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Influence of some Irrigation Levels and Foliar Application of some Antitranspirants on Vegetative Growth, Leaf Chemical Constitutes and Seed Yield of Squash Plants

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ABSTRACT

The present study was carried out at a private farm located in Bohout Village, Nabaroh District, Dakahlia Governorate, Egypt to assess the influence of different amounts of applied irrigation water, different types of antitranspirants and their interactions on vegetative growth parameters (*i.e*, plant fresh and dry weights, plant length, number of leaves and Leaf area), leaf chemical constitutes (*i.e*, N, P, K percentage as well as total Chlorophyll (a+b) content and leaves proline content) and seed yield and quality (*i.e*, seed yield plant^{-1}, plot^{-1}, feddan^{-1}, weight of 100 seeds and seed germination percentage) of squash plants (*Cucurbita pepo* L.) during the two successive summer seasons of 2012 and 2013 under drip irrigation system. The experiment included fifteen treatments resulted from the combination of three irrigation water levels (100%, 80%, 60% from ETc) and five antitranspirants (kaolin, $CaCO_3$, $MgCO_3$, green miracle and tap water (control)). The obtained results showed that irrigation with 100% from ETc was the best irrigation treatment and the negative impact of drought appeared on studied characteristics with decreasing water supply to become more serious under irrigation with 60% from ETc. The frequent foliar application of antitranspirants played a remarkable role in alleviating the hazard of drought stress. However, all antitranspirants had promotive effects, kaolin foliar application gave the best results on all studied characteristics. It improved vegetative growth, leaf chemical constitutes and increased seed yield and quality parameters under both non-stress and stress conditions. Moreover, Kaolin treated plants irrigated with 80% from ETc performed better even than untreated plants irrigated with 100% from ETc. According to findings of the current study, summer squash can be protected from the negative consequence of the drought by frequent foliar applications of reflective antitranspirants such as kaolin, as it proved to recover the growth as well as seed yield quality under water limitation conditions.

Keywords: Irrigation levels, water stress, water deficit, antitranspirants, kaolin, growth, seed production and squash plant.

INTRODUCTION

In Egypt, squash (*Cucurbita pepo* L.) is one of the most popular vegetable crops grown for local consumption or exportation .It is one of the most important vegetable crops of the family cucurbitaceae. Egypt produced 212902 ton of squash from agriculture area about 26104 fedden with an average of 8.156 ton fed.$^{-1}$ (Economic Affairs Sector, 2017). Egypt faces a problem in the irrigation water resources because its water budget is fixed, so the main step of the Egyptian government strategy is saving irrigation water and increasing agricultural productivity from unit area with the minimum irrigation water level. Due to the expansion of agriculture, water becomes a scarce commodity, thus taking measures for water conservation are important. The poor irrigation can result in the development of crop water deficit and lead to a reduced yield because of nutrient and water deficiency. The depth of roots of squash plant is shallow and sensitive to water shortage which may damage fruits and roots of squash plant (Sadik and Abd El-Aziz, 2018). Also, In this concern many investigators indicated that decreasing irrigation water levels caused significant decreases in summer squash growth and yield, while medium supply of irrigation water improved plant growth and yield (Abd El-Mageed and Semida, 2015; Sadik and Abd El-Aziz, 2018)). Chemical manipulation of transpiration by antitranspirants represent a potential option (Gaballah and Moursy, 2004). Antitranspirants are chemicals substances that are sprayed on surfaces of transpiring plants to reduce water use by suppressing transpiration. Several researchers stated that antitranspirants not only alleviate the water loss but also enhance the disease resistance, physiological process, yield and quality aspects in many vegetable crops (Koteswara Rao *et al*., 2018).

Kaolin has been shown to have useful influences on the plants growth, especially under dry conditions. Kaolin 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 grown under water stress (Cantore *et al*., 2009; Ibrahim and Selim, 2010)

Calcium carbonate ($CaCO_3$) as antitraspirant based on stomata close is active in water limited environment which acts on stomatal opening regulation in an ABA - dependent way (Iriti *et al.*, 2009).

Magnesium carbonate ($MgCo_3$) is an antitraspirant that closes stomata and therefore influence metabolic processes in leaves tissues (Khalil *et al.*, 2012).

Green miracle is an antitranspirant (contains total amino acids not less than 3 %, fatty alcohol 80%, other neutral alcohol 10%, emulsifier and stabilizers 7%) was shown to have a favorable effects on plant growth under stress conditions (Abdel-Aziz, and Geeth, 2017)

Nowadays, Egypt faces a problem in the production of vegetable seeds and the Modern Egyptian Agricultural Strategy 2030 is aiming to decrease the importation of vegetable seed to save the hard currency by increasing seed yield of vegetable crops. So, the present research was carried out to study the effects of irrigation water levels and the potential of some antitranspirants (*i.e*, kaolin, $CaCO_3$, $MgCO_3$ and green miracle) on plant vegetative growth parameters, leaf chemical constitutes, seed yield and quality of summer squash under water deficit condition.

