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EFFECT OF GIBBERELLIC ACID AND CHEMICAL FERTILIZERS ON GROWTH AND CHEMICAL COMPOSITION OF *Cryptostegia grandiflora*, R. Br. PLANTS

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ABSTRACT

This study was conducted in the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the two successive seasons of 2006/2007 and 2007/2008. The aim of the study was to investigate the response of *Cryptostegia grandiflora*, R. Br. plants to gibberellic acid spray treatments and NPK fertilization (using conventional and slow-release NPK fertilizers). The plants were fertilized monthly with a conventional NPK fertilizer (18 N – 6 P_2O_5 – 6 K_2O) at rates of 5 and 7 g/plant, or were supplied every 4 months with a commercial slow release fertilizer (Regal Nursery, 24 N -8 P_2O_5 -8 K_2O) at rates of 15 and 21 g/plant. In addition, unfertilized plants were used as the control. Plants receiving each of the NPK fertilization levels were sprayed monthly with gibberellic acid at concentrations of 50 or 100 ppm. Control plants were sprayed with tap water.

Results showed that GA_3 and/or chemical fertilization treatments increased the values recorded for most of the different vegetative growth parameters (vine length, number of internodes of main vine, average internode length, stem diameter, number of branches/plant, leaf area, fresh and dry weights of leaves, stems and roots/plant), as well as the N and K percentages in leaves, compared to the untreated plants. In most cases, increasing GA_3 concentration resulted in steady increases in these parameters. Total chlorophylls, total carbohydrates and P concentrations were decreased by GA_3 treatments and increased by chemical fertilization treatments.

Raising the application rate of each type of chemical fertilizer resulted in steady increases in the values of most of the studied growth parameters. In most cases, at the same fertilization rate, the slow-release fertilizer Regal Nursery gave higher values for most of the vegetative growth and chemical characteristics, compared to the conventional NPK fertilizer. In most cases, combining GA_3 at 50 ppm with the highest rate of Regal Nursery (21 g/plant/4 months) gave values that were insignificantly different than the highest values recorded for most of the vegetative characteristics, which were obtained in plants sprayed with GA_3 at 100 ppm and supplied with the highest rate of Regal Nursery.

From the obtained results, is recommended that, for the best vegetative growth of *Cryptostegia grandiflora*, the plants may be sprayed with GA_3 at 50 ppm and supplied with 21 g/plant/ 4 month of the slow- release fertilizer Regal Nursery (24 N -8 P_2O_5 -8 K_2O).

Keywords: *Cryptostegia grandiflora*, GA_3, NPK fertilization, slow release fertilizer, Regal Nursery.

INTRODUCTON

Cryptostegia grandiflora (*Nerium grandiflorum*, Roxbg.), a member of the *Asclepiadaceae* family, is a strong, evergreen (semi-deciduous in Egypt), twining woody climber, which grows to a height of 10 m or more. It has thick textured, oval, glossy leaves, and funnel-shaped, reddish to lilac-purple flowers which appear in summer. Its stems yield poisonous latex that may cause severe discomfort if ingested. In many parts of the world, it is known as the “rubber plant”, and in India it is also known as pulay or palay, and is widely cultivated as an ornamental plant (Brickell, 1999). In addition, extracts of *Cryptostegia grandiflora* leaves exhibit significant antibacterial activity against *Pseudomonas cepacia*, *Bacillus megatorium*, *B. subtilis*, *B. coagulans*, *Staphylococcus aureus* and *Escherichia coli* (Mukherjee *et al*., 1999). In another study, Augustus *et al*. (2000), evaluated *Cryptostegia grandiflora* as a potential multi-use crop. They found that the plant contained 14.0% protein, 6.5% fixed oil, 6.9% polyphenol, and 2.13% hydrocarbon. The hydrocarbon fraction contains natural rubber.

In view of the different possible uses of *C. grandiflora*, it is strange that this plant is not relatively wide spread in Egypt. It is grown in a number of botanical gardens (including El-Zohreya and El-Orman Gardens, and – recently – in the Ornamental Plants Nursery, Faculty of Agriculture, Cairo University), but not in commercial nurseries. The importance of *C. grandiflora* for use in landscape purposes depends primarily on its ability to grow vigorously under stress conditions such as irrigation with saline water [Mansour (2003), and Sakr and Darwish (2008)].

Slow-release fertilizers improved growth of several plant species, including *Plumbago capensis*, Thunb. (Hussein *et al.*, 2008), and *Zoysia Japonica* (Sakr *et al*., 2008). Slow-release fertilizers are safer to handle and labor-saving, compared to conventional NPK fertilizers (only 2-3 applications from the former instead of 8-12 from the latter). However, the price of slow-release fertilizers is higher than other fertilizers. Slow-release fertilizers reduce nitrogen leaching (Volterrani *et al*., 1999). Also, several researchers have reported that conventional fertilization treatments favourably influence the growth of different climbing and vining plants [Silva *et al*. (2001) on *Passiflora edulis*; Hussein (2002) on *Cryptostegia grandiflora*, and Darwish and Sakr (2008) on *Hedera canareinsis*].

The effect of GA_3 on the vegetative growth of plants was studied by Mogollon and Ojeda (2005) on *Spathiphyllum* sp. Plants; Srinivasa (2006) on *Anthurium* plants and Darwish and Sakr (2008) on *Hedera canariensis* reported that GA_3 increased the growth parameters of these plants as well as N and K contents.

