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Effect of Foliar Application of Paclobutrazol and Cycocel on Vegetative Growth, Flowering and Chemical Constituents of *Zinnia elegans* Plants

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ABSTRACT

The present study was carried-out at Antoniadis Research Branch, Horticulture Research Institute, A.R.C. Alexandria, Egypt during the two successive seasons of 2020 and 2021. This study, aimed to test the effect of applying foliar sprays of cycocel and paclobutrazol in improving the quality and performance of *Zinnia elegans* plants. The *Zinnia* seedlings were planted individually in plastic pots 25 cm diameter of sandy soil. The plants were sprayed with cycocel at the concentrations of 500, 1000, 1500 and 2000mg/l and paclobutrazol at the concentrations of 100, 200, 300 and 400 mg/l. The obtained results showed that spraying with cycocel at 2000 mg/l and paclobutrazol at 400 mg/l significantly increased decreased plant height, number of leaves per plant, leaves dry weight, leaf area, number of branches per plant, stem diameter, stem dry weight and root dry weight. In addition to, the obtained results showed that spraying with cycocel at 2000 mg/l and paclobutrazol at 400 mg/l significantly increased number of flower per plant, flower diameter, flower fresh weight, flower dry weight and flower vase life. As such as, The obtained results showed that spraying with cycocel at 2000 mg/l and paclobutrazol at 400 mg/l resulted in the highest chlorophyll content, carbohydrates content , nitrogen percentage in the leaves, phosphorus percentage in the leaves and potassium percentage in the leaves, Therefore, this study to investigate the effect of different of cycocel and paclobutrazol treatments, on the vegetative growth and flower growth and chemical constituents of *Zinnia elegans* plants grown sandy soil.

Keywords: *Zinnia elegans,* cycocel, paclobutrazol.

1. Introduction

An essential category of higher plants is ornamentals, which can also improve the environment and provide economic advantages. An annual flowering plant in the genus is the zinnia (*Zinnia elegans*). One of the most popular zinnias, Zinnia, is a member of the Asteraceae family and is indigenous to the southwest United States, Mexico, and Central America (Carter and Grieve, 2010). The dwarf varieties of zinnia are typically used in containers, while the taller varieties can be used as cut flowers as well as annual flower beds and borders in the garden. Zinnia production, however, is not quick or compact enough to result in a high-quality and marketable plant (Andersen and Andersen, 2000 and Pinto *et al.,* 2005).

Synthetic chemicals known as "plant growth regulators" are used in floriculture to regulate plant growth. In comparison to plants not treated with these substances, plants sprayed in potted ornamentals or treated directly with chemicals grow shorter (Grossi, 2009). Studies in the literature have shown that plant growth regulators can be used to successfully lower the epidendrum radicans orchids' final plant height (Patelli, 2004). Such plant growth regulators have also been successful in controlling inflorescence length on hybrids of Phalaenopsis (Wang; Hsu, 1994), as well as in limiting shoot growth in Cattleya mossiae (Torres and Mogolon, 2002). Growth regulators can enhance the effective partitioning of accumulates from source and sink and can increase physiological efficiency, including photosynthetic ability, in field crops (Solaimalai *et al.,* 2001).

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Chlormequat chloride (CCC), also known as Cycocel, is one of many plant growth regulators that is suggested for controlling height in poinsettias, azaleas, geraniums, and hibiscus (Barret, 2001). The chemical can be sprayed directly onto the plant or substrate (1000 to 3000 mg/ L), but multiple applications are required for effectiveness. Furthermore, high concentrations can result in necrotic spots on the plant and chlorotic spots being produced on the growing leaves as side effects. Another plant growth regulator for controlling height is paclobutrazol (sold under the brand name Cultar), which is effective when applied to the substrate at concentrations of 2 to 90 mg/ L (Barret, 2001).

In order to improve yield in gramme (Bangal *et al.,* 1982), pigeonpea (Vikhi *et al.,* 1983), and soybean, cyclocel (2-chloroethyl, trimethyl ammonium chloride) has been used to prevent flower abscission and modify the crop canopy (Singh *et al.,* 1987). According to Grewal *et al.,* (1993), cycocel facilitates the translocation of photosynthates. It's possible that improved photosynthate translocation to the seeds is the cause of the higher protein content stored in the seeds.

