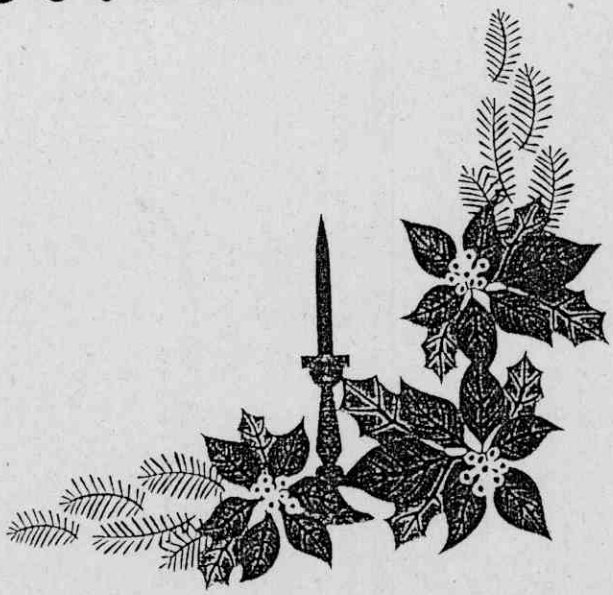
RESULTS & DISCUSSION



RESULTS AND DISSCUSION

IV.1-The first part: pot experiments

IV.1.A-Offsets study

The effect of some growth retardants on vegetative growth, flowering and chemical composition of *Strelitzia reginae* plants during 2001/2002 and 2002/2003 seasons.

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

1- Number of the leaves:

Data presented in Table (1) indicated that the number of the leaves was greatly affected by the growth retardants treatments as compared to control in both seasons. Thus, it could be noticed that all the three used growth retardants treatments had enhancing effect on leaves formation with different extends (regardless the application methods and concentrations). Hence, in both seasons, the highest number of leaves was statistically induced by those *Strelitzia reginae* plants grown in pots and treated by paclobutrazol treatment which gave 12.31 and 18.47 leaves/plant in the first and second seasons, respectively. Whereas, the lowest number of leaves / plant values (8.33 and 11.92 leaves / plant) was obtained from untreated plants in the first and second seasons, respectively.

As for the specific effect of methods of applied growth retardants on the number of leaves of Strelitzia plants, it was quit evident shown in the same Table that drench method was more effective than spray method but, the differences between the two

Table (1): The effect of some growth retardants on the number of leaves of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	8.00	11.60	9.90	13.80	11.77	9.23	8.46	11.67	9.79	7.96	8.23	9.86	8.68	9.56
	Drench	8.66	13.67	12.70	12.17	12.85	10.43	10.77	10.33	10.51	10.13	8.96	13.20	10.76	10.70
Mean		8.33	12.64	11.30	12.99	12.31	9.83	9.62	11.00	10.15	9.05	8.60	11.53	9.73	
LSD_1 at 5% = 1.54 LSD_1 at 1% = 2.06		LSD_2 at 5% = 1.09 LSD_2 at 1% = N.S				LSD_3 at 5% = 2.68 LSD_3 at 1% =3.58				LSD_4 at 5% = 2.19 LSD_4 at 1% = 2.92				LSD_5 at 5% = 3.79 LSD_5 at 1% = 5.06	
Second season (2002/2003)															
Application method	Spray	12.33	18.53	16.23	21.47	18.74	15.10	16.83	18.67	16.87	11.23	11.43	15.50	12.72	15.17
	Drench	11.50	20.00	15.90	18.67	18.19	15.57	17.83	18.10	17.17	12.50	13.57	17.17	14.41	15.32
Mean		11.92	19.27	16.07	20.07	18.47	15.34	17.33	18.39	17.02	11.87	12.50	16.34	13.57	
LSD_1 at 5% = 1.93 LSD_1 at 1% = 2.65		LSD_2 at 5% = N.S LSD_2 at 1% = N.S				LSD_3 at 5% = 3.43 LSD_3 at 1% = 4.58				LSD_4 at 5% = 2.80 LSD_4 at 1% =3.74				LSD_5 at 5% = 4.86 LSD_5 at 1% = 6.49	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

applied methods did not reach the level of highly significance at 1% in the first season. Moreover, drench method showed the same tendency of effectiveness in the second season and the differences between the prementioned two methods were so small to be significant.

Referring to, the interaction effect between growth retardants and their concentrations, data in Table (1) revealed that all combinations of paclobutrazol, cycocel and uniconazole at all rates of application increased the number of developed leaves of Strelitzia plants over control. This trend was true during both seasons of this study. However, among the different combination treatments, the application of paclobutrazol at 300 or 100 ppm appeared to be the most beneficial treatments for promoting the leaves growth of *Strelitzia reginae* plants (12.99 and 20.07 leaves / plant). The application of high growth retardants rates several times in two years may lead to its accumulation in the growing medium, and may eventually cause a considerable potential for use in the pot plant production for imporoving attractive dwarf shape and continues to release its effects for several years.

Furthermore, the data of the interaction effect between growth retardants and methods of application (Table, 1) showed that, the drench method was superior treatment in its effect on increasing the number of leaves per plant of Strelitzia with the three growth retardants used in the first season. However, the increases due to drench method over spray method of the three applied growth retardants were so small to reach a level of significant. On the other hand, during the second season, sprayed

paclobutrazol treatments slightly increased the number of leaves (the values was 18.74 leaves / plant) over drench applied treatments (the value was 18.19 leaves / plant). While, it is clear from data tabulated in Table (1) in both seasons that cycocel and uniconazole concentrations applied as drench method exceeded the same investigated concentrations applied as spray method but, no significant response was recorded between the two methods of application. The results revealed clearly highly significant increases (reached the level at 1%) in the number of the leaves / plant over control (untreated plants) accompanied all the combination treatments of paclobutrazol by the two applied methods in both seasons. Similar trend of the combination treatments of the two other growth retardants (i.e., cycocel and uniconazole) with the two methods of applications (drench and spray) in the second season only, it may be due to the accumulation effect of the several times (eight times) of application through the two seasons of study that may lead to its accumulation in the growing media especially by drench method of application.

Concerning the interaction effect between growth retardants, concentrations and methods of application, the results revealed clearly an interesting trend which pointed out that, in both seasons paclobutrazol sprayed on *Strelitzia reginae* plants at 300 ppm exerted significantly its superiority with increasing the number of leaves / plant compared with the other combinations followed by paclobutrazol at 100 ppm applied by drench method which showed a highly significant effect during both seasons of study. The differences between the abovementioned two

combination treatments are so small to be significant. On the other hand, data obtained in Table (1) showed that drench method is more suitable to uniconazole application especially at high rate (150 ppm), however uniconazole at 150 ppm applied by drench method tended to declare its own relative superiority over other interactions especially in the first season. Also, it is quite clear to be noticed from data the variable degrees of response to the differential treatments during two seasons of study. Since, cycocel at 2000 ppm applied by spray method and paclobutrazol at 300 ppm applied at drench method significantly increased the number of leaves per plant and they not only had the same trend but also gave the same exact values especially in the second season. The other combinations took intermediate place compared to control. The aforementioned results are coincided with those attained by **Choudhary (1987)**, **Reddy *et al.* (1997)**, **Tawila (2000)** on *Polianthes tuberosa*, **Youssef (2000)** who postulated that the greatest mean number of leaves was formed on *S. reginae* plants treated with PP_{333} at 200 and 300 ppm, **Dantuluri *et al.* (2002)** who reported that treated *Lilium maculatum* cv. Corrida with CCC at 3000 ppm produced the maximum number of leaves and **Saker (2004)** who reported that sprayed *Hibiscus rosa sinensis* and *Tabernamontana coronaria* shrubs with PP_{333} at 300 ppm and uniconazole at 187.5 ppm produced the highest number of leaves.

2- The number of offsets per plant:

According to data presented in Table (2) on mean number of offsets per plant as affected by using some growth retardants treatments, it could be concluded that all the three used growth

Table (2): The effect of some growth retardants on number of offsets/plant of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	1.10	1.60	1.36	1.90	1.62	1.27	1.16	1.61	1.35	1.10	1.13	1.36	1.20	1.32
	Drench	1.19	1.88	1.75	1.68	1.77	1.44	1.48	1.42	1.45	1.40	1.23	1.82	1.48	1.47
Mean		1.15	1.74	1.56	1.79	1.70	1.36	1.32	1.52	1.40	1.25	1.18	1.59	1.34	
LSD_1 at 5% = 0.214		LSD_2 at 5% = 0.141				LSD_3 at 5% = 0.371				LSD_4 at 5% = 0.303				LSD_5 at 5% = 0.524	
LSD_1 at 1% = 0.286		LSD_2 at 1% = N.S				LSD_3 at 1% =0.495				LSD_4 at 1% = 0.404				LSD_5 at 1% = 0.700	
Second season (2002/2003)															
Application methods	Spray	1.73	2.59	2.27	3.01	2.62	2.11	2.36	2.61	2.36	1.57	1.60	2.17	1.78	2.12
	Drench	1.61	2.80	2.23	2.61	2.55	2.18	2.50	2.53	2.40	1.75	1.90	2.40	2.02	2.15
Mean		1.67	2.70	2.25	2.81	2.59	2.15	2.43	2.57	2.38	1.66	1.75	2.29	1.90	
LSD_1 at 5% = 0.278		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.482				LSD_4 at 5% = 0.393				LSD_5 at 5% = 0.681	
LSD_1 at 1% = 0.371		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.643				LSD_4 at 1% = 0.525				LSD_5 at 1% = 0.909	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentration and methods of application.

retardants treatments had improving effect on offsets formation with different extends (regardless the application methods and concentrations). However, in both seasons of this study, the greatest mean number of offsets / plant was formed on plants treated with paclobutrazol which recorded 1.70 and 2.59 offsets/plant, in the first and second seasons respectively. Whereas, the lowest mean number of offsets/plant was gained from untreated plants (control) as it registered 1.15 and 1.67 offsets/plant in the first and second seasons, respectively.

Concerning the specific effect of methods of applied growth retardants on the mean number of offsets per plant, it was quit evident from Table (2) that drench method was more effective than spray method but, the differences between the two applied methods was significance at 5% in the first season and non significance in the second one.

As for the interaction effect between growth retardants and their concentrations data presented in Table (2) showed that all combinations of PP_{333}, CCC and uniconazole at all levels of application increased the number of developed offsets in Strelitzia plant over control plant. This trend was true during the two seasons of study. However, among the different combination treatments, the application of PP_{333} at 300 ppm or 100 ppm were to be the most effective treatments for inducing the offsets growth of *Strelitzia reginae* plants.

Regarding the effect of interaction between growth retardants and methods of application data in the same Table revealed that the drench method was superior treatment for increasing the number of offsets per plant of *Strelitzia reginae*

with the three growth retardants used in the first season. So, the increases due to drench method over spray method of the three growth retardants were so small to reach the level of significant. While, in the second season, sprayed paclobutrazol treatments slightly increased the number of offsets / plant (the value was 2.62 offsets / plant) over drench applied treatments (the value was 2.55 offsets / plant).

Also, it is obvious from data presented in Table (2) that in both seasons, CCC and uniconazole treatments applied as drench method exceeded the same investigated treatments applied as spray method but, no significant response was recorded between the two methods of application. The results indicated clearly a highly significant increment in the number of offsets per plant over control accompanied all the combinations treatments of PP_{333} by the two applied methods in both seasons.

Furthermore, the data of the interaction effect between growth retardants, concentrations and methods of application indicated that in both seasons PP_{333} sprayed on *S. reginae* plants at 300 ppm showed significantly its superiority for increasing the number of offsets per plant compared with the other combinations followed descendingly by using PP_{333} at 100 ppm applied by drench method which resulted in a highly significant increment as it gave 1.88 and 2.88 offsets / plant in the first and second seasons, respectively. The differences among the abovementioned two combinations treatments were non significant as the plants under such treatments had nearly close offsets number values.

The above mentioned results of the present or the other studies could be explained by the fact that growth retardant could be attributed to the new balance of endogenous hormones especially auxins and cytokinins existed under these treatments as will be mentioned later. So, cell division and elongation in dormant buds rise, thus number of leaves and offsets was increased. Also, the reduction in stem apical growth caused by growth retardant treatments may direct and channel the nutrients and other growth factors to the lateral buds where compensatating growth subsequently takes place. The mechanism essentially conforming to the "nutrient theory" **(McIntyre, 1977).** The pervious results are in agreement with those of **Tawila (2000)** on *Polianthes tuberosa* and **Youssef (2000)** on *S. reginae*, who pointed out that sprayed PP_{333} at 200 and 300 ppm gave the highest number of offsets / plant.

3-Plant height (cm)

Data in Table (3) clear that there was significant decreases in plant height of *Strelitzia reginae* plants by using the three growth retardants treatments. The obtained results indicated that the treated plants were shorter than the control by 35.89, 33.71 and 31.50% in the first season and 48.14, 35.16 and 37.77% in the second season for paclobutrazol, cycocel and uniconazole compared with control, respectively.

Consequently, paclobutrazol was more effective than cycocel and uniconazole in producing compact plants in both seasons of the study (regardless the methods of application and concentrations). The obtained data also revealed that Strelitzia

Table (3): The effect of some growth retardants on plant height(cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	102.00	69.17	67.10	61.17	65.81	79.17	64.57	65.40	69.71	75.67	65.20	69.10	69.99	76.88
	Drench	107.00	71.27	68.17	65.13	68.19	74.23	68.13	64.10	68.82	78.13	73.13	68.23	73.17	79.29
Mean		104.50	70.22	67.64	63.15	67.00	76.70	66.35	64.75	69.27	76.90	69.17	68.67	71.58	
LSD_1 at 5% = 1.81 LSD_1 at 1% = 2.42			LSD_2 at 5% = 1.28 LSD_2 at 1% = 1.71				LSD_3 at 5% = 3.14 LSD_3 at 1% = 4.20			LSD_4 at 5% = 2.56 LSD_4 at 1% = 3.43			LSD_5 at 5% = 4.45 LSD_5 at 1% = 5.94		
Second season (2002/2003)															
Application methods	Spray	95.00	57.90	47.40	46.17	50.49	74.23	51.80	56.50	60.84	63.87	56.13	55.50	58.50	66.21
	Drench	92.33	54.50	46.80	38.67	46.66	71.53	58.23	52.17	60.64	66.27	53.80	54.17	58.08	64.43
Mean		93.67	56.20	47.10	42.42	48.58	72.88	55.02	54.34	60.74	65.07	54.97	54.84	58.29	
LSD_1 at 5% = 4.68 LSD_1 at 1% = 6.25			LSD_2 at 5% = N.S LSD_2 at 1% = N.S				LSD_3 at 5% = 8.12 LSD_3 at 1% =10.84			LSD_4 at 5% = 6.63 LSD_4 at 1% = 8.85			LSD_5 at 5% = 11.48 LSD_5 at 1% = 15.33		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

plants showed a highly significant response to cycocel more than uniconazole by exhibited suppression of plant height in the first season (at small age). While, in the second season when plants get order, they responded more to uniconazole rather than cycocel treatments.

As for the specific effect of methods of application data in Table (3) indicated that in the first season spraying the three tested growth retardants on the leaves of the plants four times significantly decreased plant height of Strelitzia as compared to drench method of application. The reverse was true in the second season, therefore drench method was the most effective in decreasing plant height as compared with spray method but the decreases over spray methods did not reach the level of significant.

Regarding the interaction effect between growth retardants and their concentrations the data presented in Table (3) showed that the treatments with PP_{333} at the rates of (100, 200 and 300 ppm), cycocel at the rates of (500, 1000 and 2000) and uniconazole at the rates (50, 100 and 150 ppm) significantly reduced plant height in the two seasons. Such reduction was gradually increased by increasing PP_{333}, cycocel and uniconazole concentrations in both seasons. Four times application with the highest concentration of paclobutrazol was the most effective treatment in producing compact plant in both seasons. Hence, the greatest reduction in plant height statistically induced by plants treated with paclobutrazol at the two methods of application.

With regard to the interaction effect between growth retardants, concentration and methods of application on plant

height of *Strelitzia reginae* plants during both seasons, data are presented in Table (3) cleared that in the first season PP_{333} sprayed at 300 ppm was the most effective treatment in producing compact plants (61.17 cm) followed by cycocel at 2000 ppm applied by drench method and cycocel at 1000 ppm applied as spraying method which gave 64.10 and 64.57 cm respectively. While, control plants gave the tallest ones in both seasons.

On the other hand, during the second season, it is clear from data tabulated in Table (3) that paclobutrazol at 300 ppm applied as drench method and applied as spray method exceeded all other investigated treatments in suppression treated plants, the values were 38.67 and 46.17 cm, respectively followed by PP_{333} at 200 ppm applied by drench method and spray method which gave 46.80 and 47.40 cm, respectively. Of interest, is that the abovementioned results when related with the histological features of treated plants and also with their growth aspects. Since gibberellin is known as a stimulating and individual hormone for longitudinal growth in different plants (**Devlin and Witham, 1983**). Hence, reduction of endogenous gibberellins level due to using the treatments of growth retardants (as will be mentioned later) led to reduction in the length of different cell types and consequently reduction in the plant height especially when the reduction of both gibberellins and auxins is considered. Such results showed similar trend to those obtained by various investigators working on PP_{333}, CCC and uniconazole on different plants. In this concern **Tjia (1989)** on *Zantedeschia aethiopica* cv. Childsiana, **White *et al.* (1989)** on oriental hybrid

lily cultivar Sans Souci, **Jiao *et al.* (1991)** on *Lilium longiflorum*, **Corr and Widmer (1991)** on *Zantedeschia spp.*, **Das *et al.* (1992)** on *Hemerocallis aurantiaca*, **Healy *et al.* (1993)** on Alstromeria, **Whipker and Hammer (1997)** on *Dhalia pinnata*, **Gonzalez *et al.* (1999)** on *Zantedeschia aethiopica*, **Dantuluri *et al.* (2002)** who mentioned that treated *Lilium maculatum* cv. Corrida with CCC at 3000 ppm reduced plant height. Also, **Saker (2004)** revealed that spraying *Hibiscus rosa sinensis* and *Tabernamontana coronaria* with PP_{333} at 300 ppm and uniconazole at 187.5 ppm produced the maximum reduction of plant height.

(4) Leaf area (cm^2):

The results obtained for the leaf area (cm^2) as affected by some growth retardants treatments were shown in Table (4). The results could be summarized as follows:

The mean leaf area (cm^2) of *S. reginae* plants was greatly affected by using the all growth retardants as compared to control in both seasons. Therefore, the greatest value of leaf area was obtained by untreated plants (control) which recorded 218.5 and 227.0 cm^2 in the first and second seasons, respectively. Whereas, the smallest leaf area (cm^2) was induced by those plants received CCC treatments which gave 196.5 cm^2 in the first season. Also, PP_{333} and uniconazole resulted in highly significant decreases for this parameter as they registered 197.2 and 200.9 cm^2 in the first season, respectively. While, in the second season, the treated plants with PP_{333} induced the smallest leaf area (196.8cm^2). Moreover, uniconazole and CCC showed

Table (4): The effect of some growth retardants on leaf area (cm^2) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	215.7	202.3	190.3	192.3	195.0	204.7	191.7	199.3	198.6	195.7	205.3	194.7	198.6	202.0
	Drench	221.3	198.3	194.7	205.0	199.3	210.3	185.7	187.3	194.4	194.3	214.0	201.0	203.1	204.5
Mean		218.5	200.3	192.5	198.7	197.2	207.5	188.7	193.3	196.5	195.0	209.7	197.9	200.9	
LSD_1 at 5% = 2.83		LSD_2 at 5% = 2.00				LSD_3 at 5% = 4.91			LSD_4 at 5% = 4.01			LSD_5 at 5% = 6.94			
LSD_1 at 1% = 3.78		LSD_2 at 1% = N.S				LSD_3 at 1% = 6.55			LSD_4 at 1% = 5.35			LSD_5 at 1% = 9.27			
Second season (2002/2003)															
Application methods	Spray	229.0	211.3	195.0	181.3	195.9	225.7	200.7	196.3	207.6	216.7	201.3	198.0	205.3	209.5
	Drench	225.0	205.7	201.3	185.7	197.6	221.3	208.3	205.7	211.8	224.3	210.7	195.0	210.0	211.1
Mean		227.0	208.5	198.2	183.5	196.8	223.5	204.5	201.0	209.7	220.5	206.0	196.5	207.7	
LSD_1 at 5% = 5.64		LSD_2 at 5% =N.S				LSD_3 at 5% = 9.76			LSD_4 at 5% = 7.97			LSD_5 at 5% = 13.82			
LSD_1 at 1% = 7.52		LSD_2 at 1% = N.S				LSD_3 at 1% =13.04			LSD_4 at 1% = 10.65			LSD_5 at 1% = 18.44			

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

highly significant decreases in this parameter as they recorded 207.7 and 209.7 cm^2, respectively.

Concerning the specific effect of methods of applied growth retardants on leaf area (cm^2) of *S. reginae* plants, it was shown from data presented in Table (4) that spray method was more effective than drench method in decreasing the leaf area (cm^2) of *S. reginae* plants, the differences among the two methods of application was significant in the first season and non significant in the second one

As for the interaction effect between growth retardants and their concentrations (regardless the methods of applications) data presented in Table (4) showed that all combinations of PP_{333}, CCC and uniconazole at all concentrations resulted in highly significant decreases in leaf area of *S. reginae* plants in both seasons as compared to control. However, in the first season, among all combinations, the treatments of CCC at 1000 ppm, PP_{333} at 200 ppm and CCC at 2000 ppm statistically induced the smallest leaf area as they gave 188.7, 192.5 and 193.3 cm^2, respectively. While, in the second one using PP_{333} at the high rate (300 ppm), uniconazole at the high rate (150 ppm) and PP_{333} at the medium rate (200 ppm) significantly induced the smallest leaf area as they registered 183.5, 196.5 and 198.2 cm^2, respectively.

Regarding the interaction effect between growth retardants and methods of application data presented in Table (4) indicated that all combinations between growth retardants and method of applications resulted in highly significant decreases in the leaf area of *S. reginae* plants. Anyway, treated the plants of

S. reginae with CCC applied by drench method and sprayed pp_{333} significantly induced the smallest leaf area as they registered 194.4 and 195.0 cm^2 in the first season. While, in the second one, using PP_{333} at the two methods of application (spray and drench) statistically induced the smallest leaf area as they recorded 195.9 and 197.6 cm^2. The differences among the two abovementioned treatments were not significant as the plants under such treatments had nearly close leaf area values.

Concerning the interaction effect between growth retardants, method of application and concentrations, the results showed clearly an interesting trend which pointed out that in the first season all applied treatments of growth retardants either applied by spray or drench methods succeeded in decreasing the leaf area. However, the least mean values of leaf area was obtained by using CCC at 1000 and 2000 ppm applied by drench method as they recorded 185.7 and 187.3 cm^2, respectively. While in the second one all applied treatments of growth retardants decreased the leaf area of *S. reginae* plants. Anyhow, out of all treatments PP_{333} at the high rate (300 ppm) applied either by spray or by drench methods statistically induced the lowest leaf area as they gave 181.3 and 185.7 cm^2, respectively. Of interest, is that the abovementioned results when related with the histological features of treated plants and also with their growth aspects. Since gibberellin is known as a stimulating and individual hormone for longitudinal growth in different plants (**Devlin and Witham, 1983**). Hence, reduction of endogenous gibberellins level due to using the treatments of growth retardants (as will be mentioned later) led to reduction in the

length of different cell types and consequently reduction in leaf area especially when the reduction of both gibberellins and auxins is considered. In this respect **Tjia (1989)** on *Zantedeschia aethiopica*, **Bailey and Miller (1989)** on *Lilium longiflorum* cv. Nellie white, **Suh *et al.* (1992)** on Tulip cv. Apeldroon and **Srour (2001)** who mentioned that treated *Jacobinia carnea*, Nichols with uniconazole at 60, 90, 120, 150 and 180 ppm applied either by spray or drench method significantly decreased the mean leaf area (cm^2).

(5) Length of leaf petiole (cm):

Data presented in Table (5) revealed that the length of leaf petiole of *Strelitzia reginae* plants was greatly decreased by using all growth retardants used as compared with the control in both seasons. Thus, in both seasons of study, treated *S. reginae* plants by PP_{333} (regardless the application methods and concentrations) showed to be the most promising treatment in decreasing the length of leaf petiole compared with control in the first and second seasons. On the other hand, treating the plants with CCC resulted in a highly significant decrease in this parameter and ranked the second method in this concern. The differences among the three used growth retardants were non significant in the first season as the plants under such treatments had nearly close leaf petiole length values, while in the second season the differences were highly significant between PP_{333} and the two other growth retardants (CCC and uniconazole).

