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Effect of Some Antioxidants and Nutrients on Growth of Carnation Plants (*Dianthus caryophyllus*. L) Cv."Giant Pink" under High Temperature Stress

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ABSTRACT

An experiment was conducted to compare the ability of some antioxidants namely salicylic and ascorbic acids at 0.01-0.02g/l for each and nutrients namely boric, calcium, magnesium at 0.05-0.10g/l for each and potassium as a foliar spray at 0.7-1.4 g/l to decrease high temperature stress and to improve flower productivity of carnation plants. Calcium nitrite at 0.05 g/l was more effective than most of the other treatment for increasing plant height, leaf and flower numbers, fresh and dry weight of plants, pigments content of leaves and chemical composition. Calcium nitrate at 0.05 g/l as three foliar sprays at fifteen days intervals reduced the high temperature stress and improved number and quality of flowers of carnation plants.

Keywords: Carnation, antioxidants, nutrients and high temperature stress

INTRODUCTION

Carnation (*Dianthus caryophyllus* L.) is one of the most widely grown cut-flower crops due to long vase-life and a variety of flower forms and colors in protected cultivation in the Mediterranean areas. Carnation is a semi-hardy perennial but treated as an annual plant. It is a member of the Caryophyllaceae family and one of three hundred species of annual and perennial herbs in the genus *Dianthus*.

According to Mahajan and Tuteja, (2005) and Cançado, (2011), the main stresses consists of salt, drought, water abundance, (UV-B) radiation, cold, heat, pathogens, insects, chemicals and ozone.

The optimum temperature for growth of Carnation is between 55-65°F / 13-18°C. It has been stated that the whole earth average surface temperature has increased nearly by 0.6±2°C over the 20^{th} century and is projected to increase by 1.4-5.8°C over this century (Houghton *et al.,* 2001).

The stress of the heat is a very important abiotic factor defined as the ascent in temperature past a limit level for a specific timeframe enough to cause irreversible harm to plant growth development. Generally speaking, the transient elevation in temperature by 10–15 ◦C above ambient, is considered heat shock or heat stress. Mean, heat stress is a complex function as degree of temperature, rate of increase in temperature and duration. The specific climatic zones rely on the period of high degree of temperature and it occurs through the day or night.

Heat tolerance is described as the ability of the plant to develop, grow and produce economic yield under high temperature.Peet and Willits, (1998),Cramer *et al*.,(2011) and Bokszczanin *et al*.,(2013) proved that the diurnal mean temperature is a superior indicator of plant reaction to high temperature with day temperature having a secondary role. There are some researches proved that night temperatures are major factors while, on other hand, some researchers reported that the day and night temperature don't affect the plant in dependently. Very high temperatures, cause severe cellular injury and even cell death may occur within minutes, which could be attributed to a catastrophic collapse of cellular organization (SchÖffl *et al*., 1999).

There are two direct and indirect injuries. Direct injuries due to high temperatures contain protein denaturation and aggregation and increase fluidity of membrane lipids. While indirect heat injuries include inactivation of enzymes in chloroplast and mitochondria, inhibition of protein synthesis, protein degradation and loss of membrane integrity (Howarth, 2005).

The present study was carried out to evaluate the effect of foliar applications of some substances, i.e., B, Ca, Mg, K and ascorbic acid, salicylic acid as antioxidant substances on growth, flowering and chemical composition of carnation plants.

MATERIALS AND METHODS

The current research was conducted during the two successive seasons of 2014/2015 and 2015/2016 at the Experimental Station and Laboratory of the Vegetable and Ornamental Plants Dept., Faculty of Agriculture, Mansoura Univ., Egypt, to study the influence of some antioxidants (ascorbicacid, salicylicacid, boricacid, calciumnitrate, magnesiumsulphate and potassium sulphate) for protection from heat stress on growth, flowering and chemical constituents of carnation plants.

Plant material

Perennial carnation (Dianthus caryophyllus L.)cv. "Giant Pink" seeds were obtained from Barcelona (Spain). Seeds were sown an April 10thof each season in seedling trays filled with a mixture of sand and clay at 1:2(v/v), the seeds were covered with soil, lightly sprayed with water over the soil surface to moisten them. The seeds germinated within 2 to 3 weeks then transplanted into 10 cm2 plastic pots full the previous culture mixture. The N, P and K (20:20:20) compound fertilizer was added as a basal dose (1g/l) weekly for all plants until 8-10 leaves (25cm almost) appeared on each plant, then were trans planted in the open field in rows. 50 cm apart and between seedlings was about 30-40 cm.

