EFFECT OF FOLIAR APPLICATION WITH P AND B ON THE VEGETATIVE GROWTH AND FLOWERING QUALITIES OF CARNATION PLANT

By

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ABSTRACT

The carnation plant (*Dianthus caryophyllus* cv. Red Sim) grown under greenhouse conditions at Noubaria region was fertilized by foliar application with orthophosphoric acid rates (0.0, 50, 100, 200 or 400 mg L^{-1} P_2O_5) alone or combined with boric acid levels (0.0, 25 or 50 mg L^{-1} B). The obtained data showed that foliar application of carnation plant with P alone or combined with different levels of B, stimulated the vegetative growth characteristics (stem length, stem diameter, stem dry weight, number and dry weight of leaves/plant). As well as, stimulated the flowering parameters of carnation plant (reducing the flowering time; increased both number, size and dry weight of flowers/plant). On the other hand, there was significant effect due to the foliar application of B alone for increasing vegetative growth characteristics and the flowering parameters, excepting flowers number/plant that was not significant. The best results of vegetative growth characteristics and flowering parameters were obtained by foliar application of carnation plant at 200 mg P_2O_5 L^{-1} plus 50 mg B L^{-1}. The chlorophyll (a and b) content and carotenoides of the leaves were significantly increased from 178.98 to 350.88 and from 26.96 to 69.64 mg/100 g (leaf fresh weight), respectively. In addition, P and B contents were increased from 0.165 to 0.600 and from 10.33 to 44.78 mg/kg (leaf dry weight), respectively.

KEY WORDS: Carnation plant, orthophosphoric acid, boric acid, foliar application, growth characteristics, flowering parameters.

INTRODUCTION

The carnation plant (Caryophyllaceae; *Dianthus caryophyllus* L.) has been cultivated by man for over 2000 years (Post, 1949). It is indigenous to Mediterranean area, however it can be production over the entire world in greenhouse. The commercial production of carnation plants is very important to the florist industry of Egypt. Cut carnations are one of the most used flowers for florist cut flower arrangements. Therefore, paying a great attention to improve both quantitative and qualitative characteristics of carnations, especially those grown under greenhouse conditions is very important.

A commercial carnation plant was capable of producing 10 to 20 flowers per year. Each flowering stem originates from a "break" or "shoot" that emerged from one side of lower stem node. A typical flowering stem would developed at 15 to 18 nodes with two opposite leaves at each node. The leaf pairs on the nodes alternated at 180^0 up the stem, so that the leaves extent in two plants.

It has been reported that P deficiency delayed plant growth and the young leaves become very dark green in color. In some cases, purpling was noted especially of the underside of older leaves. When the phosphorus was applied to soils, to prevent phosphorus deficiency, there were possibilities of reacting with soil active calcium and magnesium to form of precipitated phosphate salts which were unavailable to plant. In chrysanthemum plants, the chlorosis of the middle and upper leaves was suggested to be due to reducing the concentration of active Fe in the leaves by high phosphorus, which also caused root browning, rotting and reduced the root activity (Kato and Takei, 1991).

Boron was adsorbed on various Al and Fe oxides, clay minerals, and arid-zone soils as a function of solution pH (Shorrocks et al., 1995 and Goldberg, 1999). Boron deficiency had been reported as a problem in floriculture crops (Catterjee et al., 1989). Boron deficiency inhibited meristematic activity and common symptoms would be a death or abortion of the terminal growing point followed by the growth and development of bypassing shoots from auxiliary buds further down the stem (Gupta et al., 1985). Blanc (1975) stated that the minimum adequate level of B in the auxiliary shoots of Sim carnation was 40 ppm, whereas the optimum level was 50 ppm. In addition, Adams et al., (1980) stated that the omission of B from the substrate of William Sim and white Sim carnation resulted in B deficiency symptoms. They found that 10 % of the formed buds failed to develop and the leaves contained 8-11 ppm B.

The aim of this investigation was to study the effect of phosphorus and boron as a foliar spray application, as well as their interaction, on the vegetative growth, and flowers quality and quantity of carnation plant under greenhouse conditions.

MATERIALS AND M ETHODS

This investigation was carried out on carnation plant "Dianthus caryophyllus cv. Red Sim" during seasons of 2000/2001 in the greenhouse at a Commercial Nursery in Noubaria region, West of Alexandria City, Egypt.

