IV. RESULTS AND DISCUSSION

IV.1-First part :

Effect of some mineral nutrients and some growth retardants on vegetative growth, flowering and chemical composition of *Limonium sinuatum L.* plants during 2003/2004 seasons.

IV.1.A- Mineral nutrients :

Effect of cheleate calcium, calcium bicarbonate and sodium silicate on vegetative growth, flowering and chemical composition of *Limonium sinuatum L.* plants.

IV.1.A.1- On some vegetative measurements

1- Plant height (cm):

Data reported in Table (1) indicate that spraying the foliage of *Limonium sinuatum L.* plants with different concentrations of cheleate calcium increased plant height as compared to untreated plant. The high concentration of cheleate calcium (150 ppm) produced the tallest plants as compared to other concentrations. As for the effect of spraying the foliage of *Limonium sinuatum L.* with calcium bicarbonate, it was clear that treatment of 150 ppm produced the highest plants. Meanwhile, the application of sodium silicate at the high rate (100 ppm) showed also the most effective treatment for increasing plant height as compared to the lowest rate (50 ppm) and control. The increases in the plant height were progressively increased with increasing the applied concentrations of both mineral nutrients (the two sources of calcium and sodium silicate).

Table (1): Effect of cheleate calcium, calcium bicarbonate and sodium silicate on vegetative growth of *Limonium sinuatum L.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		Plant height (cm)		F.W. of leaves g/plant		D.W. of leaves g/plant		F.W. of plant g		D.W. of plant g	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		63.10	64.30	180.40	181.20	39.68	38.05	1118.30	1080.6	256.53	237.73
Cheleate calcium	50 ppm	68.80	67.70	192.86	194.96	44.35	44.83	1204.76	1226.10	277.09	282.00
	100 ppm	75.20	73.50	209.30	212.40	54.38	55.21	1280.30	1284.30	307.27	308.23
	150 ppm	78.30	76.50	223.86	225.40	67.16	67.62	1349.43	1349.30	377.84	359.79
$Ca(HCO_3)_2$	50 ppm	68.20	68.20	191.06	192.96	45.85	46.31	1207.86	1224.30	289.86	269.34
	75 ppm	77.66	75.80	211.63	213.83	59.48	57.25	1286.66	1297.80	334.53	311.38
	150 ppm	84.40	85.50	228.96	229.30	70.97	71.08	1383.10	1403.40	387.26	364.89
Na_2SiO_3	50 Ppm	66.90	65.40	189.96	190.63	45.59	45.75	1153.30	1138.90	265.25	250.56
	100 ppm	72.06	70.30	207.20	205.30	50.86	53.37	1211.96	1223.60	290.87	269.22
L.S.D.	5%	2.98	4.14	7.22	8.21	3.27	3.05	39.10	28.54	11.43	90.07
	1%	4.17	5.79	10.10	11.49	4.46	4.27	54.74	39.95	16.00	12.69

Similar trend of results was obtained in the second season. Moreover, among the different treatments, the application of calcium bicarbonate at the highest rate (150 ppm) appeared to be the most effective dose for increasing the length of *Limonium sinuatum L.*plants. The percentages of increases were 33.75% and 32.97% over control in the first and second seasons, respectively. Also a significant differences in growth, as expressed by plant height, were associated with calcium bicarbonate and cheleate calcium treatments at the highest rates. (Table1).

However, cheleate calcium at the highest rate (150 ppm) ranked the second in this concern as it recorded 78.30 cm and 76.56 cm in the first and second seasons, respectively followed descendingly by using the medium rate of calcium bicarbonate as they gave 77.66 cm and 75.80 cm in both seasons respectively. Besides, all tested treatments of medium rate of cheleate calcium (100 ppm) and high rate of sodium silicate (100 ppm) significantly increased plant height. While, the remaining treatments of lower rates of cheleate calcium, bicarbonate and sodium silicate (50 ppm) resulted in nearly more or less similar values but still more than the control values, although they did not reach the level of highly significant at 1% in most cases.

The results are in agreement with that reported by **Cheung (1980)** who reported that there is now general agreement that calmodulin is uniquitous in animal and plant cells and is thus as essential protein in euxaryptic cells. Calmodulin is a poly peptide consisting of 148 amino acids is heat stable and insensitive to pH changes. **Marme (1983)** reported that Aluminium is believed to

interfere with calmodulin and thus antagonize the Ca^{+2} effect. **Siegel and Haug (1983)** reported that calcium concentrations in the mitochondria are much higher than in the cytoplasm. **Gavalas and Manetas (1980)** found that the maintenance of the low cytoplasmic Ca2+ concentration is of vital importance for the plant cell and there is now evidence that Ca2+ may inhibit various enzymes located in the cytoplasm and **Schwartz (1973)** found that silicon may be intimately associated with the cell wall constituents as silica or possibly as canalently found in pectins. **Raven (1983)** stated that silicon may be also present in xylem cell walls. **Wang *et al.* (1996)** mentioned addition of sodium silicate (80 ug/ml) together with selenite increased plant height

2- Fresh weight of leaves / plant (g):

According to data presented in Table (1), it could be concluded that all the three used mineral nutrient treatments progressively increased the fresh weight of Limonium leaves as its sprayed concentrations increased compared with control in both seasons. Hence, in both seasons of this study, the heaviest fresh weight of leaves was obtained from plants treated with the highest rate of calcium bicarbonate (150 ppm). The values were 228.96 g and 229.30 g as compared with 180.40 and 181.20 g from untreated plants (control) in the first and second seasons, respectively. Also, the obtained results indicated clearly a highly significant increment in Limonium leaves fresh weight per plant over control accompanied the high rate of cheleate calcium treatment in both seasons followed descendingly by using medium rate of calcium bicarbonate (75 ppm) and medium rate of cheleate calcium (100

ppm). The differences among the abovementioned two treatments were non significant as the plants under such treatments had nearly close leaves fresh weight values. This trend was true during the two seasons of study. However, it could be concluded that the two sources of calcium and sodium silicate treatments succeeded in increasing significantly the fresh weight of leaves even at lower concentrations (50 ppm).

The results are in parallel with those of **Veleuthambi and poovaih (1984)** who proved that calmodulin activates the phosphorylation of soluble and membrane bound proteins. At Ca^{2+} ATPase brings about active extrusion of Ca^{2+} through the plasmalemma and any increase in Ca^{2+} concentration in the cytoplasm directly induces Ca^{2+} extrusion. **Bahtt *et al.* (1993), Siddiqui and Bangerth, 1995 and Rases *et al.* (1995)** reported that spraying of .25% calcium chloride was very effective in improving nutritional status, yield and quality of different pear and *apples*. Also **Lee *et al.* (2000)** on cucumbers cv Eunsung backdagi . found that spraying sodium silicate increased leaves fresh weight.

3- Dry weight of leaves/ plant (g):

The data gained on dry weight of Limonium leaves as affected by cheleate calcium, calcium bicarbonate and sodium silicate treatments are presented in Table (1). Data on dry weight of leaves showed the similar trend as that of fresh weight of leaves in both seasons, with some little differences. Hence, the heaviest dry weight of leaves was obtained by using the treatment of spraying calcium bicarbonate at 150 ppm followed discendingly by the treatment of spraying cheleate calcium at the same concentration (150 ppm) in both seasons. However, the medium mean values of

leaves dry weights were obtained by using the calcium bicarbonate and cheleate calcium at medium rates (75 and 100 ppm) respectively. While, spraying Limonium leaves with calcium cheleate at 50 ppm statistically induced the lowest dry weight of leaves as it gave 44.35 g and 44.83 g, in the first and second seasons, respectively, but still more highly significant than untreated plants (control) which gave 39.68 g and 38.05 g in both seasons, respectively.

The result was agreed with that reported by **Subbiah *et al.* (1990)** on tomato they studied the effect of calcium oxide, calcium chloride, calcium sulphate and they found that the best results were obtained with using calcium chloride at 0.2%.

4- Fresh weight of whole plant (g):

The recorded data in Table (1) indicated that spraying Limonium leaves with calcium bicarbonate at 150 ppm gave the heaviest fresh weight of the whole plant (1383.10 and 1403.40 g/plant in the first and second seasons, respectively), compared to plants sprayed with distilled water which gave (1118.30 and 1080.6 g) in the first and second seasons, respectively. Nevertheless, it was also interesting to be observed clearly a firm trend that cheleate calcium (at 150 ppm) had a pronounced effect in increasing the whole plant fresh weight as compared with other treatments and control. This was true in both seasons and exhibited statistically the same effectiveness in the two seasons of study. Moreover, the medium rates of calcium bicarbonate (75 ppm) and cheleate calcium (100 ppm) followed descendingly the two abovementioned extremes treatments.

On the other hand, the high rate of sodium silicate (100 ppm) and the low rates of calcium bicarbonate and cheleate (50 ppm) not only resulted in increasing the fresh weight of the whole plant over control but also they were equally effective from the statistical point of view as compared each to other.

A similar result has been reported by **Bhatt *et al.* (1993), Siddiqui and Bangerth (1995)** and **Raese *et al.* (1995)** they found that, spraying of 0.25 % calcium chloride were very effective in improving nutritional status, yield and quality of different pears and apples. Also, **Chen-Xiao Ting *et al.* (2002)** reported that, the growth of pakchoi was apparently improved by lime and calcium magnesium phosphate application. Whereas, **Salim *et al.* (2002)** mentioned that rice grain yield was significantly higher in gypsum treated plots than the respective CaCl2 treated plots

5- Dry weight of the whole plant (g):

Whole plant dry weight (g) of Limoinium increased by all mineral nutrients applications at all levels tested. The data in Table (1) cleared that, both calcium bicarbonate and cheleate calcium especially at high rates (150 ppm) produced highly significant increases on the average whole plant dry weight (g) in both seasons of the study. The average whole plant dry weight (g) ranged from 256.53 to 387.26 g in the first season. The plants treated with calcium bicarbonate at high rate gave the largest dry weight of the whole plant (387.26 g) than the untreated (control) plants (256.53 g) followed by cheleate calcium at the same rate which gave (377.84 g). In the second season, the similar trend was also observed. As for all used mineral nutrient treatments, data in Table

(1) indicated that there were progressive increments in the whole plant dry weight parallel to the increments of concentration used.

The increase in dry weight of whole plant as result of using calcium sources is agreement with the results obtained by **Pare *et al.* (2001)** on alfalfa who showed that CaLF (a fertilizer produced from lignite) and $CaCl_2$ produced similar shoot, root and whole plant dry masses, which were much higher than when EDTA-Ca was applied. Meanwhile, **Singh and Nayyar (2001)** on cowpea found that, calcium carbonate reduced the tissue N concentration, there by mitigating the toxic effect of Ni and increasing the dry matter production in cowpea.

IV.1.A.2- On some flowering characteristics :

1- Number of flower stems/plant:

Data presented in Table (2) indicated that all tested concentrations of the two calcium sources and sodium silicate gave an increase in the number of flower stems per plant in the first season. So, the greatest number of flower stems was produced by spraying Limonium plants with the high rate of cheleate calcium (150 ppm) which gave 22.26 flower stem compared to 17.76 flower stem for control in the first season. Also, calcium bicarbonate significantly increased the number of flowering stems per plant especially at high rate (150 ppm) which recorded 22.16 flower stem followed descendingly by using medium rates of both calcium bicarbonate (75 ppm) and cheleate calcium (100 ppm) and high rate of sodium silicate (100 ppm) which gave 21.63 and 21.21 and 20.96 flower stems, respectively.

Moreover, all sprayed mineral nutrients at low rates (50 ppm) showed a non significant increase in this parameter when compared with control except for sodium silicate at 50 ppm which gave a significant increase in this parameter in the first season. Similar trend was obtained in the second season, with the exception of sodium silicate at the low rate (50 ppm) which resulted in negligible effect in this parameter as it produced the least mean value compared to those of the control.

The result agree with that reported by, **Devendra *et al.* (2001)** reported that effect of calcium nitrate as foliar nutrient on potato gave the best response as its yield increased with calcium

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Table (2): Effect of cheleate calcium, calcium bicarbonate and sodium silicate on flowering characteristics growth of *Limonium sinuatum L.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		No. of fl stem / plant		F.W. of fl. stems (g)/plant		D.W. of fl. stems (g) /plant		Thickness of flower stem (cm)	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		17.76	17.43	41.00	36.33	9.00	8.66	0.73	0.76
Cheleate calcium	50 ppm	18.20	17.90	42.00	44.33	9.33	10.00	0.76	0.83
	100 ppm	21.21	21.63	51.66	50.00	12.66	13.00	0.83	0.93
	150 ppm	22.26	22.40	50.00	53.66	15.00	16.33	0.96	0.96
$Ca(HCO_3)_2$	50 ppm	18.93	18.20	43.33	42.66	9.66	9.00	0.80	0.83
	75 ppm	21.63	20.20	56.00	60.33	13.00	14.00	0.86	0.93
	150 ppm	22.16	21.10	89.66	79.66	16.66	17.00	0.93	1.00
Na_2SiO_3	50 Ppm	19.63	16.70	50.33	48.00	11.33	10.00	0.76	0.83
	100 ppm	20.96	20.30	63.00	66.33	14.66	15.00	0.83	0.86
L.S.D.	5%	1.20	1.62	3.42	5.34	2.11	2.41	0.083	0.11
	1%	1.66	2.26	4.96	7.21	3	3.13	0.12	0.14

nitrate, as will as, **Alcaraz-Lopez *et al.* (2004)** found that spraying soluble calcium on plum trees in combination with to bioactibvators increased tree development and fruit size

2- Fresh weight of flower stems/ plant (g):

Data in Table (2) show that, in both seasons of this experiment spraying different concentrations of calcium carbonate, calcium bicarbonate and sodium silicate on *Limonium sinuatum L.*plants, increased flower stems fresh weight compared with untreated plants and the values were gradually increased with increasing concentrations of different nutrients. The high level (150 ppm) of each of cheleate calcium and calcium bicarbonate produced 27.73 and 26.82% respectively over control plants in the first season, while attained 47.70 and 50.45%, respectively over control plants in the second season.

The result agree with those reported by **Wiersum (1979)** who found that the rate of downward translocation of Ca^{2+} is very low due the fact that calcium is transport in only very small concentration in the phloem. The maintenance of this low cytoplasmic Ca^{2+} concentration is of vital importance for the plant cell for there is now evidence that calcium may inhibit various enzymes located in the cytoplasm **Subbiah *et al.* (1990)** on tomato found that the best result was obtained with using calcium chloride at 0.2%.

3- Dry weight of flower stems (g):

Data in Table (2) show that treating *Limonium sinuatum L.*plants with different concentrations of cheleate calcium were significantly increased dry weight of flower stems character compared with control plants in both seasons. The high concentration of this treatment was most promising rate compared with medium or low concentration. The flower stems dry weights were raised by about 3.541, 40.67 and 66.67 or 15.47, 50.11 and 88.56% over the control in the first and second seasons respectively for the low, medium and high concentrations of cheleate calcium treatment. As for calcium bicarbonate treatment: all concentrations of calcium bicarbonate treatments were significantly increased dry weight of flower stems character in both seasons compared with control plant, except low concentration in the first season which gave little increases over control plants. The high concentration of calcium bicarbonate treatment was the most effective on this character compared with medium and lower levels which gave 85.11 or 96.30% over control plants in the first and second seasons, respectively. Also, low and high concentrations of sodium silicate treatments were increased significantly this character compared with control plants. The high concentration of sodium silicate 100 ppm gave 62.89 and 73.21% over control plants in the first and second seasons respectively.

4- Thickness of flower stems (cm):

The mean thickness of flower stems was increased by spraying the cheleate calcium to the Limonium plants at any concentration in both seasons, the highest concentration gave the

best results in both seasons, it gave 31.51 and 26.32% over control plants in the first and second seasons, respectively as shown in Table (2)

As for calcium bicarbonate effect, the data in Table (2) show that treating Limonium plants with calcium bicarbonate at any concentration increased flower stems thickness character compared with control treatment in both seasons, this trend of results was constant in both seasons, the highest values for this character were obtained by using the calcium bicarbonate at high concentration which gave 27.4 and 31.58% (percentage of increases) over control plants in the first and second seasons, respectively.

As for sodium silicate effect, the data in Table (2) show that the thickness of flower stem was increased by spraying the Limonium plants with 50 and 100 ppm of sodium silicate. The trend of results was constant in both seasons, the high concentration of sodium silicate (100 ppm) gave the best results in both seasons. It gave 13.70 and 13.16% over control plants in the first and second seasons, respectively.

The result agree with that reported by **Mauad *et al.* (2003)** on rice they reported that silicon increased cellular wall thickness.

5- Number of flower spike peduncles / flower stem.

Data in Table (3) show that the mean number of flower spikes peduncle was increased with spraying different concentrations of cheleate calcium, calcium bicarbonate and sodium silicate on *Limonium sinuatum L.* plants. The higher concentrations of each treatment were most effective than the lower concentrations and control treatment. In the first season, the best

Table (3): Effect of cheleate calcium, calcium bicarbonate and sodium silicate on flowering characteristics of *Limonium sinuatum L.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		No. of fl spike peduncle / fl stem		Thickness of fl peduncle (cm)		Length of fl peduncle (cm)		Fresh weight of peduncle (g)		Dry weight of peduncle (g)	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		5.73	5.26	0.44	0.44	32.96	32.40	7.46	7.40	1.73	1.70
Cheleate calcium	50 ppm	5.96	5.96	0.46	0.46	35.66	34.06	8.26	8.20	1.86	1.78
	100 ppm	6.40	6.93	0.53	0.53	37.46	37.50	9.00	9.06	2.12	2.13
	150 ppm	6.90	7.30	0.56	0.60	38.10	38.06	9.63	9.56	2.21	2.15
$Ca(HCO_3)_2$	50 ppm	5.83	6.30	0.46	0.53	35.13	34.33	8.00	8.13	1.82	1.86
	75 ppm	6.42	6.83	0.60	0.53	35.26	37.16	8.73	8.93	1.91	1.99
	150 ppm	7.30	6.83	0.60	0.60	36.76	37.33	9.50	9.26	2.10	2.15
Na_2SiO_3	50 ppm	5.73	5.96	0.50	0.50	33.93	34.30	7.96	7.73	1.80	1.85
	100 ppm	6.30	6.40	0.53	0.56	35.80	35.83	8.90	8.46	1.98	1.93
L.S.D.	0.05	0.579	0.636	0.108	0.183	3.83	3.43	1.12	1.36	0.42	0.48
	0.01	0.810	0.890	0.204	0.207	4.67	4.15	1.73	1.89	0.56	0.60

result for this character was attained by spraying Limonium plants with calcium bicarbonate at the rate of 150 ppm which produced 27.40% over control plants. But in the second season the highest value for number of flower spikes peduncles / flower stem character was obtained by using cheleate calcium at the rate of 150 ppm which produced 38.78% over control plants.

