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Impact of Foliar Application with Calcium under different Kaolin Rates on Growth and Yield of Tomato Grown in High Temperature Condition.

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ABSTRACT

Two experiments were carried out at a private farm located in Dimiana village, Belqas District, Dakahlia Governorate, Egypt during the two consecutive summer seasons of 2018 and 2019 to study the effect of different rates of kaolin (0.0, 20, 40 and 60 g /l) in combined with calcium (0.0, 400 and 800 mg/l) on vegetative growth, water relations, leaf chemical composition as well as fruits yield and its quality of tomato.. The obtained results revealed that the highest values of plant height, leaf area per plant, leaf dry matter percentage, relative water content percentage, leaf pigments, fruit yield per plant as well as total marketable yield per feddan, vitamin C and lycopene content of tomato plant were achieved with kaolin at 40 g/l with significant difference comparing the other rates under study. While, increasing kaolin to 60 g/l decreased the above mentioned parameters during both seasons. Furthermore, increasing calcium rate from 400 to 800 mg/l increased tomato growth and productivity compared to control (untreated plants). In general, it could be concluded that spraying tomato plants with 40 g/l of kaolin combined with 800 mg/l of calcium, showed improvement in vegetative growth parameters, water relations, leaf pigments, fruits yield and its components as well as fruits chemical constituents under Dakahlia Governorate conditions.

***Keywords**: Lycopersicon esculentum*, kaolin, calcium, growth, yield and chemical constituents

INTRODUCTION

The one of the most important and popular vegetables all over the world and in Egypt is tomato (*Lycopersicon esculentum* Mill.). It belongs to family solanaceae. In Egypt, it is found in the market over all months of the year. Moreover, it exemplifies one of the most remarkable vegetable crops for each of local consuming and exportation. Afzal *et al.* (2013) reported that tomato fruits are well known for its nutritional significance as it is the rich source of nutrients, vitamins (A and C) and antioxidants (lycopene).

Kaolin is a white nonabrasive fine-grained and contains alumino silicate mineral [$Al_4Si_4O_{10}(OH)_8$] that has been purified and sized so that it acts as an anti-transpirant and easily disperses in water as well as reducing drought stress on plants (Kamal, 2013). Kaolin as a particle film has long been utilized to limit the impact of heat and water stress on several plants (Cantore *et al.*, 2009). Kaolin spray was get going to reducing leaf temperature by increasing leaf reflectivity and to decrease rate of transpiration in many plant species grown at a high solar radiation (Nakano and Uehara, 1996).

The application of foliar fertilizers may increase growth and productivity of vegetables plants. Calcium (Ca) is one of the nutrients most a lot utilized on the vegetables leaves (Pollyana *et al*., 2016). Calcium collaborates on the formation of cell wall of plant (Malinovsky *et al*., 2014) and is a nutrient imparted by the xylem from the root system. Small amounts of Ca reach fruit tissues, at the ending of cell split and the startung of cell development (Hahn *et al*., 2017). The development of apical or black rot in fruits occurs with calcium deficiency (Arruda Júnior *et al*., 2011).

The present study aimed to evaluate the impact of foliar nutrition of calcium on tomato grown under different kaolin rates on the growth and yield of fruit as well as quality of this crop under Dakahlia Governorate conditions.

MATERIALS AND METHODS

Two field experiments were carried out in a private farm located in Dimiana village, Belqas District, Dakahlia Governorate, Egypt in summer seasons of 2018 and 2019, to study the effect of foliar application with calcium on growth and yield of tomato under different kaolin rates grown under clay loamy soil conditions using drip irrigation system.. Soil samples from the top layer (0-30 cm depth) were randomly collected before planting for physical and chemical analysis (Table 1).

Tomato transplants (cv. 023) 30 days old were transplanted on 23th and 25th of June during both seasons. The plot area was 24 m^2. It consists of 3 dripper lines with 5 m length for each and 1.6 m distance between the two dripper lines. 0.5 m was the distance between the dripper and the other in the same line (5250 plants per fed.). In addition, one row was left between each two plots as guard area to avoid the overlapping of foliar applications.

