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Response of Croton Plants to Gibberellic Acid, Benzyl Adenine and Ascorbic Acid Application

Rawia A. Eid and Bedour H. Abou-Leila

Ornamental Plants and Woody Trees Department,
National Research Centre, Dokki, Cairo, Egypt

Abstract: Pot experiments were carried out to investigate the effect of Gibberellic acid, (GA_3), Benzyl adenine (BA) and/or Ascorbic acid (ASC) on the growth, pigments, carbohydrate and mineral content of croton plants. The results obtained showed that, the tallest plants, the largest leaf area, the highest RGR, as well as, fresh and dry weight/plant were associated with GA_3 treatments, while 75 ppm BA gave the highest number of leaves, maximum LAR and lowest SLW. Furthermore ascorbic acid 200 and 300 ppm as well as GA treatments increased carbohydrate percentage. Treatments with BA and/or ASC had no or slight effect on K concentration in plants while GA treatments showed the highest values of N, P, K, Mg, Fe, Zn, Mn and Cu. The photosynthetic pigments chlorophyll (a+b) as well as anthocyanin were the highest for GA_3 150 ppm, while ascorbic acid treatments recorded the highest β-carotine percentage.

Key words: Croton plant · gibberellic · benzyl adenine · ascorbic acid · leaf growth analysis · chemical composition

INTRODUCTION

The agricultural strategy of Egypt gives much attention to ornamental plants production for local and exportation. Croton plants is one of the beautiful indoor and outdoor plant needs extensive agriculture development. It has been known that growth regulators among the agriculture practices which is most favourable for promoting and improving plant-growth of different plants. The beneficial effect of gibberellic acid on different plants were recorded by Shedeed *et al.* [1] on croton plant, Eraki [2] on Quen Elizabeth rose plants, Bedour *et al.* [3] on *Ocimum basillicum*, they concluded that gibberellic acid is used to regulating plant growth through increasing cell division and cell elongation. The effect of cytokinins especially benzyl adenine on the plant growth and chemical constituents of different plants have mentioned by Eraki *et al.* [4] on salvia plants, Mazrou [5] on Datura, Mazrou *et al.* [6] on sweet basil, Mansoure *et al.* [7] on soybean plants and Vijakumari [8] on *Andrographis panculata*. Ascorbic acid fulfills many key function in plant biology as well as the most abundant law molecular weight antioxidant in the plant cell, it participate in the regulation of mitosis and cell expansion [9]. Also ascorbic acid caused promotion on growth and metabolism as the findings of Talaat [10] on levander, Tarraf *et al.* [11] on lemon grass, Reda and Gamal El-Din [12] on chamomile. The main object of the present work is to study the effect of different regulators, Gibberellic acid, Benzyl adenine and Ascorbic acid on the growth and some chemical constituents of croton plants.

MATERIALS AND METHODS

The present work was conducted during the two successive seasons of 2004 and 2005 at the green house of National Research Centre, Dokki, Cairo, Egypt. Plastic pots 30 cm^2 diameter were used for cultivation that were filled with media containing a mixture of sand, loam and peat as 1:1:1 by volume. Rooted terminal cuttings of *Codiameum variegatum pactum* L. cv. Norma. 4-6 cm. height with 2-3 leaves were repotted in 1st February in both seasons. All pots were supplied with phosphorus fertilizer before transplanting at a rate of 3.0 g/pot in the form of calcium super phosphate (15.5% P_2O_5). Nitrogen and potassium fertilizers were added to the media after 30 days from transplanting at the rate of 2.0 g/pot in the form ammonium sulphate (20% N) and 1.0 g/pot K_2O in the form of potassium salphate (48.0% K_2O).

Corresponding Address: Dr. Rawia A. Eid, Ornamental Plants and Woody Trees Department, National Research Centre, Dokki, Cairo, Egypt

The pots were arranged in complete randomize design with 9 treatments and 8 replicates in addition to the control. Application of gibberellic acid (50, 100 and 150 ppm), Benzyl adenine (25, 50 and 75 ppm) and Ascorbic acid (100, 200 and 300 ppm) were carried out twice as foliar spray. The first was one month after transplanting, the second was after one month from the first while the control were sprayed distilled water only. Through the two successive seasons, two samples were taken, the first was taken one month after the later spray and the second was one month after the first sample, in which plant height, number of leaves, leaf area and growth analysis of leaves were carried out according to Radford [13]. Fresh and dry weight g/plant were recorded for each replicates.

