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Research Paper

Effect of Nitrogen Fertigation on Nutrients Content and Uptake of Watermelon (*Citrulluslanatus*) under Drip Irrigation System

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ABSTRACT: *A two-year field trial was conducted during two growing seasons, 2016 and 2017, to investigate the effect of nitrogen (N) level on nutrients content and uptake of grafted watermelon grown on a calcareous soil. Five different levels of N (0, 10, 20, 30 and 40 g N /m^3) as ammonium sulfate fertilizer were applied through injection into a drip irrigation system (fertigation) using hydraulic injectors. No significant effect for the N levels was detected on the nutrients content of the leaf and fruit tissues of the crop plant in both growing seasons. However, the N levels demonstrated a significant effect on plant fruit macronutrients uptake in both seasons. A significant effect was, also, found on the plant fruit uptake of micronutrients in the second season. Nitrogen fertigation at a concentration of 30 to 40 g N /m^3 in irrigation water was sufficient to induce the highest fruits nutrients uptake, and thus yield.*

KEYWORDS: *Calcareous Soil; Drip Irrigation; Fertigation; Nitrogen;Nutrients Uptake*

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I. INTRODUCTION

Watermelon (*Citrulluslanatus*) is regarded asone of the major vegetable fruit crops widely grownacross the world (1- 3), where china is the leading country (3). The estimated world production of watermelonin 2018 was 104 million tons with anacreage of 3.2 million ha,and an average yield of 32.5 ton/ha (4). In Jordan, watermelon is, also, one of the main irrigated vegetable crops with a total cultivated area of 1,488 ha, total annual production of 95,527 tons, and average yield of 64 tons/ha in 2017 (5).

Nitrogen (N),as one of the most important nutrients for yield and quality of watermelon and other crops, has been mentioned by several investigators (6-13).On the other hand, it was pointed out (14) that N supply significantly increased nutrients contents and uptake of crops like triticale.

Fertigation is considered a powerful management tool for both nutrient and irrigation water, especially, under scarce water conditions (15-17). In this technique, fertilizer is applied frequently and periodically in small amounts in each irrigation event to ensure adequate supply of water and nutrients in the root zone to meet the actual nutrition requirements of the crop accurately(8, 17-19).Severalresearch works (17, 19-20), also,indicated that crop nutrient use efficiency and uptake can be improved significantly by fertigation. Water soluble fertilizers can be applied via drip fertigation to obtain proper distribution of nutrients in soil to match the nutrients uptake by the crop which can consequently enhance the photosynthesis process leading to improved yield,qualityand nutrient uptake (19).

The objective of the current study was to evaluate the effect of the level of Nof the irrigation water,in the form of ammonium sulfate (AS)fertilizer,onleaf and fruit nutrients contents and uptake ofdripfertigatedwatermelon crop. A commercial watermelon cultivar (Farao, RMV 8007) grafted on a resistant rootstock (Tetsukabuto) was used in the study.Grafting of cucurbitaceae family membersonto resistant rootstocks is usually a common practice to control soil-borne diseases, in particular Fusarium wilt(2-3, 21).

II. MATERIALS and METHODS

2.1. Study Area and Experimental Site

The current study was carried out during April to Juneoftwo successive growing seasons, 2016 and 2017, in Al-Mafraq region, which is considered an important irrigated area in the east desert of Jordan.A suitable private farm in the region (32.30240 N, 36.54979 E) was selected. Two adjacent sites were used to carry out the trial at the farm during the two growing seasons. The experimental site was of 720 m^2 area; 30 m in length and 24 m in width.

2.2. Plant material

The most common commercial watermelon cultivar grown in the study area (Farao, RMV 8007) was selected. Seeding was made at a private nursery onMarch1,2016 and 2017, using polystyrene seedling trays (84 cells per tray). The seedlings were then grafted onto a resistant rootstock (Tetsukabuta: Cucrbita maxima x Cucrbitamoshata) on March 26,2016 (25 days after seeding, DAS) and March 28,2017 (27 DAS).

