REGULATION OF HOLLYHOCK (ALTHAEA ROSEA. L) VEGETATIVE GROWTH AND FLOWERING BY THE USE OF PACLOBUTRAZOL, PIX AND CYCOCEL.

BY

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ABSTRACT

This study was conducted at the Experimental Area of Orman Botanical Garden, Horticulture Research Institute, Giza Egypt, during the two successive seasons of 1997/98 and 1998/99 with the aim of investigating the effect of three growth retardants "paclobutrazol, pix and cycocel" on the growth, flowering and chemical constituents of *Althaea rosea. L.* plants. The transplants were treated one month after sowing with pp-333 as soil drench at the rates of 0.25, 0.50 and 1.0 mg/pot, pix (mipequate chloride) as spray at the concentrations of 1, 2 and 5 ppm and ccc (chloromequat) as spray at the concentrations of 1000, 2000 and 4000 ppm. Each growth retardant was used three times at 3 weeks interval.

The obtained results could be briefed in the following:

- All pp-333 levels led to obvious increments in number of branches and leaves/plant, fresh weight of leaves, dry weight of all plant parts, total number of flowers, floral stalk diameter, total carbohydrates, mucilages in roots and total phenols content, but reduced plant height, leaf area, floral stalk length, carotenoides, and total indoles contents in the leaves.
- Low and medium concentrations of pp-333 caused early flowering, however the highest one delayed it.
- All pix treatments increased fresh weight of both stems and flowers, dry weight of stems, total flowers number plant, flower diameter and total carbohydrates content.
- Low and medium pix levels decreased plant height, leaf area and carotenoids content in the leaves.
- All ccc concentrations reduced plant height, floral stalk length, total carbohydrates in the stem, total phenols content in the leaves and mucilages in roots. While they increased branches and leaves number/ plant, stem diameter, fresh weight of stems and flowers, flower diameter and total chlorophylls content in the leaves.

It is recommended that to obtain compact, dwarf and healthy hollyhock (*Althaea rosea. L*) plants they should be sprayed with ccc at 4000 ppm, three times at three weeks interval. However, for early flowering bearing more flowers with good quality plants, it is recommended to apply pix at the rate of either 2.0 or 5.0 ppm.

INTRODUCTION

Hollyhock (*Althaea rosea.L.)* is a popular annual flowering plant, often used in gardens for its large colourful flowers which give it a special kind of beauty. However, the large size of the plant limits the possibility of using it as a flowering pot plants.

Controlling the height of *Althaea rosea.* L. plants to use it as a pot plant was the aim of this investigation. Growth retardants are organic chemicals which retard stem elongation, increase green colour of leaves and indirectly affect flowering. Thereafter, unique other characteristics in the plant, thus making them more useful and attractive.

Mepiquate chloride (pix), cycocel (chloromequat) and paclobutrozol (pp-333) as growth retardants for controlling the plant height and improving both flowering and fruitting of ornamental plants were used, by many researchers. Singh et al. (1999) on chrysanthemum and Nassar et al. (2001) on sweet pepper, mentioned that pp- 333 application at (10-30 ppm) reduced plant height and increased number of flowers /plant. Attia (1997) on *Celosia plumosa,* reported that applying 5 ppm of pix significantly reduced plant height and increased shoot number per plant.

Ahmed (1997) on *Malvaviscus arborus* noticed that ccc at 500 ppm increased the carbohydrates and chlorophylls in leaves. Therefore, the aim of this investigation was to find out which of these growth retardants had the most pronounced positive effect on producing hollyhock (*Althaea rosea. L*), as a pot flowering plant.

MATERIALS AND METHODS

The present study was carried out during two successive seasons of 1997/98 and 1998/99 in the Experimental Area of Orman Botanical Garden, Giza. Egypt.

Seeds of *Althaea rosea. L.*, local variety with pink flowers were sown on November 1st in 25 cm clay pots filled with clay soil as, 3-4 seeds were sown in each pot. The seedlings were thinned after 3 weeks from the sowing date, one seedling was left in each pot. The plants were placed in a sunny area in the field.

The plant growth retardants which were used in this work were pp-333 (paclobutrozol) as a soil drench at the rate of (0.25, 0.50 and 1.0 mg/pot),

pix (mepiquate chloride) as spray at the concentrations of 1, 2 and 5 ppm and ccc (chloromequat) as spray at the concentrations of 1000, 2000 and 4000 ppm. The plants were treated with growth retardant 3 times, after one month of sowing and repeated at three weeks interval Three drops of a liquid soap was added to one litre of solution as a wetting agent, and the plants were sprayed till run off. The control plants were sprayed with tap-water only. The rates of paclobutrazol as soil drench were prepared in 200 cm^3 tap-water for each pot. The layout of the experiment was a complete randomized block design, consisting of 10 treatments in three replicates each consisted of 15 plants. Conventional agriculture practices were performed which included, fertilization, irrigation, weeding and pest control.

The following data were recorded: Plant height (cm) - Number of branches/plant- Number of leaves/plant-Leaf area (cm^2)- Stem diameter (mm) at 25 cm height from soil surface-Fresh and dry weight (gm) of all plant parts.

- Flowering date - Number of flowers /plant - Spike length (cm) - Spike diameter (mm)- Flower diameter (cm) (for the lowest flower on the spike).