Preparation of cuttings and rooted cuttings of carnation plant:

Stem-tip cuttings of standard carnation cv. Red Sim were taken from certified mother plants on July 24, 2000. These uniform cuttings, with an average length of 10 cm, 5-6 visible leaf pairs and average weight of 10 g. Cuttings were directly rooted by placing them in propagation bed composite of an equal mixture of peat-moss and sand under mist for three weeks (giving 10 seconds bursts every five minutes).

The same technique was carried out to obtain cuttings and rooted cuttings on July 2001 during the second season study.

Greenhouse experiment:

The soil of the greenhouse is calcareous having, on the average, 20.3 % total carbonate and loamy sand texture. The main chemical and physical properties of the soil is shown in Table (1).

Two kilograms of farmyard manure (FYM) per m2 of the surface soil was added, few days before planting, and well mixed with the soil during preparing the greenhouse soil. The used FYD is made in the farm close to the greenhouse. It was consisted with the farm plants and animals residue mixed and composted partly in the farm. The chemical composition of the FYM is shown in Table (2).

The rooted cuttings were planted on 14 August of each season (2000 and 2001) under greenhouse conditions. The plants were drip irrigated and planting spacing was 20 cm between rows and 20 cm between plants (Arora and Saini, 1976).

Water was supplied at rate of 1.87 liters m^{-2} day^{-1} divided to three irrigation times during a day (Fisher and Kurzmann, 1987; and Malorgio et al., 1995). The source of irrigation water was tap water that had salinity of 576 ppm (0.9 dS m^{-1}) and SAR equals 4.29. The analysis of irrigation water is shown in Table (3). The analysis of soil, FYM and water were carried out according to standard methods described by Richard (1954) and Page et al. (1982).

Table (1): Chemical and physical analysis of experimental soil before planting in 2000 and 2001 seasons.

Soil analysis	Growth Seasons 2000	Growth Seasons 2001
Chemical analysis		
E.C* dS m^{-1}	1.17	1.02
pH**	8.00	7.[illegible]
Available N mg Kg^{-1} soil	33.20	29.40
" P " "	2.86	2.24
" K " "	1.22	1.10
" B " "	0.10	0.20
Total Carbonate %	20.30	19.00
Organic Matter %	0.08	0.17
Physical analysis		
Particle size distribution:		
Coarse sand %	16.2	
Fine sand %	62.8	
Silt %	13.9	
Clay %	7.1	
Soil Texture	Loamy sand	
Water holding capacity %	15.0	

* In water saturated soil paste extract.
** In 1:2.5 soil water ratio.

Table (2): Analysis of farmyard manure (FYM):

Organic matter %	Organic carbon %	Total N %	C/N ratio	%			µg/g		
				N	P	K	Mn	Fe	Zn
14.0	8.12	0.58	14/1	0.125	4.26	0.055	9.6	3.5	0.65

Table (3): Analysis of used irrigation water:

E.C dS/m	pH	Soluble cations (me/L)				Soluble anions (me/L)			
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO^{3-}	HCO^{-}	Cl^{-}	SO^{4-}
0.9	7.57	2.01	2.20	4.4	0.70	-	2.20	5.88	0.85

The explants were left to establish for three weeks. An operation single pinch was carried out on mid of Sept., 2000 (and on Sept., 2001), leaving only 5 pairs of leaves on each explant. The plants were supported with plastic grids at suitable heights. The disbudding (isolation of unused bud) was practiced to allow one terminal bud to develop per branch.

Foliar application of P and B on carnation plants:

The orthophosphoric acid (H_3PO_3) and Boric acid (H_3BO_3) were used as sources of fertilizer elements for P and B (purity of H_3PO_3 was 98 %, P_2O_5= 70 % and H_3BO_3 contains 17 % B). Fertilization of carnation plants was carried out as foliar application. Five concentrations of P_2O_5 (0.0, 50, 100, 200 and 400 mg L^{-1}) and three concentrations of B (0.0, 25, and 50 mg L^{-1}) were used.