Chemical determination: Sample from the fresh leaves of each treatment were used to determine chlorophyll a, b and carotenoids according to Saric *et al.* [14].

Total anthocyanins as mg/g dry weight were determined by using the methods of Fuleki and Francis [15] and developed by Du and Francis [16]. The carotenoids extract from the leaves of croton was identified by paper chromatography, using two solvent system.

Carbohydrate % were determined using the method described by Dubois *et al.* [17]. Nitrogen percentage was determined by the modified Microkjeldahl apparatus as described by Markham [18]. Phosphorus determination was carried out according to King [19], potassium, magnesium and micronutrients were determined using Atomic absorption spectrophotometer. The recorded data were statistically analyzed using the completely randomized design according to the procedure of Snedecor and Cochran [20], where the means of the studied treatments were compared using LSD test at 5% level of probability.

RESULTS AND DISCUSSION

Plant growth: Data present in Tables 1 and 2 show that, the application different concentrations of gibberellic acid (GA_3), benzyl adenine (BA) and/or ascorbic acid (ASC) had significantly stimulatory effect on growth parameters of croton plants in term of plant height, number of leaves as well as fresh and dry weight g/plant compared with the untreated plants, in this respect Mazrou *et al.* [6] on *Ocimum basillicum* mentioned that, benzyl adenine increased general growth compared with the control plants. The most effective treatment which had the tallest plant, the largest leaf area, the highest fresh and dry weight/plant was GA_3 when applied at concentration of 150 ppm. The results herein are in agreement with Turkey [21] on coriander, Shedeed *et al.* [1] on croton, Ibrahim *et al.* [22] on ment plant and Rahman *et al.* [23] on soybean. However, GA_3 is used to regulating plant growth through increased meristimatic activity due to enhance cell division and elongation [24] on *Corchorus olitorius* L. Treatment with BA at 75 ppm significantly raised the number of leaves/plant compared with the other treatments and control, while ascorbic acid treatments were less effective than benzyl adenine (BA) in this respect.

Leaves growth analysis: Data in Table 3 showed significant differences in leaves growth analysis due to GA_3, BA and ASC treatments compared with the control plants. The maximum value of leaf area ratio LAR was obtained in the leaves of plants treated with 75 and 50 ppm BA, whereas the minimum value was obtained in the plant treated with different concentration of GA_3. This results may be due to the stimulatory effect of BA on increasing number of leaves/plant, while GA_3 treatments were more effective in raising dry weight/plant than the other treatments.

Table 1: Effect of GA, BA and ASC on growth characters of croton plant during 1st season (2004)

		Plant height (cm)		No. of leaves/plant		Leaf area (cm^2)		Fresh weight (g/plant)		Dry weight (g/plant)	
Treatments		1st stage	2ed stage	1st stage	2ed stage	1st stage	2ed stage	1st stage	2ed stage	1st stage	2ed stage
Control		13.53	18.35	7.35	12.31	42.60	95.31	34.80	47.00	5.85	7.84
GA	50	19.40	25.00	9.89	13.73	58.57	129.62	68.00	91.00	10.70	18.30
ppm	100	21.30	36.31	12.98	17.71	82.34	133.53	47.40	115.30	15.80	18.64
	150	22.60	38.21	14.81	18.00	123.04	163.44	118.50	136.50	20.25	23.79
BA	25	18.31	32.29	11.31	16.31	54.60	107.41	53.80	61.40	8.79	9.37
ppm	50	20.51	35.00	15.00	21.00	80.21	114.32	65.50	96.60	11.93	13.87
	75	21.81	36.71	16.31	24.00	113.41	154.81	114.40	120.70	18.58	20.31
ASC	100	16.89	21.35	10.00	14.22	52.72	105.32	52.90	60.80	8.18	9.05
ppm	200	18.11	30.33	13.21	19.23	73.48	108.25	63.70	93.60	10.94	12.45
	300	20.05	31.53	15.00	22.31	108.30	150.62	106.50	109.80	17.35	19.85
LSD 0.5% level		0.513	1.32	0.489	0.313	8.31	13.41	14.28	10.42	3.21	2.53

Table 2: Effect of GA, BA and ASC on growth characters of croton plant during 2ed season (2005)