As for the specific effect of methods of application on the length of leaf petiole of *S. reginae*, it was clearly shown from

Table (5): The effect of some growth retardants on the length of leaf petiole (cm) of *Strelitzia reginae* Ait plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	75.73	42.53	44.90	36.30	41.24	51.67	43.27	36.33	43.76	49.77	35.93	39.53	41.74	50.62
	Drench	78.33	45.83	43.73	31.07	40.21	46.63	44.43	35.33	42.13	50.43	46.17	42.97	46.52	51.80
Mean		77.03	44.18	44.32	33.69	40.73	49.15	43.85	35.83	42.95	50.10	41.05	41.25	44.13	
LSD_1 at 5% = 5.10		LSD_2 at 5% = N.S				LSD_3 at 5% = 8.83				LSD_4 at 5% = 7.21				LSD_5 at 5% = 12.50	
LSD_1 at 1% = 6.81		LSD_2 at 1% = N.S				LSD_3 at 1% = 11.80				LSD_4 at 1% = 9.63				LSD_5 at 1% = 16.69	
Second season (2002/2003)															
Application methods	Spray	57.00	31.00	25.70	18.83	25.18	31.03	22.67	26.40	26.70	34.53	25.30	26.07	28.63	34.38
	Drench	55.33	28.07	19.07	10.77	19.30	40.47	27.50	23.73	30.57	34.37	25.33	26.17	28.62	33.46
Mean		56.17	29.54	22.39	14.80	22.24	35.75	25.09	25.07	28.64	34.45	25.32	26.12	28.63	
LSD_1 at 5% = 3.39		LSD_2 at 5% =N.S				LSD_3 at 5% = 5.88				LSD_4 at 5% = 4.80				LSD_5 at 5% = 8.31	
LSD_1 at 1% = 4.53		LSD_2 at 1% = N.S				LSD_3 at 1% =7.85				LSD_4 at 1% = 6.41				LSD_5 at 1% = 11.10	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

Table (5) that spray method was slightly effective than drench method concerning decreasing the length of leaf petiole, while in the second season the picture was completely converted, thus drench method showed its superiority in decreasing the length of leaf petiole than spray method. The differences between the two applied methods of application did not reach the level of significance in both seasons.

With regard to the interaction effect between growth retardants and their concentrations (regardless to the methods of application) data in Table (5) pointed out that all combinations of PP_{333}, CCC and uniconazole at all rates of application caused high significant decreasing in the length of leaf petiole in both seasons of study. The decrease in the length of leaf petiole was progressively increased with increasing the applied concentrations of growth retardants in most cases. Meanwhile, among the different combination treatments, the application of PP_{333} at the high rate (300 ppm) showed to be the most effective treatment for shortening the length of leaf petiole of *S. reginae* plants. The percentages of decrease due to this treatment reached 56.27 and 73.65% less than control plants in the first and second seasons, respectively.

Concerning the effect of interaction between growth retardants and methods of application (regardless to the effect of concentration) data in Table (5) revealed that all combinations between growth retardants and methods of application significantly decreased the length of leaf petiole in both seasons as compared to control. However, using PP_{333} combinations (applied by spray or drench method) appeared to be the most

effective applications for decreasing the length of leaf petiole. However, the differences between the two methods of application for the three applied growth retardants were so small to reach the level of significance, with the exception of PP_{333} at the second season where, the differences between the two methods of application were significant at the level of 5% only.

Referring to the interaction effect between growth retardants, methods of application and their concentrations, data tabulated in Table (5) demonstrated that all applied treatments of growth retardants used resulted in highly significant decreases in this parameter as compared to control in both seasons. Anyhow, in the first season treated *S. reginae* plants with PP_{333} at 300 ppm, CCC at 2000 ppm (applied by drench method) and uniconazole sprayed at 100 ppm showed to be the most effective treatments for decreasing the length of leaf petiole as they registered 31.07, 35.33 and 35.93 cm, respectively. The differences between the abovementioned three combinations treatments are so small to be significant. While in the second season PP_{333} at the high rate (300 ppm) with the two methods of application exerted significantly its superiority with shortening the length of leaf petiole. The percentages of decreases were 66.96% due to PP_{333} at 300 ppm (applied by spray method) and 80.53% for PP_{333} at 300 ppm (applied by drench method).

(6) Thickness of top leaf petiole (cm):

The data obtained for thickness of top leaf petiole (cm) as affected by some treatments of growth retardants were recorded in Table (6).

Table (6): The effect of some growth retardants on the thickness of top leaf petiole (cm) of *Strelitzia reginae* Ait plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	0.666	0.750	0.790	0.850	0.797	0.720	0.780	0.700	0.733	0.710	0.790	0.726	0.742	0.735
	Drench	0.700	0.700	0.780	0.800	0.760	0.770	0.750	0.800	0.773	0.700	0.720	0.750	0.723	0.739
Mean		0.683	0.725	0.785	0.825	0.778	0.745	0.765	0.750	0.753	0.705	0.755	0.738	0.733	
LSD_1 at 5% = 0.021		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.037			LSD_4 at 5% = 0.030				LSD_5 at 5% = 0.051		
LSD_1 at 1% = 0.028		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.049			LSD_4 at 1% = 0.040				LSD_5 at 1% = 0.069		
Second season (2002/2003)															
Application methods	Spray	0.733	0.783	0.966	0.966	0.905	0.966	0.800	0.950	0.905	0.800	0.933	0.933	0.889	0.858
	Drench	0.766	0.833	0.916	0.900	0.883	0.800	0.833	0.850	0.828	0.883	1.060	0.833	0.925	0.851
Mean		0.750	0.808	0.941	0.933	0.894	0.883	0.817	0.900	0.867	0.842	0.997	0.883	0.907	
LSD_1 at 5% = 0.076		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.132			LSD_4 at 5% = 0.108				LSD_5 at 5% = 0.187		
LSD_1 at 1% = 0.102		LSD_2 at 1% = N.S				LSD_3 at 1% =0.176			LSD_4 at 1% = 0.144				LSD_5 at 1% = 0.250		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

The data showed that the thickness of top leaf petiole was greatly affected by the growth retardants treatments as compared to control in both seasons. Thus, it could be noticed that all the three used growth retardants treatments had enhancing effect on increasing the thickness of top leaf petiole (regardless the application methods and concentrations). Hence, in the first season of study the highest mean value of this parameter was obtained by treated *S. reginae* plants by PP_{333} which gave 0.778 cm when compared with control which gave 0.683 cm. On the other hand, treating the offsets of *S. reginae* with CCC resulted in maximum significant increase in this parameter. While, in the second season uniconazole showed its superiority in this concern as it recorded 0.907 cm compared with 0.750 cm for control.

With regard to the specific effect of methods of applied growth retardants on the thickness of top leaf petiole, data presented in Table (6) showed that in the first season, drench method caused a slight increment in this parameter (0.739 cm) as compared with spray method (0.735 cm). While in the second season, spray method showed its superiority in increasing the thickness of top leaf petiole, but the differences between the two applied methods did not reach the level of significance in both seasons.

As for the interaction effect between growth retardants and their concentrations (regardless to the methods of application) data in Table (6) indicated that all combinations of PP_{333}, CCC and uniconazole at all rates of application increased the thickness of top leaf petiole as compared with control. However, in the first season, the applications of PP_{333} at 300

ppm and 200 ppm appeared to be the most promising treatments for increasing the thickness of top leaf petiole. Whereas, in the second season, uniconazole at the medium rate (100 ppm) showed to be the most effective treatment in increasing the thickness of top leaf petiole followed by the treatment of PP_{333} at the medium rate (200 ppm).

Additionally, using the high rates of PP_{333} and CCC caused highly significant increases in this parameter as they registered 0.933 and 0.900 cm, respectively. The differences between the two abovementioned rates were so small to reach the level of significance.

Regarding the interaction effect between growth retardants and methods of application (Table, 6) data showed that all combinations between growth retardants and methods of applications significantly increased the thickness of top leaf petiole as compared to control in both seasons of study. However, using PP_{333} combinations (applied by spray method) in the first season induced statistically the thickest leaf petiole, followed by CCC (applied by drench method). While, in the second season the highest mean value of this parameter was gained by using uniconazole combination (applied by drench method) followed by using the combinations of PP_{333} and CCC (applied by spray methods) and they not only ranked the second, but also, gave the same exact values as they gave 0.905 cm for each.

Concerning the interaction effect between growth retardants, concentrations and methods of application data presented in Table (6) pointed out that PP_{333} sprayed on *S.*

reginae plants at 300 ppm exerted significantly its superiority with increasing the thickness of top leaf petiole (0.850 cm) compared with the other combinations, followed by using PP_{333} and CCC at the high rates (applied by drench method) as they not only had the same trend, but also gave the typical values (0.800 cm for each). Similar trend was obtained by using the treatments of PP_{333} and uniconazole at the medium rates (applied by spray method). While, in the second season, using uniconazole at the medium rate (applied by drench method) showed its superiority in increasing the thickness of top leaf petiole as it gave 1.060 cm. Also, it is quite clear to be noticed that the treatments of PP_{333} at the medium and high rate and CCC at the low rate (applied by spray method) resulted in highly significant increments in this parameter and not only had the same trend but also recorded the same exact values (0.966 cm, for each).

Similar trend was obtained by sprayed bird of paradise plants by uniconazole at the medium and high rates. The other combinations took intermediate place compared to control.

(7) Fresh weight of leaf petiole (g):

According to data presented in Table (7), it could be concluded that all the three used growth retardants treatments progressively decreased the fresh weight of leaf petiole as compared with control in both seasons. Hence, in both seasons of this study the heaviest fresh weight of leaf petiole was obtained from the untreated plants (control) as they gave 33.52 g and 19.44 g in the first and second seasons, respectively. On the

Table (7): The effect of some growth retardants on the fresh weight of leaf petiole (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	32.70	19.27	20.80	17.47	19.18	22.40	20.20	15.93	19.51	18.00	19.13	17.40	18.18	22.39
	Drench	34.33	20.10	20.07	14.90	18.36	21.20	19.97	16.60	19.26	21.47	19.87	19.33	20.22	23.04
Mean		33.52	19.69	20.44	16.19	18.77	21.80	20.09	16.27	19.39	19.74	19.50	18.37	19.20	
LSD_1 at 5% = 2.42		LSD_2 at 5% = N.S				LSD_3 at 5% = 4.19				LSD_4 at 5% = 3.42				LSD_5 at 5% = 5.92	
LSD_1 at 1% = 3.23		LSD_2 at 1% = N.S				LSD_3 at 1% = 5.59				LSD_4 at 1% = 4.57				LSD_5 at 1% = 7.91	
Second season (2002/2003)															
Application methods	Spray	19.87	14.60	13.63	9.70	12.64	20.77	10.37	14.90	15.35	15.07	14.83	14.57	14.82	15.67
	Drench	19.00	13.17	8.76	5.07	9.00	18.73	13.30	14.23	15.42	20.00	15.00	10.77	15.26	14.67
Mean		19.44	13.89	11.20	7.39	10.83	19.75	11.84	14.57	15.39	17.54	14.92	12.67	15.04	
LSD_1 at 5% = 2.56		LSD_2 at 5% =N.S				LSD_3 at 5% = 4.44				LSD_4 at 5% = 3.63				LSD_5 at 5% = 6.28	
LSD_1 at 1% = 3.42		LSD_2 at 1% = N.S				LSD_3 at 1% =5.93				LSD_4 at 1% = 4.84				LSD_5 at 1% = 8.39	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of applications.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

contrary, the lowest fresh weight values of leaf petiole of *S. reginae* plant was obtained by using PP_{333} (regardless the application methods and concentrations) in the first and second seasons, respectively.

Moreover, treating the plants of *S. reginae* with uniconazole resulted in highly significant decreases in this parameter followed by using CCC in both seasons. The differences between the abovementioned two growth retardants are so small to be significant in both seasons.

As for the specific effect of methods of application on the fresh weight of leaf petiole of *S. reginae* it was obvious from Table (7) that spray method was slightly effective in decreasing the fresh weight of leaf petiole than drench method, this trend was true in the first season only, while in the second one, drench method showed its superiority in decreasing the fresh weight of leaf petiole when compared with spray method. The differences between the two applied methods of application did not reach the level of significance in both seasons.

Concerning the interaction effect between growth retardants and their concentrations (regardless to the methods of application) data presented in Table (7) showed that all combinations of PP_{333}, CCC and uniconazole at all rates of application significantly decreased the fresh weight of leaf petiole in both seasons. However, among the different combination treatments, the application of PP_{333} at the high rate (300 ppm) showed to be the most effective treatment for decreasing the fresh weight of leaf petiole of *S. reginae* plants. The percentages of decrease due to this treatment reached 51.73

and 61.99 % less than control in the first and second seasons, respectively.

Regarding the interaction effect between growth retardants and methods of application (regardless to the effect of concentrations) on the fresh weight of leaf petiole of *S. reginae* plants, data in Table (7) pointed out that all combinations between growth retardants and methods of application significantly decreased the fresh weights of leaf petiole when compared with control in both seasons of study. However, in the first season using the combinations of PP_{333} applied by drench method and uniconazole applied by spray method were superior treatments in its effect on decreasing the fresh weight of leaf petiole as they recorded 18.36 g and 18.18 g, respectively. The differences among all combinations of the three growth retardants were non significant as the plants under such treatments had nearly close fresh weight of leaf petiole values. While, in the second season PP_{333} applied either by drench method or spray method appeared to be the most effective combinations in decreasing this parameter as it gave 9.00 and 12.64 g, respectively. Besides, using uniconazole applied by spray or drench method resulted in highly significant decreases in this parameter followed by using the two methods of application of CCC.

With respect to the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (7) revealed that all applied treatments of growth retardants resulted in highly significant decreases in this parameter when compared with untreated plants in both seasons

of study. However, the treatments of PP_{333} at 300 ppm applied by drench method, CCC at 2000 ppm applied by spray method and uniconazole at 150 ppm applied by spray method showed its superiorities in this concern as they registered 14.90, 15.93 and 17.40 g, in the first season, respectively. The differences among the three abovementioned treatments were non significant. While, in the second season using the treatments of PP_{333} at the high rate (applied by drench method) produced the least fresh weight value, followed by using the medium rate of PP_{333} (applied by drench method).

(8) Dry weight of leaf petiole (g):

The data obtained for dry weight of leaf petiole as affected by some treatments of growth retardants are presented in Table (8).

The results of the dry weight of leaf petiole attained a parallel trend with the fresh weight results with some little differences. In general, the heaviest dry weight of leaf petiole was produced by untreated plants (control) as it recorded 7.28 and 3.22 g in the first and second seasons, respectively. While, the least dry weight of leaf petiole was obtained by treated *S. reginae* plants with PP_{333} treatments (regardless the application methods and concentrations) as it gave 3.08 and 1.64 g in the first and second seasons, respectively.

As for the effect of methods of applied growth retardants on the dry weight of leaf petiole of *S. reginae* plants, it was quite evident shown from Table (8) that spray method was more effective than drench method in decreasing the dry weight of

Table (8): The effect of some growth retardants on the dry weight of leaf petiole (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	7.13	3.23	3.53	2.60	3.12	3.83	3.43	2.53	3.26	3.60	3.53	2.70	3.27	4.20
	Drench	7.43	3.43	3.36	2.33	3.04	3.53	3.50	2.83	3.28	3.80	3.40	3.23	3.47	4.31
Mean		7.28	3.33	3.45	2.47	3.08	3.68	3.47	2.68	3.28	3.70	3.47	2.97	3.38	
LSD_1 at 5% = 0.167		LSD_2 at 5% = 0.118				LSD_3 at 5% = 0.289				LSD_4 at 5% = 0.236				LSD_5 at 5% = 0.409	
LSD_1 at 1% = 0.223		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.386				LSD_4 at 1% = 0.315				LSD_5 at 1% = 0.546	
Second season (2002/2003)															
Application methods	Spray	3.30	2.25	2.23	1.26	1.91	3.40	1.46	2.23	2.36	2.56	2.36	2.46	2.46	2.51
	Drench	3.13	2.16	1.21	0.74	1.37	3.10	1.80	2.60	2.50	3.13	2.56	1.60	2.43	2.36
Mean		3.22	2.21	1.72	1.00	1.64	3.25	1.63	2.42	2.43	2.85	2.46	2.03	2.45	
LSD_1 at 5% = 0.346		LSD_2 at 5% =N.S				LSD_3 at 5% = 0.600				LSD_4 at 5% = 0.490				LSD_5 at 5% = 0.849	
LSD_1 at 1% = 0.462		LSD_2 at 1% = N.S				LSD_3 at 1% =0.801				LSD_4 at 1% = 0.654				LSD_5 at 1% = 1.130	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

leaf petiole with significant differences in the first season. While, in the second season the picture was completely reversed where drench method showed its superiority in decreasing the dry weight of leaf petiole but, the differences between the two methods of application were non significant.

Concerning the interaction effect between growth retardants and their concentrations data presented in Table (8) showed that all combinations of PP_{333}, CCC and uniconazole at all rates of application decreased the dry weight of leaf petiole of bird of paradise plants when compared with untreated plants (control) in both seasons, with the exception of the low concentration of CCC at the second season which resulted in non significant increase in the dry weight of leaf petiole as it registered 3.25 g. However, among the different combination treatments, the application of PP_{333} at 300 ppm (regardless the method of application) resulted in a highly significant decrease in this parameter as it recorded 2.47 and 1.00 g when compared with 7.28 and 3.22 g for control in the first and second seasons, respectively.

With regard to the interaction effect between growth retardants and methods of application (regardless the concentrations), data in Table (8) indicated that all combinations between growth retardants and methods of applications succeeded in decreasing the dry weight of leaf petiole in both seasons. Hence, PP_{333} applied by drench or spray method showed its superiority in decreasing the dry weight of leaf petiole as they gave 3.04 and 3.12 & 1.37 and 1.91 g in the first and second seasons, respectively. Referring to the interaction

effect between growth retardants, application methods and concentrations, it is quite evident from Table (8) that all applied treatments of growth retardants decreased the dry weight of leaf petiole of *S. reginae* plants when compared with untreated plants in both seasons, with the exception of the low rate of CCC applied by spray method in the second season which resulted in negligible increment in this parameter as it gave value (3.40 g) near to those of the control plant (3.30 g) which did not reach the level of significance. On the other hand, the least dry weight of leaf petiole was obtained by treated *S. reginae* plants with the high rate of PP_{333} (300 ppm) applied by drench method as it gave 2.33 and 0.74 g in the first and second seasons, respectively. The results of leaf petiole measurements i.e., length, thickness and fresh and dry weights are in parallel with those of **Corr and Widmer (1991)** on *Zantedeschia alliottiana* and *Zantedeschia elliottiana,* Healy ***et al.*, (1993)** on Alstromeria**, Desouky (1994)** on *S. reginae* and **Youssef (2000)** who mentioned that treated *S. reginae* plants with PP_{333} at 200 and 300 ppm decreased the length of leaf petiole and their fresh and dry weights, but it increased the thickness of top leaf petiole.

(9) Length of leaf blade (cm):

According to data presented in Table (9) on the length of leaf blade of *S. reginae* plants as affected by some treatments of growth retardants, it could be concluded that all the three used growth retardants treatments (regardless the effect of concentrations and application methods) succeeded in decreasing the length of leaf blade in both seasons. Hence, in both seasons of this study, the shortest leaf blade was recorded by using PP_{333}

Table (9): The effect of some growth retardants on the length of leaf blade (cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	33.77	26.27	23.07	24.70	24.68	28.87	25.93	28.37	27.72	26.23	29.63	27.30	27.72	28.47
	Drench	33.00	26.07	25.00	26.13	25.73	29.13	24.57	27.37	27.02	27.50	27.17	26.00	26.89	28.16
Mean		33.39	26.17	24.04	25.42	25.21	29.00	25.25	27.87	27.37	26.87	28.40	26.65	27.31	
LSD_1 at 5% = 1.89		LSD_2 at 5% = N.S				LSD_3 at 5% = 3.27			LSD_4 at 5% = 2.67				LSD_5 at 5% = 4.62		
LSD_1 at 1% = 2.52		LSD_2 at 1% = N.S				LSD_3 at 1% = 4.36			LSD_4 at 1% = 3.56				LSD_5 at 1% = 6.17		
Second season (2002/2003)															
Application methods	Spray	37.00	26.23	24.27	20.83	23.78	33.73	29.17	29.13	30.68	30.30	30.30	28.90	29.83	30.32
	Drench	35.33	27.33	26.53	20.33	24.73	30.27	30.67	28.50	29.81	31.90	27.97	27.93	29.27	29.79
Mean		36.17	26.78	25.40	20.58	24.26	32.00	29.92	28.82	30.25	31.10	29.14	28.42	29.55	
LSD_1 at 5% = 2.37		LSD_2 at 5% =N.S				LSD_3 at 5% = 4.10			LSD_4 at 5% = 3.35				LSD_5 at 5% = 5.81		
LSD_1 at 1% = 3.16		LSD_2 at 1% = N.S				LSD_3 at 1% =5.48			LSD_4 at 1% = 4.47				LSD_5 at 1% = 7.75		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

which gave 25.21 and 24.26 cm in the first and second seasons, respectively. Moreover, treated the plants with CCC and uniconazole resulted in highly significant decreases in this parameter as they gave 27.37 and 27.31 cm in the first season and 30.25 and 29.55 cm in the second season, respectively. The differences among the two abovementioned growth retardants were non significant in both seasons. On the contrary, the tallest leaf blade was obtained on untreated plant (control) in both seasons.

Concerning the specific effect of methods of application on the length of leaf blade of *S. reginae* it was obvious shown from Table (9) that drench method was slightly effective than spray method in decreasing the length of leaf blade, but the differences between the two applied methods of application were non significant in both seasons of this study.

As for the interaction effect between growth retardants and their concentrations the data presented in Table (9) pointed out that all combinations of PP_{333}, CCC and uniconazole at all rates of application (regardless to methods of applications) statistically succeeded in decreasing the length of leaf blade as compared with control. This trend was true during both seasons of study. However, among the different combination treatments, the applications of PP_{333} at 200 and 300 ppm appeared to be the most beneficial treatments for decreasing the length of leaf blade in both seasons.

Regarding the interaction effect between growth retardants and methods of application, data in Table (9) revealed that all combinations between growth retardants and methods of

application resulted in highly significant reduction in this parameter in both seasons of this study. However, the combinations of PP_{333} (regardless to the concentrations) applied by spray or drench method showed to be the most effective combinations for decreasing the length of leaf blade in both seasons. The differences between the two methods of application for the three used growth retardants were non significant in both seasons. Referring to the interaction effect between growth retardants, concentrations and methods of application, the results in Table (9) revealed that all applied treatments of growth retardants significantly decreased the length of leaf blade in both seasons of this study as compared with control. However, the treatments of sprayed PP_{333} at 200 and 300 ppm and CCC at 1000 ppm (applied by drench method) in the first season and the treatments of PP_{333} at 300 ppm (applied by drench and spray method) and PP_{333} at 200 ppm (applied by spray method) in the second season showed to be the most effective treatments in decreasing the length of leaf blade as they recorded 23.07, 24.70 and 24.57 cm in the first season and 20.33, 20.83 and 24.27 cm in the second season, respectively. The differences between the abovementioned three treatments were non significant in both seasons. Similar trend was obtained by using the treatments of PP_{333} at 200 ppm applied by drench method (25.00 cm) and CCC at 1000 ppm applied by drench method (24.57 cm) in the first season and the treatments of PP_{333} at 100 ppm applied by spray method (26.23 cm) and PP_{333} at 200 ppm applied by drench method (26.53 cm) in the second season.

(10) Width of leaf blade (cm):

The data obtained on the width of leaf blade (cm) as affected by some treatments of growth retardants are shown in Table (10). These results may be discussed as follows:

The width of leaf blade (cm) of *S. reginae* plants was slightly affected by using the all growth retardants with non significant differences in both seasons in this study. Hence, the widest leaf blade was obtained on plants treated with uniconazole in the first season and PP_{333} in the second one as they gave 9.31 and 10.18 cm, respectively. On the contrary, the least width of leaf blade was obtained in the first season by using CCC which gave 9.01 cm as compared with 9.10 cm for control, while in the second season the least width of leaf blade was obtained by using uniconazole which gave 9.10 cm when compared with 9.82 cm for control.

