Journal of Horticultural Science & Ornamental Plants 4 (2): 215-220, 2012
ISSN 2079-2158

DOI: 10.5829/idosi.jhsop.2012.4.2.249

Effect of Some Growth Regulators on Growth, Flowering, Bulb Productivity and Chemical Composition of Iris Plants

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Abstract: This investigation was carried out at the Nursery of Ornamental plants, Faculty of Agriculture, Minia University, Egypt during the two successive seasons of 2008 / 2009 and 2009 / 2010 to study the effect of different concentrations of gibberellins (GA_3), cycocel (CCC) and Alar on the growth, flowering and bulb production of iris plants. In this study the plants of iris were sprayed three times with 0, 250, 500 and 750 ppm of GA_3, 250, 500 and 1000 ppm of CCC and 125, 250 and 500 ppm of Alar. Results showed that GA_3 treatments significantly increased leaf length, while, CCC and Alar treatments significantly decreased the leaf length compared to control treatment. GA_3 treatments shortened significantly the time taken from planting to flowering, while CCC and Alar treatments significantly delayed the flowering date compared to control. Also, the flowering stalk length was increased by application of GA_3 at the three used concentrations, while, CCC and Alar at the same concentrations led to decrease in the flowering stalk length. The positive or negative effects of GA_3 or CCC and Alar were gradually increased by increasing their concentrations. All treatments of GA_3, CCC and Alar led to increased flowering stalk diameter, fresh and dry weights of the flowering stalk and fresh weight of inflorescence / plant compared to control. The best results were obtained by using of high concentration of GA_3, CCC and Alar. All GA_3, CCC and Alar treatments had a stimulatory effect on the formation of new bulbs and bulblets compared to the control treatment. The highest of fresh weight of new bulbs and bulblets / plant and the highest number of bulblets / plant were obtained by the application of GA_3 at 750 ppm, CCC at 1000 ppm and Alar at 500 ppm. Total chlorophyll content of the leaves was increased as a result of using different concentrations of CCC or Alar. Meanwhile, total chlorophyll content was decreased by the application of the three used concentration of GA_3 compared to the control. The highest percentage of the total carbohydrates in the bulbs was obtained by the application of GA_3 at 750 ppm followed by CCC at 1000 and Alar at 500 ppm.

Key words: Iris · GA3 · CCC · Alar · Growth · Flowering · Bulb Productivity · Chemical Composition · Growth Regulators

INTRODUCTION

The genus Iris and iris plants have a wide use for medicinal purposes and ornamental uses. It is known for a long time and was used for the bulb frame and the alpine house, for water and bog garden, for the rock garden and as cut flowers [1]. Iris occupies a prominent economic position because of its continuous increase demands for local and foreign markets. Therefore, several investigations were done and more of studies are still needed for improving both quantitative and qualitative characteristics of this plant.

Several investigators pointed out that the application of growth regulators such as gibberellins (GA_3), cycocel (CCC) and Alar at certain doses had an effective role on the growth, flowering and bulb productivity of many flowering bulbs. The stimulatory effect of GA_3 application on growth and flowering of the different ornamental bulbs was studied by several investigators such as Hassan [2] on anemone and ranunculus; Lopez *et al*. [3] and Arrora *et al*. [4] on gladiolus; Manoly [5] on *Polianthus tuberosa*; Mohamed [6] and Singh *et al*. [7] on dahlia and Abou-Taleb and Kandeel [8] on *Iris tingitana* cv. Wedgewood who found that application of GA_3 at 500 ppm as soaking and foliar spray gave the highest values of length, diameter and fresh weight of flower stalk. Also, this treatment increased number of leaves / plant, fresh and dry weight of bulb and number and fresh weight of bulblets, as well as, gave the earliest flowering. Similar results were reported by Youssef [9] on *Strelitzia reginae* and Abou-El-Ella [10] on *Acanthus mollis* plant.

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Growth retardants such as CCC (2-chloroethyl trimethyl ammonium chloride) and Alar (succinic acid 2, 2- dimethyl hydrazide) markedly reduced stem length, number of leaves / plant of ornamental plants. Also, they promoted the flowering parameters [7, 11-15] and increased bulb production [7, 11-14, 16-18]. Also, Hassanein and Manoly [14] on *Dahlia pinnata*, they found that both of CCC and Alar at 1000 ppm increased chlorophyll a, b and carotenoides contents of leaves.

MATERIALS AND METHODS

This study was carried out at the Nursery of Ornamental plants, Faculty of Agriculture, Minia University, Egypt during the two successive seasons of 2008 / 2009 and 2009 / 2010 to examine the effect of GA_3, CCC and Alar at different concentrations on growth, flowering, bulb production and some chemical composition of iris plants.

