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Effect of irrigation methods, nitrogen and calcium spray on physical and chemical characteristics of watermelon "Top yield" var. (Citrullus lanatus) in Sulaimani Governorate

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Abstract

This study was carried out at Kanipanka Research Station / Sulaymani during growing season of 2015 to study the effect of irrigation method, nitrogen and calcium spraying and their interaction on chemical and physical characteristics of watermelon plant ("Top yield" var.).The study included surface and drip irrigation spraying nitrogen as three concentrations (0, 200 and 400 mg N l^{-1}) using urea fertilizer and spraying calcium (0, 100, 300, 600 mg Ca l^{-1}) concentrations using $CaCl_2$. The experiment was conducted as factorial experimental (2 x 3 with (3) replication. The study's characters were some physical and chemical characters. The results showed that surface (furrow) irrigation was significant in dry matter % (4.17 %) and Ca (0.92 %). N_2 (400 mg l^{-1}) was significant in dry matter (4.36 %) and N (0.18%) . While Ca_3 (600 ml l^{-1}) was superior in dry matter (4.95 %), Ca (1.21 %), fruit size (3.73 L) and rind thickness (0.92 cm). The interactions of irrigation methods, nitrogen and calcium were significantly affected on some characters. (S x N_2 x Ca_3) was superior in dry matter% (5.26 %), sucrose % (3.510 %), pH value (5.90) and rind thickness (1.06 cm).

Introduction

Watermelon (*Citrullus lanatus* L.) is a herbaceous creeping plant belonging to gourd family (Cucurbitaceae), which thrive in the tropical region and has been cultivated for thousands of years in the Middle East and South East Asia [1] . Its global consumption is greater than that of any other cucurbit [2]. There are over 1,200 varieties of watermelon worldwide. Watermelons vary in size, number and shape, and also flesh, rind and seed color [3]. The fruit ranges in size from 10-100 cm in diameter, mostly round or oblong in shape. The intense red color, spongy formation of the pulp and high water content (about 92 %) of mature fruits make the watermelon most favorite among the consumer [4]. Watermelons are associated with various health benefits; contain vitamin A, B6 and C, lycopene, antioxidants, amino acids and modest amount of potassium .It also serves as a good source of phytochemical and red carotenoid pigment which acts as an antioxidant during normal metabolism and protects against cancer [5]. Compared to neighbor countries, watermelon production in Kurdistan is low, it may related to many factors including (soil condition, inadequate agricultural guidance for the farmers, shortage of irrigation projects, pathological and physiological problems). Irrigation is a supplementary character, so it is the measure to supplement the rainfall deficiency during the vegetation period. Among all irrigated plants, cucurbit vegetables have the highest water needs during the vegetation period, so the irrigation should be used [6]. Nitrogen is the most important plant nutrient and essential element for plant growth and crop production. It is a constituent of the building blocks of almost all plant structures and essential component of chlorophyll, enzymes, vitamins, proteins… etc. Nitrogen has been recognized as a major factor affecting watermelon yield [7]. Calcium is an essential plant nutrient has a direct influence on the salt balance within plant cells and activates potassium to regulate the opening and closing of stomata .Cell wall strength and thickness is increased by calcium addition. [8]. [9] reported that a high N application rate impairs some important fruit quality characteristics, such as pH, soluble solids, glucose, and fructose contents percentage as well as the ratio of reducing sugars to total solids. [10] studied the effect of (Control and drip irrigation) on watermelon fruit sizes (Horizontal/vertical) and the obtained data were (16.66/17.34 and 18.70/20.73 cm), respectively. Rolbiecki *et al.* (2011)[6] showed the effect of nitrogen on fruit size of four different watermelon cultivars (Crimson Sweet, Sugar Baby, Madera-f1 and Paladins with granular nitrogen fertigation treatment and the obtained data were (17.2/17.9, 15.6/18.1, 20.7/ 22.6 and 18.5/25.8 cm diameter/length). [11] conducted an experiment to study the effect of calcium ammonium nitrate (CAN) with different rates (0, 35, 70, and 105 kg ha^{-1}) on watermelon rind thickness and TSS value, the achieved data for rind thickness were (1.81, 2.20, 2.33 and 2.5 cm), and the obtained TSS values were (8.11, 8.08, 8.03 and 8.03 %), and f fruit TSS values for two different watermelon cultivars (Panther and Sweet Marvel) were (11.6 and 10.78 %), respectively, consequently**.** Amine *et al.* (2014)[4] observed TSS values (5.86, 6.80, and 6.90 Brix%) for three types of watermelons (Green, light green and light green banded) and also showed the differences of pH between three types of watermelon (Green , Light green and Light green bonded) , the results of their pH values were 5.62,5.37 and 5.79 respectively**..** [12] showed effect of two irrigation methods (furrow and drip irrigation (plastic and bare) on watermelon fruit TSS values and rind thickness, the obtained TSS value were (11.13, 11.91 and 11.86 %), and the obtained rind thickness were (1.83, 1.83 and 1.76 %), respectively. Maluki *et al.* (2015)[13] explained the interaction effect of nitrogen and phosphorous levels on TSS values and rind thickness of watermelon and the obtained data were 7.9 Brix for N_0P_0 and 12.9 Brix for N12P100,while the achieved rind thickness was ranged from (1.90) cm for N0P0 to 0.53 cm for N12P100 level. Since there are little studies on this problem for this reason this investigation was selected. The objective of the study was to evaluate the effects of irrigation methods; nitrogen and calcium spray on the incidence of the chemical and physical characteristics of "Top Yield" variety of watermelon.

