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RESPONSE OF *DIANTHUS CARYOPHYLLUS* L. PLANTS TO FOLIAR NUTRITION

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ABSTRACT

This investigation was inducted at Nubaria Region, West of Alexandria City, Egypt, during 2006 and 2007 seasons to study the influence of different concentrations (0.0,0.2,0.4,0.6,0.8, and 1.0 %) of foliar fertilizer contains macro - elements (20%N, 20% P, 20% K, 0.12% Mg) and micro - elements (70 ppm Fe, 14 ppm Zn, 16 ppm Cu, 42 ppm Mn, 72ppm B and 24 ppm Mo) on the growth, flowering, and chemical analysis of leaves of *Dianthus caryophyllus* cv. "Red Sim". The foliar fertilizer was applied 5 times during the growing period. The results revealed that plant treated with foliar nutrition showed significant increase in the growth characteristics (stem length , stem diameter, stem fresh and dry weight, number of leaves/ plant, fresh and dry weight of leaves). As well as, stimulated the flowering parameters (reducing the number of days from planting to flowering, increased both number, size, fresh and dry weight of flowers/plant) compared to the untreated plants (control). The treatment of 0.6 % of foliar fertilizer gave the highest values compared to the other treatment in both seasons. The total chlorophyll (a+b) , carotenoides and total carbohydrates (%),the mineral contents of leaves(N,P,K, Zn and Cu) were significantly increased as a result of spraying the plants with foliar fertilizer at different rates compared to the control treatments.

Key words: Carnation, *Caryophyllaceae*, cut flowers, foliar nutrition , mineral content. carbohydrates, greenhouse conditions.

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INTRODUCTION

The modern carnation (*Caryophyllaceae*; *Dianthus caryophyllus* L.) cultivars offer a diversity of colors, shapes and sizes not available in other flowering plants. Carnations are cultivated on a large scale in the Mediterranean area. However, it can be produced all over the world in greenhouse. The commercial production of carnations as one of the most used flowers for florist cut flower arrangement due to its excellent keeping quality, wide range of forms, ability to withstand long distance transportation. Therefore, paying a great attention to improve both qualitative and quantitative characteristics of carnations, especially, these grown under greenhouse condition is essential.

Foliar application of nutrients is gaining more importance in fertilization of various field and floricultural crops, in many countries. The advantages of foliar fertilizers were more obvious under growing conditions restricting the absorption of nutrients from the soil , as reported by Hamdi (1979) and Verma *et al.*, (2000) .The nutrients supplied by macro and micro-elements are necessary for the various biochemical processes that occur within the plant, and are essential for normal plant growth and development (Darling, 1975). Since sandy desert soil is characterized by high pH value, foliar fertilization may be useful under these conditions to avoid the soil fixation of some micronutrients such as Fe, Mn, Zn, and Cu. Moreover, foliar fertilization technique may also be a good alternative to the conventional soil application to avoid the loss of fertilizers by leaching and thereby minimizing the ground water pollution (Paparazzi and Tukey, 1979 and Tomimori *et al.*, 1995). Foliar nutrition is recommended by several investigators as an alternative fertilization method to improve the growth and flowering of anemone (Pislornik, 1985), gladiolus (Chaturvedi, *et al.*, 1986) carnation (Stack *et al.*, 1986 and Sharaf and El- Naggar 2003). Similar findings were also reported with chrysanthemum (Mazrou *et al.*, 1991), rose plants (Eraki *et al.*, 1993 and Al-Humaid, 2001) on tuberose(Pal and Biswas 2005) and iris plants (Mahgoub *et al.*, 2006).

The objectives of the research reported in this paper were to study the influences of commercial foliar fertilizers on growth and flower production of carnation plants under greenhouse condition.

MATERIALS AND METHODS

The present work was carried out during two successive seasons (2006 and 2007) in the greenhouse in Noubaria region , Alexandria governorate ,Egypt. *Dianthus caryophyllus* cv. "Red Sim" plants were used in this study for its popularity in flower trade for decoration purposes.