Bulbs of iris (Wedgewood variety) that have the pale blue color was chosen because it is the most commonly grown iris variety in Egypt, bulbs of about14-16 gm in weight were planted in November 10th of both seasons in 25 cm diameter pots (one bulb / pot) filled with clay loamy soil. Some physical and chemical analyses of the used soil are shown in Table 1.

Table 1: Physical and chemical analysis of the used soil

Character	Value	Character	Value
Sand %	28.20	Total N %	0.08
Silt %	30.70	Available P	15.12
Clay %	40.10	Extr. K^+mg/100 g	2.11
Soil type	Clay loam	Extr. Ca^{++}mg/100 g	31.74
Organic matter %	1.62	Extr. Na^+mg/100 g	2.40
$CaCO_3$ %	2.09	DTPA Extr. ppm	
pH (1:2.5)	7.82	Fe	8.54
E.C. mmhos/cm	1.04	Cu	2.06
		Zn	2.75
		Mn	8.26

The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replications and each replicate contained 10 pots. The experiment consisted of ten treatments including three growth regulators i.e. gibberellin (GA_3), cycocel (CCC) and Alar, at three concentrations for each as follows control, GA_3 (at 250, 500 and 750 ppm), CCC (at 250, 500 and 1000 ppm) and Alar (at 125, 250 and 500 ppm).

Iris plants were sprayed with growth regulators three times at one month intervals starting on 10th December in the two growing seasons. The control treatment was sprayed with distilled water. Misrol, as a sticking agent was used at the rate of 1 cm / L for all growth regulators, treatments. All treatments received the NPK (2:2:1 g / pot) three times after 30, 60 and 90 days from planting as a soil drench in the two seasons. Leaf length at flowering time days to, flowering, (as number of days from planting till flowering), flowering stalk length, stalk diameter, stalk fresh and dry weights and fresh weight of inflorescence / plant characteristics were recorded. Furthermore, number and fresh weight of the produced bulblets per plant and fresh weight of new mother bulb were recorded for each treatment in the two seasons. Total chlorophylls were determined in fresh leaves samples taken from each treatment according to the method described by A.O.A.C. [19]. Total carbohydrates percentage in the dried bulbs of each treatment was determined in the two seasons according to the method described by Dubios *et al*. [20].

The obtained data were statistically analyzed by using the computer software M STAT-C Ver.4-0 and the L.S.D. test at 5 % was used to compare the different means [21].

RESULTS AND DISCUSSION

Vegetative Growth Characters

Leaf Length: The leaf length of iris plants significantly increased as a result of spraying the plants with GA_3 at three used concentrations compared to the untreated plants in the two seasons. The tallest leaves were obtained when the plants were applied with high concentration (750 ppm) of GA_3. Meanwhile the three concentrations used of both CCC and Alar significantly decreased the leaf length compared to the untreated plants in the two seasons. The lowest values, in both seasons, were produced on plants sprayed with higher concentrations of both Alar and CCC as shown in Table 2.

The effect of GA_3 on leaf length may due to its stimulatory effect on cell division and elongation as was reported by Tonecki [22]. Similar results were obtained by Ismail [23] on *Narcissus* and Youssef [24] on *Strelitzia elegans*. On the other hand, the reduction in leaf length due to cycocel or Alar could be referred to the inhibition of cell division and cell expansion in the plant [25] or due to the retardation of the longitudinal growth of cells [26]. In this concern, Al-Badawy *et al*. [12] and Singh *et al*. [7] reported that plant height of white calla and dahlia respectively was reduced with high concentration (2000 ppm) of Alar. Also, Hassanein and Manoly [14] found that both CCC and Alar at 1000 ppm, remarkably reduced plant height of dahlia plants.

Table 2: Effect of GA_3, CCC and Alar concentrations on leaf length (cm), flowering date (days), flowering stalk length (cm) and stalk diameter (mm) of iris plants during the seasons of 2008 / 2009 and 2009/ 2010

	Leaf length at flowering time (cm)		Flowering date (days)		Flowering stalk length (cm)		Flowering stalk diameter (mm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	18.65	21.77	121.11	123.07	31.50	33.27	8.08	8.15
GA_3 (ppm)								
250	25.34	27.22	117.62	118.23	34.73	37.70	9.74	9.84
500	27.87	29.59	116.18	117.05	36.73	39.07	9.82	9.89
750	29.94	32.48	115.24	115.71	40.93	42.50	10.11	10.21
CCC (ppm)								
250	17.21	19.11	123.67	124.88	30.90	32.11	9.89	9.98
500	15.61	16.18	124.11	125.06	28.57	30.65	9.95	10.08
1000	12.68	12.45	124.92	125.95	27.90	28.15	10.58	10.69
Alar (ppm)								
125	17.01	18.13	123.86	125.11	29.70	30.86	9.81	9.91
250	14.85	15.73	124.65	125.85	28.13	28.93	9.87	9.97
500	11.71	12.01	125.22	126.11	27.07	26.88	10.28	10.39
L.S.D. at 5 %	1.05	0.99	1.35	1.65	0.88	1.18	1.17	1.21

