EFFECT OF PHOSPHORUS AND POTASSIUM FERTILIZATION ON GROWTH AND FLOWERING OF GERANIUM

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ABSTRACT

This investigation was carried out during 2003 and 2004 seasons on a local cultivar of Pelargonium zonale, namely "Rose" growing in plastic pots of 20 cm diameter filled with an equal mixture of peat moss and sand in a private nursery in Alexandria suburban, aiming to study the effect of adding five levels of phosphorus (zero,25,50,100,200 ppm) and/or five levels of potassium (zero,50,100,200,400 ppm) in 250 ml water three times weekly singly and with all possible combinations between them (5 P_2O_5 X 5 K_2O = 25 treatments).

Results revealed that adding phosphorus and/or potassium alone or in combination significantly increased all the studied vegetative and flowering characteristics, as compared with the control treatment. Besides, using phosphorus at 200 ppm combined with 400 ppm potassium gave the maximum values of phosphorus and potassium in the leaves of geranium plant, while the maximum values of leaf-chlorophyll was found at 100 ppm phosphorus combined with 200 ppm potassium, and the inflorescence red colour was found at 400 ppm potassium alone.Highest amount of available phosphorus or potassium in the soil at the end of the experiment was found at the highest level of each element.

In brief, to obtain a flowering pot plant of Pelargonium zonale cv. "Rose" with good vegetative and flowering traits, it is recommended to fertilize the plants with phosphorus at 100-200 ppm combined with potassium at 200-400 ppm dissolved in irrigation water three times weekly with washing the pot soil for once bi-weekly to avoid excess salts in the pot medium.

Key words: *Pelargonium zonale, geranium, phosphorus, potassium, fertilization.*

INTRODUCTION

Geranium plant *(Pelargonium zonale* (L.) L 'Herit ex. Ait), is one of the famous and favorite ornamental plants originated in South Africa. It is a partly shrubby plant with hardy woody lower stems, and partly succulent with young fleshy upper ones. Many *Pelargonium zonale* varieties are suitable for all aspects of arrangement and decoration. It is grown as a bedding plant in the open gardens, and used as a pot plant. It is also grown in window-boxes, tubs, hanging baskets, rock gardens, and it is an exhibition plant.

Generally, nutritional requirement is considered as a limiting factor for geranium plant growth and flowering. Phosphorus is closely concerned with the vital growth processes in plants as it is present in cell nucleic acid as phosphoric acid combined with other constituents. It is also important in the metabolism of fats, concerned with the process of respiration and utilization of nitrogen and of great importance in the processes concerned with the root development and the ripening of seeds and fruits (Develin, 1975).

Baas *et al.* (1995) supplied the plants of *Pelargonium zonale* were with 0.02, 0.09, 0.22 or 1.06 mmol H_2PO_4/litre of nutrient solution and they found that the general effects of suboptimal phosphorus led to reduce all the growth parameters.

Dahiya *et al.* (1999) studied the effect of phosphorus at zero, 40, 80 and 120 ppm in nutrient solution on growth of potted African marigolds grown in a sandy loam soil. They found that increasing phosphorus rates up to 120 ppm improved the growth and flowering parameters of marigold plants.

Gunes and Alpaslan (2000) used phosphorus at zero, 50, and 100 ppm in nutrient solution on the growth of maize genotypes. They found that the dry weight of all genotypes was increased by phosphorus application.

Potassium does not enter in the composition of the important plant constituents such as proteins, fats and carbohydrates, but its main role in the plant is by the regulation of water condition within the plant cell and water substances, as an accelerator of enzymes action, it contributes to photosynthesis through its radio-active properties and finally it has a role in loading and translocation of carbohydrates through plant organs (Kilmer *et al.*, 1968).

Beel and Bruyn (1999) studied the effects of different levels of potassium in the nutrient solution on the quality characteristics of *Spathiphyllum* grown in soilless culture and concluded that the optimal level of potassium ranged between 113-156 ppm.