Experimental design:

The experimental treatments were arranged in a randomized complete blocks design with three replicates, each replicate included three plants and experiment design included 14 treatments as follows:

1. Shade (sown under sunflower).
2. Control (water only).
3. Salicylic acid (0.01g/l).
4. Salicylic acid (0.02g/l).
5. Ascorbic acid (0.01g/l).
6. Ascorbic acid (0.02g/l).
7. Boric acid (0.05g/l).
8. Boric acid (0.10g/l).
9. Calcium nitrate (0.05g/l).

10. Calcium nitrate (0.10g/l).
11. Magnesium sulfate (0.05g/l).
12. Magnesium sulfate (0.10g/l).
13. Potassium sulfate (0.7g/l).
14. Potassium sulfate (1.4g/l).

N.B. Each treatment consisted of 3 foliar sprays at 15 days interval.

Samples of the experimental soil were mechanically and chemically analyzed. Data of the soil analysis are showed in Table (1).

Table 1. Physical and chemical analysis of the soil before the application of any treatments in the experiment.

Mechanical analysis		Chemical analysis		Soluble cations and anions	
Coarse sand (%)	1.96	Available N (ppm)	42	Cations (meq/100 g soil)	
Fine sand (%)	29.33	Available P (ppm)	6.3	Ca^{++}	1.83
Silt (%)	37.03	Available K (ppm)	330	Mg^{++}	1.27
Clay (%)	31.68	Organic matter (%)	2.13	Na^{+}	0.97
Texture	Clay loamy	E.C.* %	0.26	K^{+}	0.08
		pH**	8.14	Anions (meq/100 g soil)	
		$CaCO_3$	1.95	$CO_3^{=}$	0.00
				HCO_3^{-}	2.53
				$SO_4^{=}$	0.74
				Cl^{-}	0.88

* 1: 5 soil: water extraction
** 1:2.5 soil suspension

The monthly average maximum and minimum temperature during the two seasons at the experimental region is shown in Table (2).

Table 2. Monthly average maximum and minimum temperature during 2015 and 2016 seasons at the experimental region.

Month	Temperature C°			
	2015		2016	
	Max.	Min.	Max.	Min.
May	31	17	31	16
June	32	20	33	22
July	34	23	34	23
August	34	24	33	23

Data recorded:

The harvest was done on August 15[th] (after about 15 days from the last foliar spray) in both seasons.

1. Vegetative growth and flower parameters:

- Plant height (cm).
- Number of leaves/plant.
- Number of flowers/plant.
- Fresh and dry weights (g/plant).

2. Chemical determinations:

1-Pigments content (mg/g f.w.)

Total chlorophyll (a + b) and total carotenoids were determined in leaf samples (mg / g fresh matter) according to Mackinney (1941).

2-Nutrient elements determination:

A. Nitrogen determination:

Nitrogen % was determined by modified micro kjeldahle method as described by Pregl (1945).

B. Phosphorus determination:

Phosphorus % was determined according to Jackson (1967).

C. Potassium determination:

Potassium % was determined according to Black (1965).

3-Total carbohydrates (d.w). :

Total carbohydrates in dried plant sample was determined according to Hedge and Hofreiter (1962).

4-Total phenols (mcg/g dry weight):

Total phenols estimation was carried out with the Folin-ciocalteau reagent according to Malick and Singh (1980).

5-Proline (mg/g dry weight):

Proline was determined by the modified ninhydrine methods of Troll and Lindsley (1955), omitting phosphoric acid to avoid interference with concentrated sugars (Mang and Larher, 1992).

Statistical analysis:

A randomized complete blocks design with three replicates was used according to Steel and Torrie (1980). Data were subjected to the statistical analysis according to SAS Institute (1994). The treatments mean were compared using the least significant difference (LSD) at 0.05 level, as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Vegetative growth and flowering parameters:

Data present in Tables (3, 4, 5, 6 and 7) illustrate the impact of certain components of shade, salicylic acid, ascorbic acid, boric acid calcium nitrate, magnesium sulfate and potassium sulfate as a foliar spray controlling heat stress, its development and the resulting effect on carnation plants growth parameters under Egyptian conditions.

Plant height:

Data presented in Table (3) demonstrated that all of the tested materials were effective on protecting from heat stress and improving carnation plants growth. Treating plants with magnesium sulfate at0.10g/l resulted in the highest significant increase in plant height in both seasons (56.33 and 55.33 cm., respectively).In the first season it was clearly indicated that plants treated with calcium nitrate at 0.05 g/l and potassium sulfate 1.4g/l, resulted in an increase in plant height values (54.33 and 53.67 cm. respectively), but without significant differences compared to than magnesium sulfate at (0.10g/l) . Data in the second season, in the same Table clearly indicated a similar trend as observed in the first season.

The observed increase may be related to the several functions of this element concerning water relations, protein and fats synthesis and magnesium activation of many plant enzymes needed for vegetative growth.

These results are in the same line with those reported by Beata and Stanislaw (2012) on marigold.