The experimental unit was 5 rows width (spacing was 20 cm between rows) and 1.2 (m) length. Each experimental unit received the foliar fertilization by using two liters of P solution and two liters of B solution per spray. The treatment was subjected to 5 sprays during the growth period which started after two weeks from the planting. Spray treatments were 0.0, 5.0, 10.0, 20.0 and 40.0 mg P_2O_5 L^{-1}, and 0.0, 2.5 and 5.0 mg B L^{-1} which were represented the five rates of P_2O_5 (0.0, 50, 100, 200 and 400 mg L^{-1}) and three rates of B (0.0, 25, and 50 mg L^{-1}), respectively. The plants of each treatment were sprayed to the point of run-off solution drop with three weeks intervals. Each treatment was replicated three times.

The layout of the experiment, of both seasons, was designed to provide complete randomized blocks in a factorial trial containing three replicates. Each replicate was contained 15 different treatments. The experimental unit contained twenty-five plants, which were used as an experimental plot, for each treatment (Snedecor and Cochran, 1974).

Nitrogen and potassium fertilizers were added as ammonium nitrate (33.3 % N) and potassium sulfate (48 % K_2O) at rates of 20 and 50 g per plot, as N and K_2O, respectively (Arora and Saini, 1976). These amounts were divided into six equal doses which were added at three weekly intervals, starting two weeks after the final transplanting in the greenhouse. All other agricultural practices were performed as usual.

Growth characteristics:

The vegetative growth measurements were included stem length (cm), stem diameter (cm) by caliper, stem oven-dried weight (g), number of leaves per branch and leaves dry weight (g). While the flowering data included the time taken to showing color stage from planting date (day), number of flowers per plant, size of flower (diameter, cm) at full-opining stage and dry weight of flowers per plant (g).

Chemical constituents:

The total content of chlorophyll (a and b) and total carotenoides (mg/100 g fresh weight of leaves) were determined in the two leaves beneath of the terminal bud at showing coloring stage (Uri et al., 1990). As well as the contents of phosphorus and boron were determined in the leaves according to methods described by Chapman and Partt (1961), Johon et al., (1975) and Bingham (1982).

RESULTS AND DISCUSSION

I-Vegetative growth: -

1-Stem Length: -

The data in Table (4) show that foliar application of carnation cv. "Red Sim" with phosphorus separately at any level (50, 100 or 200 mg L^{-1}) or in combined with boron fertilizer (0.0, 25 or 50 mg L^{-1}) produced significant increases in stem length as compared with the control, during both seasons. The highest values of stem length were obtained by addition of P at a rate of 200 mg L^{-1} plus B-fertilizer at a rate of 50 mg L^{-1} as comparing with the other treatments, during the two seasons. This treatment lead to an increase of the stem length by 14.47 % and 16.33 % ,as the average of relative increase, over the control for both the first and second seasons, respectively. These increases may be due to that P acts to regulate many enzymatic reactions which are leading to enhancement of plant metabolism and formation of new cells, and consequently increasing stem length (Epstein, 1972). It has been reported that B at this specific concentration (50 mg L^{-1}), generally, stimulated the division and elongation of cells of the new growth as well as it is very closely related to the activity of meristems, especially apical meristems and consequently stem length could be increased (Sisler et al., 1958; Blanc (1975) and Marfa et al., (1982). Similar results were obtained by Kato and Takei (1991) on chrysanthemum.

2- Stem diameter: -

The data in Table (4) show that the diameter of carnation stem (middle stem) was significantly increased by using P_2O_5 at rates of 100 or 200 mg L^{-1} in combined with B at a rate of 50 mg L^{-1}, compared with the control during the two seasons. The difference between the two treatments namely: 100 mg L^{-1} P plus 50 mg L^{-1} B and 200 mg L^{-1} P combined with 50 mg L^{-1} B were not significant. The highest thickness stems were obtained by spraying the plants with 100 or 200 mg L^{-1} P_2O_5 plus 50 mg L^{-1} B in the first

Table (4): Effect of foliar application with different concentrations of P and B on stem length, stem diameter, and stem dry weight of carnation cv. Red Sim plant grown on the two seasons (2000 and 2001) under greenhouse conditions.