Mostafa (2002) investigated the effect of potassium nutrition on the production of a local variety of poinsettia plants as a flowering pot plant. Four different concentrations of potassium (zero, 80,160 and 320 ppm) were used weekly for fourteen times of applications. It was found that addition of potassium at 80 – 160 ppm in nutrient solution increased the plant height, the production of bracts, total chlorophyll content and potassium content in the leaves.

Mohariya *et al.* (2004) studied the effects of phosphorus at zero, 7.5, 10 and 12.5 g/m^2 and potassium at zero, 10, 12.5 and 15 g/m^2 on the qualitative parameters and vase life of gerbera plants grown under plastic-house conditions. They reported that the highest values for flower stalk length, flower diameter, number of grade I flowers per plant and vase life were obtained with using 12.5 g P_2O_5 combined with 15 g K_2O/m^2.

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The aim of the present study was to find out the effects of the best levels of phosphorus and potassium dissolved in the irrigation water for the vegetative growth, flowering and some chemical analysis of *Pelargonium zonale*, cv. "Rose "planted as a pot plant.

MATERIALS AND METHODS

The present study was carried out in two successive seasons of 2003 and 2004 in a private nursery in Alexandria suburban, Egypt.

Stem tip cuttings with an average length of 13 cm were taken from mother plants grown in a private farm in Alexandria city and planted on 5 February 2003 and 2004 in 6 cm pots (one cutting per pot) filled with a medium of peat moss and sand (1: 1 by volume).The planted cuttings were placed in a partial shade place and watered after planting.

On March 2nd 2003 and 2004 rooted cuttings were transplanted to 12 cm pots (one plant per pot) using the same planting media used before.

After 3 weeks from transplanting on March 23rd the plants were transplanted to the final plastic pots of 20 cm diameter containing the same medium (peat moss and sand 1:1 v / v).

The analyses of the used planting media in both seasons are presented in Table (A).

At the beginning of the experiments each plant had only one pinched branch with five leaves. All the formed inflorescence buds were removed from the plants during the first three months after the final transplanting to encourage the vegetative growth, and then the plants were kept for other three months for flowering.

There are 25 treatments which are the combinations of five levels of phosphorus (P_2O_5) and five levels of potassium (K_2O). Phosphoric acid (40 % P_2O_5) was used as a source of P_2O_5, while potassium sulphate (48 % K_2O) was used as a source of K_2O.

The levels of phosphorus (P_2O_5) were control (zero),25,50,100 and 200 ppm ,while the levels of potassium (K_2O) were control (zero), 50,100,200 and 400 ppm .

The fertilizer treatments started on March 26th 2003 and 2004. They were added three times weekly by dissolving the amount of the used fertilizer in 250 ml of tap water, which is equalized to 75% of water holding capacity of the used medium. The plants received 65 times of such fertilization in each season.

Besides, ammonium nitrate (34 % N) was added as a source of nitrogen for all plants with a constant rate of 150 ppm (Ruth and Hagiladi, 1992) at the same time and method of adding phosphorus and potassium.

The pot soil was washed once every two weeks through adding one litter of tap water to each plant without adding any fertilizer in this day to avoid excess of salts in the medium.

The experimental design used was a randomized completely blocks with 25 treatments and three replicates, and each treatment was represented by three plants replicates. The experiment contained 225 pots for each season (25 treatments x 3 replicates x 3 plants/pots). The means of individual factors and their interactions were compared by L.S.D test (Snedecor and Cochran, 1974).

The following data were recorded: plant height, number of branches per plant, number of leaves per plant, leaves dry weight, plant dry weight, number of inflorescence per plant, florets number per inflorescences, inflorescence duration on plant, inflorescence dry weight, total chlorophyll content according to Yadava, (1986), percentage of phosphorus and potassium in the leaves according to Page *et al.* (1982), inflorescence red colour concentration according to Ziena *et al.* (1997), and available phosphorus and potassium in the soil according to Page *et al.* (1982).