In this concern, it could be noticed that in the second season the differences between the assigned concentrations of each of cheleate calcium, calcium bicarbonate and sodium silicate and control treatment were statistically significant. But in the first season, only higher concentrations of abovementioned treatments significantly increased the mean values of number of flower spikes peduncles / flower stem as compared to control treatment.

The result was in harmony with those reported by **Subbiah *et al.* (1990)** on tomato found that the best result were obtained with using calcium chloride at 0.2% and **Mauad *et al.* (2003)** on rice reported that calcium and sodium silicate increased number of flowers per plants.

6- Thickness of flower peduncle (cm):

Data recorded in Table (3) show that, foliar application of calcium bicarbonate at any concentration on *Limonium sinuatum* L. plants increased the mean thickness of flower peduncle in both seasons compared with control plants. The high and medium concentrations of calcium bicarbonate were more effective than lower concentration. This trend of results was constant in both seasons of this experiment. The spraying Limonium plants with

high concentration of calcium bicarbonate (150 ppm) gave the best results, it produced 36.36% over control plants in both seasons.

As for cheleate calcium effect, the data in the same Table clear that foliar application of cheleate calcium at any concentration on *Limonium sinuatum* L. plants increased thickness of flower peduncle in both seasons of this experiment. The trend of results was constant in both seasons. The high concentration (150 ppm) of this treatment produced 27.27% and 36.36% over control plants in the first and second seasons, respectively.

As for sodium silicate effect, the data in the same Table show that foliar application of low or high concentration of sodium silicate on Limonium plants increased the thickness of flower peduncle in both seasons compared with control treatment. The high concentration (100 ppm) attained 20.45 and 27.27% over control plants in the first and second seasons, respectively.

The result was in accordance with that reported by **Subbiah *et al.* (1990)** on tomato they found that the best results were obtained with using calcium chloride at 0.2% and **Mauad *et al.* (2003)** on rice (*Oryza sativa*) reported that silicon fertilization reduced the number of plant spikelets per panicles.

7- Length of flower peduncle (cm):

The mean length of flower peduncle was increased by spraying the Limonium plants with any concentration of cheleate calcium in both seasons of this experiment as compared with control and other treatments. The best value for this character was

attained by spraying the plants with high concentration (150 ppm) which gave 15.59 and 17.47% over control plants in the first and second seasons, respectively (Table 3). It is worth mentioning that the length of flower peduncle was promoted by the medium rate of cheleate calcium which ranked second after the superiority effect of the abovementioned treatment.

As for calcium bicarbonate effect, the data in Table (3) clear that treating Limonium plants with different concentrations of calcium bicarbonate increased peduncle length compared with control plants in both seasons. The trend of results was similar in both seasons. The high concentration of calcium bicarbonate was more effective than medium and lower concentrations. The spraying calcium bicarbonate at 150 ppm was attained 11.53 and 15.22% over control plants in the first and second seasons, respectively.

As for sodium silicate effect, the data clear that spraying Limonium plants with each of low and high concentration increased peduncle length compared with control plants in both seasons, the high concentration of this treatment was more effective than low concentration which produced 8.62 and 10.59% over control plants in the first and second seasons respectively.

The result agree with that reported by **Subbiah *et al.* (1990)** on tomato who found that the best results were obtained with using calcium chloride at 0.2%.

8- Fresh weight of flower peduncle (g):

Data recorded in Table (3) indicate that the fresh weight of flower peduncle was increased by all applied mineral nutrients in both seasons of this study, the maximum fresh weight of flower peduncle (g) was recorded by spraying limonium plants by cheleate calcium at 150 ppm as it gave the highest increases percentage (29.09 and 29.19% more than control plants in the first and second seasons, respectively). Also, spraying limonium plants by calcium bicarbonate at 150 ppm not only ranked the second, but also, gave approximately the same values of peduncle fresh weight as the above-mentioned superior treatment. It gave 27.35 and 25.14% (percentage of increases) in both seasons, respectively.

On the other hand, the low concentrations of both cheleate calcium and calcium bicarbonate (50 ppm for both) produced the least values of peduncle fresh weight but still more than control in both seasons.

As for sodium silicate, data obtained in Table (3) indicate that there were increases in the peduncle fresh weight of Limonium plants due to sodium silicate sprayed concentrations. Moreover, the concentration of sodium silicate (100ppm) appeared to be more effective than low concentration (50ppm). The increases due to spray high concentration of this treatment reached to significance level at 5% in the first season, it is so mall to reach this level in the second season.

9-Dry weight of flower peduncle (g):

The results of the dry weight of the flower peduncles of limonium plants attained a parallel trend with the fresh weight results in the first season only, with little differences in the level of significance.

In general, the heaviest dry weight of flower peduncle was recorded by spraying cheleate calcium at 150 ppm followed by the same source of calcium at medium rate (100ppm). Meanwhile, calcium bicarbonate at 150 ppm ranked the third in this concern. While, in the second season the picture was completely converted. Thus cheleate calcium and bicarbonate at high rate (150 ppm) showed its superiority in increasing the flower peduncle fresh weight followed discendingly by cheleate calcium at medium rate (100ppm).

Concerning sodium silicate treatments data in Table (3) showed that the results of dry weight of flower peduncle of limonium, go on live with those obtained with fresh weight of flower peduncle (g) in both seasons of this study.

The results are in parallel with those of **Chen-XiaoTing *et al.* (2002)** who found that the growth of pakchoi was apparently improved by lime and calcium magnesium phosphate application, the uptake of Cd, Pb, Cu and Zn by pakchoi was significantly depressed and the symptom caused by heavy metals pollution was eliminated.

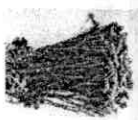
IV.1.A.3- On some chemical composition:

1- Leaf nitrogen content (%):

Data presented in Table (4) show that treating the *Limonium sinuatum L.* plants with different concentrations of cheleate calcium treatment significantly increased nitrogen content in plant leaves, this trend of results was constant in both seasons, the rate of increases was arised with increasing concentration of cheleate calcium. The high concentration of cheleate calcium (150 ppm) increased nitrogen percentage in plant leaves by 13.10 and 17.57% over control plants in the first and second seasons, respectively. As for calcium bicarbonate, the nitrogen percentage in plant leaves of Limonium plants was increased by spraying the plants with all different concentrations of calcium bicarbonate treatment. The obtained results in the second season were similar with those in the first seasons. The spraying Limonium plants with high concentration of calcium bicarbonate gave highest value for nitrogen content parameter, it resulted 20.69 and 13.51% over control plants in the first and second seasons, respectively. As for sodium silicate effect, the low and high concentrations of sodium silicate treatment increased significantly nitrogen percentage in plant leaves compared with control plants. The values of nitrogen content in plant leaves were similar in both seasons. The high concentration (100 ppm) of sodium silicate was more effective than low concentration for this character, it gave 9.66 and 6.76% over control plants in the first and second seasons, respectively.

Table (4): Effect of cheleate calcium, calcium bicarbonate and sodium silicate on N, P, K, Ca and total carbohydrate content in leaves of *Limonium sinuatum* L. plants in two successive seasons (2002/2003 and 2003/2004).

Characters		N%		P%		K%		Ca%		T. carbohydrate%	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		1.45	1.48	0.54	0.54	1.64	1.58	1.19	1.21	9.86	9.57
Cheleate calcium	50 ppm	1.58	1.56	0.61	0.56	1.75	1.64	1.36	1.40	10.50	10.55
	100 ppm	1.69	1.67	0.58	0.58	1.89	1.82	1.53	1.50	11.35	11.78
	150 ppm	1.64	1.74	0.60	0.59	1.85	1.74	1.75	1.73	12.73	12.53
$Ca(HCO_3)_2$	50 ppm	1.60	1.57	0.54	0.56	1.79	1.67	1.36	1.43	10.67	10.71
	75 ppm	1.66	1.67	0.58	0.59	1.85	1.76	1.56	1.54	11.19	11.61
	150 ppm	1.75	1.68	0.61	0.60	1.89	1.82	1.67	1.71	12.23	12.41
Na_2SiO_3	50 ppm	1.54	1.54	0.51	0.55	1.67	1.61	1.37	1.38	10.41	10.31
	100 ppm	1.59	1.58	0.55	0.57	1.68	1.63	1.59	1.50	10.94	10.83
L.S.D.	0.05	0.054	0.058	0.043	0.045	0.042	0.078	0.14	0.15	0.225	0.224
	0.01	0.075	0.079	0.053	0.061	0.058	0.108	0.182	0.195	0.310	0.337



The results were in agreement with that reported by **Dhru and Pal (1991)** on *Nerium oleander* and **El-Sallami (1996)** on *Ficus banjamina* they found that N content increased in plant leaves compared with control plants with calcium treatment.

2- Leaf Phosphorus content (%):

Data in Table (4) show that spraying Limonium plants with low, medium and high concentrations (50, 100 and 150 ppm) of cheleate calcium treatment increased phosphorus percentage in Limonium plant leaves in both seasons of this experiment. The increase was in parallel to the increasing of the applied concentrations of cheleate calcium.

As for calcium bicarbonate effect, the data in the same Table also clear that spraying the plants with medium and high concentrations of calcium bicarbonate increased phosphorus percentage in Limonium plant leaves compared with control plants in the first season, but in the second season all concentrations of calcium bicarbonate treatment increased this phosphorus percentage in plant leaves compared with control plants.

As for sodium silicate effect, the data in Table (4) show that spraying Limonium plants with 50 ppm of sodium silicate produced the least value of phosphorus percentage in the first season but increased this character in the second season while, spraying Limonium plants with high concentration of sodium silicate increased phosphorus percentage in plant leaves in the first and second seasons in this experiment compared with control plants.

The results were in harmony with that reported by **El-Sallami (1996)** on *Ficus banjamina* who found that additive the nutrient solution such as $CaSo_4$ (1.2 mg/liter), to the media of plants increased the leaf content of P compared with control plants and **Lee *et al.* (2000)** on cucumbers cv. *Eunsngback dadagi* found that P increased in leaves by spraying Si.

3- Leaf Potassium content (%):

Data obtained in Table (4) show that the potassium percentage in plant leaves was increased by spraying Limonium plants with different concentrations of cheleate calcium compared with control treatment in this respect. The medium concentration of cheleate calcium attained the highest value compared with high and low concentrations in both seasons of this experiment, it gave 15.24 and 15.19% over control plants in the first and second seasons, respectively.

As for calcium bicarbonate effect, the data presented in Table (4) show that, potassium percentage in plant leaves of Limonium plants was increased by spraying the plants with all used concentrations of calcium bicarbonate. The trend of results in both seasons was constant. The high concentration of calcium bicarbonate treatment produced the maximum content of potassium in the leaves of Limonium plants, it attained 15.24 and 15.19% over control plants in the first and second seasons, respectively.

As for sodium silicate effect, the data in the same Table cleared that spraying Limonium plants with low and high concentrations of sodium silicate increased potassium percentage in plant leaves in the first and second seasons in this study.

Treating Limonium plants with sodium silicate at the rate of (100 ppm) gave the highest value in both seasons compared with low concentration of this treatment which gave 2.44 and 3.16% more than control plants in the first and second seasons, respectively.

The results were in accordance with those reported by **El-Sallami (1996)** on *Ficus banjamina* who found that adding the nutrient solution such as $CaSO_4$ (1.2 mg/liter), to the media of plants increased the leaf content of K compared with control plants.

4- Leaf calcium content (%):

Data obtained in Table (4) show that treating the Limonium plants with different concentrations of cheleate calcium significantly increased calcium content in plant leaves in both seasons of this experiment. The high level of cheleate calcium gave the highest values for this character which attained 47.06 and 42.97% over control plants in the first and second seasons, respectively.

As for calcium bicarbonate effect, the data tabulated in the same Table clear that spraying the Limonium plants with different concentrations of calcium bicarbonate significantly increased calcium content in plant leaves of both seasons, the higher values for this character were attained from treating the plants with high concentration followed descndingly by medium and lower concentrations of calcium bicarbonate.

As for sodium silicate, the data indicated that, the calcium content in plant leaves was significantly increased in plant leaves by spraying the plants with each of low and high concentrations of this treatment in this experiment. Spraying the Limonium plants with high concentration (100 ppm) gave 33.61 and 23.975 over control plants in the first and second seasons respectively.

This result agree with those reported by **Jacques *et al.* (1991)** on poinsettia cultivars, **Starkey and Pedersen (1997)** on roses, they found that spraying calcium increased calcium content in the leaves.

5- Leaf total carbohydrates content (%):

The data presented in Table (4) clear that the total carbohydrates percentage was increased by spraying the Limonium plants with different concentrations of cheleate calcium, the higher concentrations of cheleate calcium were improved the total carbohydrates percentage in plant leaves compared with lower concentration and control treatments. The best results for this character were attained by treating the plants with high concentration (150 ppm), it gave 29.11 and 30.93% over control plants in the first and second seasons, respectively.

As for calcium bicarbonate effect, the data in Table (4) show that spraying the limonium plants with calcium bicarbonate at concentrations of 50, 75 and 150 ppm increased the total carbohydrates percentage in plant leaves compared with control plants. The high concentration of calcium bicarbonate was the most effective in this character compared with other treatments, it

produced 24.04 and 29.68% over control plants in the first and second seasons, respectively.

As for sodium silicate effect, the data in the same Table cleared that, the total carbohydrates percentage increased by spraying the Limonium plants with sodium silicate at low and high concentrations in this experiment, they gave 5.58 and 10.95 or 7.73 and 13.17% over control plants in the first and second seasons for the low and high concentrations of sodium silicate treatment in this experiment, respectively.

The result agree with that reported by **El-Sallami (1996)** on *Ficus banjamina* who found that addition the nutrient solution such as $CaSo_4$ (1.2 mg/liter) increased chlorophyll b compared with control.

IV.1.B- Growth retardants

Effect of paclobutrazol and dikegulac sodium on vegetative growth, flowering and chemical composition of *Limonium sinuatum L.* plants.

IV.1.B.1- On some vegetative measurements :

1- Plant height (cm) :

The results recorded in the two seasons (Table 5) show that spraying the plants of *Limonium sinuatum L.* by different concentrations of paclobutrazol and dikegulac sodium caused a significant reduction in the mean plant height as compared to control (untreated plants). Also, no significant reduction in the mean plant height was detected in the first and second seasons with the lowest concentration of paclobutrazol (25 ppm), but in the first season, plants sprayed with lower concentration of dikegulac sodium (250 ppm) had a non significant higher mean plant height than those of control plants. In both seasons, raising the application rates of both growth retardants resulted in a steady in the values recorded i.e. the higher concentration of the two growth retardants usually gave shorter plants than the lower concentrations.

On the other hand, plants sprayed using a paclobutrazol concentration of 100 ppm were generally gave the most compact plants than any other concentrations and dikegulac sodium treatments. The values were 43.40 and 44.33 cm length as compared with 64.33 and 65.33 cm for control in both seasons, respectively.

Table (5): Effect of paclobutrazol and Dikogulac sodium on vegetative growth of *Limonium sinuatum L.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		Plant height (cm)		F.W. of leaves g/plant		D.W. of leaves g/plant		F.W. of plant g		D.W. of plant g	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		64.33	65.33	182.30	186.63	37.60	38.30	1107.30	1113.60	252.63	242.73
PP_{333}	25 ppm	62.40	63.50	185.63	189.96	40.83	41.79	1133.30	1123.30	249.32	247.12
	50 ppm	52.90	54.50	202.96	206.20	52.76	53.60	1163.76	1174.60	279.30	281.91
	100 ppm	48.40	50.33	220.30	220.73	70.39	70.63	1265.86	1248.70	362.76	365.65
Dikogulac sodium	250 ppm	64.40	63.33	188.86	192.96	45.32	46.31	1131.96	1127.60	271.67	248.07
	500 ppm	61.00	60.20	209.30	216.83	54.41	56.38	1178.73	1194.90	306.44	286.79
	750 ppm	58.56	57.10	230.86	229.53	69.26	68.86	1259.10	1210.70	396.54	383.00
L.S.D.	5%	2.19	3.94	6.34	6.93	3.25	3.42	28.18	21.32	9.78	8.14
	1%	3.06	5.51	8.87	9.70	4.62	4.78	39.45	29.84	13.69	11.39

The above results were confirmed by those reported by **Barrett (1982)** on *Chrysanthemum* who found that 0.25 mg/pot from PP_{333} applied as drench reduced plant height. **Walker (1986)** on *Azalea simsii* found that spraying PP_{333} reduced plant height. **Wainwright and Irwin (1987)** reported that PP_{333} reduced of *Antirhinum majus* plant height. **Lee and Lee (1990), Nasr (1997)** on *Gerbera* studied the effect of PP_{333} at 0.25, 0.5 or 1.0 mg/pot and they found that both growth retardants significantly reduce plant height. Also, **Tawila (2000)** on *Polianthes tuberosa* found that spraying PP_{333} at 50ppm decreased plant height **Youssef (2000)** found that treating *Strelitzia reginae* plant with PP_{333} at 50, 100 or 200 ppm decreased plant height.

2- Fresh weight of leaves / plant (g):

The results presented in Table (5) show the effect of paclobutrazol and dikegulac sodium on fresh weight of leaves of *Limonium sinuatum L.* plants. In the first season, using dikegulac sodium at 750 ppm produced the highest fresh weight of leaves (230.86 g / plant) compared to control (182.30 g/plant). The addition of paclobutrazol at 100 ppm and dikegulac sodium at 500 ppm showed to have favourable effect on fresh weight of leaves (220.30 and 209.30 g/plant, respectively). While the lowest value of fresh weight was 185.63 g/plant for plants received paclobutrazol at 25 ppm.

These results showed that the high level of both dikegulac sodium and paclobutrazol gave the highest fresh weight of leaves. In the second season, all growth retardants treatments took similar trend of results as the first season.

The results were in agreement with those obtained by **Tawila (2000)** on *Polianthes tuberosa* who stated that spraying PP_{333} at (50 ppm) increased the fresh weight of leaves. Similar trend of results was reported by **Abd El-Fatah (2001)** on some ornamental shrubs (*Adhatoda vasica*, Hibiscus *rosa- sinensis* and *Phyllanthus emblica*) reported that PP_{333} at 50 and 100 ppm treatment increased leave fresh weight.