Preparation of cuttings and rooted cuttings of carnation plant:

The cuttings of "Red Sim" carnation were taken from certified mother plants on 25th June, 2006 and 27th June, 2007. These uniform cuttings, with an average length of 10 cm per cutting, 6 visible leaf pairs and average weight 10g. Cuttings were directly rooted under mist propagation for three weeks. The propagation soil was made by mixinng peat-moss and sand (1:1, v/v) and giving 10 second irrigation bursts every 5 minutes.

Experimental greenhouse treatments:

The physical analysis of the used soil revealed that it was containing 17.2, 61.8, 13.9 and 7.1 % of coarse sand, fine sand, silt and clay respectively. The chemical analysis cleared that, it was containing 0.19, 0.04 and 0.17 % of N, P_2O_5 and K_2O, respectively. The electric conductivity (EC) was 1.79 (dsm^{-1}) with pH of 7.98.

Two kilograms of farmyard manure / m^2 (moisture 18 %) of the surface soil was added, few days before planting , and well mixed with the soil during preparing the greenhouse soil .The chemical composition of the used manure was 0.83 %, N 0.26 % P_2O_5, and 0.19% K_2O .

The rooted cuttings were planted on 16th and 18th July for the two seasons, respectively under the greenhouse conditions. Planting spacing was 20 cm between rows and 20 cm between plants . Three weeks later, the pinching process (single pinch) of the growing points of all the plants was done to accelerate the basal branching on 7th August and 9th August 2006 and 2007 in the first and second seasons, respectively. The plants were drip irrigated, water was supplied at rate 1.87 liters m^{-1} day^{-1}divided to three irrigation times during a day (Fisher and Kurzman, 1987; and Malorgio ,*et al* ., 1995).

The plants were supported with plastic grids at suitable heights. Three well distributed branches were chosen on each plant on 12th and 14th September 2006 and 2007 in the two seasons, respectively for the experimental purposes. The disbudding was practiced to allow one terminal bud to develop per branch.

Foliar application of mineral fertilizer:

The plants were sprayed with the foliar fertilizer "Sangral" at concentrations of 0.0% (control), 0.2 %, 0.4 % , 0.6 % , 0.8 % and 1.0 %. The control plants were sprayed with distilled water. The Sangral fertilizer contains macro - elements (20%N, 20% P, 20% K, 0.12% Mg) and micro - elements (70 ppm Fe, 14 ppm Zn, 16 ppm Cu, 42 ppm Mn, 72ppm B and 24 ppm Mo).

The treatment was subjected to five sprays during the growth period which started after three weeks from the planting .The plants of each treatment were sprayed till run off point (2L/ plot) with three weeks intervals. The experimental layout was designed to provide randomized complete blocks containing, 6 treatments with four replicates and 25 plants / plot.

Growth parameters and chemical constituents

1- Vegetative growth and flowers characteristics:

Conventional methods were used to record the data on the vegetative growth parameters which included: I- stem length (cm), II- stem diameter (cm), III- fresh weight of stem (g),IV-dry weight of stem (g), V-leaves number/ plant, VI- fresh weight of leaves (g) VII- dry weight of leaves (g) and those of flowering parameters were: I- flowering time [the time taken to showing color from planting date (day)], II- flowers number/ plant, III- flower diameter (cm) IV- flower fresh weight / plant (g), V-flower dry weight / plant (g).