Chemical analyses:

- Pigments content; chlorophyll a, b and carotenoids (mg/g fresh weight) were determined in leaf samples of the middle part of the plants after three weeks from the last foliar spray according to Saric et al. (1976).
- Total carbohydrates content in leaves, stem, flowers, and roots (% D. W) were determined at the beginning of flowering time according to Herbert, et al. (1971).
- Total soluble indoles and total soluble phenols were determined in the upper leaves prior to flowering time, using colorimetirc method (A.O. A.C, 1970).
- Root contents of the mucilage was determined according to Smith and Montgomery (1959). The data were statistically analyzed according to Snedecor and Cochran (1968).

RESULTS AND DISCUSSION

I- Vegetative growth:

1- Plant height:

The different paclobutrazol treatments significantly reduced plant height (Table, 1). The shortest plants resulted from plants treated with pp-333 at the higher rate (1.0 mg/pot). This treatment reduced plant height 47%

Table (1): Effect of paclobutrazol, pix and cycocel on the vegetative growth characteristics of *Althaea rosea L.*– plant during the two seasons (1997/98 and 1998/99).

Treatments	First season					Second season				
	Plant height (cm)	Stem diameter (mm)	Number of branches/ plant	Number of leaves/ plant	Leaf area (cm^2)	Plant height (cm)	Stem diameter (mm)	Number of branches/ plant	Number of leaves/ plant	Leaf area (cm^2)
Control	107.7	13.0	2.9	24.3	58.37	109.7	13.3	2.8	25.8	57.66
PP-333 0.25 mg/pot	96.4	11.3	3.7	29.3	56.32	96.2	11.5	3.8	29.8	55.86
PP-333 0.5 mg/pot	74.2	13.7	3.9	32.3	48.39	83.5	13.9	3.9	32.8	53.50
PP-333 1.0 mg/pot	57.9	14.1	3.9	33.3	34.29	70.7	14.3	4.1	33.9	33.90
Pix 1.0 ppm	109.7	12.0	2.9	25.4	59.40	110.2	12.2	2.8	26.9	52.10
Pix 2.0 ppm	96.8	13.2	3.9	26.8	53.33	95.8	13.4	2.8	27.8	44.21
Pix 5.0 ppm	90.6	13.9	3.9	28.9	44.43	92.9	13.8	2.9	29.5	36.60
CCC 1000 ppm	72.4	14.5	4.2	37.5	49.60	87.9	14.3	4.8	38.8	54.73
CCC 2000 ppm	66.6	15.5	4.8	43.2	37.72	82.1	15.8	4.9	42.4	44.58
CCC 4000 ppm	58.7	17.2	4.9	49.1	35.54	69.0	18.2	4.9	48.8	33.77
L.S.D 5%	10.84	0.74	0.66	4.23	5.19	11.81	0.168	0.81	3.57	3.90

compared to the control. These findings are in agreement with those obtained by Bazzochi and Giorioni (1996) on *Gardenia jasminoides*, Nasr (1997) on gerbera and Singh et al. (1999), who mentioned that plant height of chrysanthemum was least with paclobutrazol as soil drench application.

Pix treatments showed another trend, the low concentration of 1.0 ppm gave the tallest plants compared to the control with non significant differences, however the other two concentrations significantly reduced the plant height compared to the control. In this regard El-Khateeb et al (1994) on *Hibiscus sabdariffa* and Attia (1997) on *Celosia plumosa*, reported that applying at 5 ppm of pix significantly reduced plant height. In general, ccc treatments at all concentrations significantly reduced plant height compared to the control. Also, increasing the rate of ccc caused more reduction in plant height. These results are in agreement with those reported by Ahmed (1997) on *Bougianvillea Mrs* Butt, who found that ccc at the rate of 6000 ppm decreased the plant height.

- Stem diameter:

The data in Table (1) indicated that the low level of pp- 333 (0.25 mg/pot) significantly reduced the stem diameter, when compared to control in both seasons. However, the medium and high levels (0.50 and 1.0 mg/pot) significantly increased the stem diameter in both seasons than the control. In this connection El-Tantawy et al. (1994), mentioned that paclobutrazol at 50-150 ppm increased stem diameter of *Chrysanthemum morifolium* plants.

A similar trend was also observed for the effect of pix treatments, the low concentration (1.0 ppm) significantly reduced stem diameter, while the medium, and high ones (2.0 and 5.0 ppm) significantly increased stem diameter in both seasons.

In this regard El-Khateeb et al. (1994) reported that applying pix at 400 ppm significantly increased stem thickness of *Hibiscus sabdariffa* .

Regarding the effect of ccc, the data in Table (1) indicated that all treatments significantly increased the stem diameter over the control for both seasons. The medium and high concentrations of ccc (2000 and 4000 ppm) produced the thickest stem diameter in the first and second seasons. These results are in agreement with those obtained by Attia (1997) on *Schinus terebenthifolius.*

- Number of branches /plant:

All pp-333 treatments significantly increased number of branches over control. The greatest number of branches resulted from plants treated with pp-333 at the highest rate (1.0 mg/pot) in both seasons. These findings are in

harmony with those pointed out by Eliwa (1994) on *Solanum capsicastrum* and Ahmed (1997) on *Bougainvillea Mrs* Butt, who reported that pp- 333 at the rate of 40 ppm as soil drench increased number of branches per plant.