RESULTS AND DISCUSSION

Vegetative growth

Generally data of the two experimental seasons (2003 and 2004) of the present study showed that using each of phosphorus or potassium alone gave significant increases in the most of the studied vegetative growth data i.e. plant height, branches number, leaves number and dry weight and total plant dry weight as compared with the control treatment (Table 1).

These results may be due to that the content of the used medium from the two elements (phosphorus or potassium) was not enough to supply the geranium plants with their needs to grow well, thus any application from any element led to improve the growth rate of geranium plants.

Furthermore, data of the two seasons in Table (1) indicated that increasing the added level of phosphorus from zero to 100 or 200 ppm gave significant increases in all vegetative growth data, as compared with the control treatment.

These results may be due to that increasing the amount of added phosphorus led to increase the absorbed amount and translocation of it within the plants. Besides, phosphorus is an important element increasing many biological processes such as synthesis of adenosin diphosphate (ADP) and adenosin triphosphate (ATP), which are responsible for the formation of new cells, accordingly, the rate of cell division and cell elongation could be increased, as a result, all the growth characteristics could be increased as reported by Epstein (1972), and Mengel and Haeder (1977) on other plants. Similar trend was reported by the results of Dahiya *et al.* (1999) on African marigold Katiyar *et al.* (1999) on hybrid tea rose and Fageria and Costa (2000) on *Phaseolus vulgaris*.

In this investigation it is also clear that, in general most growth characteristics were increased with increasing potassium fertilizer level up to 100 ppm, which is may be due to the role of potassium in the

plants. Using potassium fertilizer at a suitable rate plays a vital role in the activation of enzymes involved in the energy transfering and building up of ATP which store the energy needed for CO_2 assimilation and the synthesis of sugar, starch and proteins, thus the whole growth of geranium plant could be increased as reported by Kemmler *et al.* (1997) and Epstein, (1972). Similar trend of results was reported by Eakes *et al.* (1992) on *Salvia splendens*, Barman and Talukdar (1999) and Mostafa (2000) on chrysanthemum.

Also, data of the two seasons indicated generally that, using phosphorus at 200 ppm combined with potassium at 200 to 400 ppm gave the highest values of the vegetative growth data as compared with the other treatments. These results may be due to the role of each element (phosphorus and / or potassium) at suitable rates and their importance's in the life processes of geranium plants. Geranium plants cannot carry of its life process if it lacks phosphorus and / or potassium. Also, these results were probably due to that presence of the two used elements at suitable level, led to synergetic effects on the data of the vegetative growth (plant height, number of branches, leaves number and dry weight and plant dry weight), consequently, values of the vegetative growth parameters could be increased over the value of each element alone.

Similar trend of results was reported by Yasui *et al.* (1982) on carnation, Hedge (1991) on *Catharanthus roseus*, Lodhi and Tiwari (1995) on chrysanthemum and Gurav *et al.* (2002) on gerbera.

Flowering characteristics

Generally, data on the number of inflorescences per plant showed that the maximum number of inflorescences per plant was found at 100 ppm phosphorus (P_2O_5) combined with 200 ppm potassium (K_2O) in both seasons (Table 2).

These results were probably due to that application of phosphorus at specific level is of paramount importance in stimulating initiation and development of many new inflorescences, or due to the importance of phosphorus at proper concentrations in the synthesis of materials to built up the flower buds beside, the influence of potassium on promoting photosynthesis and accelerating the translocation of assimilates materials from the leaves to other plant parts, particularly to storage tissues through the sieve tubes of phloem tissue, consequently, the number of inflorescences could be increased. Similar trend of results was reported by Barman and Talukdar (1999) on chrysanthemum, Dahiya *et al.* (1999) on African marigold, Subrata and Maiti (1999) on China aster and Mohariya *et al.* (2004) on gerbera.

Besides, data of the number of florets per inflorescence showed generally that, the highest number of florets per inflorescence was found by using 200 ppm phosphorus (P_2O_5) combined with 400 ppm potassium (K_2O) in the two experimental seasons (Table 2).