2- Chemical Analysis:

The total chlorophyll, mineral percentage and total carbohydrate content of the leaves were determined as follows: I-The total chlorophyll content and total carotenoides of fresh leaf samples (mg/100g F.W.L) was determined by using the method described by Greig *et al.*, (1968) in the leaves beneath the terminal bud at showing

color stage (Uri *et al.*, 1990). II-The nitrogen content and phosphorus percentage of the dried leaves were determined according to methods described by Chapman and Pratt (1961), and Bringham (1982).III-The potassium percentage was determined by using Flame Photometer according to Brown and Lilleland (1946) and Chapman and Pratt (1961). IV- Micronutrients Zn and Cu contents were determined by using Perkin – Elmer Atomic Absorption spectrophotometer . V- Total carbohydrate contents in the dried leaf samples were determined according to Herbert, *et al.*, (1971).

Statistical analysis :-

The data on the growth characteristics were subjected to statistical analysis of variance and the means were compared using the "Least Significant Difference (L.S.D)" test at the 5% level, as described by Snedecor and Cochran, (1981).

RESULTS AND DISCUSSION

I- Effect of foliar nutrition treatments on vegetative growth characteristics:

The results recorded in the two seasons and presented in tables (1-2) showed that spraying "Red Sim" carnation plants with different concentration of foliar fertilizer increased significantly the different vegetative growth parameters ; stem length, stem diameter, fresh and dry weight of stem , leaves number , as well as the fresh and dry weights of leaves, compared to the untreated control plants. The reduction in growth parameters was more in the control treatments.

The highest values were obtained by the application of foliar fertilizer at concentration of 0.6%for several growth characteristics, such as stem length, stem diameter, stem fresh and dry weight, number of leaves/branch as well as, fresh and dry weight of leaves/ plant (giving values of 80.59 cm, 0.78 cm, 63.75 g, 4.32 g, 24.76 ,39.47 g and 3.63 g, respectively in the first season, and 82.86 cm, 0.79 cm, 64.80 g, 4.30 g, 25.89,40.77 g and 3.68 g , respectively, in the second season for the above mentioned parameters.). These results

may be due to the effect of the nutrient elements at their suitable and adequate concentrations in promoting the vegetative growth and dry matter accumulation. In addition, the effect of suitable concentration of the foliar fertilizer which the required macro- elements (N, P, K, Mg) and micro - elements (Fe, Zn, Cu, Mn, B and Mo) for optimum growth as the synthesis of organic N – compounds in the plant depends on a number of inorganic ions Mg for chlorophyll formation, P for synthesis of nucleic acids and K which is necessary for nitrogen assimilation into protein (Mengel and Kirkby 1987). Also, the stimulating effects of macro and micro nutrients may be due to activating apical meristems beside the protoplasm formation, division and elongation of meristems cells, enhancing the biosynthesis of proteins and carbohydrates. These together led to enhancing the growth. Similar results were obtained by Verma *et al.*, (2000) on carnation plants and Al-Humaid (2001) with rose plants and El-Naggar (2005)on gladioli plants. On the other hand, using the highest fertilization level (0.08 and/or1.0%) reduced the growth characters (Table 1-2). This effect could be attributed to accumulation of salts on the leaf surface, which causes leaf scourching and burning (Mengel and Kirkby, 1987).

Table (1) : Effect of different concentrations of foliar nutrition on the stem length (cm) , stem diameter (cm), stem fresh and dry weight (g) of *Dianthus caryophyllus* cv. "Red Sim" plants grown on the two seasons (2006 and 2007) under greenhouse conditions.

Concentrations of Foliar nutrition	Stem length (cm)		Stem diameter (cm)		Stem fresh weight (g)		Stem dry weight (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0.0 %	49.79	50.54	0.54	0.49	37.18	37.31	3. 22	3.25
0.2%	57.62	58.21	0.59	0.60	42.53	42.62	3.31	3.33
0.4 %	63.26	64.10	0.66	0.68	49.46	49.97	3.57	3.63
0.6 %	80.59	82.86	0.78	0.79	63.75	64.80	4.32	4.30
0.8%	78.49	77.83	0.73	0.75	57.59	57.82	3.93	3.97
1.0%	73.60	72.94	0.62	0.65	55.39	55.40	3.60	3.58
LSD (0.05)	2.15	2.49	0.03	0.03	1.53	1.65	0.16	0.16

L.S.D $_{(0.05)}$ = Least significant differences at 0.05 level of probability.