In order to determine the impact of various dosages of cycocel and paclobutrazol treatments on the vegetative growth, flower growth, and chemical constituents of *Zinnia elegans* plants grown in sandy soil, this study was carried out. By making plants flowering potted plants, the information from this study may increase their marketability.

2. Materials and Methods

The present study was carried-out at Antoniadis Research Branch, Horticultural Research Institute, A.R.C. Alexandria, Egypt, during two successive seasons of 2020 and 2021. The aim of this study was to evaluate the effects of foliar application of Cycocel and Paclobutrazol on growth quality of *Zinnia elegans* plants grown in sandy soil under the circumstances of Alexandria.

On the 1st of April 2020 and 2021 in the first and second seasons, respectively, homogeneous seedlings of *Zinnia elegans* (15-20 cm height and with number of leaves 4 per plant) were planted individually in plastic pots (25 cm diameter) filled with 5 kg of sandy soil. The chemical constituents of the soil were measured as described by Jackson (1973) and presented in Table (1).

On the 1st of June in the first and second seasons, the plants were sprayed with Cycocel at the concentrations of 500, 1000, 1500 and 2000 mg/l and Paclobutrazol at the concentrations of 100, 200, 300 and 400 mg/l, every 15 days starting from on the 1st of June till 15th of July in both seasons. The control plants were sprayed with tap water. On 1st of August in both seasons the plants were harvested.

Table 1: Some chemical analyses of the used sandy soil for the two successive seasons 2020 and 2021.

Season	pH	EC (dSm^{-1})	Soluble cations (meq/l)				Soluble anions (meq/l)		
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_2^{--}
2020	7.93	1.55	3.4	3.4	6.5	1.3	3.6	6.7	2.4
2021	7.91	1.52	3.2	3.0	6.3	1.2	3.3	6.5	2.2

In both seasons, all plants received NPK chemical fertilization using soluble fertilizer (Milagro Aminoleaf 20-20-20) at the rate of 2 g/ pot. Fertilization was repeated every 30 days throughout the growing season (from the 15th of April till the 30st of July). In addition, weeds were removed manually upon emergence.

2.1. Data recorded :

2.1.1. Vegetative growth parameters:

Plant height (cm), number of leaves per plant, leaves dry weight per plant (g), leaves area (cm^2) according to Koller (1972), branches number per plant, stem diameter (cm), stem dry weight (g), root length (cm), root dry weight (g), flower number per plant, flower diameter (cm), flower fresh weight (g), flower dry weight (g) and flower vase life (day).

2.1.2. Chemical analyses:

- Chlorophyll contents were determined as SPAD unit in the fresh leaves of plants for the different treatments under the experiment at the end of the season using Minolta (chlorophyll meter) SPAD 502 according to Yadava (1986).
- Carbohydrate contents of the leaves were determined according to Dubios *et al.*(1956).

- Nitrogen in the leaves (%) was determined according to the methods described by Evenhuis and Waard, (1980).
- Phosphorus in the leaves (%) was determined according to the methods described by Murphy and Riley, (1962).
- Potassium in the leaves (%)was determined according to the methods described by Page *et al.,* (1982).

2.2. Statistical Analysis

The layout of the experiment was a randomized complete block design (RCBD) contained 9 treatments with three replicates. Data were subjected to analysis of variance (ANOVA) using the SAS program (SAS Institute, 2002). The Means of the individual factors and their interactions were compared by L.S.D test at 5% level of probability according to Snedecor and Cochran (1989).

3. Results

3.1. Vegetative growth

The data in Table (2) indicate that different Cycocel and Paclobutrazol treatments had a significant effect on the plant height (cm), leaves number per plant, leaves dry weight per plant (g) and leaf area (cm^2) of *Zinnia elegans* plants in both seasons, respectively.

The plants sprayed with Cycocel at 2000 mg/l gave the shortest plant height (cm), leaves number per plant, leaves dry weight per plant (g) and leaf area (cm^2), compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Cycocel at 2000 mg/l gave the less stem length, leaves number per plant, leaves dry weight per plant and leaf area (59.83 and 60.83 cm), (29.33 and 31.16), (3.44 and 3.52 g) and (593.20 and 613.41cm^2) in the first and second seasons, respectively.