This study was conducted to evaluate the effect of different GA_3 levels on growth and chemical composition *Cryptostegia grandiflora*, and to compare the responses to different NPK fertilizer types and levels.

MATERIALS AND METHODS

This study was conducted at the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the two successive seasons of 2006/2007 and 2007/2008. The aim of the study was to investigate the response of *Cryptostegia grandiflora*, R. Br. plants to gibberellic acid and NPK fertilization.

Seeds of *Cryptostegia grandiflora* were sown on 15th March 2006 and 2007 (in the first and second seasons, respectively), in a glasshouse in 8-cm plastic pots filled with a 1:1 (v/v) mixture of sand and clay. On 15th May 2006 and 2007, the seedlings (with an average height of 15 cm) were transplanted into perforated polyethylene bags (25-cm diameter) filled with sand + cattle manure (4:1, v/v) as recommended by Hussein (2002). The sand was obtained from the Giza desert, while the cattle manure was obtained from the Animal Production Department, Faculty of Agriculture, Cairo University. The physical and chemical characteristics of the sand are shown in Table (1), while the physical and chemical characteristics of the cattle manure are presented in Table (2).

Table (1): Physical and chemical characteristics of the soil used for growing *Cryptostegia grandiflora* plants during the 2006/2007 and 2007/2008 seasons.

Physical characteristics								
Soil texture	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	$CaCO_3$ (%)	EC (dS/m)	Field capacity (%)	CEC (meq/100 g)
sand	30.6	60.6	4.3	4.5	0.62	0.94	19.9	5.30
Chemical characteristics								
pH	Organic matter (%)		Available macro-nutrients (ppm)					
			N		P		K	
7.8	1.34		19.5		2.11		97.8	

Table (2): Physical and chemical characteristics of the cattle manure used for growing *Cryptostegia grandiflora* plants during the 2006/2007 and 2007/2008 seasons.

Physical characteristics		Chemical characteristics								
Density (g/cm^3)	Humidity (%)	Organic matter (%)	EC (dS/m)	N (%)	P (%)	K (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
0.51	10.66	61.4	1.11	1.9	1.3	2.1	6.50	43	85	19

The plants were moved outdoors to a sunny area on June 1st 2006 and 2007 (in the first and second seasons, respectively), and fertilized with two different rates of conventional NPK fertilizer (18 N – 6 P_2O_5 – 6 K_2O), or with two different rates of Regal Nursery (24 N -8 P_2O_5 -8 K_2O) as a commercial slow-release fertilizer (obtained from Regal Nursery Chemical Company, USA). One kilogram of conventional NPK fertilizer was prepared by mixing 391.3 g urea (46% N), 387.1 g calcium superphosphate (15.5% P_2O_5), 125 g potassium sulphate (48% K_2O), and 96.6 g sand as an inert component. Plants receiving conventional NPK fertilizer were treated with monthly applications of this mixture, at two rates, viz., 5 or 7 g / plant. Regal Nursery was added every four months at two rates, viz., 15 or 21 g fertilizer/plant. These rates of the slow-release fertilizer provided the plants with doses of N, P_2O_5 and K_2O equal to those provided by the conventional NPK fertilization treatments. In addition to the four chemical fertilization treatments, unfertilized plants were used as the control.

In both seasons, plants receiving each of the NPK fertilization treatments were sprayed monthly (from 1st July, 2006 and 2007 till 1st May, 2007 and 2008, in the two seasons, respectively) with gibberellic acid at concentrations of 50 or 100 ppm. Control plants were sprayed with tap water. On 1st August 2006 and 2007 (in the first and second seasons, respectively), wooden rods were inserted in the bags to support the plants.

The study consisted of 180 plants. The layout of the experiment was a randomized complete blocks design with 3 blocks (replicates) and 15 treatments (5 fertilization treatments X 3 GA_3 treatments). Each replicate consisted of 4 plants/ treatment.

On 1st June, 2007 and 2008, the experiment was terminated. The vegetative growth parameters, including vine length, number of internodes of main vine, average internode length (of internodes of main vine, cm), stem diameter (at 5 cm above soil surface), number of branches, average leaf area (of leaves on the fifth, sixth and seventh node from the top of the main stem, cm^2), as well as fresh and dry weights of leaves, stems and roots/plant were recorded. In addition, chemical analysis of fresh leaf samples was conducted to determine their total chlorophylls concentration using the method described by Nornai (1982), while the total carbohydrates percentage in dried leaf samples was determined using the method described by Dubois *et al.* (1956).

Also, dried leaf samples were digested to extract nutrients as described by (Piper, 1947). The extract was analyzed to determine the nitrogen (% in dry matter) as described by Pregl (1945), phosphorus % according to Jackson (1967). The potassium % was determined using a flame photometer, as recommended by Chapman and Pratt (1961).

The data on the vegetative 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 Little and Hills (1978).

RESULTS AND DISCUSSION

I-Vegetative characteristics

1- Effect of gibberellic acid treatments

The data presented in Tables (3-6) showed that in both seasons, Spraying *Cryptostegia grandiflora* plants with GA_3 had a generally favourable effect on the vegetative characteristics, as compared to the control plants. In most cases, spraying *Cryptostegia grandiflora* plants with GA_3 significantly increased vine and internode length, stem diameter, number of branches/ plant, leaf area, as well a the fresh and dry weights of leaves, stems and roots/plant compared to the control. Increasing GA_3 concentration from 50 to 100 ppm caused only a slight (insignificant) improvement in the vegetative characteristics, in most cases. The favourable effects of GA_3 on vegetative characteristics may be attributed to its role in promoting cambial activity, cell elongation as well as activating RNA and protein synthesis (Devlin, 1975).