MATERIALS AND METHODS

To achieve the goal of this investigation, two field experiments were carried out at a private farm located in Bohout Village, Nabaroh District, Dakahlia Governorate, Egypt, during the two successive summer seasons of 2012 and 2013. The effect of three different levels of applied irrigation water (100%, 80%, 60% from ETc) and five foliar applications of antitranspirants (*i.e*, kaolin 2%, $CaCo_3$ 2%, $MgCo_3$ 2%, Green miracle 3 ml.L^{-1} and Control) and their interactions on squash plants (*Cucurbita pepo* L.) "cv. Eskandrani" vegetative growth parameters, leaf chemical constitutes and seed yield and quality under clay soil conditions. Fifteen treatments were arranged in a split plot design in a randomized complete block design, the irrigation

levels represented the main plots while the antitranspirants were allocated in the sub-plots. Each treatment was replicated three times. Thus, the total number of experimental units used for each season were 45. The experimental unit area was 40 m^2 and each plot included two ridges (ridge was 1.6 m in width and 12.5 m length).

After 15 days from sowing date, irrigation water treatments i.e, 100%, 80%, 60% from ETc were started. The irrigation water requirement was calculated according to Food and Agricultural Organization (FAO) Penman-Monteith (PM) procedure, FAO 56 (Allen *et al.*,1998). The antitranspirants were sprayed three times (after 15, 30 and 45 days from sowing).

Before planting, surface soil samples (0-30 cm) were collected from the experimental area and analyzed according to Dewis and Fertias (1970) as shown in Table (1).

Table 1. Some characteristics of the experimental soil during 2012 and 2013 seasons.

Soil properties		seasons 2012	seasons 2013
Particle size distribution (%)	C. Sand	2.7	2.9
	F. Sand	19.0	19.2
	Silt	26.0	25.5
	Clay	52.3	52.4
Textural class		Clay	Clay
EC dSm^{-1*}		1.55	1.50
pH**		8.25	8.20
$CaCO_3$ %		2.29	2.27
O.M %		1.17	1.10
F.C %		36.0	36.0
S.P %		72.0	72.0
Soluble anions, meq L^{-1}	CO_3^-	--------	----------
	HCO_3^{--}	0.80	0.75
	Cl^-	8.90	8.70
	SO_4^{--}	5.30	5.55
Soluble cations, meq L^{-1}	Ca++	5.80	5.90
	Mg++	2.50	2.40
	K+	3.10	3.20
	Na+	3.60	3.50

All agricultural operations were performed according to the traditional local agriculture management practices. Dry seeds of squash "cv. Eskandrani" was sown immediately in the moderately moist soil on one side of the ridges at 50 cm apart on 15th and 17th March in both summer seasons, respectively. Irrigation water treatments were started 15 day after sowing. The plants were irrigated using drip irrigation system (drip tubing GR type, 16mm diameter with 50 cm emitter spacing built in delivering 4 L/h), where the irrigation was carried out every day. During soil preparation, farmyard manure was applied at the rate of 20 m^3 fed^{-1}. The chemical fertilizers were used as recommended by Egyptian Ministry of Agricultural. Plant samples were collected for vegetative growth characteristics measurements. Fruits harvest started on May 1st, harvested twice by hand for fresh consumption then fruits were left on plant to physiological maturity stage for seed production purpose.

Recorded Data

1- Five plants were randomly chosen from each treatment after 50 days from sowing in the two seasons for measuring vegetative growth parameters of squash plants , *i.e*, plant fresh and dry weights (g $plant^{-1}$), plant length (cm), number of leaves $plant^{-1}$ and Leaf area (cm^2 $plant^{-1}$ measure according to Koller, 1972).

2- leaf chemical constitutes, i.e, Chlorophylls content(a+b) were determined according to the methods described by Goodwine (1965). as well as, nitrogen was determined according to Pregle (1945). Phosphorus was determined according to Jackson (1967). Potassium was determined according to the methods of Hammerschmidt et al. (1982) and leaves proline content was determined according to the methods of Bates et al. (1973).

3- Seed yield and quality, *i.e*, seed yield plant-1, plot-1, feddan-1, weight of 100 seeds and seed germination percentage which, were recorded (form fully mature fruits after harvesting and cleaning by the end of the growing season). Seed germination percentage was determined according to ISTA, 2011.