Regarding the specific effect of methods of application i.e., spray or drench of the three growth retardants on the width of leaf blade (cm) of *S. reginae* plants, it was clearly from data tabulated in Table (10) that spray method was slightly effective than drench method in increasing the width of leaf

petiole of *S. reginae* in both seasons. The differences among the two methods of application were non significant in both seasons.

Concerning the effect of interaction between growth retardants and their concentrations (regardless the effect of methods of application) data presented in Table (10) pointed out that all combinations of PP_{333}, CCC and uniconazole resulted in non significant effects in this parameter in both seasons.

Table (10): The effect of some growth retardants on the width of leaf blade (cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	9.13	8.60	9.50	9.46	9.19	9.50	8.50	9.70	9.23	9.26	9.60	9.03	9.30	9.21
	Drench	9.06	8.86	8.73	9.50	9.03	9.06	7.97	9.30	8.78	8.66	10.17	9.13	9.32	9.05
Mean		9.10	8.73	9.12	9.48	9.11	9.28	8.24	9.50	9.01	8.96	9.89	9.08	9.31	
LSD_1 at 5% = N.S LSD_1 at 1% = N.S		LSD_2 at 5% = N.S LSD_2 at 1% = N.S					LSD_3 at 5% = N.S LSD_3 at 1% = N.S				LSD_4 at 5% = N.S LSD_4 at 1% = N.S				LSD_5 at 5% = 1.65 LSD_5 at 1% = 2.19	
Second season (2002/2003)															
Application methods	Spray	9.73	9.96	10.03	11.30	10.43	10.03	10.30	9.76	10.03	9.30	9.23	9.13	9.22	9.85
	Drench	9.90	9.66	9.93	10.20	9.93	9.20	9.90	11.17	10.09	9.20	9.90	7.86	8.98	9.73
Mean		9.82	9.81	9.98	10.75	10.18	9.62	10.10	10.47	10.06	9.25	9.57	8.50	9.10	
LSD_1 at 5% = N.S LSD_1 at 1% = N.S		LSD_2 at 5% =N.S LSD_2 at 1% = N.S					LSD_3 at 5% = N.S LSD_3 at 1% =N.S				LSD_4 at 5% = 1.07 LSD_4 at 1% = N.S				LSD_5 at 5% = 1.85 LSD_5 at 1% = 2.47	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

However, in the first season, the treatments of uniconazole at 100 ppm, CCC at 2000 ppm and PP_{333} at 300 ppm showed to be the most effective treatments in increasing the width of leaf blade, while in the second season the applications of PP_{333} at 300 ppm, CCC at 1000 and 2000 ppm showed its superiorities in this concern. On the contrary, the least width of leaf blade was obtained by using the treatment of CCC at 1000 ppm in the first season and the treatment of uniconazole at 150 ppm in the second season.

As for the interaction effect between growth retardants and methods of application (regardless to the concentrations) data presented in Table (10) showed that all combinations between growth retardants and methods of application resulted in non significant increases in the width of leaf blade of *S. reginae* plants in both seasons, with the exception of CCC applied by drench method in the first season, and the application of uniconazole applied by drench method in the second season as they caused non significant decreases in this parameter. However, the highest mean value of the width of leaf blade was obtained by using the drench method of uniconazole in the first season and the spray method of PP_{333} in the second season.

As for the interaction effect between growth retardants, concentrations and methods of application data presented in Table (10) indicated that the treatments of uniconazole at 100 ppm (applied by drench method), CCC at 2000 ppm (applied by spray method) and uniconazole at 100 ppm (applied by spray method) appeared to be the most effective treatments for increasing the width of leaf blade in the first season as they

recorded 10.17, 9.70 and 9.60 cm, respectively. The differences between the abovementioned three treatments and controls (untreated plants) were so small to reach the level of significance. This trend was true in the first season only, while in the second season the picture was completely changed, since the treatments of sprayed PP_{333} at 300 ppm, CCC at 2000 ppm applied by drench method and CCC at 1000 ppm applied by spray method showed its superiorities in increasing the width of leaf blade as they registered 11.30, 11.17 and 10.30 cm, respectively. On the contrary, the lowest mean value of this parameter was obtained by using the treatment of CCC at 1000 ppm applied by drench method in the first season and the treatment of uniconazole at 150 ppm applied by drench method in the second one.

(11) Fresh weight of leaf blade (g):

The data obtained on fresh weight of leaf blade (g) as affected by some growth retardants are shown in Table (11).

All the three used growth retardants resulted in highly significant decreases in the fresh weight of leaf blade of *S. reginae* plants in the two seasons, with the exception of PP_{333} in the first season and uniconazole in the second season, as they caused non significant decreases in this parameter. However, the least fresh weight of leaf blade was obtained by treating the plants with uniconazole (Regardless the effect of concentrations and methods of applications) in the first season and PP_{333} in the second season as they recorded 14.36 and 15.24 g, respectively followed by using the treatment of CCC in the first and second seasons.

Table (11): The effect of some growth retardants on the fresh weight of leaf blade (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	16.57	15.57	15.80	15.83	15.73	14.53	14.30	15.30	14.71	14.33	14.57	13.83	14.24	15.31
	Drench	16.87	15.23	16.33	17.17	16.24	14.63	14.33	14.43	14.46	13.87	15.33	14.23	14.48	15.51
Mean		16.72	15.40	16.07	16.50	15.99	14.58	14.32	14.87	14.59	14.10	14.95	14.03	14.36	
LSD_1 at 5% = 0.92		LSD_2 at 5% = N.S				LSD_3 at 5% = 1.61			LSD_4 at 5% = 1.31				LSD_5 at 5% = 2.27		
LSD_1 at 1% = 1.24		LSD_2 at 1% = N.S				LSD_3 at 1% = 2.15			LSD_4 at 1% = 1.75				LSD_5 at 1% = 3.04		
Second season (2002/2003)															
Application methods	Spray	21.97	14.40	16.97	14.43	15.27	20.90	15.93	17.30	18.04	19.47	19.07	16.07	18.20	18.37
	Drench	19.13	14.07	15.43	16.10	15.20	20.03	16.60	15.93	17.52	20.30	19.67	15.33	18.43	17.57
Mean		20.55	14.24	16.20	15.27	15.24	20.47	16.27	16.62	17.79	19.89	19.37	15.70	18.32	
LSD_1 at 5% = 2.33		LSD_2 at 5% =N.S				LSD_3 at 5% = 4.05			LSD_4 at 5% = 3.30				LSD_5 at 5% = 5.73		
LSD_1 at 1% = 3.12		LSD_2 at 1% = N.S				LSD_3 at 1% =5.40			LSD_4 at 1% = 4.41				LSD_5 at 1% = 7.65		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

As for the specific effect of methods of application on the fresh weight of leaf blade of *S. reginae* plants, it was obviously shown from Table (11) that spray method was slightly effective than drench method in decreasing the fresh weight of leaf blade (g) in the first season, while in the second season, the picture was completely changed, thus drench method showed its superiority in decreasing the fresh weight of leaf blade than spray method. The differences between the two applied methods of application did not reach the level of significance in both seasons.

With regard to the interaction effect between growth retardants and their concentrations (regardless to the methods of application) data obtained in Table (11) declared that on both seasons, all combinations of PP_{333}, CCC and uniconazole at all rates of application significantly decreased the fresh weight of leaf blade in most cases. Meanwhile, the treatments of uniconazole at 150 and 50 ppm and CCC at 1000 ppm appeared to be the most effective applications for decreasing the fresh weight of leaf blade in the first season as they gave 14.03, 14.10 and 14.32 g, respectively. This trend was true only in the first season, while in the second one PP_{333} at 100 and 300 ppm and uniconazole at 150 ppm showed its superiorities in decreasing this parameter as they recorded 14.24, 15.27 and 15.70 g, respectively. Irrespective control, the heaviest fresh weight of leaf blade was obtained by using the high rate of PP_{333} (300 ppm) in the first season and the low rate of CCC (500 ppm) in the second one, as they registered 16.50 and 20.47 g, respectively.

Concerning the interaction effect between growth retardants and methods of application (regardless to concentrations) data presented in Table (11) showed that all combinations between growth retardants and methods of application succeeded in decreasing the fresh weight of leaf blade when compared with control (untreated plants) in both seasons. However, in the first season, using uniconazole or CCC applied by spray or drench method caused high significant decreases in the fresh weight of leaf blade. This trend was true only in the first season. On the contrary, the combination treatment of PP_{333} applied by spray or drench method in the second season showed to be the most effective combination for decreasing the fresh weight of leaf blade as they registered 15.27 and 15.20 g, respectively. On the other hand, the remaining combinations of growth retardants resulted in non significant decreases in this parameter when compared with control in the second season.

Regarding to the interaction effect between growth retardants, concentrations and methods of application, results obtained in Table (11) revealed that all applied growth retardants treatments affected the fresh weight of leaf blade with significant differences in most cases. However, in the first season, the heaviest fresh weight of leaf blade was obtained by treated *S. reginae* plants with the high rate of PP_{333} (applied by drench method) as it gave 17.17 g. The differences between the abovementioned treatment and control plant (16.87g) were non significant. On the contrary, the lowest mean value of the fresh weight of leaf blade was obtained by sprayed the plants with

uniconazole at the high rate (150 ppm). Such trend was true only in the first season, while in the second season, treated the plants with PP_{333} at the low rate (100 ppm) at the two methods of application statistically induced the lowest fresh weight of leaf blade comparing with untreated plants. Irrespective control, the heaviest fresh weight of leaf blade was obtained by using the treatments of CCC at 500 ppm (applied by spray method) and uniconazole at 50 ppm (applied by drench method).

(12) Dry weight of leaf blade (g):

The data obtained on dry weight of the leaf blade as affected by some treatments of growth retardants are presented in Table (12).

The results of the dry weight of the leaf blade attained a parallel trend with the results of the fresh weight of leaf blade, with little differences in the level of significance. In general, all the three used growth retardants treatments (regardless to methods of application and concentrations) significantly decreased the dry weight of leaf blade in both seasons of this study. However, the least dry weight of leaf blade was obtained by using uniconazole application in the first season (2.84 g) followed by CCC application (2.87 g). While, in the second season, PP_{333} application showed its superiority in decreasing the dry weight of leaf blade as it recorded 3.13 g compared with 4.73 g for control.

As for the specific effect of methods of applied growth retardants on the dry weight of leaf blade of *S. reginae* plants, it was quite evident shown from Table (12) that in both seasons,

Table (12): The effect of some growth retardants on the dry weight of leaf blade (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol				Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	3.33	3.06	3.13	3.23	3.14	2.73	2.90	3.03	2.89	2.83	2.96	2.73	2.84	3.05
	Drench	3.36	2.86	3.26	3.40	3.17	2.86	2.83	2.83	2.84	2.66	3.03	2.83	2.84	3.05
Mean		3.45	2.96	3.20	3.32	3.16	2.80	2.87	2.93	2.87	2.75	3.00	2.78	2.84	
LSD_1 at 5% = 0.17		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.29				LSD_4 at 5% = 0.24			LSD_5 at 5% = 0.41		
LSD_1 at 1% = 0.22		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.39				LSD_4 at 1% = 0.32			LSD_5 at 1% = 0.55		
Second season (2002/2003)															
Application methods	Spray	4.86	2.93	3.53	3.10	3.19	4.93	3.26	4.06	4.08	4.80	4.23	3.33	4.12	4.06
	Drench	4.60	2.70	3.13	3.36	3.06	4.76	3.36	3.36	3.83	4.63	4.70	3.10	4.14	3.91
Mean		4.73	2.82	3.33	3.23	3.13	4.85	3.31	3.71	3.96	4.72	4.47	3.22	4.14	
LSD_1 at 5% = 0.58		LSD_2 at 5% =N.S				LSD_3 at 5% = 1.02				LSD_4 at 5% = 0.83			LSD_5 at 5% = 1.44		
LSD_1 at 1% = 0.78		LSD_2 at 1% = N.S				LSD_3 at 1% =1.36				LSD_4 at 1% = 1.11			LSD_5 at 1% = 1.92		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

the differences among the two applications of growth retardants were non significant especially at the first season, as the plants under such methods of application recorded the same exact value (3.05 g for each).

Regarding the interaction effect between growth retardants and their concentrations (regardless to methods of application) data presented in Table (12) indicated that all the concentrations of growth retardants significantly decreased the dry weight of leaf blade in the first season, with the exception of PP_{333} at the high rate (300 ppm) which resulted in non significant decrease in this parameter when compared. However, the lowest mean value of the dry weight of leaf blade was gained by using the application of uniconazole at the low rate (50 ppm) in the first season. Such trend was true only in the first season, while in the second one, all rates of growth retardants decreased the dry weight of leaf blade, with the exception of the low rate of CCC which resulted in non significant increase in this parameter when compared with control.

Concerning the interaction effect between growth retardants and methods of application data in Table (12) declared that all combinations between growth retardants and methods of application (regardless to concentrations) decreased the dry weight of leaf blade in both seasons.

With respect to the interaction effect between growth retardants, concentrations and methods of applications, data obtained in Table (12) showed that all applied treatments of growth retardants decreased the dry weight of leaf blade in the first season, with the exception of PP_{333} at the high rate (300 ppm)

applied by drench method which resulted in non significant increase in this parameter as it gave 3.40 g. On the other hand, the lowest mean value of dry weight of leaf blade was obtained by using the treatment of uniconazole at the high rate (150 ppm) applied by spray method as it recorded 2.73 g. While, in the second season, the treatments of PP_{333} at the low rate (spray or drench method) showed to be the most effective treatments in decreasing the dry weight of leaf blade as they gave 2.93 and 2.70 g, respectively. On the contrary, the heaviest dry weight of leaf blade was obtained by sprayed *S. reginae* with CCC at the low rate (50 ppm) which resulted in non significant increase in this parameter. The previous results of leaf blade measurements i.e., length, width and fresh and dry weights are in agreement with the results of **Corr and Widmer (1991)** on *Zantedeschia alliottiana* and *Zantedeschia elliottiana,* Healy ***et al.*, (1993)** on Alstromeria, **Desouky (1994)** on *S. reginae* and **Youssef (2000)** on *S. reginae* who showed that PP_{333} at 300 ppm increased the width of leaf blade, but it decreased the length of leaf blade and their fresh and dry weights.

IV.1.A.2- Flower growth measurements:

1-Number of flowers per plant:

The data obtained on the number of flowers per plant, as affected by some growth retardant treatments are presented in Table (13).

The results revealed that all the three used growth retardant treatments (regardless to methods of application and concentrations) increased the number of flowers per plant with a

Table (13): The effect of some growth retardants on flowers number per plant of *Strelitzia reginae* Ait. during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	0.566	0.666	1.000	1.330	0.999	0.333	0.333	0.666	0.444	0.335	0.336	0.666	0.446	0.614
	Drench	0.433	1.000	0.666	1.000	0.889	0.666	0.666	1.000	0.777	0.666	0.666	0.335	0.556	0.664
Mean		0.500	0.833	0.833	1.165	0.944	0.500	0.500	0.833	0.611	0.501	0.501	0.501	0.501	
LSD_1 at 5% = 0.132		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.229			LSD_4 at 5% = 0.187				LSD_5 at 5% = 0.320		
LSD_1 at 1% = 0.176		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.306			LSD_4 at 1% = 0.250				LSD_5 at 1% = 0.430		
Second season (2002/2003)															
Application methods	Spray	1.333	1.666	2.900	3.333	2.633	1.760	1.860	2.333	1.984	1.333	1.860	2.100	1.764	1.929
	Drench	1.666	2.000	3.100	3.666	2.924	2.200	1.930	3.000	2.377	1.666	1.930	2.230	1.942	2.227
Mean		1.500	1.833	3.000	3.500	2.778	1.980	1.900	2.667	2.182	1.500	1.895	2.165	1.853	
LSD_1 at 5% = 0.370		LSD_2 at 5% =0.260				LSD_3 at 5% = 0.650			LSD_4 at 5% = 0.530				LSD_5 at 5% = 0.920		
LSD_1 at 1% = 0.500		LSD_2 at 1% = N.S				LSD_3 at 1% =0.870			LSD_4 at 1% = 0.710				LSD_5 at 1% = 1.230		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

non significant increment in this parameter in the first season, with the exception of PP_{333} treatment which resulted in highly significant increment in this parameter as it gave 0.944 flowers / plant compared with 0.500 flowers / plant for control. While, in the second season all the three used growth retardants resulted in highly significant increments in the number of flowers produced by *Strelitzia reginae* plants, only the treatment of uniconazole caused negligible increases over control, whereas, PP_{333} treatment induced the highest number of flowers/plant as it registered 2.778 flowers/plant compared with 1.500 flowers/plant for control.

As for the specific effect of methods of applied growth retardants on the number of flowers of Strelitzia plants, it was clear from Table (13) that drench method was more effective than spray method with significant differences only in the second season.

Referring to the interaction effect between growth retardants and their concentrations, data presented in Table (13) indicated that all concentrations of the three growth retardants (regardless to methods of application) succeeded in increasing the number of flowers/plant in most cases. However, the greatest number of flowers/plant was obtained by using PP_{333} at the highest rate (300 ppm) when compared with control and other treatments as it recorded 1.165 and 3.500 flowers/plant in the first and second seasons, respectively. In addition, the applications of PP_{333} at 100 and 200 ppm and CCC at 2000 ppm in the first season resulted in significant increments in this parameter and gave the same exact values (0.833 flower/plant).

Similarly, the applications of PP_{333} at 200 ppm, CCC at 2000 ppm and uniconazole at 150 ppm in the second season caused significant increases in this parameter.

Concerning the interaction effect between growth retardants and methods of application, data in Table (13) showed that the application of PP_{333} at the two methods of application (regardless to concentrations) showed to be the most effective treatments for increasing the number of flowers/plant when compared with other combinations in both seasons of this study. On the other side, it is worthy to notice that, the drench method was superior treatments in its effect on increasing the number of flowers per plant of *S. reginae* with the three supplied growth retardants in the second season only. However, the increases due to the drench method over spray method of the three applied growth retardants were so small to reach the level of significant.

Regarding to the interaction effect between growth retardants, methods of application and concentrations, data presented in Table (13) pointed out that in the first season PP_{333} sprayed on *Strelitzia reginae* plants at 300 ppm exerted significantly its superiority with increasing the number of flowers/plant compared with other combinations as it recorded 1.333 flowers/plant. Besides, the treatments of PP_{333} at 300 ppm (applied by drench method), PP_{333} at 200 ppm (applied by spray method), PP_{333} at 100 ppm (applied by drench method) and CCC at 2000 ppm (applied by drench method) significantly increased the number of flowers/plant and not only had the same trend but also gave the same exact values (1.000 flower / plant). This trend was true only in the first season, while in the second one, treated

the plants of *Strelitzia reginae* with PP_{333} at the high rate (300 ppm) applied by the two methods of application proved to be the most effective treatments for producing the greatest number of flowers/plant as they recorded 3.666 and 3.333 flowers/plant for drench and spray application, respectively. The differences between the abovementioned two applications were so small to be significant. Additionally, the drench applications of PP_{333} at 200 ppm and CCC at 2000 ppm resulted in highly significant increments in this parameter as they recorded 3.100 and 3.000 flowers/plant, respectively.

On the other hand, the obtained results showed clearly an interesting trend which pointed out that the drench method of the three supplied growth retardants at all tested rates was superior treatments in its effect on increasing the number of flowers per plant of *S. reginae* in the second season. However, the increments due to drench method over spray method of the three applied growth retardants at all rates were so small to reach a level of significant.

Supporting for our discussion the previously mentioned note of the nature of PP_{333} effect on the prolongation of the vegetative and reproductive growth of bird of paradise plants. Since, increasing the endogenous level of cytokinins led to increasing the formation of leaves as well as the number of offsets per plant. This effect was reflected on the increase in the formation of the number of flower spikes / plant.

The effect of PP_{333}, CCC and uniconazole on increasing the number of flowers per plant was noticed by many workers on several plants, in this respect, **Biswas *et al.* (1983)** and

Choudhary (1987) on *Polianthes tuberose,* **Badaway (1992)** on *Calendula officinalis*, **Das *et al.*, (1992)** on *Hemnerocallis aurantiaca*, **Sujatha and Bhattacharjee (1992)** on *Lilium longiflorum*, **Khallafalla (1995)** on Begonia, **Reddy *et al.* (1997)** on *Polianthes tuberosa*, **Tawila (2000)** on *Polianthes tuberosa*, **Dhiman *et al.* (2002)** on Lilium cultivars pollyana and Gran Paradiso, , and **Saker (2004)** who mentioned that spraying *Hibiscus rosa sinensis* and *Tabernamontana coronaria* shrubs with PP_{333} at 200 and 300 ppm and uniconazole at 125 and 187.5 ppm increased the number of flowers per plant.

2-Fresh weight of the first opening floret (g):

According to data presented in Table (14) on the fresh weight of the first opening floret of the flower spathe as effected by using some treatments of growth retardants, it could be concluded that all the three used growth retardants treatments (regardless to methods of application and concentrations) resulted in highly significant increments in the fresh weight of the first opening floret of flower spathe in both seasons, except for uniconazole in the second season as it gave the same value of control (3.37 g). However, the application of PP_{333} proved to be the most effective growth retardant for producing the heaviest fresh weight of floret as it gave 3.86 and 3.89 g in the first and second seasons, respectively.

As for the specific effect of methods of applied growth retardants on the fresh weight of floret, it was quite evident shown from Table (14) that spray method was slightly effective than drench method for increasing the fresh weight of floret g in both seasons. The increment due to spray method over drench

Table (14): The effect of some growth retardants on the fresh weight of first opening floret (g) of *Strelitziaa reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	3.26	3.76	4.00	3.90	3.89	3.66	3.80	3.96	3.81	3.56	3.86	3.66	3.70	3.67
	Drench	3.23	3.76	3.80	3.93	3.83	3.60	3.76	3.93	3.76	3.70	3.80	3.53	3.68	3.63
Mean		3.25	3.76	3.90	3.92	3.86	3.63	3.78	3.95	3.789	3.63	3.83	3.60	3.69	
LSD_1 at 5% = 0.097		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.168			LSD_4 at 5% = 0.137				LSD_5 at 5% = 0.238		
LSD_1 at 1% = 0.129		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.224			LSD_4 at 1% = 0.183				LSD_5 at 1% = 0.317		
Second season (2002/2003)															
Application methods	Spray	3.33	4.36	3.42	4.01	3.93	3.43	3.46	3.56	3.48	3.36	3.46	3.40	3.41	3.54
	Drench	3.40	4.00	3.70	3.83	3.84	3.50	3.43	3.66	3.53	3.30	3.43	3.26	3.33	3.52
Mean		3.37	4.18	3.56	3.92	3.89	3.467	3.45	3.61	3.51	3.33	3.45	3.33	3.37	
LSD_1 at 5% = 0.097		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.168			LSD_4 at 5% = 0.137				LSD_5 at 5% = 0.238		
LSD_1 at 1% = 0.129		LSD_2 at 1% = N.S				LSD_3 at 1% =0.224			LSD_4 at 1% = 0.183				LSD_5 at 1% = 0.317		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

method (regardless to growth retardants and their concentrations) was so small to reach the level of significance in both seasons.

With regard to the interaction effect between growth retardants and their concentrations, data in Table (14) showed that the heaviest fresh weight of floret was recorded by using the application of PP_{333} at the high rate (regardless to methods of application) as it registered the same exact value in the first and second seasons. Moreover, the application of PP_{333} at the medium rate (200 ppm) resulted in highly significant increments in this parameter as it gave 3.90 and 3.56 g in the first and second seasons, respectively.

Furthermore, the data of the interaction effect between growth retardants and methods of application (Table, 14) indicated that the spray method was superior treatment in its effect on increasing the fresh weight of floret of *S. reginae* plants in both seasons, with the exception of the drench method of CCC in the second season as it was more effective than spray method with non significant differences. The increases due to spray method over spray method of the applied growth retardants were so small to be significant in both seasons. However, the application of PP_{333} at the two methods of application (regardless to concentrations) showed to be the most effective combinations for increasing the fresh weight of floret (g) in both seasons of this study.

Concerning the interaction effect between growth retardants, methods of application and concentrations, the results revealed that in the first season, the heaviest fresh weight of floret was obtained by spraying *S. reginae* plants with PP_{333} at

200 ppm as it gave 4.00 g. Moreover, spraying the plants with CCC at 2000 ppm resulted in a highly significant increment in this parameter (3.96 g) followed by using the drench method of CCC and PP_{333} at the high rates and they not only had the same trend but also gave the same exact values (3.93 g). This trend was true only in the first season, while in the second one, sprayed Strelitzia plants with PP_{333} at the low rate (100 ppm) showed its superiority for increasing the fresh weight of floret (4.36 g).

