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Stimulatory Effect of Kinetin, Ascorbic acid and Glutamic Acid on Growth and Chemical Constituents of *Codiaeum variegatum* L. Plants

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Abstract: Two pot experiments were conducted during two successive seasons (2009 and 2010) in the nursery of the National Research Center. The aim of this work is to study the stimulatory effect of kinetin (20 and 40 ppm), ascorbic acid (100 and 200 ppm) and glutamic acid (100 and 200 ppm) on growth and chemical constituents of *Codiaeum variegatum* L. Results showed that, increasing concentration of the three foliar applications gradually increased all growth parameters (plant height, number of branches, number of leaves, stem diameter, root length as well as fresh and dry weights of all plant organs) and also the content of the total carbohydrates, nitrogen, phosphorus and potassium percentages. The effect of glutamic acid was superior to that of kinetin, ascorbic acid on increasing plant growth at vegetative growth especially when plants were sprayed with glutamic acid at 200 ppm.

Key words: Croton (*Codiaeum variegatum* L.) · Amino acid · Vitamins · Cytokinins

INTRODUCTION

Croton (*Codiaeum variegatum* L.) C.V. Pictum Var "Gold Star". Family Euphorbiaceae is a tropical woody shrub native to South Sea Island and the Malaya Peninsula. House plant specimens are pot grown to a single stem, up to 2 feet high, with smooth leathery leaves marked in vivid coloures. The plants are exacting in their requirements, ample light, high humidity, an even temperature and watering and syringing in summer, less in winter. Cytokinins are synthesized by a condensation of an isopentenyl group with the amino group of adenosine mono-phosphate. Cytokinins also form conjugates with sugars and are metabolized by oxidation [1]. A major site of cytokinin biosynthesis in higher plants is the root, then transported to the aerial portion of the plant through the xylem. The effects of cytokinins on metabolic processes it seems clear that they play a role in some phases of nucleic acid metabolism or protein metabolism. The response of plants to cytokinins have been also reported by Eraki *et al*. [2] on *Salvia officinalis*, Youssef and Talaat [3] on *Lavandula officinalis* L. and Balbaa [4] on *Tagetes minuta* L. mentioned that foliar application of kinetin had significantly affected plant height, number of branches, fresh and dry weight of herbs as well as total carbohydrates protein and total carotenoids.

Ascorbic acid (Vitamin C) acts as coenzyme reaction by which carbohydrates, fats and protein and metabolized. Vitamin C led to increase nucleic acid content especially RNA. Smirnoff and Wheeler [5] reported that ascorbic acid is an abundant component of plans. It reaches a concentration of over 20 mM in chloroplasts and occurs in all cell compartments including cell wall. It has proposed functions in photosynthesis, as an enzyme cofactor [6]. Abdel-Aziz *et al*. [7] on *Khaya senegalensis* and Abdel Aziz *et al*. [8] on *Gladiolus grandiflora* L. indicated that application of ascorbic acid significantly increased all growth parameters as well as some chemical constituents.

Amino acids are organic nitrogenous compounds are the building blocks in the synthesis of proteins which formed by a process in which ribosome catalyze the polymerization of amino acids [9]. They were known as growth factors of higher plants and they stated them as constituents of the protein part enzyme [10]. The role of the amino acid in stimulating the growth and some chemical constituents of several plant species were

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studied by Talaat *et al*. [11] on *Catharanthus roseus* L., Abou-Dahab and Abd El-Aziz [12] on *Philodendron erubescens* and Abd El-Aziz *et al*. [13] on *Thuja orientalis*.

Therefore, the aim of the present study is to investigate the stimulatory effect of kinetin, ascorbic acid and glutamic acid on growth and chemical constituents of *Codiaeum variegatum* L. plants.

MATERIALS AND METHODS

Pot experiments were carried out during two successive seasons of 2009-2010 at the greenhouse of National Research Centre, Dokki, Giza, Egypt to study the effect of foliar application of cytokinins (Kinetin), ascorbic acid (Vitamin C) and glutamic acid (amino acid) on growth and some chemical constituents of *Codiaeum variegatum* L. plants. Rooted terminal cutting of croton cv. Pictum var. "Gold Star" (15-20 cm height) which leaves were transplanted on 21st March in both seasons, as two cuttings in plastic pots 30 cm in diameter that were filled with media containing peat and sand (1:1) by volume. The physical and chemical properties of the different media are shown in Tables 1 and 2.