Number of leaves/plant:

Data presented in Table (3) showed significant increase in number of leaves with calcium nitrate at 0.05 g/l (19.33) in the first season when compared with all the other studied treatments. In this respect, adding 0.05 g/l of calcium nitrate increased number of leaves about to 67.25% than treated plants with 0.10 g/L of the same material.

However in the second season calcium nitrate at 0.05 g/l resulted in the highest number of leaves than the other treatment (11.33) without significant differences in between.

Table 3. Effect of foliar applications of carnation plants under high temperature stress on plant height, leaf number and flower number/plant during the two seasons of 2014/2015 and 2015/2016.

Character	Vegetative growth parameters					
	Plant height(cm.)		Leaf number		Flower number	
Treatments	1^{st}	2^{nd}	1^{st}	2^{nd}	1^{st}	2^{nd}
Shade	35.33 d	31.00c	7.67bc	6.00b	5.00bc	3.33c
Control	44.00 cd	43.33abc	9.67bc	6.00b	9.00bc	4.66bc
$C_7H_6O_3$ (0.01g/l)	46.67 bc	48.66ab	12.67b	9.66 ab	6.33bc	6.33 abc
$C_7H_6O_3$ (0.02g/l)	44.00 cd	48.33 ab	7.33bc	9.33 ab	11.00bc	10.66ab
$C_6H_8O_6$ (0.01g/l)	43.00 cd	41.33bc	6.33c	8.00 ab	4.00c	6.66 abc
$C_6H_8O_6$ (0.02g/l)	52.33abc	53.66 ab	9.67bc	10.33a	5.33bc	6.66 abc
H_3BO_3 (0.05g/l)	45.00 bc	52.00 ab	8.00bc	9.00 ab	5.00bc	7.66 abc
H_3BO_3 (0.10g/l)	51.33abc	52.33 ab	11.33bc	10.33a	7.67bc	10.66ab
$Ca(NO_3)_2$ (0.05g/l)	54.33 ab	54.00a	19.33a	11.33a	21.33a	12.00a
$Ca(NO_3)_2$ (0.10g/l)	51.33abc	53.00 ab	6.00c	8.66 ab	8.33bc	7.66 abc
$MgSO_4$ (0.05g/l)	49.67abc	50.00 ab	9.33bc	9.00 ab	10.33bc	9.33 abc
$MgSO_4$ (0.10g/l)	56.33 a	55.33a	12.00b	10.33a	4.33c	5.33bc
K_2SO_4 (0.7g/l)	51.00 abc	52.66 ab	6.33c	9.66 ab	4.00c	6.66 abc
K_2SO_4 (1.4g/l)	53.67 ab	55.33a	10.67bc	11.00a	11.67b	9.00 abc

Means having the same letter (s) in a column are not significant at 5% level

Actually, the increase in number of leaves means achieving a preferable and superior quality.

Calcium is one of the most important mineral elements that it is effective on flower quality and shelf life. This element exists in structure of cells' middle lamella in a compound that called calcium pectate and until its amount is enough prevents pectin wall demolition (Marschner,1995; Khaladbarin and Islam Zade, 2001)

Calcium is already related in plant tolerance to heat stress by regulating antioxidant metabolism or water relations (Jiang and Huang 2001)

Number of flower/plant:

Data presented in Table (3) and illustrated in Fig. (1) showed that pronounced increase in number of flowers was achieved with calcium nitrate at 0.05 g/l in both seasons (21.33 and 12.00 flowers, respectively) but in the second season plants treated with salicylic acid at 0.02 g/l and boric acid at 0.10 gave 10.66 without significant differences in between.

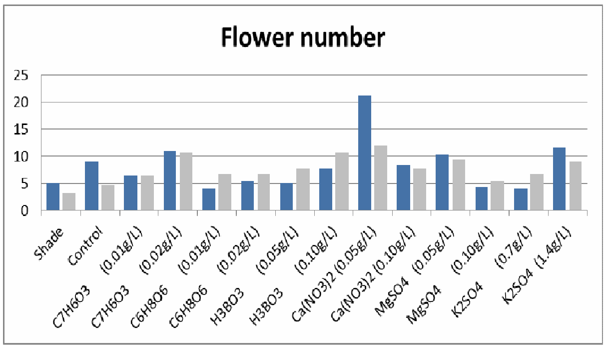

Fig. 1. Effect of foliar applications of carnation plants under high temperature stress on number of flowers/ plant.

Under heat stress conditions, Ca^{2+}requirement for growth is high to mitigate adverse effects of the stress Kleinhenz and Palta, (2002).

Hansch and Mendel,(2009) reported that boron has a main role in many processes specially transport of sugars and carbohydrates metabolism in plants.