2.3. Cultural practices

The soil of the experimental sites was prepared with a total number of plots of twenty, and a plot size of 36 m^2 (6 m x 6 m). Each plot consisted of 3 rows and 5 plants per row. An organic fermented animal manure was incorporated into the soil at a rate of 40 ton/ha and raised beds were prepared for planting. Then, 30 kg N/ha was applied to the soil (22). Drip irrigation system was installed at the middle of the bed with one plastic lateral line per planting line (row), and three laterals per plot. The spacing between the lateral lines (GR type) of 16 mm in diameter was 2 m;while the spacing between the inline emitters of 4 liter per hr discharge rate was 0.40 m. Laterals were connected to a polyethylene (PE) manifold of 50 mm in diameter. After that, the beds were covered with black plastic mulch. Finally, watermelon crop seedlings of 3 to 4 true leaves were transplanted on April 11,2016 (42 DAS) and April16, 2017 (47 DAS), at spacing of 1.2 m x 2.0 m on and between rows, respectively (4167 plants per ha).

Irrigation was scheduled using soil moisture tensiometers placed at 15 and 30 cm soil depths at each replicate to determine when to irrigate, and a Class A-pan evaporation method to determine the volume of irrigation water to be applied at each irrigation event according to the other research works (22-23). A data logger (1200 Micro Station, model 3680WD1, Spectrum Technologies, Inc., U.S.A.) connected to a soil moisture tensiometer via a soil moisture transducer (model 3669, Spectrum Technologies, Inc., U.S.A.) was also used to monitor soil moisture tension and store readings at an hour interval. Irrigation water was applied whenever the soil moisture tension approached 40 centibar (cbar), as recommended by several researchers (24-26).

The volumes of applied water for irrigation events during the growing seasonswere measured by a 2 inch water flow meter installed on a (PE) mainline of 63 mm in diameter. The total applied volumes of the irrigation water in the first and second growing seasons(2016 and 2017) were 282.2 and 250.0 mm, respectively.Pests, diseases, and weeds were controlled by standard practices.

2.4. Treatments

The treatments consisted of 5 different levels of N in irrigation water (N0 = 0, N1 = 10, N2 = 20, N3 =30 and N4 = 40 g N /m^3), where water soluble ammonium sulfate, AS,$(NH_4)_2SO_4$ (21% N) was used as a N source fertilizer. The respective total amounts of N applied with the irrigation water to the different treatments in the first growing season 2016 were 0, 23.6, 47.2, 70.9 and 94.5 kg/ha. On the other hand, the amounts of applied P_2O_5 (phosphoric acid form, H_3PO_4, 85% w/v), K_2O (potassium sulfate form, K_2SO_4, 50% K_2O) and micronutrients,Pro Max (4% FeO, 3% ZnO, 2% MnO, 0.5% B_2O_3, 0.5% CuO, +2%MgO) with the irrigation water for the different treatments were 40.2, 40.2, and 8.1 kg/ha, respectively. In the second growing season 2017, the respective total amounts of N applied with the irrigation water to the different treatments were 0.0, 21.4, 42.8, 64.3 and 85.7 kg/ha. Meanwhile, the amounts of applied P_2O_5,K_2O,and micronutrients with the irrigation water for the different treatments were 36.4,36.4, and 8.1 kg/ha, respectively. Five proportional hydraulic injectors were used for nutrients injection into the irrigation water; four injectors (MiniDos, model 20%, Hydro Systems Company, Cincinnati, Ohio, U.S.A.) for N injectioninto the fourmanifolds (one for each treatment, except control), and the fifth injector (SuperDos, model 5%, Hydro Systems Company, Cincinnati, Ohio, U.S.A.) for the injection of P, K and micronutrients into the mainline for all treatments.

2.5. Experimental design and statistical analysis

The experimental design followed for the field experiment was randomized complete block design (RCBD) replicatedfour times (5 x 4 = 20 treatments)**.** Data were subjected to analysis of variance (ANOVA) using SAS version 9.0 for Windows (27).Means were compared and separated byleast significant difference (LSD) at the 5% level of probability ($P< 0.05$).

2.6. Soil chemical analysis

Composite soil samples (0-30 cm) were collected from the experimental sites from each of the four blocks (4 composite samples) at the beginning of the growing seasons 2016 and 2017. At the end of the seasons, soil samples were,also, collected from each plot (20 composite samples = 5 treatments x 4 blocks). The samples were air dried, crushed and passed through a 2 mm sieve and then analyzed for some chemical and physical properties. Soil pH and salinity (electrical conductivity, EC) of the paste extract,organic matter, calciumcarbonate, total N, available P, available K, and soil texture, were analyzed as described in previous works (28-34).