Table (2) : Effect of different concentrations of foliar nutrition on leaves number / branch, fresh and dry weight of leaves /branch (g) of *Dianthus caryophyllus* cv. "Red Sim" plants grown on the two seasons (2006 and 2007) under greenhouse conditions.

Concentrations of Foliar nutrition	Leaves number per branch		Leaves fresh weight (g)		Leaves dry weight (g)	
	1st	2nd	1st	2nd	1st	2nd
0.0 %	18.27	18.12	21.86	21.34	2.67	2.63
0.2%	20.54	20.93	24.54	24.67	2.97	2.93
0.4%	23.41	23.86	29.15	28.98	3.56	3.52
0.6%	24.76	25.89	39.47	40.77	3.63	3.68
0.8%	24.50	24.46	36.28	37.21	3.21	3.30
0.1%	22.23	22.54	28.68	28.19	3.44	3.41
LSD (0.05)	1.12	1.12	1.53	1.49	0.18	0.18

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 level of probability.

II- Effect of foliar nutrition treatments on flower production:

The data reported in Table (3) clearly show a pronounced improvement in the flowering characteristics[number of days from planting to flowering, flowers number/ plant, flower size (cm), fresh and dry weight of flowers (g)] as a result of spraying" Red Sim" carnation plants with foliar fertilizer (Sangral), compared to the control.

The results in table (3) indicated that the time taken to showing color in the two growing seasons were significantly decreased with the spraying of foliar application(Sangral fertilizer).The earliest reduction in the period from planting date until appearance of color, was obtained by using 0.6% Sangral fertilizer as gave 113.25 and 113.63 day in the first season and second seasons, respectively compared with the control as gave 131.56 and 133.02 day in both seasons. The increment in the number of flowers, size, fresh and dry weight of flowers as a result of using suitable foliar fertilizer concentration at optimum doses may be due to the role of the nutrient elements such as nitrogen, phosphorus and potassium, which is necessary for the

synthesis of protein and cytokinin; consequently, affects cell division. These results are similar to those obtained by Mazrou *et al.* (1988) on rose, Papadimitrio and Manios (1984), Starck *et al* ., (1991) , Ramesh *et al.*, (2002) on carnation plants,Dufour and Guerin (2005)on anthurium and Pal and Biswas (2005) on tuberose plants. On the other hand, the observed decrease in this respect as a result of spraying the plants with the highest foliar fertilizer concentrations (1.0 %) may be due to the presence of high salt concentrations in the spraying solution which may raise the respiration rate and increase the rate of metabolic catabolism (Luttge *et al.,* 1971). These obtained results agreed with those obtained by Koriesh, (1984) on chrysanthemum and Chaturvedi, *et al.,* (1986), El-Naggar (2005) on gladiolus.

Table (3): Effect of different concentrations of foliar nutrition on flowering time (day), flowers number / plant, flower diameter (cm), flower fresh and dry weight(g) of *Dianthus caryophyllus* cv. "Red Sim" plant grown on the two seasons (2006 and 2007) under greenhouse conditions.

Concentrations of Foliar nutrition	Flowering time (day)		Flowers number/ plant		Flower diameter (cm)		Flower fresh weight (g)		Flower dry weight (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0.0 %	131.56	133.02	3.57	3.49	3.47	3.61	15.53	15.70	2.11	2.14
0.2 %	128.14	128.42	5.23	5.42	5.12	5.32	19.78	19.99	2.23	2.25
0.4 %	121.67	122.74	7.61	8.10	7.39	7.66	24.85	25.92	3.00	3.03
0.6%	113.25	113.63	10.59	11.21	12.05	11.87	42.20	42.07	3.26	3.26
0.8%	115.22	114.23	9.15	9.43	10.50	10.65	37.53	39.67	3.12	3.21
1.0 %	117.95	116.32	9.00	9.14	9.57	9.33	36.59	36.21	3.06	3.09
LSD (0.05)	2.32	2.46	0.57	0.63	0.87	0.92	0.78	0.91	0.12	0.12

L.S.D $_{(0.05)}$ = Least significant differences at 0.05 level of probability.