Fresh and dry weight (g/plant):

From data recorded in Table (4) showed that treating plants with calcium nitrate at 0.05 g/l significantly increased fresh weight values in the first season followed by boric acid at 0.10g/l 64.00 and 45.00g, respectively), compared with other used treatments in this study. In the second season using 0.10g/l boric acid gave significant increase in fresh weight followed by calcium nitrate at 0.05 g/l and other concentrations of boric acid and without significant difference between them(50.33,46.33 and 46.33g) respectively. Most other treatments, showed no significant difference between them; actually this result may be due to the differences in environmental conditions prevailing.

Table 4. Effect of antioxidant responses of carnation plants under high temperature stress on fresh and dry weights during the two seasons of 2014/2015 and 2015/2016.

Character	Vegetative growth parameters			
	Fresh weight g/plant		Dry weight g/plant	
Treatments	1^{st}	2^{nd}	1^{st}	2^{nd}
Shade	11.67e	11.66c	5.76c	4.21c
Control	40.67bc	28.33bc	10.75bc	7.46bc
$C_7H_6O_3$ (0.01g/l)	33.00bcd	29.33bc	9.26bc	9.31 abc
$C_7H_6O_3$ (0.02g/l)	26.67bcde	44.33 ab	8.33bc	11.65 ab
$C_6H_8O_6$ (0.01g/l)	22.00cde	29.33bc	6.07c	9.21 abc
$C_6H_8O_6$ (0.02g/l)	34.67bcd	40.33 ab	10.86bc	11.67 ab
H_3BO_3 (0.05g/l)	26.67bcde	46.33 ab	7.93bc	12.58 ab
H_3BO_3 (0.10g/l)	45.00ab	50.33a	12.85ab	12.89a
$Ca(NO_3)_2$ (0.05g/l)	64.00a	46.33 ab	17.42a	12.41 ab
$Ca(NO_3)_2$ (0.10g/l)	38.33bcd	39.33 ab	11.73b	11.24 ab
$MgSO_4$ (0.05g/l)	35.00bcd	36.33 ab	10.62bc	11.95 ab
$MgSO_4$ (0.10g/l)	34.67bcd	43.00 ab	11.15bc	12.48 ab
K_2SO_4 (0.7g/l)	20.00ed	36.33 ab	6.82c	10.95 ab
K_2SO_4 (1.4g/l)	35.00bcd	41.66 ab	11.14bc	12.17 ab

Means having the same letter (s) in a column are not significant at 5% level

The superiority of boron may be due to the important and essential role for the growth- carbohydrate metabolism, cell wall, protein synthesis and sugars translocation of higher plants. The primary function of boron element is to provide structural integrity to the cell wall, in plants. Other functions likely include the maintenance of the plasma membrane and other metabolic pathways. The results agree with those obtained by Singh and Sant Ram (1983), Babu *et al.* (1984) and Khan *et al.*(1993), Abd El-Mageed and Abd El-Fattah (2007), Fawzia *et al.*(2008) and Abd El-Messih *et al.* (2010).They found that calcium spray improved the formation of cellulose and lignin. An increased cell wall thickening by reinforcement of the secondary wall with hemicellulose and lignin deposition can be protecting from heat stress Gall *et al*.,(2015).

Minerals (N, P and K%):

The function of N is important in protein and chlorophyll manufacture, phosphorous as one of the factors influence the rate of photosynthesis (carbohydrates, proteins, fats, vitamins and enzymes) beside the other factors involved in photosynthesis process such as light, carbon dioxide, water, temperature and apparently potassium are necessary for the synthesis of carbohydrates and proteins. It seems to be involved entirely as a regulator of processes or as catalyst.

In this concern data presented in Table (5) showed that plants treated with calcium nitrate at 0.05g/l gave the highest nitrogen, phosphorous and potassium % in both seasons, but there was significant difference as compared with each other. In opposite, carnation plants which were sprayed water (control) produced the lowest N, P and K % in both seasons.

From the previous results it is clear that the high concentration of nitrogen, potassium and phosphorus resulted when used calcium nitrate at 0.05 g/l may be due to their use for building up of the plant's body and increase number of flowers as evidenced in the previous tables in this study.

Table 5. Effect of antioxidant responses of carnation plants under high temperature stress on mineral N, P and K% during the two seasons of 2014/2015 and 2015/2016.