Data were statistically analyzed according to Gomez and Gomez (1984) using CoStat (Version 6.303, CoHort, USA, 1998–2004). Means of treatments were compared using Duncan Multiple Range test at 0.05% probability according to Duncan (1955).

RESULTS AND DISCUSSION

1- Vegetative growth parameters

The results in Table (2) show the effect of different levels of irrigation water, foliar spraying with antitranspirants and their interactions on fresh and dry weights ,plant length, No. of leaves and leaf area of squash plant at 50 days after sowing during both seasons of the experimentation.

Effect of irrigation water quantities

As shown in Table (2) different amounts of applied irrigation water (100, 80, and 60% from ETc) pronouncedly affected the fresh and dry weights, plant length, No. of leaves and leaf area of squash plant during both seasons of experimentation. The values of all aforementioned traits were significantly decreased, except dry weights, with the decrease of irrigation water amount, where the highest values were realized when the plants irrigated with 100% from ETc followed by 80% from ETc and lastly 60% from ETc **,** respectively

The highest values of shoot dry weights were realized when the plants irrigated with 60% from ETc followed by 100% from ETc and lastly 80% from ETc **,** respectively.

Effect of foliar antitranspirants

The obtained results in Table (2) reveal that all studied antitranspirants(kaolin, $CaCO_3$, $MgCO_3$ and green miracle) had a significant increase in the fresh and dry weights , plant length, No. of leaves and leaf area of squash plant during both seasons. Spraying kaolin 2% was superior treatment regarding the aforementioned traits of squash plants compared with other treatments and untreated plant (control), followed by $MgCo_3$ 2%.

Effect of the interactions

The present results in the same table indicate that the interaction effect between irrigation water levels and foliar spraying applications was significant. For the fresh and dry weights, plant length, No. of leaves and leaf area of squash plant, the highest values were recorded with irrigation treatment 100% from ETc and foliar application of kaolin 2%, while the lowest values were recorded with irrigation treatment 60% from ETc and untreated plants (control) (tap water). This trend was found for the two studied seasons.

In this connect, spraying squash plants with kaolin under irrigation with 80% from ETc gave better results than untreated plants under irrigation with 100% from ETc. Also, the values of all previously measured parameters were

significant increased under irrigation with 80% from ETc and spraying with $MgCo_3$ as compared with plants irrigated with 100% from ETc and sprayed with tap water (control). This trend was found under both studied seasons. Similar results were obtained by Ertek *et al.* (2004) and Ibrahim and Selim (2010) on squash and Abdel-Aziz and Geeth (2017) who found that the application of Green miracle to pea plants resulted in increases in growth parameters.

The obtained increment values of squash plant vegetative growth parameters with increasing irrigation water levels may be due to that water is intrinsic factor in plant life and water deficit is one of the major abiotic stresses, which adversely affects plant growth and metabolic functions, one of those is either loss or reduced synthesis of photosynthetic pigments and in turn resulting in declined light harvesting and generation of reducing powers, which are a source of energy for dark reactions of photosynthesis. These changes in the amount of photosynthetic pigments are closely associated to plant biomass yield (Abdul Jaleel *et al.* 2009).

Generally, the positive effect of spraying antitranspirants on squash plant vegetative parameters may be due to reducing the rate of transpiration and alleviate the harmful effect of water stress on metabolic processes in leaves tissue. The application of kaolin 2% gained superiority in plant growth parameters as compared to other used antitranspirants during the two growing seasons due to decrease leaf temperature and increase leaf reflectance, reduce transpiration rate and improve metabolic process in plants grown under water stress, strong protection against downy mildew, increasing water use efficiency and capacity of kaolin to enhance net photosynthesis (Wafaa, 2002; Erez and Glenn, 2004; Cantore *et al*., 2009; Ibrahim and selim, 2010)

Table 2. Effect of irrigation water levels, foliar spraying with some antitranspirants and their interactions on vegetative growth parameters of squash plant during 2012 and 2013 seasons after 50 days from sowing