Table 3: Effect of GA_3, CCC and Alar concentrations on fresh weight of flowering stalk (g), dry weight of flowering (g), fresh weight of the inflorescence / plant (g) and fresh weight of new bulb (g) of iris plants during the seasons of 2008 / 2009 and 2009 / 2010

	Fresh weight of flowering stalk (g)		Dry weight of flowering stalk (g)		Fresh weight of the inflorescence / plant (g)		Fresh weight of new bulb (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	30.53	33.09	7.32	7.94	9.12	9.27	12.03	12.50
GA_3 (ppm)								
250	45.63	48.16	8.21	8.77	9.97	10.87	13.30	13.70
500	47.78	51.73	8.38	9.19	10.93	12.40	14.44	14.65
750	53.06	54.71	9.23	9.65	12.03	12.47	15.32	15.92
CCC (ppm)								
250	37.36	37.62	8.58	8.65	10.77	11.20	13.40	13.72
500	37.60	38.00	8.64	8.78	12.53	13.20	14.28	14.65
1000	39.89	40.31	9.17	9.35	13.77	14.43	15.18	15.20
Alar (ppm)								
125	36.98	37.36	8.49	8.58	9.77	9.93	12.99	13.36
250	37.21	37.58	3.56	8.60	11.13	11.80	13.69	13.84
500	38.76	39.17	8.90	8.97	12.37	12.57	14.20	14.32
L.S.D. at 5 %	1.68	1.89	0.50	0.64	0.64	0.66	0.77	0.85

Days to Flowering: Results in Table 2 indicated clearly that the growth regulators treatments at all concentrations affected days to flowering date for iris plants. Both of CCC and Alar at all their concentrations led to a delay in flowering, while, GA_3 at the three used concentrations produced earlier flowering in both seasons. The most obvious treatments to delay flowering were 500 ppm of Alar and 1000 ppm of CCC which delayed the flower appearance by 4.11 and 3.81 days in the first seasons and by 3.04 and 2.88 days in the second season, respectively, as compared to control plants. The earliest flowering was observed in plants treated with high concentration of GA_3 (750 ppm) which earlied the flower by 5.87 and 7.36 days in the first and second seasons, respectively, as compared to the control. Early flowering of treated plants by GA_3 might be due to their vital role in the production and regulation of floral stimulus. Many authors agreed with our findings that GA_3 caused early flowering such as Abou-Taleb and Kandeel [8] on *Iris tingitana*; Mohamed [27] on gladiolus and Gomaa [28] on *Dahlia pinnata*. A delay in flowering date was observed when Alar at 1500 ppm was used by Al-Badawy *et al*. [12] on white calla.

Flowering Stalk Characteristics: The present data in Tables 2 and 3 clearly show that applying iris plants with the three used concentrations of GA_3 had a significant positive effect on the flowering stalk measurements compared to control in the two seasons. The treatment of 750 ppm of GA_3 produced the tallest and the heaviest

flowering stalk in the two seasons. Meanwhile, the three used concentrations of CCC or Alar caused a reduction in the flowering stalk measurements i.e. flowering stalk length and fresh and dry weights of flowering stalk of iris plant compared with control in the two growing seasons. However, the lowest values in this respect were obtained by plants sprayed with high concentration of both Alar and CCC. Moreover data in Table 2 revealed that spraying plants with GA_3, CCC and Alar at three used concentrations significantly increased the thickness of the flowering stalk over control, in both seasons. Flowering stalk diameter was greatly increased in the plants treated with GA_3, Alar and CCC, in an ascending order. Cycocel gave the best results (highest values) in this respect compared to the other two growth regulators.

The improving effect of GA_3 on flowering characteristics may be due to their stimulatory effect on cell division, elongation and differentiation [22]. Also, more vigorous vegetative growth was accompanied with increasing of carbohydrates and some other chemical constituents required for better quality inflorescence [29]. This result is in agreement with that of Abou-Taleb and Kandeel [8] on iris plants; Abou-El-Ella [10] on *Acanthus mollis* and Ismail [23] on narcissus plant. Concerning the effect of CCC or Alar, Singh *et al*. [7]; Al-Badawy *et al*. [12] on white calla and Hassanein and Manoly [14] on dahlia plants concluded that each of CCC and Alar reduced stalk length and increased stalk diameter compared to the control treatment.