3-The dry weight of first opening floret (g):

The data obtained on dry weight of the first opening floret on flower spathe as affected by using some growth retardant treatments are presented in Table (15).

The results of the dry weight of the first opening floret on the flower spathe attained a parallel trend with the fresh weight results in both seasons, with little differences in the level of significance. In general, the heaviest dry weight of the first opening floret on the flower spathe was recorded by spraying PP_{333} at 200 ppm in the first season (0.396 g) and the treatment of spraying PP_{333} at 100 ppm in the second one (0.440 g). The results of fresh and dry weights of the first opening floret are in parallel with those of **Laskowska and Durlak (1995)** on tulips and **Talukdar and Paswan (1996)** on *Dendrantha grandiflora*, **Tawila (2000)** on tuberose and **Adham (2001)** on *Althaea rosea*, indicated that CCC at 4000 ppm and PP_{333} at 25 and 100 ppm increased the fresh and dry weights of flowers.

Table (15): The effect of some growth retardants on the dry weight of first opening floret (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2000/2001 and 2001/2002.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	0.326	0.380	0.396	0.393	0.390	0.363	0.376	0.393	0.377	0.360	0.383	0.363	0.369	0.365
	Drench	0.323	0.380	0.383	0.393	0.385	0.356	0.376	0.396	0.376	0.366	0.376	0.356	0.366	0.363
Mean		0.325	0.380	0.390	0.393	0.388	0.360	0.376	0.395	0.377	0.363	0.380	0.360	0.368	
LSD_1 at 5% = 0.021		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.036				LSD_4 at 5% = 0.030				LSD_5 at 5% = 0.051	
LSD_1 at 1% = 0.028		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.049				LSD_4 at 1% = 0.040				LSD_5 at 1% = 0.069	
Second season (2002/2003)															
Application methods	Spray	0.336	0.440	0.346	0.410	0.399	0.353	0.356	0.363	0.357	0.340	0.350	0.343	0.344	0.359
	Drench	0.340	0.406	0.390	0.390	0.395	0.360	0.350	0.373	0.361	0.333	0.346	0.333	0.337	0.358
Mean		0.338	0.423	0.368	0.400	0.397	0.357	0.353	0.368	0.359	0.336	0.348	0.338	0.341	
LSD_1 at 5% = 0.020		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.034				LSD_4 at 5% = 0.028				LSD_5 at 5% = 0.049	
LSD_1 at 1% = 0.026		LSD_2 at 1% = N.S				LSD_3 at 1% =0.046				LSD_4 at 1% = 0.038				LSD_5 at 1% = 0.065	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

4-The number of opening florets / flower:

Data presented in Table (16) indicated that the number of opening florets/flower was greatly influenced by the growth retardants treatments as compared to control in both seasons. Thus, it could be noticed that all the three used growth retardants treatments had enhancing effect on the number of opening florets/flower. Hence, in both seasons of this study, the greatest number of opening floret/flower was statistically induced by those *S. reginae* plants grown in pots and treated by PP_{333} (regardless to the application methods and concentrations) which gave 6.14 and 8.04 florets/flower in the first and second seasons, respectively. Whereas, the lowest number of opening florets/flower values (4.25 and 5.25) obtained from untreated plants (control) in both seasons. On the other hand, treating the plants of *S. reginae* with CCC caused a high significant increment in this parameter as it recorded 5.47 and 6.94 in the first and second seasons, respectively and ranked the second in this concern.

With respect to the specific effect of methods of applied growth retardants on the number of opening florets/flower, it was obviously shown from Table (16) that spray method was slightly effective than drench method in increasing the number of opening floret/flower in the first season, while in the second one, the picture was completely reversed, where drench method showed its superiority in increasing this parameter. The differences between the two applied methods of application did not reach the level of significant in both seasons.

Table (16): The effect of some growth retardants on the number of opening florets /flower of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	4.50	6.00	6.83	5.00	5.94	5.00	6.00	6.16	5.72	4.33	5.16	4.50	4.66	5.21
	Drench	4.00	6.33	6.66	6.00	6.33	5.16	5.33	5.10	5.20	4.00	5.00	4.00	4.33	4.97
Mean		4.25	6.17	6.75	5.50	6.14	5.08	5.67	5.63	5.47	4.16	5.08	4.25	4.50	
LSD_1 at 5% = 0.441 LSD_1 at 1% = 0.588		LSD_2 at 5% = N.S LSD_2 at 1% = N.S					LSD_3 at 5% = 0.763 LSD_3 at 1% = 1.020				LSD_4 at 5% = 0.623 LSD_4 at 1% = 0.832				LSD_5 at 5% = 1.080 LSD_5 at 1% = 1.440
Second season (2002/2003)															
Application methods	Spray	5.00	8.33	7.60	7.50	7.81	5.00	8.00	7.50	6.83	6.00	7.00	5.16	6.05	6.42
	Drench	5.50	8.00	8.50	8.30	8.27	6.33	7.00	7.80	7.04	5.00	7.16	6.00	6.05	6.72
Mean		5.25	8.17	8.05	7.90	8.04	5.67	7.50	7.65	6.94	5.50	7.08	5.58	6.05	
LSD_1 at 5% = 0.565 LSD_1 at 1% = 0.755		LSD_2 at 5% = N.S LSD_2 at 1% = N.S					LSD_3 at 5% = 0.979 LSD_3 at 1% =1.300				LSD_4 at 5% = 0.800 LSD_4 at 1% = 1.060				LSD_5 at 5% = 1.380 LSD_5 at 1% = 1.850

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

Furthermore, the results of the interaction effect between growth retardants and their concentrations (Table, 16) revealed that the maximum number of opening floret/flower in the first season was observed on plants treated with the medium rate of PP_{333} (regardless to the methods of application) as it gave 6.75 florets/flower compared with 4.25 florets / flower for control. While, in the second season, the low rate of PP_{333} (100 ppm) showed its superiority in this connection as it registered 8.17 florets/flower. In addition, the application of PP_{333} at the medium rate (200 ppm) in the second season resulted in a highly significant increment in this parameter followed by using the application of PP_{333} at the high rate (300 ppm). The differences between the three applied rates of PP_{333} (regardless to methods of application) were non significant in the second season.

With respect to the interaction effect between growth retardants and methods of application, data in Table (16) showed that all combinations of PP_{333}, CCC and uniconazole (regardless to concentrations) succeeded in increasing the number of opening florets / flower in both seasons. Since, the greatest number of opening florets / flower was recorded by using PP_{333} with the two methods of application in both seasons. However, the increases due to drench method over spray method of the application of PP_{333} were so small to reach the level of significant in both seasons.

As for the interaction effect between growth retardants, methods of application and concentration, data presented in Table (16) pointed out that in the first season, sprayed the plants of *S. reginae* with the medium rate of PP_{333} (200 ppm) induced

the highest number of opening floret / flower (6.83 florets / flower) followed by using the drench method of PP_{333} at 200 ppm (6.66 florets / flower). The differences between the prementioned two treatments were non significant. While, in the second season, the drench application of PP_{333} at 200 ppm was the superior treatment which induced the greatest number of opening floret / flower (8.50 florets / flower) followed by sprayed Strelitzia plants with PP_{333} at 100 ppm (8.33 florets / flower). Moreover, the treatments of PP_{333} at the high and medium rates and applied by drench method resulted in highly significant increments in this parameter.

5-Duration of flower on plant (days):

Data on the duration of flowers on plants as affected by some treatments of growth retardants are given in Table (17). The data indicated that the duration of flower on plant was greatly affected by the growth retardants treatments as compared to control in both seasons. Thus, it could be observed that all the three used growth retardants treatments had improving effect on duration of flowers on plant. Hence, in both seasons of this study, the highest mean value of duration of flower on plant was statistically induced by those plants grown in pots and treated with PP_{333} (regardless to concentrations and methods of application) which recorded 58.61 and 76.67 days in the first and second seasons, respectively. Whereas, the lowest mean value of this parameter was obtained from untreated plants (control) which registered 47.00 and 57.05 days in the first and second seasons, respectively. On the other side, treating the plants of Strelitzia with CCC increased the duration of flowers on plants

Table (17): The effect of some growth retardants on the duration of flower on plant (days) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

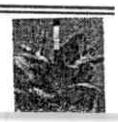
First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	48.00	57.67	63.33	52.33	57.78	53.67	58.33	51.33	54.44	50.67	53.67	49.33	51.22	52.86
	Drench	46.00	55.67	61.33	61.33	59.44	56.33	55.67	55.00	55.67	47.67	52.00	46.33	48.67	52.45
Mean		47.00	56.67	62.33	56.83	58.61	55.00	57.00	53.17	55.06	49.17	52.84	47.83	49.95	
LSD_1 at 5% = 1.29		LSD_2 at 5% = N.S				LSD_3 at 5% = 2.24				LSD_4 at 5% = 1.83				LSD_5 at 5% = 3.17	
LSD_1 at 1% = 1.72		LSD_2 at 1% = N.S				LSD_3 at 1% = 2.99				LSD_4 at 1% = 2.44				LSD_5 at 1% = 4.23	
Second season (2002/2003)															
Application methods	Spray	54.43	78.67	72.33	72.33	74.44	57.33	77.00	72.67	69.00	62.67	65.67	56.67	61.67	64.89
	Drench	59.67	75.67	81.67	79.33	78.89	58.33	70.67	78.67	69.22	58.33	67.33	61.33	62.33	67.53
Mean		57.05	77.17	77.00	75.83	76.67	57.83	73.84	75.67	69.11	60.50	66.50	59.00	62.00	
LSD_1 at 5% = 1.61		LSD_2 at 5% =1.14				LSD_3 at 5% = 2.79				LSD_4 at 5% = 2.28				LSD_5 at 5% = 3.95	
LSD_1 at 1% = 2.15		LSD_2 at 1% = 1.52				LSD_3 at 1% =3.73				LSD_4 at 1% = 3.04				LSD_5 at 1% = 5.28	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

as it gave 55.06 and 69.11 days and ranked the second in this concern, followed by uniconazole which gave 49.95 and 62.00 days. These values were lower than those recorded for all other treatments but it still gave highly significant increments over control in both seasons.

As for the specific effect of methods of applied growth retardants on duration of flowers on plants of *S. reginae*, it was clearly shown from Table (17) that spray method was more effective than drench method, but the differences between the two applied methods did not reach the level of significance in the first season. While, in the second season, drench method showed its superiority for increasing the duration of flowers on plants, and the increment due to drench method over spray method reach the level of highly significant at 1%.

Considering, the interaction effect between growth retardants and their concentrations, data in Table (17) exhibited that all combinations between the three growth retardants and their concentrations (regardless methods of application) markedly increased duration of flowers on plants in both seasons. However, in the first season, using the application of PP_{333} at the medium rate (200 ppm) approved to be the most effective treatment for increasing duration of flower on plant (62.33 days) followed by the medium rate of CCC (1000 ppm) as compared to other applications and control. Similarly, the applications of PP_{333} at the low and high rates caused highly significant increments in this parameter. The differences between the prementioned two applications were non significant. While, in the second season, using PP_{333} at the low rate (100 ppm)



showed its superiority for increasing the duration of flowers on plants as it gave 77.17 days followed by using the medium rate of PP_{333} which recorded 77.00 days. In addition, the applications of PP_{333} and CCC at the high rates resulted in highly significant increments in this parameter and exhibited not only insignificant variance between each other but also, showed approximately the same value of duration of flower on plant.

With regard to the interaction effect between growth retardants and methods of application, data presented in Table (17) declared that all combinations between growth retardants and methods of application (regardless to concentrations) significantly succeeded in increasing duration of flowers on plants in both seasons of this study. However, treating the plants with the two methods of PP_{333} resulted in the highest mean values of this parameter as compared with other combinations and control plants in both seasons.

Concerning the interaction effect between growth retardants, methods of application and concentrations, data tabulated in Table (17) pointed out that most applied treatments of growth retardants significantly increased duration of flowers on plants in both seasons. Hence, in the first season sprayed PP_{333} at 200 ppm showed to be the most effective treatment for prolonging duration of flower on plant as it gave 63.33 days. Also, both treatments of PP_{333} at 200 and 300 ppm applied by drench method resulted in highly significant increments in this parameter and showed not only insignificant variance between each other but also, registered the same exact values of duration of flower on plant

While, in the second season, treating the plants of *S. reginae* with PP_{333} at 200 ppm (applied by drench method) approved to be the most effective treatment for extending the duration of flowers on plants as it gave 81.67 days as compared to other treatments and control, followed by using the drench method of PP_{333} at 300 ppm which recorded 79.33 days. Similarly, both PP_{333} at 100 ppm (applied by spray method) and CCC at 2000 ppm (applied by drench method) resulted in highly significant increases in this parameter and exhibited not only insignificant variance between each other but also, recorded the same exact values of the duration of flower on plant. Such results are coincided with those of **Bhattacharjee (1983)** on *Hippeastrum hybridum*, **Suh *et al.* (1992)** on Tulip cv. Apeldoorn and **Srour (2001)** who mentioned that uniconazole at 90 to 180 ppm enhanced the longevity of flower on *Jacobinbia carnea* plants.

6-Length of flower stalk (cm):

Data in Table (18) exhibited that there were significant decreases in the length of flower stalk of *S. reginae* plants by using all the three growth retardants treatments.

The gained results showed that the treated plants were shorter than the control by 32.09, 17.72 and 18.77% in the first season and 59.76, 41.95 and 42.65% in the second season for PP_{333}, CCC and uniconazole compared with control, respectively. Consequently, PP_{333} was more effective than CCC and uniconazole in reducing the length of flower stalk in both seasons.

Table (18): The effect of some growth retardants on the length of flower stalk (cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	83.33	71.33	60.33	48.67	60.11	75.33	68.33	58.33	67.33	81.00	62.33	62.67	68.67	69.86
	Drench	86.00	58.67	54.33	51.67	54.89	77.67	70.67	67.67	72.00	78.33	64.00	64.33	68.89	70.45
Mean		84.67	65.00	57.33	50.17	57.50	76.50	69.50	63.00	69.67	79.67	63.17	63.50	68.78	
LSD_1 at 5% = 1.75		LSD_2 at 5% = N.S				LSD_3 at 5% = 3.04				LSD_4 at 5% = 2.48				LSD_5 at 5% = 4.30	
LSD_1 at 1% = 2.34		LSD_2 at 1% = N.S				LSD_3 at 1% = 4.06				LSD_4 at 1% = 3.31				LSD_5 at 1% = 5.74	
Second season (2002/2003)															
Application methods	Spray	88.67	51.33	30.00	28.00	36.44	53.33	50.33	45.33	49.67	53.33	49.67	49.33	50.78	56.39
	Drench	86.67	41.00	36.33	25.00	34.11	56.67	52.33	47.33	52.11	55.33	47.67	46.33	49.78	55.67
Mean		87.67	46.17	33.17	26.50	35.28	55.00	51.33	46.33	50.89	54.33	48.67	47.83	50.28	
LSD_1 at 5% = 2.73		LSD_2 at 5% =N.S				LSD_3 at 5% = 4.73				LSD_4 at 5% = 3.86				LSD_5 at 5% = 6.70	
LSD_1 at 1% = 3.65		LSD_2 at 1% = N.S				LSD_3 at 1% =6.32				LSD_4 at 1% = 5.16				LSD_5 at 1% = 8.94	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

Considering the specific effect of methods of application, data presented in Table (18) showed that in the first season sprayed the three tested growth treatments (regardless to the effect of growth retardants and their concentrations) on the leaves of the plants four times decreased the length of flower stalk with non significant differences when compared to the drench method of application. The opposite was true in the second season, therefore drench method was the most effective in shortening the length of flower stalk as compared with spray method, but the decreases over spray method did not reach the level of significance. The results may be due to the accumulation of active substances of the growth retardants in the growing media by increasing drench applications up to four times in the first season, while reached eight times in the second one.

Additionally, data of the interaction effect between growth retardants and their concentrations (Table, 18) cleared that the treatments of PP_{333} at the rates of 100, 200 and 300 ppm, CCC at the rates of 500, 1000 and 2000 ppm and uniconazole at the rates of 50, 100 and 150 ppm significantly reduced the length of flower stalk in both seasons. Such reduction was gradually increased by increasing PP_{333}, CCC and uniconazole concentration in both seasons. Four times application with the highest concentration of PP_{333} (regardless to methods of application) was the most effective treatment in reducing the length of flower stalk in the first season, whereas in the second season PP_{333} applied eight times with the high concentration tended to declare its own relative superiority over other

combinations and control treatments in producing the shortest flower stalk at all (26.50 cm).

As for the influence of interaction between growth retardants and methods of application on the length of flower stalk of *S. reginae* plants, data in Table (18) displayed an obvious response, hence the greatest reduction in the length of flower stalk statistically induced by plants treated with the two methods of application of PP_{333} (regardless to concentrations) as it registered 60.11 and 36.44 cm for spray application and 54.89 and 34.11cm for drench application in the first and second seasons, respectively. It is worthy to notice that the differences between the two methods of application were so small to be significant in the second season.

With regard to the interaction effect between growth retardants, concentrations and methods of application on the length of flower stalk, data tabulated in Table (18) pointed out that treated plants with PP_{333} at 300 ppm for the two methods of application showed to be the most effective applications for reducing the length of flower stalk as they gave 48.67 and 28.00 cm for spray method and 51.67 and 25.00 cm for drench method in the first and second seasons, respectively.

On the other hand, the inferior taller flower stalk were produced by the treatments of uniconazole at 50 ppm with the two methods of application in the first season as they gave 81.00 and 78.33 cm, but still gave a highly significant decrease in this parameter compared to control which gave 83.33 and 86.00 cm for spray and drench method, respectively. While, in the second season the inferior taller flower stalk was more responded more

to CCC at 500 ppm applied by drench method than other treatments. Of interest, is that the abovementioned results when related with the histological features of treated plants and also with their growth aspects. Since gibberellin is known as a stimulating and individual hormone for longitudinal growth in different plants (**Devlin and Witham, 1983**). Hence, reduction of endogenous gibberellins level due to using the treatments of growth retardants (as will be mentioned later) led to reduction in the length of different cell types and consequently reduction in the length of flower stalk especially when the reduction of both gibberellins and auxins is considered.

7-The thickness of top flowers stalk (cm):

Data presented in Table (19) revealed that the thickness of top flower stalk was greatly affected by the growth retardants treatments when compared with control in both seasons. Hence, in both seasons of this study and regardless to the effect of concentrations and methods of application, the maximum thickness of top flower stalk was obtained on *S. reginae* plants which treated with PP_{333} as it registered 1.24 and 1.35 (cm) as compared with 1.02 and 1.16 (cm) for control in the first and second seasons, respectively. On the other side, treating the plants of bird of paradise with CCC showed a high significant increment in this parameter and ranked the second followed by the application of uniconazole which ranked the third in this respect.

As for the specific effect of methods of applied growth retardants on the thickness of top flower stalk (cm) data in Table (19) showed that spray application was slightly effective than

Table (19): The effect of some growth retardants on the thickness of top flower stalk (cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	1.03	1.16	1.23	1.34	1.24	1.14	1.19	1.33	1.22	1.10	1.18	1.25	1.18	1.17
	Drench	1.00	1.15	1.28	1.30	1.24	1.13	1.15	1.23	1.17	1.11	1.17	1.26	1.18	1.15
Mean		1.02	1.16	1.26	1.32	1.24	1.14	1.17	1.28	1.20	1.10	1.17	1.26	1.18	
LSD_1 at 5% = 0.036		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.063			LSD_4 at 5% = 0.051				LSD_5 at 5% = 0.090		
LSD_1 at 1% = 0.049		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.084			LSD_4 at 1% = 0.069				LSD_5 at 1% = 0.120		
Second season (2002/2003)															
Application methods	Spray	1.16	1.43	1.20	1.46	1.36	1.23	1.23	1.33	1.26	1.16	1.26	1.33	1.25	1.26
	Drench	1.16	1.20	1.33	1.50	1.34	1.20	1.26	1.30	1.25	1.13	1.23	1.30	1.22	1.24
Mean		1.16	1.32	1.27	1.48	1.35	1.22	1.25	1.32	1.26	1.15	1.25	1.32	1.24	
LSD_1 at 5% = 0.042		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.073			LSD_4 at 5% = 0.060				LSD_5 at 5% = 0.103		
LSD_1 at 1% = 0.056		LSD_2 at 1% = N.S				LSD_3 at 1% =0.098			LSD_4 at 1% = 0.080				LSD_5 at 1% = 0.138		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

drench application for increasing the thickness of top flower stalk (cm) in both seasons of this study. The increment due to spray application over drench application was so small to reach the level of significant in both seasons.

With respect to the interaction effect between growth retardants and their concentrations, data in Table (19) pointed out that all rates of the three used growth retardants succeeded in increasing the thickness of top flower stalk (cm) in both seasons, with the exception of the low rate of CCC (500 ppm) in the second season as it decreased this parameter with non significant differences. However, the maximum thickness of top flower stalk (cm) was obtained by using the high rate of PP_{333} (regardless to methods of application) as it registered 1.32 and 1.48 cm in the first and second seasons, respectively.

Furthermore, the data of the interaction effect between growth retardants and methods of application (Table, 19) indicated that all combinations of PP_{333}, CCC and uniconazole at the two methods of applications (regardless to concentrations) significantly increased the thickness of top flower stalk (cm) in both seasons. Since, in both seasons of this study, using PP_{333} at the two methods of application showed to be the most effective combinations for increasing the thickness of top flower stalk (cm) when compared with other combinations of growth retardants and control.

Concerning the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (19) pointed out that all applied treatments of the three used growth retardants significantly increased the

thickness of top flower stalk (cm) in most cases. However, in both seasons, treating Strelitzia plants with PP_{333} at the high rate with the two methods of application appeared to be the most effective treatments for inducing the maximum thickness of top flower stalk when compared with other treatments and control.

8--Fresh weight of the flower stalk (g):

According to data tabulated in Table (20), it could be concluded that all the three used growth retardants treatments obviously decreased the fresh weight of flower stalk / plant when compared with control in both seasons of this study. Thus, the heaviest fresh weight of flowers stalk (g) was recorded on untreated plants (control) as it gave 41.97 and 49.17g in the first and second seasons, respectively. On the other hand, the least fresh weight values of flower stalk of *S. reginae* plant was obtained by treating the plants with PP_{333} (regardless to application methods and concentrations) as it registered 31.08 and 24.29 g in the first and second seasons, respectively.

As for the specific effect of methods of applied the three used growth retardant treatments on the fresh weight of flower stalk (g), data in Table (20) showed that drench method was slightly effective than spray method for decreasing the fresh weight of flower stalk in both seasons. The differences between the two methods of application were non significant in both seasons of this study.

With respect to the interaction effect between growth retardants and their concentrations, data obtained in Table (20) revealed that all rates of the three used growth retardants

Table (20): The effect of some growth retardants on the fresh weight of flower stalk (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	41.67	37.40	32.30	29.13	32.94	40.53	38.70	34.30	37.84	42.83	33.90	36.17	37.63	37.52
	Drench	42.27	29.60	29.70	28.37	29.22	41.27	38.50	38.80	39.52	41.03	35.07	37.07	37.72	37.18
Mean		41.97	33.50	31.00	28.75	31.08	40.90	38.60	36.55	38.68	41.93	34.49	36.62	37.68	
LSD_1 at 5% = 1.32		LSD_2 at 5% = N.S				LSD_3 at 5% = 2.29				LSD_4 at 5% = 1.87				LSD_5 at 5% = 3.23	
LSD_1 at 1% = 1.76		LSD_2 at 1% = N.S				LSD_3 at 1% = 3.05				LSD_4 at 1% = 2.29				LSD_5 at 1% = 4.32	
Second season (2002/2003)															
Application methods	Spray	49.67	43.67	16.47	20.03	26.72	34.33	32.33	25.00	30.55	32.00	33.00	34.33	33.11	35.01
	Drench	48.67	22.20	23.67	19.67	21.85	38.33	35.67	27.00	33.67	33.33	30.33	31.00	31.55	33.94
Mean		49.17	32.94	20.07	19.85	24.29	36.33	34.00	26.00	32.11	32.67	31.67	32.67	32.34	
LSD_1 at 5% = 2.08		LSD_2 at 5% = N.S				LSD_3 at 5% = 3.61				LSD_4 at 5% = 2.95				LSD_5 at 5% = 5.11	
LSD_1 at 1% = 2.78		LSD_2 at 1% = N.S				LSD_3 at 1% =4.83				LSD_4 at 1% = 3.94				LSD_5 at 1% = 6.83	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

significantly succeeded in decreasing the fresh weight of flower stalk (g) in both seasons, with the exception of the low rates of CCC and uniconazole as they caused non significant decreases in this parameter in the first season only. However, the least fresh weight of flower stalk was gained by treated Strelitzia plants with the high rate of PP_{333} (regardless to methods of application) as it gave 28.75 and 19.85 g in the first and second seasons, respectively. Furthermore, the data of the interaction effect between growth retardants and methods of application (Table, 20) indicated that all combinations of PP_{333}, CCC and uniconazole at the two methods of application (regardless to concentrations) resulted in highly significant decreases in this parameter in both seasons. However, PP_{333} at the two methods of application proved to be the most effective combination treatments for decreasing the fresh weight of flower stalk (g) in both seasons.