Concerning the effect of pix, it appears from the data in Table (1), that the low concentration (1.0 ppm) had non significant effect, whereas, the other concentrations of 2.0 and 5.0 ppm led to significant increase in this parameter in the first season only. These results are supported by results that had been reported by El-Khateeb et al. (1994) on *Hibiscus sabdariffa* and Attia (1997) on *Schinus terebenthifolius* and *Celosia plumosa*, they found that applying at 5 ppm of pix significantly increased shoot number /plant.

Referring to the effect of cycocel, the data revealed that it caused significant increments in number of branches /plant over control. The most effective treatment in producing the greatest number of branches was ccc at the rate of 4000 ppm, in both seasons. These results were in agreement with those obtained by Talukdar (1996) on chrysanthemum and Ahmed (1997) on *Bougainvillea Mrs Butt*, who mentioned that ccc at 6000 ppm increased number of branches /plant.

- Number of leaves/plant:

It is clear from data in Table (1), that all levels pp-333 led to significant increments in number of leaves/ plant. The high rate of pp- 333 (1.0 mg/pot) was the most effective treatment in both seasons. These results were in agreement with those obtained by Mao et al (1991) on *Salvia splendens*, Nasr (1997) on gerbera and Ahmed (1997) on *Bougainvillea Mrs* Butt, who reported that pp- 333 at the rate of 40 ppm as soil drench increased number of leaves. Concerning the effect of pix, the data revealed that the low and medium concentrations (1.0 and 2.0 ppm) slightly increased number of leaves with non significant differences when compared to control. However the high concentration (5.0 ppm) led to significant increments in this parameter. These results are in agreement with the findings of Hashim et al. (1991) on *Senecio cruentus*, El-Khateeb and Farahat (1994) on *Polianthes tuberosa* and Attia (1997) on *Schinus terebenthifolius* and *Celosia plumosa*.

Regarding the effect of cycocel, the data revealed that all ccc treatments significantly increased number of leaves /plant over control and the other growth retardants used. These results were in agreement with those obtained by Talukdar and Paswan (1994) on chrysanthemum, Attia (1997) on *Schinus terebenthifolius* and Ahmed (1997) on *Bougainvillea Mrs* Butt.

- Leaf area:

It is clear from data in Table (1), that all pp -333 treatments caused noticeable reduction in leaf area. Such reduction reached the level of

significancy for the medium and high concentration only. These findings are in agreement with Awad et al. (1994) on poinsettia, Aliwa (1994) on *Solanum capsicastrum* and Nassar et al. (2001) on sweet pepper who, mentioned that pp- 333 at 10-30 ppm significantly decreased the leaf area.

In case of using Pix, data showed that, all pix treatments caused a noticeable decrease in the leaf area in both seasons with the exception of the low concentration (1.0 ppm), which slightly increased leaf area with non significant differences in the first season. The high concentration (5.0 ppm) was the most effective treatment in reducing leaf area. In this connection Landivar et al.(1995) on cotton and Attia (1997) on *Celosia plumosa*, reported that applying pix at 5.0 ppm significantly reduced leaf area. In case of ccc treatments, also the same observations were found; i.e. increasing the level of ccc increased the reduction of leaf area. Such results showed similar trend to those obtained by Attia (1997) on *Thevetia nereifolia* who found that the least leaf area was obtained from the highest level of ccc (5000 ppm).

II- Flowering:

- Number of days from planting till the appearance of the first flower bud.

Data presented in Table (2) indicated that using pp- 333 at the low and medium rates (0.25 and 0.50 mg/pot) slightly promoted flowering date when compared to the control in the two seasons, however, the high level (1.0 mg/pot) caused slight delay in flowering date with non significant differences in both seasons. These results are in agreement with those of Bazzochi and Giorioni (1996) who, suggested that pp- 333 at 0.25, 0.50 or 1.0 mg/pot did not delay flowering of *Gardenia jasminoides*.

Regarding the effect of pix, data showed that pix at various levels hastened flowering with non significant differences when compared to control with the exception of the medium level (2.0 ppm), which significantly advanced flowering in the first season only. In this respect, Jiang and Deng (1986) mentioned that pix led to earliness in flowering of cotton plant.

All ccc used treatments slightly delayed flowering date in both seasons, with non significant differences compared to the control. These results may be confirmed with those recorded by Ahmed (1997) on *Malvaviscus arborus*, that ccc at 5000 ppm delayed flowering.

- Number of days from planting to opening of the first flower:

It is clear from data in Table (2), that pp- 333 at the low level (0.25 mg/pot) slightly accelerated flower opening in both seasons, with non significant differences when compared to the control. However, the high

Table (2): Effect of paclobutrazol, pix and cycocel on flowering of *Althaea rosea L.* plant during the two seasons (1997/98 and 1998/99).