These results were probably due to that application of phosphorus at specific level is of paramount importance in stimulating initiation and development of many new florets on the formed flower buds beside the role of potassium at specific rate on enhancing the biosynthesis and translocation of assimilates materials leading to initiation of more florets primordias, consequently, the number of florets per inflorescence could be increased. Generally, data of the two seasons indicated that using 200 ppm phosphorus (P_2O_5) combined with 400 ppm potassium (K_2O) in the two experimental seasons gave the longest flowering period of geranium.

The previous result may be related to the influence of a suitable rate of phosphorus led to produce large inflorescence size which have more number of florets per inflorescence. Besides, adding of potassium at a suitable rate enhanced the turgor of the inflorescence cells with supplying them with sugars (Hartt, 1969) and keeping the water potential of the inflorescence cells at high levels. As a result, the inflorescence duration could be increased. Similar trend of results was reported by Haitbura and Misra (1999) and Khan and Ahmad (2004) on gladiolus.

Furthermore, the maximum dry weight of inflorescence was obtained by using 200 ppm phosphorus (P_2O_5) combined with 400 ppm potassium (K_2O) in both experimental seasons (Table 2).These results were probably due to that adding phosphorus at the highest level led to produce large inflorescence size, which have more number of florets per inflorescence beside the effect of potassium at specific concentration on enhancing the accumulation of biosynthesates and increasing the number of florets per inflorescence, consequently the dry weight of the inflorescence could be increased. Similar trend of results was reported by Belgonkar *et al.* (1998) on chrysanthemum.

Table (A): Analysis of the used medium in the two seasons.

Seasons	Texture	pH	EC ds/m	Organic matter %	Total N ppm	Total P ppm	Cations mq/l				Anions mq/l		
							Na^+	K^+	Ca^{++}	Mg^{++}	HCO_3^-	SO_4^{--}	Cl^-
2003	Sandy	6.86	1.05	3.1	53	0.36	2.8	0.05	5.3	3.05	5.2	5.5	1.0
2004	Sandy	6.79	1.89	3.9	58	0.04	6.3	0.05	10.9	3.20	9.6	6.4	4.9

Chemical analysis

Plant analysis

Generally, the maximum total chlorophyll content of geranium leaves was found at 100 ppm phosphorus combined with potassium at 200 ppm (K_2O) in both seasons (Table 3).

This result may be attributed to the indirect role of potassium in the biosynthesis of the green pigment, hence using potassium at a suitable rate activate the synthesis of chlorophyll, thus the total chlorophyll content could be increased, as reported by Epstein (1972). Similar trend of results was reported by Mostafa (2000) on chrysanthemum.

Generally, the highest percentage of the phosphorus content in leaves was found by using phosphorus (P_2O_5) at the highest level (200 ppm) combined with 200 or 400 ppm potassium (K_2O) in both seasons (Table 3).

These results may be related to the effect of added ortho-phosphoric acid as a source of phosphorus in increasing the availability of the absorbed and translocated phosphorus, consequently the percentage of phosphorus in the geranium leaves could be increased. Similar trend of results was reported by Whipker and Hammer (1994) on poinsettia, Iersel *et al.* (1998) on impatiens, petunia and vinca and Mostafa (2000) on chrysanthemum.

Besides, the maximum percentage of potassium content in leaves of geranium plant was found by using the highest level of potassium (400 ppm) combined with the highest level of phosphorus (200 ppm) in both seasons.

These results were probably due to that, as the elements absorbed without selectively, the higher rate of added potassium (K_2O) resulted in more absorption and translocation and hence accumulated it in the leaves (Epstein, 1972).

Table (1): Means of vegetative growth characteristics of *Pelargonium zonale* plants as influenced by the different levels of phosphorus (P) and potassium (K) fertilizers and their interactions (P x K) in the two seasons of 2003 and 2004.