III - Chemical constituents:

1- Effect of foliar nutrition treatments on total chlorophyll (a+b) , total carotenoides (mg/100 g F.W.) and total carbohydrate percentages in leaves:

The results of chemical analysis of fresh leaf samples has revealed that the total chlorophyll (a+b) , carotenoides content (mg/100 g L. F.W.) and total carbohydrates (%) in the dried leaves of "Red Sim" carnation plants tended to increase generally as a result of spraying the plants with foliar fertilization (sangral) , compared to the control (table 4). The highest significant increase in total chlorophyll, carotenoides and total carbohydrates contents were obtained from spraying of foliar nutrition at 1.0% which gave 237.32, 58.27 mg/100 g F.W. and26.92 (%) respectively, in the first season, and 236.41, 59.96 (mg/100 g F.W.) and 27.84 (%) respectively, in the second season)

This improvement in the chlorophyll , carotenoides and total carbohydrates content as a result of foliar nutrition could be attributed to the mode of action of macro and micro elements in enhancing the photosynthetic activity and enzymes of carbohydrates transformation. Such results were reported by Hassan *et al.*, (1985) on dahlia, Eraki *et al.*, (1993) on rose plants and Verma *et al.*, (2000) on carnation plants and El-Naggar (2005) on gladiolus.

2- effect of foliar nutrition treatments on mineral content :

The results in Table (5) showed the percentage of N in the leaves on dry weight basis. It was significantly increased as foliar fertilization dose increased up to the highest fertilizer level (1.0 %) of foliar fertilizer. Potassium (%), phosphorus(%), Zinc (ppm) and cupper (%) elements followed the same trend as nitrogen. These results reflect the positive relationship between the concentration of foliar fertilizer and the mineral content of the leaves. This could be attributed to the rapid absorption of these elements by the plant surface, especially the leaves, and their translocation within the plant (Mengel and Kerkby, 1987). Similar results were obtained by Khattab and Hassan (1980) on chrysanthemum, Strack *et al.*, (1991) on carnation, Haikal (1992) on gladiolus , Sharaf and El- Naggar, (2003) on carnation, Mahgoub *et al.*, (2006) on iris plants.

Finally, these results show that the spraying of foliar fertilization (sangral) at suitable concentration (0.6%) had a considerably beneficial effect in improving the quantitative and the qualitative

characteristics of *Dianthus caryophyllus* cv. "Red Sim" under greenhouse condition.

Table (4): Effect of different concentrations of foliar nutrition on the total chlorophyll , total carotenoides(Mg/100g L.F.W.) and Total carbohydrates (%) of *Dianthus caryophyllus* cv. "Red Sim" plant grown on the two seasons (2006 and 2007) under greenhouse conditions.

Concentrations of Foliar nutrition	Total chlorophyll Mg/100g L.F.W.		Total carotenoides Mg/100g L.F.W.		Total carbohydrates (%)	
	1st	2nd	1st	2nd	1st	2nd
0.0 %	171.89	174.09	28.19	27.47	13.09	12.87
0.2 %	197.65	199.78	38.77	39.09	17.11	17.42
0.4%	224.95	226.77	46.98	48.15	21.34	22.64
0.6 %	235.46	237.13	67.23	66.89	28.29	29.15
0.8%	234.76	233.89	56.46	56.99	25.03	25.17
0.1%	237.32	236.41	58.27	59.96	26.92	27.84
LSD (0.05)	2.23	2.11	1.53	1.53	1.12	1.14

L.S.D $_{(0.05)}$ = Least significant differences at 0.05 level of probability.