Plants were sprayed twice with freshly prepared solutions of kinetin (20 and 40 ppm), ascorbic acid (100 and 200 ppm) and glutamic acid (100 and 200 ppm), in addition to the untreated plants (control). Foliar application of kinetin, ascorbic acid and glutamic acid were carried out two times of 30 days intervals, starting at the first week of May at both seasons. Fertilization was carried out at the rate of 4g/pot calcium super phosphate (16.0% P_2O_5), 4g/pot calcium nitrate (15.5% N) and 2g/pot potassium sulphate (48-50% K_2O). The experiment was sit up in a Completely Randomized Design (CRD) with three replicates.

The following data were recorded after six months from transplanting: plant height (cm), number of leaves, number of branches, stem diameter (mm), fresh and dry weights of leaves, stems and roots (g). Samples were used to determine Total carbohydrates percentage of dried leaves, stems and roots (70°C) was determined using the method described by Dubois *et al*. [14] and nitrogen, phosphorus and potassium contents according to Cottenie *et al*. [15].

All data obtained were subjected to statistical analysis according to a procedure outlined by Snedecor and Cochran [16]. Treatment means were compared by L.S.D. at 5% test and combined analysis of the two seasons were calculated according to the method of Steel and Torrie [17].

RESULTS AND DISCUSSION

Effect of Kinetin: Data presented in Table 3 showed that the application of kinetin had a significant stimulatory effect on growth parameters of croton plants. However, the most effective treatment which had the tallest plants, the highest number of leaves, branches, stem diameter and root length when application of kinetin at the concentration of 40 ppm, the increment were 50.0 33.0, 63.64, 27.40 and 88.89%, respectively, compared with control plants. These increments may be due to accumulation of greater photosynthates leading to better growth parameters [18]. The increment percentages of all previous growth parameters were reduced with application of 20 ppm kinetin compared with control plants by 33.33, 22.92, 36.36, 19.18 and 51.85%, respectively. This increment in plant height may be due to the role of cytokinin (kinetin) in increasing cell division in apical meristems and cambium. Our results are comparable with those obtained by Eraki [19] on *Hibiscus sabdariffa*.

Table 1: Physical and chemical properties of sand soil

						Anions (meq/l)			Cations (meq/l)			
Coarse sand%	Fine sand%	Silt	Clay	EC mmohs/cm^3	pH	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^{++}	K^+
71.0	18.0	4.5	6.5	2.1	7.1	2.0	23.0	--	4.0	13.0	15.0	5.0

Table 2: Chemical analysis of peat

pH	Ash%	Organic matter %	N %	P %	K %	Ca ppm	Mg ppm	Fe ppm	Mn ppm	Cu ppm
3.4-3.9	1.2-2.2	95-98	3.0	0.03	2.1	1.9	2.7	17.0	4.0	1.0

Table 3: Effect of kinetin, ascorbic acid and glutamic acid on growth of *Codiaeum variegatum* L. during two seasons (Average of two seasons)

						Fresh weight (g)			Dry weight (g)		
Treatments	Plant height cm	No. of leaves	Stem diameter mm	No. of branches	Root length cm	Leaves	Branches	Root	Leaves	Branches	Root
Control	48.0	48.0	7.30	11.0	18.9	33.0	19.2	18.9	7.60	6.40	6.60
Kinetin 20 ppm	64.0	59.0	8.70	15.0	28.7	39.0	23.5	28.7	9.70	8.40	10.30
Kinetin 40 ppm	72.0	64.0	9.30	18.0	35.7	43.0	27.6	35.7	12.20	9.00	12.00
Ascorbic acid 100 ppm	63.0	53.0	8.00	13.0	25.5	40.0	22.0	25.8	9.30	6.90	8.50
Ascorbic acid 200ppm	67.0	62.0	8.60	14.0	40.3	47.0	24.0	40.3	12.80	8.50	13.50
Glutamic acid 100 ppm	68.0	66.0	10.20	19.0	33.0	41.0	24.0	33.0	9.50	7.90	10.30
Glutamic acid 200 ppm	77.0	72.0	11.00	21.0	42.0	50.0	28.4	42.0	15.20	8.60	14.60
LSD 0.05	4.6	3.9	1.05	1.83	4.23	3.46	2.98	4.23	3.18	1.36	1.57

Abdel El-Aziz [20] on *Codiaeum variegatum* L. The increment in branches number as a result of kinetin application may be attributed to its influence on counteracting or eliminating the apical dominance [21].

It could be also observed from data in Table 3 that application of 20 and 40 ppm kinetin significantly increased fresh and dry weight of leaves, stems and roots of *Codiaeum variegatum* plants, in both seasons compared with the control plants. The increment in the herb fresh weight could be explained through the role of kinetin in stimulating xylem differentiation and vascular strand development, consequently more absorption of water and nutrients from the soil, which was reflected in more growth, as mentioned by Sorokin and Thimann [22].