Treatments (ppm)		Plant height (cm)		No. of branches per plant		No. of leaves per plant		Leaves dry weight (g)		Plant dry weight (g)	
P	K	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
0	0	15.55	18.66	5.00	5.22	18.55	23.44	3.40	6024	14.45	12.31
0	50	19.77	20.22	8.78	6.66	38.44	37.77	7.04	8.95	13.97	14.82
0	100	21.33	17.11	7.88	5.66	36.66	34.22	4.59	7.38	12.08	10.65
0	200	15.83	14.55	6.67	5.00	25.00	23.66	3.52	6.52	8.02	9.65
0	400	15.33	12.66	5.11	4.11	23.33	17.33	1.83	4.65	6.43	7.40
25	0	30.44	44.55	17.77	15.66	122.22	149.66	12.93	28.43	44.92	55.06
25	50	29.00	42.22	20.89	20.77	129.22	178.11	18.35	29.98	69.88	53.48
25	100	33.44	43.88	19.33	20.55	150.22	183.77	23.65	32.35	77.83	61.45
25	200	31.78	42.77	21.11	21.77	155.55	185.00	23.45	32.67	78.23	65.50
25	400	36.66	41.00	18.55	20.33	132.66	169.99	25.96	34.30	81.05	64.03
50	0	29.66	41.33	17.88	23.00	109.55	201.00	13.85	30.95	53.93	59.92
50	50	38.77	32.11	22.89	21.55	159.33	213.11	20.23	35.78	66.47	63.89
50	100	32.89	33.00	20.22	19.33	132.22	197.89	20.95	35.93	73.07	64.65
50	200	42.44	35.66	22.22	22.55	141.33	216.55	21.62	38.98	82.53	71.81
50	400	45.11	31.88	22.78	23.11	132.00	215.22	24.98	36.76	78.60	67.40
100	0	31.00	45.11	20.44	21.22	115.11	197.44	16.39	31.41	68.76	66.35
100	50	38.77	42.33	25.77	26.55	168.11	216.66	20.07	35.70	65.38	59.65
100	100	36.33	42.22	19.66	25.88	187.66	221.44	22.67	35.56	75.68	59.83
100	200	45.77	45.22	25.88	27.11	172.22	222.00	24.23	38.30	90.11	75.46
100	400	33.55	43.22	21.89	23.78	168.33	217.77	26.94	38.72	83.47	66.56
200	0	29.66	40.77	19.67	22.66	125.77	203.99	22.43	34.02	68.17	65.01
200	50	35.55	41.88	21.78	24.22	156.22	202.22	21.56	35.96	71.19	62.99
200	100	33.66	42.00	23.44	26.00	187.33	224.00	22.01	37.24	78.33	66.55
200	200	39.44	41.88	20.33	25.78	157.77	204.99	25.26	38.93	86.25	74.63
200	400	44.66	44.55	17.89	22.22	193.33	225.089	29.95	41.56	86.85	73.63
L.S.D (0.05) P		2.63	1.91	1.58	1.37	7.71	8.59	1.94	1.44	5.57	2.41
	K	2.63	1.91	1.58	1.37	7.71	8.59	1.94	1.44	5.57	2.41
Interaction PK		5.99	4.29	3.54	3.07	17.26	19.20	4.33	3.23	12.45	5.38

L.S.D = Least significant difference at 0.05 of probability.

Also, presence of a high concentration of potassium in the rooting medium, led to absorb a high amount of it, Beside that the high mobility and translocation of potassium at the presence of phosphorus at suitable level in the plant tissue led to increase the concentration of potassium in the plant (Kemmler *et al.* 1997). Similar trend of results was reported by Hosni and El-Shoura (1997) on carnation, Iersel *et al.* (1999) on vinca plants and Mostafa (2002) on poinsettia.

Inflorescence red colour value (C.I.E units)

Generally, the maximum value of red colour in the inflorescence was found by using the highest level of potassium (400 ppm) alone in both seasons (Table 4).

This result may be probably due to that the presence of potassium at a suitable level led to the formation of K – salt of some pigments such as delphinidin, consequently the concentration of the red colour could be increased. Similar trend of results was reported by Allen (1931), Munch and Fritzsche (1975) and Abbas (1982) on hydrangea.