Kaolin (0.0, 20, 40 and 60 g /litter) and calcium (0.0, 400 and 800 mg/l) were added as foliar application. Its volume was 150 and 250 litter per fed. in the 1st and 2nd foliar application, respectively but 350 litter per fed in the other times. The first application began after 15 days after

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planting and repeated every two week until the end of the season.

All treatments received 80 kg N, 55 kg P_2O_5 and 75 kg K_2O kg/ fed. as ammonium nitrate (33.5 %), phosphoric acid (85 % P_2O_5) and potassium sulfate (50 % K_2O), respectively as fertigation at 2 days interval beginning one week after planting. Also, Farmyard manure (FYM) at 20 m^3/ fed. was applied during soil preparation.

Table 1. Physical and chemical parameters during the two seasons of 2018 and 2019.

Seasons	Silt %	Clay %	Sand %	Texture soil	F.C %	W.P %	AW %	PH	E.C (dSm-1)	O.M %	$CaCO_3$ %	N ppm	P ppm	K ppm
2018	40.5	37.2	22.3	Clay loamy	35.7	18.9	16.8	8.22	1.51	1.8	3.39	51.9	5.7	288
2019	41.1	36.9	22.0	Clay loamy	35.2	18.4	16.8	8.13	1.78	2.o	3.45	54.1	6.2	294

F.C : Field Capacity; W.P.: Welting point; AW: Available water; OM: Organic matter

Experimental design:

Treatments were arranged in split plots in complete randomized blocks design with three replicates. Foliar applications of kaolin were assigned in the main plots, while foliar applications with calcium were allocated in the sub plots.

Measurements:

Three plants were taken at random from each plot at 65 days after planting to evaluate the following parameters for the two seasons.

1.Vegetative growth characters:

Plant height (cm), foliage weight (g) / plant, leaves fresh weight, leaves number / plant, leaves area (m2) / plant and leaves dry matter percentage.

2.Water relations and leaves chemical composition:

Leaf relative water content (LRWC) and leaf membrane stability index were evaluated according to Hayatu et al. (2014). Chlorophyll a, b and carotenoids content were determined according to AOAC (1990).

3.Fruits set, fruits yield and its physical quality:

At 65 days after planting, the fruits set percentage were determined as /(flowers buds number + flowers number and fruits number / plant) × 100.

At 75 days after planting ten plants from each plot were chosen and labeled for the present study to measured fruits weight and numbers per plant, fruits weight with blossom end rot(ton/ fed).marketable yield (ton/ fed) and total yield (ton/ fed).

4.Fruits chemical quality:

At 85 days after planting fruits DM%, Vit. C, acidity, TSS and lycopene content were determined according to A.O.A.C (1990).

Statistical analysis:

Data were statistically analyzed using the analysis of variance according to Snedecor and Cochran (1980). Least significance difference (LSD) was used to differentiate means at the at 5 % level of probability.

RESULTS AND DISCUSSION

1- Vegetative growth characters:

The obtained results in Table 2 demonstrate that the tallest, heaviest foliage and leaves as well as the more leaves of tomato plants were achieved with the medium kaolin rate (40 g/l) compared to the other rates under study and control during both seasons. Furthermore, leaf area (m2/plant) and leaves dry matter gradually increased with increasing kaolin rates up to 40 g/l then it was decreased. Generally, all kaolin rates significantly increased tomato vegetative growth characters compared to control (untreated) in the two seasons. The positive effect on growth of tomato may be due to that kaolin foliar spray help to reduce the transpiration rate, and this in turn led to hold higher water content in the tissues of plant and this might favor the plant metabolism especially carbohydrate metabolism and many other important functions that directly influence growth of the plants (Bafeel and Moftah, 2008 and Cantore et al., 2009). Obtained results are in agreement with those stated by Ibrahim and Selim (2010) on squash and Ahmed (2019) on tomato.

Table 2. Impact of foliar application with calcium on vegetative growth characters of tomato at 65 days under different kaolin rates during the two seasons of 2018 and 2019.