The soil at the experimental sites was calcareous and alkaline in reaction, loam in texture (36% sand, 42% silt, and 22% clay). The results of the soil analysis for the experimental site before planting at the beginning of the growing seasons are presented in Table 1.

Table 1: The results of the analysis of some chemical and physical properties of the soil for the four blocks at the experimental site (0-30 cm depth) before the beginning of the growing seasons, 2016 and 2017.

Block	Paste extract		Total N	Available		$CaCO_3$	Organic Matter	Texture
	pH	EC		P	K			
		(dS/m)	--- (%) ---	------ (mg/kg)	-------	------- (%)	--------	
Growing season 2016								
1	8.2	2.47	0.098	9.4	228.9	28.1	1.07	Loam
2	8.1	3.86	0.104	24.3	331.1	24.1	1.10	Loam
3	8.2	2.41	0.104	7.8	275.4	26.0	1.13	Loam
4	8.2	2.91	0.101	26.2	294.0	25.2	1.43	Loam
Average ±S.D.	8.2±0.0	2.91±0.67	0.102±0.003	16.9±9.7	282.4±42.5	25.9±1.7	1.18±0.17	Loam
Growing season 2017								
1	8.1	2.23	0.098	8.9	331.1	26.8	1.03	Loam
2	8.1	2.35	0.120	7.0	340.4	26.8	1.17	Loam
3	8.1	3.42	0.118	6.3	349.7	26.1	0.88	Loam
4	8.0	5.16	0.120	5.8	294.0	28.8	1.03	Loam
Average ±S.D.	8.0±0.0	3.29±1.36	0.114±0.011	7.0±1.4	359±24.4	27.1±1.2	1.03±0.12	Loam

2.7. Irrigation water and animal manure chemical analysis

Chemical analysis for the irrigation water was made according to previous works (35) to evaluate its quality in both seasons. According to USSLS (36), the irrigation water quality was of C2-S1 class; medium in salinity (EC, 0.64 dS/m),andlow in sodium adsorption ratio (SAR, 2.22), while alkaline in reaction (pH, 8.15).Meanwhile, results of the chemical analysis of the fermentedanimalmanureappliedto the soil of the siteswereas follows in average: EC, 5.05 dS/m; pH, 9.10; moisture, 19.95%; organic matter, 29.45%; ash, 50.6%; N, 1.2%; P_2O_5, 1.49%; and K_2O, 1.89%.

2.8. Plant harvesting and yield

Watermelon fruits were harvested on June 22, 2016 (72 days after transplanting, DAT) and June 28, 2017 (73 DAT). Harvesting was made when fruits reached maturity stage as described byothers(1). At harvest, both total yield and dry matter yieldof the crop weredeterminedand recorded(13).

2.9. Plant chemical analysis

Representative leaf and fruit samples were collected from the three middle plants of the middle row from each plot (Total = 20 samples for leaf and 20 samples for fruit from the 20 plots) according to the previous work (8).The plant samples were washed with tap water and then distilled water, and after that dried at 65 ^oC for 48 h,to constant weight and ground to a fine powder. Plant macro and micro nutrients contents(total N, P, K, Ca, Mg, Na, Fe, Cu, Zn and Mn) were determined in the leaf and fruit samples according to others (35). The accumulation (uptake)of a given nutrient (kg/ha),in the plant organ (fruit) was calculated as the product of the concentration of that nutrient(%) in the fruitand the dry biomass (kg/ha) of the fruit.

III. RESULTS and DISCUSION

3.1. Effect of N on plant nutrients contents

No significant effect was detected for the N levels on the nutrients contents of the leaf and fruit tissues of the watermelon crop plant in both growing seasons (Tables2 and3, respectively). In the first season 2016, the average nutrients contents of the leaf for all treatments were as follows: N (1.73 %), P (0.27 %), K (0.76 %), Ca (9.03 %), Mg (2.85 %), Na (968.5mg/kg), Fe (1054.8mg/kg), Cu (8.44mg/kg), Zn (37.68mg/kg), and Mn (74.91mg/kg).Meanwhile, the average values for the nutrients contents of the fruit tissues for all treatments,in the same season, were as follows: N (2.49 %), P (0.45 %), K (3.48 %), Ca (0.65 %), Mg (0.56 %), Na (0.27 %), Fe (67.6mg/kg), Cu (5.85mg/kg), Zn (22.33mg/kg), and Mn (22.6mg/kg).