Treatments (mg L^{-1})		Stem length (cm)		Stem diameter (cm)		Stem dry weight (g)	
P_2O_5	B	Season		Season		Season	
		1 St	2 nd	1 St	2 nd	1 St	2 nd
0.0	0.0	65.86	64.39	0.41	0.39	2.98	2.93
	25	68.52	68.19	0.46	0.44	3.25	3.20
	50	71.31	70.90	0.49	0.51	3.39	3.40
Average		68.56	67.83	0.45	0.45	3.21	3.18
50	0.0	69.21	69.84	0.44	0.46	3.29	3.32
	25	71.85	71.02	0.49	0.51	3.39	341
	50	73.13	73.95	0.54	0.56	3.60	3.68
Average		71.40	71.60	0.49	0.51	3.47	3.47
100	0.0	69.97	70.31	0.49	0.49	3.59	3.62
	25	72.95	72.98	0.57	0.58	3.69	3.70
	50	74.18	74.85	0.59	0.60	3.97	3.99
Average		72.36	72.71	0.55	0.56	3.75	3.77
200	0.0	70.01	71.21	0.53	0.51	3.65	3.67
	25	73.18	73.91	0.59	0.59	3.73	3.79
	50	75.39	74.91	0.60	0.61	4.20	4.22
Average		72.86	73.34	0.57	0.57	3.86	3.89
400	0.0	68.15	69.35	0.49	0.48	3.49	3.51
	25	71.00	71.21	0.52	0.52	3.57	3.59
	50	70.36	70.13	0.50	0.51	3.55	3.59
Average		69.84	70.23	0.50	0.50	3.54	3.56
LSD 0.05	P_2O_5	0.76	0.60	0.04	0.05	0.20	0.21
	B	0.53	0.42	0.02	0.03	0.12	0.13
	Interaction	1.02	0.88	0.07	0.07	0.20	0.32

and second seasons, respectively. These increases may be due to the role of phosphorus at, the suitable level, in the energetic metabolism and biosynthetic reactions. While boron prevented the accumulation of phenolic compounds and breakdown the conductive tissues it was necessary for sugars to move through the protoplasmic membranes out of leaves, consequently increased the stem diameter (Sisler et al., 1958). These results are in agreement with Mostafa (1996) on carnation.

3- Stem dry weight: -

Adding P_2O_5 at a rate of 200 mg L^{-1} and B at a rate of 50 mg L^{-1}, in combination, produced the maximum production of stem dry matter, as compared with the control during the two seasons (Table 4). These results may be due to the increases in the stem length or stem diameter or both. Similar results were obtained by El-Baky (1986) on carnation and Lodhi and Tiwari (1993) on chrysanthemum.

4- Leaves number: -

Data in Table (5) show that foliage spray of P alone at any level, significantly increased leaves number/branch compared with the control of the two seasons. Generally, the highest number of leaves was produced by spray of P_2O_5 and B together at rates of 200 and 50 mg L^{-1}, respectively, as compared with the other treatments. The average values of the relative increase were 32.76 % and 31.70 % with respect to the control of the first and second seasons, respectively. This increase may be due to the function of P, at the specific level, on the energetic metabolism and biosynthetic reactions, hence the formation and initiation of new leaves will generally increase the leaf number. Also, these increases may be attributed to the role of boron in the translocation of the fixed carbon, leading to development of new leaves which formation large amounts of carbohydrates (Sisler et al., 1958). Similar results were found by Adams et al., (1980) on carnation and Conny et al., (1998) on chrysanthemum.

5- Leaves dry weight:-

Data in Table (5) show that foliar application of P at a rate of 100 or 200 mg L^{-1}, with B at a rate of 50 mg L^{-1} as a foliage application, gave the heaviest leaves dry weight compared with the other treatments in the two growing seasons. The difference between treatments of 100 or 200 mg P_2O_5 L^{-1} combined with 50 mg B L^{-1} was not significant. The maximum dry weight of leaves was obtained by application of P at a rate of 200 mg L^{-1} plus boron level of 50 mg L^{-1}, which produced relative increase of 70.93 and 66.19% over the control in the first and second seasons, respectively. These increases may be due to the accumulation of the biosynthetic compounds, which have positive roles for the formation and division of cells and leading

Table (5): Effect of foliar application with different concentrations of P and B on number of leaves, and leaves dry weight per branch of carnation cv. Red Sim plant grown on the two seasons (2000 and 2001) under greenhouse conditions.