Treatments		First season						Second season					
		1st flower showing date (days)	1st flower opening date (days)	Spike length (cm)	Flower diameter (cm)	Spike diameter (mm)	No. of flowers/ plant	1st flower showing date (days)	1st flower opening date (days)	Spike length (cm)	Flower diameter (cm)	Spike diameter (mm)	No. of flowers/ plant
Control		133.5	161.3	26.8	6.81	3.7	56.7	135.9	164.7	24.2	7.2	3.5	61.9
PP-333	0.25 mg/pot	131.5	160.1	21.9	7.6	3.9	69.7	133.8	161.4	18.7	7.6	3.7	71.4
	0.5 mg/pot	131.0	160.4	20.3	7.7	4.6	63.4	132.9	164.5	17.4	7.7	4.1	70.3
	1.0 mg/pot	135.0	165.4	18.2	7.8	4.0	61.5	137.1	169.1	15.7	7.8	4.0	66.8
Pix	1.0 ppm	132.7	152.7	28.4	7.8	4.0	84.7	133.9	151.5	26.8	7.9	4.3	89.2
	2.0 ppm	126.7	155.3	24.1	8.1	4.0	81.9	127.7	159.8	23.5	8.3	3.9	87.9
	5.0 ppm	129.5	152.2	22.4	7.9	3.9	77.3	128.7	153.4	21.8	7.9	3.8	86.8
CCC	1000 ppm	134.7	157.3	18.7	7.6	3.4	74.8	136.9	161.9	18.6	7.8	3.5	83.9
	2000 ppm	134.9	163.6	13.8	7.5	3.9	75.3	139.7	165.5	15.3	7.5	3.6	82.5
	4000 ppm	135.5	163.1	11.4	7.4	3.8	72.3	142.6	166.8	13.1	7.4	3.6	78.9
L.S.D	5%	5.413	4.137	5.185	1.142	0.17	5.60	9.706	6.81	4.184	1.086	0.54	10.23

level of pp- 333 (1.0 mg/pot) caused slight delay in flower opening date. These results are in agreement with those obtained by Bazzochi and Giorgioni (1996) who, suggested that pp- 333 at 0.25, 0.5 or 1.0 mg/pot did not delay flowering of *Gardenia jasminoides*.

Using pix at various levels significantly hastened flower opening than control in both seasons, with the exception for the medium level (2.0 ppm) in the second season, which registered 159.85 days compared to 164.68 for the control, with non significant differences. These findings were in agreement with those pointed out by Jiang and Deng (1986) on cotton who reported that pix at 500, 750 and 1000 cm3/feddan led to earliness in flowering. Referring to the effect of ccc, the data showed that using ccc at the low level (1000 ppm) caused slight effect on the number of days from planting to flower opening however the medium and high ccc concentrations (2000 and 4000 ppm) led to a slight delay in flower opening with non significant differences. In this regard Ahmed (1997) mentioned that ccc at 6000 ppm delayed flowering of *Bougainvillea Mrs* butt.

- Spike length:

Data in Table (2) show that all pp- 333 treatments significantly decreased the spike length than the control for both seasons, except for the low level (0.25 mg/pot), which caused non significant decrease in the first season only. These results are in agreement with those obtained by Mao et al. (1991) on *Salvia Splendens* who, stated that pp- 333 at 80-160 ppm shortened flower spikes.

With regard to the effect of pix, data showed that the low concentration (1.0 ppm) slightly increased the length of the spike with non significant differences, however, the medium and high level (2.0 and 5.0 ppm) caused slight reduction in this parameter. In this regard

El-Khateeb and Farahat (1994) on *Polianthes tuberosa*, found that pix at 250 ppm increased flower stalk length.

All ccc treatments significantly reduced terminal spike length, such reduction was progressively increased with increasing ccc concentration. These results are in parallel with those obtained by Attia (1997) on *Celosia plumosa* who, suggested that 5000 ppm ccc application reduced spike length.

- Flower diameter:

Data presented in Table (2) showed that application of pp- 333 at various rates slightly increased flower diameter for both seasons, with non significant differences over the control. In this respect, Abbas (1994) on *Zinnia elegans* and Haggag (1997) on Chrysanthemum, reported that pp-

333 at 200 ppm significantly increased inflorescence diameter. Regarding pix treatments data showed that the low level (1.0 ppm) had non significant effect on flower diameter. However, the medium and high levels (2.0 and 5.0 ppm) were more effective on increasing this parameter, with significant effect over control for the medium level in both seasons, and in the first season only for the high level. In this regard El-Khateeb and Farahat (1994), found that pix at 250 ppm increased flower diameter of *Polianthes tuberosa*. For cycocel treatments, all used concentrations led to to slight increments in flower diameter with non significant differences over control. In this connection, Talukdar and Paswan (1994) mentioned that ccc at 5000 ppm increased flower diameter of chrysanthemum.

- Spike diameter:

Data in Table (2) indicated that, all pp- 333 treatments significantly increased spike diameter over the control for both seasons, expect for the low level (0.25 mg/pot) in the second season only. The results were in agreement with those obtained by Essa, (1992) on rose, who found that pp - 333 at 200 ppm increased flower stem diameter. Referring to the effect of pix, the low concentration (1.0 ppm) significantly increased spike diameter for both seasons, however the medium and high levels (2.0 and 5.0 ppm) were less effective, as they significantly increased this parameter in the first season only.

For the cycocel treatments, the data showed that, the low concentration (1000 ppm) had significant effect on reducing spike diameter in the first season only, however the medium and high levels (2000 and 4000 ppm) caused considerable increments in spike diameter, which reached level of significancy for the medium level (2000 ppm) in the first season only.

In this concern, El-Khateeb and Farahat (1994) found that pix at 250 ppm increased flower stalk diameter of *Polianthus tuberosa*.