In the second season 2017, on the other hand, the nutrients contents of the leaf for all treatments (Table2) recorded the following average values: N (3.27%), P (0.21%), K (1.33%), Ca (10.01%), Mg (1.87%), Na (822.4 mg/kg), Fe (1169.2 mg/kg), Cu (18.51 mg/kg), Zn (30.33 mg/kg), and Mn (74.87 mg/kg). Whereas, the average values for the nutrients contents of the fruit tissues for all treatments, in the same season (Table 3) were as follows: N (2.73%), P (0.75%), K (4.45%), Ca (0.67%), Mg (0.47%), Na (1.12%), Fe (128.43 mg/kg), Cu (6.71 mg/kg), Zn (29.74 mg/kg), and Mn (13.55 mg/kg).The findings of the present study, especiallyregarding leaf N content were supported by other research works which indicated that the optimal level of foliar N of watermelon (cv. Top Gun) is 1-5%(37).

Table 2: Effect of the N levels (g/m^3) in irrigation water on leaf nutrients contents of drip fertigated watermelon crop in the two growing seasons, 2016 and 2017.

Treatment Nitrogen level	Total N	P	K	Ca	Mg	Na	Fe	Cu	Zn	Mn
Growing season 2016										
(g/m^3)	(%)					(mg/kg)				
N0 = 0	1.61 a	0.26 a	0.66 b	9.04 a	2.67a	982.5a	1005.3 a	9.23a	27.38 a	73.18a
N1 =10	1.82 a	0.26 a	0.77 ab	8.86 a	2.78 a	925.0a	1260.0 a	7.85 a	29.13 a	84.73a
N2=20	1.89 a	0.26 a	0.71 ab	9.60a	2.92a	1047.a	1183.3 a	7.85a	47.90a	67.60a
N3=30	1.60 a	0.28 a	0.85 a	8.19 a	2.98a	1002.a	855.8 a	7.73 a	36.23 a	74.50a
N4 =40	1.72 a	0.28 a	0.85 a	9.49a	2.90a	885.0a	969.8 a	9.55a	47.78 a	74.55a
Mean	1.73	0.27	0.76	9.03	2.85	968.5	1054.8	8.44	37.68	74.91
$LSD_{0.05}$	0.95	0.05	0.19	1.61	0.40	191.3	517.0	3.10	34.42	25.90
Significance level	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
Growing season 2017										
N0 = 0	3.21 a	0.20 a	1.31 ab	9.85 a	1.63 a	740.5 a	1193.0 a	21.07a	31.42 a	73.17 a
N1 =10	3.11 a	0.19 a	1.27 b	10.97 a	2.03 a	900.5 a	1150.3 a	17.12ab	34.00 a	74.77 a
N2=20	3.11 a	0.20 a	1.29 ab	9.85 ab	2.00 a	859.0a	1122.8 a	18.77ab	31.75 a	77.60 a
N3=30	3.60 a	0.24 a	1.51 a	9.67 b	1.81 a	695.3a	1276.0 a	19.85a	23.90 a	73.77 a
N4 =40	3.11 a	0.24 a	1.28 ab	9.70 b	1.91 a	916.5a	1104.3 a	15.75b	30.57 a	75.02 a
Mean	3.27	0.21	1.33	10.01	1.87	822.3	1169.2	18.51	30.33	74.87
$LSD_{0.05}$	0.84	0.06	0.24	1.24	0.50	291.9	236.3	4.05	17.22	12.78
Significance level	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns

Ns : Not significant;

Within each column, means with different letter(s) are significantly different according to LSD test at 0.05 level of probability.

Table 3: Effect of the N levels (g/m^3) in the irrigation water on the fruit nutrients contents of drip fertigated watermelon crop in the two growing seasons 2016 and 2017.