Fresh Weight of the Inflorescence/ Plant: Data in Table 3 clearly show that, the fresh weight of the inflorescence / plant was significantly stimulated in response to using the three growth regulators compared to the control treatment. The promotion was associated with increasing the concentrations of each growth regulators. Application of CCC, Alar and GA_3 in the descending order was effective in enhancing fresh weight of the inflorescence / plant. It could be stated that application of CCC surpassed the application of the other two growth regulators. The untreated plants gave the minimum values, while, the maximum values were detected on plants sprayed three times with 1000 ppm of CCC in both growing seasons. Similar results were obtained by Abou-Taleb and Kandeel [8] on iris plants; Hassanein and Manoly [14] on dahlia plants.

Bulbing Parameters: It is evident from the data in Tables 3 and 4 that using the different concentrations of GA_3, CCC and Alar had significantly affected the formation of bulbs and bulblets of iris plants. The treatments of GA_3 at 750 ppm, CCC at 1000 ppm and Alar at 500 ppm, in the descending order produced high numbers and the highest values of fresh weight of bulblets, as well as, highest values of fresh weight of new mother bulbs than the other treatments including the control treatment in both seasons. Similar results were obtained by Arrora *et al*. [4]; Abou-Taleb and Kandeel [8] on iris plants; Mohamed [27] on gladiolus; Preeti *et al*. [30] on tuberose and Ved *et al*. [31] on gladiolus plants who reported that GA_3 at 500 ppm had enhancement effects on bulb yield and bulb weight. Manloy [13] on iris plants; Otoo [16] and El-Habbal and Osaman [17] on onion plants concluded that bulb size and bulb weight were increased by CCC or Alar treatments.

Total Chlorophylls Content: In regards to growth retardants, total chlorophylls content in the leaves of iris plants was increased by all CCC or Alar treatments in the two seasons. Alar at high concentration (500 ppm) was more effective than CCC at high concentration (1000 ppm).On the other hand, total chlorophylls content (mg/g F.W.) of the leaves was decreased as a result of spraying plants in the different concentrations of GA_3 in the two seasons compared with control. The lowest values were obtained by the treatment of (750 ppm) of GA_3.

The aforementioned results of total chlorophylls content are coincided with those obtained by Menesy *et al*. [11] on *Senecio hybrid;* Al-Badawy *et al*. [12] on white calla and Hussanein and Manoly [14] on dahlia plants reported that spraying plants with CCC or Alar increased the total chlorophyll contents. Similar results were obtained by Zaghloul [18] on summer squash and who reported that CCC at all tested concentrations resulted in accumulating more chlorophyll in the leaves.

Total Carbohydrate Content: The application of all concentrations of GA_3, CCC and Alar significantly increased the stored carbohydrates in the new bulbs of iris plants comparing to the control treatment. The best results in this respect were obtained by the treatments of (750 ppm) of GA_3 followed by (1000 ppm) of CCC as shown in Table 4. Ahmed [32] obtained an increase in carbohydrates content in tub-root of dahlia as a result of GA_3 application. Similar results were obtained by Manoly [13]; Tawila [33] and Wankhede *et al*. [34] on *Polianthus tuberosa*. The increment in the total carbohydrate percentages as a result of CCC and Alar treatments might be due to their role in increasing chlorophyll contents of the leaves as previously mentioned in Table 4, which was reflected in raising the

Table 4: Effect of GA_3, CCC and Alar concentrations on number of bulblets /plant, fresh weight of bulblets / plant (g), total chlorophylls (mg /g F.W.) and total carbohydrates (%) in the bulbs of iris plants during the seasons of 2008 / 2009 and 2009 / 2010

	No. of bulblets / plant		Fresh weight of bulblets / plant (g)		Total chlorophylls mg / g F. Wt.		Total carbohydrate % in the bulbs	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	5.42	6.89	23.22	25.15	3.281	3.313	56.18	60.30
GA_3 (ppm)								
250	5.96	6.48	25.96	28.06	2.953	3.049	65.11	67.80
500	7.04	7.52	30.84	32.94	2.789	2.849	73.22	77.15
750	8.44	8.74	37.31	38.63	2.625	2.750	75.92	78.11
CCC (ppm)								
250	5.77	6.30	24.34	26.59	3.379	3.396	64.01	66.12
500	6.52	7.06	28.30	30.15	3.478	3.479	72.18	74.31
1000	6.30	6.50	27.41	28.02	3.543	3.562	73.26	77.82
Alar (ppm)								
125	5.68	6.18	23.99	26.08	3.346	3.363	63.12	64.10
250	6.34	6.88	27.52	29.24	3.412	3.418	70.16	71.12
500	6.12	6.42	26.62	27.61	3.477	3.462	72.11	73.19
L.S.D. at 5 %	0.25	0.28	0.73	0.62	0.311	0.244	1.16	2.11

photosynthetic rate and consequently the total carbohydrate percentages increased. Similar results were obtained by Al-Badawy *et al*. [12] on while calla and Hassanein and Manoly [14] on *Dahlia pinnata*.

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