Materials and Methods

Location**:** Field experiment was conducted during growing season of 2015 at Knipanka Research Station, 35 km east of Sulaimani city, with GPS reading of 35º 22'25" N, 45º 43'25", E with an altitude (550 m above sea level). The experiment includes the study of the effect of irrigation methods, nitrogen and calcium with different levels on watermelon. Top Yield variety of watermelon was used in this experiment, the standard properties of this grown variety are: Top Yield is a seeded watermelon variety.. It has a green foliage and (1-2 m) vine length. Top yield fruit weight is a bout (8-10) kg oval shape and its color is light green with light dark stripes. The flesh of this variety is light red and seeds are small and light dark Top Yield fruit needs 70-100 day to maturity.

Some physical and chemical properties of the study location soil, water and metrological data during the study period are shown in the tables (1, 2 and 3) respectively

Table -1: Some physical and chemical properties of the experiment location soil.

Properties	Sand g kg^{-1}	Silt g kg^{-1}	Clay gkg^{-1}	Texture	EC ($dS.m^{-1}$)	pH	Total N %	Available P (mg kg^{-1})	Soluble K^{+} (Meq l^{-1})	Soluble Ca (Meq l^{-1})	$CaCO_3$ g kg^{-1}
Values	*46*	*532*	*422*	*Silty-Clay*	*0.11*	*7.77*	*0.15*	*8.4*	*0.058*	*1.4*	*185*

Table -2: Some meteorological data of the study location during the study period.

Months (2014-2015)	*Jan. (2015)*	*Feb. (2015)*	*Mar. (2015)*	*Apr. (2015)*	*May. (2015)*	*June (2015)*	*July (2015)*	*Aug. (2015)*
Rainfall (mm)	*70.7*	*99.5*	*62.5*	*4.5*	*11*	…..	…..	…..
Minimum TC^{0} (day)	*8*	*10*	*10*	*16*	*29*	*37*	*40*	*38*
Maximum TC^{0} (day)	*18*	*22*	*25*	*34*	*40*	*44*	*48*	*45*
Minimum TC^{0} (night)	*-6*	*-4*	*-4*	*-1*	*4*	*12*	*17*	*16*
Maximum TC^{0} (night)	*3*	*8*	*9*	*8*	*19*	*20*	*28*	*29*

Table -3: Chemical analyses of the irrigation water in Kanipanka (Meq l^{-1})

Sample water	**EC ($ds.m^{-1}$)**	**pH**	**K^{+}**	**Na^{+}**	**Ca^{2+}**	**Mg^{2+}**	**HCO_3**	**Cl^{-}**
Well water	**0.47**	**7.62**	**0.053**	**0.870**	**2.5**	**3.7**	**2.7**	**0.7**

***Experimental design*:** Experiments were designed as a split-split plot design embedded in a randomized complete block design (RCBD) with (3) replications.

The factorial experiment included 3 factors as follow:

1. Factor of methods of irrigation (Drip and surface) irrigation systems.
2. Nitrogen factor (0, 200 and 400 ppm N). as pure nitrogen
3. Calcium factor (0, 100, 300 and 600 ppm Ca) as pure calcium

***Seed sowing and Plowing*:** The field was prepared through plowing by rotary Rotuvator in 13 April and the rows were prepared mechanically with (3 m) length and (1.5) width. Seeds were planted directly in the field on 15 April (2015). Six holes were prepared on one side of the rows with a tool or finger, (2-4) seeds were put in each hole then covered by moist soil and pressed lightly to keep the moisture around the seeds. After planting the first irrigation was applied directly, and after emergence of the seedlings were thinned to a single strong plant per hole. Each plot consisted of a single row by six plants spaced (50 cm) between them giving an area of (0.75 m^2). Standard agricultural practices such as hoeing, weeding and pest controls were carried out during the growing season for all replications, and the chemical fertilizer TSP triple superphosphate was added to the soil once at a rate of 340 kg ha^{-1}. The field was irrigated as needed by using tensiometer depended on vacuum gauge reading (35) centibar for flowering and fruit setting phase and (40) centibar for vegetative growth phase, which was every (3-4) days for drip irrigation and once a week for the surface irrigation. The fruits were harvested 80-95 days after sowing seeds.