Treatments / Character	N% 1st	N% 2nd	P% 1st	P% 2nd	K% 1st	K% 2nd
	Chemical constituent parameters					
Shade	1.29l	1.40m	0.12j	0.14m	1.75m	1.64l
Control	1.17m	1.28n	0.11k	0.13n	1.63n	1.52m
$C_7H_6O_3$ (0.01g/l)	1.98e	2.17e	0.20d	0.22e	2.56e	2.40e
$C_7H_6O_3$ (0.02g/l)	2.25b	2.46b	0.22b	0.25b	2.83b	2.68b
$C_6H_8O_6$ (0.01g/l)	1.80f	1.97g	0.18e	0.20g	2.38g	2.20g
$C_6H_8O_6$ (0.02g/l)	2.18c	2.37c	0.21c	0.24c	2.74c	2.58c
H_3BO_3 (0.05g/l)	1.71g	1.87h	0.17f	0.19h	2.29h	2.12h
H_3BO_3 (0.10g/l)	2.07d	2.25d	0.21c	0.23d	2.64d	2.49d
$Ca(NO_3)_2$ (0.05g/l)	2.34a	2.55a	0.23a	0.26a	2.93a	2.76a
$Ca(NO_3)_2$ (0.10g/l)	1.91e	2.07f	0.19d	0.21f	2.46f	2.32f
$MgSO_4$ (0.05g/l)	1.44j	1.59k	0.14h	0.16k	1.94k	1.82j
$MgSO_4$ (0.10g/l)	1.64h	1.80i	0.16g	0.18i	2.18i	2.03i
$K2SO_4$ (0.7g/l)	1.36k	1.49l	0.13i	0.15l	1.84l	1.74k
$K2SO_4$ (1.4g/l)	1.56i	1.67j	0.15g	0.17j	2.08j	1.89j

Means having the same letter (s) in a column are not significant at 5% level

Al-Hamzawi (2010)found that Ca $(No_3)_2$ at 10-15mMincreased K% and P% in the cucumber.

Total carbohydrates (D.W)%:

Data recorded in Table (6) showed that total carbohydrates % in carnation were increased with treating plants by calcium nitrate at 0.05g/l, since values were 56.56 and 63.31% respectively, in the both seasons with a significant difference when compared with other treatments.

The increases noticed in carbohydrates% as affected by calcium nitrate at 0.05g/l may be attributed to the different enzymes, vitamins atc. and the Ca^{2+}have a response on photosynthesis process.

Through photosynthesis, rubisco activation in light independent reactions has been determined as a critical step, being inhibited at 35–40 ◦C, which results in decreased net CO2 intake and the production of carbohydrates (Crafts-Brandner and Salvucci,2000; Dubey, 2005).

Table 6. Effect of antioxidant responses of carnation plants under high temperature stress on minerals%, total carbohydrates %, phenol and proline content during the two seasons of 2014/2015 and 2015/2016.

Treatments / Character	Total carbohydrates (%) 1st	Total carbohydrates (%) 2nd	Phenol (mcg/g dry weight) 1st	Phenol (mcg/g dry weight) 2nd	Proline mg/g dry (weight) 1st	Proline mg/g dry (weight) 2nd
	Chemical constituent parameters					
Shade	54.05m	55.38b	0.59ab	0.54a	11.71a	12.16a
Control	53.85n	55.07b	0.61a	0.54a	11.81a	12.27a
$C_7H_6O_3$ (0.01g/l)	55.75e	56.86b	0.51fg	0.45i	10.32g	10.49i
$C_7H_6O_3$ (0.02g/l)	56.34b	57.75b	0.42ij	0.43j	9.76j	10.30j
$C_6H_8O_6$ (0.01g/l)	55.32g	56.42b	0.50fg	0.47g	10.73e	10.97g
$C_6H_8O_6$ (0.02g/l)	56.14c	57.55b	0.44hi	0.41l	9.92i	9.89l
H_3BO_3 (0.05g/l)	55.14h	56.21b	0.52ef	0.48f	10.94d	11.18f
H_3BO_3 (0.10g/l)	55.98d	57.09b	0.46h	0.42k	10.12h	10.66h
$Ca(NO_3)_2$ (0.05g/l)	56.56a	63.31a	0.41j	0.39m	9.50k	9.70m
$Ca(NO_3)_2$ (0.10g/l)	55.58f	56.64b	0.49g	0.46h	10.51f	10.08k
$MgSO_4$ (0.05g/l)	54.52k	55.87b	0.56cd	0.52c	11.47b	11.80c
$MgSO_4$ (0.10g/l)	54.93i	56.31b	0.53ef	0.49e	11.14c	11.38e
K_2SO_4 (0.7g/l)	54.27l	55.63b	0.58bc	0.53b	11.58b	11.99b
K_2SO_4 (1.4g/l)	54.71j	56.07b	0.55de	0.50d	11.26c	11.61d

Means having the same letter (s) in a column are not significant at 5% level

Phenol and proline(mg/100g DW):

Data presented in Table (6) show that all treatments decreased total phenols and proline when compared to control, the minimum values of total phenols and proline resulted with applying calcium nitrate at 0.05g/l(0.41 and 9.50 mg /100g dw, respectively),during the first season.

Data in the second season clearly indicated that it had almost the same trend observed in the first season.