The above results are in agreement with the findings of Srinivasa (2006) on *Anthurium* plants, all reported that GA_3 increased plant growth parameters. Also, Darwish and Sakr (2008) on *Hedera canariensis* reported that spraying the plants with GA_3 at the rate of 125 ppm monthly or 250 ppm bimonthly significantly encouraged the vegetative characteristics (plant height, stem diameter, leaf area as well as fresh and dry weights of foliage and roots).

In both seasons, spraying *Cryptostegia grandiflora* plants with GA_3 had no significant effect on number of internodes of the main vine, as compared to the control plants. While results revealed that the significant increase in vine length was a result of the GA_3 treatments that may be attributed to the increase in internode length. This result is in agreement with Wareing and Phillips (1973).

2- Effect of NPK fertilizer treatments

Data presented in Tables (3-6) indicated that, in both seasons, addition of any rate of the two types of fertilizers (conventional NPK fertilizers or Regal Nursery) significantly increased the values of the vegetative parameters of *Cryptostegia grandiflora* plants, compared to the unfertilized plants (control). These results are in agreement with the findings of Hussein (2003) on *Senna occidentalis* and Hussein *et al*. (2008) on *Plumbago capensis* plants.

Moreover, with either one of the two types of fertilizer, raising the application rate increased the values recorded for all of the vegetative characteristics recorded. In both seasons, raising the either rate of the conventional or slow-release NPK fertilizers resulted in significant increases in number of branches /plant, fresh weight of leaves/plant, dry weight of stems/plant, as well as the fresh and dry weights of roots/plant. Also, raising the dose rate of the conventional NPK fertilizer increased stem diameter and fresh weight of stems/plant significantly, while raising the application rate of Regal Nursery increased the dry weight of leaves/plant (in both seasons). The favourable effect of the NPK fertilization treatments on the vegetative growth characteristics (compared to the control) may be explained on the bases of the important roles of N, P and K in the different physiological processes within the plant, which in turn affect plant growth. Also, nitrogen is present in the structure of protein molecules, while phosphorus is an essential constituent of nucleic acids and phospholipids, and potassium is essential as an activator for enzymes involved in the synthesis of certain peptide bonds (Devlin, 1975).

In both seasons, at the same NPK rates, Regal Nursery (slow-release NPK fertilizer) gave better results than conventional NPK fertilization, with no significant difference between them in most cases. In both seasons, using the highest Regal Nursery fertilization rate (21 g/pot/4 months) gave significantly higher fresh and dry weights of leaves /plant, as well as a significantly higher dry weight of roots, compared to the other fertilization treatments.

3- Effect of combinations of GA_3 and NPK fertilizer

Regarding the interaction between the effects of spraying *Cryptostegia grandiflora* plants with GA_3 and the fertilization treatments, the data recorded on the vegetative characteristics (Tables 3-6) showed that, within each GA_3 concentration, fertilization improved vegetative characteristics. Increasing fertilization rate increased the values recorded for the studied parameters. Also, at the same NPK rates, Regal Nursery (slow-release NPK fertilizer) gave generally better results than conventional NPK fertilization.

Table (3): Effect of chemical NPK fertilizers and GA_3 on vine length (cm), number of internodes of main vine and average internodes length (cm) of *Cryptostegia grandiflora* plants during the 2006/2007 and 2007/2008 seasons

Fertilization treatments, **(F)** (g/plant)		GA_3, ppm (G)							
		0	**50**	**100**	**Mean (F)**	**0**	**50**	**100**	**Mean (F)**
		2006/2007				**2007/2008**			
		Vine length (cm)							
Control		112.1	121.8	125.9	**119.9**	132.8	141.9	147.8	**140.8**
NPK	5	182.3	206.1	218.4	**202.3**	171.0	186.8	211.5	**189.8**
	7	194.8	215.2	221.7	**210.6**	185.4	199.1	215.2	**199.9**
Regal Nursery	15	192.5	218.6	219.8	**210.3**	164.9	211.1	215.6	**197.2**
	21	201.1	225.6	232.8	**219.8**	189.5	224.8	241.0	**218.4**
Mean (G)		**176.6**	**197.5**	**203.7**	**----**	**168.7**	**192.7**	**206.2**	**----**
LSD $_{(0.05)}$ G		**9.2**				**11.5**			
F		**11.8**				**14.9**			
G × F		**17.2**				**19.1**			
		Number of internodes of main vine							
Control		14.4	15.0	15.2	**14.9**	16.6	17.1	17.8	**17.2**
NPK	5	21.7	21.7	22.3	**21.9**	20.6	21.5	21.6	**21.2**
	7	22.4	22.4	22.6	**22.5**	22.1	22.1	22.0	**22.1**
Regal Nursery	15	22.1	22.3	22.4	**22.3**	19.6	22.2	22.5	**21.4**
	21	22.3	22.8	22.8	**22.6**	21.8	22.9	23.2	**22.6**
Mean (G)		**20.6**	**20.8**	**21.1**	**----**	**20.1**	**21.2**	**21.4**	**----**
LSD $_{(0.05)}$ G		**NS**				**NS**			
F		**1.5**				**1.8**			
G × F		**1.9**				**2.1**			
		Average internodes length (cm)							
Control		7.8	8.1	8.3	**8.1**	8.0	8.3	8.3	**8.2**
NPK	5	8.4	9.5	9.8	**9.2**	8.3	8.7	9.8	**8.9**
	7	8.7	9.6	9.8	**9.4**	8.4	9.0	9.8	**9.1**
Regal Nursery	15	8.7	9.8	9.8	**9.4**	8.4	9.5	9.6	**9.2**
	21	9.0	9.9	10.2	**9.7**	8.7	9.8	10.4	**9.6**
Mean (G)		**8.5**	**9.4**	**9.6**	**----**	**8.4**	**9.1**	**9.6**	**----**
LSD $_{(0.05)}$ G		**0.5**				**0.4**			
F		**0.8**				**0.6**			
G × F		**1.1**				**0.9**			