Treatments		Plant height (cm).		Foliage FW g / plant		Leaves FW g / plant		Leaves No / plant		Leaves area (m^2) / plant		Leaves DM %	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Kaolin g/l.													
zero		123.8	126.5	1585	1623	1061	1086	174.2	178.3	1.874	1.918	12.56	12.86
20		131.8	135.0	1689	1729	1130	1157	185.5	190.0	1.996	2.044	13.39	13.71
40		137.1	140.4	1757	1799	1175	1203	193.2	197.6	2.076	2.126	14.22	14.56
60		132.3	135.4	1694	1734	1133	1160	186.0	190.5	2.002	2.050	13.43	13.75
LSD 5%		2.8	2.7	36	41	24	26	3.9	4.4	0.042	0.043	0.30	0.28
Calcium mg/l													
zero		126.3	128.4	1618	1647	1082	1102	177.8	180.9	1.912	1.947	12.82	13.05
400		132.5	135.8	1697	1740	1135	1164	186.4	191.0	2.006	2.056	13.67	14.02
800		134.9	138.7	1729	1777	1167	1189	190.0	195.4	2.043	2.101	13.70	14.09
LSD 5%		2.2	2.4	28	29	19	21	3.1	3.4	0.034	0.049	0.23	0.26
Interaction													
	zero	122.4	124.1	1567	1595	1049	1067	172.3	175.3	1.852	1.886	12.42	12.64
zero	400	122.8	125.8	1572	1613	1052	1078	172.6	177.0	1.859	1.905	12.46	12.78
	800	126.2	129.7	1616	1661	1081	1112	177.7	182.6	1.910	1.964	12.81	13.17
	zero	123.9	126.1	1586	1615	1061	1081	174.3	177.3	1.875	1.909	12.57	12.80
20	400	134.2	137.5	1719	1761	1150	1179	189.0	193.3	2.031	2.082	13.62	13.96
	800	137.5	141.4	1761	1811	1179	1212	193.3	199.3	2.082	2.140	13.96	14.35
	zero	130.8	133.1	1675	1705	1121	1141	184.3	187.3	1.980	2.015	13.28	13.52
40	400	139.7	143.2	1789	1834	1197	1227	196.6	201.6	2.115	2.168	15.07	15.45
	800	141.0	145.0	1806	1857	1209	1243	198.7	204.0	2.135	2.195	14.32	14.72
	zero	128.2	130.6	1643	1672	1099	1119	180.3	183.6	1.942	1.976	13.02	13.25
60	400	133.3	136.7	1708	1751	1143	1171	187.3	192.3	2.019	2.069	13.54	13.88
	800	135.2	139.0	1731	1780	1158	1191	190.3	195.6	2.046	2.104	13.72	14.11
LSD 5%		4.6	4.8	59	63	39	43	6.5	7.1	0.070	0.91	0.49	0.51

Also, growth parameters of tomato were gradually increased as calcium rates increased (Table 2). The best results in this regard are significantly obtained by 800 mg Ca/l compared to other rates under study. Calcium element performs many roles in the plant cell physiology. It is important intracellular messengers, abiotic and biotic stress signals, mediating responses to hormones and a variety of developmental processes (Reddy and Reddy, 2004). Kazemi (2013) on cucumber and Ashraf *et al*. (2018) on tomato plants also reported similar results.

Data recorded in Table 2 show that all combination treatments between kaolin and calcium increased tomato plant height, fresh weights of foliage and leaves, leaf number/tomato plant, leaves area and leaf dry weight compared to control. Moreover, the highest values in this concern were obtained by the combination treatment between 40 g/l of kaolin + 800 mg/l of calcium during both seasons. These results in accordance with El-Said (2015) on eggplant and Abd-Hamied and Abd-Hady (2018) on tomato

2- Water relations and leaves chemical pigments:

Table 3 shows that the highest values for each of relative water content (%), membrane stability as well as chlorophyll a, chlorophyll b and carotenoids contents were obtained by tomato plants which treated with 40 kaolin g/l., followed with plants treated with 60 kaolin g/l., compared to the lowest level (0.0 kaolin g/l.,) in both seasons. In general, increasing rates of kaolin contributed to an increase in water relations and leaves chemical pigments of tomato plants. The positive effect of kaolin on the preservation of the photochemical processes especially pigments may be its application as a foliar spray was found to decrease leaf temperature due to increase leaf reflectance, reduce transpiration rate and improve metabolic process in plants. Our results are in harmony with those obtained by Kuruppaiah *et al*. (2003), El-Said (2015) on eggplant and Ahmed (2019) on tomato.