Proline, an amino acid, plays an important role in plants. It protects the plants from various stresses and also helps plants to recover from stress more rapidly (Shamsul *et al*.,2012)

It may be possible, by manipulating factors involved in the bioactivity of phenolic compounds, to trigger acclimated mechanisms in plants under stress caused by temperature (Rosa *et al.,*2001).

Pigments content (total chlorophyll and carotenoids):

Chlorophyll contributes by far the amount of total photosynthesis for plant growth.

Data presented in Table (7) showed that plants treated with the higher level of potassium sulfate at 1.4 g/l significantly induced the highest amount of total chlorophyll (43.11 mg/g f.w.) in the first season over the other treatments. Also, in the second season plant treated with potassium sulfate at 0.7 g/l and calcium nitrate at 0.05 g/l had non significant difference in between when compared with non-treated plants.

The same Table revealed that carotenoids was nearly about the same trend as reported in the total chlorophyll.

Heat stress at short term resulted in transient increase in the content of Chl. but, long term of heat stress led to lose of Chl and that may be related to damage of reaction centers (Kyle, 1987). Under heat stress, external Ca^{2+} treatment inhibits the loss of chlorophyll, that is due to its reducing photo oxidation (Wise and Naylor, 1987) or by maintaining membrane integrity (Coria *et al.,* 1998).

Table 7. Effect of antioxidant responses of carnation plants under high temperature stress on Photosynthetic pigments (total chlorophyll and carotenoid mg \ g F.W.)during the two seasons of 2014/2015 and 2015/2016.

Photosynthetic pigments(total chlorophyll and carotenoid)				
Character / Treatments	Total chlorophyll (mg \ g f.w.)		Carotene (mg \ g f.w.)	
	1st	2nd	1st	2nd
Shade	15.24d	14.01c	7.93c	1.68c
Control	21.40bcd	21.11bc	8.69bc	2.36ab
$C_7H_6O_3$ (0.01g/l)	17.30cd	23.47bc	9.64abc	2.43ab
$C_7H_6O_3$ (0.02g/l)	24.34bc	21.87bc	10.85ab	2.41ab
$C_6H_8O_6$ (0.01g/l)	21.38bcd	24.35bc	10.87ab	2.35ab
$C_6H_8O_6$ (0.02g/l)	28.46b	21.63bc	11.18ab	2.36ab
H_3BO_3 (0.05g/l)	22.19bcd	19.13bc	10.57ab	2.22b
H_3BO_3 (0.10g/l)	26.89b	28.49ab	11.04ab	2.58ab
$Ca(NO_3)_2$ (0.05g/l)	23.05bcd	36.71a	10.98ab	2.62a
$Ca(NO_3)_2$ (0.10g/l)	21.76bcd	21.98bc	11.31a	2.57ab
$MgSO_4$ (0.05g/l)	28.61b	28.58ab	10.91ab	0.94d
$MgSO_4$ (0.10g/l)	27.27b	30.58ab	11.27ab	2.61a
K_2SO_4 (0.7g/l)	25.89b	36.34a	10.99ab	2.64a
K_2SO_4 (1.4g/l)	43.11a	30.50ab	11.83a	2.53ab

Means having the same letter (s) in a column are not significant at 5% level

General conclusions:

The extreme temperatures those are consequences of present-day global climate changes are considered as major abiotic stresses for crop plants.

Some agriculture treatments of antioxidants substances were used to improve carnation flowers. This substances should be beneficial in the protection structure and function of the photo systems against excess light (Rajagopal *et al.,* 2005).

According to these results, we conclude that carnation plants may develop an acclimated mechanism against super optimal thermal stress caused, this is much more than the optimum growth temperature. This acclimated mechanism in plant appears to consist of the accumulation of phenolic compounds, cellulose and lignin as a possible form of adapting to this stress. It may be possible, by manipulating factors involved in the bioactivity of phenolic compounds, cellulose and lignin to trigger acclimated mechanisms in plants under stress caused by temperature.

Thus, it may be concluded that application of Ca $(No_3)_2$ would reduce loss of carnation in hot environments.

Finally, the results in this study indicate that treated carnation plants by calcium nitrite at 0.05 g/l was more effective than most of the other treatments as increased plant height, leaf and flower numbers, fresh and dry weight of plants, pigments content of leaves and chemical composition.

REFERENCES

Abd El Messeih, W.M.; Yehia, M.M.; Abd El-Megeed. Nagwa, A. and Mikheal, G.B.(2010). Effect of some treatments for improving vegetative growth, leaf mineral compositions, fruit set, yield, fruit quality and limitation of flowers and fruit abscission of Le Conte pear trees at El Nubaria region. J. Adv. Agric. Res. (Fac. Agric, Saba Basha), 15(1): 151-170.