In most cases, within each fertilization treatment, increasing GA_3 concentration improved the vegetative characteristics.

In both seasons, the highest values recorded for most of the vegetative characteristics were obtained from plants sprayed with GA_3 at 100 ppm, and supplied with the highest rate of slow-release fertilizer (Regal Nursery at 21g/plant/4 months). In most cases, plants sprayed with GA_3 at 50 ppm, and supplied with the highest rate of slow-release fertilizer (Regal Nursery at 21g/plant/4 months) gave insignificantly different values, as compared to the highest values recorded for the different vegetative characteristics.

On the other hand, in most cases, the lowest values for the studied vegetative parameters were obtained from untreated plants (control).

Table (4): Effect of chemical NPK fertilizers and GA_3 on stem diameter (mm), number of branches/plant and leaf area (cm^2) of *Cryptostegia grandiflora* plants during the 2006/2007 and 2007/2008 seasons

Fertilization treatments, (F) (g/plant		GA3, ppm (G)							
		0	50	100	Mean (F)	0	50	100	Mean (F)
		2006/2007				2007/2008			
		Stem diameter (mm)							
Control		16.4	17.5	18.4	**17.4**	14.3	15.6	16.2	**15.4**
NPK	5	18.5	20.1	21.0	**19.9**	16.1	17.8	18.4	**17.4**
	7	19.6	22.2	22.8	**21.5**	17.4	18.8	20.8	**19.0**
Regal Nursery	15	19.4	23.5	23.8	**22.2**	17.0	18.5	21.3	**18.9**
	21	20.8	24.0	24.2	**23.0**	19.6	20.6	22.8	**21.0**
Mean (G)		**18.9**	**21.5**	**22.0**	----	**16.9**	**18.3**	**19.9**	----
LSD $_{(0.05)}$ G					**1.3**				**1.2**
F					**1.6**				**1.5**
G × F					**2.2**				**2.1**
		Number of branches/ plant							
Control		6.6	7.8	8.6	**7.7**	8.2	11.5	13.3	**11.0**
NPK	5	10.8	13.0	14.4	**12.7**	10.4	11.8	14.3	**12.2**
	7	12.1	14.5	15.6	**14.1**	13.8	15.1	16.6	**15.2**
Regal Nursery	15	11.4	13.1	15.0	**13.2**	11.2	13.8	15.6	**13.5**
	21	12.8	15.8	16.8	**15.1**	13.8	15.6	17.1	**15.5**
Mean (G)		**10.7**	**12.8**	**14.1**	----	**11.5**	**13.6**	**15.4**	----
LSD $_{(0.05)}$ G					**0.8**				**0.6**
F					**1.2**				**1.0**
G × F					**1.6**				**1.5**
		Leaf area (cm^2)							
Control		15.2	16.1	17.2	**16.2**	14.1	16.5	16.9	**15.8**
NPK	5	16.1	19.0	20.4	**18.5**	15.4	17.8	18.9	**17.4**
	7	16.8	19.9	20.6	**19.1**	16.5	18.0	19.3	**17.9**
Regal Nursery	15	17.4	20.5	20.8	**19.6**	16.0	18.1	18.9	**17.7**
	21	17.8	20.7	20.9	**19.8**	16.5	18.5	19.6	**18.2**
Mean (G)		**16.7**	**19.2**	**20.0**	----	**15.7**	**17.8**	**18.7**	----
LSD $_{(0.05)}$ G					**1.3**				**1.1**
F					**1.5**				**1.4**
G × F					**2.6**				**2.1**

II- Chemical compositions

a- Total chlorophylls concentration

The data presented in Table (7) showed that, in both seasons, leaves of untreated *Cryptostegia grandiflora* plants had higher total chlorophylls (a+b) concentrations, compared to those of plants sprayed with GA_3 at 50 or 100 ppm. Moreover, increasing GA_3 concentration from 50 to 100 ppm decreased total chlorophylls concentration in leaves. These results are in agreement with the findings of Asmaael (1997) on *Casuarina equisetifolia*, L.

In most cases, the decrease in the total chlorophylls concentration in fresh leaves as a result of spraying GA_3 at 50 or 100 ppm can be attributed to the role of GA_3 growth stimulation (as previously discussed), which is accompanied by an increase in the total chlorophylls content in all the leaves of the treated plants, as compared to the control plants (which can be confirmed by calculating the total amount of chlorophylls in the leaves, by multiplying the leaves fresh weight by the total chlorophylls concentration). However, the total chlorophylls concentration was reduced because the total chlorophylls content was diluted in a high fresh weight of leaves.