Treatment Nitrogen level	Total N	P	K	Ca	Mg	Na	Fe	Cu	Zn	Mn
Growing season 2016										
(g/m^3)	(%)						(mg/kg)			
N0 = 0	1.98 b	0.42a	3.32a	0.61a	0.53a	0.263a	55.3b	5.75 a	24.3a	22.3a
N1 =10	2.56ab	0.44a	3.27a	0.56a	0.48a	0.295a	68.5a	5.93a	18.9a	18.3a
N2=20	2.53 ab	0.46a	3.33a	0.67a	0.59a	0.278a	72.0ab	5.60a	24.5a	19.7a

N3=30	2.72a	0.51a	3.56a	0.70a	0.56a	0.238a	63.3b	5.95a	22.3a	18.3a
N4 =40	2.65 a	0.43a	3.94a	0.72a	0.65a	0.305a	78.8ab	6.03a	21.7a	34.6a
Mean	2.49	0.45	3.48	0.65	0.56	0.276	67.6	5.85	22.3	22.6
LSD $_{0.05}$	0.61	0.21	0.98	0.22	0.17	0.132	32.0	2.83	16.5	20.6
Significance level	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
Growing season 2017										
N0 = 0	2.56a	0.73a	4.62a	0.68a	0.45a	1.17ab	108.0b	5.93a	28.63a	9.95b
N1 =10	2.86a	0.76a	3.95a	0.67a	0.45a	1.25a	117.5ab	7.25a	28.40a	12.57ab
N2=20	2.81a	0.73a	4.27a	0.68a	0.48a	0.94b	136.6 ab	6.83a	31.26a	14.70ab
N3=30	2.73a	0.75a	4.80a	0.69a	0.51a	1.05ab	145.0ab	6.82a	29.35a	15.87a
N4 =40	2.72a	0.79a	4.60a	0.65a	0.44a	1.16ab	135.0 ab	6.70a	31.02a	14.65 ab
Mean	2.73	0.75	4.45	0.67	0.47	1.12	128.4	6.71	29.74	13.55
LSD $_{0.05}$	0.38	0.07	1.06	0.08	0.13	0.30	32.6	1.95	7.02	4.76
Significance level	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns

Ns : Not significant;
Within each column, means with different letter(s) are significantly different according to LSD test at 0.05 level of probability.

3.2. Effect of N on plant nutrients uptake

In both growing seasons, the N levels in the irrigation water demonstrated a significant effect on plant fruit macronutrients uptake (N, P, K, Ca, and Mg) (Table 4). It is obvious that plant uptake of these nutrients exhibited a significant increase at high levels of N as compared with those at low levels and control treatments. The results suggested that, in the first growing season 2016, the highest significant uptake values of N, P, K, Ca, and Mg in fruit tissues were obtained at N4 treatment (72.47, 11.33, 103.80, 19.28, and 16.62 Kg/ha, respectively), while the lowest respective values of uptake were recorded at the control treatment (25.48, 5.25, 43.07, 8.06, and 6.33 Kg/ha, respectively).

Similarly, in the second growing season 2017, the highest significant uptake values of N, P, K, Ca, and Mg in fruits were realized at N4 treatment (80.3, 23.2, 138.2, 19.8, and 13.3 Kg/ha, respectively), and the lowest respective values of uptake were reportedat the control treatment (36.3, 10.5, 66.9, 9.7, and 6.1 Kg/ha). No significant effect on Na uptake was noticed, where the average values of uptake in the first and second seasons were 5.8 and 26.6 Kg/ha, respectively.However, there was anobvious trend for Na uptake to increase with increasing N level in both seasons.

While no significant effect for the N level of irrigation water on the plant fruit uptake of micronutrients (Fe, Cu, Zn and Mn) was detected in the first growing season, there was a trend for these uptake values to increase as N level increased (Table 4). The average values of plant uptake for these micronutrients in the first season were 142.4, 11.9, 44.1 and 46.0 g/ha, respectively. However, a significant effect for the N level on micronutrient (Fe, Cu, Zn and Mn) uptake was detected in the second season.The highest values were recorded at N4 treatment (415.3, 20.7, 93.8 and 43.4 g/ha, respectively).Meanwhile, N0 treatment recorded the lowest values (156.5, 8.4, 39.8 and 14.4g/ha, respectively), with an average values,for all treatments, of 304.6, 16.1, 70.1 and 32.3 g/ha, respectively. In almost all cases, however, no significant differences in macro and micro nutrients uptake at N3 and N4 treatments in both seasons were detected, as the results revealed. This suggested that N levels in irrigation water, particularly in AS form, at 30 to 40 g/m^{3}were sufficient to obtain the highest uptake of nutrients.And, consequently,the highest crop yield, under the prevailing environmental conditions. Given that, the other nutrients are at optimum levels through adopting a balanced fertilization program.