The results illustrated in Table 3 reveal that relative water content percentage, membrane stability, chlorophyll a, chlorophyll b and carotenoids contents (mg/100g) were significantly affected by calcium rates. The values of abovementioned parameters were significantly increased by application of the highest calcium rate (800 mg/l) compared to control in the two seasons. The obtained results in Table 3 demonstrate that under each calcium rate treatment the values of water relations and leaves chemical pigments of tomato plant were increased by increasing kaolin rates except that of 60 g/l. which showed a decrease in this concern comparing to the other combinations under study. Furthermore, the best combination treatment in this connection was 40 g/l of kaolin combined with 800 mg/l of calcium compared to the other treatments including control; such increase was significant in the first and second seasons, in most cases. These results are in accordance with those reported by Hadidi *et al* (2017) who found that spraying potato plant with Ca as (calcium nitrate contains 17 % Ca) at 0.8% increased chlorophylls and carotenoids contents

Table 3. Impact of foliar application with calcium on water relations and pigments in leaves of tomato under different kaolin rates during the two seasons of 2018 and 2019.

Treatments		Relative water content %		Membrane stability index		Chl. a mg/100 FW		Chl.b mg/100 FW		Carotenoids mg/100g FW	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Kaolin g/l.											
zero		71.26	72.95	22.48	23.01	76.38	78.20	35.15	35.99	20.36	20.85
20		75.92	77.73	25.81	26.43	82.99	84.97	40.30	41.27	22.51	23.05
40		78.98	80.86	27.50	28.16	87.23	89.31	43.87	44.92	23.94	24.51
60		76.15	77.86	25.81	26.43	83.25	85.23	40.31	41.27	22.56	23.10
LSD 5%		1.63	1.74	0.50	0.64	1.23	1.41	0.58	0.93	0.33	0.47
Calcium mg/l											
zero		72.73	74.04	23.41	23.84	78.63	80.05	36.72	37.38	21.06	21.44
400		76.29	78.20	25.77	26.42	83.13	85.21	40.63	41.64	22.60	23.16
800		77.72	79.89	27.01	27.77	85.63	88.02	42.38	43.57	23.37	24.03
LSD 5%		1.29	1.38	0.40	0.51	1.18	1.37	0.56	0.84	0.31	0.38
Interaction											
	zero	70.45	71.72	21.65	22.03	73.52	74.84	33.08	33.68	19.47	19.81
zero	400	70.70	72.46	22.17	22.72	76.20	78.10	35.05	33.92	20.31	20.81
	800	72.65	74.68	23.62	24.29	79.42	81.64	37.32	38.37	21.32	21.91
	zero	71.32	72.60	22.86	23.27	77.97	79.37	36.26	36.90	20.86	21.23
20	400	77.26	79.19	26.59	27.26	84.46	86.57	41.38	42.42	22.98	23.55
	800	79.18	81.40	27.97	28.76	86.56	88.98	43.28	44.49	23.71	24.37
	zero	75.30	76.65	25.06	25.51	82.32	83.80	39.27	39.97	22.20	22.60
40	400	80.43	82.44	28.34	29.05	87.92	90.12	45.72	46.86	24.40	25.01
	800	81.21	83.48	29.10	29.92	91.44	94.00	46.63	47.94	25.21	25.92
	zero	73.85	75.18	24.09	24.54	80.73	82.18	38.26	38.95	21.73	22.12
60	400	76.78	78.70	25.99	26.64	83.94	86.03	40.37	41.38	22.70	23.26
	800	77.84	80.01	27.35	28.11	85.09	87.47	42.29	43.47	23.26	23.91
LSD 5%		2.67	2.84	0.83	1.05	2.29	2.64	1.09	1.65	0.61	0.79

3- Fruits set, fruits yield and its physical quality:

Data listed in Table 4 suggested that, clear differences in fruits fresh weight per tomato plant, fruits number per plant, weight of fruit with blossom and rot per feddan and total marketable yield per feddan were detected due to supplying plants with different rates of kaolin. The rate of kaolin (40 g/l) was the best treatment used in raising total yield of tomato fruits per feddan with significant

differences compared with the control (0.0 g/l) in both seasons. In addition, The increasing values of the previously mentioned parameters may be kaolin significantly increased the vegetative growth parameters, chlorophyll a, chlorophyll b and carotenoids contents, leaf relative water content as shown in Tables 2 and 3, which led to increasing the number of fruits per plant, average fruit weight, yield. Our results agree with Kamal (2013) on bell pepper, El-Said (2015) on eggplant and Ahmed (2019) on tomato. Also, Makeen *et al.* (2019) mentioned that kaolin at 2% gave the highest values of fruits number and weight per plant, early yield and total yield (ton/fed) on squash.

Table 4. Impact of foliar application with calcium on fruits yield and its components of tomato under different kaolin during the two seasons of 2018 and 2019.

Treatments		Fruits set %		Fruits fresh weight kg / plant		Fruits No./ plant		Blossom and rot (ton/fed)		Total marketable yield (ton/ fed.)		Total yield (ton/ fed.)	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Kaolin g/l.													
zero		28.66	29.34	5.015	5.134	62.19	63.67	1.621	1.659	24.77	25.34	26.39	27.01
20		30.53	31.26	5.342	5.470	66.13	67.71	0.868	0.887	27.25	27.90	28.12	28.79
40		31.76	32.52	5.558	5.690	68.71	70.35	0.472	0.482	28.78	29.46	29.25	29.94
60		30.63	31.36	5.359	5.486	66.32	67.90	0.807	0.825	27.39	28.05	28.20	28.87
LSD 5%		0.65	0.63	0.114	0.112	1.37	1.31	0.202	0.207	0.76	0.75	0.60	0.59
Calcium mg/l													
zero		29.25	29.78	5.118	5.210	62.43	63.55	1.378	1.402	25.56	26.02	26.93	27.42
400		30.68	31.45	5.368	5.502	66.44	68.10	0.836	0.857	27.42	28.09	28.25	28.95
800		30.26	32.13	5.469	5.622	68.65	70.57	0.613	0.631	28.17	28.96	28.78	29.59
LSD 5%		0.52	0.56	0.091	0.098	1.09	1.22	0.180	0.184	0.63	0.67	0.48	0.51
Interaction													
	zero	28.33	28.84	4.957	5.047	60.50	61.59	1.758	1.789	24.33	24.77	26.09	26.56
zero	400	28.43	29.13	4.975	5.099	61.71	63.26	1.716	1.759	24.46	25.02	26.18	26.77
	800	29.22	30.04	5.112	5.255	64.36	66.17	1.391	1.430	25.51	26.23	26.90	27.66
	zero	28.68	29.20	5.019	5.109	61.24	62.34	1.612	1.641	24.80	25.25	26.41	26.89
20	400	31.07	31.85	5.437	5.572	67.26	68.94	0.622	0.638	27.99	28.69	28.61	29.33
	800	31.85	32.74	5.572	5.728	69.89	71.84	0.371	0.381	28.95	29.76	29.32	30.14
	zero	30.28	30.83	5.299	5.394	64.60	65.77	0.949	0.966	26.94	27.42	27.88	28.39
40	400	32.35	33.16	5.660	5.801	69.94	71.68	0.302	0.309	29.48	30.22	29.79	30.53
	800	32.66	33.57	5.715	5.874	71.59	73.60	0.165	0.170	29.91	30.75	30.07	30.92
	zero	29.70	30.23	5.196	5.290	63.37	64.51	1.191	1.213	26.16	26.63	27.35	27.84
60	400	30.88	31.65	5.403	5.538	66.86	68.53	0.702	0.720	27.73	28.42	28.43	29.15
	800	31.30	32.18	5.478	5.631	68.74	70.67	0.526	0.541	28.30	29.09	28.82	29.63
LSD 5%		1.07	1.12	0.187	0.195	2.25	2.39	0.356	0.364	1.29	1.33	0.98	1.02

Results outlined in Table 4 show that the application of different rates of calcium had significant effect on tomato fruit yield and its physical quality as well as total yield per faddan compared with control (untreated plants). Also, the highest values in this concern were recorded by the highest concentration of calcium especially 800 mg/l, in most cases, in the two seasons. On contrast, the lowest blossom and rot (ton/fed) was recorded by using calcium at 800 mg/l. Also, Sajid *et al*. (2020) reported that the foliar application of Ca at 1.5% significantly increased the total yield of tomato plants compared to control.