Treatments: The experiment included three factors which were 1. Irrigation systems (Drip and Surface) which is assigned in the main plot. 2. Nitrogen in the form of urea $CO(NH_2)_2$ (46% N) (0,200 and 400 ppm) in sub-plot and 3.Calcium in the form of $CaCl_2$ (0, 100, 300 and 600 ppm) which represented in the sub-sub plot.

***Fertilizer application*:** Foliar application was used at three times. The first application was 20 days after planting on (May 5) (true leaf formation phase, second at the early runner phase on (May 25)(flowering phase) and third when the diameter of fruit was about 5 cm on(June 15) (fruit setting phase).

***Studied parameters*:** Three plants were labeled from each plot and the means were calculated for the following parameters.

Fruit size (cm^3): 2. Rind thickness: 3. Total soluble solids: (T.S.S %) 4. pH: 5 Dry matter%: 6. Sucrose%: 7. Nitrogen%: 8. Calcium%

***Statistical analysis*:** The results were analyzed statistically and the comparisons among means were carried out by Duncan's multiple range test (0.05) which analyzed by a computer JMP7 program statistical social science. Values were subjected to square root transformation whenever it was necessary

Results and Discussion

1. *Dry matter %*: Table (4) explains significant difference of irrigation methods, the highest value of dry matter % (4.17) was obtained from surface irrigation and the lowest value (3.90 %) was obtained from drip irrigation. Table (5) shows significant effects of nitrogen levels on watermelon dry matter (%), the obtained data (3.96, 3.80 and 4.36 %) were obtained from (N_0, N_1 and N_2), respectively. These differences may be due to nitrogen which enhanced more leaf area resulting in higher assimilations and thereby resulting in more dry matter accumulation (Indira, 2005). These results agree with [7].Similar effects of nitrogen were reported by [14] who found that highest dry matter obtained from 4000 mg l, while lowest dry matters obtained from zero nitrogen (control treatment).

Table (6) demonstrates that calcium levels was significantly affected on fruit dry mater content , the highest percentage (4.95%) was obtained from (Ca_3), and the lowest percentages (3.88%) were obtained from (Ca_1). Similar finding observed by [14] who found that maximum dry matter obtained from 300 mg.IL., while minimum dry matter obtained from zero calcium. The increase of Ca concentration from 1.5 to 4 mmol l^{-1} increased root and shoot dry matter weights in sweet pepper [15]. The beneficial effect of Ca supply on dry matter and yield could be a consequence of the positive correlation between membrane and calcium content in plant tissue [16].

Tables (7, 8 and 9) demonstrate that fruit dry matter % was significantly affected by different interactions. The highest value (4.39, 4.57 and 5.19 %) obtained from (S x N_2), (S x Ca_3) and (N_2 x Ca_3) interactions, respectively, while the lower dry matter contents (3.78, 3.69 and 3.52%) obtained from (D x N_1), (D x Ca_1) and (N_1 x Ca_0) interactions, respectively. Table (10) explains significant differences between different (irrigation, nitrogen and calcium) interactions. Maximum and minimum fruit dry matter content (5.26%) and (3.48%) observed from (S x N_2 x Ca_3) and (D x N_1 x Ca_0) interactions, respectively. There were no significant differences between nitrogen levels.