Treatments		Plant height (cm)		No. of leaves/plant		Leaf area (cm^2)		Fresh weight (g/plant)		Dry weight (g/plant)	
		1st stage	2ed stage	1st stage	2ed stage	1st stage	2ed stage	1st stage	2ed stage	1st stage	2ed stage
Control		13.21	19.05	8.33	13.23	46.43	97.42	35.90	49.83	6.21	8.34
GA	50	20.81	27.31	14.59	18.91	59.31	133.46	70.41	93.83	12.34	20.74
ppm	100	22.44	38.43	14.93	19.34	84.21	135.81	49.53	117.85	18.73	21.71
	150	24.83	40.51	15.21	20.31	124.81	165.81	112.50	140.40	22.84	26.93
BA	25	18.53	23.85	13.42	18.52	53.21	108.21	55.41	64.50	10.89	12.42
ppm	50	21.62	36.31	14.04	23.21	81.35	115.89	66.70	98.73	13.74	15.93
	75	22.34	38.83	18.53	26.38	115.21	156.70	113.85	124.83	24.91	26.41
ASC	100	17.91	22.32	13.00	14.98	75.46	110.32	54.31	62.80	10.21	11.34
ppm	200	19.21	30.54	14.21	20.41	76.45	111.83	65.32	95.83	12.85	14.52
	300	21.34	32.35	16.21	23.41	110.40	152.34	108.70	111.92	19.38	22.24
LSD 0.5% level		0.834	1.91	0.113	1.05	10.45	11.23	8.31	12.35	2.85	1.89

Table 3: Effect of GA, BA and ASC application on leaves growth analysis of croton plants (Average of two seasons 2004 and 2005)

Treatments		LAR (cm^2/g/day)	SLW (cm^2/mg/day)	RGR (mg/g/day)
Control		101.63	7.97	4.0
GA	50	75.69	11.50	8.0
ppm	100	96.21	9.83	2.3
	150	106.20	8.48	2.3
BA	25	128.61	7.73	8.3
ppm	50	136.96	6.34	2.2
	75	141.24	5.66	1.2
ASC	100	114.97	8.05	1.91
ppm	200	127.96	6.90	1.33
	300	131.46	6.00	1.33
LSD 0.5% level		3.21	1.03	N.S

Table 4: Gibberellic acids, Benzyl adenine and Ascorbic acid effect on photosynthetic pigments of croton leaves (Average of the two seasons 2004 and 2005)

Treatments		(mg/g fresh weight)				(mg/100g D.W)
		Chl. (a)	Chl. (b)	Total Chl. a+b	Carotenoids	Anthocyanin
Control		2.46	1.876	4.336	0.25	35.41
GA	50	3.415	2.218	5.633	0.35	60.32
ppm	100	4.344	2.148	6.492	0.37	73.71
	150	4.819	2.943	7.762	0.41	88.52
BA	25	2.879	1.713	4.592	0.28	58.32
ppm	50	3.874	2.380	6.254	0.31	67.91
	75	4.125	2.775	6.900	0.38	73.82
ASC	100	2.031	1.180	3.211	0.43	70.52
ppm	200	2.110	2.880	4.990	0.46	90.32
	300	1.495	2.541	4.036	0.49	91.53

Specific leaf area (SLW) reached the lowest value compared with the control plants when plants treated with the highest concentration of BA, while the maximum values were obtained for the leaves of plants treated with GA_3 50, 100 and 150 ppm followed by those treated with 100 ppm ASC. This results are associated with the stimulatory effect of GA_3 on raising dry weight of leaves. In this respect Halter *et al.* [25] mentioned that the SLW was higher in artichokes plants treated with GA_3. Relative growth rate (RGR) was increased in plants treated with 50 ppm GA_3 and/or 25 ppm BA while ASC treatments gave the lowest values in this respect, where Khan *et al.* [26] concluded that GA sprays enhanced (RGR) mustard plants.

Photosynthetic pigments: It can be observed from Table 4 that, the lowest concentration of chlorophyll (a) and the highest concentration of chlorophyll (b) as well as carotenoids and anthocyanin were obtained in leaves of croton treated with ascorbic acid (ASC) compared with the other treatments and control plants. In spite of that, plants treated with benzyl adenine (BA) showed leaves

Table 5: Effect of Gibberellic acid, Benzyl adenine and Ascorbic acid on the quantitative analysis of the Carotenoids fraction % in the croton leaves (Average of the two seasons 2004 and 2005)

Treatments		Rhodoxenthin	β-cytoxanthin	Violaxanthin	Zeaxanthin	β-carotine
Control		16.34	14.39	76.85	16.71	13.25
GA	50	14.54	16.74	13.52	11.32	16.71
ppm	100	17.18	17.83	14.81	12.41	17.82
	150	18.15	18.41	15.32	15.92	18.95
BA	25	11.35	12.35	17.32	14.51	14.56
ppm	50	16.48	13.49	17.45	13.21	15.35
	75	17.31	14.32	17.43	15.31	18.07
ASC	100	12.51	11.32	11.52	13.41	14.21
ppm	200	13.83	14.23	15.37	14.21	19.71
	300	15.49	19.73	17.41	13.11	19.53