- Number of flowers/ plant:

Data in Table (2) revealed that, the low concentration of pp- 333 (0.25 mg/pot) significantly increased the total number of flowers /plant. Plants treated with the medium and high level of pp- 333 (0.5 and 1.0 mg/pot) showed considerable increments in number of flowers /plant, which reached to the level of significancy for the medium level in the first season only. These results coincide with those recorded by Abbas (1994) on *Zinnia elegans*, and Nasr (1997) on gerbera, who suggested that pp- 333 at 25 ppm produced the highest number of flowers/plant. Regarding the effect of pix, data indicated that the greatest flower number were formed on plants treated with pix at 1.0 and 2.0 ppm, respectively. Such results showed similar trend

to those obtained by Hussein et al (1994) on *Hibiscus sabdariffa* and El-Khateeb and Farahat (1994) on *Polianthus tuberosa.*

All ccc treatments significantly increased number of flowers/plant over the control in both reasons. The differences among all ccc treatments were non significant. The findings are in harmony with those pointed out by Khalafalla (1996) on *jasminum grandiflorum* and Ahmed (1997) on *Malvaviscus arborus* who, reported that ccc at 5000 ppm increased the number of flowers.

- Fresh weight:

Data presented in Table (3) showed that, all pp- 333 levels caused significant increments in the fresh weight of leaves, however it slightly affected root fresh weight. The medium and high levels of pp- 333 (0.5 and 1.0 mg/pot) led to significant increase in stem fresh weight while the high level of pp-333 significantly increased flower fresh weight for both seasons. In this regard Nasr (1997) on *Gerbera* and Ahmed (1997) on *Bougainivillea Mrs* Butt, reported that pp-333 at the rate of 40 ppm as soil drench increased the plant fresh weight.

All pix treatments caused significant increments in stem and flower fresh weight, however they slightly affected leaves and root fresh weight.

In this connection, Attia (1997) on *Celosia Plumosa* reported that applying 5 ppm of pix significantly increased fresh weight of the vegetative parts. All ccc treatments significantly increased stem and flower fresh weight, while it slightly affected root fresh weight. The high concentration of ccc (4000 ppm) led to significant increments in leaves fresh weight for both seasons. In this connection Ahmed (1997)on *Bougainvillea Mrs. Butt* found that cycocel at 6000 ppm increased fresh weight

Dry weight.

Data in Table (3) showed that, all PP-333 levels caused considerable increase in the dry weight of leaves over the control. The medium level of PP-333 (0.5 mg/pot) was the most effective in this respect, as it significantly increased leaves and roots dry weight in both seasons. All PP-333 treatments slightly increased stem and flower dry weight for both seasons, except for the high level (1.0 mg/pot), which significantly increased stem dry weight in the second season only. These results were in agreement with those obtained by Nassar et al (2001) who noticed that, PP-333 at (10-30 ppm) significantly increased leaf and shoots dry weight of sweet pepper All Pix concentration used slightly affected leaves and roots dry weight, however they significantly increased stem dry weight over the control in both seasons. The high level of Pix (5 ppm) led to significant increments in

Table (3): Effect of paclobutrazol, pix and cycocel on the fresh and dry weight (gm) of *Althaea rosea L.* plant during the two seasons (1997/98 and 1998/99).

Treatments		First season					Second season				
		Leaves	Stem	Root	Flower	Total	Leaves	Stem	Root	Flower	Total
Fresh weight											
Control		17.5	18.6	26.2	58.4	120.7	15.2	16.8	23.2	55.00	110.2
PP-333	0.25 mg/pot	26.2	22.4	29.2	69.4	147.2	26.1	21.7	26.0	62.7	136.5
	0.5 mg/pot	25.4	25.2	31.4	72.7	154.7	27.1	27.2	31.0	64.5	149.8
	1.0 mg/pot	23.9	26.8	25.9	80.0	156.6	21.7	28.5	26.6	71.3	148.1
Pix	1.0 ppm	19.7	35.1	22.8	73.5	151.1	19.4	32.3	19.3	75.3	146.3
	2.0 ppm	18.3	31.7	25.0	78.4	153.9	19.5	31.2	23.0	78.2	151.9
	5.0 ppm	17.8	31.7	28.7	79.3	157.9	18.5	30.3	27.8	72.2	148.8
CCC	1000 ppm	19.1	29.7	26.5	82.8	158.1	19.4	28.7	25.2	81.4	154.7
	2000 ppm	21.5	27.2	27.8	85.3	161.8	21.4	30.3	26.2	84.3	164.2
	4000 ppm	27.9	35.2	28.8	87.3	179.2	25.8	33.2	27.8	86.3	173.1
L.S.D	5%	6.413	5.574	5.369	11.146	-	5.77	6.818	7.713	11.45	-
Dry weight											
Control		3.9	5.0	9.2	12.2	30.3	3.7	4.5	9.0	13.6	30.8
PP-333	0.25 mg/pot	5.3	5.8	10.8	15.3	37.2	4.4	5.3	10.1	15.6	35.4
	0.5 mg/pot	5.6	5.9	12.5	15.8	39.8	5.5	6.9	13.9	15.4	41.7
	1.0 mg/pot	5.0	6.2	9.4	16.9	37.5	4.7	7.9	10.5	16.2	39.3
Pix	1.0 ppm	4.0	8.5	8.9	15.8	37.2	4.0	8.9	8.9	16.2	38.0
	2.0 ppm	4.9	8.8	8.2	16.9	38.8	4.2	9.2	9.3	17.3	40.0
	5.0 ppm	4.0	9.6	11.3	18.8	43.7	4.1	9.4	10.2	18.6	42.3
CCC	1000 ppm	5.0	7.4	10.2	16.4	39.0	5.1	7.7	9.8	17.6	40.2
	2000 ppm	5.6	8.4	11.1	19.3	44.4	5.8	8.0	11.6	19.5	44.9
	4000 ppm	6.9	9.9	11.6	19.8	48.2	6.1	9.7	11.9	19.8	47.5
L.S.D	5%	1.501	2.983	2.17	5.094	-	1.373	3.26	2.76	4.43	-