2. *Nitrogen %*: Table (4) explains that nitrogen concentration in watermelon fruit juice was not affected by irrigation methods. Table (5) shows that nitrogen treatment significantly nitrogen effected the concentration in watermelon fruit juice. Increase in nitrogen levels (N_0, N_1 and N_2) caused increase in nitrogen content of fruit juice (0.05, 0.07 and 0.18 %), respectively. Table (6) demonstrated that calcium treatments had no significant effect on nitrogen concentration in watermelon fruit juice. Table (7) demonstrates that the interaction treatment (Irrigation x Nitrogen) affected significantly on nitrogen concentration of fruit juice. The highest value (0.14%) was obtained from (D x N_2), while the lowest value (0.05 %) was obtained from (D x N_0) and (S x N_0) interaction. Table (8) shows that there was no significant effect between the interaction treatments (irrigation x calcium). Table (9) shows that the interaction effect between (nitrogen^x x calcium) significantly affected on nitrogen concentration in the fruit juice, the highest N% (0.25) was obtained from (N_2 x Ca_3) and (N_2 x Ca_1), while the lowest N% (0.04) was obtained from (N_0 x Ca_0).According to some authors, Ca has a direct, positive effect on N assimilation, promoting both the uptake and better use of nitrogen [17] and [18]. Table (10) shows significant interaction effect of (irrigation, nitrogen and calcium) on N%.. Maximum N% (0.40) observed in (D x N_2 x Ca_1) and (D x N_2 x Ca_3), while the minimum value (0.04) observed in (D x N_0 x Ca_0), (S x N_0 x Ca_0) and (S x N_0 xCa_0).

3. *Ca%*: Table (4) explains significant effect of irrigation method on concentration of calcium in watermelon fruit juice, the highest Ca% (0.92) was obtained from surface irrigation , while the lowest Ca% (0.89) was obtained from drip irrigation. This may be due to differing in amount of irrigation water which causes differing in calcium added from irrigation water to plant [19]. Table (5) shows that nitrogen levels had not significantly affected on calcium concentration in watermelon fruit juice. Table (6) shows that fruit calcium concentration was increased with increase in calcium application. The observed Ca% (0.58, 0.84, 0.99 and 1.12) were obtained from (Ca_0, Ca_1, Ca_2 and Ca_3), respectively.

Table -4: Effect of irrigation methods on some physical and chemical characteristics of watermelon*

Irrigation system	*Dry matter %*	*N %*	*Ca %*	*Sucrose %*	*T.S.S %*	*pH*	*Fruit size (cm^3)*	*Rind thickness (cm)*
Drip	3.90^b	0.10^a	0.89^b	2.72^a	6.71^a	5.50^a	3160^a	0.77^a
Surface	4.17^a	0.08^a	0.92^a	3.01^a	7.04^a	5.61^a	2940^a	0.81^a

*Numbers within a column carrying the same letters are not different significantly according to Duncan's multiple range test at 0.05 level.

Table-5: Effect of Nitrogen on some physical and chemical characteristics of watermelon*

N-levels ppm	*Dry matter %*	*N%*	*Ca %*	*Sucrose %*	*T.S.S %*	*pH*	*Fruit size (cm^3)*	*Rind thickness (cm)*
N0	3.96^b	0.05^b	0.89^a	2.69^b	6.94^a	5.55^a	3120^a	0.79^a
N1	3.80^b	0.07^b	0.88^a	2.94^a	6.85^a	5.55^a	2990^a	0.78^a
N2	4.36^a	0.18^a	0.92^a	2.96^a	6.83^a	5.57^a	3040^a	0.79^a

*Numbers within a column carrying the same letters are not different significantly according to Duncan's multiple range test at 0.05 level.

Table-6: Effect of Calcium on some physical and chemical characteristics of watermelon

Ca-levels ppm	*Dry matter %*	*N%*	*Ca %*	*Sucrose %*	*T.S.S %*	*pH*	*Fruit size (cm^3)*	*Rind thickness (cm)*
Ca 0	*3.99 b*	*0.07 a*	*0.58 d*	*2.56 c*	*6.78 a*	*5.49 a*	*2542 c*	*o.71 b*
Ca 100	*3.88 b*	*0.13 a*	*0.84 c*	*2.61 c*	*6.72 a*	*5.59 a*	*2680 c*	*0.78 b*
Ca300	*3.98 b*	*0.08 a*	*0.99 b*	*3.01 b*	*6.82 a*	*5.51 a*	*3243 b*	*0.74 b*
Ca 600	*4.95 a*	*0.11 a*	*1.12 a*	*3.27 a*	*6.91 a*	*5.63 a*	*3731 b*	*0.92 a*

*Numbers within a column carrying the same letters are not different significantly according to Duncan's multiple range test at 0.05 level.

Tables (7, 8 and 9) explain that fruit Ca% was significantly affected by different interactions. The higher Ca% (0.96, 1.23 and 1.26) were obtained from (D x N_2), (S x Ca_3) and (N_0 x Ca_3) interactions, respectively, while the lowest Ca% (0.82, 0.56 and 0.54) obtained from (D x N_1), (S x Ca_0) and (N_0 x Ca_0) interactions, respectively. Table (10) shows significant differences among different (irrigation, nitrogen and calcium) interactions. Maximum (1.35) and minimum (0.44) Ca% were observed from (D x N_0 x Ca_3) and (D x N_0 x Ca_0) interactions, respectively.