3- Dry weight of leaves / plant (g):

Data in Table (5) revealed that increasing of the dry weights of leaves was accompanied the increased growth regulators rates. The best results in this respect were obtained by spraying paclobutrazol at 100 ppm followed by dikegulac sodium at 750 ppm compared to the control in the first season. Similar trend was observed in the second season. Also, plants treated with the medium level of dikegulac sodium showed to have a favourable effect on dry weight of leaves (54.41 and 56.38 g/plant in the first and second seasons, respectively). It might be indicated that, moderate level of paclobutrazol and low level of dikegulac sodium significantly increased the fresh weight of leaves over control. Plants sprayed by paclobutrazol at the lowest rate (25 ppm) resulted in non significant increment in the value recorded in the first season but, the increment reach the level of significant in the second one.

The result was on the line with that reported by, **Nasr (1997)** on *Gerbera*, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2000)** on *Steriliztia reginae*, **Carter *et al.* (1996)** on *Nephrolepis exalatala* cv. compact who reported that spraying PP_{333} and dikegulac sodium increased the dry weight of leaves.

4- Fresh weight of the whole plant (g):

The data obtained on fresh weight of the whole plant of *Limonium sinuatum* L .as affected by using some growth retardant treatments are presented in Table (5).

The results of the fresh weight of the whole plant attained a parallel trend with the increasing of the rate of growth retardants treatments till the medium rates of both (PP_{333} at 50 ppm and dikegulac sodium at 500 ppm). Then, Limonium plants showed a negative response to the highest rates of both growth retardants (PP_{333} at 100 ppm and dikegulac sodium at 750 ppm). In general, the heaviest fresh weight of the whole plant was recorded by spraying dikegulac sodium at 500 ppm (1178.73 and 1194.90 g/plant) in the first and second seasons, respectively. Moreover, spraying the plants with PP_{333} at medium level 50 ppm resulted in a highly significant increment in this parameter and ranked the second in this respect.

On the other hand, plants treated with the high level of PP_{333} (100 ppm) increased the fresh weight of the whole plant to the minimum values (1265.86 and 1248.70 g/plant) compared to control which gave (1107.30 and 1113.60 g/plant) in the first and second seasons, respectively. Also, dikegulac sodium sprayed at high rate (750 ppm) showed to have increasing the fresh weight of whole plant.

The results were in accordance with those obtained by **Salem and El-Khateeb (1988)** on *Chrysanthemum frutessens* and **El-Mowafy (1996)** on *Pelargonium graveolens,* they reported that spraying PP_{333} (40 and 60 ppm) increased fresh weight of herb.

5- Dry weight of whole plant (g):

Similarly, the results of the dry weight of the whole plant (Table, 5) attained a parallel trend with the fresh weight results, with little differences. The heaviest dry weight of the whole plant was obtained by the medium rate of dikegulac sodium (500 ppm) in both seasons as it recorded (306.44 and 286.79 g/plant) in the first and second seasons, respectively. Also, the high rate of dikegulac sodium (750 ppm) increased dry weight of the whole plant in both seasons.

On the contrary the lowest dry weight of whole plant was recorded by spraying Limonium plants with the low rate of PP_{333} (25 ppm) as it gave (249.32 g/plant) compared to control (252.63 g/plant) in the first season only. But, in the second season using the PP_{333} at 25 ppm increased the fresh weight of whole plant but the differences still unsignificant as compared to control.

The results were in harmony with those obtained by **Salem and El-Khateeb (1988)** on *Chrysanthemum* and **Abou El-Ghait (1993)** on *Epipreinum aureum* who reported that PP_{333} and dikegulac sodium increased dry weight of plant.

IV.1.B.2- On some flowering characteristics:

1- Number of flower stems / plant:

Data presented in Table (6) show that the number of flower stems of *Limonium sinuatum* L. plants was significantly increased as a result of application of different concentrations of paclobutrazol and dikegulac sodium as compared to the control. In both seasons, the number of flower stems increased gradually in positive linear with the increases of both growth retardants concentrations. The best treatment was 100 ppm paclobutrazol which gave the greatest number of flower stems followed by dikegulac sodium at 750 ppm in the first season but, in the second season the abovementioned two superior treatments exchanged the places of each other. So, the greatest values in the number of flower stems were obtained as a result of spraying paclobutrazol at 100 ppm and dikegulac sodium at 750 ppm. Whereas, the treatment of paclobutrazol at 25 ppm gave the lowest value of number of flower stems (18.30) in the first season while, in the second one dikegulac sodium at 250 ppm resulted the lowest value of number of flower stems (17.85) but, they still more than the control (untreated plants) which gave 17.22 and 17.62 flower stems in the first and second seasons, respectively.

The results were in conformity with those reported by **Heursel and Witt (1985)** on *Azalea simsii*, **Nasr (1997)** on *Gerbera*, **Singh *et al.* (1999)** on *Chrysanthemum*, **Porter and Show (1983)** on *Lavandula angustifolia* x L. latifolia, **Nightingale *et al.* (1985)** on *Kalanchoe* who proved that PP_{333} and dikegulac sodium increased the number of flowers.

Table (6): Effect of paclobutrazol and dikogulac sodium on flowering characteristics growth of *Limonium sinuatum L.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		No. of fl stem / plant		F.W. of flower stem (g)/plant		D.W. of flower stem (g)/plant		Thickness of flower stem	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		17.22	17.62	43.00	39.66	9.33	8.33	0.76	0.73
PP_{333}	25 ppm	18.30	18.40	48.33	46.66	11.66	10.33	0.83	0.80
	50 ppm	19.73	19.30	50.66	53.66	12.33	12.33	0.93	0.86
	100 ppm	20.26	20.50	59.66	55.33	15.66	15.00	0.96	0.93
Dikogulac sodium	250 ppm	18.93	17.86	43.66	48.00	10.00	10.66	0.86	0.83
	500 ppm	20.73	19.06	50.66	51.66	12.00	12.66	0.93	0.93
	750 ppm	21.16	20.63	56.33	52.00	15.00	15.66	0.96	0.96
L.S.D.	5%	1.13	1.43	5.32	5.82	2.46	2.04	0.093	0.12
	1%	1.56	2.00	7.12	7.31	3.13	2.83	0.13	0.16

2- Fresh weight of flower stems / plant (g):

Data presented in Table (6) revealed that the mean fresh weight of flower stems / plant was increased in both seasons by spraying Limonium plants with different concentrations of PP_{333} treatment, the high concentration of this treatment (100 ppm) produced the heaviest flower stems fresh weight as compared to medium, low concentrations and other treatments. Treating the Limonium plants with 100 ppm of PP_{333} attained 59.67 and 69.77% more than control plants in the first and second seasons respectively whereas, spraying Limonium plants by PP_{333} at the medium level (50 ppm) gave a promising effect and ranked the second in this concern. Also, spraying the Limonium plants with different concentrations (250, 500 and 750 ppm) of Atrimmec treatments were significantly increased this character in both seasons especially the medium and high concentrations. The rate of increases was gradually increased with raising the concentration of Atrimmec treatment. Thus, spraying Limonium plants with 750 ppm Atrimmec produced 54.26 and 73.98% over control plants in the first and second seasons, respectively.

The result was in harmony with that reported by **Abou El-Ghait and Wahba (1994)** on *Viola odorata*, **Haggag (1997)** on *Chrysanthemum*, **Porter and Show (1983)** on *Lavendula angistifolia* x L. latifolia, they found that spraying PP333 and dikegulac sodium increased fresh weight of flowers.

3- Dry weight of flower stems / plant (g):

Data in Table (6) indicated that spraying the Limonium plants with low, medium and high concentrations of PP_{333} treatments significantly increased the dry weight of flower stems / plant in both seasons compared with control plant. The high concentration of PP_{333} (100 ppm) was the most effective for this character compared with medium and low levels (50 and 25 ppm). Spraying the plants with PP_{333} at rate of 100 ppm attained 67.85 and 80.07% over control plants in the first and second seasons, respectively.

As for Atrimmec treatment, the data in the same Table clear that the spraying Limonium plants with different concentrations of Atrimmec (250, 500 and 750 ppm) significantly increased this character, the maximum value for dry weight of flower stems was obtained from treating the Limonium plants with 750 ppm of Atrimmec treatment which attained 60.77 and 88.00% over control plants in the first and second seasons, respectively. In addition, it could be concluded that the best treatment was 100 ppm PP_{333} which gave the heaviest dry weight of flower stems / plant followed by dikegulac sodium at 750 ppm in the first season but, in the second one the abovementioned two superior treatments exchanged the places of each other.

The result was on the line with that reported by **Maghazy (1991)** on *Viola odorata,* **Haggag (1997)** on *Chrysanthemum* and **Al-Badawy and Abdalla (1984)** on yarrow plant, they found that spraying PP_{333} and dilegulac sodium increased the dry weight of flowers.

4- Thickness of flower stems:

Data in Table (6) show that the mean thickness of flower stems was increased by using PP_{333} treatment at any concentration, the highest value for this character was attained by using highest concentration of PP_{333} (100 ppm), it gave 26.32% more over control plants in the first season, followed descendingly by spraying PP_{333} at medium level (50 ppm). The trend of results was similar in both seasons.

As for Atrimmec effect, the data in Table (6) show that spraying Limonium plants with Atrimmec at different concentrations increased the thickness of flower stems character compared with control plants in both seasons. The rate of increase for this character was increased by increasing concentrations of Atrimmec treatment. Spraying Limonium plants with (750 ppm) of Atrimmec resulted in the greatest thickness of flower stems as it attained 26.32 and 31.51% over control plants in the first and second seasons, respectively. Followed by using the medium level (500 ppm) which gave 0.93 cm .and0.93 cm compared to 0.76 and 0.73 cm for control in the first and second seasons, respectively.

These result were insured with that reported by **Helal (1993) and Awad *et al.* (1994)** on ponisettia, *Euphorbia pulcherrima* and **Haggag (1997)** on Chrysanthemum, they found that spraying PP_{333} increased thickness of flower stems.

5- Number of flower spikes peduncle / flower stem:

Data in presented Table (7) show that all concentrations of PP_{333} treatment increased mean number of flower spikes peduncles flower stem in both seasons compared with control treatment. The rate of increases was arised with increasing concentrations of PP_{333} treatment in this experiment. The high concentration 100 ppm gave the best result compared with medium and low concentrations, it produced 10.32 and 17.96% over control plants in the first and second seasons, respectively.

As for Atrimmec treatment, the data in the same Table clear that the different concentrations of Atrimmec treatment increased mean number of flower spikes peduncles / flower stem in both seasons compared with untreated plants. The rate of increment reached to level of superiority with spraying the *Limonium sinuatum L.* plants with high and medium concentrations (750 and 500 ppm) specially in the second season. Spraying the limonium plants with 750 ppm gave 17.44 and 28.13% over control plants, but the medium concentration 500 ppm was attained 7.83 and 19.78% over control plants in the first and second seasons, respectively.

The abovementioned results were in harmony with that reported by **Heursel and Witt (1985)** on *Azalea simsii*, **Nasr (1997)** on *Gerbeara*, **Singh *et al.* (1999)** on *Chrysanthemum*, **Porter and Show (1983)** on *lavandula angustifolia* x L. latifolia, **Nightingale *et al.* (1985)** on *Kalanchoe* who reported that PP_{333} and dikegulac sodium increased the number of flowers.

Table (7): Effect of paclobutrazol and dikogulac sodium on flowering characteristics growth of *Limonium sinuatum L.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		No. of fl spike peduncle / fl stem		Thickness of fl peduncle (cm)		Length of fl peduncle (cm)		Fresh weight of fl peduncle (g) /plant		Dry weight of fl peduncle(g) /plant	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		5.62	5.51	0.43	0.46	31.72	32.23	6.93	7.36	1.63	1.72
PP_{333}	25 ppm	5.83	5.63	0.46	0.46	33.33	34.16	7.93	7.83	1.78	1.85
	50 ppm	5.83	5.96	0.50	0.53	34.13	34.73	8.80	8.63	1.92	1.96
	100 ppm	6.20	6.50	0.56	0.60	33.46	33.76	9.56	9.26	2.11	2.03
Dikogulac sodium	250 ppm	5.73	5.93	0.46	0.50	33.10	33.86	7.66	7.73	1.73	1.77
	500 ppm	6.06	6.60	0.53	0.53	36.30	34.20	8.50	8.56	1.89	1.90
	750 ppm	6.60	7.06	0.60	0.66	32.00	33.63	9.16	8.86	1.92	1.98
L.S.D.	0.05	0.397	0.574	0.178	0.179	3.13	3.18	1.41	1.14	0.52	0.58
	0.01	0.555	0.803	0.201	0.202	4.76	4.83	1.98	1.42	0.62	0.67

6- Thickness of flower peduncle (cm):

Data tabulated in Table (7) show that foliar application with any of the three used concentrations of PP_{333} treatment on *Limonium sinuatum L.* plants had enhancing effect on increasing the thickness of flower peduncle compared with control treatment in both seasons, this increment was arised by increasing PP_{333} concentrations. Spraying the plants with PP_{333} at rate of 100 ppm produced 30.23 and 30.04% over control plants in the first and second seasons, respectively.

As for Atrimmec effect, the data in the same Table clear that, treating the Limonium plants with any concentration of Atrimmec treatment increased the thickness of peduncle in both seasons compared with control plants, the best result for this character was obtained by spraying the plants with Atrimmec at 750 ppm, which produced the greatest thickness of flower peduncle (0.60 and 0.66 cm) compared with control which gave (0.43 and 0.46 cm) in the first and second seasons, respectively.

The results of the present study were in agreement with that reported by **Helal (1993) and Awad *et al.* (1994)** on *Euphorbia pulcherrima* and **Haggag (1997)** on Chrysanthemum, they found that spraying PP_{333} increased thickness of flowers.

7- Length of flower peduncle (cm):

The data in Table (7) pointed out that spraying Limonium plants with any concentration of PP_{333} treatment increased peduncle length compared with control plants in both seasons. The trend of results was constant in both seasons, the best results for it character were attained by treating the plants with PP_{333} at concentration of

50 ppm, it gave 7.50 and 7.76% over control plants in the first and second seasons, respectively.

As for Atrimmec effect, the data in Table (7) indicate that spraying Limonium plants with different concentrations of Atrimmec were increased length of peduncle compared with control plants in both seasons, the highest values for this character in both seasons were obtained by using Atrimmec treatment at medium concentration (500 ppm), it attained 14.44 and 6.11% over control plants in the first and second seasons, respectively. In general, it could be noticed that the high concentrations of the two used growth retardants gave a slight increases in flower peduncle length. This increment did not reach the level of significant.

These results were emphasized by that reported by **Adriansen (1985)** on *Chrysanthemum*, **Wainwright an Irwin (1987)** on *Antirrhinum majus* and **Youssef (2004)** on *Strelitzia reginae* who mentioned that spraying PP_{333} and dikegulac sodium decreased flower peduncle length.

8- Fresh weight of flower peduncle / plant (g):

Data presented in Table (7) clear that, the fresh weight of peduncle was increased by spraying the Limonium plants with different concentrations of PP_{333} treatment, the high concentration of PP_{333} (100 ppm) gave the best result, followed descendingly by medium rate (50 ppm). This trend of results was constant in both seasons.

As for Atrimmec effect, at the same Table data show that spraying the Limonium plants with Atrimmec at any concentrations increased the fresh weight of peduncle character in both seasons

compared with control plants. The spraying plants with high concentration (750 ppm) gave the best results compared with the other concentrations of this treatment, it gave 32.18 and 20.38% over control plants in the first and second seasons, respectively. While, the least value was obtained by spraying dikegulac sodium at 250 ppm in both seasons of this study.

The results were in accordance with that reported by **Abou El-Ghait and Wahba (1994)** on *Viola odorata*, **Haggag (1997)** on *Chrysanthemum*, **Porter and Show (1983)** on *Lavendula angistifolia* x L. latifolia cv., who found that spraying PP_{333} and dikegulac sodium increased fresh weight in flowers.

9- Dry weight of flower peduncle / plant (g):

The data gained on dry weight of flower peduncle as affect by paclobutrazol and dikegulac sodium treatments are presented in Table (7). Data on dry weight of flower peduncle showed the similar trend as that of fresh weight of flower peduncle in both seasons. Hence, the heaviest dry weight of flower peduncle was obtained by using the treatment of PP_{333} at 100 ppm followed descendingly by the treatment of PP_{333} at 50 ppm and dikegulac sodium at 750 ppm in both seasons. These results may explain the importance of growth retardants in the synthesis process of reversed food which leads of course, to increase their dry matter.

The aforementioned results of growth retardants are in parallel with those obtained by **Maghazy (1991)** on *Viola odorata*, **Haggag (1997)** on *Chrysanthemum* and **Al-Badawy and Abdalla (1984)** on yarrow plant, they found that spraying PP_{333} and dilegulac sodium increased the dry weight of flowers.

IV.1.B.3- On some chemical composition:

1- Leaf nitrogen content (%):

The data presented in Table (8) show that spraying the Limonium plants with low, medium and high concentrations of PP_{333} treatments significantly increased nitrogen percentage in plant leaves in the first and second seasons of this experiment. The medium concentration (50 ppm) treatment produced the best values for this character in both seasons, it attained 29.92 and 28.24% over control plants in the first and second seasons, respectively.

As for Atrimmec effect, the data in the same Table (8) showed that, the nitrogen content in plant leaves was increased by spraying the plants with different concentrations of Atrimmec treatment, the higher concentrations of this treatment (500 and 750 ppm) produced higher values for this character more than the lower concentration of this treatment, the medium concentration (500 ppm) produced the maximum value for this character.

This result was in harmony with that reported by **Tawila (2000)** on *Polianthes tuberosa,* **Youssef (2004)** on *Strelitzia reginae* and **Haggag (1997)** on *Chrysanthemum,* they reported that the high level of PP_{333} increased N percentage in leaves.

2- Leaf phosphorus content (%):

The data presented in Table (8) clear that leaf phosphorus content was increased by using PP_{333} treatment at all concentrations in both seasons compared with control plants, the medium concentration of PP_{333} treatment was attained the highest value for this character compared with other treatments in both seasons of this experiment, it produced 17.86 and 18.18% over control plants in the first and second seasons, respectively.