Data in Table 3 also showed that the heaviest fresh and dry weights expressed in terms of leaves, stems and roots were obtained from plants received of 40 ppm kinetin which increased fresh weight by 30.30, 43.75 and 88.89%, respectively over control plant, as well as, dry weight of these parameters increased by 60.53, 40.63 and 81.81%, respectively over control. These results are in harmony with those obtained by El-Sayed *et al*. [23] on *Polianthus tuberose*, Menesi *et al*. [24] on some ornamental plants and Abd-El-Aziz [20] on *Codiaeium variegatum* L.

Effect of Ascorbic Acid: Data in Table 3 revealed that application of 100 or 200 ppm ascorbic acid as a foliar application had a favourable effect on all growth parameters of *Codiaeum variegatum* L. plants during the two growing seasons. The highest plant heights, number of leaves, stem diameter, number of branches, root length as well as fresh and dry weight of all plant organs were recorded with plants treated with 200 ppm ascorbic acid compared with control or other treatments in the two seasons. The increments on fresh weight of leaves, branches and roots estimated by 42.42, 25.00 and 36.51%, respectively compared with the control in the two seasons. Also, the increase in dry weight of all previous plant organs estimated by 68.42, 32.81 and 1.05%, respectively compared with the control plants. These results are in accordance by Balbaa [4] on *Tagets minuta* L. Talaat [25] on sweet pepper plants and Abdel Aziz *et al*. [8] on *Gladiolus grandflorum* L. plants. In this respect, Smirnoff [26] reported that ascorbate has been implicated in regulation of cell division. In this connection, who also pointed out that cell wall ascorbate and cell wall localized ascorbate oxidase has been implicated in control of growth; high ascorbate oxidase activity is associated with rapidly expanding cells. Accordingly, these increments in growth parameters by ascorbic acid. Treatments might be attributed to the postulation of Shaddad *et al*. (27) who assumed that the effect of ascorbic acid on plant growth may be due to the substantial role of ascorbic acid in many metabolic and physiological processes.

Effect of Glutamic Acid: Treatments of *Codiaeum variegatum* L. plants with glutamic acids had a significant effect on growth parameters (Table 3). However, all growth parameters were increased by different levels of glutamic acid as compared with the control plants. The highest values of all growth parameters were obtained with plants treated with 200 ppm glutamic acid. The increments of leaves, stems and roots fresh weights estimated by 51.52, 47.92 and 1.22%, respectively compared with the control plant in the two seasons. In this concern, all plants organs were increased by 100, 34.38 and 1.21%, respectively compared with the control plants. The positive effect of glutamic acid that plant growth regulators may produce their effects within the part in which they were synthesized. Steeve [28] demonstrated that certain messengers called plant growth substances are generally like hormones in their action, controlled utilization of nutritional substances for a balanced coordinated development of plant body. Growth regulators are used as natural compounds that are applied

Table 4: Effect of kinetin, ascorbic and glutamic acid on total carbohydrates percentage of *Cadiaeum variegation* L. during two seasons (Average of two seasons)

Treatments	Leaves	Stem	Root
Control	34.3	31.7	30.6
Kinetin 20 ppm	35.9	32.1	30.9
Kinetin 40 ppm	39.6	33.7	31.7
Ascorbic acid 100 ppm	41.7	34.7	32.6
Ascorbic acid 200ppm	42.5	35.9	33.7
Glutamic acid 100 ppm	44.7	37.7	34.5
Glutamic acid 200 ppm	46.8	39.6	37.7

Table 5: Effect of kinetin, ascorbic acid and glutamic acid on nitrogen, phosphorus and potassium percentages in all plan organs of *Codiaeium variegatum* L. during two seasons (mean of two seasons)

	Leaves			Stem			Root		
Treatments	N	P	K	N	P	K	N	P	K
Control	1.05	0.37	1.49	0.63	0.36	0.70	1.15	0.26	0.5
Kinetin 20 ppm	1.06	0.37	1.46	1.20	0.45	0.65	1.25	0.25	0.68
Kinetin 40 ppm	1.87	0.35	1.35	1.70	0.33	0.85	1.46	0.42	1.40
Ascorbic acid 100 ppm	1.38	0.45	1.46	1.2	0.36	0.70	1.24	0.38	0.60
Ascorbic acid 200 ppm	1.14	0.55	1.43	1.15	0.38	0.70	1.24	0.40	0.70
Glutamic acid 100 ppm	1.45	0.45	1.45	1.00	0.33	0.70	1.00	0.39	0.60
Glutamic acid 200 ppm	1.00	0.40	1.50	1.30	0.24	0.50	1.50	0.40	1.20