The obtained results were, also, in agreement with those reported by many researchers (19, 38-41) that N fertigation created significant improvements in crop yield and nutrient uptake. This was alsoattributedpartly to the increasedplantbiomass of the plant organs with increasing N application rate (42).Similar findings werereported by other researchers (12, 14) that Napplicationcan significantly improve crop nutrients uptake and dry matter yield.Theobtainedresults are, also,corroborated by other researchers (43) who indicated that N uptake, crop and dry matter yields tend to increase with increasing the application rate of N nutrient.

Table 4: Effect of the N levels (g/m^3) in the irrigation water on the fruit nutrients uptake of drip fertigated watermelon crop in the two growing seasons 2016 and 2017.

Growing season 2016										
Treatment Nitrogen Level	N	P	K	Ca	Mg	Na	Fe	Cu	Zn	Mn
(g/m^3)	--------------------------------- (Kg/ha) -----------------------------------						------------------------ (g/ha) --------------------------			
N0 = 0	25.5 c	5.25 b	43.1 d	8.1 d	6.3 c	3.56b	73.6 b	7.4 b	28.0 b	27.7 b
N1 =10	49.2 b	8.05 ab	58.0 cd	10.2 cd	8.7 cb	5.97ab	137.7ab	11.6 ab	34.6 b	34.4b
N2=20	51.8 b	8.89 ab	65.6 cb	13.8bc	11.3 b	5.39ab	141.0ab	11.2 ab	47.6 ab	39.4b
N3=30	63.4 ab	11.34 a	81.6 b	15.6 ab	11.9 b	5.97ab	146.6ab	13.2 a	48.8 ab	42.3b
N4 =40	72.5a	11.33 a	103.8 a	19.3 a	16.6 a	8.04a	213.0 a	16.2 a	61.6 a	86.4a
Mean	52.5	8.97	70.4	13.4	11.0	5.78	142.4	11.9	44.1	46.0
LSD $_{0.05}$	18.2	3.86	17.1	4.1	3.7	3.30	92.0	5.5	24.4	43.9
Significance level	*	*	*	*	*	Ns	Ns	Ns	Ns	Ns
Growing season 2017										
N0 = 0	36.3c	10.50c	66.9d	9.7b	6.0b	16.94b	156.4c	8.4b	39.8c	14.4c
N1 =10	60.2b	16.21b	84.7cd	14.8ab	9.7ab	27.64ab	242.3bc	16.7a	61.3bc	26.5bc
N2=20	69.7ab	17.82b	104.8bc	16.8a	12.0a	23.48ab	334.1ab	16.9a	78.9ab	35.7ab
N3=30	72.3ab	19.89ab	126.5ab	18.1b	13.7a	29.17ab	374.7ab	17.9a	76.9ab	41.2a
N4 =40	80.3a	23.18a	138.2a	19.8a	13.3a	35.62a	415.3a	20.7a	93.8a	43.3a
Mean	63.8	17.52	104.2	15.8	10.9	26.57	304.6	16.1	70.1	32.2
LSD $_{0.05}$	17.8	5.26	26.9	5.6	4.2	13.45	156.6	7.3	28.7	13.4
Significance level	*	*	*	*	*	Ns	*	*	*	*

Ns: Not significant;
*: Significant at $P \leq 0.05$
Within each column, means with different letter(s) are significantly different according to LSD test at 0.05 level of probability.

3.3. Effect of N on soil chemical properties

The results of the soil chemical analyses (pH, salinity, organic matter, total N, available P and K) at the end of the two growing seasons revealed that there was no significant effect for N levels of irrigation water on these soil attributes (Table 5). However, there was a noticeable trend for the soil salinity to increase with increasing N application rate during the first growing season 2016. This could be attributed to the salinity effect associated with the ammonium sulfate. In the second growing season 2017, this trend is not clear but the control treatment recorded less salinity as compared to the other treatments.