Table (8): Effect of paclobutrazol and Dikogulac sodium on N, P, K, Ca and total carbohydrate content in leaves of *Limonium sinuatum L.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		N%		P%		K%		Ca%		T. carbohydrates%	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		1.27	1.31	0.56	0.55	1.42	1.48	1.19	1.20	10.67	10.82
PP_{333}	25 ppm	1.56	1.54	0.60	0.61	1.71	1.59	1.37	1.40	11.23	11.34
	50 ppm	1.65	1.68	0.66	0.65	1.80	1.66	1.48	1.53	12.46	13.17
	100 ppm	1.54	1.57	0.62	0.63	1.70	1.62	1.46	1.45	11.83	12.53
Dikogulac sodium	250 ppm	1.52	1.47	0.60	0.59	1.68	1.58	1.48	1.50	11.51	11.25
	500 ppm	1.66	1.57	0.65	0.65	1.86	1.64	1.41	1.47	11.96	11.72
	750 ppm	1.60	1.55	0.63	0.61	1.83	1.60	1.49	1.56	12.23	12.12
L.S.D.	0.05	0.027	0.046	0.049	0.043	0.069	0.721	0.14	0.15	0.268	0.193
	0.01	0.037	0.064	0.068	0.060	0.101	1.009	0.182	0.195	0.375	0.270

As for Atrimmec effect, the data in the same Table indicated that, spraying the Limonium plants with different concentrations of Atrimmec treatment increased phosphorus percentage in plant leaves compared with control plants in both seasons. The trend of results was constant in both seasons of this experiment. The highest value was attained by treating the Limonium plants with medium concentration of Atrimmec treatment.

The result were in conformity with that reported by **Haggag (1997)** on *Chrysanthemum*, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2004)** on *Strelitzia reginae* who mentioned that spraying PP_{333} at 50, 100 and 200 ppm increased leaf P content

3- Leaf potassium content (%):

Data presented in Table (8) indicate that the application of PP_{333} at any concentration as foliar spraying on Limonium plants significantly increased potassium content in plant leaves in both seasons, the medium concentration of PP_{333} (50 ppm) produced the best values compared with other concentrations of this treatment, it attained 26.76 and 12.16% over control plants in the first and second seasons, respectively.

As for Atrimmec treatment, the data show that the different concentrations of Atrimmec treatment attained highly significant increase of potassium percentage in plant leaves compared with control plants in both seasons. The trend of results was constant in both seasons. The most promising effect for potassium content was gained by using Atrimmec at medium concentration (500 ppm) in both seasons.

This result was insured with those reported by **Haggag (1997)** on *Chrysanthemum*, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2004)** on *Strelitzia reginae,* they mentioned that spraying PP_{333} at 50, 100 and 200 ppm increased leaf K content.

4- Leaf calcium content (%):

Data presented in Table (8) obviously clear that spraying the Limonium plants with different concentrations of PP_{333} treatment increased the leaf calcium content compared with control plants in both seasons of this experiment, the medium concentration of PP_{333} gave the highest value for this character compared with low and high concentrations of this treatment, the results in the second season for this character were similar with that obtained in the first season.

As for Atrimmec effect, the data indicated that calcium content in plant leaves was increased compared with control plants in both seasons by using Atrimmec at any used concentration. The rate of increases for this character was increased by increasing the concentrations of Atrimmec treatment. Spraying Limonium plants with high concentration of Atrimmec produced the highest value of calcium in plant leaves in both seasons, it gave 25.21 and 30.00% over control plants in the first and second seasons, respectively.

5- Leaf total carbohydrates content (%):

The data in Table (8) indicated that the leaf total carbohydrates content in limonium plant was increased by spraying PP_{333} treatment at all concentrations, it produced 5.25, 16.78 and 10.87 or 4.81, 22.34 and 15.80% over control plants in the first and

second seasons for the low, medium and high concentrations of PP_{333} treatment in this experiment.

As for Atrimmec effect, the data cleared that spraying the Limonium plants with all assigned concentrations of Atrimmec treatment increased the total carbohydrates content in plant leaves compared with control plants in both seasons of this experiment. The trend of results was constant in both seasons. Spraying Limonium plants with high concentration 750 ppm preoduced the highest value for this character in both seasons, it gave 14.62 and 12.01% over control plants in the first and second seasons, respectively, of this experiment.

These obtained results were on the line with that reported by **Essa (1992)** on *Baccara Rosa,* **Awad *et al.* (1994)** on ponisettia, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2004)** on *Strelitzia reginae,* they mentioned that spraying PP_{333} at 50 and 100 ppm increased total carbohydrates content in leaves.

Effect of some mineral nutrients and some growth retardants on vegetative growth, flowering and chemical composition of *Helichrysum bracteatum* Andr. plants during 2003/2004 seasons.

IV.1.A- Mineral nutrients :

Effect of cheleate calcium, calcium bicarbonate and sodium silicate on vegetative growth, flowering and chemical composition of *Helichrysum bracteatum* Andr. plants.

IV.1.A.1- On some vegetative measurements :

1- Plant height:

The data obtained on plant height as affected by some mineral nutrient treatments are shown in Table (9). These results may be discussed as follows:

Spraying the foliage of *Helichrysum bracteatum Andr.* at different concentrations of cheleate calcium increased plant height as compared to control. The high rate of cheleate calcium (150 ppm) gave the tallest plants as it gave 142.96 and 138.53 cm when compared with 118.96 and 115.30 cm for control in the first and second seasons, respectively.

As for the effect of spraying the foliage of *Helichrysum bracteatum Andr.* with calcium bicarbonate, it was obvious that using the high rate (150 ppm) proved to be the most effective treatment for producing the tallest plant as it gave 139.10 and 133.63 cm in the first and second seasons, respectively. Moreover,

Table (9): Effect of cheleate calcium, calcium bicarbonate and sodium silicate on vegetative growth of *Helichrysum bracteatum Andr.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		Plant height cm		No. of leaves/plant		F.W. of leaves g/plant		D.W. of leaves g/plant		F.W. of plant g		D.W. of plant g	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		118.96	115.30	117.30	115.30	167.43	165.43	29.46	28.46	1092.73	1121.63	240.32	235.54
Cheleate calcium	50 ppm	125.40	120.96	124.53	122.10	186.30	181.40	32.30	30.83	1156.50	1151.63	250.54	245.65
	100 ppm	136.40	130.76	131.63	132.30	202.53	200.06	37.49	34.99	1220.86	1253.96	264.57	259.08
	150 ppm	142.96	138.53	142.76	141.76	213.06	212.16	40.48	38.18	1452.93	1471.63	295.36	304.18
$Ca(HCO_3)_2$	50 ppm	121.40	118.63	126.43	124.10	186.86	188.30	33.01	32.01	1149.73	1144.63	241.44	240.28
	75 ppm	131.63	125.20	133.86	131.30	198.76	200.06	33.01	34.92	1241.63	1257.96	256.54	257.81
	150 ppm	139.10	133.63	139.30	135.53	207.76	209.16	38.79	41.12	1406.63	1398.96	276.67	294.24
Na_2SiO_3	50 ppm	121.76	118.96	121.43	120.30	174.63	175.10	30.60	29.78	1183.06	1154.06	248.44	240.43
	100 ppm	125.76	121.30	126.76	124.40	186.63	185.20	33.59	31.93	1225.20	1203.86	256.88	250.79
L.S.D	0.05	3.64	5.52	3.58	4.39	8.67	12.63	2.45	1.33	34.22	38.04	11.08	11.24
	0.01	5.09	7.72	5.01	6.14	12.13	17.68	3.43	1.86	47.90	53.25	15.51	15.73

the application of sodium silicate at the high level (100 ppm) showed also the most effective treatment for increasing this parameter as compared to the lowest rate (50 ppm) and control. However, the increases in plant height were progressively increased with increasing the rate of application of both micro-nutrients (the two source of calcium and sodium silicate).

Generally, among the different treatments, the application of cheleate calcium at the high rate showed to be the most effective treatment for producing the tallest plants. The percentages of increase were 20.17 and 20.14 over control in the first and second seasons, respectively. Furthermore, the remaining treatments of lower rates of cheleate calcium, calcium bicarbonate and sodium silicate resulted in nearly more or less similar values but still more than the control values, although they did not reach the level of highly significant at 1% in most cases.

The result agreement with that reported by **Gavalas and Manetas (1980)** who proved that the maintenance of this low cytoplasmic Ca2+ concentration is of vital importance for the plant cell for there is now evidence that Ca2+ may inhibit various enzymes located in the cytoplasm. this relative superiority of sodium silicate over other mineral nutrient could be attributed to **Schwartz (1973)** who found that silicon may be intimately associated with the cell wall constituents as silica or possibly as canalently found in pectins. **Raven (1983)** stated that silicon may be also present in xylem cell walls. **Wang *et al.* (1996)** noted that addition of sodium silicate (80 ug/ml) together with selenite increased plant height.

2) Number of leaves/plant:

Data tabulated in Table (9) revealed that all tested concentrations of the two calcium sources and sodium silicate significantly increased the number of leaves per plant in both seasons as compared to control. So, the highest number of leaves was gained by sprayed *Helichrysum bracteatum Andr.* plants with the high rate of cheleate calcium (150 ppm) as it gave 142.76 and 141.76 leaves compared to 117.30 and 115.30 leaves for control in the first and second seasons respectively. Besides, the medium rate of cheleate calcium gave highly significant increase in this parameter as it gave 131.63 and 132.30 leaves per plant in the first and second seasons, respectively.

Also, all calcium bicarbonate concentrations increased the number of leaves per plant in both seasons especially at the high rate (150 ppm) which registered 139.30 and 135.53 leaves/plant in the first and second seasons, respectively. Similar trend was obtained by using the high rate of sodium silicate (100 ppm) which recorded 126.76 and 124.40 leaves / plant in the first and second seasons, respectively. Moreover, all sprayed mineral nutrientat the low rates (50 ppm) significantly increased the number of leaves per plant in both seasons.

The result was agreed with that reported by **Subbiah (1990)** on tomato who found that, the best results were obtained with using calcium chloride at 0.2%, **Mauad *et al.* (2003)** on *rice* found that silicon increased number of leaves.

3- Fresh weight of leave (g):

Regarding to data tabulated in Table (9) it could be concluded that all the three used micro-nutrients treatments progressively increased the fresh weight of *Helichrysum bracteatum* leaves as its sprayed rates increased when compared with control in both seasons. So, in both seasons of this study, the heaviest fresh weight of leaves / plant was produced from plants sprayed with the highest level of cheleate calcium (150 ppm). The values were 213.06 and 212.16 g as compared to 167.43 and 165.43 g for control in the first and second seasons, respectively Also, the obtained results showed clearly a highly significant increment in Helichrysum leaves fresh weight per plant over control accompanied the high rate of calcium bicarbonate treatment in both seasons, followed descendingly by using the medium rate of cheleate calcium (100 ppm) and the medium rate of calcium bicarbonate (75 ppm) as the registered 202.53 and 200.06 and 198.76 and 200.06 g in the first and second season, respectively.

The differences among the aforementioned two treatments were non significant as the plants under such treatments had nearly close leaves fresh weight values. However, it worthy to notice that the two sources of calcium and sodium silicate treatments at the lowest rate succeeded in increasing significantly the fresh weight of leaves/plants in both seasons

4- Dry weight of leaves (g):

The data obtained on dry weight of Helichrysum leaves as affected by cheleate calcium, calcium bicarbonate and sodium silicate treatments are presented in Table (9). It worthy to notice that the data of dry weight of leaves showed the similar trend as

that of fresh weight of leaves in both seasons, with some little differences. Thus, the heaviest dry weight of leaves was gained by using the treatment cheleate calcium at the high rate (150 ppm) as it gave 40.48 g followed descendingly by using calcium bicarbonate at the high rate (150 ppm) and medium rate of cheleate calcium as they gave 38.79 g and 37.49 g. The differences among the abovementioned two treatments were non significant as the plants under such treatments had nearly close leaves .dry weight values. This trend was true only in the season, while in the second season the first heaviest dry weight of leaves was obtained by using the treatment of bicarbonate calcium at the high rate as it gave 41.12 g followed descendingly by using the treatments of celeate Ca at 150 ppm and 100 ppm as they gave 38.18 and 34.99 g respectively.

5) Fresh weight of whole plant (g):

According to data presented in Table (9), it could be concluded that all treatments of the three used mineral nutrients progressively increased the fresh weight of whole plant as compared with control in both seasons. Hence in both seasons of this study, the heaviest fresh weight of whole plant (g) was obtained by using the high rate of cheleate calcium as it gave 1452.93 and 1471.63 g compared to 1092.73 and 1121.63 g for control in the first and second seasons, respectively. Moreover, spraying the plants of Helichrysum with calcium bicarbonate at the high rate resulted in highly significant increases in this parameter as it gave 1406.63 and 1398.96 g followed by using the medium rate of calcium bicarbonate which registered 1241.63 and 1257.96 g in

the first and second seasons, respectively. Irrespective control, the lowest mean value in this parameter was obtained by using the low rate of cheleate calcium as it gave 1156.50 and 1151.63 g in the first and second seasons, respectively.

A similar result has been reported by **Bhatt *et al.* (1993), Siddiqui and Bangerth (1995)** and **Raese *et al.* (1995)** they found that, spraying of 0.25 % calcium chloride were very effective in improving nutritional status, yield and quality of different pears and apples. Also, **Chen-Xiao Ting *et al.*, (2002)** reported that, the growth of pakchoi was apparently improved by lime and calcium magnesium phosphate application. Whereas, **Salim *et al.* (2002)** mentioned that rice grain yield was significantly higher in gypsum treated plots than the respective CaCl2 treated plots

6- Dry weight of the whole plant (g):

The data obtained on dry weight of the whole plant as affected by some treatments of the three used chemicals are presented in Table (9).

The results of the dry weight of the whole plant attained a parallel trend with the fresh weight of whole plant results with some little differences in the level of significance. In general, the heaviest dry weight of the whole plant was recorded by spraying Helichrysum plants by cheleate calcium at 150 ppm which gave 295.36 and 304.18 g compared to control which gave 240.32 and 235.54 g in the first and second seasons, respectively. Meanwhile, spraying calium carbonate at high rate (150 ppm) increased significantly dry weight of whole plant and ranked the second in

this concern. Also, medium rate of cheleate calcium followed descendingly by high rate of sodium silicate and medium rate of calcium bicarbonate gave the same trend of significant increases in whole plant dry weight and they not only had the same trend but also gave approximately near values. This trend was true in both seasons of this study.

The increase in dry weight of whole plant as result of using calcium sources is agreement with the results obtained by **Pare *et al.* (2001)** on alfalfa who showed that CaLF (a fertilizer produced from lignite) and $CaCl_2$ produced similar shoot, root and whole plant dry masses, which were much higher than when EDTA-Ca was applied. Mean while, **Singh and Nayyar (2001)** on cowpea found that, calcium carbonate reduced the tissue N concentration, there by mitigating the toxic effect of Ni and increasing the dry matter production in cowpea.

IV.1.A.2- On some flowering characteristics:

1- Flower diameter (cm):

According to data presented in Table (10) on the diameter of flower as affected by some treatments of micro-elements, it could be concluded that all treatments of the calcium sources and sodium silicate progressively increased the diameter of flower in both seasons, as compared with control. However, in the first season, spraying *Helichrysum bracteatum Andr.* plants with the high rate of calcium carbonate induced the highest diameter of flower as it gave 6.00 cm, followed descendingly by using the treatments of sodium silicate at 100 ppm and the medium rate of calcium bicarbonate (75 ppm) as they gave 5.33 and 5.30 cm, respectively. Besides, the high and medium rates of cheleate calcium resulted in highly significant increments in this parameter as they produced 5.26 and 5.00 cm, respectively. This trend was true only in the first season, while in the second one, calcium bicarbonate at 100 ppm showed its superiority on producing the highest diameter of flower as it gave 6.20 cm, followed descendingly by using the high rates of cheleate calcium and sodium silicate as they gave 5.50 and 5.23 cm, respectively. On contrary, the lowest diameter of the flower was gained on untreated plants (control) in both seasons. On the other hand, the remaining treatments occupied intermediate place in this concern.

These result were in harmony with that reported by **Subbiah *et al.* (1990)** on tomato who found that the best result were obtained with using calcium chloride at 0.2% and **Mauad *et al.* (2003)** on rice (*Oryza sativa*) reported that silicon increased the diameter of flowers.

Table (10): Effect of cheleate calcium, calcium bicarbonate and sodium silicate on flowering characteristic of *Helichrysum bracteatum Andr.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		Mean fl. diameter cm		No. of fl. in panicles / peduncle		F.W. of fl. Panicles g		D.W. of fl. Panicles g		Thickness of fl. panicles cm		Length of fl. Panicles cm	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		4.46	4.36	3.46	3.66	6.13	6.16	2.38	2.34	0.36	0.33	12.36	12.33
Cheleate calcium	50 ppm	4.66	4.60	3.73	4.30	6.83	6.96	2.82	2.71	0.36	0.40	13.23	13.16
	100ppm	5.00	4.90	4.16	4.83	8.23	8.56	3.29	3.36	0.43	0.46	14.13	14.73
	150 ppm	5.26	5.50	5.23	5.33	9.83	10.36	3.93	4.07	0.53	0.56	16.23	16.00
$Ca(HCO_3)_2$	50 ppm	4.73	4.70	3.40	4.30	7.20	6.96	2.80	2.89	0.43	0.43	13.00	13.30
	75 ppm	5.30	5.13	4.40	4.70	8.83	8.33	3.31	3.24	0.46	0.50	14.26	14.60
	150 ppm	6.00	6.20	5.66	5.50	10.06	10.50	3.98	4.04	0.53	0.53	16.63	16.03
Na_2SiO_3	50 ppm	4.86	5.00	3.76	3.93	6.50	6.36	2.53	2.71	0.36	0.40	13.83	13.80
	100 ppm	5.33	5.23	4.40	4.63	7.66	7.83	2.90	3.17	0.46	0.46	15.36	14.70
L.S.D.	0.05	0.262	0.464	0.647	0.448	0.416	0.477	0.427	0.434	0.08	0.076	1.12	0.93
	0.01	0.366	0.649	0.905	0.627	0.582	0.667	0.597	0.607	0.104	0.098	1.45	1.20

2) Number of flowers in panicles / peduncle

Data presented in Table (10) pointed out that all tested treatments of mineral nutrient succeeded in increasing the number of flowers in panicles / **peduncle** in both seasons. However, the greatest number of flowers in panicles / **peduncle** was attained by spraying *Helichrysum bracteatum Andr.* plants by $Ca(HCo_3)_2$ at the medium rate (75 ppm) as it gave 5.66 and 5.50, followed by using the high rate of cheleate calcium which ranked the second in this concern and gave 5.23 and 5.33 in the first and second seasons, respectively. On the contrary, the least number of flowers in panicles was recorded on untreated plants "control" which gave 3.46 and 3.66 in the first and second seasons, respectively. The other treatments took intermediate position in this connection.

The result agree with that reported by **Bhatt *et al.* (1993)** on apples and **Mauad *et al.* (2003)** on rice who reported that calcium and sodium silicate increased number of flowers per plants.