Abd El-Mageed, Nagwa, A. and Abd El-Fattah, S.M. (2007).Effect of calcium and boron treatments on yield, fruit quality, leaf and fruit mineral contents of pear trees grown in calcareous soils. J. Adv. Agric. Res. (Fac. 3 Agric., Saba Basha), 12(3): 459-477.

Al-Hamzawi, M.K. (2010).Effect of calcium nitrate, potassium nitrate and anfaton on growth and storability of plastic houses cucumber (*Cucumis sativus* L. cv. Al-Hytham).American J. of Plant Physiology, 5(2):278-290.

Babu, R.S.; Rajput, C.B.S. and Rath, S. (1984).Effect of zinc, 2, 4, D and GA in Kagzi lime *Citrus aurantifolia* Swingle, IV.Fruit quality. Haryana J. Hort. Sci., 11(1/2): 59-65.

Beata, S. and Stanislaw, B. (2012) Effect of nitrogen and magnesium fertilization on the development and yields of pot marigold (*Calendula officinalis* L.) Acta Sci. Pol., Hortorum Cultus, 11(2): 141-148.

Black, C.A.(1965). Methods of Soil Analysis. Part2. Amer. Soc. of Agric. [NC] Publisher, Madison, Wisconsin.

Bokszczanin K. L.; Solanaceae Pollen Thermotolerance Initial Training Network (SPOT-ITN) Consortium; and Fragkostefanakis S. (2013). Perspectives on deciphering mechanisms underlying plant heat stress response and thermotolerance. Front. Plant Sci; 4:315. 10.3389/fpls.2013.00315

Cançado GMA (2011).The importance of genetic diversity to manage abiotic stress. In: Shanker A (ed) Abiotic Stress in Plants - Mechanisms and Adaptations. In Tech, Rijeka،Croatia, p: 351-366.

Coria, N.A.; Sarquis J. I.; Penalosa I and Urzua M. (1998). Heat-induced damage in potato (*Solanum tuberosum*) tubers: membrane stability, tissue viability, and accumulation of glycoalkaloids. Journal of Agricultural and Food Chemistry, 46: 4524-4528.

Crafts-Brander, C. and Salvucci, M.E. (2002).Sensitivity to photosynthesis in the C4 plant, maize to heat stress. Plant Cell, 12:54–68.

Cramer G. R.; Urano K.; Delrot S., Pezzotti M. and Shinozaki K. (2011). Effects of abiotic stress on plants: a system biology perspective. BMC Plant Biol., 11:163. 10.1186/1471-2229-11-163.

Dubey, R.S., (2005). Photosynthesis in plants under stressful conditions. In: Pessarakli, M. (Ed.), Handbook of Photosynthesis. CRC Press, Boca Raton, Florida, p: 717–737.

Eissa, Fawzia, M., Naser, Magda M. and Yehia, M.M. (2008).Effect of boron and calcium treatments on yield and fruit quality of Le Conte pears. Minufiya J. Agric. Res., 33(2): 471-488.

Gall L.H.; Philippe, F.; Domon, J.; Gillet, F.; Pelloux, J. and Rayon, C., (2015).Cell wall metabolism in response to abiotic stress.Plant, 4: 112-166.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures. Agric. Res. 2nd Ed. Johnwiley and Sons, Inc, New York, USA.

Hansch, R. and Mendel, R.R. (2009).Physiological functions of mineral micro-nutrients (Cu, Zn, Mn, Fe, Ni, Mo, B, Cl). Current Opinion in Plant Biol., 12: 259-266.

Hedge, J. E. and Hofreiter, B. T. (1962). Carbohydrate Chemistry, Whistler R. L.; Be Miller. J. N. (Eds.) Academic. Press New York. 17-22.

Houghton, J. T.; Ding, Y.; Griggs, D. J.; Noguer, M., van der Linden, P. J., and Xiaosu, D. (eds.) (2001). Climate change 2001, the scientific basis. Working group I contribution to the Third Assessment Report of the IPCC. Cambridge University Press, Cambridge.

Howarth, C.J., (2005). Genetic improvements of tolerance to high temperature. In: Ashraf, M.; Harris, P.J.C. (Eds.), Abiotic Stresses: Plant Resistance Through Breeding and Molecular Approaches. Howarth Press Inc., New York.

Jackson M.L.(1967). " Soil Chemical Analysis advanced course" Puble, by the auther, Dept. of Soils, Wise Univ., Madison 6, Wischensen, U.S.A

Jiang Y. and Huang, B. (2001).Effects of calcium on antioxidant activities and water relations associated with heat tolerance in two cool□season grasses. J. Exp. Bot., 52 (355): 341-349.

Khaladbarin, B. and Islam Zade, T. (2001).Mineral Nutrition of Higher Plants. Shiraz University.

Khan, M.N.;Malik, A.B.; Makbdoom, M.I. and Hag, A. (1993). Investigations on the efficiency of exogenous synthetic growth regulators on fruit drop in mango *Mangifera indica* Linn. J. Hort., 20(1): 1-14.