While, the plants sprayed with Paclobutrazo at 400 mg/l gave the less plant height (cm), leaves number per plant, leaves dry weight per plant (g) and leaf area (cm^2) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Paclobutrazo at 400 mg/l gave the less plant height, leaves number per plant, leaves dry weight per plant and leaf area (30.66 and 31.58 cm), (49.50 and 50.50), (6.32 and 6.39 g) and (768.72 and 819.85 cm^2) in the first and second seasons, respectively.

Table 2: Means of plant height (cm), number of leaves per plant, leaves dry weight (g) and leaf area (cm^2) of foliar application of cycocel and paclobutrazol on growth quality of *Zinnia elegans* plants in the two seasons of 2020 and 2021.

Treatments	Plant height (cm)		Number of leaves per plant		Leaves dry weight (g)		Leaf area (Cm^2)	
	2020	2021	2020	2021	2020	2021	2020	2021
Control	72.33	77.25	62.16	67.00	7.52	8.02	935.89	1076.35
CCC 500 mg/l	64.41	70.08	37.00	38.16	4.11	4.12	703.18	810.57
CCC 1000 mg/l	62.16	66.58	34.66	36.00	3.87	3.91	673.23	715.80
CCC 1500 mg/l	61.33	64.33	33.66	34.00	3.77	3.71	624.56	669.40
CCC 2000 mg/l	59.83	60.83	29.33	31.16	3.44	3.52	593.20	613.41
PBZ 100 mg/l	38.08	38.41	54.33	60.00	6.77	7.31	871.10	915.09
PBZ 200 mg/l	36.08	36.25	51.83	56.33	6.49	6.94	835.52	881.75
PBZ 300 mg/l	34.66	34.33	51.00	54.16	6.44	6.79	821.11	852.42
PBZ 400 mg/l	30.66	31.58	49.50	50.50	6.32	6.39	768.72	819.85
L.S.D. at 0.05	**1.44**	**2.55**	**1.51**	**2.57**	**0.18**	**0.27**	**56.003**	**64.655**

Data in Table (3) indicate that different Cycocel and Paclobutrazol treatments had a significant effect on the branches number per plant, Stem diameter (cm), Stem dry weight (g) and Root dry weight (g) of *Zinnia elegans* plants in both seasons, respectively.

The plants sprayed with Cycocel at 2000 mg/l gave the less branches number per plant, Stem diameter (cm), Stem dry weight (g) and Root dry weight (g) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Cycocel at 2000 mg/l gave the less branches number per plant, Stem diameter (cm), Stem dry weight (g) and Root dry weight (g) (4.00 and 6.16), (3.61 and 3.63 cm), (2.63 and 2,65 g) and (7.70 and 7.99 g) in the first and second seasons, respectively.

The plants sprayed with Paclobutrazo at 400 mg/l gave the less branches number per plant, Stem diameter (cm), Stem dry weight (g) and Root dry weight (g) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Paclobutrazo at 400 mg/l gave the less branches number per plant, Stem diameter (cm), Stem dry weight (g) and Root dry weight (g) (5.66 and 8.83), (6.51 and 7.02 cm), (5.32 and 5.83 g) and (4.73 and 4,82 g) in the first and second seasons, respectively.

Table 3: Means of branches number per plant, stem diameter (cm), stem dry weight (g) and root dry weight (g) of foliar application of cycocel and paclobutrazol on growth quality of *Zinnia elegans* plants in the two seasons of 2020 and 2021.

Treatments	Branches number per plant		Stem diameter (cm)		Stem dry weight (g)		Root dry weight (g)	
	2020	2021	2020	2021	2020	2021	2020	2021
Control	3.50	4.50	3.62	3.88	3.02	3.29	8.77	9.24
CCC 500 mg/l	3.16	5.00	3.18	3.16	1.99	1.97	8.00	8.54
CCC 1000 mg/l	3.33	5.83	3.48	3.44	2.29	2.25	7.78	8.21
CCC 1500 mg/l	3.66	6.00	3.82	3.84	2.42	2.44	7.55	7.65
CCC 2000 mg/l	4.00	6.16	3.61	3.63	2.63	2.65	7.70	7.99
PBZ 100 mg/l	4.33	6.33	6.03	6.12	4.84	4.93	5.44	5.48
PBZ 200 mg/l	5.00	6.66	6.18	6.51	4.99	5.32	5.26	5.27
PBZ 300 mg/l	5.00	7.16	6.22	6.67	5.03	5.48	5.12	5.09
PBZ 400 mg/l	5.66	8.83	6.51	7.02	5.32	5.83	4.73	4.82
L.S.D. at 0.05	**1.19**	**1.69**	**0.13**	**0.23**	**0.23**	**0.23**	**0.14**	**0.24**

3.2. Flowering parameter

Data in Table (4) indicate that different Cycocel and Paclobutrazol treatments had a significant effect on the flower number per plant, flower diameter (cm), flower fresh weight (g) and flower dry weight (g) of *Zinnia elegans* plants in both seasons, respectively.