3) Fresh weight of flower panicles (g):

The data obtained on the fresh weight of flower (g) as affected by some treatments of Ca-cheleate, $Ca(HCO_3)_2$ and Na_2Sio_3 are presented in Table (10). The data showed that all treatments progressively increased the fresh weight of flower in both seasons of this study. However, the heaviest fresh weight of flower was obtained by spraying the plants with $Ca(HCO_3)_2$ at the high rate as it gave 10.06 and 10.50 g followed descendingly by using the high rate of cheleate calcium which recorded 9.83 and 10.36 g as compared with 6.13 and 6.16 g for control in the first and second seasons, respectively. Additionally, using the medium

rate of $Ca(HCo_3)_2$ in the first season and the medium rate of cheleate calcium in the second season resulted in highly significant increments in this parameter as it gave 8.83 and 8.56 g respectively.

The result agree with that reported by **Subbiah *et al.* (1990)** on tomato found that the best result were obtained with using calcium chloride at 0.2%.

4) Dry weight of flower panicles (g):

The data obtained on dry weight of flower as affected by various treatments of mineral nutrients shown in Table (10). The results of dry weight of flower attained a parallel trend with fresh weight of the flower results, with some differences in both seasons. In general, the heaviest dry weight of flower was gained by spraying the plants with the high rate of $Ca(HCo_3)_2$ and the high rate of cheleate calcium in the first season as they gave 3.98 and 3.92 g, respectively. The differences between the prementioned two treatments were non significant while, in the second season using the high rate of cheleate calcium proved to be the most effective treatment for increasing the dry weight of flower as it gave 4.07 g followed descendingly by using the high rate of $Ca(HCo_3)_2$ which gave 4.04 g. The differences between the aforementioned two treatments were did not reach to the level of significance. On the reverse, the lowest dry weight of flower was registered on untreated plants "control" as it gave 2.38 and 2.34 g in the first and second seasons, respectively. The rest treatments occupied in between position in this concern.

5) Thickness of flower panicles (cm):

Data presented in Table (10) indicated that most treatments of used mineral nutrients significantly increased the thickness of flower panicles in both seasons. However, the thickest flower panicles was gained by spraying *Helichrysum bracteatum Andr.* plants with the high rates of cheleate calcium and $Ca(HCo_3)_2$ in both seasons as they gave 0.53 and 0.56 cm for cheleate calcium and 0.53 and 0.53 cm for $Ca(HCo_3)_2$ in the first and second seasons, respectively. On the contrary, the lowest mean value of this parameter was recorded on control. Irrespective control, the lowest mean values of this parameter were gained by using the low rates of cheleate calcium and Na_2Sio_3 in both seasons.

The result agree with that reported by, and **Mauad *et al.* (2003)** on rice who reported that silicon increased cellular wall thickness.

6) Length of flower panicles (cm):

The results obtained for the length of flower panicles were averaged and exhibited in Table (10). These results could be summarized as follows:

The tallest flower panicles of *Helichrysum bracteatum* Andr. flower was obtained by spraying the plants with the high rate of $Ca(HCO_3)_2$ as it gave 16.63 and 16.03 cm followed descendingly by using the high rate of cheleate calcium which gave 16.23 and 16.00 cm in the first and second seasons, respectively. The differences between all the abovementioned treatments were non-significant in both seasons on the reverse, the shortest panicles was obtained on control plant which recorded 12.36 and 12.33 cm in the first and second seasons, respectively.

IV.1.A.3- On chemical composition:

(1) Leaf nitrogen content (%)

Data presented in Table (11) indicated that N content in leaves of *Helichrysum bracteatum Andr.* plants was greatly increased by using all treatments of the two calcium sources and sodium silicate as compared to control in both seasons. However, the high rate of $Ca(HCo_3)_2$ (100 ppm) was the most effective treatment for increasing leaf N% and gave 1.74 and 1.65% compared with 1.24 and 1.28% for control in the first and second seasons, respectively. Also, the medium rate of $Ca(HCo_3)_2$ in the first season and the high rate of cheleate calcium in the second season resulted in highly significant increases in this parameter as they gave 1.66 and 1.62%, respectively. Besides, spraying the plants with the low rate of $Ca(HCo_3)_2$ resulted in highly significant increases in this parameter and ranked the third in this concern.

These result are in confirmaty with that reported by **Dhru and Pal (1991)** on *Nerium oleander* and **El-Sallami (1996)** on *Ficus benjamina,* they found that calcium treatments increased N content in plant leaves compared with control plants.

(2) Leaf phosphorus content (%)

Data illustrated in Table (11) showed that all tested concentrations of used mineral nutrient significantly increased leaf phosphorus content (%). However, spraying *Helichrysum bracteatum Andr.* plants with $Ca(HCo_3)_2$ at the high rate (100 ppm) showed to be the most effective treatment for producing the richest

Table (11): Effect of cheleate calcium, calcium bicarbonate and sodium silicate N, P, K, Ca and total carbohydrate content in leaves of *Helichrysum bracteatum Andr.* plants in two successive seasons (2002/2003 and 2003/2004).

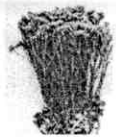
Characters		N%		P%		K%		Ca%		T. carbohydrates%	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		1.24	1.28	0.58	0.57	1.37	1.45	1.15	1.22	10.6	10.16
Cheleate calcium	25 ppm	1.42	1.44	0.63	0.62	1.45	1.51	1.31	1.39	12.62	11.43
	50 ppm	1.54	1.54	0.66	0.67	1.55	1.56	1.51	1.53	13.65	12.59
	100 ppm	1.60	1.62	0.67	0.67	1.63	1.67	1.75	1.70	14.33	13.30
$Ca(HCO_3)_2$	50 ppm	1.61	1.57	0.62	0.62	1.52	1.58	1.41	1.43	11.71	11.45
	75 ppm	1.66	1.59	0.66	0.65	1.64	1.63	1.52	1.55	12.69	12.32
	100 ppm	1.74	1.65	0.91	0.67	1.55	1.59	1.69	1.66	13.51	13.15
Na_2SiO_3	50 ppm	1.51	1.45	0.59	0.61	1.43	1.49	1.45	1.49	11.14	10.71
	100 ppm	1.55	1.48	0.63	0.60	1.52	1.58	1.59	1.65	11.61	11.13
L.S.D.	0.05	0.025	0.048	0.051	0.048	0.077	0.781	0.15	0.16	0.262	0.197
	0.01	0.034	0.069	0.071	0.067	0.106	0.108	0.195	0.208	0.361	0.271

leaf phosphorus content as it gave 0.91% compared for 0.58% for control in the first season. Additionally, the high rate of cheleate calcium resulted in highly significant increase in this parameter as it gave 0.67%, followed descendingly by using the medium rates of $Ca(HCo_3)_2$ and cheleate calcium. The differences between the three abovementioned treatments were non significant as the plants under such treatments had nearly close leaf phosphorus content (%). This trend was true only in the first season, while in the second one using the high rates of $Ca(HCo_3)_2$ and cheleate calcium and the medium rate of cheleate calcium approved to be the most effective treatments for increasing leaf phosphorus content (%). The differences between the three abovementioned treatments were so small to be significant as they exhibited not only insignificant variance between each other but also, showed the same value (0.67 for each).

The abovementioned results were in accordance with that reported by **El-Sallami (1996)** on *Ficus benjamina* who found that addition the nutrient solution such as $CaSO_4$ (1.2 mg/liter), to the media of plants increased the leaf content of P compared with control plants and **Lee *et al.* (2000)** on cucumbers cv. Eunsungback dadagi found that P increased in leaves by spraying si treatment.

(3) Leaf potassium content (%)

The obtained results of potassium content (%) in leaves of *Helichrysum bracteatum Andr.* plants in response to different treatments of some micro-nutrients are tabulated in Table (11) cleared that spraying the plants with $Ca(HCo_3)_2$ at 75 ppm gave the



most promising effect in increasing the leaves content of potassium (%) as it gave 1.63% followed by using the high rate of cheleate calcium which gave 1.63% compared with 1.37% for control in the first season. Besides, using the medium rate of cheleate calcium and the high rate of $Ca(HCo_3)_2$ resulted in highly significant increase in this parameter. The differences between the two abovementioned treatments were non significant as the plants under such treatments had exactly the same value (1.55% for each). This trend was true only in the first season, while in the second one, the picture was completely changed. So, the greatest leaf potassium content was gained by using the medium rate of $Ca(HCo_3)_2$ as they recorded 1.67 and 1.63% compared with 1.45% for control, respectively. Moreover, spraying the plants with the low rate of $Ca(HCo_3)_2$ and Na_2Sio_3 at 100 ppm resulted in highly significant increments in this parameter and exhibited not only insignificant variance between each other but also, showed the same value of leaf potassium content (1.58% for each).

The result was in agreement with that reported by **El-Sallami (1996)** on *Ficus benjamina* who found that , addition the nutrient solution such as $CaSo_4$ (1.2 mg/liter), to the media of plants increased the leaf content of K compared with control plants.

(4) Leaf calcium content (%)

According to data presented in Table (11), it could be concluded that all the three used mineral nutrient treatments progressively increased leaf calcium content (%) of *Helichrysum bracteatum Andr.* plants as it sprayed concentrations increased as

compared with control in both seasons of this study. However, the highest mean value of leaf calcium content (%) was recorded by spraying the plants with the high rate of cheleate calcium as it registered 1.75 and 1.70% compared with 1.15 and 1.22% for control in the first and second seasons, respectively. Moreover, using the high rate of $Ca(HCo_3)_2$ resulted in highly significant increments in this parameter as it gave 1.69 and 1.66% followed descendingly by using Na_2Sio_3 at 100 ppm which gave 1.59 and 1.65%, respectively.

The result agree with that reported by **Jacques *et al.* (1991)** on poinsettia cultivars, **Saito *et al.* (1993)** on muskmelon and **Starkey and Pedersen (1997)** on roses they found that spraying calcium increased calcium content in the leaves.

(5) Leaf total carbohydrates content (%)

Data presented in Table (11) indicated that all tested concentrations of the two calcium sources and sodium silicate progressively increased leaf total carbohydrates content of *Helichrysum bracteatum Andr.* plants. Generally, the richest leaf total carbohydrates content (%) was gained by using the high rate of cheleate calcium (100 ppm) compared with other treatments and control which gave 10.6 and 10.16 (%) in the first and second seasons, respectively. Also, using the medium rate of cheleate calcium in the first season and the high rate of calcium bicarbonate in the second one resulted in highly significant increments in this parameter as they gave 13.65 and 13.15%, respectively.

Moreover, spraying the plants with the high rate of calcium bicarbonate in the first season progressively increased leaf total carbohydrates content (%) as they gave 13.51 and 12.59%, respectively and ranked the third in this concern.

The result agree with that reported by **El-Sallami (1996)** on *Ficus benjamina* who found that, addition of the nutrient solution such as $CaSo_4$ (1.2 mg/liter) increased total carbohydrate content compared with control.

IV.1.B- Growth retardants

The effect of paclobutrazol and dikegulac sodium on vegetative growth, flowering and chemical composition of *Helichrysum bracteatum* Andr. plants.

IV.1.B.1- On some vegetative measurements

1) Plant height (cm):

According to data presented in Table (12) on the plant height of *Helichrysum bracteatum Andr.* plant as affected by using some treatments of growth retardants, it could be concluded that all treatments of the two used growth retardants (paclobutrazol and dikegulac-sodium) succeeded in decreasing the plant height in both seasons, with the exception of the low rate of PP_{333} (25 ppm) at the second season only as it gave the same value of untreated control plants 112.66 cm compared with 112.66 cm for control. However, the greatest reduction on plant height of Helichrysum plant was obtained by using the high rate of dikegulac-sodium (750 ppm) as it gave 98.06 cm compared to 115.33 cm for control in the first season, followed descendingly by using the high rate of PP_{333} (100 ppm) which gave 101.16 cm. Besides, the medium rates of dikegulac-sodium and paclobutrazol resulted in highly significant decreases in this parameter as they gave 104.06 and 108.06 cm, respectively. This trend was true only in the first season, while in the second one, PP_{333} at the high rate (100 ppm) showed its superiority in decreasing the plant height of Helichrysum as it gave 94.50 cm, followed by using the high rate of dikegulac-sodium (750 ppm) and the medium rate of PP_{333} (50 ppm) as they gave 96.30 and 99.50 cm, respectively. The differences between the prementioned two treatments were so small to be significant.

Table (12): Effect of paclobutrazol and Dikogulac sodium on vegetative growth of *Helichrysum bracteatum Andr.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		Plant height cm		No. of leaves /plant		F.W. of leaves g/plant		D.W. of leaves g/plant		F.W. of plant g		D.W. of plant g	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		115.33	112.66	119.66	117.33	170.66	167.33	28.16	27.06	1085.20	1096.60	234.30	238.60
PP_{333}	25 ppm	114.40	112.76	121.26	120.10	173.20	171.63	30.59	29.17	1162.20	1135.96	240.18	244.22
	50 ppm	108.06	99.50	126.40	123.76	180.30	179.16	33.06	32.24	1221.06	1246.53	256.42	259.73
	100 ppm	101.16	94.50	130.50	126.53	178.43	172.96	32.11	32.95	1224.63	1079.30	248.15	237.44
Dikogulac sodium	250ppm	115.30	111.76	122.96	117.33	175.53	179.63	32.18	32.33	1150.50	1167.30	241.60	243.14
	500ppm	104.06	101.73	129.20	120.86	188.43	191.06	34.54	35.10	1258.40	1214.30	255.81	255.00
	750ppm	98.06	96.30	133.30	121.86	187.63	189.73	33.77	36.04	1215.63	1130.96	251.16	239.41
L.S.D.	0.05	3.21	6.81	3.18	3.46	5.61	9.38	3.14	1.84	28.61	32.48	8.25	9.11
	0.01	4.49	9.53	4.45	4.84	7.85	13.13	4.39	2.57	40.05	45.47	11.55	12.75

The result of this investigation were insured by that reported by **Barrett (1982)** on *Chrysanthemum*, **Walker (1986)** on *Azalea sinsii*, **WainWright and Irwin (1987)** on *Antirhinum majus*,. **Nasr (1997)** on *Gerbera*, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2000)** on *Strelitzia reginae* plant stated that spraying with PP_{333} at 50, 100 or 200 ppm decreased plant height. **Lee and Lee (1990) on gerbera Abou El-Ghait (1993)** on *Epipreinmum aureum* who found that, dikegulac sodium at the rate of 100 ppm decreased plant height. **Banko and Stefani (1996),** reported that, Atrimmec (Dikegulac sodium) at 5000 ppm decreased length of new shoots of *Elneagnus pungenus* and Ilex crenata.

2- Number of leaves / plant:

The results obtained for number of leaves as affected by some growth retardants treatments were averaged and exhibited in Table (12). They could be summarized as follow: the number of leaves of Helichrysum plant was greatly affected by using all treatments of the two growth retardants as compared to control in both seasons. Therefore, the greatest number of leaves per plant was obtained by using the high rate of dikegulac-sodium (750 ppm) as it gave 133.30 leaves/plant compared to 119.66 for control in the first season. Also, PP_{333} at 100 ppm resulted in highly significant increment in this parameter followed descendingly by using the medium rate of dikegulac-sodium as they gave 130.50 and 129.20 leaves / plant, respectively.

The differences among the abovementioned two treatments were non significant as the plants under such treatments had nearly close leaves number values. This trend was true only in the first

season, while in the second one PP_{333} at the high rate showed its superiority in this parameter as it gave 126.53 leaves / plant compared with 117.33 leaves / plant for control. Besides, the medium rate of PP_{333} (50 ppm) resulted in highly significant increases in this parameter followed by spraying the plants with the high rate of dikegulac-sodium.

The obtained results in the present study were on the line with those obtained by **Nasr (1997)** on *Gerbera*, **Tawila (2000)** on *Polianthes tuberosa*, **Saker (2004)** on *Hibiscus rosa-sinensis* and *Taberna montana coronaria,* they found that spraying PP_{333} increased the number of leaves. Also **Youssef (2000)** on *Sterlitizia reginae* found that dikegulac-sodium at 500 ppm gave the highest number of leaves / plant.

3- Fresh weight of leaves / plant (g):

The data gained on fresh weight of leaves as affected by various treatments of PP_{333} and dikegulac-sodium are presented in Table (12). In general, the heaviest fresh weight of leaves / plant was obtained by using the medium rate of dikegulac-sodium (500 ppm) as it gave 188.43 and 191.06 g compared to 170.66 and 167.33 g for control in the first and second seasons, respectively. Also, sprayed Helichrysum plants with dikegulac-sodium at 750 ppm and PP_{333} at 500 ppm resulted in highly significant increases in this parameter.

The aforementioned results were confirmed with those obtained by **Tawila (2000)** on *Polianthes tuberosa* who stated that, spraying PP_{333} at (50 ppm) increased the fresh weight of leaves. Similar trend of results was reported by **Abd El-Fatah (2001)** on

some ornamental shrubs (*Adhatoda vasica, Hibiscus rosa-sinensis* and *Phyllanthis emblica*) found that, PP_{333} at 50 and 100ppm increased the fresh weight of leaves .

4- Dry weight of leaves / plant (g):

Concerning the data presented in Table (12), it was obvious that all treatments of the two growth retardants increased the dry weight of leaves as compared to control in both seasons. However, the heaviest dry weight of leaves / plant was obtained by spraying Helichrysum plant with dikegulac-sodium at the medium rate (500 ppm) as it gave 34.54 g compared with 28.16 g for control in the first season. Additionally, dikegulac-sodium at 750 ppm and PP_{333} at 50 ppm resulted in highly significant increases in this parameter as they gave 33.77 and 33.06 g, respectively. The differences among the two abovementioned treatment were so small to be significant.

This trend was true only in the first season, while in the second one dikegulac-sodium at the high rate (750 ppm) showed its superiority in increasing this parameter as it gave 36.04 g compared with 27.06 g for control, followed descendingly by spraying the plants with the medium rate of dikegulac-sodium and the high rate of PP_{333}.

