plants grown under highest levels of water treatment produced higher marketable yield than the deficit irrigation treatments (Table 6).

Moreover, increasing "N" rates caused significant decreases in AEN in both summer seasons (Table 7). The lower AEN with increase in rate of N application suggests that fruit yield produced with per unit "N" additionally applied was lower than at the previous rate. In the same line, Sayed *et al.* (1998) found that cucumber plants received higher amount of "N" had lower AEN values than others. Also, Mohammad (2004) found that fertilizer N utilization efficiency tends to decrease with increasing "N" rates applied to squash plants.

Table (7): Effect of irrigation intervals, nitrogen rates and their interactions on seasonal applied water, water use efficiency (WUE) and agronomic efficiency of nitrogen (AEN) during summer 2006 and 2007 seasons

Treatments		Seasonal applied water (m^3/fed.)		WUE (kg fruits per m^3 water)		AEN (kg fruits per kg N)	
Irrigation intervals (days)	Nitrogen rates (kg /fed.)	2006	2007	2006	2007	2006	2007
8		1764	1787	10.10	10.20	242.0	246.5
12		1325	1349	13.03	13.02	234.4	238.5
16		1084	1106	13.52	13.61	198.9	202.8
LSD (5%)		29	27	0.15	0.11	7	7
	60	1322	1346	11.77	11.79	253.3	258.8
	75	1408	1428	12.32	12.43	225.6	229.7
	90	1443	1468	12.57	12.60	196.4	199.3
LSD (5%)		34	31	0.26	0.21	12	11
8	60	1666	1688	9.79	9.96	271.9	278.6
	75	1797	1823	10.26	10.33	245.8	250.1
	90	1828	1850	10.25	10.30	208.3	210.9
12	60	1260	1281	12.52	12.38	262.8	268.3
	75	1347	1371	13.10	13.19	235.2	239.4
	90	1369	1396	13.48	13.48	205.0	207.8
16	60	1040	1069	12.99	13.04	225.2	229.5
	75	1080	1091	13.59	13.75	195.7	199.5
	90	1123	1158	13.94	14.03	175.8	179.2
LSD (5%)		44	39	0.47	0.34	18	19

(75 kg N /fed.= control)

The interaction between the two studied factors had significant effects on AEN in both seasons (Table 7). The decrease in quantity of "N" applied (60 kg N/fed.) was accompanied by corresponding increase in agronomic efficiency of nitrogen at all the levels of water supply, although the maximum effect was at the lowest irrigation interval (8 days). Improved AEN can be obtainied by achieving same yield when reduced nitrogen applied.

Conclusions

The previous findings emphasize the importance of determining the interaction effects between irrigation intervals and nitrogen rates to find out the optimum combinations for maximum early and marketable yield accompanied by high water use efficiency and Agronomic efficiency of nitrogen. The treatment of 12 days irrigation intervals within 75 kg N/fed. was the best combination and it is recommended for summer squash cv. Eskandrani grown under similar field conditions in order to get higher economical yield and to save water and nitrogen fertilizer.

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تأثير فترات الري و معدلات التسميد بالنتروجين على النمو و المحصول والحالة الغذائية و كفاءة استخدام المياه للكوسة

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تمثل الإدارة المزرعية المثلى لمياه الري و السماد النيتروجيني تحدياً رئيسياً لتحسين كفاءة استخدام المياه والنيتروجين وزيادة غلة محاصيل الخضر في مصر؛ نظراً لندرة مياه الري و زيادة التوسع في استصلاح الأراضي. و تعتبر الكوسة من محاصيل الخضر الصيفية التي ينخفض محصولها و تقل جودتها عند التعرض للإجهاد المائي أو نقص التسميد الآزوتي، ويعود ذلك أساساً إلى ارتفاع محتوى ثمارها من المياه. لذلك نفذت تجربتان حقليتان في تربة طينية طميية بمزرعة خاصة بمركز المنصورة, بمحافظة الدقهلية خلال الموسمين الصيفيين ٢٠٠٦، ٢٠٠٧م لدراسة تأثير ثلاث فترات للري (كل ٨ ، ١٢ ،١٦يوما، تبدأ بعد أول رية) ، و ثلاثة معدلات من السماد الآزوتي (٦٠ ، ٧٥ (الموصى به) ، ٩٠ كجم ن للفدان) و كذلك التفاعل بينهما على النمو و المحصول والحالة الغذائية و كفاءة استخدام نباتات الكوسة (صنف الاسكندراني) لمياه الري.

أوضحت النتائج أن ري النباتات كل ٨ أيام خلال موسم النمو أدى إلى زيادة كل من الوزن الطازج للنبات و عدد الأوراق و وزن الأوراق للنبات و المحصول الكلي للفدان و محصول الفدان الصالح للتسويق ومتوسط وزن الثمرة و الماء الكلي المضاف للفدان خلال موسم الزراعة و الكفاءة المحصولية لاستخدام النتروجين.

وأدى ري النباتات كل ١٢ يوم خلال موسمي النمو إلى الحصول على أعلى محصول مبكر للفدان وعلى أعلى تركيز للبوتاسيوم في الأوراق و على أعلى امتصاص لكل من النتروجين و الفسفور و البوتاسيوم بواسطة النبات. ولم تكن هناك فروق معنوية بين الري كل ٨ و ١٢ يوم على امتصاص النتروجين و الفسفور و البوتاسيوم بواسطة النبات في كلا الموسمين.

بينما أدى الري كل ١٦ يوم خلال موسمي النمو إلى الحصول على أعلى كفاءة لاستخدام المياه و على أعلى تركيز للنتروجين و الفسفور في أوراق الكوسة.

ومن ناحية أخرى أدت زيادة معدلات النتروجين المضافة إلى حدوث زيادة معنوية في جميع الصفات المدروسة فيما عدا صفة الكفاءة المحصولية لاستخدام النتروجين و التي انخفضت بزيادة معدلات النتروجين، و لم تكن هناك اختلافات معنوية بين المعاملتين ٧٥ و ٩٠ كجم ن للفدان في صفتي تركيز للنتروجين و الفسفور في الأوراق و كفاءة استخدام المياه في كلا الموسمين.

ومن ناحية أخرى أثر التفاعل بين عاملي الدراسة (الري و التسميد الآزوتي) معنويا على جميع الصفات المدروسة في كلا الموسمين.

وخلصت الدراسة إلى أن ري نباتات الكوسة كل ١٢ يوم(٧ريات) مع إضافة ٧٥ كجم "ن" للفدان يمكن أن يحسن من كمية ونوعية المحصول مع زيادة كفاءة استخدام ماء الري والتسميد الآزوتي مما يؤدي إلى تقليل الأثر البيئي للإفراط في التسميد.