flower dry weight over control for both seasons. In this regard Attia (1997) on *Celosia Plumosa*, reported that applying Pix at 5 ppm significantly increased dry weight of the vegetative plant parts. Referring to the effect of cycocel, the data indicated that, all ccc levels caused significant increments in the dry weight of leaves except for the low concentration (1000 ppm) in the frist season only. The medium and high levels of ccc (2000 and 4000 ppm) significantly increased stem and flower dry weight both the seasons. The high level of ccc (4000 ppm) led to significant increments in the roots dry weight over the control in both seasons. These findings were in agreement with those obtained by Attia (1997) on *Schimus terebenthifolius*.

Chemical composition:

Chlorophyll a content in the leaves:

Evidently, the data in Table (4) indicated that low and medium levels of PP-333 (0.25 and 0.50 mg/pot) showed a considerable increase in chlorophyll a over the control in both seasons, however, the high level of PP-333 caused a decrease in this parameter.

Concerning Pix treatments, data showed that the low and medium levels (1.0 and 2.0 ppm) increased chlorophyll a content in the leaves in the two seasons, however the high level of Pix (5.0 ppm) decreased this parameter. Referring to the effect of cycocel, it is obvious from the data, the low level (1000 ppm) decreased chlorophyll a content in the leaves, whereas the medium and high level (2000 and 4000 ppm) increased this parameter when compared to control in both seasons.

Chlorophyll b content in the leaves.

It is obvious from data that the low PP-333 rate (0.25 mg/pot) increased chlorophyll b content in the leaves, when compared to the control. Whereas PP-333 at the medium and high level (0.52 and 1.00 mg/pot) showed a reduction in chlorophyll b.

Concerning the effect of pix, the data showed that plants treated with the low level of pix (1.0 ppm) recorded the lowest amount of chlorophyll b. Whereas, the medium and high levels of pix (2.0 and 5.0 ppm) increased this parameter. Regarding the effect of cycocel, the data revealed that plants treated with the low level of ccc (1000 ppm) recorded the lowest amount of chlorophyll b when compared to the control. However, the medium and high levels of ccc showed slight reduction in this parameter compared to the control.

Table (4): Effect of paclobutrazol, pix and cycocel on photosynthetic pigments, content (mg/g. F.W.) in the leaves of *Althaea rosea L.* plant during the two seasons (1997/98 and 1998/99).

Treatments		First season				Second season			
		Chl. A	Chl. B	Total Chl. (A+B)	Caroten-oids	Chl. A	Chl. B	Total Chl. (A+B)	Caroten-oids
Control		9.0	3.70	12.7	5.9	10.2	3.9	14.2	6.8
PP-333	0.25 mg/pot	10.4	3.90	14.3	5.7	11.4	4.4	15.8	6.8
	0.5 mg/pot	10.5	2.70	12.2	5.4	11.5	3.7	15.2	6.7
	1.0 mg/pot	7.5	2.70	10.2	4.5	8.5	2.9	11.3	5.7
Pix	1.0 ppm	11.1	2.40	13.5	4.8	12.4	2.8	15.2	5.8
	2.0 ppm	10.4	5.50	15.9	5.8	10.8	5.8	16.7	6.2
	5.0 ppm	7.8	4.80	12.6	4.4	8.8	4.8	13.6	5.4
CCC	1000 ppm	5.3	0.66	5.9	1.9	6.5	1.6	8.1	2.1
	2000 ppm	9.5	2.68	12.2	4.1	10.6	2.9	13.5	5.4
	4000 ppm	11.0	3.60	14.7	7.7	12.0	3.9	15.9	8.7

Total chlorophylls (a+b):

It was obvious from data, that the low and medium rates of PP-333 (0.25 and 0.50 mg/pot) increased the total chlorophyll content in the leaves more than the control, whereas the high level (1.0 mg/pot) markedly decreased it. In this respect Haggag (1997) on chrysanthemum reported that the lowest PP-333 rate (1000PPm) resulted the highest chlorophyll a and b content. Concerning the effect of Pix, the data showed that the greatest values in the total chlorophylls (a+b) contents over all other treatments occurred when the plants were treated with the medium level of Pix (2.0 ppm). However, the Low level (1.0 ppm) slightly increased this parameter over the control. Whereas plants treated with the high level of Pix (5 ppm)showed slight decrease in this parameter. In this regard, Attia (1997) on *Celosia Plumosa* suggested that Pix at 5 Ppm increased the leaves content of chlorophyll a , b and total chlorophylls. With regard to cycocel, the data showed that plants treated with low level (1000 ppm) gave the lowest values. The medium level of ccc (2000 ppm) showed slight reduction in this parameter, however the high level (400 ppm) markedly increased the total chlorophylls content in the leaves over the control in both seasons. In this concern Khalafalla (1995) on *Begonia semperflorens* reported that 5000 ppm ccc application in creased the leaves content of chlorophyll a , b and total chlorophyll.