Characters / Treatments		Fresh weight (g plant^{-1})		Dry weight (g plant^{-1})		Plant length (cm)		Number of leaves plant^{-1}		leaf area plant^{-1} (cm^2)	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Irrigation levels (% from ETc)											
100% from ETc		2551.0 A	2649.4 A	248.62 B	263.53 B	56.41 A	58.73 A	29.60 A	30.77 A	3504.6 A	3518.5 A
80% from ETc		2193.9 B	2278.5 B	245.85 C	260.47 C	49.08 B	51.09 B	25.78 B	26.81 B	3014.2 B	3026.0 B
60% from ETc		1989.8 C	2066.6 C	252.03A	266.87 A	42.87 C	44.62 C	22.79 C	23.70 C	2733.7 C	2744.5 C
Foliar spraying (Antitranspirants)											
Control		2038.7 E	2117.2 E	240.97 D	255.11 D	43.97 E	45.79 E	22.01 E	22.88 E	2606.4 E	2616.8 E
Kaolin 2%		2455.2 A	2549.9 A	256.92 A	272.33 A	55.52 A	57.79 A	30.96 A	32.19 A	3517.2 A	3531.0 A
$CaCO_3$ 2%		2138.4 D	2221.0 D	243.22 D	257.67 D	48.98 C	50.99 C	25.68 C	26.70 C	2957.0 D	2968.3 D
$MgCO_3$2%		2346.7 B	2437.2 B	253.60 B	268.78 B	51.91 B	54.02 B	27.88 B	28.98 B	3236.9 B	3249.9 B
Green miracle 3 m L^{-1}		2245.6 C	2332.2 C	249.46 C	264.22 C	46.90 D	48.82 D	23.77 D	24.71 D	3103.3 C	3115.7 C
Interaction (Irrigation levels * Antitranspirants)											
	Control	2316.7 F	2406.0 F	240.90 HI	255.33 HI	50.17 F	52.23 F	25.00 E	25.99 E	2961.7 I	2973.7 I
100%	Kaolin 2%	2790.0 A	2897.7 A	256.67 AB	272.00 AB	63.33 A	65.93 A	35.17 A	36.56 A	3996.7 A	4012.7 A
From	$CaCO_3$ 2%	2430.0 D	2524.0 D	243.00 GH	257.67 GH	55.87 C	58.17 C	29.17 C	30.32 C	3360.0 E	3373.0 E
ETc	$MgCO_3$2%	2666.7 B	2769.3 B	253.33 BCD	268.67 BCD	59.20 B	61.63 B	31.67 B	32.92 B	3678.3 B	3693.0 B
	Green miracle 3 m L^{-1}	2551.7 C	2650.0 C	249.20 DEF	264.00 EF	53.50 D	55.70 D	27.00 D	28.07 D	3526.3 C	3540.3 C
	Control	1992.3 I	2069.0 I	238.07 I	252.00 I	43.63 J	45.43 J	21.78 GH	22.64 HI	2547.3 M	2557.3 M
80%	Kaolin 2%	2399.3 E	2492.0 E	253.87 BC	269.00 BCD	55.10 C	57.37 C	30.63 B	31.85 B	3437.3 D	3450.7 D
From	$CaCO_3$ 2%	2090.0 H	2170.3 H	240.30 HI	254.67 HI	48.60 G	50.60 G	25.40 E	26.41 E	2890.0 J	2901.0 J
ETc	$MgCO_3$2%	2293.3 F	2382.0 F	250.57 CDE	265.67 DE	51.53 E	53.60 E	27.58 D	28.68 D	3163.3 F	3176.0 F
	Green miracle 3 m L^{-1}	2194.7 G	2279.3 G	246.47 EFG	261.00 FG	46.53 H	48.47 H	23.52 F	24.45 FG	3033.0 H	3045.0 H
	Control	1807.0 K	1876.7 K	243.93 GH	258.00 GH	38.10 M	39.70 M	19.25 I	20.01 J	2310.3 N	2319.3 N
60%	Kaolin 2%	2176.3 G	2260.0 G	260.23 A	276.00 A	48.13 G	50.07 G	27.08 D	28.15 D	3117.7 G	3129.7 G
From	$CaCO_3$ 2%	1895.3 J	1968.7 J	246.37 FG	260.67 FG	42.47 K	44.20 K	22.46 G	23.35 GH	2621.0 L	2631.0 L
ETc	$MgCO_3$2%	2080.0 H	2160.3 H	256.90 AB	272.00 ABC	45.00 I	46.83 I	24.38 EF	25.35 EF	2869.0 J	2880.7 J
	Green miracle 3 m L^{-1}	1990.3 I	2067.3 I	252.70 BCD	267.67 CDE	40.67 L	42.30 L	20.79 H	21.62 I	2750.7 K	2761.7 K

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

2- Chemical Constituents in Squash leaves

Data illustrated in Table (3) show the impact of different amounts of applied water, different types of antitranspirants and their interactions on some chemical constituents in squash leaves in expression of N, P and K percentage as well as total chlorophyll (a+b) and leaves proline contents for squash plants grown under drip irrigation system during 2012 /2013 seasons.