Table 5: Effect of chemical NPK fertilizers and GA_3 on fresh weights of leaves, stems and roots (g)/plant of *Cryptostegia grandiflora* plants during the 2006/2007 and 2007/2008 seasons

Fertilization treatments, (F) g/plant		GA3, ppm (G)							
		0	50	100	Mean (F)	0	50	100	Mean (F)
		2006/2007				2007/2008			
		Fresh weight of leaves (g/plant)							
Control		18.3	21.8	19.6	**19.9**	14.8	16.9	16.1	**15.9**
NPK	5	32.2	36.4	37.2	**35.3**	26.5	29.8	30.8	**29.0**
	7	38.5	42.2	43.8	**41.5**	29.6	31.7	33.8	**31.7**
Regal Nursery	15	36.8	41.9	42.8	**40.5**	29.0	36.5	39.7	**35.1**
	21	45.1	48.4	48.1	**47.2**	38.1	45.3	48.0	**43.8**
Mean (G)		**34.2**	**38.1**	**38.3**	**----**	**27.6**	**32.0**	**33.7**	**----**
LSD $_{(0.05)}$ G		**2.1**				**1.9**			
F		**2.9**				**2.5**			
G × F		**3.4**				**3.5**			
		Fresh weight of stems (g/plant)							
Control		45.4	48.8	50.1	**48.1**	51.4	52.8	53.6	**52.6**
NPK	5	69.9	76.8	80.1	**75.6**	72.6	76.9	79.4	**76.3**
	7	78.6	83.4	85.5	**82.5**	86.8	89.4	91.3	**89.2**
Regal Nursery	15	74.1	82.0	87.3	**81.1**	84.4	90.3	92.5	**89.1**
	21	81.5	87.0	88.9	**85.5**	89.1	92.5	93.4	**91.7**
Mean (G)		**69.9**	**75.6**	**78.4**	**----**	**76.9**	**80.4**	**82.0**	**----**
LSD $_{(0.05)}$ G		**3.7**				**4.1**			
F		**4.2**				**5.6**			
G × F		**6.7**				**7.8**			
		Fresh weight of roots (g/plant)							
Control		32.1	33.5	33.5	**33.0**	34.5	36.8	38.9	**36.7**
NPK	5	45.4	48.5	49.5	**47.8**	44.4	49.6	50.3	**48.1**
	7	51.0	56.4	56.9	**54.8**	53.0	56.8	57.9	**55.9**
Regal Nursery	15	52.1	54.3	56.5	**54.3**	46.5	53.1	56.5	**52.0**
	21	54.2	60.4	63.6	**59.4**	57.2	59.9	64.1	**60.4**
Mean (G)		**47.0**	**50.6**	**52.0**	**----**	**47.1**	**51.2**	**53.5**	**----**
LSD $_{(0.05)}$ G		**3.5**				**3.6**			
F		**4.7**				**4.9**			
G × F		**6.1**				**6.7**			

Chemical fertilization increased the total chlorophylls concentration in leaves of *Cryptostegia grandiflora* plants in both seasons, as compared to the unfertilized plants (Table 7). A similar increase in the chlorophylls concentration as a result of fertilization treatments has been recorded by El-Shewaikh (2000) on *Brunfelsia calycina*. Within each type of fertilizer, raising the application rate increased the total chlorophylls concentration. The increase in the total chlorophylls concentration as a result of raising the fertilization rate is in agreement with the results reported by Hussein *et al*. (2008) on *Plumbago capensis* plants. In both seasons, when the two chemical fertilizers were applied at rates providing equivalent supplies of nutrients, Regal Nursery was more effective than conventional NPK fertilization for increasing the concentrations of total chlorophylls. Consequently, treating *Cryptostegia grandiflora* plants with the highest rate of Regal Nursery every 4 months gave the highest concentrations of total chlorophylls.

Table 6: Effect of chemical NPK fertilizers and GA_3 on dry weights of leaves, stems and roots (g)/plant of *Cryptostegia grandiflora* plants during the 2006/2007 and 2007/2008 seasons

Fertilization treatments, (F) g/plant		GA3, ppm (G)							
		0	50	100	Mean (F)	0	50	100	Mean (F)
		2006/2007				2007/2008			
		dry weight of leaves (g/plant)							
Control		5.18	5.56	5.12	**5.29**	3.74	4.58	4.27	**4.20**
NPK	5	8.73	10.74	11.20	**10.22**	7.63	9.27	10.01	**8.97**
	7	10.97	12.79	13.84	**12.53**	8.64	9.76	10.95	**9.78**
Regal Nursery	15	10.86	13.24	13.70	**12.60**	8.61	11.38	13.42	**11.14**
	21	13.80	15.68	16.11	**15.20**	11.01	14.72	15.26	**13.66**
Mean (G)		**9.91**	**11.60**	**11.99**	**----**	**7.93**	**9.94**	**10.78**	**----**
LSD $_{(0.05)}$ G					**0.82**				**0.88**
F					**0.94**				**0.96**
G × F					**1.54**				**1.68**
		dry weight of stems (g/plant)							
Control		12.44	13.91	14.08	**13.48**	14.65	15.36	15.06	**15.02**
NPK	5	20.83	23.65	24.27	**22.92**	22.72	24.99	26.84	**24.85**
	7	25.55	28.86	30.18	**28.20**	29.95	32.99	32.05	**31.66**
Regal Nursery	15	23.19	28.29	29.68	**27.05**	28.78	32.06	33.39	**31.41**
	21	28.16	31.58	32.98	**31.06**	31.90	34.13	33.16	**33.06**
Mean (G)		**22.12**	**25.26**	**26.24**	**----**	**25.60**	**27.91**	**28.10**	**----**
LSD $_{(0.05)}$ G					**1.15**				**1.23**
F					**1.46**				**1.55**
G × F					**2.11**				**2.24**
		dry weight of roots (g/plant)							
Control		9.66	10.45	11.22	**10.44**	10.07	11.59	12.76	**11.47**
NPK	5	15.71	17.85	18.36	**17.31**	14.25	17.81	19.11	**17.06**
	7	18.41	20.98	22.13	**20.51**	17.76	21.64	22.47	**20.62**
Regal Nursery	15	18.29	20.91	22.09	**20.43**	15.86	19.97	21.75	**19.19**
	21	20.70	23.86	25.76	**23.44**	20.71	23.06	25.58	**23.12**
Mean (G)		**16.55**	**18.81**	**19.91**	**----**	**15.73**	**18.81**	**20.33**	**----**
LSD $_{(0.05)}$ G					**1.45**				**1.64**
F					**1.84**				**1.95**
G × F					**2.94**				**3.01**