Treatments (mg L^{-1})		Leaves number/branch		Leaves dry weight (g)/branch	
P_2O_5	B	Season		Season	
		1 St	2 nd	1 St	2 nd
0.0	0.0	18.50	18.74	2.03	2.10
	25	18.96	19.90	2.16	2.23
	50	20.17	20.86	2.47	2.56
Average		19.21	19.83	2.22	2.29
50	0.0	19.42	19.56	2.45	2.49
	25	20.69	21.50	2.66	2.76
	50	21.56	22.30	2.98	3.10
Average		20.55	21.12	2.67	2.78
100	0.0	20.84	20.98	2.58	2.62
	25	22.67	22.49	3.03	3.10
	50	24.16	23.97	3.44	3.46
Average		22.55	22.48	3.02	3.06
200	0.0	20.98	21.39	2.58	3.00
	25	23.39	23.61	3.16	3.12
	50	24.56	24.68	3.47	3.49
Average		22.97	23.23	3.07	3.20
400	0.0	20.42	20.40	2.49	2.47
	25	21.53	21.56	2.58	2.60
	50	22.00	21.87	2.51	2.54
Average		21.32	21.28	2.53	2.54
LSD 0.05	P_2O_5	0.43	0.40	0.26	0.23
	B	N.S	0.34	0.10	0.12
	Interaction	0.83	0.78	0.33	0.29

to produce thicker and heavier leaves. Also, the increase in leaves dry matter may be related to the increase in the number or of leaf area or both of them. Similar results were obtained by Ateeque et al., (1994) on sunflower plant.

II- Flower characteristics :-

1- Flowering time: -

The data in Table (6) show that the flowering time from a planting date was significantly decreased with increasing P concentration in the foliar solution, alone or in combination with B, as a compared with the control in the two growing seasons. As well as, spraying foliage of carnation plant with increment B concentration lead to decreasing the flowering time, at any level of P applied, in both the two growing seasons.

2- Number of Flowers/plant :-

Data in Table (6) show that foliar application of P was the most effective as fertilizer on flowers number per plant. Also, the spray of B on carnation plants increased the average of flowers number/plant during the two seasons. Generally, the greatest number of flowers/plant was obtained by adding 200 mg L^{-1} of P_2O_5 in combination with 50 mg L^{-1} of B, whereas the relative increases were 150.28 and 157.59 % for the two seasons as compared with the control treatment. These increases may be due to, as reported by (Katalymow, 1969), the function of phosphorus with boron at specific level on the promotion of indol acetic acid oxidase (IAA) activity to prevent the accumulation of supra-optimal levels of endogenous IAA. In addition, boron is essential for the nucleic acid metabolism and incorporation of phosphorus into RNA and DNA which lend to stimulation the initiation and development of flowers on the plant. On the other hand, the observed decrease in this respect because of spray the plants with the highest levels may be due to the presence of high salt concentration in the spraying solution that may raise the respiration rate and /or increase the rate of metabolic catabolism (Luttge et al., 1971). These results are similar to those obtained by Kirilov et al., (1989), Skowalczyk et al., (1992) and Mostafa (1996) on carnation plants.

3- Flower size (diameter):-

Data in Table (7) show that the flower diameter (cm) was highly significantly increased due to foliar application of all levels of P in combination with B. Generally, the largest diameter of flower was found by using 100 or 200 mg P_2O_5 L^{-1} plus 50 mg B L^{-1} as a compared with the other treatments. These increases may be due to the low level of the two elements in the soil (Table, 1) and that foliar application with a suitable

Table (6): Effect of foliar application with different concentrations of P and B on flowering time, and number of flowers per plant of carnation cv. Red Sim plant grown on the two seasons (2000 and 2001) under greenhouse conditions.