Effect of irrigation water quantities

For the individual effect of irrigation levels, data in Table (3) indicated that different amounts of applied irrigation water significantly affected the N, P , K percentage, total chlorophyll (a+b) and leaves proline content of squash leaves, where the values of aforementioned traits, except proline content, were significantly decreased with the decrease of irrigation water amount. In this connect, the highest values of the N, P, K percentages and total chlorophyll (a+b) in squash leaves were realized when the plants were irrigated with 100% from ETc followed by 80% from ETc and lastly 60% from ETc. On the contrary, for proline content in squash leaves, the values were significantly increased with the decreasing irrigation water level, where the highest values were realized when the plants irrigated with 60% from ETc followed by 80% from ETc and lastly 100% from ETc. Such effect was the same during the two seasons of the study.

Generally, irrigation treatment of 60% from ETc recorded the lowest values of N,P,K percentage and chlorophyll (a+b) and this may be due to that water stress which limits the plants ability for nutrients uptake of such elements.

Effect of foliar antitranspirants

Regarding the effect of antitranspirants foliar spraying on aforementioned traits, obtained results in Table (3) indicate that the kaolin at 2% recorded the highest significant values of the N, P , K percentage and total chlorophyll (a+b) in squash leaves compared with other

foliar antitranspirants in this respect. Concerning chlorophyll (a+b), foliar spray of kaolin and $MgCo_3$ recorded the highest values compared with other foliar antitranspirants without significant difference between both materials. While the lowest values was found with untreated plant (control treatment).

Table 3. Effect of irrigation levels, foliar spraying with some antitranspirants and their interaction on leaf chemical constitutes of squash leaves during 2012 and 2013 seasons after 50 days from sowing

Characters / Treatments		N%		P %		K%		Total Chlorophyll (a+b) (mg/g FW)		Leaf proline content (mg/gDw)	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Irrigation levels (% from ETc)											
100% from ETc		2.105 A	2.225 A	0.317 A	0.322 A	3.724 A	4.080 A	1.897 A	1.906 A	0.932 C	0.809 C
80% from ETc		1.879 B	1.985 B	0.283 B	0.288 B	3.405 B	3.731 B	1.502 B	1.511 B	1.483 B	1.286 B
60% from ETc		1.478 C	1.562 C	0.223 C	0.227 C	2.679 C	2.936 C	1.138 C	1.147 C	1.745 A	1.512 A
Foliar spraying (Antitranspirants)											
Control		1.600 E	1.693 E	0.241 E	0.246 E	2.903 E	3.180 E	1.441 C	1.450 C	1.621 A	1.406 A
Kaolin 2%		2.231 A	2.359 A	0.336 A	0.343 A	3.892 A	4.264 A	1.537 A	1.546 A	1.168 E	1.011 E
$CaCO_3$ 2%		1.731 C	1.828 C	0.260 C	0.267 C	3.136 C	3.434 C	1.515 B	1.524 B	1.473 B	1.278 B
$MgCO_3$2%		1.827 B	1.930 B	0.275 B	0.278 B	3.310 B	3.627 B	1.533 A	1.542 A	1.271 D	1.101 D
Green miracle 3 m L^{-1}		1.714 D	1.811 D	0.258 D	0.261 D	3.107 D	3.406 D	1.533 A	1.542 A	1.401 C	1.216 C
Interaction (Irrigation levels * Antitranspirants)											
	Control	1.860 F	1.967 G	0.280 F	0.283 G	3.370 H	3.693 H	1.802 E	1.811 E	1.083 F	0.940 G
100%	Kaolin 2%	2.547 A	2.693 A	0.383 A	0.390 A	4.160 A	4.557 A	1.982 A	1.991 A	0.783 I	0.680 J
From	$CaCO_3$ 2%	2.010 D	2.123 D	0.302 D	0.310 D	3.640 D	3.987 D	1.850 D	1.859 D	1.000 FG	0.867 GH
ETc	$MgCO_3$2%	2.120 C	2.240 C	0.319 C	0.323 C	3.843 C	4.210 C	1.950 B	1.959 B	0.853 HI	0.740 IJ
	Green miracle 3 m L^{-1}	1.990 D	2.103 E	0.300 D	0.303 E	3.607 E	3.953 E	1.900 C	1.909 C	0.940 GH	0.817 HI
	Control	1.670 H	1.770 J	0.252 H	0.260 I	3.033 K	3.320 K	1.441 I	1.450 I	1.757 B	1.523 B
80%	Kaolin 2%	2.213 B	2.340 B	0.335 B	0.340 B	4.010 B	4.393 B	1.441 I	1.450 I	1.250 E	1.083 F
From	$CaCO_3$ 2%	1.810 G	1.910 H	0.272 G	0.280 G	3.277 I	3.590 I	1.585 F	1.594 F	1.550 C	1.343 CD
ETc	$MgCO_3$2%	1.910 E	2.017 F	0.287 E	0.290 F	3.460 G	3.790 G	1.480 H	1.489 H	1.360 DE	1.180 EF
	Green miracle 3 m L^{-1}	1.790 G	1.890 I	0.270 G	0.270 H	3.247 J	3.560 J	1.560 G	1.569 G	1.500 C	1.300 CD
	Control	1.270 K	1.343 M	0.192 K	0.193 L	2.307 O	2.527 N	1.081 N	1.090 N	2.023 A	1.753 A
60%	Kaolin 2%	1.933 E	2.043 F	0.291 E	0.300 E	3.507 F	3.843 F	1.189 J	1.198 J	1.470 CD	1.270 DE
From	$CaCO_3$ 2%	1.373 J	1.450 L	0.207 J	0.210 K	2.490 M	2.727 M	1.110 M	1.119 M	1.870 B	1.623 B
ETc	$MgCO_3$2%	1.450 I	1.533 K	0.218 I	0.220 J	2.627 L	2.880 L	1.170 K	1.179 K	1.600 C	1.383 C
	Green miracle 3 m L^{-1}	1.363J	1.440L	0.205J	0.210 K	2.467 N	2.703M	1.140L	1.149L	1.763C	1.530C