Table 4: Means of flower number per plant, flower diameter (cm), flower fresh weight (g) and flower dry weight (g) of foliar application of cycocel and paclobutrazol on growth quality of *Zinnia elegans* plants in the two seasons of 2020 and 2021.

Treatments	Flower number per plant		Flower diameter (cm)		Flower fresh weight (g)		Flower dry weight (g)	
	2020	2021	2020	2021	2020	2021	2020	2021
Control	9.5	13.5	4.16	4.50	3.34	3.32	1.12	1.11
CCC 500 mg/l	12.0	18.5	6.00	6.00	4.34	4.38	1.44	1.45
CCC 1000 mg/l	11.0	18.0	5.50	5.83	4.20	4.25	1.39	1.41
CCC 1500 mg/l	10.0	17.5	4.83	5.16	3.93	3.95	1.30	1.31
CCC 2000 mg/l	10.5	15.0	4.66	4.83	3.75	3.70	1.24	1.23
PBZ 100 mg/l	17.0	26.5	5.66	7.83	8.91	9.61	2.96	3.20
PBZ 200 mg/l	15.0	21.5	5.50	6.66	8.78	9.48	2.92	3.15
PBZ 300 mg/l	15.0	20.0	5.00	6.50	7.80	8.49	2.59	2.82
PBZ 400 mg/l	13.0	19.0	4.50	6.00	7.40	8.01	2.46	2.66
L.S.D. at 0.05	**3.57**	**5.08**	**1.41**	**0.94**	**0.29**	**0.41**	**0.09**	**0.13**

The plants sprayed with Cycocel at 2000 mg/l gave the less flower number per plant, flower diameter (cm), flower fresh weight (g) and flower dry weight (g) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Cycocel at 2000 mg/l gave the less flower number per plant, flower diameter (cm), flower fresh weight (g) and flower dry weight (g) (10.50 and 15.00), (4.66 and 4.83 cm), (3.75 and 3.70 g), (1.24 and 1.23 g) in the first and second seasons, respectively.

The plants sprayed with Paclobutrazo at 400 mg/l gave the less flower number per plant, less flower diameter (cm), less flower fresh weight (g) and less flower dry weight (g) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Paclobutrazo at 400 mg/l gave the less flower number per plant, less flower diameter (cm), less flower fresh weight (g) and less flower dry weight (g) (13.00 and 19.00), (4.5 and 6.00 cm), (7.40 and 8,01 g) and (2.46 and 2,66 g) in the first and second seasons, respectively.

3.3. Flower vase life (day)

The data in Table (5) and Fig. (1) indicate that different Cycocel and Paclobutrazol treatments had a significant effect on the flower vase life (day) of *Zinnia elegans* plants in both seasons, respectively.

The plants sprayed with Cycocel at 2000 mg/l gave the highest flower vase life (day) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Cycocel at 2000 mg/l gave the highest flower vase life (day) (17.00 and 18.00 day), in the first and second seasons, respectively.

Table 5: Means of flower vase life (day) of foliar application of cycocel and paclobutrazol on growth quality of *Zinnia elegans* plants in the two seasons of 2020 and 2021.

Treatments	Flower vase life (day)	
	2020	**2021**
Control	12.5	13.5
CCC 500 mg/l	13.5	14.5
CCC 1000 mg/l	15.0	15.5
CCC 1500 mg/l	16,5	17.5
CCC 2000 mg/l	17,0	18.0
PBZ 100 mg/l	14.0	18.0
PBZ 200 mg/l	14.5	19.5
PBZ 300 mg/l	16.5	20.0
PBZ 400 mg/l	18.0	23.5
L.S.D. at 0.05	**4.23**	**2,83**