However, the effect combination between the different rates of kaolin and calcium treatments in the two seasons is shown in Table 4. The results indicated that the positive effect of applying the different combinations in improving fruit yield and its physical quality as well as total yield per feddan of tomato compared to control. Since, the best combination treatment in this regard was kaolin at 40 g/l + calcium at 800 mg/l during both seasons. Likewise, Raslan *et al*. (2018) pointed out that treatment of kaolin at 7% combined with calcium at 7% gave the highest number of inflorescences per shoot and number of flowers per inflorescence with good fruit set on mid-December in olive Kalamata cv. However, Manzanillo cv. recorded with the same rates on mid-November a good final fruit set and initial with lowest fruit drop percentage.

4- Fruits chemical quality:

It is quite clear from the data in Table 5 that, the maximum increase in fruits dry matter percentage, vitamin C, acidity percentage, total soluble solids, and lycopene content of tomato plant was obtained from the treatment of 40 g kaolin/l. compared with the other ones under study. Mostly, such increase was significant during both seasons. Also, fruits chemical quality parameters of tomato were increased with increasing kaolin rates. Furthermore, all kaolin rates significantly increased these parameters of tomato compared with control (0 rate). Our results in agreement with Cantore *et al.* (2009) who reported that kaolin treatment increased lycopene fruit content by 16% on tomato. And El-Said (2015) who mentioned that increasing of total soluble solids content, vitamin C, titratable acidity by using kaolin at 4% on eggplant.

Table 5 pointed out that fruits chemical quality of tomato plants were gradually increased with increasing calcium rates. Also, the treatment rate of calcium (800 mg/l) resulted in the highest values in this concern (fruits dry matter percentage, vitamin C, acidity percentage, total soluble solids and lycopene content) under study. Such

increase was significant in the first and second seasons. In the same line, Soundharya *et al*. (2019) reported that the maximum values of lycopene, TSS and vitamin C content at Ca2O4Si (0.5%)compared with the control or Ca_2O_4Si (1.0%) on tomato. In contrast, Sahin *et al*. (2015) found that the vitamin C, titratable acidity (TA) and soluble solid dry matter were not significantly affected by treatment calcium doses on tomatoes.

Table 5. Impact of foliar application with calcium on fruits chemical quality of tomato under different kaolin during the two seasons of 2019 and 2019.

Treatments		Fruits dry matter %		Vit. C mg/100g FW		Acidity %		TSS (Brix)		Lycopene mg/100g FW	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Kaolin g/l.											
zero		4.95	5.06	29.13	29.82	0.707	0.724	4.36	4.46	5.47	5.60
20		5.27	5.40	31.65	32.41	0.753	0.771	4.75	4.85	6.13	6.28
40		5.48	5.61	33.26	34.06	0.784	0.802	4.94	5.06	6.59	6.75
60		5.29	5.42	31.75	32.50	0.755	0.773	4.76	4.87	6.19	6.33
LSD 5%		0.11	0.10	0.47	0.56	0.016	0.015	0.14	0.17	0.24	0.27
Calcium mg/l											
zero		5.05	5.14	29.99	30.53	0.722	0.734	4.50	4.58	5.74	5.84
400		5.30	5.43	31.70	32.49	0.757	0.776	4.75	4.86	6.12	6.27
800		5.40	5.55	32.65	33.57	0.771	0.793	4.86	5.00	6.43	6.61
LSD 5%		aw	0.10	0.45	0.58	0.013	0.014	0.07	0.09	0.19	0.21
Interaction											
zero	zero	4.89	4.98	28.04	28.54	0.699	0.710	4.20	4.30	5.15	5.25
	400	4.91	5.03	29.06	29.79	0.702	0.719	4.33	4.43	5.42	5.56
	800	5.04	5.19	30.29	31.13	0.721	0.741	4.56	4.66	5.84	6.00
20	zero	4.95	5.05	29.74	30.27	0.708	0.720	4.46	4.53	5.69	5.79
	400	5.35	5.50	32.21	33.01	0.767	0.786	4.83	4.93	6.28	6.44
	800	5.50	5.65	33.01	33.93	0.786	0.808	4.96	5.10	6.43	6.61
40	zero	5.23	5.32	31.39	31.96	0.747	0.760	4.73	4.80	6.12	6.23
	400	5.58	5.72	33.53	34.37	0.798	0.818	5.03	5.16	6.54	6.70
	800	5.64	5.80	34.87	35.85	0.806	0.828	5.06	5.23	7.13	7.33
60	zero	5.13	5.22	30.79	31.34	0.733	0.746	4.63	4.70	6.01	6.11
	400	5.33	5.46	32.01	32.81	0.762	0.781	4.80	4.93	6.24	6.39
	800	5.40	5.56	32.45	33.36	0.772	0.794	4.86	5.00	6.32	6.50
LSD 5%		0.18	0.20	0.87	1.09	0.026	0.028	0.18	0.23	0.40	0.44