4. *Sucrose%*: Table (4) explains that watermelon fruit sucrose concentration % was not significantly affected by irrigation methods. Table (5) shows that fruit sucrose% concentration significantly affected by different nitrogen levels. Maximum sucrose concentration (2.96%) was obtained from (N_2), while minimum sucrose content (2.69%) was obtained from (N_0). There were no significant differences between irrigation methods. Table (6) explains that watermelon fruit sucrose concentration was increased by the increase in calcium application. The observed sucrose concentration (2.56, 2.61, 3.15, 3.27%) were obtained from (Ca_0, Ca_1, Ca_2 and Ca_3), respectively.

Tables (7, 8 and 9) show that watermelon fruit sucrose% was significantly affected by different interaction treatments. The higher fruit sucrose concentration (3.15, 3.19 and 3.38%) was obtained from (S x N_2), (S x Ca_3) and (N_1 x Ca_3) interactions, respectively, while the lowest value (2.49, 2.20 and 2.13) obtained from (D x N_0), (D x Ca_0) and (N_0 x Ca_0) interactions, respectively. Table (10) shows that the interaction among factors (irrigation, nitrogen and calcium) affected significantly on watermelon fruit sucrose %. The highest (3.51) and lowest (1.65) values were recorded from (S x N_2 x Ca_3) and (D x N_0 x Ca_0), respectively.

5. *Total soluble solids %*: Tables (4, 5 and 6) demonstrate that irrigation methods, calcium and nitrogen had no significant effect on watermelon fruit T.S.S value. Tables (7, 8 and 9) show that T.S.S value of watermelon fruit juice was significantly affected by different interactions. The highest fruit TSS value (7.17, 7.41 and 7.25 %) were obtained from (S x N_0), (S x Ca_3) and (N_1 x Ca_3) interactions, respectively, while lowest fruit TSS value (6.60, 6.51 and 6.56 %) obtained from (D x N_2), (D x Ca_0) and (N_1 x Ca_2) interactions, respectively.

Table (10) shows that the interactions among (irrigation, nitrogen and calcium) were significantly affected on TSS values of fruit juice , the highest TSS value (7.63) and the lowest TSS value (6.20), were obtained from (S x N_0 x Ca_3) and (D x N_2 x Ca_0), respectively. This may be due to combination of individual factor which some resulted in physiological status leads to further more absorption of mineral nutrition [20].

6. *pH:* Tables (4, 5 and 6) demonstrate that irrigation methods, Calcium and nitrogen levels were not significantly affected on watermelon fruit pH value. Table (7) explains that watermelon fruit pH value was significantly affected by (irrigation x nitrogen) interactions. The highest value (5.72) was obtained from (S x

N_2), while the lowest value (5.43) was obtained from (D x N_2). Tables (8 and 9) explain that watermelon fruit pH value was not affected by the interaction between (irrigation x calcium) and (Nitrogen x calcium). Table (10) shows the interaction among (irrigation methods x levels of nitrogen x levels of calcium) affected significantly on watermelon fruit pH value. The maximum (5.96) and minimum (5.30) values observed in (S x N_2 x Ca_1) and (D x N_1 x Ca_2) interactions, respectively.

7. *Fruit Size*:Tables (4 and 5) explain that watermelon fruit size was not significantly affected by irrigation methods and nitrogen levels. Table (6) shows that watermelon fruit size significantly affected by calcium levels, the maximum fruit size (3731 cm^3) was obtained from (Ca_3) and the minimum size (2542 cm^3) was obtained from (Ca_0). Cell wall strength and thickness are increased by calcium addition. Calcium is a critical part of the cell wall that produces strong structural rigidity by forming cross-links within the pectin polysaccharide matrix. With rapid plant growth, the structural integrity of stems that hold flowers and fruit, as well as the quality of the fruit produced, is strongly coupled with calcium availability [8]. Table (7) shows that the interaction between (irrigation x nitrogen) had significant effect on fruit size, the largest fruit size (3343 cm^3) was obtained from (D x N_0), while the lowest volume (2842 cm^3) was obtained from (S x N_2). Tables (8 and 9) demonstrate that there was significant differences among different interactions (irrigation x calcium) and (nitrogen x calcium). The largest fruit size (3920 and 3914 cm^3) were obtained from (D x Ca_3) and (N_0 x Ca_3), while the least fruit size (2411 and 2305 cm^3) were obtained from (S x Ca_0) and (N_2 x Ca_0), respectively. Table (10) shows significant differences between different (irrigation, nitrogen and calcium) interactions. Maximum fruit size (4261 cm^3) and minimum (2101 cm^3) observed in (D x N_2 x Ca_3) and (S x N_2 x Ca_0) interactions, respectively.