Treatments (mg L^{-1})		Flowering time (day)		Flowers number/plant	
P_2O_5	B	Season		Season	
		1 St	2 nd	1 St	2 nd
0.0	0.0	129.94	130.10	3.56	3.49
	25	127.90	127.89	4.02	3.96
	50	124.36	125.09	4.83	4.80
Average		127.40	127.69	4.14	4.08
50	0.0	127.34	128.19	4.37	4.28
	25	122.39	122.46	5.79	5.84
	50	120.26	121.00	6.42	6.92
Average		123.33	123.88	5.53	5.68
100	0.0	122.97	123.06	5.26	5.38
	25	117.68	118.42	7.31	7.52
	50	115.87	115.65	8.64	8.73
Average		118.84	119.04	7.07	7.21
200	0.0	119.85	119.95	5.92	5.96
	25	116.02	116.33	7.73	7.85
	50	113.66	114.06	8.91	8.99
Average		116.51	116.78	7.52	7.60
400	0.0	121.86	122.30	5.04	5.10
	25	119.57	120.32	7.12	7.18
	50	120.10	120.86	6.85	6.62
Average		120.51	121.16	6.34	6.30
LSD 0.05	P_2O_5	1.47	1.77	0.39	0.36
	B	1.17	1.18	N.S	N.S
	Interaction	2.75	2.95	0.72	0.66

concentrations lead to increases in the petals number, their expansion or both of them, consequently, the diameter of flowers could be increased.

Similar results were obtained by Adams et al., (1979), Kirilov et al., (1989) on carnation and Belgaonkar et al., (1997) on chrysanthemum.

4- Flowers dry weight:-

Data in Table (7) show that foliar application of P_2O_5 at a rate of 100 mg L^{-1} with B at a rate of 50 mg L^{-1} produced the heaviest flower weight (as dry matter), compared with the other treatments, in the two growing seasons. These may be due to the effect of phosphorus and boron on increasing the biosynthesis and accumulation of materials, as well as, P and B are important for cell division activity, leading to the increase of flower dry weight (Bakry, 1979 and Thalooth et al., 1981). Also, these increases may be due to the increases in size. Similar results were found by El-Shafie (1977) on carnation and Ateeque et al., (1994) on sunflower plant.

III- Chemical constituents: -

1-Total chlorophyll and carotenoides: -

The results in Table (8) indicated that the total chlorophyll content (a+b) and total carotenoides were significantly increased with increasing P_2O_5 at any levels, in combined with boron at a rate of 50 mg L^{-1}. Furthermore, the highest significant increase in the total chlorophyll and carotenoide contents were obtained from spraying of P at either 100 or 200 mg P_2O_5 L^{-1} in the presence of B at a rate of 50 mg L^{-1}, as compared with the control. These increases may be due to the role of phosphorus in synthesis of phospholipids of membranes, sugar phosphates, various nucleotides and co-enzymes. This, in turn, increased the total chlorophyll and carotenoides contents as a result of foliar fertilization. This could be also attribute to the physiological role of phosphorus in enhancing the plastid pigments content (chlorophyll and carotenoides contents). These results are in agreement with El-Naggar (1994) on gladiolus and Mostafa (2000) on Dendranthema grandiflorum.

2- Phosphorus content:-

The data in Table (9) show that increasing the levels of P_2O_5 applied increased of the phosphorus content in carnation leaves (cv. Red Sim). The highest significant increase of phosphorus (P %) was obtained by using the highest level of P (400 mg P_2O_5 L^{-1}) with boron at a rate of 50 mg L^{-1} comparing with control treatment of the two growing seasons. This result may be related to the effect of spraying phosphoric acid, as a source of phosphorus, to increase P absorption and translocation phosphorus in plant and hence its accumulation in the leaves (Epstein, 1972). Similar results were found by El-Baky (1986) on carnation; El-Naggar (1994) on gladiolus;

Table (7): Effect of foliar application with different concentrations of P and B on flower diameter (size), and flower dry weight per plant of carnation cv. Red Sim grown on the two seasons (2000 and 2001) under greenhouse conditions.

Treatments (mg L^{-1})		Flower diameter (cm)		Flower dry weight (g)/plant	
P_2O_5	B	Season		Season	
		1 St	2 nd	1 St	2 nd
0.0	0.0	3.87	3.82	1.22	1.21
	25	4.39	4.48	1.30	1.36
	50	4.85	4.92	1.39	1.41
Average		4.37	4.41	1.30	1.33
50	0.0	4.46	4.51	1.36	1.39
	25	5.62	5.68	1.48	1.52
	50	6.09	6.14	1.71	1.79
Average		5.39	5.44	1.52	1.57
100	0.0	5.67	5.59	1.48	1.46
	25	6.52	6.62	1.62	1.64
	50	7.69	7.73	1.96	1.99
Average		6.63	6.65	1.69	1.70
200	0.0	6.18	6.20	1.52	1.57
	25	6.97	7.10	1.87	1.92
	50	7.96	7.98	2.05	2.12
Average		7.04	7.09	1.81	1.87
400	0.0	5.46	5.51	1.47	1.49
	25	6.38	6.29	1.64	1.63
	50	6.42	6.36	1.68	1.72
Average		6.09	6.05	1.60	1.61
LSD 0.05	P_2O_5	0.43	0.40	0.21	0.20