Table (2): Means of flowering characteristics of *Pelargonium zonale* plants as influenced by the different levels of phosphorus (P) and potassium (K) fertilizers and their interactions (P x K) in the two seasons of 2003 and 2004.

Treatments (ppm)		No. of inflorescence per plant		No. of florets per inflorescence		Inflorescence duration on plant (days)		Inflorescence dry weight (g)	
P	K	2003	2004	2003	2004	2003	2004	2003	2004
0	0	4.44	5.88	10.85	11.00	22.08	22.97	0.08	0.10
0	50	5.66	7.55	15.50	14.71	24.60	24.36	0.30	0.26
0	100	4.44	6.77	14.96	13.94	24.57	24.06	0.25	0.24
0	200	3.78	6.89	14.09	12.80	24.49	23.83	0.21	0.24
0	400	3.66	5.67	13.05	11.94	24.31	23.65	0.21	0.23
25	0	24.44	23.77	22.05	21.63	31.54	33.06	0.36	0.50
25	50	30.66	34.11	26.29	25.79	32.71	33.99	0.56	0.61
25	100	30.33	33.00	26.07	26.80	32.97	34.06	0.59	0.75
25	200	32.11	31.33	25.18	27.01	33.00	32.97	0.65	0.83
25	400	31.00	29.22	25.88	27.17	32.88	34.01	0.76	0.89
50	0	25.55	26.00	22.26	21.54	32.17	33.44	0.38	0.52
50	50	32.55	29.78	25.07	25.35	32.31	33.94	0.66	0.87
50	100	31.89	34.66	25.69	27.81	32.74	34.16	0.66	0.90
50	200	33.77	34.00	26.06	27.25	32.70	34.05	0.67	0.95
50	400	32.22	30.78	26.34	27.12	32.74	33.95	0.89	1.02
100	0	28.22	24.89	22.84	22.85	32.42	33.63	0.42	0.60
100	50	33.66	31.77	26.40	26.65	32.85	33.79	0.86	0.98
100	100	31.33	33.66	26.29	26.99	33.02	33.85	0.86	0.95
100	200	35.77	36.88	26.62	27.77	33.25	33.91	0.86	0.97
100	400	33.11	34.11	27.13	28.11	33.37	33.46	0.91	0.97
200	0	30.89	27.33	22.74	23.08	32.46	34.25	0.54	0.64
200	50	31.55	32.66	26.41	27.05	33.09	33.68	0.95	0.99
200	100	32.22	34.88	27.00	27.76	32.82	33.82	0.93	1.02
200	200	32.00	32.11	27.32	28.25	33.58	33.79	0.97	0.99
200	400	32.89	31.78	28.43	29.69	33.98	34.36	1.08	1.04
L.S.D (0.05) P		1.33	1.64	0.55	0.73	0.35	0.24	0.03	0.02
K		1.33	1.64	0.55	0.73	0.35	0.24	0.03	0.02
Interaction PK		3.06	3.66	1.23	1.63	0.78	0.54	0.07	0.05

L.S.D = Least significant difference at 0.05 of probability.

Medium analysis

Generally, the maximum amount of the available phosphorus in the medium at the end of the experiment was found by using the highest level of phosphorus (200 ppm P_2O_5) alone in both seasons (Table 4).

This result may be probably due to that increasing the amount of added phosphorus led to accumulate more phosphorus in the rooting medium; consequently the amount of available phosphorus in the medium could be increased. Similar trend of results was reported by Abdel-Reheem *et al.* (1992) on broad beans, Dahdoh *et al.* (1996) on lucerne and rocket and El-Tilib *et al.* (2004) on sugarcane.

Also, the highest percentage of the available potassium in medium at the end of the experiment was found by using the highest potassium level (400 ppm K_2O) alone in both seasons (Table 4).

This result may be probably due to that any addition of potassium fertilizer led to increase and accumulate the amount of available potassium in the medium. Similar trend of results was reported by El-Tilib *et al.* (2004) on sugarcane plants.