Regarding the interaction between GA_3 and chemical fertilization, the data in Table (7) showed that in both seasons, within each fertilization treatment, increasing GA_3 concentration resulted in a decrease in total chlorophylls concentration. Within each GA_3 concentration, fertilization increased total chlorophylls concentrations of leaves as compared to the control plants, in both seasons. Increasing fertilization rate resulted in an increase in total chlorophylls. Also, at the same NPK rates, Regal Nursery (slow-release NPK fertilizer) gave better results than conventional NPK fertilization. In both seasons, plants that did not receive GA_3 but were fertilized with the highest Regal Nursery rate had the highest total chlorophylls value, whereas the lowest value was recorded with unfertilized plants that were sprayed with GA_3 at 100 ppm.

2-Total carbohydrates percent:

The data presented in Table (7) showed that, in both seasons, *Cryptostegia grandiflora* plants that were not sprayed with GA_3 had higher percentage of total carbohydrates in their leaves, compared to plants sprayed with GA_3 at 50 or 100 ppm. Increasing GA_3 concentration steadily decreased total carbohydrates percentage in leaves. These results are in agreement with the findings of Asmaael (1997) on *Casuarina equisetifolia*, L., and Habib (1997) on *Dahlia hybrida* plants.

Generally, the decrease in the total carbohydrates percentage in dried leaves as a result of spraying GA_3 at 50 or 100 ppm, compared to the control plants, may be attributed to the dilution effect as previously discussed regarding the total chlorophylls concentration.

The data in Table (7) also showed that chemical fertilization was beneficial for the synthesis and accumulation of carbohydrates in the leaves of *Cryptostegia grandiflora* plants. In both seasons, the values recorded were higher in plants receiving any of the different chemical fertilization treatments, compared to the control. Similar increases in the carbohydrates percent have been reported by Hussein (2003) on *Senna occidentalis* plants.

Within each type of chemical fertilizer, raising the application rate increased the carbohydrates percentage. At the lower fertilization rate, conventional NPK fertilization treatment was more effective than Regal Nursery treatment for increasing the carbohydrates percentage. On the other hand, with using the higher fertilization rate, Regal Nursery was more effective than conventional NPK fertilization treatment for increasing the carbohydrates percentage. In both seasons, the highest values were obtained from plants fertilized with Regal Nursery at 21 g/plant/4 months. The increase in the percentage of total carbohydrates as a result of raising the rate of NPK or slow-release fertilizers is similar to that reported by **Hussein *et al*. (2008)** on *Plumbago capensis* plants.

The favourable effect of the different chemical fertilization treatments on the percentage of total carbohydrates may be indirectly attributed to the increase in the percentage of total chlorophylls as a result of the treatments. As the synthesis of total chlorophylls was promoted, the rate of photosynthesis increased, leading to an increase in carbohydrate synthesis. Also, potassium can act as an activator of several enzymes involved in carbohydrate metabolism) Taiz and Zeiger, 1998). Moreover, this promotion in the synthesis of total chlorophylls and total carbohydrates as a result of chemical fertilization may explain the increase in vegetative growth that was detected in plants receiving the different chemical fertilization treatments.

As a result of the interaction between the GA_3 treatments and chemical fertilization treatments, the highest total carbohydrates percentage (in both seasons) was obtained from plants receiving no GA_3 treatment, but fertilized with Regal Nursery at 21 g/plant/4months. On the other hand, the lowest total carbohydrates values were recorded in leaves of unfertilized plants sprayed with GA_3 at 100 ppm., only.