Table (8): Effect of foliar application with different concentrations of P and B on total chlorophyll (a and b), and total carotenoides (mg/100 g fresh weight) of carnation cv. Red Sim plant grown on the two seasons (2000 and 2001) under greenhouse conditions.

Treatments, ($mg\ L^{-1}$)		Chlorophyll (a+b) (mg/100 g F.W.)		Carotenoides (mg/100 g F.W)	
P_2O_5	B	Season		Season	
		1 St	2 nd	1 St	2 nd
	0.0	179.85	178.10	26.01	27.90
0.0	25	188.30	189.52	29.81	29.85
	50	225.54	225.7	35.60	37.00
Average		197.90	197.78	30.47	31.58
	0.0	191.26	192.41	31.90	32.19
50	25	246.78	249.30	42.09	42.52
	50	298.12	296.39	48.28	49.31
Average		245.38	246.03	40.76	41.34
	0.0	215.85	216.31	39.52	40.51
100	25	215.81	310.21	49.82	52.35
	50	349.46	351.60	64.85	68.91
Average		293.71	292.71	51.40	53.92
	0.0	219.63	221.51	42.05	44.21
200	25	327.01	329.59	56.89	59.52
	50	351.26	350.50	69.96	69.32
Average		299.30	300.53	56.30	57.68
	0.0	216.91	219.02	40.52	41.30
400	25	326.81	329.91	50.08	52.01
	50	345.24	342.83	63.90	64.81
Average		296.32	297.25	51.50	52.71
LSD 0.05	P_2O_5	2.53	2.49	1.95	2.01
	B	2.03	1.72	1.46	1.86
	Interaction	3.91	3.65	2.81	3.13

Kageyama and Konishi (1994) and Belgamonkar et al., (1997) on chrysanthemum plants

3- Boron Content :-

The data presented in Table (9) show also that the addition of the highest level of B (50 mg L^{-1}) to carnation plant was increased the content of boron in leaves (as mg/kg leaves dry matter). The highest significant increase was obtained by spraying of Boron at a rate of 50 mg L^{-1} combined with 200 mg P_2O_5 L^{-1}, as compared with the other treatments. This increase may be due to the high amount of boron, which sprayed on the plant, may resulted in a higher absorption and translocation of boron into plant. Also, phosphorus played a role in the biosynthesis of ATP which implicated of ion absorption, especially on the B (Epstein 1972). Similar trend of results was obtained by Mostafa (1996) on carnation plants; Buzetti et al., (1991) on soybean plant and Sharaf (1997) on wheat and faba bean plants.

CONCLUSSION

From the results obtained, it could be concluded that:

1-The best results of vegetative growth characteristics and flowering parameters were obtained by foliar application of carnation plant with P and B at rates of 200 mg P_2O_5 L^{-1} and 50 mg B L^{-1}.

2-The flowering time from a planting date of carnation plant was significantly decreased with increasing P concentration in the foliar solution, alone or in combination with B sprayed. Also, increment B rates lead to decreasing the flowering time at any level of P applied.

3-Foliar application of P_2O_5 was the most effective on the leaves and flowers numbers per plant alone or in combination with spray of B-fertilizer.

4-Foliar application of B alone on carnation plant was significant effect for increasing vegetative growth characteristics and flowering parameters except flowers number per plant was not significant.

Table (9): Effect of foliar application with different concentrations of P and B on average contents of P (%) and B (mg/ kg dry weight) in leaves of carnation cv. Red Sim plant grown on the two seasons (2000 and 2001) under greenhouse conditions.