Kleinhenz, M.D. and Palta, J.P., (2002). Root zone calcium modulates the response of potato plants to heat stress. Physiol. Plant., 115: 111–118.

Kyle, D.J (1987). The biochemical basis for photo inhibition of photo system II.In: Kyle D.J, Osmond C.B., Arntzen C.J., eds. Photo inhibition. Amsterdam:Essevier,197-226.

Mackinney, G. (1941). Absorpation of light by cholorphyll solution. J. Bio. Chem., 140:315-332.

Mahajan S and Tuteja N (2005). Cold, salinity and drought stresses: an overview. Arch Biochem Biophys, 444:139-158.

Malick , C. P. and Singh, M. B. (1980). Ins .Plant Enzymology and Histo Enzymology , Kalyani Publishers , New Delhi ,286pp.

Mang, C. and Larher, F. (1992). High sugar content of extracts interferes with colorimatric determination of amino acids and free proline. Anal.Bio. Chem., 200:358-362.

Marschner, H., (1995). Mineral Nutrition of Higher Plants. 2nd ed., Academic Press., Harcourt-Brace Pub. Company, New York.

Peet, M.M., Willits, D.H., (1998). The effect of night temperature on greenhouse grown tomato yields in warm climate. Agric. Forest Meteorol., 92: 191–202.

Pregl, F. (1945)."Quantitative Organic Microanalysis 4th." Ed. I. Chudrial, London.

Rajagopal S.; Joly D.; Gauthier A., Beauregard M. and Carpentier R.(2005). Protective effect of active oxygen scavengers on protein degradation and photochemical function in photosystem I submembrane fractions during light stress..The FEBS Jor. 272:892–902

Rosa M. R.; Juan M. R.; Pablo C. G.; Luis R. L.;Esteban S. and Luis R. (2001). Resistance to cold and heat stress: accumulation of phenolic compounds in tomato and watermelon plants. Plant Science, 160:315–321.

SAS Institute (1994). SAS/STAT User's Guide: Statistics. Vers.6.04, 4th Ed., SAS Institute Inc., Cary, N. C., USA.

Schöffl, F.; Prandl, R. and Reindl, A. (1999). Molecular responses to heat stress.In: Shinozaki, K., Yamaguchi-Shinozaki, K. (Eds.), Molecular Responses to Cold, Drought, Heat and Salt Stress in Higher Plants. R.G. Landes Co.,Austin, Texas, p: 81–98.

Shamsul , H.; Qaiser, H.; Mohammed, N. A.; Arif, S.W.; John, P. and Aqil, A. (2012). Role of proline under changing environments. Plant Signal Behav, 7(11): 1456–1466.

Singh. R.S. and Ram S. (1983).Studies on the use of plant growth substances for fruit retention in mango cv. Dashehair. Indian J. Hort.,40(3 and 4): 188-194.

Steel, R. G. D. and Torrie; G. H. (1980). Principles and Procedures of Statistics, 2nd Ed. McGraw-Hill, book Co. Inc. New York, U.S.A. pp.633

Troll, W. and J. Lindsley (1955). Aphotometric method for the determination of praline. J. Biol-Chem, 215:655-660.

Wise, R.R. and Naylor, A.W. (1982).Chilling-enhanced photo-oxidation. The per oxidative destruction of lipids during chilling injury to photosynthesis and ultranstructure. Plant Physiology, 83: 278-282.

تأثير بعض مضادة الاكسدة والمغذيات على نمو نباتات القرنفل تحت ظروف الإجهاد الحراري

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قسم الخضر و الزينة – كلية الزراعة – قسم الخضر و الزينة

أجريت التجربة لمقارنة قدرة بعض مضادات الاكسدة مثل حمض الساليسيليك والاسكوربيك بتركيز 0.01-0.02جرام/لترلكل منه والمغذيات مثل البوريك والكالسيوم والماغنيسيوم بتركيز 0.05-0.10جرام/لتر لكل منها والبوتاسيوم كرش ورقي بتركيز 0.7-1.4 جرام/لترلتقليل الإجهاد الحراري وتحسين إنتاج الازهار لنباتات القرنفل . وكانت نترات الكالسيوم بتركيز 0.05 جم / لتر أكثر فعالية من معظم المعاملات الأخرى التي زادت من ارتفاع النبات وعدد ألاوراق والازهار والوزن الطازج والجاف للنباتات ومحتوى الأصباغ في الأوراق والتركيب الكيميائي. ووجد ان استخدام نترات الكالسيوم عند 0.05 جم / لتر على شكل ثلاث رشات ورقيه على فترات كل خمسة عشر يوما ادي الي خفض الإجهاد الحراري وتحسين عدد ونوعية الزهور من نباتات القرنفل.