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

On the contrary, the highest value of proline content in squash leaves was recorded with control treatment , while the lowest value was recorded at **(**Kaolin**)** treatment, where the treatments sequence from less to top was the (Kaolin**)** > ($MgCO_3$) > ($CaCO_3$) > (Green miracle) > control (tap water). These results were true in the two seasons of the experiment.

Effect of interactions between irrigation water treatments and foliar antitranspirants

The obtained results in the same table show that the interaction of the different treatments had a significant impact on the percentages of the N,P, K, total chlorophyll (a+b) and proline content determined in the squash leaves , where the highest values of N, P, K percentages and total chlorophyll (a+b) content of squash leaves were obtained with squash plants irrigated with 100% from ETc and sprayed with Kaolin 2**%**, while the lowest values were recorded with applied water at 60% from ETc and treated with tap water (control). Also, treating squash with kaolin 2% was superior under all irrigation water levels in comparison with other interaction treatments.

Generally, for the proline content in squash leaves, under all foliar spraying antitranspirants, the values of proline content in squash leaves were decreased as compared to the untreated plant (control) under all irrigation levels. The highest values of proline content in squash leaves were recorded under 60% from ETc and sprayed with tap water (control), while the lowest values were recorded with plants irrigated with 100% from ETc and sprayed with kaolin 2%.

Spraying squash plants by kaolin 2% and $MgCO_3$ 2% under irrigation with 80% from ETc gave better results than untreated plants under irrigation with 100% from ETc .These results are supported by the findings of El-Afifi *et al*. (2013) and Kamal (2013) who showed a significant superiority of adding kaolin on the N,P,K percentage in eggplant and bell pepper leaves.

3- Seed Yield

Results presented in Table (4) show the impact of different amounts of applied water, different types of antitranspirants and their interactions on seed yield and some quality parameters of summer squash plants in expression of seed yield $plant^{-1}$, seed yield $plot^{-1}$, seed yield $feddan^{-1}$, average weight of 100 seeds and seed germination percentage under drip irrigation system during 2012 /2013 seasons.

Effect of irrigation water quantities

For the individual effect of irrigation levels, results in Table (4) indicated that different amounts of applied irrigation water pronouncedly affected the seed yield $plant^{-1}$, seed yield $plot^{-1}$, seed yield $feddan^{-1}$, average weight of 100 seeds and seed germination percentage of squash plants, where the were values significantly decreased with the decrease of irrigation water amount. In this connect, the highest values of the aforementioned traits were realized when the plants irrigated with 100% from ETc followed by 80% from ETc and lastly 60% from ETc. Such effect was the same during the two seasons of the study.

Effect of foliar antitranspirants

Results in Table (4) show also the individual impact of some foliar spraying antitranspirants on seed yield $plant^{-1}$, seed yield $plot^{-1}$, seed yield $feddan^{-1}$, average weight of 100 seeds and seed germination percentage of squash plants and indicated that the kaolin at 2% recorded the highest significant values of aforementioned traits compared with

other treatments in this respect. Spraying $MgCo_3$ or green miracle came in the second order. While, $CaCO_3$ and control plants gave the lowest values and came in the third order. This trend was found for the both study seasons.