Remarkable increases in the average values of most of soil parameters at the end of both seasons were noticed. For example, at the end of the first growing season, 2016, an obvious increase in soil salinity was detected (from 2.91 to 4.64 dS/m). Similarly, marked increases in the average values of available P (from 16.9 to 125.7 mg/kg) and K (from 282.4 to 382.3 mg/kg) were realized. Additionally, total N increased from 0.102 % to 0.146%, and organic matter content increased from 1.18 % to 1.89%. Meanwhile, a negligible increment in the average of soil pH was noticed, as it increased from 8.2 at the start of the season to 8.3 at the end.

On the other hand, at the end of the second season 2017, average values of soil salinity (EC) increased from 3.29 to 4.13dS/m; total N increased from 0.114 to 0.149 %; organic matter increased from 1.03 to 1.64 %; and available P and K increased from 7.0 to 96.0 mg/kg, and from 359 to 826.6 mg/kg, respectively. Similarly, a small increment in the average value of soil pH (from 8.0 to 8.2)was,also, recorded.

The possible reasons for the increases in soil salinity at the end of the two growing seasons could be attributed to the problems inherited upon using drip irrigation systems; namely, salinity build up at the soil surface as the crop consumes irrigation water leaving salts behind. Moreover, chemical fertilizers and animals manureadditions may, also, contribute to the soil salinity, besides increasing the soil nutrients contents (N, P and K). The appreciable recognized increment in the soil organic matter content could, also, be attributed to the manure incorporation into the soil at the beginning of the growing seasons, in addition tothecrop residues left after harvesting. However, the possible explanations for the slight changes in soil pH might be for the high buffering capacity of the calcareous soil which inhibits changes in soil pH (44).

Table 5: Effect of the N levels (g/m^3) on some soil chemical properties at the experimental sites at the end of the growing seasons 2016 and 2017.

Treatment Nitrogen Level	pH	EC	Organic matter	Total N	Available	
					P	K
(g/m^3)		(dS/m)	---------- (%)	----------	---------- (mg/kg)	-------
Growing seasons 2016						
N0 = 0	8.38 a	2.86 a	1.57 a	0.139 a	92.6 a	289.3 b
N1 =10	8.28 ab	3.84 a	1.530 a	0.128 a	99.2 a	321.9 b
N2=20	8.20 b	4.458 a	2.27 a	0.158 a	160.9 a	405.5 ab
N3=30	8.20 b	6.21 a	1.98 a	0.153 a	157.8 a	500.8 a
N4 =40	8.28 ab	5.83 a	2.08 a	0.153 a	118.2 a	393.9 ab
Mean	8.27	4.64	1.89	0.146	125.7	382.3
LSD $_{0.05}$	0.12	3.98	0.75	0.044	80.7	174.7
Significance level	Ns	Ns	Ns	Ns	Ns	Ns
Growing season 2017						
N0 = 0	8.22a	3.59a	1.49a	0.156a	93.0a	805.3a
N1 =10	8.22a	4.24a	1.55a	0.154a	97.0a	779.7a
N2=20	8.20a	4.33a	1.59a	0.157a	102.1a	868.0a
N3=30	8.22a	4.49a	1.66a	0.143a	96.1a	854.1a
N4 =40	8.27a	4.03a	1.94a	0.136a	91.8a	826.2a
Mean	8.23	4.13	1.64	0.149	96.0	826.6
LSD $_{0.05}$	0.16	3.17	0.78	0.028	36.0	269.6
Significance level	Ns	Ns	Ns	Ns	Ns	Ns

Ns : Not significant;
Within each column, means with different letter(s) are significantly different according to LSD test at 0.05 level of probability.

IV. CONCLUSION

To obtain high nutrients uptake and thus watermelon crop yield, it is recommended to apply N to the plant crop, via irrigation water (fertigation) at a concentration of 30 to 40 g N /m^3. Provided that balanced fertilization for the other nutrients would be followed.Modern fertigation techniques like proportional hydraulic injectors can be considered as one of the most efficient methods in the deliveryand management ofplant nutrients. This was significantly pronounced in the watermelon nutrients uptake enhancement. However, further future research works regarding the management of the other plant nutrients for watermelon and other horticultural crops are warranted.

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