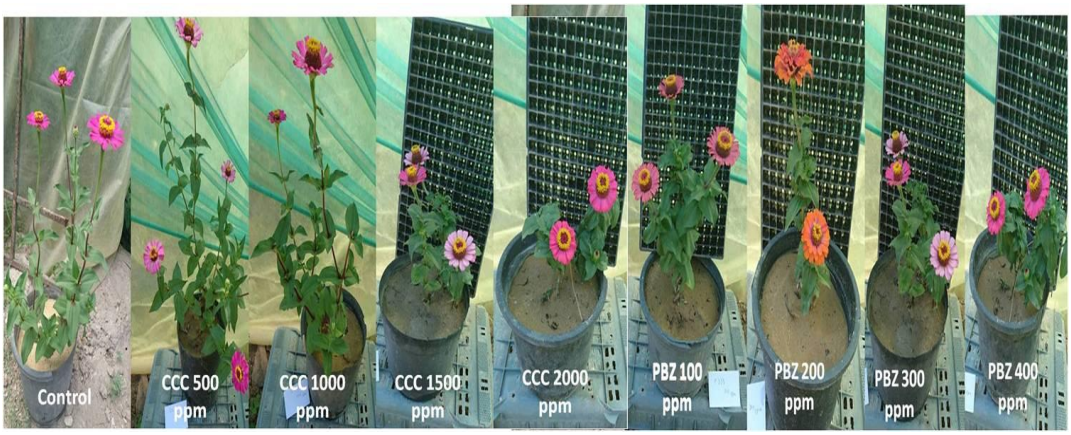

Fig. 1: Effect of cycocel and paclobutrazol treatments on Zinnia elegans plants.

The plants sprayed with Paclobutrazo at 400 mg/l gave the highest flower vase life (day) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Paclobutrazo at 400 mg/l gave the highest flower vase life (day) (18.00 and 23.50 day) in the first and second seasons, respectively.

3.4. Chemical constituents

The data in Table (6) indicate that Cycocel and Paclobutrazol treatments had a significant effect on the chlorophyll content in leaves (SPAD), carbohydrate content (%), nitrogen content in the leaves (%), phosphorus content in the leaves (%) and potassium content in the leaves (%) of *Zinnia elegans* plants in both seasons, respectively.

The plants sprayed with Cycocel at 2000 mg/l gave the highest chlorophyll content in leaves (SPAD), carbohydrate content (%), nitrogen content in the leaves (%), phosphorus content in the leaves (%) and potassium content in the leaves (%) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Cycocel at 2000 mg/l gave the highest chlorophyll content in leaves (SPAD), carbohydrate content (%), nitrogen content in the leaves (%), phosphorus content in the leaves (%) and potassium content in the leaves (%) (32.70 and 32,67 SPAD), (6.53 and 6.53 %), (2.29 and 2.49 %), (0.229 and 0,249 %) and (2,62 and 2.93 %) in the first and second seasons, respectively.

The plants sprayed with Paclobutrazo at 400 mg/l gave the highest chlorophyll content in leaves (SPAD), carbohydrate content (%), nitrogen content in the leaves (%), phosphorus content in the leaves (%) and potassium content in the leaves (%) compared to the control plants. As with other vegetative characteristics parameters, spraying the plants with Paclobutrazo at 400 mg/l gave the highest chlorophyll content in leaves (SPAD), carbohydrate content (%), nitrogen content in the leaves (%), phosphorus content in the leaves (%) and potassium content in the leaves (%) (37.47 and 36.95 SPAD), (7.49 and 7.39 %), (2.47 and 2.62 %), (0.247 and 0.262 %) and (2.71 and 2,99 %) in the first and second seasons, respectively.

Table 6: Means of chlorophyll content (SPAD), carbohydrate content (%), nitrogen content (%), phosphorus content (%), and potassium content (%)of foliar application of cycocel and paclobutrazol on growth quality of *Zinnia elegans* plants in the two seasons of 2020 and 2021.