Concerning the interaction effect between growth retardants, concentrations and methods of application data presented in Table (20) pointed out that the fresh weight of flower stalk (g) was greatly affected by all applied treatments of the three growth retardants as compared to control in both seasons. However, in the first season, treated Strelitzia plants with PP_{333} at 300 ppm by the two methods of application showed to be the most effective treatments for decreasing the fresh weight of flower stalk (g) as compared to control. Such trend was true only in the first season, while in the second one, sprayed PP_{333} at 200 ppm showed to be the most effective treatment for producing the least fresh weight of flower stalk as

it gave 16.47g. Moreover, using PP_{333} at the high rate (300 ppm) with the two methods of application caused highly significant reduction in this parameter. Irrespective control, the heaviest fresh weight of flower stalk (g) in the second season was obtained by spraying the plants with PP_{333} at the low rate (100 ppm). The remaining treatments of growth retardants occupied intermediate position when compared to control in both seasons.

9--Dry weight of the flower stalk (g):

With respect to the effect of some growth retardants treatments on the dry weight of flower stalk (g) of *S. reginae* plants, data in Table (21) showed that the results of dry weight of flower stalk, go on line with those obtained with fresh weight of flower stalk (g), with little differences in the level of significance.

In general, the heaviest dry weight of flower stalk (g) was recorded by spraying the plants of *Strelitzia reginae* with the low rate of uniconazole in the first season, and the treatment of spraying PP_{333} at the low rate (100 ppm) in the second season, but the differences between the prementioned two treatments and control were non significant. On the other hand, the least dry weight of flower stalk of *S. reginae* plants was recorded in the first season by using the drench application of PP_{333} at the low and high rates, while in the second season spraying PP_{333} at 200 ppm showed its superiority for decreasing the dry weight of flower stalk (g) as compared to control. The results of flower stalk traits i.e., length, thickness and fresh and dry weights of flower stalk as affected by PP_{333}, CCC and uniconazole are coincided with those of **Horn and Wischer (1987)** on *Elatior*

Table (21): The effect of some growth retardants on the dry weight of flower stalk (g) of *Strelitzia reginae* Ait plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	5.08	4.13	3.60	3.50	3.74	5.07	4.41	4.11	4.53	5.22	4.16	4.38	4.59	4.49
	Drench	5.15	3.25	3.35	3.25	3.28	4.82	4.24	4.65	4.57	4.93	4.57	4.46	4.65	4.41
Mean		5.12	3.69	3.48	3.38	3.52	4.95	4.323	4.38	4.55	5.08	4.37	4.42	4.62	
LSD_1 at 5% = 0.207		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.356			LSD_4 at 5% = 0.290				LSD_5 at 5% = 0.503		
LSD_1 at 1% = 0.274		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.475			LSD_4 at 1% = 0.388				LSD_5 at 1% = 0.672		
Second season (2002/2003)															
Application methods	Spray	6.00	6.14	1.83	2.26	3.41	3.63	3.53	2.50	3.22	3.50	3.53	3.73	3.59	4.06
	Drench	5.88	2.41	2.51	2.20	2.37	4.03	3.80	2.80	3.54	3.70	3.33	3.40	3.48	3.82
Mean		5.94	4.28	2.17	2.23	2.89	3.83	3.67	2.65	2.38	3.60	3.43	3.57	3.54	
LSD_1 at 5% = 0.221		LSD_2 at 5% =0.156				LSD_3 at 5% = 0.383			LSD_4 at 5% = 0.313				LSD_5 at 5% = 0.542		
LSD_1 at 1% = 0.295		LSD_2 at 1% = N.S				LSD_3 at 1% =0.512			LSD_4 at 1% = 0.418				LSD_5 at 1% = 0.724		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

begonias cv. Schwabenland Rot, **Hradilik and Fiserova (1987)** on *Cyclamen persicum* cv. Cervenokvety, **Whipker and Hammer (1997)** on Dhalia cultivar Non-Stop Scarlet, **Tawila (2000)** who showed that PP_{333} at 50 ppm decreased the length of flower stalk, but it increased the diameter of flower stalk. Also, **Srour (2001)** indicated that treated *Jacobinia carnea* plants with uniconazole at 60 to 180 ppm applied as a soil drench markedly decreased the length of inflorescence and their fresh and dry weights.

10-Length of flower spathe (cm):

Data presented in Table (22) revealed that the length of flower spathe (cm) was greatly affected by using the applications of PP_{333} (regardless to concentrations and methods of application) which resulted in highly significant reduction in the length of flower spathe (cm) as it registered 15.37 and 13.73 cm as compared to 16.17 and 16.50 cm for control in the first and second seasons, respectively. On the other hand using the applications of CCC and uniconazole decreased the length of flower spathe (cm) with non significant differences in the first season, and highly significant differences in the second season when compared with untreated plants (control) in the first and second seasons, respectively.

Regarding to the specific effect of methods of applied growth retardants on the length of flower spathe (cm), it was clear from data in Table (22) that spray application was slightly effective than drench application for shortening the length of flower spathe (cm). Such trend was true only in the first season, while in the second one drench application showed its

Table (22): The effect of some growth retardants on the length of flower spathe (cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	16.00	15.67	15.33	15.10	15.37	16.33	15.20	15.10	15.54	15.17	16.67	16.33	16.06	15.74
	Drench	16.33	16.23	15.20	14.67	15.37	17.23	16.13	15.33	16.23	16.23	15.33	16.27	15.94	15.97
Mean		16.17	15.95	15.27	14.89	15.37	16.78	15.67	15.22	15.89	15.70	16.00	16.30	16.00	
LSD_1 at 5% = 0.470 LSD_1 at 1% = 0.628		LSD_2 at 5% = N.S LSD_2 at 1% = N.S					LSD_3 at 5% = 0.815 LSD_3 at 1% = 1.080				LSD_4 at 5% = N.S LSD_4 at 1% = N.S				LSD_5 at 5% = 1.150 LSD_5 at 1% = 1.530
Second season (2002/2003)															
Application methods	Spray	16.67	14.50	13.60	13.33	13.81	14.50	13.67	13.50	13.89	14.17	13.83	13.33	13.78	14.54
	Drench	16.33	14.17	13.77	13.00	13.65	15.17	13.50	13.67	14.11	14.33	13.67	13.17	13.72	14.45
Mean		16.50	14.34	13.69	13.17	13.73	14.84	13.59	13.59	14.00	14.25	13.75	13.25	13.75	
LSD_1 at 5% = 0.258 LSD_1 at 1% = 0.344		LSD_2 at 5% = N.S LSD_2 at 1% = N.S					LSD_3 at 5% = 0.447 LSD_3 at 1% =0.596				LSD_4 at 5% = 0.365 LSD_4 at 1% = 0.487				LSD_5 at 5% = 0.632 LSD_5 at 1% = 0.844

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

superiority for decreasing the length of flower spathe (cm). The differences between the two methods of application were so small to reach a level of significant.

Furthermore, the data of the interaction effect between growth retardants and their concentrations (Table, 22) revealed that the application of PP_{333} at 300 ppm, CCC at 2000 ppm and PP_{333} at 200 ppm (regardless to methods of application) are being the most effective applications for decreasing the length of flower spathe (cm) in the first season, while in the second season treated Strelitzia plants with the high rate of PP_{333} (300 ppm) showed its superiority for decreasing the length of flower spathe (cm) as compared to other rates of growth retardants and control. Similarly, the applications of uniconazole at 150 ppm and CCC 1000 and 2000 ppm in the second season resulted in highly significant decreases in this parameter.

With regard to the interaction effect between growth retardants and methods of application data in Table (22) showed that all combinations of the three used growth retardants at the two methods of application (regardless to concentrations) succeeded in decreasing the length of flower spathe (cm) with non significant differences in the first season and highly significant differences in the second one. Therefore, the lowest mean values of the length of flower spathe (cm) was obtained by using PP_{333} at the two methods of application in both seasons.

As for the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (22) pointed out that the drench method of PP_{333} at the high rate (300 ppm) proved to be the most effective treatment for

producing the least length of flower spathe (cm) as it registered 14.67 and 13.00 cm in the first and second seasons, respectively. Moreover, sprayed PP_{333} and CCC at the high rates in the first season, and using uniconazole at the high rate with the two methods of application in the second season caused highly significant decreases in this parameter.

11-Width of flower spathe (cm):

Data presented in Table (23) declared that the width of flower spathe (cm) was greatly affected by the growth retardant treatments as compared to control in both seasons. Hence, it could be observed that all the three used growth retardant treatments had improving effect on the width of flower spathe (cm). However, in both seasons of this study, the widest flower spathe (cm) was statistically induced by those *S. reginae* plants grown in pots and treated by PP_{333} which gave highly significant increments in this parameter as it registered 2.18 and 2.42 cm compared to 1.85 and 2.18 cm for control in the first and second seasons, respectively.

As for the specific effect of methods of applied growth retardants (regardless to growth retardant and their concentrations) on the width of flower spathe (cm), data in Table (23) showed that spray method was slightly effective than drench method for increasing the width of flower spathe (cm) with non significant differences in both seasons.

Concerning the interaction effect between growth retardants and their concentrations (regardless to methods of application), data in Table (23) pointed out that all the three used

Table (23): The effect of some growth retardants on the width of flower spathe (cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	1.86	2.10	2.26	2.20	2.19	1.96	2.20	2.26	2.14	1.90	2.10	2.03	2.01	2.05
	Drench	1.83	2.00	2.20	2.30	2.17	1.90	2.06	2.21	2.06	2.00	2.20	1.91	2.04	2.03
Mean		1.85	2.05	2.23	2.25	2.18	1.93	2.13	2.24	2.10	1.95	2.15	1.97	2.02	
LSD_1 at 5% = 0.063 LSD_1 at 1% = 0.084		LSD_2 at 5% = N.S LSD_2 at 1% = N.S			LSD_3 at 5% = 0.110 LSD_3 at 1% = 0.147		LSD_4 at 5% = 0.090 LSD_4 at 1% = 0.120			LSD_5 at 5% = 0.155 LSD_5 at 1% = 0.208					
Second season (2002/2003)															
Application methods	Spray	2.20	2.33	2.33	2.53	2.40	2.26	2.40	2.50	2.39	2.23	2.13	2.03	2.13	2.28
	Drench	2.16	2.30	2.50	2.50	2.43	2.23	2.33	2.46	2.34	2.23	2.16	2.00	2.13	2.27
Mean		2.18	2.32	2.42	2.52	2.42	2.25	2.37	2.48	2.37	2.23	2.15	2.02	2.13	
LSD_1 at 5% = 0.070 LSD_1 at 1% = 0.093		LSD_2 at 5% = N.S LSD_2 at 1% = N.S			LSD_3 at 5% = 0.121 LSD_3 at 1% =0.162		LSD_4 at 5% = 0.099 LSD_4 at 1% = 0.132			LSD_5 at 5% = 0.172 LSD_5 at 1% = 0.230					

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

growth retardants at the three rates of application succeeded in increasing the width of flower spathe (cm) in both seasons, with the exception of the medium and high rates of uniconazole in the second season as they decreased the width of flower spathe with non significant differences when compared to control. However, treated Strelitzia plants with pp_{333} the high rate of application (300 ppm) showed to be the most effective treatment for producing the widest flower spathe as it recorded 2.25 and 2.52 cm, in the first and second seasons, respectively.

Referring to the interaction effect between growth retardant and methods of application (regardless to concentrations) data tabulated in Table (23) showed that all combinations of PP_{333}, CCC and uniconazole significantly increased the width of flower spathe (cm) in both seasons, except for uniconazole at the two methods of application in the second season as it decreased the width of flower spathe with non significant differences when compared to control. Anyhow, using PP_{333} at the two methods of applications recorded the highest values and resulted in highly significant increments in this parameter when compared with other treatments and control in both seasons of this study.

Furthermore, the data of the interaction effect between growth retardant, methods of application and concentrations (Table, 23) showed that in the first season, the maximum width of flower spathe (cm) was recorded by using the drench method of PP_{333} at 300 ppm as it gave 2.30 cm followed by spraying the plants of *S. reginae* with PP_{333} at 200 ppm and CCC at 2000 ppm as they resulted in highly significant increments in this parameter

and they not only had the same trend but also gave the same exact values (2.26 cm, for each), while in the second one, sprayed PP_{333} at 300 ppm induced the greatest width of flower spathe (2.53 cm). Also, the drench application of PP_{333} at the medium and high rates and spraying CCC at the high rate resulted in highly significant increments in this parameter and they not only had the same trend but also gave the same exact values (2.50 cm, for each).

12-Fresh weight of flower spathe (g):

Data presented in Table (24) cleared that all the three used growth retardants succeeded in increasing the fresh weight of flower spathe in both seasons of this study.

Hence, the heaviest fresh weight of flower spathe was gained by using the application of PP_{333} (regardless to methods of application and concentrations) which gave 25.72 and 28.06 g compared to 22.64 and 24.82 g for control in the first and second seasons, respectively. On the other side, the differences between the three used growth retardants were non significant in the first season and significant in the second one.

Referring to the specific effect of methods of applied growth retardants (regardless to growth retardants and their concentrations) on the fresh weight of flower spathe (g) data in Table (24) revealed that spray method was slightly effective than drench method for increasing the fresh weight of flower spathe (g) with non significance differences in both seasons.

Furthermore, the data of the interaction effect between growth retardants and their concentrations (Table, 24), showed

Table (24): The effect of some growth retardants on the fresh weight of flower spathe (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	22.40	25.07	27.60	25.73	26.13	24.50	25.50	27.00	25.67	21.00	26.67	24.50	24.06	24.57
	Drench	22.87	24.00	25.50	26.40	25.30	23.80	25.60	26.07	25.16	24.00	26.73	22.40	24.38	24.43
Mean		22.64	24.54	26.55	26.07	25.72	24.15	25.55	26.54	25.42	22.50	26.70	23.45	24.22	
LSD_1 at 5% = 1.20		LSD_2 at 5% = N.S				LSD_3 at 5% = 2.08				LSD_4 at 5% = 1.69				LSD_5 at 5% = 2.94	
LSD_1 at 1% = 1.60		LSD_2 at 1% = N.S				LSD_3 at 1% = 2.77				LSD_4 at 1% = 2.26				LSD_5 at 1% = 3.92	
Second season (2002/2003)															
Application methods	Spray	24.63	30.80	26.27	30.23	29.10	25.47	25.30	27.93	26.23	25.33	25.47	24.47	25.09	26.26
	Drench	25.00	27.57	24.50	29.00	27.02	25.50	25.83	26.30	25.88	26.13	25.60	23.80	25.18	25.77
Mean		24.82	29.19	25.38	29.62	28.06	25.49	25.57	27.12	26.06	25.73	25.54	24.14	25.14	
LSD_1 at 5% = 1.28		LSD_2 at 5% = N.S				LSD_3 at 5% = 2.22				LSD_4 at 5% = 1.81				LSD_5 at 5% = 3.14	
LSD_1 at 1% = 1.71		LSD_2 at 1% = N.S				LSD_3 at 1% =2.96				LSD_4 at 1% = 2.42				LSD_5 at 1% = 4.19	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

that the applications of uniconazole at 100 ppm, PP_{333} at 200 ppm and CCC at 2000 ppm (regardless to methods of application) showed to be the most effective applications for increasing the fresh weight of flower spathe as they recorded 26.70, 26.55 and 26.54 g in the first season, respectively. The differences between the prementioned three applications were so small to be significant. While, in the second season the application of PP_{333} at the high rate showed its superiority for increasing the fresh weight of flower spathe as it registered 29.62 g followed by the applications of PP_{333} at 100 ppm which gave 29.19 g. The differences between the abovementioned two applications were non significant.

With regard to the interaction effect between growth retardants and methods of application data in Table (24) revealed that all combinations of PP_{333}, CCC and uniconazole at the two methods of application (regardless to concentrations) succeeded in increasing the fresh weight of flower spathe in both seasons. However, treated *S. reginae* plants with PP_{333} at the two methods of application appeared to be the most effective treatments for increasing the fresh weight of flower spathe in both seasons.

Concerning the interaction effect between growth retardants, methods of application and concentrations, data presented in Table (24) pointed out that in the first season, the heaviest fresh weight of flower spathe (g) was obtained by sprayed bird of paradise plants with PP_{333} at 200 ppm as it gave 27.60 g, followed descendingly by spraying Strelitzia plants with CCC at 2000 ppm. The differences between the abovementioned two treatments were so small to be significant. While, in the

second season sprayed PP_{333} at the low and medium rates showed its superiorities for increasing the fresh weight of flower spathe (g) as they gave 30.80 and 30.23 g, respectively.

On the other hand, the least fresh weight of flower spathe of *S. reginae* plants was recorded by spraying the plants with the low rate of uniconazole in the first season and using the drench method of uniconazole at the high rate in the second season.

13-Dry weight of flower spathe (g):

Table (25) showed that the response of dry weight of flower spathe of *S. reginae* plants to the effect of some growth retardants treatments followed nearly the same trend previously detected with fresh weight of flower spathe in both seasons. In general, using PP_{333} at the medium rate, CCC at the high rate and uniconazole at the medium rate with the two methods of application showed to be the most effective treatments for increasing the dry weight of flower spathe (g) in the first season. While in the second season the applications of PP_{333} at 300 ppm and the high rate of CCC at the two methods of application showed its superiorities in increasing this parameter.

14-Number of days to start flowering:

Data of the time to the first flower showing color as an indicator of flowering date by days determined from the beginning of the treatments, March 1st, in the two seasons, are shown in Table (26).

Data revealed that all the three used growth retardants caused high significant increases in the number of days to start flowering of *S. reginae* plants in both seasons. Thus, in both

Table (25): The effect of some growth retardants on the dry weight of flower spathe (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	2.80	2.86	3.36	3.16	3.13	3.03	3.10	3.30	3.14	2.60	3.33	3.00	2.98	3.01
	Drench	2.83	2.63	3.26	2.80	2.90	2.90	3.20	3.20	3.10	2.96	3.30	2.76	3.01	2.96
Mean		2.82	2.75	3.31	2.98	3.02	2.97	3.15	3.25	3.12	2.78	3.32	2.88	2.99	
LSD_1 at 5% = 0.123		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.214				LSD_4 at 5% = 0.175				LSD_5 at 5% = 0.303	
LSD_1 at 1% = 0.165		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.286				LSD_4 at 1% = 0.233				LSD_5 at 1% = 0.404	
Second season (2002/2003)															
Application methods	Spray	2.93	3.60	3.13	3.72	3.48	3.23	3.20	3.60	3.34	3.13	3.13	3.00	3.09	3.21
	Drench	3.13	3.07	2.31	3.70	3.03	3.26	3.30	3.36	3.31	3.23	3.16	2.93	3.11	3.15
Mean		3.03	3.34	2.72	3.71	3.26	3.25	3.25	3.48	3.33	3.18	3.15	2.97	3.10	
LSD_1 at 5% = 0.087		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.151				LSD_4 at 5% = 0.123				LSD_5 at 5% = 0.214	
LSD_1 at 1% = 0.116		LSD_2 at 1% = N.S				LSD_3 at 1% =0.202				LSD_4 at 1% = 0.165				LSD_5 at 1% = 0.286	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

Table (26): The effect of some growth retardants on the number of days to start flowering of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	240.7	268.3	271.0	280.7	273.3	251.0	261.0	275.3	262.4	260.7	272.0	278.7	270.5	261.7
	Drench	242.7	265.7	275.3	285.7	275.6	245.3	265.0	273.7	261.3	262.7	275.0	276.7	271.5	262.8
Mean		241.7	267.0	273.2	283.2	274.5	248.2	263.0	274.5	261.9	261.7	273.5	277.7	271.0	
LSD_1 at 5% = 3.53		LSD_2 at 5% = N.S				LSD_3 at 5% = 6.13			LSD_2 at 5% = 5.01				LSD_3 at 5% = 8.67		
LSD_1 at 1% = 4.73		LSD_2 at 1% = N.S				LSD_3 at 1% = 8.19			LSD_2 at 1% = 6.68				LSD_3 at 1% = 11.58		
Second season (2002/2003)															
Application methods	Spray	235.3	275.3	288.7	301.0	288.3	241.3	281.0	291.7	271.3	265.0	284.7	293.3	281.0	269.0
	Drench	234.7	271.3	288.0	295.3	284.9	238.7	284.3	287.3	270.1	272.3	286.7	291.0	283.3	268.3
Mean		235.0	273.3	288.4	298.2	286.6	240.0	282.7	289.5	270.7	268.7	285.7	292.2	282.2	
LSD_1 at 5% = 2.53		LSD_2 at 5% = N.S				LSD_3 at 5% = 4.38			LSD_2 at 5% = 2.98				LSD_3 at 5% = 6.20		
LSD_1 at 1% = 3.37		LSD_2 at 1% = N.S				LSD_3 at 1% = 5.85			LSD_2 at 1% = 4.77				LSD_3 at 1% = 8.27		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

seasons of this study treated the plants with PP_{333} (regardless to methods of application and concentrations) recorded the highest number of days to start flowering in both seasons as it registered 274.5 and 286.6 days in the first and second seasons, respectively as compared to control and other treatments. Moreover, uniconazole treatment delayed flowering date with high significant differences as compared to control in both seasons. On the other side, the earlier flowering date was obtained on untreated plants (control) as it recorded 241.7 and 235.0 days in the first and second seasons, respectively.

As for the specific effect of methods of applied growth retardants, data in Table (26) showed that drench method was slightly effective in increasing the number of days to start flowering in the first season, while in the second one, spray method showed its superiority for increasing the number of days to start flowering. The differences between the abovementioned two methods of application were non significant in both seasons.

Furthermore, the data of the interaction effect between growth retardants and their concentrations (Table, 26) cleared that all rates of the three growth retardants (regardless to methods of application) caused high significant increases in the number of days to start flowering in both seasons. It was interest to note that there was a positive relationship between the number of days to start flowering and growth retardants concentrations. Since, as the rates of growth retardants increased, the number of days to start flowering increased until reach to maximum increasing at the high rates of application in both seasons. However, among the different application treatments, the

application of PP_{333} at 300 ppm appeared to be the most effective treatment for delaying flowering date of *S. reginae* plants as it registered 283.2 and 298.2 days in the first and second seasons, respectively.

Concerning, the interaction effect between the two methods of application and the three growth retardants (regardless to concentrations), it is clearly obvious in Table (26) that all combinations between growth retardants and methods of application significantly delayed flowering date in both seasons, However, using PP_{333} at the two methods of application showed to be the most effective applications for increasing the number of days to start flowering as they recorded 273.3 and 288.3 days for spray applications and 275.6 and 284.9 days for drench method in the first and second seasons, respectively.

Considering the interaction effect between growth retardants, methods of application and concentrations, data presented in Table (26) exhibited that all applied treatments of the three growth retardants resulted in highly significant increments of the number of days to start flowering in both seasons of this study in most cases. Anyway, treated *S. reginae* plants with PP_{333} at 300 ppm with the two methods of application appeared to be the most effective treatments for producing the greatest number of days to start flowering. Such trend was really during both seasons of this study. Irrespective control, the low concentration of CCC applied by the two methods of application produced the lowest number of days to start flowering, but still more than control in both seasons. Also, the two application methods of uniconazole at 150 ppm resulted

in highly significant increments in number of days to start flowering and the differences between the two methods of application were non significant in both seasons.