Carotenoids content

The data showed that carotenoids content was decreased progressively as the concentration of PP-333 increased. In this respect Nasr (1997) on gerbera and Haggag (1997) on chrysanthemum reported that PP-333application at 100, 200 or 300 ppm decreased the carotenoids content. Regarding the effect of Pix , it was obvious from the data that, the medium level (2 ppm) had a little effect upon leaves content of carotenoids. However, the low and high levels of Pix (1.00 and 5.0 ppm) caused more reduction in this parameter. Referring to the effect of cycocel, the data showed that, the minimum amount of carotenoids content was recorded in the leaves of plants treated with ccc at the low level (1000 ppm). The medium level of ccc (2000 ppm) slightly reduced this parameter in the two seasons than the control.

However, the high level of ccc (4000 ppm) showed the highest increment in the leaves content of carotenoids comparing to all other treatments.

Total carbohydrates:

Data presented in Table (5) revealed that, all PP-333 levels led to considerable increments in the total carbohydrates content of the leaves, roots and flowers for both seasons. The stem contents of total carbohydrates showed increment due to the medium level of PP-333 (0.5 mg/pot), however the low and high levels (0.25 and 1.0 mg/pot) caused slight decrease in this parameter than the control. These results were in agreement with Awad et al. (1994) on poinsettia and Ahmed (1997) on *Bougainvillea Mrs Butt*, who stated PP-333 at the rate of 40 ppm increased total carbohydrates.

Referring to the effect of Pix, data revealed that, the low level (1.0 ppm) slightly affected the total carbohydrate content in the leaves, stems and flowers. However, the medium and high levels (2.0 and 5.0 Ppm) increased it. No clear trend was detected in the root content of total carbohydrates due to using all Pix treatments. In this regard El-Khateeb et al. (1994) on *Hibiscus sabdariffa* and Attia (1997) on *Celosia plumosa* stated that Pix at 5 ppm increased total carbohydrates over control. Concerning the effect of cycocel, it was obvious from data that, all treatments increased the leaves content of total carbohydrates, however they slightly reduced it in the stem. No clear trend was detected in the root content of total carbohydrates due to using ccc at the low and medium levels (1000 and 2000 ppm), as they decreased it in the first season, but increased it in the second one. The flower content of total carbohydrates showed noticeable increments due to all ccc levels except for the low level (1000 ppm), which reduced it in first season only. In this concern, Attia (1997) on

Celosia plumosa, suggested that 5000 ppm ccc application increased the total carbohydrates over control.

Table (5): Effect of paclobutrazol, pix and cycocel on total carbohydrates (%DW) of *Althaea rosea L.* plant during the two seasons (1997/98 and 1998/99).

Treatments		First season				Second season			
		Leaves	Stem	Roots	Flowers	Leaves	Stem	Roots	Flowers
Control		2.13	2.64	3.05	2.16	1.98	3.01	3.19	2.10
PP-333	0.25 mg/pot	2.43	1.99	3.20	2.19	2.36	2.92	3.32	2.18
	0.5 mg/pot	2.61	2.67	3.44	2.56	2.53	3.18	3.79	2.26
	1.0 mg/pot	2.83	2.47	3.92	2.78	2.72	2.98	3.73	2.49
Pix	1.0 ppm	1.97	2.27	3.07	2.21	2.03	2.92	3.91	2.13
	2.0 ppm	2.51	2.71	2.97	2.54	2.48	3.32	4.07	2.49
	5.0 ppm	2.67	2.81	2.98	2.65	2.75	3.72	3.37	2.64
CCC	1000 ppm	2.59	2.39	2.71	1.97	2.30	2.83	3.92	2.23
	2000 ppm	2.71	2.55	2.46	2.44	2.09	2.91	4.10	2.59
	4000 ppm	2.64	2.55	3.65	2.65	2.53	2.74	3.44	2.30

Total indoles

Data in Table (6) indicated that, all PP-333 levels led to considerable reduction in this parameter in both seasons. In this regard Abbas (1994) on *Zinnia elegans* and Ahmed (1997) on *Bougainvillea Mrs Butt*, stated that PP-333 at 40 ppm decreased total indoles. Referring to Pix, data indicated that low concentration (1.0 ppm) slightly decreased total indoles content in the leaves. However, the medium and high levels (2.0 and 5.0 ppm) were more effective on decreasing this parameter.

With regard to the effect of cycocel, the data indicated that, the low and medium levels caused a reduction in this parameter than the control while the high concentration (4000 ppm) increased it . In this regard Nasr (1997) on gerbera and Ahmed (1997) on *Malvaviscus_arborus* found that ccc at 5000 ppm decreased total indoles.

Total phenols

It was clear from data in Table (6), that the control plants recorded the lowest contents of total phenols. Plants treated with PP-333 showed progressive increment in total phenols with increasing the level, in both seasons. In this respect, Abbas (1994) on *Zinnia elegans* and Nasr (1997) on gerbera reported that spray of pp-333 at 100 ppm was the most effective treatment for inducing more accumulation of phenolic compounds in the leaves.

A similar trend was observed for the effect of Pix, the medium and high levels (2.0 and 5.00 ppm) gave higher values than the low one. With regard to the effect of cycocel, the data obtained showed that all ccc treatments caused noticeable increments in the total phenols compared to all other treatments.

Table (6): Effect of paclobutrazol, pix and cycocel on total indoles and total soluble phenols (mg/100 g F.W) in the leaves of *Althaea rosea L.* plant during the two seasons (1997/98 and 1998/99).