Table 6: Effect of kinetin, ascorbic acid and glutamic acid on nitrogen, phosphorus and potassium uptake in all plant organs of *Codiaeum variegatum* L. during two seasons (mean of two seasons)

	Leaves			Stem			Root		
Treatments	N	P	K	N	P	K	N	P	K
Control	76.9	27.0	40.6	40.5	23.0	44.0	69.0	32.4	33.0
Kinetin 20 ppm	105.0	35.8	141.3	71.7	38.0	55.0	127.0	25.6	70.0
Kinetin 40 ppm	207.0	42.5	164.8	159.6	30.0	77.0	176.0	50.5	169.0
Ascorbic acid 100 ppm	127.0	42.2	136.9	83.0	27.0	48.0	105.0	32.5	51.0
Ascorbic acid 200 ppm	146.0	70.6	184.0	95.5	32.0	58.0	170.0	54.0	96.0
Glutamic acid 100 ppm	137.0	42.3	137.0	79.5	26.0	56.0	103.0	40.0	62.0
Glutamic acid 200 ppm	152.0	60.9	228.0	111.0	21.0	43.0	220.0	58.0	143.0
LSD 0.05	49.5	11.7	32.6	16.2	5.5	9.76	20.4	6.1	37.8

directly to a target plant to alter its life processes or its structure in order to improve quality and productivity of plants, in addition to facilitate harvesting. These results are in line with those obtained by Farooqi *et al*. [29] on *Artemisia annual* L., Kim *et al*. [30] on *Dendranthama grandiflorum* and El-Maadawy *et al*. [31] on *Begonia semperflorens*.

Total Carbohydrates Percentage: Effect of foliar application with different levels of kinetin, ascorbic acid and glutamic acid are presented in Table 4 indicated that total carbohydrates percentage as affected by different levels treatments in all plants organs, followed the same trend obtained previously on vegetative growth, were gradually increased by increasing the level of treatments used. Comparing the effect of three foliar applications, data indicated that glutamic acid was superior to kinetin or ascorbic acid application. Application of 200 ppm glutamic acid increased total carbohydrates in leaves, stems and roots compared with the control by 36.44, 24.92 and 23.20%, respectively. The promotion affect of amino acids on total carbohydrates may be due to their important role of biosynthesis of chlorophyll molecules which in turn affected total carbohydrates content. Similar results were reported by Talaat *et al*. [11] on *Catheranthus roseus* L., Attoa *et al*. [32] on *Iberis amara* L., Nahed and Balbaa [33] on *Salvia forinacea* plants and Abdel Aziz *et al*. [34] on *Antirrhinum majus*.

Mineral Contents: Regarding the effect of kinetin, ascorbic acid and glutamic acid foliar application on nitrogen, phosphorus and potassium, data presented in Table 5 revealed that, spraying croton plants with different concentrations of kinetin, ascorbic acid and glutamic acid stimulated the all plant organs content of nitrogen compared with the control treatment, except glutamic acid at 200 ppm in leaves and glutamic acid at 100 ppm in roots. Leaves, stems and roots percentage of phosphorus parallel to the increase in the concentration of ascorbic acid was sloping upward to 200 ppm. Leaves and stems phosphorus were decrease by increasing kinetin concentration compared with the control. In this context, P% was also increased by increasing glutamic acid concentrations in leaves and root compared with the control plants. In addition, K% gradually was increased by increasing all foliar application concentration in roots. The positive effect in N concentration by ascorbic treatments could be explained by the finding of Talaat [25] who showed that the accumulation of nitrate by ascorbic acid foliar application may be due to the positive effect of ascorbic on root growth which consequently increased nitrate absorption. In this context, the increase in P concentration by ascorbic treatments may be attributed to the postulation of Hanafy Ahmed *et al*. [35] who mentioned that foliar spray with ascorbic acid might increase the organic acids excreted from the roots into the soil and consequently increase the solubility of most nutrients which release slowly into the rhizosphere zone where it may be utilized by the plants. In addition, Hiatt and Lowe [36] reported that electrostatic binding of inorganic ions by organic ions such as organic acid is undoubtedly involved in the process of K-ions accumulation. Concerning the effect of three foliar applications on nutrient uptake, the data followed the same behviour obtained previously on the three nutrient percentages (Table 6).

Hence, it could be recommended that treatment of kinetin, ascorbic acid and glutamic acid especially at the concentration of 200 ppm had a beneficial effect on growth and chemical constituents of *Codiaeum variegatum*.

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