The delaying in the flowering that existed with the growth retardant treatments could be attributed to the obtained stimulation of cytokinins synthesis. So, the vegetative and reproductive growth periods were prolonged as cytokinin is known as a true shooting hormone **(Devlin and Witham, 1983).**

The effect of PP_{333}, CCC and uniconazole on increasing the number of days to start flowering was recorded by many researchers on several plants. In this respect, **Jiao *et al.*, (1990)** on Hybrid lily cv. Star Gazer, **Wilfert (1990)** on *Lilium longiflorum*, **Suh *et al.*, (1992)** on Tulip cv. Apeldoorn, **Healy *et al.*, (1993)** on Alstromeria, **Chio *et al.*, (1998)** on Lilium cv. Star Gazer, **Adham (2001)** on *Althaea rosea*, **Dantuluri *et al.*, (2002)** on *Lilium maculatum* cv. Corrida, mentioned that using CCC at 3000 ppm increased the number of days to start flowering, **Dhiman *et al.*, (2002)** who reported that the application of PP_{333} at 10-20 ppm, increased the number of days to start flowering of Lilium cultivars Pollyana and Gran Paradiso.

IV.1.A.3- Root growth measurements:

1- Number of roots per plant:

The data obtained on the number of roots at the end of both seasons as affected by some growth retardants treatments are presented in Table (27).

Table (27) :The effect of some growth retardants on roots number of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	7.40	8.13	9.66	10.13	9.31	9.40	10.17	10.37	9.98	8.40	7.73	10.40	8.84	8.88
	Drench	7.13	8.66	12.13	11.17	10.66	9.73	10.67	11.33	10.58	9.13	8.36	10.80	9.43	9.45
Mean		7.27	8.40	10.90	10.65	9.99	9.57	10.42	10.85	10.28	8.77	8.05	10.60	9.14	
LSD_1 at 5% = 0.801		LSD_2 at 5% = 0.566				LSD_3 at 5% = 1.380				LSD_4 at 5% = 1.130				LSD_5 at 5% = 1.960	
LSD_1 at 1% = 1.070		LSD_2 at 1% = N.S				LSD_3 at 1% = 1.850				LSD_4 at 1% = 1.510				LSD_5 at 1% = 2.620	
Second season (2002/2003)															
Application methods	Spray	8.80	14.13	15.67	16.20	15.33	11.13	14.33	14.67	13.38	10.43	13.33	14.20	12.65	12.54
	Drench	9.23	15.23	16.33	17.13	16.23	11.67	15.13	15.67	14.16	11.73	15.33	15.80	14.29	13.48
Mean		9.02	14.68	16.00	16.67	15.78	11.40	14.73	15.17	13.77	11.08	14.33	15.00	13.47	
LSD_1 at 5% = 0.539		LSD_2 at 5% = 0.381				LSD_3 at 5% = 0.934				LSD_4 at 5% = 0.762				LSD_5 at 5% = 1.320	
LSD_1 at 1% = 0.719		LSD_2 at 1% = 0.509				LSD_3 at 1% =1.240				LSD_4 at 1% = 1.010				LSD_5 at 1% = 1.760	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

Data showed that the number of roots was greatly influenced by the growth retardants treatments as compared with control in both seasons. Thus, it could be noticed that all the three used growth retardants treatments had enhancing effect on roots formation with different extends (regardless the application methods and concentrations). Hence, in the first season, treating the plants of *S. reginae* with CCC produced the highest number of roots per plant as it gave 10.28 compared with 7.27 for control. In addition the treatments of PP_{333} and uniconazole resulted in highly significant increments in this parameter as they gave 9.99 and 9.14, respectively. While, in the second season PP_{333} treatments showed to be the most effective treatment for increasing the number of roots per plant as it registered 15.78 roots / plant as compared with 9.02 roots / plant for control. Similarly, treating the plants with CCC and uniconazole applications resulted in highly increments in this parameter.

As for the specific effect of methods of applied growth retardants on the number of roots per plants, it was quite evident from Table (27) that drench method was more effective than spray method for delaying the flowering date and the differences between the two applied methods were significant at 5% in the first season and highly significant in the second one.

Concerning the interaction effect between growth retardants and their concentrations, data in Table (27) pointed out that all combinations of PP_{333}, CCC and uniconazole at all rates of application significantly increased the number of roots per plant as compared with control in the first season, with the exception of the medium rate of uniconazole (100 ppm) which

resulted in non significant increment in this parameter. However, the highest number of roots / plant was obtained by using the medium rate of PP_{333} (200 ppm) followed by the high rate of CCC (2000 ppm) as they recorded 10.90 and 10.85 roots / plant, respectively. While, in the second season, the application of PP_{333} at 300 ppm showed its superiority in increasing the number of roots / plant as it recorded 16.67 roots / plant compared with 9.02 for control. Also, the application of PP_{333} at 200 ppm and CCC at 2000 ppm showed highly significant increments in this parameter.

Regarding to the interaction effect between growth retardants and methods of application (regardless to concentrations), data presented in Table (27) showed that drench method was superior treatment in its effect on increasing the number of roots / plant of *S. reginae* with the three supplied growth retardants in both seasons. Anyhow the drench application of pp_{333} showed to be the most effective combinations for increasing the number of roots per plant in both seasons.

Referring to the interaction effect between growth retardants, concentrations and methods of application, data tabulated in Table (27) indicated that all applied concentrations of the three growth retardants increased the number of roots / plant in both seasons when compared with control. Meanwhile, in the first season treating *S. reginae* plants with pp_{333} at 200 ppm applied by drench method induced the highest number of roots / plant as it gave 12.13 roots/plant. Also, using the high rate of pp_{333} and CCC applied by drench method resulted in highly

significant increments in this parameter. While, in the second season, the highest number of roots / plant was obtained by using the drench method of pp_{333} at 300 ppm as it gave 17.13 roots / plant, followed by the treatments of pp_{333} at 200 ppm applied by drench method, pp_{333} at 300 ppm applied by spray method and uniconazole at 150 ppm applied by drench method.

2- Mean length of root/plant (cm):

Data presented in Table (28) showed that all the three used growth retardant treatments (regardless to methods of application and concentrations) resulted in highly significant reduction in the mean root length of *Strelitzia reginae* in both seasons. Thus, in both seasons of study treated the plants with PP_{333} showed to be the most effective combination in decreasing the length of roots / plant as it registered 35.19 and 31.74 (cm) compared with 42.87 and 55.50 (cm) for control in the first and second seasons, respectively.

With regard to the specific effect of methods of applied growth retardants on the mean length of roots per plant, data presented in Table (28) revealed that spray method was more effective than drench method in decreasing the mean length of roots / plant with significant difference in the first season. Meanwhile, in the second season, drench method slightly decreased the mean length of roots / plant than spray method and the differences between the prementioned two methods were so small to be significant.

Referring to the interaction effect between growth retardants and their concentrations, data in Table (28) indicated

Table (28): The effect of some growth retardants on mean root length (cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	41.73	32.33	34.13	34.67	33.71	40.47	39.33	40.53	40.11	40.47	34.67	39.33	38.16	38.43
	Drench	44.00	37.67	35.67	36.67	36.67	38.73	42.33	34.33	38.46	42.67	37.67	37.20	39.18	39.58
Mean		42.87	35.00	34.90	35.67	35.19	39.60	40.83	37.43	39.29	41.57	36.17	38.27	38.68	
LSD_1 at 5% = 1.46		LSD_2 at 5% = 1.03				LSD_3 at 5% = 2.53				LSD_4 at 5% = 2.06				LSD_5 at 5% = 3.58	
LSD_1 at 1% = 1.95		LSD_2 at 1% = N.S				LSD_3 at 1% = 3.38				LSD_4 at 1% = 2.76				LSD_5 at 1% = 4.78	
Second season (2002/2003)															
Application methods	Spray	54.33	37.67	32.33	27.67	32.56	43.50	37.00	32.40	37.63	45.00	37.67	33.33	38.67	40.80
	Drench	56.67	36.33	31.17	25.27	30.92	42.40	36.13	29.13	35.89	44.33	36.33	31.17	37.28	40.19
Mean		55.50	37.00	31.75	26.47	31.74	42.95	36.57	30.77	36.76	44.67	37.00	32.25	37.97	
LSD_1 at 5% = 1.15		LSD_2 at 5% = N.S				LSD_3 at 5% = 2.00				LSD_4 at 5% = 1.63				LSD_5 at 5% = 2.83	
LSD_1 at 1% = 1.54		LSD_2 at 1% = N.S				LSD_3 at 1% =2.68				LSD_4 at 1% = 2.18				LSD_5 at 1% = 3.74	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

that all combinations of PP_{333}, CCC and uniconazole at all rates of application significantly decreased the mean length of roots / plant in both seasons, with the exception of CCC at 1000 ppm and uniconazole at 50 ppm in the first season as they caused non significant decreases in this parameter. However, the shortest mean length of roots/plant was obtained by using the three rates of PP_{333} at the first season and the differences between the three rates of PP_{333} were non significant. While, in the second season PP_{333} at the high rate (300 ppm) showed to be the most effective application for shortening the mean length of roots per plant as it gave 26.47 roots / plant. Similar trend was obtained by using the high rate of CCC (2000 ppm) which resulted in highly significant decreases in this parameter followed by using the medium rate of PP_{333}. Irrespective control, the tallest mean length of roots per plant was obtained by using the low rate of uniconazole in both seasons, as it gave 41.57 and 44.67 roots / plant, respectively.

Concerning the interaction effect between growth retardants and methods of application, data in Table (28) showed that all combinations between growth retardants and methods of application (regardless to concentrations) significantly decreased the mean length of roots/plant in both seasons, with the exception of CCC combination (spray method) in the first season which gave non significant differences. However, PP_{333} combinations showed to be the most effective treatments (applied by spray or drench method) for decreasing the mean length of roots / plant in both seasons.

With regard to the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (28) pointed out that all applied treatments of growth retardants succeeded in decreasing the mean length of roots / plant with highly significant differences in most cases. Hence, in the first season sprayed the plants of *S. reginae* with PP_{333} at 100 ppm produced the shortest mean length of roots/plant as it recorded 32.33 roots / plant. Similar trend was obtained by sprayed PP_{333} at the medium and high rates. While, in the second season using PP_{333} at the high rate (applied by spray or drench method) showed its superiority in decreasing the mean length of roots / plant. In addition, using the high rate of CCC (applied by drench method) resulted in highly significant decreases in this parameter as compared with control. Irrespective control, the highest mean value of mean roots length / plant was obtained by using the treatment of uniconazole at 50 ppm (applied by drench method) in the first season and the treatment of uniconazole at 50 ppm (applied by spray method) in the second one.

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

The data obtained on fresh weight of roots/plants as affected by some treatments of growth retardants are averaged in Table (29).

Data showed that the fresh weight of roots / plant was greatly increased by using all the three growth retardants in both seasons. So, the heaviest fresh weight of roots / plant was recorded by using CCC application (regardless to methods of

Table (29): The effect of some growth retardants on the fresh weight of root (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	518.7	554.3	656.3	703.3	638.0	655.3	721.3	761.7	712.8	635.0	588.3	683.7	635.7	626.3
	Drench	516.3	586.7	804.3	751.0	714.0	698.3	791.7	748.0	746.0	654.7	608.7	747.7	670.4	661.7
Mean		517.5	570.5	730.3	727.2	676.0	676.8	756.5	754.9	729.4	644.9	598.5	715.7	653.0	
LSD_1 at 5% = 20.73		LSD_2 at 5% = 14.66				LSD_3 at 5% = 35.90				LSD_4 at 5% = 29.31				LSD_5 at 5% = 50.77	
LSD_1 at 1% = 27.67		LSD_2 at 1% = 19.57				LSD_3 at 1% = 47.93				LSD_4 at 1% = 39.13				LSD_5 at 1% = 67.78	
Second season (2002/2003)															
Application methods	Spray	735.3	1106.0	1108.0	1105.0	1106.3	1037.0	931.7	1110.0	1026.2	812.3	871.7	987.7	890.6	939.6
	Drench	748.3	1099.0	1116.0	1123.0	1112.7	1052.0	982.7	1112.0	1048.9	821.7	845.3	993.7	886.9	949.2
Mean		741.8	1102.5	1112.0	1114.0	1109.5	1044.0	957.2	1111.0	1037.6	817.0	858.5	990.7	888.8	
LSD_1 at 5% = 40.02		LSD_2 at 5% = N.S				LSD_3 at 5% = 92.52				LSD_4 at 5% = 56.59				LSD_5 at 5% = 98.02	
LSD_1 at 1% = 53.42		LSD_2 at 1% = N.S				LSD_3 at 1% =69.31				LSD_4 at 1% = 75.55				LSD_5 at 1% = 130.80	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

application and concentrations) in the first season as it recorded 729.4 g compared with 517.5 g for control. Moreover, using PP_{333} application caused a highly significant increase in this parameter followed descendingly by using uniconazole application. This trend was true only in the first season, while in the second one, PP_{333} application showed its superiority in increasing the fresh weight of roots / plant as it recorded 1109.5 g when compared with 741.8 g for control. Additionally, CCC application resulted in a highly significant increment in this parameter followed by uniconazole application.

As for the specific effect of methods of applied growth retardants on the fresh weight of roots / plant, it was quite evident shown from Table (29) that drench method was more effective than spray method in increasing the fresh weight of roots/ plant and the differences between the two applied methods were highly significant in the first season and non significant in the second one.

Concerning the interaction effect between growth retardants and their concentrations, data in Table (29) revealed that all combinations between growth retardants and their concentrations (regardless to methods of application) significantly succeeded in increasing the fresh weight of roots / plant in both seasons. However, in the first season the heaviest fresh weight of roots/plant was obtained by using the medium application of CCC (1000 ppm) which gave 756.5 g followed by the high rate of CCC (2000 ppm) as it recorded 754.9 g. Such trend was true only in the first season, while in the second season PP_{333} at 300 ppm showed its superiority for increasing the fresh

weight of roots / plant compared with other combinations and control followed by using the application of PP_{333} at 200 ppm. Similar trend was obtained by using the medium rate of PP_{333} in the first season and the application of CCC at the high rate in the second season.

With regard to the interaction effect between growth retardants and methods of application, data tabulated in Table (29) indicated that all combinations of PP_{333}, CCC and uniconazole (regardless to concentrations) resulted in highly significant increases in the fresh weight of roots/plant in both seasons. So, the heaviest fresh weight of roots/plant was obtained by using the drench method of CCC and PP_{333} in the first season as they gave 746.0 and 714.0 g, respectively. Meanwhile, the drench and spray applications of PP_{333} in the second season showed its superiority in increasing this parameter compared with other combinations.

Regarding to the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (29) pointed out that all applied treatments of growth retardants significantly succeeded in increasing the fresh weight of roots / plant in both seasons, with the exception of sprayed PP_{333} at the low rate (100 ppm) in the first season which resulted in non significant increment in this concern when compared with untreated plants. However, the heaviest fresh weight of roots / plant was gained by using the drench method of PP_{333} at 200 ppm in the first season and the drench method of PP_{333} at 300 ppm in the second one as they registered 804.3 and 1123.0 g, respectively.

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

The data obtained on dry weight of roots/ plant as affected by some treatments of growth retardants are presented in Table (30).

The results of the dry weight of the roots / plant attained a parallel trend with the fresh weight results, with little differences in the level of significantly. In general, the heaviest dry weight of roots / plant was obtained by using the medium rate of PP_{333} (200 ppm) applied by drench method as it recorded 44.33 and 63.00 g in the first and second seasons, respectively.

5- Mean thickness of roots / plant (cm):

Data presented in Table (31) showed that all the three growth retardants (regardless to concentrations and methods of application) significantly increased the thickness of roots / plant (cm) in both seasons of this study. However, in both seasons the highest mean value of this parameter was obtained by using PP_{333} application which recorded 2.16 and 2.51 cm in the first and second seasons, respectively.

As for the specific effect of methods of applied growth retardants on the mean thickness of roots / plant, data in Table (31) revealed that spray method was more effective in increasing the thickness of roots/ plant than drench method and the differences between the prementioned two methods were significant. Such trend was true only in the first season, whereas in the second one, drench method showed its superiority in increasing the mean thickness of roots / plant than spray method,

Table (30): The effect of some growth retardants on the dry weight of root (g) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	28.43	30.40	35.57	38.50	34.82	35.23	39.20	41.60	38.68	34.87	31.07	38.13	34.69	34.16
	Drench	28.33	32.30	44.33	41.07	39.23	38.17	43.47	40.73	40.79	35.57	33.67	40.40	36.55	36.23
Mean		28.38	31.35	39.95	39.79	37.03	36.70	41.34	41.17	39.74	35.22	32.37	39.27	35.62	
LSD_1 at 5% = 1.27		LSD_2 at 5% = 0.904				LSD_3 at 5% = 2.21				LSD_4 at 5% = 1.80				LSD_5 at 5% = 3.13	
LSD_1 at 1% = 1.70		LSD_2 at 1% = 1.20				LSD_3 at 1% = 2.95				LSD_4 at 1% = 2.41				LSD_5 at 1% = 4.18	
Second season (2002/2003)															
Application methods	Spray	41.00	62.33	61.13	62.33	61.93	57.67	50.47	61.67	56.60	45.33	49.00	55.33	49.89	52.36
	Drench	42.33	61.67	63.00	62.73	62.47	58.67	53.40	62.13	58.07	46.00	47.33	55.33	49.55	53.11
Mean		41.67	62.00	62.07	62.53	62.20	58.17	51.94	61.90	57.34	45.67	48.17	55.33	49.72	
LSD_1 at 5% = 2.23		LSD_2 at 5% = N.S				LSD_3 at 5% = 3.87				LSD_4 at 5% = 3.16				LSD_5 at 5% = 5.47	
LSD_1 at 1% = 2.98		LSD_2 at 1% = N.S				LSD_3 at 1% =5.17				LSD_4 at 1% = 4.22				LSD_5 at 1% = 7.31	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

Table (31): The effect of some growth retardants on the mean thickness of root (cm) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	1.83	2.13	2.26	2.30	2.23	1.86	2.16	2.30	2.11	1.96	2.13	2.03	2.04	2.05
	Drench	1.90	1.96	2.16	2.16	2.09	1.90	1.93	2.36	2.06	1.86	2.00	2.10	1.98	2.01
Mean		1.87	2.05	2.21	2.23	2.16	1.88	2.05	2.33	2.09	1.91	2.07	2.07	2.02	
LSD_1 at 5% = 0.042		LSD_2 at 5% = 0.030				LSD_3 at 5% = 0.073			LSD_4 at 5% = 0.060				LSD_5 at 5% = 0.103		
LSD_1 at 1% = 0.056		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.098			LSD_4 at 1% = 0.080				LSD_5 at 1% = 0.138		
Second season (2002/2003)															
Application methods	Spray	1.96	2.23	2.50	2.70	2.48	2.13	2.36	2.50	2.33	2.16	2.23	2.26	2.22	2.25
	Drench	2.00	2.33	2.46	2.83	2.54	2.10	2.26	2.56	2.31	2.23	2.26	2.30	2.26	2.28
Mean		1.98	2.28	2.48	2.77	2.51	2.12	2.31	2.53	2.32	2.20	2.25	2.28	2.24	
LSD_1 at 5% = 0.070		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.121			LSD_4 at 5% = 0.099				LSD_5 at 5% = 0.172		
LSD_1 at 1% = 0.093		LSD_2 at 1% = N.S				LSD_3 at 1% =0.162			LSD_4 at 1% = 0.132				LSD_5 at 1% = 0.230		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

but the differences between the two methods of application were so small to reach the level of significance.

Concerning the interaction effect between growth retardants and their concentrations data in Table (31) showed that all interactions between growth retardants and their concentrations (regardless to methods of application) induced significant increments in this parameter in both seasons, except for the application of CCC at the low rate (500 ppm) in the first season which induced non significant increase in this parameter when compared with untreated plants. Generally, the highest mean thickness of roots/plant was obtained by using the application of CCC at the high rate (2000 ppm) in the first season and the application of PP_{333} at the high rate (300 ppm) in the second one.

Regarding to the interaction effect between growth retardants and methods of application, data tabulated in Table (31) pointed out that all interactions between growth retardants and methods of application (regardless to concentrations) significantly increased the mean thickness of roots / plant in both seasons. So, the highest mean value of this parameter was gained by using the spray method of PP_{333} in the first season (2.23 cm) and the drench method of PP_{333} in the second season (2.54 cm) as compared with other combinations.

With respect to the interaction effect between growth retardants, concentrations and methods of application, data in Table (31) showed that all applied treatments of growth retardants increased the mean thickness of roots/ plant with significant differences in most cases. However, the highest mean

value of thickness of roots / plant was obtained by using the drench method of CCC at 2000 ppm in the first season (2.36 cm) and the drench method of PP_{333} at 300 ppm in the second season (2.83 cm). Followed by the treatments of sprayed CCC at 2000 ppm and PP_{333} at 300 ppm as they induced high significant increments in this parameter in both seasons of this study.

The previous mentioned findings of root traits i.e., number, length, thickness and fresh and dry weights could be interpreted on the basis of the physiological role of the nature of growth retardants action. Since, (as will be mentioned later) PP_{333} treatments alter the endogenous levels of different determined phytohormones i.e. auxin, gibberellins, ABA and cytokinins level that tended to increase the size of root system of bird of paradise plants. It is well established that cytokinins stimulate lateral roots initiation and thus increasing the size (number, thickness, fresh and dry weights) **Devlin and Witham (1983).** Such results are in agreement with those obtained by **Youssef (2000)** on *S. reginae*, who mentioned that treated the plants with PP_{333} at 200 and 300 ppm increased the number of roots and their fresh and dry weight / plant, **Adham (2001)** on *Althaea rosea* and **Saker (2004)** who stated that sprayed *Hibiscus rosea sinensis* and *Tabernamontana coronaria* plants with PP_{333} at 200 and 300 ppm and uniconazole at 125 and 187.5 ppm produced the heaviest fresh and dry weights of roots / plant.

IV.1.A.4- Chemical composition measurements:

1-Leaf nitrogen content (%):

Data presented in Table (32) indicated that N content in leaves of *S. reginae* plants was greatly affected by using all the three used growth retardants treatments as compared to control in both seasons. However, using PP_{333} (regardless to concentrations and methods of application) was the most effective treatment for increasing leaf nitrogen content (%) as it gave 1.89 and 2.02% when compared to 1.55 and 1.75% for control in the first and second seasons, respectively. Also, CCC treatment showed a great increase in N content in leaves and ranked the second in this concern, followed by uniconazole in both seasons.

As for the specific effect of methods of applied growth retardants on leaf N content (%) of *S. reginae* plants, data in Table (32) revealed that spray method was slightly effective than drench method for increasing N content in leaves of *S. reginae* plants in both seasons. The increment due to spray method over drench method was so small to reach the level of significance in both seasons.

In addition, data obtained on the interaction between growth retardants and their concentrations (Table, 32) cleared that the application of PP_{333} at 200 ppm (regardless to methods of application) showed to be the most effective application for increasing N content in leaves (%) of *S. reginae* plants as it recorded 2.08 and 2.18 % when compared either with control or other applications in the first and second seasons, respectively.

Table (32): The effect of some growth retardants on leaf nitrogen content (%) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	1.56	1.93	2.03	1.73	1.90	2.06	1.83	1.70	1.86	1.80	1.73	1.56	1.70	1.76
	Drench	1.53	1.83	2.13	1.66	1.87	1.86	1.83	1.83	1.84	1.93	1.73	1.53	1.73	1.74
Mean		1.55	1.88	2.08	1.70	1.89	1.96	1.83	1.77	1.85	1.87	1.73	1.55	1.72	
LSD_1 at 5% = 0.063		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.110				LSD_4 at 5% = 0.090				LSD_5 at 5% = 0.155	
LSD_1 at 1% = 0.084		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.147				LSD_4 at 1% = 0.120				LSD_5 at 1% = 0.208	
Second season (2002/2003)															
Application methods	Spray	1.73	2.03	2.23	1.83	2.03	2.00	1.90	1.83	1.91	1.83	1.96	1.73	1.84	1.88
	Drench	1.76	1.93	2.13	1.96	2.01	2.06	1.86	1.86	1.93	1.76	1.76	1.66	1.73	1.86
Mean		1.75	1.98	2.18	1.90	2.02	2.03	1.88	1.85	1.92	1.80	1.86	1.70	1.79	
LSD_1 at 5% = 0.056		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.970				LSD_4 at 5% = 0.079				LSD_5 at 5% = 0.137	
LSD_1 at 1% = 0.074		LSD_2 at 1% = N.S				LSD_3 at 1% =0.129				LSD_4 at 1% = 0.106				LSD_5 at 1% = 0.183	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

Concerning the interaction effect between growth retardants and methods of application, data in Table (32) pointed out that all applications of PP_{333}, CCC and uniconazole (regardless to concentrations) succeeded in increasing leaf N content (%). However, the greatest N content in leaves was obtained by using PP_{333} at the two methods of application in both seasons.