Table (5): Effect of different concentrations of foliar nutrition on the mineral contents[N,P,K (%) Zn, Cu (ppm)] in the dried leaves of *Dianthus caryophyllus* cv. "Red Sim" plant grown on the two seasons (2006 and 2007) under greenhouse conditions.

Concentrations of Foliar nutrition	N (%)		P (%)		K (%)		Zn (ppm)		Cu (ppm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0.0 %	1.37	1.39	0.19	0.20	2.69	2.70	43.78	44.08	18.75	18.53
0.2 %	1.89	1.90	0.24	0.26	3.29	3.32	64.51	64.62	22.57	22.78
0.4 %	2.21	2.25	0.32	0.30	3.68	3.66	75.59	76.14	28.46	29.01
0.6 %	2.57	2.61	0.38	0.39	3.83	3.85	82.00	82.25	34.73	35.12
0.8 %	2.66	2.69	0.42	0.42	3.92	3.94	88.13	88.53	39.20	39.64
1.0 %	2.74	2.78	0.46	0.47	4.03	4.10	92.59	91.97	43.24	43.91
LSD (0.05)	0.20	0.18	0.07	0.07	0.12	0.10	2.13	2.17	2.44	2.44

L.S.D $_{(0.05)}$ = Least significant differences at 0.05 level of probability.

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الملخص العربي

استجابة نباتات القرنفل المجوز للتسميد الورقى

على حسن النجار[1] سهير جمعة السيد[2]

1- قسم الزهور و نباتات الزينة و تنسيق الحدائق – كلية الزراعة – جامعة الإسكندرية (الشاطبى)- الإسكندرية- مصر.

2- فرع بحوث نباتات الزينة – معهد بحوث البساتين – حديقة أنطونيادس – الإسكندرية.

أجريت التجربتان خلال موسمي 2006 / 2007 في منطقة النوبارية غرب مدينة الاسكندرية وذلك لدراسة تأثير الرش بتركيزات مختلفة (صفر، 0.2، 0.4، 0.6 ،0.8، 1.0 %) من السماد الورقي المحتوي على عناصر كبرى(20% نيتروجين ، 20% فوسفور ،20% بوتاسيوم ، و0.12 ماغنسيوم) وعناصر صغرى (70، 14، 16، 42 ،72 ، 24جزء فى المليون حديد،زنك ، نحاس، منجنيز، بورون ، موليبدنيم على التوالى) على النمو والازهار والتركيب الكيماوى لنباتات القرنفل المجوز صنف " رد سيم" المنزرعة تحت ظروف الصوب، واوضحت النتائج ان اضافة السماد الورقي أدت الي زيادة معنوية في كل من طول الساق ، قطر الساق ، الوزن الطازج والجاف للساق ،عدد الاوراق لكل نبات والوزن الطازج والجاف للاوراق وزيادة في طول الشمراخ الزهري ووزنه الطازج والجاف و كذلك زيادة معنوية فى الإنتاج الزهرى و انخفاض عدد الأيام اللازمة للوصول لمرحلة ظهور اللون و زيادة فى قطر الأزهار و عدد الأزهار لكل نبات و الوزن الطازج و الجاف لها. كما أدى رش النباتات بتركيز 0.6 % من السماد الورقي الي الحصول على افضل القيم لمعظم لصفات الخضرية والزهرية خلال الموسمين بالمقارنة بالمعاملات الاخرى . و أوضحت نتائج التحليل الكيماوى تحسن محتوى الأوراق من الكلوروفيلات الكلية والكاروتينات والكربوهيدرات الكلية و العناصر المعدنية(النيتروجين و الفسفور و البوتاسيوم و الزنك والنحاس) نتيجة للرش بالسماد الورقي مقارنة بنباتات معاملة الكنترول.