Table 7: Effect of chemical NPK fertilizers and GA_3 on total chlorophylls concentrations, total carbohydrates percent, N, P, K% in leaves of *Cryptostegia grandiflora* plants during the 2006/2007 and 2007/2008 seasons

Fertilization treatments, (F) g/plant		GA3, ppm (G)							
		0	50	100	Mean (F)	0	50	100	Mean (F)
		2006/2007				2007/2008			
		Total chlorophylls concentration (mg/g fresh matter))							
Control		1.52	1.40	1.21	**1.38**	1.61	1.58	1.42	**1.54**
NPK	5	1.64	1.49	1.37	**1.50**	1.80	1.65	1.44	**1.63**
	7	1.83	1.70	1.56	**1.70**	1.94	1.86	1.64	**1.81**
Regal Nursery	15	1.79	1.68	1.48	**1.65**	1.86	1.70	1.51	**1.69**
	21	2.01	1.94	1.69	**1.88**	1.98	1.86	1.70	**1.85**
Mean (G)		**1.76**	**1.64**	**1.46**	**----**	**1.84**	**1.73**	**1.54**	**----**
		Total carbohydrates (% of dry matter)							
Control		35.3	34.2	30.0	**33.2**	32.7	32.3	29.7	**31.6**
NPK	5	38.9	37.2	33.2	**36.4**	37.4	36.6	33.2	**35.7**
	7	39.2	37.7	33.8	**36.9**	38.0	37.1	33.3	**36.1**
Regal Nursery	15	35.7	33.8	32.3	**33.9**	35.7	34.5	32.7	**34.3**
	21	39.8	38.7	34.2	**37.6**	38.3	37.7	35.7	**37.2**
Mean (G)		**37.8**	**36.3**	**32.7**	**----**	**36.4**	**35.6**	**32.9**	**----**
		N (% of dry matter)							
Control		1.41	1.48	1.56	**1.48**	1.31	1.34	1.34	**1.33**
NPK	5	1.85	1.99	2.04	**1.96**	1.72	1.80	1.84	**1.79**
	7	2.09	2.28	2.26	**2.21**	1.89	1.96	2.13	**1.99**
Regal Nursery	15	1.98	2.11	2.13	**2.07**	1.79	1.98	2.11	**1.96**
	21	2.18	2.22	2.15	**2.18**	1.85	1.98	2.23	**2.02**
Mean (G)		**1.90**	**2.02**	**2.03**	**----**	**1.71**	1.81	**1.93**	**----**
		P (% of dry matter)							
Control		0.19	0.16	0.15	**0.17**	0.22	0.20	0.15	**0.19**
NPK	5	0.23	0.19	0.17	**0.20**	0.24	0.22	0.21	**0.22**
	7	0.25	0.22	0.21	**0.23**	0.28	0.27	0.23	**0.26**
Regal Nursery	15	0.26	0.24	0.20	**0.23**	0.26	0.25	0.21	**0.24**
	21	0.29	0.25	0.23	**0.26**	0.29	0.26	0.23	**0.26**
Mean (G)		**0.24**	**0.21**	**0.19**	**----**	**0.26**	**0.24**	**0.21**	**----**
		K (% of dry matter)							
Control		1.53	1.58	1.64	**1.58**	1.46	1.61	1.63	**1.57**
NPK	5	1.99	2.11	2.15	**2.08**	1.89	2.06	2.16	**2.04**
	7	2.16	2.20	2.28	**2.21**	1.95	2.11	2.24	**2.10**
Regal Nursery	15	2.01	2.19	2.21	**2.14**	1.90	2.18	2.28	**2.12**
	21	2.25	2.28	2.29	**2.27**	2.11	2.21	2.29	**2.20**
Mean (G)		**1.99**	**2.07**	**2.11**	**----**	**1.86**	**2.03**	**2.12**	**----**

3- N, P and K%

a- Effect of gibberellic acid treatments

The results recorded in the two seasons (Table 7) showed that the uptake and accumulation of N and K in *Cryptostegia grandiflora* plants were enhanced by GA_3 treatments, since control plants had lower N and K% than plants sprayed with different GA_3 concentrations. The N and K% were increased with increasing GA_3 concentrations. These results are in agreement with the findings of Srinivasa (2006) on *Anthurium* plants and Darwish and Sakr (2008) on *Hedera canareinsis* plants. They reported that GA_3 increased the N and K%.

Regarding the effect of GA_3 treatments on the P% in the leaves, the data presented in Table (7) showed that, in both seasons, leaves of untreated *Cryptostegia grandiflora* plants had higher P%, compared to those of plants sprayed with GA_3 at 50 or 100 ppm. Increasing GA_3 concentration steadily decreased P% in leaves. These results are in agreement with the findings of Owais *et al.* (1991) on *Casuarina cunninghamiana* and *C. glauca* plants. Generally, the decrease in the P% in dried leaves as a result of spraying GA_3 at 50 or 100 ppm, in most cases, compared to the control plants can be attributed to the dilution effect as previously discussed regarding the total chlorophylls and total carbohydrates.

b- Effect of NPK fertilizer treatments

As shown in Table (7), the N, P and K% exhibited a similar trend of response to the different chemical fertilization treatments, in most cases. In both seasons, the lowest percentages of the three nutrients were recorded in the leaves of the control plants. Raising the fertilization rate increased the percentages of the three nutrients, regardless of the type of chemical fertilizer applied. The increase in the percentages of nutrients in the tissues of leaves as a result of increasing fertilization rates can be easily explained, since raising NPK levels in the root medium led to more vegetative and root growth. This may be accompanied by more absorption of essential elements from the soil, and their accumulation in plant tissues (Jain, 1983). Similar increases in the N, P and K% as a result of raising the fertilization rates have been reported by Hussein *et al*. (2008) on *Plumbago capensis* plants. In both seasons, the slow-release NPK fertilizer (Regal Nursery) appeared to be more effective than the conventional NPK fertilizer for increasing the percentages of the three nutrients, since the highest N, P and K% were obtained from the leaves of plants fertilized with the highest rate of Regal Nursery (21 g / plant/ 4 months). The only exception to this general trend was observed in the first season with plants fertilized with the highest rate of the conventional NPK fertilizer (7 g/ plant/ month) which gave the highest N%.

c- Effect of GA3 and NPK fertilizer combinations.