8. *Rind thickness*: Tables (4 and 5) explain that irrigation methods and nitrogen levels were not significantly affected on watermelon rind thickness. .
Table (6) shows significant differences among calcium levels, regarding rind thickness (0.71, 0.78, 0.74 and 0.92 cm) were obtained from (Ca_0, Ca_1, Ca_2 and Ca_3), respectively. However irrigation methods and nitrogen treatment had no significant effect on rind thickness. The reason may be due to that calcium plays an integral role in growth and cell wall stabilization [21]. Increased Ca concentrations in developing watermelon rind tissue might allow development of a stronger rind. Increased Ca rates have increased watermelon rind thickness or failed to influence rind thickness or rupture pressure [22]. The most important metabolic functions of Ca include its role in membrane stability and maintenance of cell integrity [16].
Tables (7, 8 and 9) show that watermelon rind thickness was significantly affected by different interactions (irrigation x nitrogen) (irrigation x calcium) and (nitrogen x calcium). The thickest rind (0.86, 0.95 and 0.93 cm) were obtained from (S x N_2), (S x Ca_3) and (N_2 x Ca_3), while the thinnest rind (0.72, 0.68 and 0.70 cm) were obtained from (D x N_2), (D x Ca_2) and (N_2 x Ca_2), respectively. .
Table (10) shows significant differences among different (irrigation, nitrogen and calcium) interactions. Maximum (1.06 cm and minimum 0.53) cm rind thickness were observed in (S x N_2 x Ca_3) and (D x N_2 x Ca_2) interactions, respectively.

Table-7: Effect of (Irrigation X Nitrogen) interactions on some chemical and physical characteristics of watermelon*

Irr. × N	*Dry matter %*	*N%*	*Ca %*	*Sucrose%*	*T.S.S (Brix)*	*pH*	*Fruit size (cm^3)*	*Rind thickness (cm)*
D × N0	3.81^{cd}	0.05^{b}	0.88^{ab}	2.49^{d}	6.71^{ab}	5.62^{a-c}	3340^{a}	0.77^{ab}
D × N1	3.78^{d}	0.07^{b}	0.82^{b}	2.80^{bc}	6.82^{ab}	5.45^{bc}	2900^{ab}	0.84^{ab}
D × N2	4.32^{ab}	0.14^{a}	0.96^{a}	2.77^{c}	6.60^{b}	5.43^{c}	3250^{ab}	0.72^{b}
S × N0	4.10^{a-c}	0.05^{b}	0.90^{ab}	2.88^{bc}	7.17^{a}	5.47^{bc}	2900^{ab}	0.83^{ab}
S × N1	4.02^{bc}	0.07^{b}	0.94^{ab}	3.00^{ab}	6.88^{ab}	5.64^{ab}	3070^{ab}	0.73^{b}
S × N2	4.39^{a}	0.10^{b}	0.93^{ab}	3.15^{a}	7.06^{ab}	5.72^{a}	2840^{b}	0.86^{a}

*Numbers within a column carrying the same letters are not different significantly according to Duncan's multiple range test at 0.05 level

Table-8: Effect of (Irrigation x Calcium) interactions on some chemical and physical characteristics of watermelon*

Irr. × Ca	*Dry matter %*	*N%*	*Ca %*	*Sucrose %*	*T.S.S %*	*pH*	*Fruit size (cm^3)*	*Rind thickness (cm)*
D × Ca0	3.92^{bc}	0.07^{a}	0.59^{e}	2.20^{f}	6.51^{c}	5.50^{a}	2670^{cd}	0.77^{c}
D × Ca1	3.69^{c}	0.18^{a}	0.82^{d}	2.59^{e}	6.53^{c}	5.51^{a}	2610^{cd}	0.77^{bc}
D × Ca2	3.88^{c}	0.07^{a}	0.96^{bc}	2.89^{cd}	6.87^{bc}	5.48^{a}	3450^{ab}	0.68^{c}
D × Ca3	4.42^{ab}	0.11^{a}	1.19^{a}	3.19^{a}	6.91^{b}	5.52^{a}	3920^{a}	0.90^{ab}
S × Ca0	3.96^{b-c}	0.07^{a}	0.56^{e}	2.91^{bc}	7.05^{b}	4.48^{a}	2410^{d}	0.70^{c}
S × Ca1	4.06^{bc}	0.08^{a}	0.87^{cd}	2.64^{de}	6.85^{bc}	5.67^{a}	2760^{cd}	0.78^{bc}
S × Ca2	4.09^{bc}	0.08^{a}	1.02^{b}	3.14^{ab}	6.81^{bc}	5.53^{a}	3010^{bc}	0.80^{abc}
S × Ca3	4.57^{a}	0.07^{a}	1.23^{a}	3.19^{a}	7.41^{a}	5.75^{a}	3550^{ab}	0.95^{a}