Furthermore, the data of the interaction effect between growth retardants, concentrations and methods of application (Table, 32) showed that application of PP_{333} at the medium rate with the two methods of application approved to be the most effective treatments for increasing leaf nitrogen content (%) in both seasons. Moreover, spraying CCC at 500 ppm in the first season and the drench method in the second season resulted in highly significant increases in this parameter. Meanwhile, in the second season, sprayed both PP_{333} and CCC at the low rates on *S. reginae* plants induced highly significant increments in this parameter and exhibited not only insignificant variance between each other but also, showed approximately the same value of leaf nitrogen content (%).

2-Leaf phosphorus content (%):

The obtained results of phosphorus content (%) in leaves of *S. reginae* plants in response to different treatments of growth retardants and tabulated in Table (33) cleared that in the first season, the plants treated with CCC (regardless to concentrations and methods of application) gave the most promising effect in increasing the leaves content of phosphorus (%) which gave 0.279 % followed by using PP_{333} which registered 0.273 (%)

Table (33): The effect of some growth retardants on leaf phosphorus content (%) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	0.223	0.283	0.266	0.253	0.267	0.276	0.283	0.263	0.274	0.273	0.290	0.263	0.275	0.262
	Drench	0.220	0.283	0.273	0.276	0.277	0.270	0.280	0.300	0.283	0.263	0.276	0.263	0.267	0.262
Mean		0.222	0.283	0.270	0.265	0.273	0.273	0.282	0.282	0.279	0.268	0.283	0.263	0.271	
LSD_1 at 5% = 0.030		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.051				LSD_4 at 5% = 0.042				LSD_5 at 5% = 0.053	
LSD_1 at 1% = 0.040		LSD_2 at 1% = N.S				LSD_3 at 1% = N.S				LSD_4 at 1% = 0.056				LSD_5 at 1% = N.S	
Second season (2002/2003)															
Application methods	Spray	0.240	0.296	0.313	0.296	0.302	0.266	0.286	0.270	0.274	0.293	0.296	0.233	0.274	0.273
	Drench	0.243	0.296	0.293	0.303	0.297	0.273	0.296	0.283	0.284	0.273	0.290	0.270	0.278	0.276
Mean		0.241	0.296	0.303	0.300	0.300	0.270	0.291	0.277	0.279	0.283	0.293	0.252	0.276	
LSD_1 at 5% = 0.047		LSD_2 at 5% = N.S				LSD_3 at 5% = N.S				LSD_4 at 5% = 0.067				LSD_5 at 5% = 0.071	
LSD_1 at 1% = N.S		LSD_2 at 1% = N.S				LSD_3 at 1% = N.S				LSD_4 at 1% = 0.089				LSD_5 at 1% = N.S	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

compared to 0.222% for control. While, in the second season, PP_{333} application showed its superiority for increasing leaf phosphorus content (%) in the plants (0.300%). Moreover, the differences between the three used growth retardants were non significant in both seasons.

Additionally, data gained of the specific effect of methods of applied growth retardants (regardless to growth retardants and their concentrations) (Table, 33) indicated that the differences between the two methods of application were so small to be significant especially in the first season as they exhibited not only insignificant variance between each other but also, showed the same value (0.262% for each).

Concerning the interaction effect between growth retardants and their concentrations, data in Table (33) showed that in the first season, all concentrations of the three used growth retardants (regardless to methods of application) succeeded in increasing leaf phosphorus content (%) with non significant increments in this parameter, except for the application of PP_{333} at 100 ppm and uniconazole at 100 ppm as they resulted in significant increments when compared with control, and they not only exhibited the same trend but also, gave the same exact value (0.283 %, for each). While, in the second season, PP_{333} at the three rates showed to be the most effective treatments for increasing leaf phosphorus content (%) when compared either with control or other applications.

With regard to the interaction effect between growth retardants and methods of application, data in Table (33) revealed that all combinations of PP_{333}, CCC and uniconazole

with the two methods of application (regardless to concentrations) succeeded in increasing leaf phosphorus content in both seasons. However, the highest mean value of this parameter was obtained by using the drench method of CCC in the first season and spraying PP_{333} in the second season.

As for the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (33) pointed out that in the first season sprayed the plants of Strelitzia with uniconazole at 100 ppm produced the greatest leaf phosphorus content (0.290%) followed by spraying CCC at 1000 ppm and PP_{333} at 100 ppm (applied with the two methods of application) as they exhibited not only in significant variance between each other but also, recorded the same value of leaf phosphorus content (0.283%). While, in the second season, sprayed the plants of *S. reginae* with PP_{333} at 200 ppm showed its superiority for increasing leaf phosphorus content (0.313%) followed by the drench application of PP_{333} at 300 ppm (0.303%). Similarly, the treatments of sprayed PP_{333} at 300 ppm , PP_{333} at 100 ppm (applied with drench method), CCC at 1000 ppm (applied with drench method) and uniconazole at 100 ppm (applied by spray method) showed great increments in this parameter and they exhibited not only insignificant variance between each other but also, registered the same values of leaf phosphorus content (0.296 %).

3-Leaf potassium content (%):

Data presented in Table (34) pointed out that potassium content in leaves was greatly affected by using all the three used growth retardants in both seasons. However, the application of

Table (34): The effect of some growth retardants on leaf potassium content (%) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	1.46	1.80	2.10	2.23	2.04	1.66	1.70	1.83	1.73	1.63	1.80	1.53	1.65	1.72
	Drench	1.53	1.83	2.03	2.13	2.00	1.76	1.83	1.93	1.84	1.56	1.73	1.43	1.57	1.74
Mean		1.50	1.82	2.07	2.18	2.02	1.71	1.77	1.88	1.79	1.60	1.77	1.48	1.61	
LSD_1 at 5% = 0.058		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.100				LSD_4 at 5% = 0.082				LSD_5 at 5% = 0.142	
LSD_1 at 1% = 0.077		LSD_2 at 1% = N.S				LSD_3 at 1% = 0.134				LSD_4 at 1% = 0.109				LSD_5 at 1% = 0.190	
Second season (2002/2003)															
Application methods	Spray	1.53	1.93	2.13	2.13	2.06	1.93	1.93	2.13	2.00	1.76	2.03	1.70	1.83	1.86
	Drench	1.56	2.06	2.10	2.23	2.13	1.83	1.86	2.03	1.91	1.63	1.90	1.66	1.73	1.83
Mean		1.55	2.00	2.11	2.18	2.10	1.88	1.90	2.08	1.95	1.70	1.97	1.68	1.78	
LSD_1 at 5% = 0.082		LSD_2 at 5% = N.S				LSD_3 at 5% = 0.142				LSD_4 at 5% = 0.116				LSD_5 at 5% = 0.201	
LSD_1 at 1% = 0.109		LSD_2 at 1% = N.S				LSD_3 at 1% =0.190				LSD_4 at 1% = 0.155				LSD_5 at 1% = 0.268	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

PP_{333} (regardless to methods of application and concentrations) exhibited to be the most effective treatment for increasing leaf K content (%) of *S. reginae* as it recorded 2.02 and 2.10% compared to 1.50 and 1.55 % for control in the first and second seasons, respectively. Moreover, using CCC combinations caused a great increment in this parameter and ranked the second in this respect followed by using uniconazole combinations in both seasons.

Additionally, the data of the specific effect of methods of applied growth retardants on leaf potassium content % of *S. reginae* plants (Table, 34) showed that the differences between the two methods of application did not reach to the level of significance in both seasons.

Referring to the interaction effect between growth retardants and their concentrations data in Table (34) declared that the application of PP_{333} at 300 ppm (regardless to methods of application) showed to be the most effective application for inducing the richest leaf potassium content as it recorded the same value (2.18%) in both seasons. followed by using the application of PP_{333} at 200 ppm which gave 2.07 and 2.12% in the first and second seasons, respectively.

Concerning the interaction effect between growth retardants and methods of application, data in Table (34) indicated that all combinations of PP_{333}, CCC and uniconazole at the two methods of application succeeded in increasing leaf potassium content (%). Thus, in both seasons the application of PP_{333} at the two methods of application (regardless to concentrations) appeared to be the most effective applications for

increasing leaf K content (%) as compared to other combinations.

As for the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (34) indicated that in both seasons the greatest potassium content in leaves of *S. reginae* plants was recorded by using PP_{333} at the high rate (300 ppm) with the two methods of application. Also, sprayed Strelitzia plants with PP_{333} at 200 ppm resulted in highly significant increments in this parameter as it gave 2.10 and 2.13% in the first and second season, respectively. The aforementioned results of N, P and K are in accordance with those attained by **Essa (1992)** on roses, **Desouky (1994)** and **Youssef (2000)** on *S. reginae* indicated that PP_{333} treatments increased N, P and K content in the leaves and **Abd El-Fatah (2001)** on *Adhatoda vasica* and *Hibiscus rosa sinensis*.

4-Total carbohydrates content in leaves (%):

Data of total carbohydrates content (%) in dried leaf of *S. reginae* plants are presented in Table (35). It was obvious that all the three used growth retardants (regardless to methods of application and concentrations) resulted in highly significant increments in leaf total carbohydrates content (%). However, in both seasons using the application of CCC showed to be the most effective growth retardant to increasing leaf total carbohydrates content as it gave 17.23 and 19.19% followed by using PP_{333} which recorded 17.22 and 18.59% compared to 14.40 and 15.57% for control, in the first and second seasons, respectively. The differences between the abovementioned two growth retardants were non significant in both seasons.

Table (35): The effect of some growth retardants on leaf total carbohydrates content (%) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	14.23	17.20	18.17	15.13	16.83	15.57	18.47	17.43	17.16	17.20	16.27	14.13	15.87	16.02
	Drench	14.57	17.10	19.47	16.23	17.60	16.50	17.20	18.17	17.29	17.40	16.70	13.33	15.81	16.32
Mean		14.40	17.15	18.82	15.68	17.22	16.04	17.84	17.80	17.23	17.30	16.48	13.73	15.84	
LSD_1 at 5% = 0.831		LSD_2 at 5% = N.S				LSD_3 at 5% = 1.440				LSD_4 at 5% = 1.170				LSD_5 at 5% = 2.030	
LSD_1 at 1% = 1.110		LSD_2 at 1% = N.S				LSD_3 at 1% = 1.920				LSD_4 at 1% = 1.560				LSD_5 at 1% = 2.710	
Second season (2002/2003)															
Application methods	Spray	16.13	19.47	21.10	16.17	18.91	18.23	18.90	20.23	19.12	17.93	18.33	15.27	17.18	17.84
	Drench	15.00	18.17	20.17	16.43	18.26	19.27	19.30	19.17	19.25	19.03	19.63	15.57	18.08	17.65
Mean		15.57	18.82	20.64	16.30	18.59	18.75	19.10	19.70	19.19	18.48	18.98	15.42	17.63	
LSD_1 at 5% = 0.960		LSD_2 at 5% = N.S				LSD_3 at 5% = 1.660				LSD_4 at 5% = 1.350				LSD_5 at 5% = 2.350	
LSD_1 at 1% = 1.280		LSD_2 at 1% = N.S				LSD_3 at 1% =2.220				LSD_4 at 1% = 1.810				LSD_5 at 1% = 3.140	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

As for the specific effect of methods of applied growth retardants on leaf total carbohydrates content of *S. reginae*, data in Table (35) showed that the differences between the two methods of application were so small to be significant in both seasons.

Besides, the data of the interaction effect between growth retardants and their concentrations (Table, 35) cleared that in both seasons treated the plants of *S. reginae* with PP_{333} at 200 ppm caused a highly significant increment in this parameter as it recorded 18.82 and 20.64% followed by CCC at 1000 ppm which registered 17.84 and 19.10% in the first and second seasons, respectively.

Concerning the interaction effect between growth retardants and methods of application, data in Table (35) pointed out that the drench application of PP_{333} and CCC in the first season is being the most promising treatments for increasing leaf total carbohydrates content as they registered 17.60 and 17.29%, respectively. While, in the second season using CCC at the two methods of applications showed its superiority for increasing leaf total carbohydrates content (%). On the other hand, the differences between the abovementioned two treatments were non significant in the first and second seasons.

Referring to the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (35) showed that the greatest leaf total carbohydrates content (%) in the first season was obtained by using the drench application of PP_{333} at 200 ppm (19.47%) followed by sprayed Strelitzia plants with CCC at 1000 ppm

(18.47%). Moreover, plants sprayed with PP_{333} at 200 ppm and using the drench method of CCC at 2000 ppm showed great increases in leaf total carbohydrates content (%) and they exhibited not only the same trend but also, gave the same exact value (18.17%). While, in the second season, sprayed CCC at 2000 ppm and PP_{333} at 200 ppm (applied with the two methods of application) appeared to be the most promising treatments for increasing leaf total carbohydrates content (%) of bird of paradise plants. The differences between the prementioned three treatments were non significant. Similarly, the treatments of uniconazole at 100 ppm (applied by drench method), sprayed PP_{333} at 100 ppm and CCC at 1000 ppm (applied by drench method) resulted in highly significant increments in this parameter. These results are in line with those of **Selim (1985)** on *Bougainvillea Mrs Butt*, **Selim and El-Khateeb (1988)** on *Senecio cruentus*, **Khalafalla (1995)** on *Begonia semperflorens*, **desouky (1994)** on *S. reginae*, **Tawila (2000)** on tuberose and **Saker (2004)** who found that spraying *H. rosa sinensis* and *T. coronaria* shrubs with PP_{333} at 200 and 300 ppm and uniconazole at 125 and 187.5 ppm increased leaf total carbohydrates content.

5-Leaf chlorophyll a content [mg/100 g fresh weight (FW)]:

According to data presented in Table (36), it could be concluded that chlorophyll a content in leaves of *Strelitzia reginae* plants was greatly increased by using all the three used growth retardants (regardless the application methods and concentrations). Hence, in both seasons of this study, the greatest leaf chlorophyll a content of Strelitzia plants was obtained by using the application of PP_{333} which gave 154.9 and 177.0

Table (36): The effect of some growth retardants on leaf chlorophyll (a) content (mg/100g FW) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	111.0	150.3	151.3	161.3	154.3	140.3	160.3	150.0	150.2	140.3	150.7	120.7	137.2	138.2
	Drench	114.3	145.7	155.3	165.3	155.4	145.0	155.7	152.7	151.1	145.3	151.7	115.3	137.4	139.6
Mean		112.7	148.0	153.3	163.3	154.9	142.7	158.0	151.4	150.7	142.8	151.2	118.0	137.3	
LSD_1 at 5% = 6.58		LSD_2 at 5% = N.S				LSD_3 at 5% = 11.38			LSD_4 at 5% = 9.28				LSD_5 at 5% = 16.09		
LSD_1 at 1% = 8.76		LSD_2 at 1% = N.S				LSD_3 at 1% = 15.19			LSD_4 at 1% = 12.40				LSD_5 at 1% = 21.48		
Second season (2002/2003)															
Application methods	Spray	115.3	164.7	171.0	190.3	175.3	171.0	180.7	176.0	175.9	165.3	173.7	134.7	157.9	156.1
	Drench	120.7	170.7	180.7	184.7	178.7	166.0	185.7	170.7	174.1	160.0	169.0	141.0	156.7	157.6
Mean		118.0	167.7	175.9	187.5	177.0	168.5	183.2	173.4	175.0	162.7	171.4	137.9	157.3	
LSD_1 at 5% = 6.49		LSD_2 at 5% = N.S				LSD_3 at 5% = 11.26			LSD_4 at 5% = 9.19				LSD_5 at 5% = 15.92		
LSD_1 at 1% = 8.67		LSD_2 at 1% = N.S				LSD_3 at 1% =15.03			LSD_4 at 1% = 12.27				LSD_5 at 1% = 21.25		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

mg/100 g FW as compared to 112.7 and 118.0 mg/100 g FW for control in the first and second seasons, respectively. Moreover, treating the plants of *S. reginae* with CCC caused highly significant increments in this parameter, followed by using uniconazole application which ranked the third in this concern.

As for the specific effect of methods of applied growth retardants on chlorophyll a content in the leaves of bird of paradise plants, data presented in Table (36) showed that drench method caused a slight increment in leaf chlorophyll a content over spray method and the differences between the two methods of application were non significant in both seasons.

Furthermore, the data of the interaction effect between growth retardants and their concentrations (Table, 36) declared that all rates of the three used growth retardants (regardless to methods of application) significantly increased chlorophyll a content in the leaves of *S. reginae* in both seasons, with the exception of uniconazole at the high rate in the first season as it resulted in non significant increases in this parameter. However, using the high rate of PP_{333} (300 ppm) resulted in highly significant increments in this parameter and ranked the first in this concern as it gave 163.3 and 187.5 mg/100 g FW followed by using the medium rate of CCC (1000 ppm) in bot seasons. The differences between the prementioned two treatments were so small to be significant in both seasons.

Concerning the interaction effect between growth retardants and methods of application, data tabulated in Table (36) cleared that all the three used growth retardants at the two methods of application (regardless to concentrations) succeeded

in increasing leaf chlorophyll a content in both seasons. Thus, PP_{333} at the two methods of application showed to be the most effective applications for increasing chlorophyll a content in the leaves of *S. reginae* plants followed by using the two methods of application of CCC in both seasons.

. Referring to the interaction effect between growth retardants, methods of application and concentrations, data presented in Table (36) pointed out that all applied treatments of growth retardants at the three rates with the two methods of application succeeded in increasing chlorophyll a content in the leaves of *S. reginae* plants. However, using the drench method of PP_{333} at 300 ppm in the first season and the spray application of PP_{333} at 300 ppm in the second one are being the most promising treatment for increasing chlorophyll a content in the leaves of *S. reginae* plants as they registered 165.3 and 190.3 mg/100 g FW in the first and second season, respectively. Moreover, sprayed PP_{333} at 300 ppm in the first season and the drench method of CCC at 1000 ppm in the second season resulted in highly significant increments in this parameter. Similar trend was obtained by sprayed the plants with the medium rate of CCC (1000 ppm) in both seasons.

6-Leaf chlorophyll b content (mg/100 g FW):

It is obvious from data presented in Table (37) that chlorophyll b content in the leaves of *S. reginae* was greatly increased by using all the three used growth retardants in both seasons of this study. Hence, treating Strelitzia plants with PP_{333} (regardless to methods of application and concentrations) is

Table (37): The effect of some growth retardants on leaf chlorophyll (b) content (mg/100g FW) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)															
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	75.33	116.7	115.7	120.7	117.7	111.0	118.3	116.0	115.1	111.7	118.7	94.67	108.4	104.1
	Drench	78.33	112.0	118.3	121.7	117.3	115.3	120.0	120.0	118.4	115.0	115.3	90.67	107.0	105.3
Mean		76.83	114.4	117.0	121.2	117.5	113.2	119.2	118.0	116.8	113.4	117.0	92.67	107.7	
LSD_1 at 5% = 4.34		LSD_2 at 5% = N.S				LSD_3 at 5% = 7.52				LSD_4 at 5% = 6.14				LSD_5 at 5% = 10.64	
LSD_1 at 1% = 5.79		LSD_2 at 1% = N.S				LSD_3 at 1% = 10.04				LSD_4 at 1% = 8.20				LSD_5 at 1% = 14.20	
Second season (2002/2003)															
Application methods	Spray	78.67	132.7	125.3	134.7	130.9	120.3	132.3	120.3	124.3	121.3	130.3	108.7	120.1	113.5
	Drench	81.00	123.3	134.0	125.0	127.4	119.0	135.7	123.7	126.1	120.3	125.7	115.3	120.4	113.7
Mean		79.84	128.0	129.7	129.9	129.2	119.7	134.0	122.0	125.2	120.8	128.0	112.0	120.3	
LSD_1 at 5% = 4.48		LSD_2 at 5% = N.S				LSD_3 at 5% = 7.77				LSD_4 at 5% = 6.34				LSD_5 at 5% = 10.99	
LSD_1 at 1% = 5.99		LSD_2 at 1% = N.S				LSD_3 at 1% =10.38				LSD_4 at 1% = 8.47				LSD_5 at 1% = 14.68	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

being the most effective treatment for producing leaves with the richest chlorophyll b content followed by using CCC treatment.

As for the specific effect of methods of applied growth retardants on leaf chlorophyll b content, data in Table (37) showed that drench method slightly increased leaf chlorophyll b content over spray method. The increment due to method application over spray method was so small to be significant in both seasons.

In addition, the data of the interaction effect between growth retardants and their concentrations (Table, 37) pointed out that all the three used growth retardants (regardless to methods of application) significantly succeeded in increasing chlorophyll b content in the leaves of *S. reginae*. So, in the first season, the application of PP_{333} at 300 ppm and CCC at 1000 ppm are being the most promising application for increasing leaf chlorophyll b content, while in the second season the application of CCC at 1000 ppm and PP_{333} at 300 ppm showed their superiorities for increasing this parameter. The differences between the prementioned two applications were non significant in both seasons.

Besides, the data of the interaction effect between growth retardants and methods of application (Table, 37) cleared that all the three used growth retardants at the two methods of application (regardless to concentrations) resulted in highly significant increases in this parameter.

Concerning the interaction effect between growth retardants, concentrations and methods of application, data in

Table (37) declared that all applied treatments of the three growth retardants and their concentrations with the two methods of application significantly increased leaf chlorophyll b content of *S. reginae* plants in both seasons. However, treated the plants in the first season with PP_{333} at 300 ppm at the two methods of application induced the highest leaf chlorophyll b content (mg/100 g FW), while in the second season the greatest leaf chlorophyll b content was obtained by using the drench application of CCC at 1000 ppm and sprayed PP_{333} at 300 ppm.

7-Leaf carotenoids content (mg/100 g FW):

Data in Table (38) exhibited that all the three used growth retardants had enhancing effect on increasing leaf carotenoids content (mg/100 g FW). Hence, the greatest leaf carotenoids content in the first season was obtained by using CCC (regardless to concentrations and methods of application) and using PP_{333} in the second season as they gave 45.11 and 54.11 mg/100 g FW, respectively.

As for the specific effect of methods of applied growth retardants on leaf carotenoids content data in Table (38) revealed that drench application slightly increased leaf carotenoids content in *S. reginae* plants with non significant increments when compared with spray application in both seasons.

Also, the data of the interaction effect between growth retardants and their concentrations (Table, 38) cleared that carotenoids content in the leaves of bird of paradise plants was greatly increased by using all rates of the three used growth retardants (regardless to methods of application). Since, using

Table (38): The effect of some growth retardants on leaf carotenoids content (mg/100g FW) of *Strelitzia reginae* Ait plants during two successive seasons of 2001/2002 - 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	32.33	40.67	41.33	48.37	43.46	40.67	51.67	45.33	45.89	41.33	44.33	38.33	41.33	40.75
	Drench	33.33	40.00	42.67	52.33	45.00	41.33	49.33	42.33	44.33	40.67	42.33	38.67	40.56	40.81
Mean		32.83	40.34	42.00	50.35	44.23	41.00	50.50	43.83	45.11	41.00	43.33	38.50	40.95	
LSD_1 at 5% = 3.04 LSD_1 at 1% = 4.06		LSD_2 at 5% = N.S LSD_2 at 1% = N.S				LSD_3 at 5% = 5.28 LSD_3 at 1% = 7.04			LSD_4 at 5% = 4.31 LSD_4 at 1% = 5.75			LSD_5 at 5% = 7.46 LSD_5 at 1% = 9.96			
Second season (2002/2003)															
Application methods	Spray	30.33	45.00	51.00	62.33	52.78	45.33	56.67	52.33	51.44	46.33	48.33	41.00	45.22	44.94
	Drench	35.67	53.33	54.67	58.33	55.44	47.00	57.67	49.67	51.45	45.33	44.67	43.33	44.44	46.75
Mean		33.00	49.17	52.84	60.33	54.11	46.17	57.17	51.00	51.45	45.83	46.50	42.17	44.83	
LSD_1 at 5% = 3.43 LSD_1 at 1% = 4.58		LSD_2 at 5% = N.S LSD_2 at 1% = N.S				LSD_3 at 5% = 5.94 LSD_3 at 1% =7.93			LSD_4 at 5% = 4.85 LSD_4 at 1% = 6.48			LSD_5 at 5% = 8.41 LSD_5 at 1% = 11.23			

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

CCC at 1000 ppm is being the most promising application for increasing leaf carotenoids content (50.50 mg/100 g FW), while in the second season, the application of PP_{333} at 300 ppm showed its superiority for increasing leaf carotenoids content (60.33 mg/100 g FW).