Treatments	Chlorophyll content in leaves (SPAD)		Carbohydrate content (%)		Nitrogen content in the leaves (%)		Phosphorus content in the leaves (%)		Potassium content in the leaves (%)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Control	28.47	27.15	5.69	5.43	2.08	2.28	0.208	0.228	2.51	2.89
CCC 500 mg/l	30.12	30.19	6.02	6.03	2.18	2.32	0.218	0.233	2.52	2.90
CCC 1000 mg/l	31.07	31.12	6.21	6.22	2.21	2.37	0.221	0.237	2.60	2.91
CCC 1500 mg/l	32.32	32.55	6.46	6.51	2.27	2.47	0.228	0.247	2.61	2.92
CCC 2000 mg/l	32.70	32.67	6.53	6.53	2.29	2.49	0.229	0.249	2.62	2.93
PBZ 100 mg/l	33.26	33.31	6.64	6.66	2.27	2.51	0.228	0.251	2.55	2.94
PBZ 200 mg/l	34.72	34.78	6.94	6.95	2.31	2.55	0.231	0.255	2.65	2.95
PBZ 300 mg/l	35.71	35.77	7.14	7.15	2.37	2.56	0.237	0.256	2.70	2.97
PBZ 400 mg/l	37.47	36.95	7.49	7.39	2.47	2.62	0.247	0.262	2.71	2.99
L.S.D. at 0.05	**1.04**	**0.95**	**0.20**	**0.19**	**0.28**	**0.28**	**0.28**	**0.28**	**0.18**	**0.27**

4. Discussion

The way that plants react to various plant growth regulators depends on the species or varieties, the concentration of growth regulators, and the frequency of application. In this study, *Zinnia elegans* were exposed to four different concentrations of chlormequat chloride (also marketed as Cycocel) at 500, 1000, 1500, and 2000 mg/l. When compared to the control, CCC treatments increased rooting, which increased the amount of nutrients reaching the plant. On the other hand, they had a light-retardant effect when compared to other CCC treatments with high concentrations. Compared to the other CCC

concentrations, it is found where the leaf area and inflorescence pedicel are the largest. In terms of increasing plant height, branch length, fresh and dry weight, 2000 mg/l CCC was more effective. Additionally, it accomplishes, by preventing the conversion of geranyl pyrophosphate to coponyl pyrophosphate, the first stage in the production of gibberellins, Cycocel, an anti-gibberellin dwarfing agent, may cause a lack of gibberellins in the plant and inhibit growth (Moore, 1980). With bioregulators, there were noticeably more branches, dry weight, and leaf area index than with the control. The use of mepiquat chloride, cycocel, and TIBA greatly increases the amount of dry matter production in soybean, according to Ravinchandran and Ramaswami (1991).

According to the data, all paclobutrazol and cycocel treatments studied statistically increased the dry weight of leaves per plant over the control in both seasons. The plants sprayed with 2000 and 400 mg/l of cycocel and paclobutrazol, respectively, had the heaviest dry leaf weights and the highest paclobutrazol concentrations during the two seasons. Additionally, in both of the study's seasons, medium concentrations of cycocel and paclobutrazol showed highly significant increases in this regard. Saker (2004) on Hibiscus *rosa sinensis* and *Tabernaemontana coronaria*, Youssef (2004) on *Strelitzia reginae*, and others are examples in this regard. Sibel *et al.,* (2009) on Consolida orientalis, Abd El-Kader (2009) on *Cestrum elegans* and *Tecoma stans*, *Jatropha curcas*, sunflower, and patumma cv were the subjects of studies by Gosh *et al.,* (2010), Ribeiro *et al.,* (2011), and Jungklang and Saengnil (2012). On the plants *Tabernaemontana coronaria*, Chiang Mai Pink, Youssef, and Abd El-Aal (2013); Eissa (2014); on *Murraya exotica* and *Duranta repens;* Mohamed, (2016) on kumquat plants and Turky, (2015) on hibiscus plants.

Apical dominance is eliminated when one inflorescence (the apical inflorescence) is removed from the branch, which promotes secondary branching. Because early inflorescence cutting promoted the formation of secondary branches, the 2000 mg/l CCC concentration had the heaviest fresh and dry weight Zinnia elegans plants, despite having the greatest number of primary branches with the high concentration of CCC. This is because Zinnia elegans, an annual plant, has finished growing for the year. In comparison to the control and other treatments, 2000 mg/l CCC showed the greatest number of primary branches, longest vase life of Zinnia elegans inflorescence, highest percentage of essential oils, polyphenols, flavonoids, and antioxidant activity. This concentration's capacity to produce the greatest fresh and dry weight of roots is to blame. In the meantime, increasing the uptake of macroelements led to an increase in chlorophyll content, which ultimately gave these treated plants their highest carbohydrate content. The treated plants were dwarfed by the high CCC concentrations. Therefore, the tissues of the treated plants had a concentration of the plant's chemical components.