Table-9: Effect of (Nitrogen X Calcium) interactions on some chemical and physical characteristics of watermelon*

N × Ca	*Dry matter %*	*N %*	*Ca %*	*Sucrose %*	*T.S.S %*	*pH*	*Fruit size (cm^3)*	*Rind thickness (cm)*
N0 × Ca0	4.05^{b}	0.04^{b}	0.54^{g}	2.135^{f}	$6.81^{b\text{-}d}$	5.56^{a}	$2710^{c\text{-}f}$	0.71^{c}
N0 × Ca1	3.89^{b}	0.06^{b}	0.75^{f}	2.418^{ef}	$6.78^{b\text{-}d}$	5.55^{a}	2530^{ef}	$0.80^{a\text{-}c}$
N0 × Ca2	3.87^{bc}	0.05^{b}	1.02^{d}	3.02^{bc}	$7.05^{a\text{-}c}$	5.48^{a}	$3330^{a\text{-}c}$	0.71^{c}
N0 × Ca3	4.32^{bc}	0.05^{b}	1.26^{a}	3.19^{ab}	7.13^{ab}	5.60^{a}	3910^{a}	0.93^{a}
N1 × Ca0	3.52^{c}	0.07^{ab}	0.61^{g}	$2.68^{d\text{-}f}$	$6.86^{a\text{-}d}$	5.50^{a}	$2610^{d\text{-}f}$	0.68^{c}
N1 × Ca1	3.81^{bc}	0.07^{ab}	0.88^{e}	$2.69^{d\text{-}f}$	$6.73^{b\text{-}d}$	5.53^{a}	$2500^{e\text{-}f}$	0.73^{bc}
N1 × Ca2	3.98^{bc}	0.08^{ab}	0.88^{e}	3.03^{bc}	6.56^{d}	5.60^{a}	$3230^{b\text{-}d}$	$0.81^{a\text{-}c}$
N1 × Ca3	4.53^{b}	0.07^{ab}	1.15^{bc}	3.38^{a}	7.25^{a}	5.56^{a}	3610^{ab}	0.91^{ab}
N2 × Ca0	4.25^{b}	0.10^{ab}	0.58^{g}	2.85^{cd}	6.68^{cd}	5.41^{a}	2300^{f}	0.73^{bc}
N2 × Ca1	3.92^{bc}	0.25^{a}	0.90^{e}	2.74^{cd}	6.65^{cd}	5.70^{a}	$3030^{b\text{-}e}$	$0.81^{a\text{-}c}$
N2 × Ca2	4.06^{b}	0.11^{ab}	1.07^{cd}	2.99^{bc}	$6.85^{a\text{-}d}$	5.45^{a}	$3160^{b\text{-}e}$	0.70^{c}
N2 × Ca3	5.19^{a}	0.25^{a}	1.23^{ab}	3.25^{ab}	7.15^{ab}	5.75^{a}	3687^{ab}	0.93^{a}

*Numbers within a column carrying the same letters are not different significantly according to Duncan's multiple range test at 0.05 level.

Table-10: Effect of (Irrigation X Nitrogen x Calcium) interactions on some chemical and physical characteristics*