Treatments (mg L^{-1})		Average P content (% of leaves D.W)		B content (mg/ kg of leaves D.W.)	
P_2O_5	B	Season		Season	
		1 St	2 nd	1 St	2 nd
	0.0	0.16	0.17	10.01	11.25
0.0	25	0.19	0.21	14.81	14.97
	50	0.25	0.28	16.96	17.05
Average		0.20	0.22	13.92	14.42
	0.0	0.24	0.26	13.79	14.11
50	25	0.37	0.39	18.51	18.75
	50	0.46	0.49	23.99	22.98
Average		0.37	0.38	18.76	18.61
	0.0	0.29	0.28	17.16	16.90
100	25	0.42	0.40	36.90	37.00
	50	0.52	0.54	42.35	44.02
Average		0.41	0.41	32.14	32.64
	0.0	0.36	0.39	20.52	21.12
200	25	0.48	0.47	39.14	38.95
	50	0.56	0.58	44.40	45.16
Average		0.47	0.48	34.69	35.08
	0.0	0.38	0.39	20.51	20.95
400	25	0.52	0.52	38.95	39.01
	50	0.59	0.61	39.90	37.82
Average		0.50	0.51	33.12	32.59
LSD 0.05	P_2O_5	0.062	0.072	1.59	1.92
	B	0.035	0.038	0.90	0.96
	Interaction	0.192	0.198	2.14	2.10

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الملخص العربى

تأثير التسميد الورقي بعنصر الفوسفور والبورون على النمو الخضرى والصفات الزهرية لنبات القرنفل

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أجريت تجربتان لتسميد نبات القرنفل المجوز (Red Sim) المنزرع بالعقل المجـذرة تسـميداً ورقـياً بعنصرى الفوسفور او البورون او كليهما تحت ظروف الصوب الزراعية فـى الاراضى الجديدة الجيرية بمنطقة النوبارية ، غرب مدينة الاسكندرية خلال موسمى ٢٠٠٠ و٢٠٠١ ، وذلـك لدراسـة اثر رش خمس معدلات من الفوسفور (صفر ، ٥٠ ، ١٠٠ ، ٢٠٠ ، ٤٠٠ مجم P_2O_5/لتر محلول حامض الفوسفوريك) او ثلاثة مستويات من الـبورون (صفر ، ٢٥ ، ٥٠ مجم B /لتر محلول حامض البوريك) كلاً منفرداً او الاثنين معـاً بكل التوافيق الممكنة، وذلك على صفات النمو الخضرى (طول الساق ، قطر الساق ، الـوزن الجـاف للساق ، وعدد ووزن الاوراق / نبات) وكذلك معايير النمو الزهرى (تقليل الوقت اللازم للازهار من وقت الزراعة الى بداية ظهور اللون فى البراعم الزهرية، العدد والحجم والوزن الجاف للازهار/نبات) مقارنه بنباتات معاملة الكنترول.

وقـد أوضـحت النـتائج ان اضافة الفوسفور ورقياً ، منفرداً او مع اضافة تركيزات الـبورون المخـتلفة ادى الى تحسن معنوى فى صفات النمو الخضرى والزهري تدريجياً بـزيادة تركيزات الفوسفور. وعلى الجانب الاخر فان اضافة البورون منفرداً قد ادى ايضاً الـى تحسن معنوى فى صفات النمو الخضرى والزهري ، فيما عدا ان زيادة عدد الازهار لكل نبات كانت غير معنوية.

وتحققت افضل النتائج لتحسين صفات النمو الخضرى والزهرى نتيجة التسميد الورقي بحـامض الفوسـفوريك وحامض البوريك معاً عند استخدام ٢٠٠ مجم P_2O_5/لتر مع ٥٠ مجم B /لتر.

كمـا اوضحت نتائج التحليل الكيماوى تحسن فى محتوى الاوراق من الكلوروفيل الكلى (أ+ب) والكاروتينات فكانت الزيادة من ١٧٨,٩٨ الى ٣٥٠,٨٨ ومن ٢٦,٩٦ الى ٦٩,٦٤ مللـيجرام/١٠٠ جم – وزن اوراق طازجة ، لكل منهما على الترتيب. كذلك زيادة محتوى الاوراق مـن الفوسـفور والـبورون ، فكانـت الزيادة من ٠,١٦٥ ال ٠,٦٠٠ % ومن ١٠,٦٣ الى ٤٤,٧ ملليجرام/كجم – وزن اوراق جافة، على الترتيب.