These results were in agreement with that reported by. **Nasr (1997)** on *gerbera*, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2000)** on *Strelitzia reginae* found that, spraying PP_{333} at 50, 100 or 200 increased the dry weight of leaves. **Malek *et al.* (1992)** on *Rhododendron calendulaceum* who reported that, dikegulac sodium decreased dry weight of leaves as the dikegulac concentration increased

5- Fresh weight of whole plant (g):

The data obtained on fresh weight of plant as affected by some treatments of growth retardants are averaged in Table (12). Data showed that the fresh weight of the plant was greatly increased by using all the treatments of paclobutrazol and dikegulac-sodium. So, the heaviest fresh weight of the plant was recorded by spraying the plants with dikegulac-sodium at the medium rate (500 ppm) as it gave 1258.40 g compared with 1085.20 g for control in the first season, followed descendingly by using the high and medium rates of PP_{333} as they gave 1224.63 and 1221.06 g, respectively. The differences between the two abovementioned treatments were small to reach the level of significance. This trend was true only in the first season, while in the second one PP_{333} at the medium rate (50 ppm) showed its superiority in this parameter as it produced the heaviest fresh weight of the plant as it gave 1246.53 g, followed descendingly by using the treatments of dikegulac-sodium at 500 ppm and the high rate of ppm (100 ppm) as they gave 1214.30 and 1079.30 g, respectively. Whereas, the least fresh weight of the plants was obtained on untreated plants (control) which gave 1096.60 g.

In agreement with our results were those obtained by **Salem and El-Kateeb (1988)** on *Chrysanthemum* who found that, spraying PP_{333} at 625-3000 ppm increased the whole fresh weight of plant. **El-Mowafy (1996)** on *Pelargonium graveolens* found that, PP_{333} (40 and 60 ppm) increased fresh weight of herb.

6- Dry weight of whole plant (g):

Data on dry weight of the plant as affected by some treatments of PP_{333} and dikegulac-sodium are given in Table (12). Data showed that all used treatments progressively increased the dry weight of the plant as its sprayed concentrations increased as compared with control in both seasons. Therefore, the heaviest dry weight of the plant was obtained by using PP_{333} at the medium rate (50 ppm) as it gave 256.42 and 259.73 g compared with 234.30 and 238.60 g for control, in the first and second seasons, respectively. Also, the medium rate of dikegulac-sodium resulted in highly significant increments in this parameter as it gave 255.81 and 255.00 g followed descendingly by using the high rates of dikegulac-sodium and PP_{333} in the first season and the low rates of PP_{333} and dikegulac-sodium in the second one.

The abovementioned results were in harmony with that reported by **Salem and El-Khateeb (1988)** on *Chrysanthemum* who found that pp_{333} increased dry weight of plant.

IV.1.B.2- On some flowering characteristics:

1- Flower diameter (cm):

Data tabulated in Table (13) showed that all tested concentrations of paclobutrazol and dikegulac-sodium succeeded in increasing inflorescence diameter in both seasons of this work. However, spraying *Helichrysum bracteatum Andr.* plants with PP_{333} at the high rate showed to be the most effective treatment for increasing this parameter as it recorded 5.53 and 5.73 cm when compared with 4.52 and 4.48 cm for control in the first and second seasons, respectively. Besides, using the high rate of dikegulac sodium (750 ppm) resulted highly significant increment in this parameter and ranked the second in this respect as it gave 5.40 and 5.40 cm followed descendingly by using the medium rate of dikegulac sodium which gave 5.30 and 5.33 cm in the first and second seasons, respectively.

The differences between the two abovementioned treatments were non significant in both seasons.

In accordance with the aforementioned results were that reported by **Helal (1993) and Awad *et al.* (1994)** on *Euphorbia pulcherrima* found that 50 and 75 ppm of PP_{333} increased diameter of the flowers.

2- Number of flowers in panicles /peduncle

Data gained on number of flowers in panicles / peduncle as affected by some treatments of growth retardants are presented in Table (13). The data indicated that all tested treatments progressively increased the number of flowers in panicles /peduncle in both seasons. Meanwhile, spraying *Helichrysum bracteatum Andr.*

Table (13): Effect of paclobutrazol and Dikogulac sodium on flowering characteristics of *Helichrysum bracteatum Andr.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		Mean fl. diameter		No. of fl. in panicles / peduncle		F.W. of fl. Panicles g		D.W. of fl. Panicles g		Thickness of fl. Panicles cm		Length of Panicles cm	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		4.52	4.48	3.49	3.46	6.18	6.52	2.42	2.51	0.36	0.33	12.23	12.31
PP_{333}	25 ppm	4.76	4.73	3.63	4.03	7.13	7.23	2.73	2.83	0.43	0.36	13.63	13.43
	50 ppm	5.16	5.26	4.30	4.63	8.16	9.13	3.20	3.58	0.46	0.46	14.16	14.43
	100ppm	5.53	5.73	4.83	4.90	9.50	10.10	3.73	3.93	0.53	0.50	13	12.90
Dikogulac sodium	250 ppm	4.83	4.93	3.53	3.80	7.43	7.13	2.87	2.72	0.43	0.43	13.80	13.83
	500 ppm	5.30	5.33	4.20	4.80	8.56	8.46	3.33	3.32	0.50	0.53	13.06	13.50
	750 ppm	5.40	5.40	4.63	5.00	9.26	9.60	3.61	3.89	0.56	0.56	12.66	12.76
L.S.D.	0.05	0.211	0.421	0.496	0.324	0.543	0.518	0.396	0.389	0.09	0.68	1.01	0.89
	0.01	0.295	0.589	0.694	0.453	0.760	0.725	0.554	0.544	0.117	0.88	1.31	1.15

plants with the high rate of paclobutrazol (100 ppm) approved to be the most effective treatment for increasing this parameter as it gave 4.83, followed descendingly by using the high rate of dikegulac sodium which ranked the second in this concern as it gave 4.63. Also, using the medium rate of PP_{333} resulted in highly significant increment in this parameter and ranked the thrid in the first season, while in the second one, the picture was completely changed. So, using the high rate of dikegulac sodium showed its superiority in this concern as it gave 5.00, followed descendingly by using the high rate of PP_{333} and the medium rate of dikegulac sodium as they gave 4.90 and 4.80, respectively. On the contrary, the lowest mean values of this parameter were obtained on untreated plants in both seasons, as it gave 3.49 and 3.46 in the first and second seasons, respectively. The other treatments took intermediate position in this concern.

These results were insured with that reported by **Heursel and Witt, (1985)** on Azalea simsii, **Mao *et al.* (1991)** on *Salvia splendens* and **Abou El-Ghait and Wahba (1994)** on *Viola odorata,* L. who found that, pp_{333} increased the number of flowers plant.

3- Fresh weight of flower panicles (g):

Data presented in Table (13) indicated that most applied treatments of the two used growth retardants significantly increased the fresh weight of flower panicles in both seasons. So, spraying *Helichrysum bracteatum Andr.* plants with the high rate of PP_{333} appeared to be the most effective treatment for increasing the fresh weight of flower panicles as it gave 9.50 and 10.10 g followed by

using the high rate of dikegulac sodium at the high rate (750 ppm) as it gave 9.26 and 9.60 g in the first and second seasons, respectively. Additionally, using the medium rates of dikegulac sodium and paclobutrazol resulted in highly significant increments in this parameter in both seasons.of this work.

Thees results were in agreement with that reported by **Porter and Show (1983)** on *Lavandula angustifolia* xL. latifolia, **Maghazy (1991)** on *Viola odorata* **Abou El-Ghait and Wahba (1994)** on *Viola odorata*, **Haggag (1997)** on *Chrysanthemum,* they found that, spraying PP_{333} and dikegulac sodium increased fresh weight of flowers.

4- Dry weight of the flower panicles (g):

The data obtained on dry weight of flower panicles as affected by some treatments of growth retardants are presented in Table (13). The results of dry weight of flower panicles attained the same trend with the results of the fresh weight of flower panicles in both seasons of this investigation. Generally, the highest mean values of this parameter were obtained by sprayed *Helichrysum bracteatum Andr.* plants with the high rate of PP_{333} as it gave 3.73 and 3.93 g followed by using the high rate of dikegulac sodium which gave 3.61 and 3.89 g compared with 2.425 and 2.51 g for control, in the first and second seasons, respectively.

The abovementioned results were in harmony with that reported by **Maghazy (1991)** on *Viola odorata* and **Haggag (1997)** on *Chrysanthemum* **Al-Badawy and Abdalla (1984)** on yarrow plant who reported that, spraying pp_{333} and dikegulac sodium increased the dry weight of flowers.

5- Thickness of flower panicles (cm):

Data presented in Table (13) pointed out that all tested concentrations of the two used growth retardants significantly increased the thickness of flower panicles in both seasons of this work. Meanwhile, spraying *Helichrysum bracteatum Andr.* plants with the high rate of dikegulac sodium was considered to be the most effective treatment for increasing the thickness of flower panicles in both seasons of this study and ranked the first in this concern as it gave 0.56 and 0.56 cm compared with 0.36 and 0.33 cm for control in the first and second seasons, respectively. Also, using the high rate of PP_{333} and the medium rate of dikegulac sodium resulted in highly significant increment in this parameter as they gave 0.53 and 0.50 cm in the first season, respectively. Besides, using the medium rate of dikegulac sodium and the high rate of PP_{333} resulted in highly significant increases in this parameter as they recorded 0.53 and 0.50, respectively.

The result was in accordance with that reported by **Tawila (2000)** on *Polianthes tuberosa* he found that, using pp_{333} at 50 ppm significant increased thickness of flower stalk.

6- Length of flower panicles (cm):

Data tabulated in Table (13) showed that all applied treatments of paclobutrazol and dikegulac sodium succeeded in decreasing the length of flower panicles of *Helichrysum bracteatum Andr.* plants in both seasons of this study. However, the lowest flower panicles were observed on the plants which sprayed with the medium rate of PP_{333} (50 ppm) as it registered 11.16 and 11.43 cm

followed descendingly by using the medium rate of dikegulac sodium as it gave 10.66 and 10.50 cm compared with 13.23 and 13.31 cm for control in the first and second seasons, respectively. Also, spraying the plants with the high rate of PP_{333} in the first season and the medium rate of dikegulac sodium in the second one resulted in significant decreases of this parameter as they gave 11.00 and 10.50 cm, respectively.

The results of the present work were on line with that reported by **Adriansen (1985)** on *Chrysanthemum,* **Wainwright and Irwin (1987)** on *Antirrhinum majus* and **Youssef (2004)** on *Strelitzia reginae* who mentioned that, spraying PP_{333} and dikegulac sodium at high concentration (100 ppm) decreased flower spike length.

IV.1.B.3- On some chemical composition:

1- Leaf nitrogen content (%):

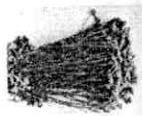
According to data presented in Table (14) on leaf nitrogen content (%) as affected by PP_{333} and Dikegulac-sodium, it could be concluded that all paclobutrazol treatments i.e., 25, 50 and 100 ppm showed a high increments upon leaf nitrogen content (%) as they caused highly significant increases in this parameter when compared with the control in both seasons, However, spraying *Helichrysum bracteatum* Andr. plants with the medium rate of PP_{333} showed its superiority in this concern as it gave 1.65 and 1.68% compared with 1.27 and 1.31% for control in the first and second seasons, respectively. Also, using PP_{333} at the low rate in the first season and the high rate of PP_{333} at the second one resulted in highly significant increment in this parameter as they recorded 1.56 and 1.57 %, respectively.

As for the effect of dikegulac-sodium, it was obvious that all treatments succeeded in increasing leaf nitrogen content (%) of Helichrysum plants in both seasons. Meanwhile, using the medium rate of dikegulac sodium approved to be the most effective treatment for increasing leaf nitrogen content as it gave 1.66 and 1.57% followed by the high rate which recorded 1.60 and 1.55%, respectively.

These results were in accordance with that reported by **Haggag (1997)** on *Chrysanthemum*, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2004)** on *Strelitzia reginae*, who stated that, application of PP_{333} increased N percentage in leaves.

Table (14): Effect of paclobutrazol and Dikogulac sodium on N, P, K, Ca and total carbohydrate content in leaves of *Helichrysum bracteatum Andr.* plants in two successive seasons (2002/2003 and 2003/2004).

Characters		N%		P%		K%		Ca%		T. carbohydrates%	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		1.27	1.31	0.56	0.55	1.42	1.48	1.19	1.20	10.67	10.82
PP_{333}	25 ppm	1.56	1.54	0.60	0.61	1.71	1.59	1.37	1.40	11.23	11.34
	50 ppm	1.65	1.68	0.66	0.65	1.80	1.66	1.48	1.53	12.46	13.17
	100 ppm	1.54	1.57	0.62	0.63	1.70	1.62	1.46	1.45	11.83	12.53
Dikogulac sodium	250 ppm	1.52	1.47	0.60	0.59	1.68	1.58	1.48	1.50	11.51	11.25
	500 ppm	1.66	1.57	0.65	0.65	1.86	1.64	1.41	1.47	11.96	11.72
	750 ppm	1.60	1.55	0.63	0.61	1.83	1.60	1.49	1.56	12.23	12.12
L.S.D.	0.05	0.027	0.046	0.049	0.043	0.069	0.721	0.14	0.15	0.268	0.193
	0.01	0.037	0.064	0.068	0.060	0.101	1.009	0.182	0.195	0.375	0.270



2- Leaf phosphorus content (%):

It is quite evident that leaf phosphorus content (%) of *Helichrysum bracteatum* Andr. plants was positively responded to all treatments of this study. Data obtained in Table (14) showed that all treatments of paclobutrazol resulted in highly significant increments in this parameter in both seasons. However, plants sprayed with PP_{333} at 50 ppm appeared to be the most effective treatment for producing the richest leaf phosphorus content as it gave 0.66 and 0.65 % compared with 0.56 and 0.55% for control in the first and second seasons, respectively. Also, PP_{333} at 25 ppm in the first season and PP_{333} at 100 ppm in the second one resulted in highly significant increment in this parameter as they gave 1.56 and 1.57%. With respect to the effect of dikegulac sodium, it is obvious that all tested treatments of dikegulac sodium succeeded in increasing leaf phosphorus content in both seasons. However, spraying the plants with the medium rate approved to be the most effective treatment for increasing leaf phosphorus content as it gave 0.65 and 0.65% followed descendingly by using the high rate as it gave 0.63 and 0.61% in the first and second seasons, respectively.

The result agree with that reported by **Haggag (1997)** on *Chrysanthemum*, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2004)** on *Strelitzia reginae* who mentioned that spraying PP_{333} at 50, 100 and 200 ppm increased leaf P content.

3-Leaf potassium content (%):

Data presented in Table (14) exhibited that, all tested concentrations of paclobutrazol and dikegulac sodium significantly increased leaf potassium content in both seasons. However, in the first season, the highest mean value of leaf potassium content (%)

was gained by spraying the plants of Helichrysum with the medium rate of dikegulac sodium as it gave 1.86% followed descendingly by using dikegulac sodium at 750 ppm and the medium rate of PP_{333} as they recorded 1.83 and 1.80%, respectively. This trend was true only in the first season, while in the second one, the picture was completely changed, hence spraying the plants with PP_{333} at 50 ppm showed its superiority in increasing leaf potassium content as it registered 1.66%. Also, plants sprayed with the medium rate of dikegulac sodium and the high rate of PP_{333} resulted in highly significant increments in this parameter as they recorded 1.64 and 1.62%, respectively. On the contrary, the lowest mean value of this parameter was gained on untreated plants (control) as it gave 1.42 and 1.48% in the first and second seasons, respectively.

The abovementioned results were emphasized with that reported by **Haggag (1997)** on *Chrysanthemum*, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2004)** on *Strelitzia reginae* who mentioned that spraying PP_{333} at 50, 100, 200 ppm increased leaf K content.

4- Leaf calcium content (%):

Data of leaf calcium content (%) in dried leaf of *Helichrysum bracteatum* Andr. plants are presented in Table (14). It was obvious that all treatments of paclobutrazol and dikegulac sodium increased leaf calcium content (%) in both seasons with highly significant differences in all cases. So, the greatest mean value in this concern was obtained by spraying the plants with the high rate of dikegulac sodium (750 ppm) as it gave 1.49 and 1.56% followed descendingly by using the medium rate of PP_{333} which

registered 1.48 and 1.53% in the first and second seasons, respectively. Moreover, using the low rate of dikegulac sodium and the high rate of PP_{333} resulted in highly significant increases in this parameter in both seasons. On the reverse, the lowest mean value of this parameter was registered on untreated plants (control) which gave 1.19 and 1.20% in the first and second seasons, respectively.

5- Leaf total carbohydrates content (%):

It is quite evident that leaf total carbohydrates content (%) of *Helichrysum bracteatum Andr.* plants was positively responded to the all treatments of growth retardants under this study in both seasons. Data presented in Table (14) indicated that plants treated with the medium rate of PP_{333} resulted in the richest leaf total carbohydrates content as it registered 12.46 and 13.17% compared with 10.67 and 10.82% for control in the first and second seasons, respectively. Additionally, using the high rate of dikegulac-sodium and the medium rate of dikegulac sodium resulted in highly significant increment in this parameter in the first season as they gave 12.23 and 11.96% respectively, while in the second one, PP_{333} and dikegulac-sodium at the high rates showed its superiority in this concern.

The aforementioned results were in harmony with that reported by **Essa (1992)** on *Baccara Rosa,* **Awad *et al.* (1994)** on Poinsettia, **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2004)** on *Strelitzia reginae* who mentioned that, spraying PP_{333} at 50 and 100 ppm increased total carbohydrates content in the leaves.

IV.2- Second Part

Effect of stage of flower development of *Limonium sinuatum L.* and *Helichrysum bacteatum Andr* at harvest on number of flower and quality of dry flowers yield

IV.2.A- *Limonium sinuatum L.*

IV.2.A.1- Effect of stage of flower spike development at harvest:

Data presented in Table (15) demonstrated that the stage of flower development of *Limonium sinuatum L.* plants at harvest had a great influence on the number of flower spikes open before and after drying. So, it is obviously clear (Table 15) that the percentages of flower spikes open progressively increased with increasing the flower spikes development stage at harvest from bud stage till the full open stage. The superior value recorded was obtained with harvesting flower spikes at half open stage which significantly increased the percentage flowers open after drying. The percentage of increases was 0.38 over bud stage at harvest. On the other hand, the percentage of increases in the flowers open after drying was gradually decreased by increasing flower development at harvest.

As for the weight of breakage dust after two weeks of drying (g), it is clear from data tabulated in Table (15) that the abovementioned parameter was greatly affected by the development stage of flower spike at harvest. It is worthy to mentioned that bud stage was the superior stage of flower development which decreased significantly the loss in weight of dry flowers expressed as breakage dust, followed descendingly by the half open stage of flower development. In addition, the greatest loss in dry flowers weight was obtained by harvesting at

full open stage. Therefore, from the above mentioned results, it could be concluded that the most appropriate stage for flower harvest of *Limonium simiatum L.* to the porpose of everlasting flowers is the half open stage (it has a white stamens in the middle of each floret).