Treatments		Total indoles (mg/100 g F.W)		Total phenols (mg/100 g F.W)	
		First season	Second season	First season	Second season
Control		105.9	107.8	42.09	48.33
PP-333	0.25 mg/pot	71.3	80.8	56.58	68.38
	0.5 mg/pot	74.8	68.8	71.47	69.84
	1.0 mg/pot	78.9	88.5	73.70	78.29
Pix	1.0 ppm	98.3	103.3	49.95	63.02
	2.0 ppm	96.4	95.9	73.18	68.32
	5.0 ppm	84.8	88.8	74.32	76.83
CCC	1000 ppm	78.9	81.3	81.83	78.93
	2000 ppm	87.5	98.5	89.82	90.32
	4000 ppm	107.4	111.5	97.89	98.00

Mucilage content in roots.

It was observed from data in Table (7) that, all PP-333 treatments slightly increased mucilage content in the roots over control except for the low level (0.25 mg/pot) as it reduced this parameter in the second season only. However the medium and high levels (0.5 and 1.0 mg/pot) led to more increments in this parameter. With regard to the effect of Pix, the data indicated that all Pix levels showed a reduction in this parameter, whereas the low level (1.0 Ppm) was the more effective in reducing mucilage content than the two other levels. Referring to the effect of cycocel, it was obvious that mucilage content in the roots was decreased by various ccc levels in both seasons. The medium and high concentrations caused more reduction.

Table (7): Effect of paclobutrazol, pix and cycocel on mucilage content (% D.W.) in roots of *Althaea rosea L.* plant during the two seasons (1997/98 and 1998/99).

Treatments		Mucilage (% D.W)	
		First season	Second season
Control		11.7	11.4
PP-333	0.25 mg/pot	11.9	10.9
	0.5 mg/pot	12.0	11.8
	1.0 mg/pot	12.0	11.6
Pix	1.0 ppm	9.9	9.0
	2.0 ppm	10.0	10.8
	5.0 ppm	9.8	10.4
CCC	1000 ppm	10.2	11.1
	2000 ppm	9.9	10.4
	4000 ppm	9.9	10.9

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الملخص العربى

تنظيم النمو الخضري والزهري لنبات الخطمية بإستعمال الباكلوبترازول والبكس والسيكوسيل.

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أجري هذا البحث في حديقة الأورمان النباتية بالجيزة وذلك خلال موسمين متتالين هما ١٩٩٨/١٩٩٧ و ١٩٩٩/١٩٩٨ بهدف دراسة تأثير ثلاث من مثبطات النمو هي الباكلو بترا زول PP – 333 بتركيزات صفر, ٢٥٠ , ٥٠٠ , ١ ملليجرام

/ أصيص قطر ٢٥ سم سقيا للتربة. والبكس PIX رشا علي النبات بتركيزات صفر ، ١ ، ٢ ، ٥ جزء في المليون والسيكوسيل CCC رشا علي النبات بتركيزات صفر ، ١٠٠٠ ، ٢٠٠٠ ، ٤٠٠٠ جزء في المليون لمعرفة تأثيرها علي النمو الخضري والتزهير والمحتوي الكيماوي .

وفيما يلي أهم النتائج التي أمكن ا-توصل إليها :-

- أدت كل معدلات الباكلوبترازول PP-333 إلي زيادات واضحة في عدد الأفرع والأوراق / نبات والوزن الطازج للأوراق والوزن الجاف لكل أجزاء النبات والعدد الكلي للأزهار وقطر الشمراخ الزهري والكربوهيدرات الكلية ومحتوي الجذر من المواد المخاطية ومحتوي الأوراق من الفينولات . لكنها أدت إلي نقص في إرتفاع النبات ومساحة الورقة وطول الشمراخ الزهري ومحتوي الأوراق من الكاروتينويدات والإندولات الكلية .
- أدت التركيزات المنخفض والمتوسط من الباكتيرازول إلي تبكير التزهير لكن التركيز المرتفع أخره .
- تسببت كل معاملات البكس في زيادة الوزن الطازج لكل من الساق والأزهار والوزن الجاف للسوق والعدد الكلي للأزهار وقطر الزهرة وقطر الشمراخ الزهري ومحتوي الكربوهيدرات الكلية .
- أنقص المعدلان المنخفض والمتوسط من البكس إرتفاع النبات ومساحة الورقة ومحتوي الأوراق من الكاروتنيويدات .
- أدت كل تركيزات السيكوسيل إلي نقص في إرتفاع النبات وطول الشمراخ الزهري والكربوهيدرت الكلية في السوق والفينولات الكلية في الأوراق المواد المخاطية في الجذور لكنها أدت إلي زيادة عدد الأفرع والأوراق علي النبات وقطر الساق والوزن الطازج للسوق والأزهار وقطر الزهرة ومحتوي الأوراق من الكلوروفيلات الكلية .
- وبذلك يمكن التوصية بأنه للحصول علي نباتات خطمية قصيرة ومندمجة تصلح كنباتات أصص مزهرة يتم الرش بالسيكوسيل بتركيز ٤٠٠٠ جزء في المليون , ثلاث رشات أول رشة بعد الزراعة بشهر ثم كل ٣ أسابيع أما للحصول علي تزهير مبكر وزيادة في عدد وجودة الأزهار فانه يتم الرش بالبكس بتركيز ٢ أو ٥ جزء في المليون .