Auxin, gibberellins, ABA, and cytokinins are endogenous phytohormones that can be altered by CCC, which is a growth inhibitor. Therefore, according to Youssef and Abd El-Aal (2013), the application of CCC increased endogenous cytokinin levels while decreasing gibberellin and auxin levels. Cytokinins slow down the degradation of chlorophyll, keep it intact, and boost its synthesis (Devlin and Witham, 1983). Additionally, the effect of some growth retardants on reducing leaf area, which results in an intensification of pigments in leaves, may be responsible for the increase in chlorophyll content as a result of growth retardant treatments. Cytokinins promote the initiation of lateral shoots and roots. increasing the dry weights of various plant parts as a result (Devlin and Witham, 1983). Such findings revealed trends that were similar to those attained by many.

Jungklang and Saengnil (2012) on patumma cv. chiang Mai Pink, Gibberellins are recognised as a hormone that stimulates and promotes long-term growth in various plants (Devlin and Witham, 1983). Therefore, the use of growth retardants treatments (CCC) with high concentrations of 2000 and 1500 mg/l led to a reduction in the level of endogenous gibberellins, which in turn led to a reduction in the length of various cell types and, as a result, a reduction in plant height and leaf area. In comparison to the control plants, these treatments produced the smallest leaves and the shortest plants. These findings concur with those of Youssef and Abd El-Aal (2013) who discovered that the Tabernaemontana coronaria plants treated with 1000, 1500, and 2000 mg/l CCC were shorter than the untreated control plants. Joshi and Reddy (2006) found that application of cycocel and alar at higher concentrations (500 to 2000 mg/l) reduced plant height in China aster compared to the control. According to Grewal *et al.,* (1993), cycocel facilitates the translocation of photosynthates. It's possible that improved photosynthate translocation to the seeds is the cause of the higher protein content stored in the seeds. The results obtained here are consistent with those from Selim (1985) on Bougainvillea Mrs. Butte, Selim (1990) on Pelargonium zonale, and Selim (1985) on Bougainvillea plants. Saker (2004) studied *Hibiscus rosa*

sinensis and *Tabernaemontana coronaria* shrubs, Youssef (2004) studied *Strelitzia reginae*, Regarding *Hippeastrum vittatum*, El-Malt *et al.,* (2006) On *Cestrum elegans* and *Tecoma stans*, Abd El-Kader (2009) On patumma cv, on patumma cv Chiang Mai Pink, Jungklang and Saengnil (2012). Youssef, Abd El-Aal (2013) on *Tabernaemontana coronaria*, Eissa (2014) on *Murraya exotica* and *Duranta repens* plants, Mohamed (2016) on a kumquat plant, and Turky (2015) on *Hibiscus rosea sinensis* plant.

5. Conclusions

Plant growth regulators (growth retardants) are known to regulate the metabolism in the plant by increasing the duration of the source there by maintaining the proper balance of source and sink. The degree of perfect physiological relations indirectly affects without causing malformation in the plants. In this connection, application of growth regulators to optimize plant production by modifying growth, development and the quantitative and qualitative yield of plants.

According to these points, necessity of using growth regulator to improve quality, marketing is completely justification. Among treatments, cycocel 2000 mg/l in addition to paclobutrazol 400 mg/l treatment showed the good results and their means did not have significant difference with each other, but they showed significant difference with other treatments. cycocel 2000 mg/l in addition to paclobutrazol 400 mg/l had the most decreased plant height, leaves number per plant, dry weight of leaves, leaves area, stem diameter, dry weight of stem, branches number per plantand dry weight of root that were showed significant difference with other treatments. cycocel 2000 mg/l with paclobutrazol 400 mg/l was the most effective treatment on total chlorophylls, carbohydrates and nitrogen percentage in the leaves, phosphorus percentage in the leaves and potassium percentage in the leaves. This treatment was significantly difference with control respecting to total chlorophylls and was significantly different with control.

Generally, the obtained results showed that spraying *Zinnia elegans* plants with cycocel and paclobutrazol at high concentrations alone was better than spraying *Zinnia* plants with cycocel and paclobutrazol at low concentrations. The two growth regulators improved vegetative growth, flowering growth and some chemical components of *Zinnia elegans* plants.

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