Irr. × N × Ca	Dry matter %	N %	Ca %	Sucrose %	T.S.S %	pH	Fruit size (cm^3)	Rind thickness (cm)
D. × N0 × Ca0	4.15^{b-d}	0.04^{b}	0.44^{n}	1.65^{m}	6.76^{c-f}	5.63^{ab}	3060^{d-h}	0.66^{c-e}
D. × N0 × Ca1	3.63^{cd}	0.06^{b}	0.68^{k-m}	2.23^{l}	6.56^{d-f}	5.66^{ab}	2430^{g-i}	0.80^{a-e}
D. × N0 × Ca2	4.04^{b-d}	0.05^{b}	0.99^{d-g}	3.18^{a-f}	6.90^{b-e}	5.53^{ab}	4060^{ab}	0.60^{de}
D. × N0 × Ca3	4.60^{ab}	0.05^{b}	1.35^{a}	3.2^{a-f}	6.63^{c-f}	5.66^{ab}	3800^{a-d}	0.93^{a-c}
D. × N1 × Ca0	3.48^{d}	0.07^{b}	0.66^{lm}	2.56^{j-l}	6.66^{c-f}	5.46^{ab}	2460^{d-i}	0.70^{b-e}
D. × N1 × Ca1	3.51^{d}	0.076^{b}	0.84^{hg}	2.58^{i-l}	6.80^{c-e}	5.43^{ab}	2200^{hi}	0.76^{b-e}
D. × N1 × Ca2	3.71^{b-d}	0.08^{b}	0.69^{j-l}	3.04^{b-h}	6.80^{c-e}	5.63^{ab}	3260^{b-g}	0.93^{a-c}
D. × N1 × Ca3	4.63^{b}	0.07^{b}	1.10^{g-e}	3.38^{ab}	7.03^{b-d}	5.30^{b}	3700^{a-e}	0.96^{a-c}
D. × N2 × Ca0	4.13^{b-d}	0.11^{b}	0.62^{l-n}	2.41^{kl}	6.20^{f}	5.40^{ab}	2500^{g-i}	0.80^{a-e}
D. × N2 × Ca1	3.95^{b-d}	0.40^{a}	0.93^{fi}	2.95^{c-j}	6.33^{ef}	5.48^{ab}	3200^{b-g}	0.76^{b-e}
D. × N2 × Ca2	4.07^{b-d}	0.11^{b}	1.186^{c}	2.74^{g-k}	6.76^{c-f}	5.30^{b}	3030^{d-i}	0.53^{e}
D. × N2 × Ca3	5.13^{a}	0.40^{a}	1.12^{cd}	2.99^{b-i}	7.10^{a-d}	5.60^{ab}	4260^{a}	0.80^{a-e}
S. × N0 × Ca0	3.95^{b-d}	0.04^{b}	0.58^{l-n}	2.62^{h-l}	6.86^{c-d}	5.50^{ab}	2360^{gi}	0.66^{de}
S. × N0 × Ca1	4.15^{b-d}	0.06^{b}	0.81^{jk}	2.60^{i-l}	7.00^{b-d}	5.43^{ab}	2630^{fi}	0.83^{a-e}
S. × N0 × Ca2	4.18^{b-d}	0.06^{b}	1.05^{c-f}	3.15^{a-g}	7.20^{a-c}	5.43^{ab}	2600^{fi}	0.83^{a-e}
S. × N0 × Ca3	4.27^{b-d}	0.04^{b}	1.17^{c}	3.16^{a-f}	7.63^{a}	5.53^{ab}	4030^{a-c}	0.93^{abc}
S. × N1 × Ca0	3.56^{d}	0.07^{b}	0.57^{l-n}	2.81^{e-k}	7.06^{a-d}	5.53^{ab}	2760^{e-i}	0.70^{b-e}
S. × N1 × Ca1	4.12^{b-d}	0.07^{b}	0.93^{f-i}	2.79^{f-k}	6.66^{c-f}	5.63^{ab}	2800^{e-i}	0.73^{b-e}
S. × N1 × Ca2	4.12^{b-d}	0.08^{b}	1.06^{c-f}	3.03^{b-h}	6.33^{ef}	5.56^{ab}	3200^{b-g}	0.70^{b-e}
S. × N1 × Ca3	4.33^{bc}	0.07^{b}	1.19^{bc}	3.38^{ab}	7.46^{ab}	5.83^{ab}	3530^{a-f}	0.86^{a-d}
S. × N2 × Ca0	4.36^{b}	0.10^{b}	0.55^{mn}	3.31^{a-c}	7.16^{a-c}	5.43^{ab}	2100^{i}	0.73^{c-e}
S. × N2 × Ca1	3.90^{b-d}	0.11^{b}	0.87^{g-i}	2.54^{j-l}	6.96^{b-d}	5.96^{a}	2860^{d-i}	0.86^{a-d}
S. × N2 × Ca2	4.24^{bc}	0.11^{b}	0.96^{e-h}	3.24^{a-d}	6.93^{b-d}	5.60^{ab}	3300^{b-g}	0.86^{a-d}
S. × N2 × Ca3	5.263^{a}	0.10^{b}	1.34^{ab}	3.510^{a}	7.20^{a-c}	5.90^{a}	3100^{c-h}	1.06^{a}

*Numbers within a column carrying the same letters are not different significantly according to Duncan's multiple range test at 0.05 level.

Conclusions

According to the results obtained from this study, the following conclusions could be drawn: Surface (furrow) irrigation, Calcium and Nitrogen increased dry matter. The interactions of irrigation methods, nitrogen and calcium were significantly affected dry matter%, sucrose, pH value and rind thickness.

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