Table (15): Effect of stage of flower development of *Limonium sinuatum L.* at harvest on number of flower spikes open percentage and quality of dry flowers yield

Stage of flower development at harvest	Number of flower spikes open (%)		Weight of breakage dust after 2 weeks in (g)
	At harvest time	After drying	
1- Bud stage	0.00	0.30	0.01
2- Half open stage	0.31	0.68	0.02
3- Full open stage	0.71	0.95	0.10
L.S.D. at 5%	0.12	0.23	0.007
L.S.D. at 1%	0.18	0.31	0.009

IV.2.A.2- Effect of foliar application of mineral nutrients:

1. Weight of breakage dust of flowers (g):

Data obtained in Table (16) and Fig. (1) showed that the weights of flower breakage dust after flower spikes drying were determined. In both two seasons, increasing the concentration of cheleate calcium, calcium bicarbonate and sodium silicate gave a parallel decrease in the weights of breakage dust of *Limonium sinuatum L.* flowers. The lowest breakage dust of flowers was gained by spraying Limonium plant by Ca bicarbonate at the high rate (150 ppm) which gave 0.01 and 0.06 (g), followed by using the high rate of cheleate Ca which ranked the second in this concern and gave 0.04 and 0.05 in the first and second seasons, respectively.

2. Flowers reflexd percentage (bent neck):

Table (16) and Fig. (2) showed the percentage of *Limonium sinuatum L.* reflexed flower spikes. It quite noticed that increase the concentration of cheleate calcium, calcium bicarbonate and sodium silicate treatments decrease the geotropic case of Limonium flower stems. On the other hand, both second and third concentrations produced highly significant decrease in the bent neck of Limonium flower stems for the two seasons of treatments. Therefore, the lowest percentage of reflexed flower stem was obtained by using the high rate of cheleate Ca (150 ppm) which gave 6.6% and 3.3% compared to 23.3 and 26.6% for control in the first and second seasons, respectively. Also, Ca bicarbonate and sodium silicate at the height rate of (150 ppm) and (100 ppm) gave 6.6 and 6.6% of reflexed flower stems in the first and second seasons, respectively compared with control treatment.

Table (16): Effect of different concentrations of cheleate calcium, calcium bicarbonate and sodium silicate on breakage dust of flower stems, percentage of reflexed flower and the flowers colour of *Limonium sinuatum L.* after and before flowers drying.

Characters		Breakage dust of fl (g)		Percentage of reflexed fl. panicles		H.J. colour chart. flower		H.J. colour fl. for 15 day	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		0.20	0.18	23.3	26.6	89 A	88 A	89 B	89 B
Cheleate calcium	50 ppm	0.13	0.15	16.6	2.33	90 A	89 A	90 B	90 B
	100 ppm	0.10	0.12	13.3	10.3	90 A	90 A	91 B	90 B
	150 ppm	0.04	0.05	6.6	3.3	91 A	91 A	91 B	91 B
$Ca(HCO_3)_2$	50 ppm	0.13	0.16	20	20	89 A	89 A	90 B	90 B
	75 ppm	0.06	0.12	13.3	10.6	90 A	90 A	90 B	90 B
	150 ppm	0.01	0.06	6.6	6.6	90 A	90 A	91 B	91 B
Na_2SiO_3	50 Ppm	0.13	0.15	13.3	16.6	89 A	89 A	90 B	90 B
	100 ppm	0.05	0.07	6.6	6.6	90 A	90 A	90 B	90 B
L.S.D.	5%					N.S.	N.S.	N.S.	N.S.
	1%					N.S.	N.S.	N.S.	N.S.

Fig. (1): Effect of different concentrations of cheleate calcium, calcium bicarbonate and sodium silicate on breakage dust of *Limonium sinuatum* flowers during 2002/2003 and 2003/2004 seasons.

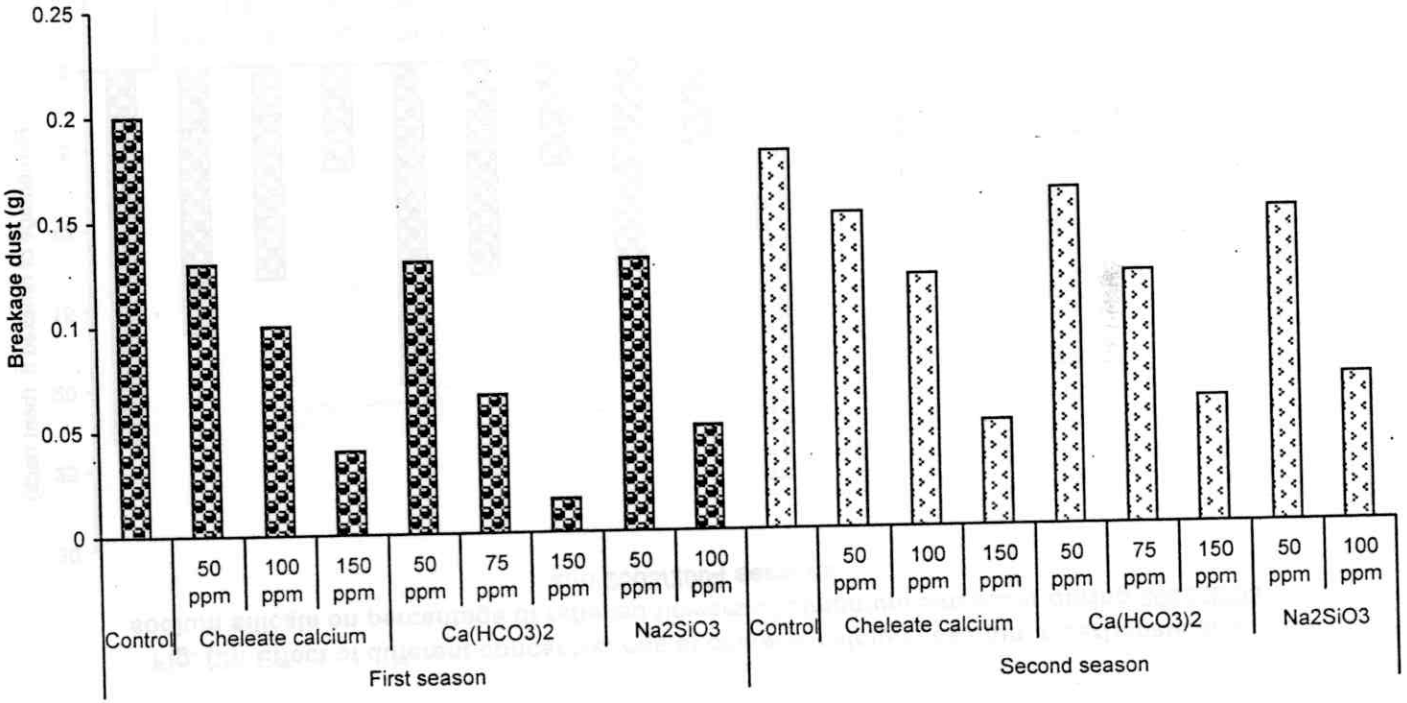
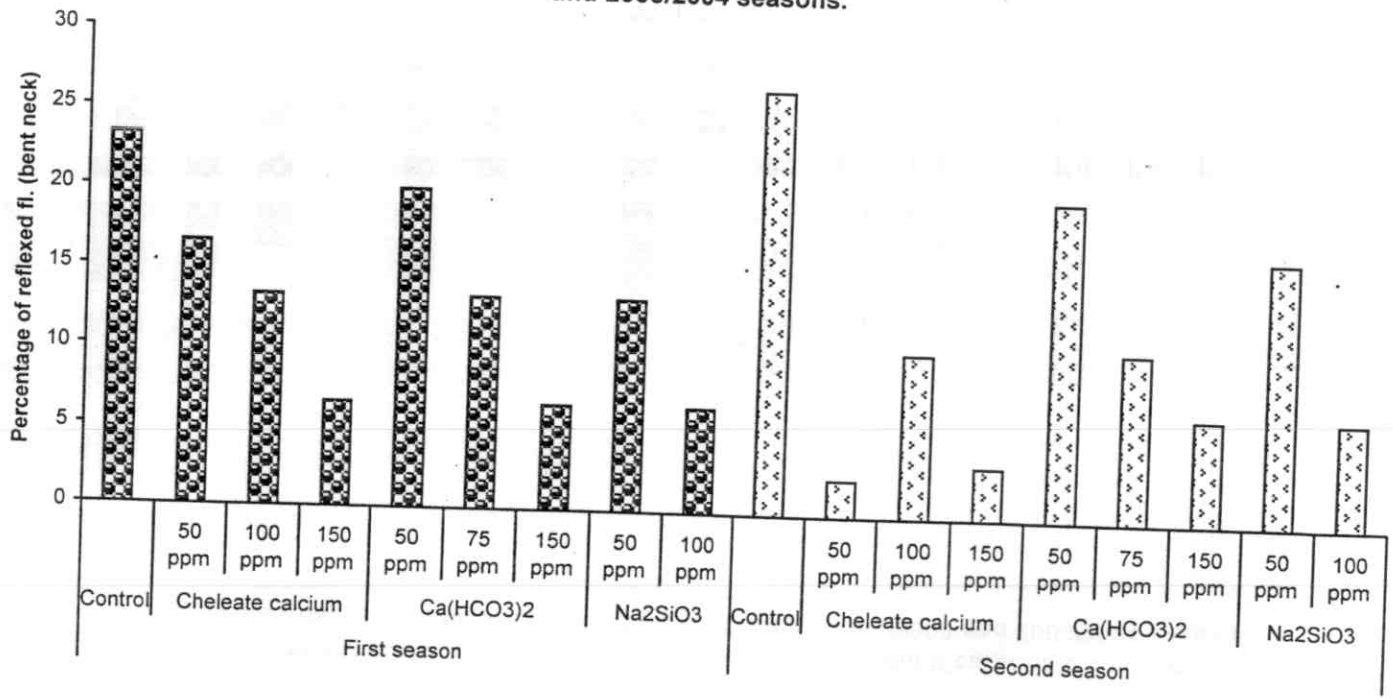


Fig. (2): Effect of different concentrations of cheleate calcium, calcium bicarbonate and sodium silicate on percentage of reflexed flowers of *Limonium sinuatum* during 2002/2003 and 2003/2004 seasons.



The results are in agreement with those of **Mauad *et al.* (2003)** on rice they reported that Silicon fertilization reduced the number of blank-spikelets per penicles.

3. Human judgment of colours density of flowers spikes:

According to data presented in Table (16) on Human judgment of the colour chart flowers spikes of *Limonium sinuatum L.* plant, all treatments were slightly affect the colour density of Limonium flower spikes, it could be concluded that all treatments of cheleate calcium, at high rate (150 ppm) produced the darkest flower spikes colour in both seasons of this study.

4. Human judgment of the colour density of Limonium flowers after 15 days from flowers spikes drying.

Data presented in Table (16) showed that all foliar application treatments by Ca cheleate, Ca bicarbonate and sodium silicate were weakly had a slight effected on colour density of *Limonium sinuatum L.* flowers after 15 days from their cutting. That mean that the colour of Limonium flowers did not changed during the time of flowers handling for the two seasons of treatments.

IV.2.A.3- Effect of foliar application of growth retardants:

1- Weight of breakage dust of flowers spikes (g):

Data tabulated in Table (17) and Fig. (3) cleared the effect of some growth retardants (Paclobutrazol and Dikegulac sodium) treatments in reducing the weight of breakage of *Limonium sinuatum L.* flowers during the handling of these flowers as dried flowers in the marketing. It could be summarized as follow, increase the concentration of both Paclobutrazol and Atrimmec decreased the breakage of flowers materials of Limonium in both seasons of treatments.

The lowest breakage dust of flower was obtained by using the high rate of PP_{333} (100 ppm) which gave 0.03 and 0.08 (g) compared to 0.16 and 0.20 (g) for control in the first and second seasons, respectively. Also, dikegulac sodium resulted in high significant decreasing in this character, using high rate of this treatment gave 0.05 and 0.06 (g) in the first and second seasons, respectively compared with control treatment.

2. Flowers reflexed percentage (bent neck):

Data in Table (17) and Fig. (4) showed that increasing the concentration of Paclobutrazol and dikegulac sodium led of decrease the bent neck of flowers spikes percentage of *Limonium sinuatum L.* flower stems and always gave the lowest reflex flower percentage. This trand was found with the highest concentration of both growth retardants. However, the greatest reduction on percentage of reflexed flower stem of *Limonium sinuatum L.* was obtained by using the high rate of PP_{333} (100 oom) and dikegulac sodium (750 ppm), they gave 6.6 and 6.6% in the first and second

Table (17): Effect of different concentrations of paclobutrazol and dikegulac sodium on breakage dust of flowers, percentage of reflexed flower and the flowers colour of *Limonium sinuatum L.* after and before flowers drying.

Characters		Breakage dust of fl (g)		Percentage of reflexed fl. panicles		H.J. colour chart. fl		H.J. colour fl. for 15 day	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		0.16	0.20	26.6	23.3	89 A	89 A	89 B	90 B
PP_{333}	25 ppm	0.10	0.12	23.3	20	90 A	89 A	90 B	90 B
	50 ppm	0.08	0.10	13.3	13.3	91 A	90 A	90 B	90 B
	100 ppm	0.03	0.08	6.6	6.6	91 A	91 A	91 B	91 B
Dikegulac sodium	250 ppm	0.13	0.14	20	16.6	90 A	89 A	90 B	90 B
	500 ppm	0.06	0.12	10	10	90 A	90 A	91 B	91 B
	750 ppm	0.05	0.06	6.6	6.6	90 A	91 A	92 B	91 B
L.S.D.	5%					N.S.	N.S.	N.S.	N.S.
	1%					N.S.	N.S.	N.S.	N.S.

Fig. (3): Effect of different concentrations of paclobutrazol and dikegulac sodium on breakage dust of *Limonium sinuatum* L. flowers during 2002/2003 and 2003/2004 seasons.

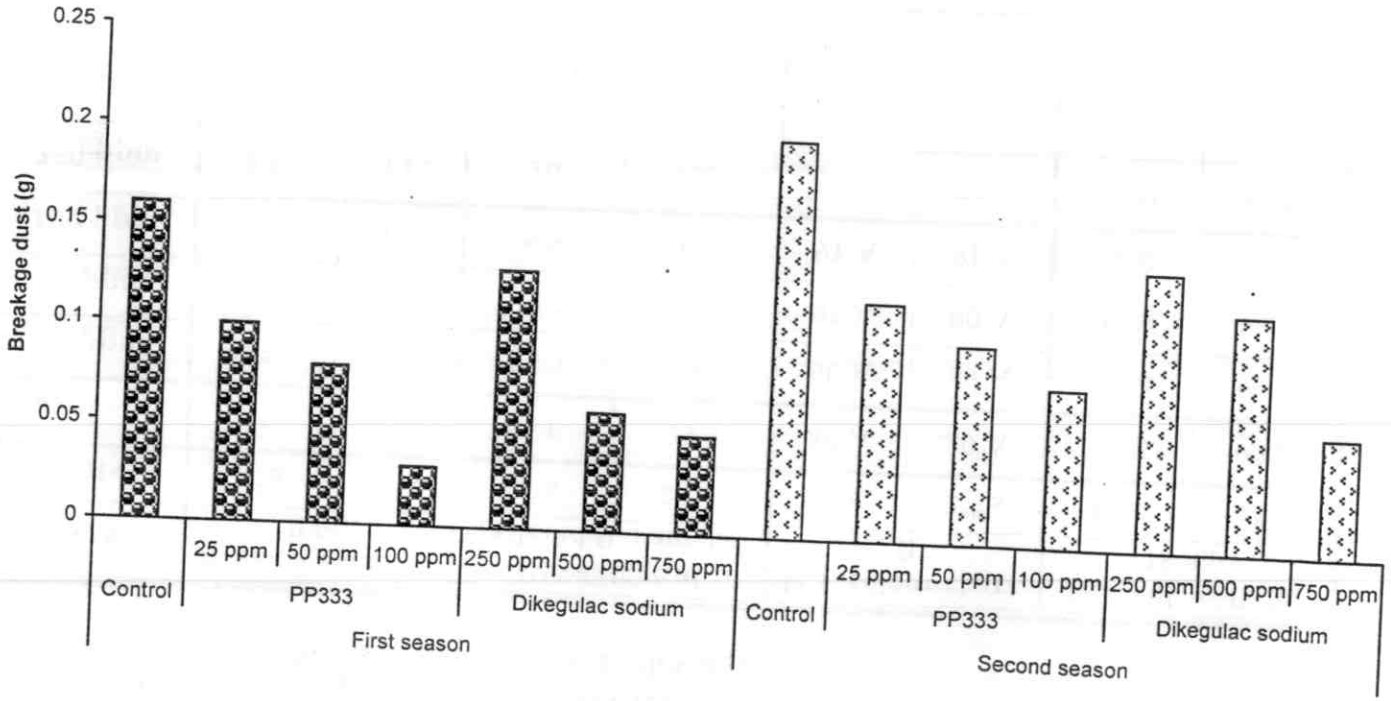
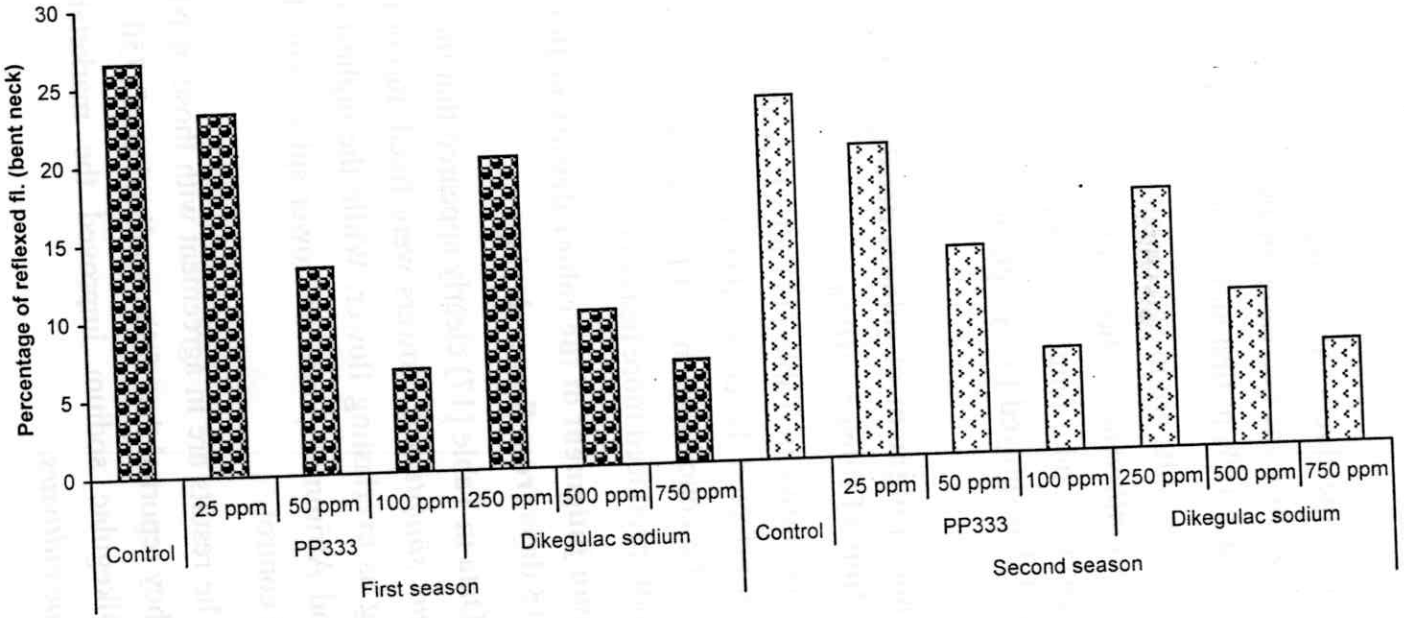


Fig. (4): Effect of different concentrations of paclobutrazol and dikegulac sodium on percentage of reflexed flowers of *Limonium sinuatum L.* during 2002/2003 and 2003/2004 seasons.



seasons, respectively. Also, dikegulac sodium at (500 ppm) resulted in high significant decreases in the percentage of reflexed flower stem, it gave 10% in first and second seasons, respectively.