Regarding the interaction between the effects of GA_3 and chemical fertilization on the N, P and K%, the data in Table (7) showed that, within each GA_3 concentration, fertilization increased N, P and K%. Increasing fertilization rate resulted in an increase of the values recorded for the three elements. Also, at the same NPK rates, Regal Nursery (slow-release NPK fertilizer) gave generally better results than conventional NPK fertilization. In most cases, within each fertilization treatment, increasing GA_3 concentration increased the N and K%, but decreased the P%.

In the first season, the highest N% was recorded in the leaves of plants sprayed with 50 ppm GA_3 and supplied with the highest rate of the conventional NPK fertilizer, whereas in the second season, plants sprayed with 100 ppm., GA_3 and fertilized with the highest rate of Regal Nursery had the highest N%. In both seasons, plants that received no GA_3 treatment but were fertilized with the highest rate of Regal Nursery gave the highest P%. The highest K% was recorded in leaves of plants sprayed with 100 ppm GA_3 and supplied with the highest rate of Regal Nursery.

In both seasons, untreated *Cryptostegia grandiflora* plants had the lowest N and K% in their leaves, whereas the lowest P% was found in unfertilized plants sprayed with 100 ppm GA_3.

CONCLUSION

From the above results, it may be recommended that, for the best vegetative characteristics, *Cryptostegia grandiflora* plants should be sprayed with GA_3 at 50 ppm, and supplied with the highest rate of the slow-release fertilizer Regal Nursery (21g/plant/4 months).

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تأثير حمض الجبريلك والتسميد الكيماوى على النمو والتركيب الكيماوى لنباتات الكربتوستيجيا

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أجرى هذا البحث فى مشتل التجارب بقسم بساتين الزينة، كلية الزراعة، جامعة القاهرة، خلال الموسمين المتتاليين ٢٠٠٦/٢٠٠٧ و ٢٠٠٧/٢٠٠٨. وإستهدف البحث دراسة إستجابة نباتات الكربتوستيجيا *Cryptostegia grandiflora*, R. Br لمعاملات الرش بحمض الجبريلك والتسميد الكيماوى المركب (بإستخدام سماد تقليدى أو سماد بطيء التحلل). تم تسميد النباتات بمعدل ٥ و ٧ جم سماد/نبات/شهر بسماد كيماوى مركب تقليدى (١٨ن – ٦ فو٢أ٥ – ٦ بو٢أ)، أو بسماد كيماوى بطيء التحلل "Regal Nursery" (٢٤ن – ٨ فو٢أ٥ – ٨ بو٢أ) بمعدلات ١٥ و٢١ جم سماد /نبات/٤ أشهر. بالإضافة إلى ذلك تم استخدام نباتات غير معاملة للمقارنة. تم رش النباتات المعاملة بالمعاملات السمادية بحامض الجبريلك بتركيز ٥٠ أو ١٠٠ جزء فى المليون شهريا، و تم رش نباتات المقارنة بماء الصنبور.

أظهرت النتائج أن معاملات الجبرالين أوالتسميد الكيماوى أو هما معاً أدت إلى زيادة قيم معظم مؤشرات النمو التى درست (طول المتسلق وعدد السلاميات على الساق الرئيسى ومتوسط طول السلامية وقطر الساق وعدد الأفرع /نبات ومساحة الورقة والأوزان الطازجة والجافة للأوراق والسيقان والجذور/نبات)، و كذلك النسبة المئوية للنتروجين والبوتاسيوم، مقارنة بالنباتات الغير معاملة. زاد تركيز الكلورفيلات الكلية والكربوهيدرات الكلية والفوسفور باستخدام الأسمدة الكيماوية، ولكن إنخفضت قيم هذه المكونات كنتيجة للرش بالجبرالين.

أدت زيادة معدل الإضافة لكل من نوعى السماد الكيماوي إلى زيادة قيم معظم صفات النمو التي درست. فى معظم الأحيان أعطى سماد "Regal Nursery" البطيء التحلل قيماً أعلى لمعظم الصفات الخضرية والمكونات الكيماوية التي درست وذلك بالمقارنة يالسماد المركب التقليدي. فى معظم الأحيان أدى الرش بالجبرالين بتركيز ٥٠ جزء فى المليون مع التسميد بالمعدل الأعلى من سماد Regal Nursery (٢١جم سماد /نبات/٤ أشهر) الى الحصول على قيم لا تختلف معنويا عن أعلى القيم الخاصة بمعظم الصفات الخضرية، والمسجلة للنباتات التى تم رشها بالجبرالين بمعدل ١٠٠ جزء فى المليون والمسمدة بنفس المعدل الأعلى من سماد Regal Nursery.

من النتائج المتحصل عليها يمكن التوصية برش نباتات الكربتوستيجيا بالجبرالين بمعدل ٥٠ جزء فى المليون مع تسميد النباتات بسماد Regal Nursery البطيء التحلل (٢٤ن – ٨ فو٢أ٥ – ٨ بو٢أ) بمعدل ٢١ جم سماد /نبات/٤ أشهر وذلك للحصول على أفضل نمو خضرى.