With regard to the combination between kaolin and calcium, it is evident from tabulated results in Table 5, all combination treatments caused an increment in fruits chemical quality of tomato comparing with that recorded from untreated plants with kaolin when combined with calcium at zero mg/l, in both seasons, in most cases. Furthermore, the best combination treatment in this connection was 40 g/l of kaolin, with the high rate of calcium at 800 mg/l compared to control.

CONCLUSION

Generally, it could be concluded that, from the above mentioned results, foliar application of kaolin (at 40 g/ l) could be successfully used in addition to calcium (at 800 mg/l), to obtain the highest vegetative growth characters, leaves chemical composition, total fruits yield per feddan and significantly enhanced fruits quality parameters of tomato plants and reduced weight of fruit with blossom and rot quantity under Dakahlia Governorate conditions.

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تأثير الرش الورقي بالكالسيوم تحت معدلات مختلفة من الكاؤلين على نمو ومحصول الطماطم الناميه تحت ظروف الحرارة العاليه

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أجريت تجربتان حقليتان في مزرعة خاصة تقع في قرية ديميانا، بمركز بلقاس، محافظة الدقهلية، مصر خلال الموسمين الصيفيين المتتاليين لعامي 2018 و 2019، لدراسة تأثير معدلات مختلفة من الكاؤلين (صفر، 20 ، 40، 60 جم/ لتر) بالتادخل مع الكالسيوم (صفر، 400 و 800 ملليجم/ لتر) على النمو الخضري، العلاقات المائية، التركيب الكيمياني للأوراق وكذلك محصول وجودة ثمار الطماطم.. أوضحت النتائج التي تم الحصول عليها أن أعلى قيم لارتفاع النبات، مساحة الأوراق لكل لنبات، النسبة المئوية من المادة الجافة للأوراق، والمحتوى النسبي من الماء، وصبغات الأوراق، ومحصول الثمار لكل نبات، وكذلك المحصول التسويقي الكلي للفدان، وفيتامين ج، والمحتوى من الليكوبين في نبات الطماطم عند المعاملة بالكاؤلين بمعدل 40 جم/لتر مع وجود فرق معنوي بين المعدلات الأخرى تحت الدراسة. بينما، أدت زيادة الكاؤلين إلى 60 جم/ لتر إلى انخفاض الصفات المذكورة أعلاه خلال الموسمين. علاوة على ذلك، فإن زيادة معدل الكالسيوم من 400 إلى 800 ملليجم/لتر أدى إلى زيادة في نمو وإنتاجية الطماطم مقارنة بالكنترول (النباتات غير معاملة). بشكل عام، يمكن أن نستنتج أن نباتات الطماطم التي تم رشها بمعدل 40 جم / لتر من الكاؤلين مع 800 ملليجم/لتر من الكالسيوم، أظهرت تحسن فى النمو الخضري والعلاقات المائية والصبغات فى الاوراق ومحصول الثمار ومكوناته بالإضافة إلى المكونات الكيميائية للثمار تحت ظروف محافظة الدقهلية.