The results are in agreement with those of **Adriansen (1985)** on *Chrysanthemum* who found that spraying PP_{333} reduced inflorescence spike length, **Auda *et al.* (2002)** on *Barleria cristata* reported that sprayed PP_{333} significantly increased stem diameter of plants.

3. Human judgment of colours density of flower spikes during the time of flower cutting.

As shows in Table (17) all PP_{333} and Atrimmec treatments were not affected the colour density of *Limonium sinuatum*. While increase the concentration of PP_{333} at (100 ppm) and Atrimmec at (750 ppm) produced more heavy colour than the control.

4. Human judgment of the colour density of flowers spikes after 15 days from flower drying:

Data in Table (17) clearly appeared that the colour density of *Limonium sinuatum L.* flowers were fixed during the time of their handling as everlasting flower. While the highest concentration of PP_{333} and Atrimmec produced flower spikes with full deep colour than the control.

The results are in agreement with those of **Nighingale *et al.* (1985)** they reported that, foliar application of (750, 1500 amd 2250 ppm) Dikegulac sodium improved the marketable of several *Kalanchoe cultivars.*

IV.2.B- *Helichrysum bracteatum Andr.*

IV.2.B.1- Effect of stage of flower development at harvest:

Data in Table (18) show that the stages of flower development of *Helichrysum bracteatum Andr.* plants at harvest had a promising effect on the number of flowers open before and after drying. Flowers harvested at tight bud, half and full open stages significantly increased the number of flowers open before and after drying, the percentages of increases were 3.33 for flowers number harvested at half bud stage over those harvested at tight bud stage.

Also, harvesting flowers at full opening stage produced 2.33% of flowers open over the harvesting at bud stage.

As for the weight of breakage dust after two weeks of drying (g), it is noticed from the data in the same Table that the weight of breakage dust was influenced by the development stage of *Helichrysum* flowers at harvest. Thus, the most appropriate stage flower development which significantly decreased the loss of weight of dry flowers expressed as breakage dust was bud harvest stage, followed by the half open stage of flower development. On the other hand, the heaviest breakage dust obtained by harvesting flowers of *Helichrysum bracteatum* at full open stage. From gained results, it could be concluded that the most favorite stage for handling *Helichrysum bracteatum* flowers as everlasting was the half open stage (before the first petal beginning to unfold calyx in a downward position).

Table (18): Effect of stage of flower develoment of *Helichrysum bracteatum Andr.* at harvest on number of flower and quality of dry flowers yield

Stages of flower development at harvest	Number of flower open (%)		Weight of breakage dust after 2 weeks in (g)
	At harvest time	After drying	
1- Bud stage	0.00	4.00	0.01
2- Half open stage	3.00	7.33	0.03
3- Full open stage	6.33	9.66	0.11
L.S.D. at 5%	1.83	2.32	0.008
L.S.D. at 1%	2.11	3.12	0.009

IV.2.B.2- Effect of foliar application of mineral nutrients:

1. Weight of breakage dust of flowers (g):

The data presented in Table (19) and Fig. (5) indicated that weight of flowers breakage dust after flower drying was determined. In both two seasons, increase the concentration of cheleate calcium, calcium bicarbonate and sodium silicate decreased the weights of breakage dust of *Helichrysum bractatum Andr.* flowers. That mean that spraying Helichrysum plants with cheleate calcium, calcium bicarbonate and Sodium silicate increased the handling ability during the everlasting marketing.

The lowest weight of breakage dust flower obtained by using the treatment of spraying calcium bicarbonate at (150 ppm) which gave (0.02 and 0.06 g) in the first and second seasons, respectively. Also, the treatment of spraying cheleate calcium at the same concentration gave (0.03 and 0.07 g) in both seasons. While, spraying Helichrysum with Sodium silicate at (100 ppm) induced the lowest weight of breakage dust of flower as it produced (0.07 and 0.10 g) in the first and second seasons, respectively.

2. Flower reflex percentage (bent neck):

The data presented in Table (19) and Fig. (6) show the percentage of Helichrysum bracteatum Andr. reflexed flowers as affected by drying process. It is quite noticed that increase the concentration of cheleate calcium, calcium bicarbonate and sodium silicate treatments decrease the geotropic case of Helichrysum flower stems. On the other hand, both medium and high concentrations of cheleate calcium and calcium bicarbonate significantly decreased the

Table (19): Effect of different concentrations of cheleate calcium, calcium bicarbonate and sodium silicate on breakage dust of flowers, percentage of reflexed flower and the flowers colour of *Heliehrysum bracteatum* Andr. after and before flowers drying.

Characters		Breakage dust of fl(g)		Percentage of reflexed fl.		H.J. colour chart. fl		H.J. colour fl. for 15 day	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		0.18	0.22	33.3	36.6	3 D	3 D	5 D	4 D
Cheleate calcium	50 ppm	0.15	0.18	20	26.6	2 D	3 D	4 D	4 D
	100 ppm	0.07	0.15	13.3	16.6	1 D	2 D	3 D	3 D
	150 ppm	0.03	0.07	10	10	1 D	2 D	2 D	3 D
$Ca(HCO_3)_2$	50 ppm	0.15	0.19	23.3	23.3	2 D	3 D	4 D	4 D
	75 ppm	0.07	0.10	16.6	16.6	2 D	2 D	3 D	4 D
	150 ppm	0.02	0.06	6.6	10	1 D	2 D	2 D	3 D
Na_2SiO_3	50 Ppm	0.16	0.20	23.3	16.6	2 D	2 D	4 D	3 D
	100 ppm	0.07	0.10	10	10	2 D	2 D	2 D	2 D
L.S.D.	5%					0.83	0.64	1.30	0.94
	1%					1.13	0.85	1.71	1.21

crooking of Helichrysum flower for the two seasons. The lowest percentage of reflexed flower was obtained by using the high rate of calcium bicarbonate (150 ppm) as it gave 6.6 and 10% compared the control in the first and second seasons, receptively. Also, cheleate calcium and sodium silicate at the high rate gave 10 and 10% percentage of bent neck flowers in the first and second seasons compared with the control plants.

The results are in agreement with those of **Mauad *et al.* (2003)** on rice they reported that silicons fertilization reduced the number of blank-spikelets per penicles.

3. Human judgment of the colours density of flower:

According to data presented in Table (19) on Human judgment of the colour chart flower during the time of flowering cutting of *Helichrysum bracteatum Andr.* it is clearly appeared that all nutrient applications had effect on the colour density of Helichrysum flowers in the first and second seasons, respectively.

4. Human judgment of the colour density of flower after 15 days from flowers drying.

Data presented in Table (19) show that all foliar application of cheleate calcium, calcium bicarbonate and sodium silicate had a slight effected on the colour density of *Helichrysum bractatum Andr.* flower after 15 days from their cutting. It mean that the colour of Helichrysum flowers did not change during the time of flowers handling for the two seasons of treatments.

IV.2.B.3- Effect of foliar application of growth retardants:

1. Weight of breakage dust of flowers (g):

Data in Table (20) and Fig. (7) show the effect of some growth retardants (Paclobutrazol and Atrimmec) treatments in decreasing the loss of weight of breakage dust of *Helichrysum bracteatum Andr.* flowers during the handling of these flowers as dried flowers in the marketing. It could be summarized the results as the follow, the weight of breakage dust of flower was reduced by using treatments of the two growth retardants as compared to control in both seasons. Therefore, the lowest breakage dust of flowers was obtained by using the high rate of PP_{333} (100 PPM) as it gave (0.05 and 0.07g) compared to (0.19 and 0.18g) for control in the first and second seasons. Also, Dikegulac sodium resulted in highly significant decreasing in this parameter by using the high rate as it gave (0.06 and 0.08 g) in the first and second seasons respectively, compared to the control.

2. Flowers reflex percentage (bent neck);

Data in Table (20) and Fig (8) shows that increasing the concentration of Paclobutrazol and dikegulac sodium decreased the reflexed flowers percentage of *Helichrisum bractatum Andr.* this trend was found with the highest concentration of both growth retardants. However, the greatest reduction on percentage of reflexed flowers of Helichrysum was obtained by using the high rate of PP_{333} (100 PPm) as it gave (10 and 6.6%) compared to the control in the first and second seasons, respectively. Also, dikegulac-sodium at (750 ppm) resulted in highly significant decreases in the flowers bent neck percentage as it gave (10 and 10%) in the first and second seasons, respectively.

Table (20): Effect of different concentrations of paclobutrazol and dikegulac sodium on breakage dust of flowers, percentage of reflexed flower and the flowers colour of *Heliehrysum bracteatum Andr.* after and before flowers drying.

Characters		Breakage dust of Fl(g)		Percentage of reflexed fl.		H.J. colour chart. Fl		H.J. colour fl. for 15 day	
Treatments		1st s	2nd s	1st s	2nd s	1st s	2nd s	1st s	2nd s
Control		0.19	0.18	36.6	33.3	3 D	3 D	4 D	4 D
PP_{333}	25 ppm	0.12	0.15	26.6	23.3	3 D	3 D	4 D	4 D
	50 ppm	0.08	0.12	20	13.3	2 D	2 D	3 D	3 D
	100 ppm	0.05	0.07	10	6.6	2 D	2 D	2 D	2 D
Dikegulac sodium	250 ppm	0.18	0.17	23.3	20	3 D	3 D	4 D	3 D
	500 ppm	0.13	0.10	16.6	16.6	2 D	2 D	3 D	3 D
	750 ppm	0.06	0.08	10	10	1 D	1 D	2 D	2 D
L.S.D.	5%					0.79	0.59	0.92	0.98
	1%					1.08	0.80	1.21	1.22

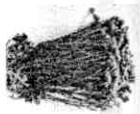


Fig. (7): Effect of different concentrations of paclobutrazol and dikegulac sodium on breakage dust of *Helichrysum bracteatum Andr.* flowers during 2002/2003 and 2003/2004 season

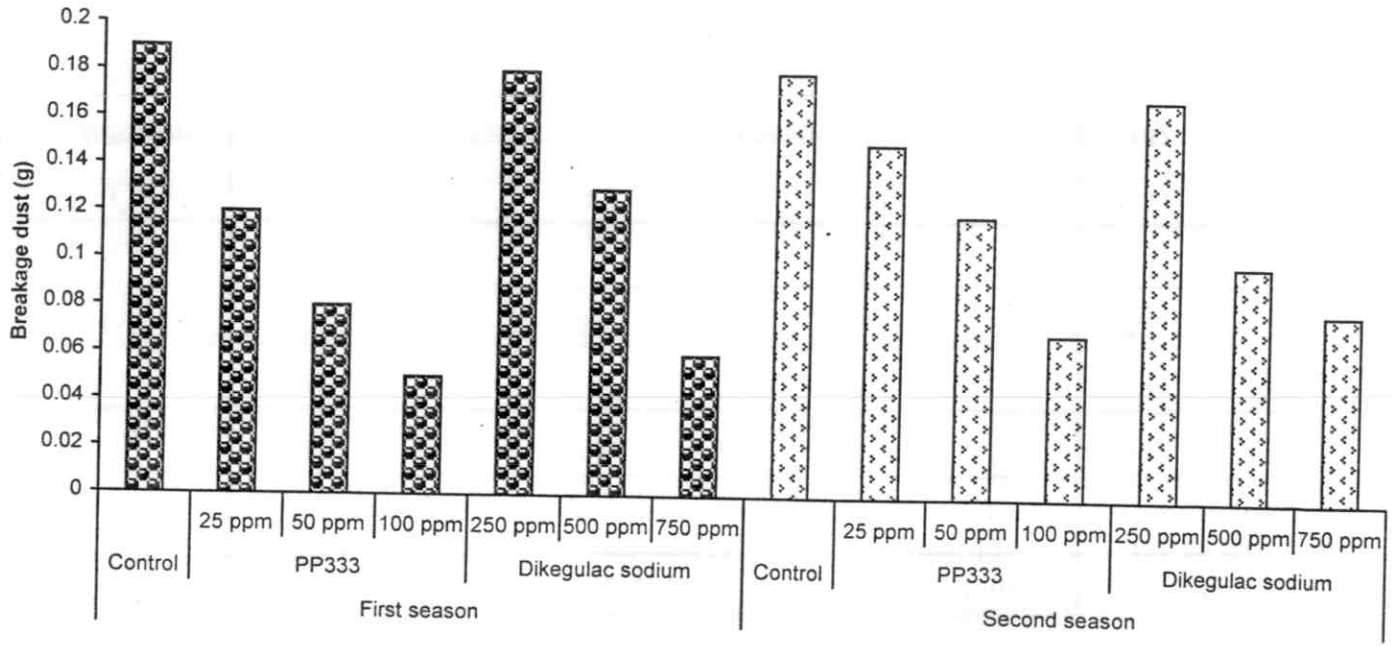
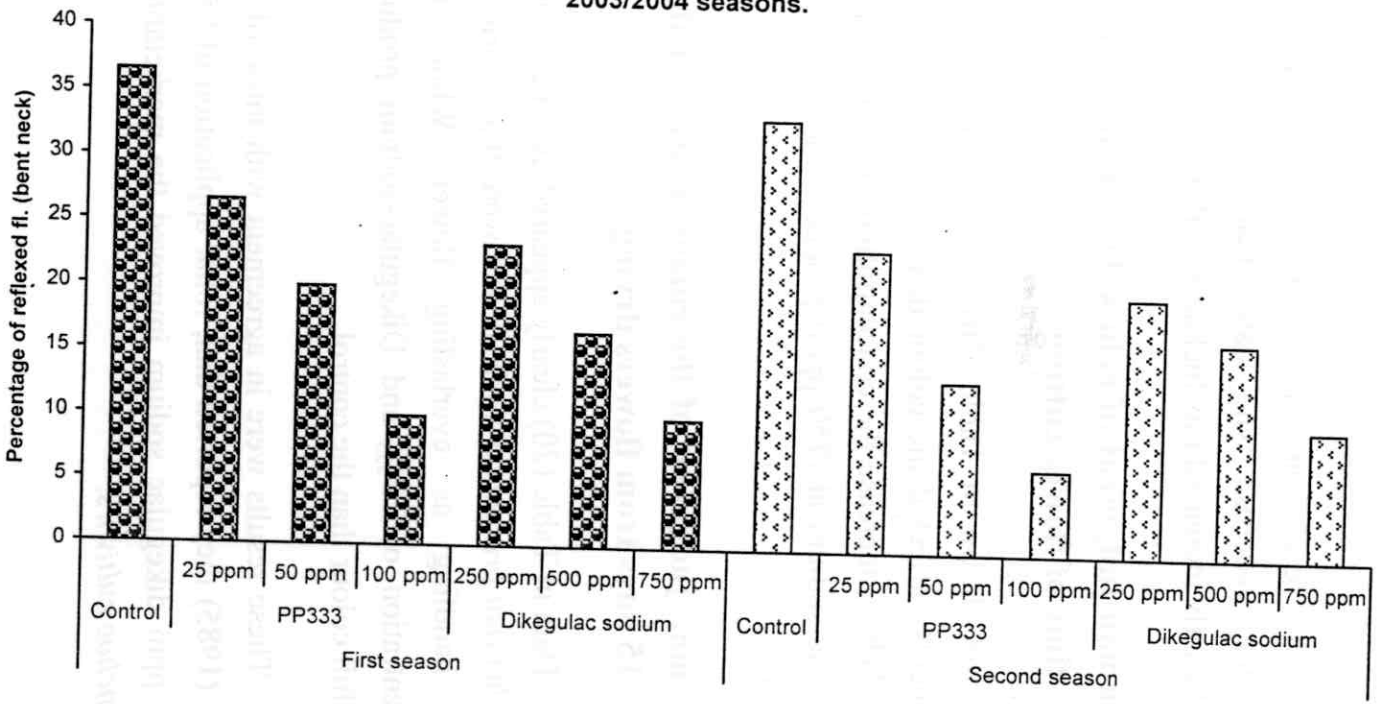


Fig. (8): Effect of different concentrations of paclobutrazol and dikegulac sodium on percentage of reflexed flowers of *Heliehrysum bracteatum Andr.* during 2002/2003 and 2003/2004 seasons.



The results are in agreement with **Tawila (2000)** on *Polianthes tuberosa* who stated that using PP_{333} at 50 ppm significantly increased the thickness of flower.

3. Human judgment of colors density of flower during the time of flower cutting :

As shown in Table (20) all PP_{333} and dikegulac sodium treatments affected the colour density of *Helichrysum bractatum Andr.* While, increase the concentration of PP_{333} at (100 ppm) and dikegulac sodium at (750 ppm) produced more heavy colour than control.

4. Human judgment of the colour density of flowers after 15 days from flowers drying:

Data in Table (20) clearly appeared that the colour density of *Helichrysum bractatum Andr.* flower were fixed during the time of their handling as everlasting flower. While, the highest concentration of PP_{333} and Dikegulac-sodium produced flowers with full colour than the control.

These results were in agreement with those of **Nightingale *et al.* (1985)** they reported that, foliar application of 750, 1500 and 2250 ppm dikegulac sodium improved the marketable of several *Kalanchoe cultivars.*