Table 4. Effect of irrigation levels, foliar spraying with some antitranspirants and their interactions on seed yield and quality characteristics of summer squash plants during 2012 and 2013 seasons

Characters / Treatments		Seed yield plant^{-1} (g)		Seed yield Plot^{-1} (g)		seed yield Fadden^{-1} (Kg)		Weight of 100 seeds(g)		Germination percentage (GP)	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Irrigation levels (% from ETc)											
100% from ETc		70.86 A	73.45 A	1771.5 A	1835.3 A	354.31 A	367.24 A	18.50 A	18.724 A	80.18 A	79.57 A
80% from ETc		61.65 B	63.90 B	1541.1 B	1596.7 B	308.25 B	319.50 B	16.83 B	17.040 B	72.97 B	72.99 B
60% from ETc		47.48 C	49.21 C	1186.8 C	1229.5 C	237.39 C	246.05 C	14.24 C	14.417 C	61.74 C	61.79 C
Foliar spraying (Antitranspirants)											
Control		55.01 C	57.02 C	1375.2 C	1424.8 C	275.05 C	285.09 C	15.44 D	15.63 D	66.93 D	66.96 C
Kaolin 2%		64.72 A	67.08 A	1618.0 A	1676.2 A	323.60 A	335.41 A	17.84 A	18.06 A	77.32 A	76.28 A
$CaCO_3$ 2%		55.01 C	57.02 C	1375.1 C	1424.7 C	275.05 C	285.09 C	16.47 C	16.67 C	71.39 C	71.41 B
$MgCO_3$2%		62.38 B	64.66 B	1559.4 B	1615.6 B	311.91 B	323.30 B	17.42 B	17.63 B	75.52 B	75.54 A
Green miracle 3 m L^{-1}		62.86 B	65.15 B	1571.3 B	1628.0 B	314.28 B	325.75 B	15.45 D	15.65 D	67.00 D	67.04 C
Interaction (Irrigation levels * Antitranspirants)											
	Control	64.97 D	67.35 D	1624.3 D	1683.0 D	324.87 D	336.72 D	17.28 E	17.49 E	74.92 E	74.92 DE
100%	Kaolin 2%	76.44 A	79.23 A	1911.0 A	1980.0 A	382.20 A	396.15 A	19.97 A	20.21 A	86.55 A	83.36 A
From	$CaCO_3$ 2%	64.97 D	67.35 D	1624.3 D	1682.7 D	324.87 D	292.95 E	18.43 C	18.66 C	79.91 C	79.95 B
ETc	$MgCO_3$2%	73.68 B	76.37 B	1842.0 B	1908.0 B	368.40 B	381.84 B	19.50 B	19.74 B	84.53 B	84.57 A
	Green miracle 3 m L^{-1}	74.24 B	76.95 B	1856.0 B	1922.7 B	371.20 B	384.75 B	17.30 E	17.51 E	75.00 E	75.03 DE
	Control	56.52 E	58.59 E	1413.0 E	1464.0 E	282.63 E	292.95 E	15.73 G	15.92 G	68.18 G	68.21 F
80%	Kaolin 2%	66.50 C	68.93 C	1662.7 C	1722.3 C	332.51 C	344.65 C	18.17 C	18.39 C	78.77 C	78.77 BC
From	$CaCO_3$ 2%	56.53 E	58.59 E	1413.0 E	1464.0 E	282.63 E	336.73 D	16.77 F	16.98 F	72.72 F	72.75 E
ETc	$MgCO_3$2%	64.10 D	66.44 D	1602.3 D	1660.3 D	320.51 D	332.21 D	17.75 D	17.96 D	76.92 D	76.94 CD
	Green miracle 3 m L^{-1}	64.59 D	66.95 D	1614.7 D	1673.0 D	322.95 D	334.73 D	15.74 G	15.94 G	68.25 G	68.28 F
	Control	43.53 H	45.12 H	1088.3 H	1127.3 H	217.66 H	225.60 H	13.31 J	13.47 J	57.69 J	57.76 I
60%	Kaolin 2%	51.21 F	53.09 F	1280.3 F	1326.3 F	256.07 F	265.42 F	15.38 H	15.56 H	66.65 H	66.71 FG
From	$CaCO_3$ 2%	43.53 H	45.12 H	1088.0 H	1127.3 H	217.66 H	225.60 H	14.19 I	14.37 I	61.53 I	61.53 H
ETc	$MgCO_3$2%	49.36 G	51.17 G	1234.0 G	1278.3 G	246.83 G	255.84 G	15.02 H	15.20 H	65.09 H	65.12 G
	Green miracle 3 m L^{-1}	49.74 G	51.56 G	1243.3 G	1288.3 G	248.71 G	257.78 G	13.32 J	13.48 J	57.75 J	57.81 I

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

Effect of the interactions

Data of the same table show that the interactions of the treatments had pronounced effect on seed yield plant^{-1}, seed yield plot^{-1}, seed yield feddan^{-1}, average weight of 100 seeds and seed germination percentage of squash plants, where the highest significant values of aforementioned traits were recoded when the plants irrigated with 100% from ETc and sprayed with Kaolin 2% treatment, while the lowest values were recoded when the plants irrigated with 60% from ETc and sprayed with tap water (control) treatment. Also, treating squash plants with kaolin 2% was superior under all irrigation water levels in comparison with other interaction treatments.