Table 6: Effect of Gibberellic acid, Benzyl adenine and Ascorbic acid on carbohydrate % of croton leaves (Average of the two seasons 2004 and 2005)

	Gibberellic acid GA_3 (ppm)			Benzyl adenine BA (ppm)			Ascorbic acid ASC (ppm)		
Control	50	100	150	25	50	75	100	200	300
9.10	11.23	11.41	11.21	9.43	10.32	10.38	9.73	11.23	11.74

Table 7: Macro and micronutrients content of croton plants as affected by Gibberellic acid, Benzyl adenine and ascorbic acid (Average of the two seasons 2004 and 2005)

		Micronutrients (mg/g/D.W)				Micronutrients (ppm)			
Treatments		N	P	K	Mg	Fe	Zn	Mn	Cu
Control		5.34	0.73	13.41	0.89	168.3	18.3	38.1	3.4
GA	50	8.37	1.32	16.35	1.73	239.4	20.4	40.2	7.3
Ppm	100	12.43	2.53	18.43	2.34	297.2	22.3	68.9	6.4
	150	12.83	2.87	18.46	3.45	298.1	26.4	70.2	6.2
BA	25	6.71	2.34	13.21	1.08	241.2	17.3	39.1	5.7
Ppm	50	7.32	2.53	14.21	1.73	242.5	17.7	40.3	6.3
	75	10.53	2.81	14.25	1.94	243	19.9	42.7	5.8
ASC	100	7.41	1.04	12.35	1.05	238.2	18.7	36.7	9.3
ppm	200	5.52	2.13	13.85	1.45	240.3	22.3	39.4	9.8
	300	5.34	2.21	12.71	1.34	237.2	21.4	37.5	10.41

with intense chlorophyll (a) and low concentration of carotenoids and anthocyanin especially with 25 ppm BA compared with the other treatments. However, GA_3 treatment 150 ppm was more effective than ascorbic acids and/or benzyl adenine (BA) in raising total chlorophyll (a+b) and had also promotion effect on carotenoids and/or anthocyanin concentration as compared with the control.

The results herein are agreement with the finding of Mousa *et al.* [27] on *Nigella sativa* and Shedeed *et al.* [28] who mentioned that GA_3 treatments were more effective than kinetin in increasing carotenoids and anthocyanin in croton leaves.

The carotenoids extract, from leaves of croton Table 5 show five fractions were found, the different concentrations used of GA_3, BA and/or ASC raised generally β-carotine % in leaves over the control treatment and the highest increments were achieved by ASC treatments. On the other hand the previous mentioned regulators decreased zeanthin %. The same table also showed that GA_3 treatments were more effective than other treatments including control in raising rhodoxethin and β-cytoxanthin %. However, the highest volaxanthin % was associated with BA treatments.

Carbohydrate content: Data in Table 6 show that, the application of GA_3, BA and/or ascorbic acid with different concentrations were favourable for accumulation of carbohydrate in leaves of the tested plants compared with the control. The greatest carbohydrate % occurred in the leaves of plants treated with GA_3 and those plants treated with 200 and 300 ppm ASC.

This results are analogy with the finding of Talaat [10] on lavender, Tarraf *et at.* [11] on lemon grass, Reda and Gamal-Eldin [12] on wheat. They concluded that ascorbic acid (ASC) favoured the carbohydrate accumulation, also Sheren [29] on flax plants recorded that GA_3 application resulted in an increase of

carbohydrate content. On the other hand 25 ppm BA and/or 100 ppm treatments gave leaves with the lowest carbohydrate compared with the other treatments.

Minerals: Data in Table 7 reveal that, spraying croton plants with different concentration of GA_3, BA and/or ASC stimulated the concentration of minerals N, P, K, Mg, Fe, Zn, Mn and Cu in croton plants compared with the control treatment. The greatest concentration of N, K, Mg, Fe, Zn and Mn were obtained from plants sprayed with 150 ppm GA. The stimulatory effect of GA_3 and Zn uptake in *Nigella sativa* plants was recorded by Mousa *et al.* [27] The enhancing effect of GA in increasing phosphorus and potassium concentration in plant may be due to the vital role in regulating plant growth via nucleic acid and enzyme synthesis on flax [30].

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