Table (3): Means of total chlorophyll content (SPAD unites) and percentage of phosphorus and potassium in the leaves of *Pelargonium zonale* plants as influenced by the different levels of phosphorus (P) and potassium (K) fertilizers and their interactions (P x K) in the two seasons of 2003 and 2004.

Treatments (ppm)		Total chlorophyll content (SPAD unites)		Phosphorus in the leaves (%)		Potassium in the leaves (%)	
P	K	2003	2004	2003	2004	2003	2004
0	0	44.33	42.35	0.28	0.28	1.96	2.04
0	50	52.30	45.03	0.28	0.28	2.06	2.04
0	100	50.03	45.61	0.28	0.28	2.16	2.15
0	200	55.76	49.41	0.28	0.28	2.43	2.42
0	400	52.60	48.15	0.28	0.27	2.77	2.75
25	0	45.08	42.50	0.28	0.28	2.03	2.02
25	50	49.00	44.76	0.29	0.29	2.03	2.03
25	100	51.83	46.18	0.28	0.29	2.16	2.12
25	200	55.73	48.75	0.28	0.30	2.17	2.16
25	400	52.46	46.21	0.29	0.31	2.42	2.42
50	0	46.86	42.95	0.29	0.30	2.11	2.10
50	50	48.80	45.93	0.30	0.31	1.03	2.04
50	100	52.66	47.98	0.30	0.31	1.12	2.15
50	200	55.26	49.01	0.30	0.31	2.26	2.24
50	400	51.10	46.66	0.30	0.31	2.57	2.59
100	0	46.93	42.55	0.30	0.31	2.27	2.27
100	50	49.96	47.55	0.30	0.31	2.03	2.07
100	100	52.83	46.26	0.31	0.31	2.24	2.24
100	200	56.20	50.16	0.32	0.32	2.35	2.36
100	400	53.03	48.81	0.31	0.32	2.69	2.68
200	0	46.63	42.51	0.30	0.34	2.28	2.27
200	50	47.20	46.65	0.31	0.34	2.29	2.31
200	100	51.73	49.35	0.32	0.34	2.29	2.32
200	200	55.10	49.90	0.32	0.35	2.46	2.49
200	400	52.73	47.61	0.32	0.35	2.83	2.76
L.S.D (0.05) P		N.S	N.S	0.004	0.004	0.02	0.01
K		1.90	1.72	0.004	0.004	0.02	0.01
Interaction PK		N.S	N.S	0.009	0.008	0.05	0.03

L.S.D = Least significant difference at 0.05 of probability.
NS = Not significant.

Table (4): Means of inflorescence red colour concentration (C.I.E. unites) and available phosphorus and potassium in the soil as influenced by the different levels of phosphorus (P) and potassium (K) fertilizers and their interactions (P x K) in the two seasons of 2003 and 2004.

Treatments (ppm)		Inflorescence red colour concentration (C.I.E. unites)		Available phosphorus in the soil (ppm)		Available potassium in the soil (ppm)	
P	K	2003	2004	2003	2004	2003	2004
0	0	7.86	8.20	1.95	0.91	0.08	0.11
0	50	10.06	10.06	2.81	1.08	0.17	0.21
0	100	10.46	10.40	4.28	1.30	0.25	0.39
0	200	10.40	10.50	3.68	1.73	0.44	0.35
0	400	10.60	10.90	3.29	0.99	1.13	0.99
25	0	9.70	9.76	23.46	12.59	0.04	0.02
25	50	9.80	9.76	4.55	12.03	0.09	0.05
25	100	9.33	9.50	6.27	13.50	0.21	0.14
25	200	9.33	9.66	6.57	10.78	0.41	0.35
25	400	9.76	9.56	7.61	10.08	0.85	0.95
50	0	9.86	9.83	25.02	31.21	0.03	0.02
50	50	9.73	9.73	12.12	17.44	0.11	0.05
50	100	9.36	9.46	13.55	18.65	0.15	0.17
50	200	9.83	9.53	11.30	18.18	0.40	0.43
50	400	10.43	10.33	15.54	18.87	0.81	0.93
100	0	9.50	9.43	32.85	44.85	0.04	0.02
100	50	9.60	9.96	19.13	38.57	0.14	0.07
100	100	10.13	9.96	30.33	42.08	0.15	0.18
100	200	9.46	9.93	31.73	41.17	0.43	0.48
100	400	9.50	9.53	33.59	41.51	1.03	0.91
200	0	9.53	9.40	49.22	82.73	0.06	0.03
200	50	9.96	9.79	39.56	73.89	0.14	0.06
200	100	9.73	9.86	40.86	67.70	0.17	0.15
200	200	10.03	10.06	44.46	71.47	0.38	0.35
200	400	10.13	10.30	46.88	75.89	1.09	0.95
L.S.D (0.05)	P	N.S	N.S	1.38	3.50	0.05	0.04
	K	0.35	0.36	1.38	3.50	0.05	0.04
Interaction	PK	0.79	0.88	2.76	7.01	0.12	0.09