Spraying squash plants by kaolin under irrigation with 80% from ETc gave better values of seed yield plant^{-1}, seed yield plot^{-1}, seed yield feddan^{-1}, average weight of 100 seeds and seed germination percentage of squash plants than untreated plants(control) under irrigation with 100% from ETc. The positive effect of spraying antitranspirants materials on seed yield of squash plants that achieved in our study may be attributed to the increased vegetative growth parameters, *i.e*, fresh and dry weights, plant length, No. of leaves and leaf area, and chemical constituents in leaves, *i.e*, N, P and K percentage as well as total chlorophyll (a+b) and leaves proline content, as previously shown in Tables 2 & 3. The obtained results are supported by the findings of Wafaa (2002); Kuruppaiah *et al.* (2003); Al-Omran *et al.* (2005); Ibrahim and Selim (2010); El-Afifi *et al.* (2013); Kamal (2013) and Ramadan and Omar (2017).

CONCLUSION

According to the obtained results in this investigation, irrigation of squash cv. Eskandrani with 100% from ETc and sprayed with kaolin 2% as antitranspirants application is considered the best combinations. Also, spraying squash plants by kaolin under irrigation with 80% from ETc gave better values of seed yield and quality parameters than untreated plants under irrigation with 100% from ETc. So, the recommendation reported herein is irrigation of squash with 80% from ETc and spray with kaolin 2% to save more irrigation water and gave good growth and seed quality parameters under the conditions of this study.

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تأثير بعض مستويات الرى والرش الورقى لبعض مضادات النتح على النمو الخضرى والمحتوى الكيماوى للأوراق والمحصول البذرى للنباتات قرع الكوسه

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تم تنفيذ الدراسه الحاليه فى مزرعه خاصه بقرية بهوت مركز نبروه محافظة الدقهليه بمصر لتقييم تأثيرتطبيق كميات مختلفه من مياه الرى وتطبيق انواع مختلفه من مضادات النتح وكذلك تقيم تأثير التداخل بينهم على النمو الخضرى (مثل الوزن الطازج والجاف والطول وعدد الاوراق والمساحه الورقيه لكل نبات) وكذلك المحتوى الكيماوى للأوراق (مثل النسبه المئويه للنيتروجين والفسفور والبوتاسيوم والمحتوى الكلى لكلوروفيل (أ و ب) ومحتوى البرولين فى الأوراق) وكذلك تقييم التأثيرعلى المحصول الثمرى وصفات الجوده (مثل تقييم الاختلاف بين المحصول الثمرى للنبات والوحده التجريبيه والفدان وكذلك وزن 100 بذره و نسبه الإنبات) وذلك لنباتات قرع الكوسه أثناء موسمين ناجحين لعامين 2012 و2013 تحت نظام الرى بالتنقيط.تضمنت التجربة 15 معامله نتجت من تطبيق ثلاث مستويات من المياه (100% و80% و60% من البخر نتح للمحصول) ورش خمس مضادات نتح (ماء صنبور (كنترول) وكاؤلين وكربونات كالسيوم وكربونات ماغنسيوم وجرين ميراكل).أوضحت النتائج المتحصل عليها أن الرى ب100% من البخر نتح للمحصول كانت أفضل معامله وأن التأثير السلبى للجفاف ظهر على الصفات المدروسه بتقليل امداد النبات بالماء ليصبح أكثر وضوحا تحت الرى ب 60% من البخر نتح للمحصول . يلعب الرش الورقى لمضادات النتح دور بارز فى تخفيف الأثار الضاره الناتجه عن اجهادات الجفاف. وكل مضادات النتح لها دورمعزز للنبات. رش الكاؤلين أعطى أفضل النتائج على كل الصفات المدروسه حيث زاد من صفات النمو الخضرى ومحتوى الكيماوى فى الاوراق وكذلك زاد المحصول البذرى وجودته فى كلا ظروف الإجهاد والظروف العاديه. علاوه على ذلك الكاؤلين المعامل للنباتات المرويه ب 80% من البخر نتح للمحصول أعطى نتائج أفضل من النباتات الغير معامله والمرويه ب 100% من البخر نتح للمحصول. وحسب ما توصل اليه فى الدراسه الحاليه نستطيع ان نحمى محصول الكوسه من الأثار الضاره للجفاف بالرش الورقى لمضادات النتح العاكسه مثل الكاؤلين حيث اثبت انه حسن النمو وكذلك المحصول البذرى وصفات جودته تحت ظروف محدودية المياه.