L.S.D = Least significant difference at 0.05 of probability.
NS = Not significant.

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الملخص العربى

تأثير التسميد الفوسفورى و البوتاسى على نمو وإزهارالجارونيا العادية

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أجرى هذا البحث فى مشتل خاص فى ضواحى الاسكندرية عامى ٢٠٠٣،٢٠٠٤ على صنف محلى من الجارونيا العادية هو " Rose " منزرع فى أصص بلاستيك مقياس ٢٠ سم مملوءة بخليط متساوى من البيت موس و الرمل بهدف دراسة تأثيرات إضافة خمسة مستويات من حامض الفوسفوريك كمصدر للفسفور(٤٠ % فو٢أ٥) هى صفر، ٢٥، ٥٠، ١٠٠، ٢٠٠ جزء فى المليون فو٢أ٥ و خمسة مستويات من كبريتات البوتاسيم (٤٨ % بو٢ أ) هى صفر، ٥٠، ١٠٠، ٢٠٠، ٤٠٠ جزء فى المليون بو٢ أ منفردة أو فى جميع التوافيق الممكنة بينهما لتعطى ٢٥ معاملة على بعض صفات النمو الخضرى و الزهرى و التحليل الكيماوى.

أظهرت النتائج المتحصل عليها أن إضافة الفسفور أو البوتاسيوم منفردا أو فى توافيق معا أدى إلى زيادات معنوية فى كل صفات النمو الخضرى و الزهرى بالمقارنة بنباتات الكنترول . بجانب ذلك أدى إستخدام الفسفور بتركيز ٢٠٠ جزء فى المليون مع البوتاسيوم بتركيز ٤٠٠ جزء فى المليون إلى الحصول على أقصى محتوى للاوراق لكل من عنصرى الفوسفور و البوتاسيوم ، فى حين أن أعلى قيم لمحتوى الأوراق من الكلوروفيل الكلى وجد عند استخدام الفسفور بتركيز ١٠٠ جزء فى المليون والبوتاسيم بتركيز ٢٠٠ جزء فى المليون و أعلى تركيز للون الأحمرفى النورات وجد عند إستخدام البوتاسيوم منفردا بتركيز ٤٠٠ جزء فى المليون. أما أعلى قيم لمحتوى التربة المستخدمة من الفوسفور و البوتاسيوم فى نهاية التجربة فقد وجد عند إستخدام التركيز الاعلى لكل منهما.

عموما للحصول على نبات أصص مزهر من الجارونيا العادية الصنف " Rose " ذو نمو خضرى و زهرى جيد ينصح بتسميد النباتات بحمض الفوسفوريك بتركيز من ١٠٠–٢٠٠ جزء فى المليون فو٢أ٥ مع كبريتات البوتاسيم بتركيز ٢٠٠–٤٠٠ جزء فى المليون بو٢ أ من مذابين فى ماء الرى بمعدل ثلاث مرات أسبوعيا مع غسيل التربة مرة كل أسبوعين للتخلص من الأملاح الزائدة.