Concerning the interaction effect between growth retardants and methods of application, data in Table (38) pointed out that all the three used growth retardants at the two methods of application (regardless to concentrations) caused significant increments in leaf carotenoids content (mg/100 g FW) in both seasons. However, in the first season, using the spray method of CCC and the drench application of PP_{333} showed to be the most effective application for increasing leaf carotenoids content as they gave 45.89 and 45.00, respectively. While, in the second season using the two applications method of PP_{333} showed its superiority for increasing leaf carotenoids content as they registered 52.78 and 55.44 mg/100 g FW for spray and drench methods, respectively. The differences between the prementioned two applications were non significant in the first and second seasons.

Referring to the interaction effect between growth retardants, concentrations and methods of application, data in Table (38) indicated that all applied treatments of growth retardants succeeded in increasing leaf carotenoids content in both seasons. However, the greatest carotenoids content in the leaves of *S. reginae* plants was obtained by using the drench application of PP_{333} at 300 ppm in the first season (52.33

mg/100g FW) and sprayed PP_{333} at 300 ppm in the second season (62.33 mg/100 g FW).

As for the explanation of the incremental effect of paclobutrazol on chlorophylls content, it could be illustrated here on the basis that PP_{333} treatments stimulated the endogenous cytokinins synthesis as will be mentioned afterwards and there is an intimate relationship between cytokinins and chlorophylls metabolism in both excided or detached leaf disks and intact plants i.e., cytokinins retard chlorophylls degradation, preserve it and increase its synthesis **(Devlin and Witham, 1983).** Besides, cytokinins activate a number of enzymes participating in a wide range of metabolic reactions in the leaves. These reactions included the maturation of proplastid into chloroplasts. These enzymes could be divided into two groups according to their response to cytokinins. The first group of enzymes could be said to relate to chloroplast differentiation, while the second group could be related to cytokinin stimulated group **(Kulaeva, 1979).** Also, the increase in chlorophyll content due to growth retardants treatments might be attributed to the character of some growth retardants on depressing leaf area which lead to intensification of pigments in leaf. These results go on line with that obtained by **Selim (1985)** on *Bougainvillea Mrs Butte*, **Khalafalla (1995)** on *Bengonia semperflorens*, **Desouky (1994)** and **Youssef (2000)** on *S. reginae* reported that PP_{333} treatments increased leaf chlorophylls (a, b) and carotenoids, **Srour (2001)** on *Althaea rosea* and **Saker (2004)** who revealed that spraying *Hibiscus rosa sinensis* and *Tabernamontana coronaria* shrubs with PP_{333} at 200 and 300 ppm and uniconazole at 125 and 187.5

ppm inducing the richest leaf chlorophyll a, b and carotenoids content.

8-Leaf total phenols content (mg/100 g FW):

The data obtained on total phenols content in the leaves of *S. reginae* plants as affected by using some growth retardants treatments are presented in Table (39).

The results revealed that leaf total phenols content (mg/100 g FW) was greatly affected by using all the three growth retardants treatments as compared to control in both seasons. Thus, it could be noticed that in the first season the greatest leaf total phenols content was obtained by using PP_{333} (regardless to concentrations and methods of application) which gave 187.4 mg/100 g FW as compared to 178.0 mg/100g FW for control, on the contrary, the lowest leaf total phenols content was obtained by using CCC treatment which gave 169.9 mg/100 g FW. While, in the second season the highest leaf total phenols content was obtained by using uniconazole application (226.7 mg/100 g FW) whereas, the lowest leaf total phenols content in *S. reginae* (irrespective control) was obtained by using CCC treatment (193.1 mg/100 g FW).

Referring to the specific effect of methods of applied growth retardants on leaf total phenols content, data in Table (39) showed that drench application was more effective than spray application in increasing leaf total phenols content, but the differences between the two applied methods of application did not reach the level of highly significance at 1% in the first season. While, in the second season spray application showed its

Table (39): The effect of some growth retardants on leaf total phenols content (mg/100g FW) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	175.0	180.7	181.0	195.0	185.6	150.3	175.7	180.3	168.8	161.0	181.0	190.3	177.4	176.7
	Drench	181.0	176.0	190.7	200.7	189.1	150.3	171.3	191.0	170.9	173.7	191.0	195.0	186.6	181.9
Mean		178.0	178.4	185.8	197.9	187.4	150.3	173.5	185.7	169.9	167.4	186.0	192.7	182.0	
LSD_1 at 5% = 6.18		LSD_2 at 5% = 4.37				LSD_3 at 5% = 10.72				LSD_4 at 5% = 8.75				LSD_5 at 5% = 15.16	
LSD_1 at 1% = 8.26		LSD_2 at 1% = N.S				LSD_3 at 1% = 14.31				LSD_4 at 1% = 11.68				LSD_5 at 1% = 20.24	
Second season (2002/2003)															
Application methods	Spray	171.0	190.7	204.7	240.3	211.9	161.3	194.0	225.7	193.7	200.3	236.0	243.0	226.4	200.8
	Drench	165.3	181.0	201.3	231.3	204.5	145.3	201.0	231.0	192.4	195.7	240.3	245.0	227.0	197.3
Mean		168.2	185.9	203.0	235.8	208.2	153.3	197.5	228.4	193.1	198.1	238.2	244.0	226.7	
LSD_1 at 5% = 6.26		LSD_2 at 5% = N.S				LSD_3 at 5% = 10.85				LSD_4 at 5% = 8.86				LSD_5 at 5% = 15.53	
LSD_1 at 1% = 8.36		LSD_2 at 1% = N.S				LSD_3 at 1% =14.49				LSD_4 at 1% = 11.83				LSD_5 at 1% = 20.49	

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

superiority over drench application but the differences between the two methods of application were not significant.

In addition, the data of the interaction effect between growth retardants and their concentrations (Table, 39) declared that in the first season, treated *S. reginae* plants with PP_{333} at 300 ppm (regardless to methods of application induced the richest leaf total phenols content (197.9 mg/100 g FW) followed by using uniconazole at 150 ppm (192.7 mg/100 g FW) on the contrary, the lowest leaf total phenols content was obtained by using the low rate of CCC (500 ppm). While, in the second season treating the plants with uniconazole at 150 ppm showed its superiority for increasing leaf total phenols content as it gave 244.0 mg/100 g FW followed by the application of uniconazole at 100 ppm, whereas the least total phenols content in the leaves of *S. reginae* plants was gained by using the low rate of CCC (500 ppm).

Concerning to the interaction effect between growth retardants and methods of application, data presented in Table (39) exhibited that using the drench method of PP_{333} and uniconazole are being the most promising applications for increasing total phenols content in the leaves of Strelitzia plants as they gave 189.1 and 186.6 mg/100 g FW in the first and second seasons, respectively. While, in the second season, using uniconazole at the two methods of application induced the greatest total phenols content in the leaves of bird of paradise plants as it gave 226.4 and 227.0 mg/100 g FW for spray and drench applications, respectively.

As for the interaction effect between growth retardants, methods of application and concentrations, data presented in Table (39) pointed out that treated the plants with PP_{333} at 300 ppm (applied with drench method) is being the most promising effect for increasing leaf total phenols content as it gave 200.7 mg/100 g FW followed by using PP_{333} at 300 ppm (applied by spray method) and uniconazole at 150 ppm (applied by drench method) as they exhibited not only insignificant variance between each other but also, showed the same exact values (195.0 mg/100 g FW), whereas the least leaf total phenols content was obtained by using CCC at the low rate with the two methods of application. While, in the second season treated the plants with uniconazole at the high rate (150 ppm) with the two methods of application resulted in highly increments in this parameter. Similar trend was obtained by using uniconazole at 100 ppm (applied by drench method) and PP_{333} at 300 ppm (applied with spray method) as they exhibited not only insignificant variance between each other but also, showed the same exact values (240.3 mg/100 g FW). These results coincides with that obtained by **Youssef (2000)** who mentioned that treated *S. reginae* plants with PP_{333} at 200 or 300 ppm increased leaf total phenols content and **Adham (2001)** who pointed out that using PP_{333} at 50 and 100 ppm and CCC at 4000 ppm increased total phenols content in the leaves of *Althaea rosea*, plants.

9-Leaf total indoles content (mg/100 g FW):

The average data of the total indoles content of *Strelitzia reginae* leaves as affected by some growth retardants treatments of this work are shown in Table (40).

Table (40): The effect of some growth retardants on leaf total indoles content (mg/100g FW) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001/2002 and 2002/2003.

First season (2001/2002)														
Growth retardants		Paclobutrazol					Cycocel				Uniconazole				Mean
Concentrations		Cont.	100 ppm	200 ppm	300 ppm	Mean	500 ppm	1000 ppm	2000 ppm	Mean	50 ppm	100 ppm	150 ppm	Mean	
Application methods	Spray	281.3	246.0	230.0	231.0	235.7	261.0	240.3	231.3	244.2	281.3	253.3	260.3	265.0	256.6
	Drench	271.0	241.0	234.0	225.0	233.3	265.7	240.7	234.0	246.8	276.0	245.7	255.3	259.0	252.5
Mean		276.2	243.5	232.0	228.0	234.5	263.3	240.5	232.7	245.5	278.7	249.5	257.8	262.0	
LSD_1 at 5% = 8.52		LSD_2 at 5% = N.S				LSD_3 at 5% = 14.77			LSD_4 at 5% = 12.06				LSD_5 at 5% = 20.88		
LSD_1 at 1% = 11.38		LSD_2 at 1% = N.S				LSD_3 at 1% = 19.71			LSD_4 at 1% = 16.10				LSD_5 at 1% = 27.88		
Second season (2002/2003)															
Application methods	Spray	291.0	251.3	220.7	211.0	227.7	281.7	245.0	222.7	249.8	295.0	275.0	253.7	274.6	260.8
	Drench	284.7	261.3	231.3	223.0	238.6	270.3	231.0	224.3	241.9	290.7	271.3	251.0	271.0	259.0
Mean		287.8	256.3	226.0	217.0	233.1	276.0	238.0	223.5	245.8	292.8	273.2	252.3	272.8	
LSD_1 at 5% = 6.67		LSD_2 at 5% = N.S				LSD_3 at 5% = 11.56			LSD_4 at 5% = 9.43				LSD_5 at 5% = 16.34		
LSD_1 at 1% = 8.90		LSD_2 at 1% = N.S				LSD_3 at 1% =15.43			LSD_4 at 1% = 12.60				LSD_5 at 1% = 21.82		

LSD_1 = Specific effect of growth retardants.
LSD_2 = Specific effect of methods of application.
LSD_3 = Interaction effect between growth retardants and their concentrations.
LSD_4 = Interaction effect between growth retardants and methods of application.
LSD_5 = Interaction effect between growth retardants, concentrations and methods of application.

Data shown in Table (40) revealed that all the three used growth retardants greatly decreased leaf total indoles content in the leaves of *S. reginae* plants in both seasons of this study. However, in both seasons of this study treating the plants with PP_{333} (regardless to methods of application and concentrations) caused highly significant decreases in this parameter giving the values of 234.5 and 233.1 mg/100 g FW when compared either with other growth retardants or control in both seasons. On the other hand, treating the plants with CCC resulted in highly significant decreases in this parameter as it gave 245.5 and 245.8 mg/100 g FW and ranked the second in this concern, followed by uniconazole which gave 262.0 and 272.8 mg/100 g FW in the first and second seasons, respectively. Whereas, the highest mean values was obtained from untreated plants that recorded 276.2 and 287.8 mg/100 g FW in the first and second seasons, respectively.

With regard to the specific effect of methods of applied growth retardants on the total indoles content of the leaves of bird of paradise plants, data in Table (40) cleared that drench method was more effective than spray methods for decreasing the total indoles content in the leaves, but the differences between the two methods of application were not significant in both seasons.

Furthermore, the data of the interaction effect between growth retardants and their concentrations (Table, 40) pointed out that all combinations between growth retardants and their concentrations (regardless to methods of application) succeeded in decreasing leaf total indoles content of *S. reginae* in both

seasons. It was interested to note that there was a negative relationship between the total indoles content in the leaves of *S. reginae* plants and the used concentrations of growth retardant. Since, as the concentrations of the three used growth retardants increased, leaf total indoles content decreased until reached to the maximum reduction at the high rates. Therefore, using the highest rate of the three growth retardants produced the lowest mean values of leaf total indoles content (mg/100 g FW) especially in the second season. However, treating the plants by PP_{333} at the high rate (300 ppm) showed to be the most effective application for producing the lowest leaf total indoles content as it gave 228.0 and 217.0 mg/100 g FW in the first and second seasons, respectively when compared either with other applications or control in both seasons.

Referring to the interaction effect between growth retardants and methods of application, data in Table (40) declared that all combinations between the three used growth retardants and the two methods of application (regardless to concentrations) declined total indoles content in the leaves of *S. reginae* plants in both seasons. Hence, using the two methods of application of PP_{333} showed to be the greatest effective application for decreasing leaf total indoles content in both seasons.

Considering the interaction effect between growth retardants, concentrations and methods of application, data presented in Table (40) exhibited that all applied treatments of the three growth retardants decreased leaf total indoles content in most cases. However, treating Strelitzia plants with PP_{333} at 300

ppm applied by drench method is being the most effective treatment for reducing leaf total indoles content as it recorded 225.0 mg/100 g FW when compared either with control or other treatments. Such trend was true only in the first season, while in the second one sprayed PP_{333} at 300 ppm showed its superiority for decreasing this parameter as it registered 211.0 mg/100 g FW. Additionally, spraying the plants with PP_{333} at 200 ppm resulted in highly significant decreases in this parameter as it gave 230.0 and 220.7 mg/100 g FW in the first and second seasons, respectively. These results are in conformity with the results of **Adham (2001)** who revealed that CCC at 4000 ppm decreased total indoles content in the leaves of *Althaea rosea* plants.

*Endogenous phytohormones study:

Of different applied treatments in this experiment the treatment of PP_{333} at the medium and high rates (applied by spray or drench method) gave the best characteristics in vegetative and flowering growth behavior of bird of paradise plant, so the treatment of pp_{333} at 300 ppm applied as a soil drench was chosen for endogenous phytohormones determination.

As shown in Table (41) each of endogenous GA_3, auxin and ABA was decreased in leaves of treated plants. The reduction of endogenous level reached its maximum in case of ABA followed by auxin, yet GA_3 ranked the last in this respect.

With regard to endogenous total cytokinin level obviously it was increased with PP_{333} treatment as it reached to 18.9504

Table (41): Endogenous phytohormones in the leaves of *S. reginae* plants as affected by drenched the soil with pp_{333} at 300 ppm.

Measurement / Treatments	GA_3 mg/100 g FW	IAA mg/100 g FW	ABA mg/100 g FW
PP_{333} at 300 ppm	43.537	1.178	0.048
Control	102.741	7.819	0.139

Measurement / Treatments	Zeatin mg/100 g FW	Kinetin mg/100 g FW	Benzyladenine mg/100 g FW	Total
PP_{333} at 300 ppm	0.71573	3.1757	15.059	18.9504
Control	0.49218	0.78372	7.973	9.2489

mg/100g FW comparing with 9.2489 mg/100g FW of control plant. The above mentioned results are of great interest, since increment of endogenous cytokinin was on the acount of reduction of other determined phytohormones (GA_3, IAA and ABA), that clearly could be explained the improvement of all growth characteristics obtained in the present study. Since, cytokinin is known as shooting hormones (**Salisbury and Ross, 1974**) e.g. No. of leaves and offsets were significantly increased as well as the significant increase in flower number.

Also, of interest is to note that this treatment was accompanied with significant reduction in plant height that being more expectable when related with the obtained reduction in endogenous GA_3 and auxin levels. Besides, of interest the conclusion that such treatment ornamentally is being of economic value. Since more marketable characteristics of making this plant as a pot one were achieved.

The pervious results are in agreement with those of **Abou El Ghait (1993)** on *Epipremnum aureum* indicated that treated the plants with pp_{333} at 25 and 50 ppm increased leaf cytokinins contents however, they decreased leaf GA_3 and auxins contents, and **Wanas (1996)** who pointed out that treated wheat plants with pp_{333} at 10 and 50 ppm increased leaf cytokinins contents, but they decreased leaf GA_3 and auxins contents.

*Anatomical study:

According to the growth habit of *S. reginae* plants under different applied growth retardants treatments i.e., PP_{333} at 100, 200 and 300 ppm, CCC at 500, 1000 and 2000 ppm and

uniconazole at 50, 100 and 150 ppm (applied as spray or drench method) during the two seasons of the present study; So, some of these treatments were selected for the histological studies.

Data obtained on anatomical features of leaf of *S. reginae* plants as affected by some treatments of growth retardants are presented in Table (42). In this respect, as shown in Table (42) and Fig. (1-8) the different assigned treatments of growth retardants markedly increased the midrib thickness in leaves of treated plants. Here, spraying PP_{333} at 200 ppm gave the maximum thickness of midrib that reached 3.739 µm followed by PP_{333} at 300 ppm applied with drench method as its value was 3.007 µm compared with 1.905 µm for control. The rest treatments showed intermediate position as compared to control.

With regard to the vascular bundle of the middle major vein traits (length & width of vascular bundle, thickness of xylem and phloem tissues), data presented in Table (42) showed that PP_{333} applied as drench method at 100 ppm is being the most promising treatment for producing the tallest and widest vascular bundle as it recorded 720.0 and 229.2 µm when compared either with control (470.0 and 166.8 µm, respectively) or other treatments. Similarly, spraying PP_{333} at 200 ppm and at 300 ppm applied with drench method gave high increments in the length of vascular bundle as they registered 692.4 and 600.0 µm, respectively. On the other hand, the only sprayed CCC at 2000 ppm which decreased each of the length and the width of vascular bundle as they gave 454.8 and 160.8 µm, respectively, when compared with control or other treatments.

Table (42): Anatomical features of the leaves of *S. reginae* in response to different treatments of growth retardants compared to control.

Measurements / Treatments	midrib thickness (mm)	vascular bundle of the middle major vein				Leaf blade (Lamina)			
		vascular bundle length (μm)	vascular bundle width (μm)	xylem thickness (μm)	phloem thickness (μm)	Lamina thickness (μm)	Upper epidermis thickness (μm)	Lower epidermis thickness (μm)	mesophyll thickness (μm)
PP_{333} at 300 ppm (spray)	2.7072	577.2	184.8	194.4	147.6	498.0	28.8	10.8	458.4
PP_{333} at 300 ppm (drench)	3.0072	600.0	168.6	106.8	153.6	627.6	25.2	19.2	583.2
PP_{333} at 200 ppm (drench)	2.4792	493.2	225.6	148.8	135.6	564.0	31.2	20.4	512.4
PP_{333} at 200 ppm (spray)	3.7392	692.4	167.2	176.4	148.8	662.4	19.2	20.4	622.8
PP_{333} at 100 ppm (drench)	2.316	720.0	229.2	157.2	136.8	454.8	14.4	9.6	430.8
CCC at 2000 ppm (drench)	2.568	454.8	160.8	120.0	134.4	429.6	15.6	13.2	400.8
Uniconazole at 100 ppm (spray)	2.3736	480.0	171.6	152.4	130.8	492.0	21.6	15.6	454.8
Control	1.9056	470.4	166.8	133.2	120.0	314.4	20.4	14.4	279.6

* Measurements was taken using micrometric eye piece 10X (ERMA, Tokyo).

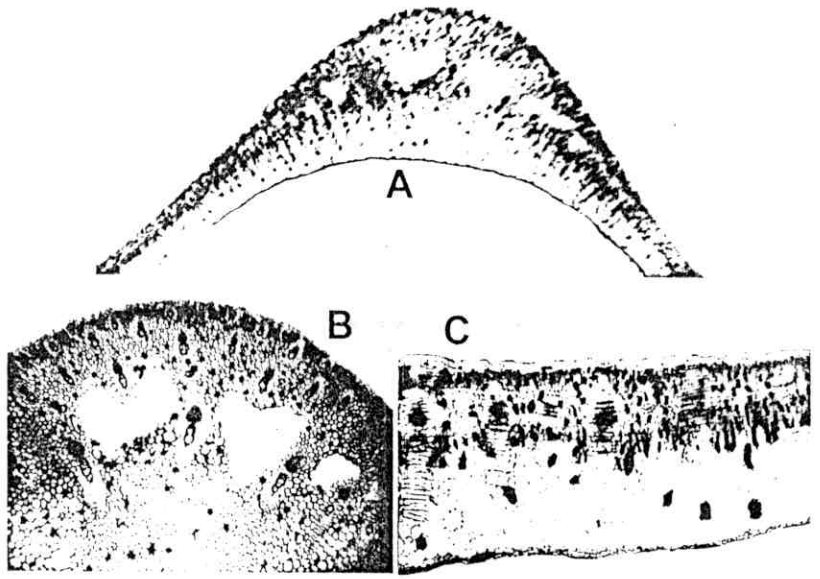


Fig. (1): Transverse section through the leaf blade of *Strelitzia reginae* plants as affected by sprayed the plants with PP_{333} at 300 ppm.

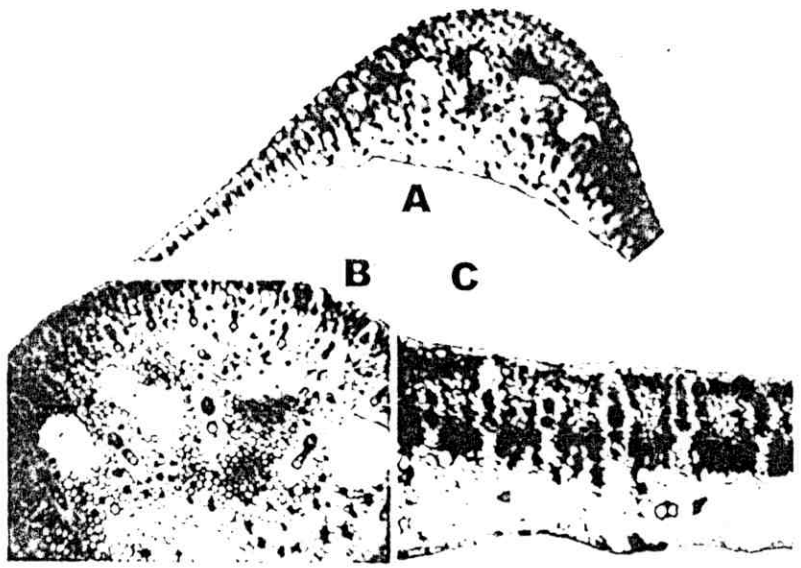


Fig. (2): Transverse section through the leaf blade of *Strelitzia reginae* plants as affected by drenched the soil with PP_{333} at 300 ppm.

A= Leaf blade **B=Midrib** **C= Lamina**

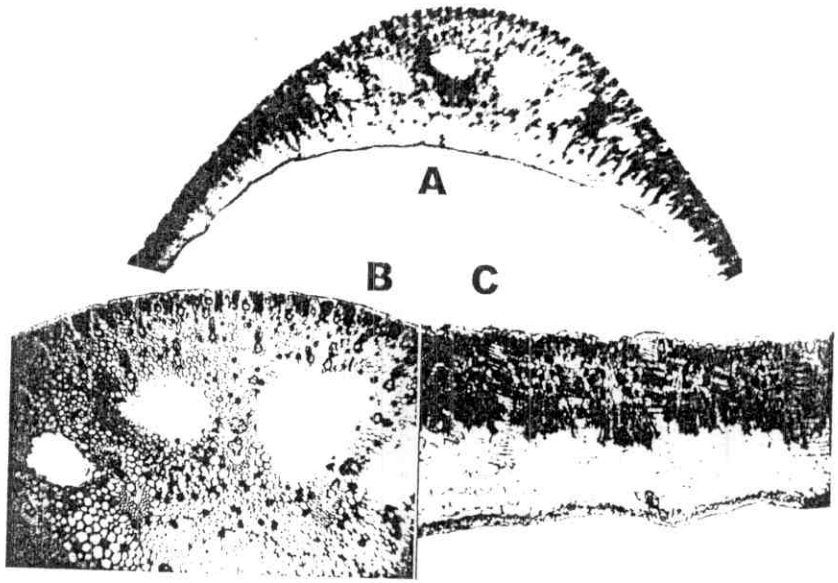


Fig. (3): Transverse section through the leaf blade of *Strelitzia reginae* plants as affected by drenched the plants with PP_{333} at 200 ppm.

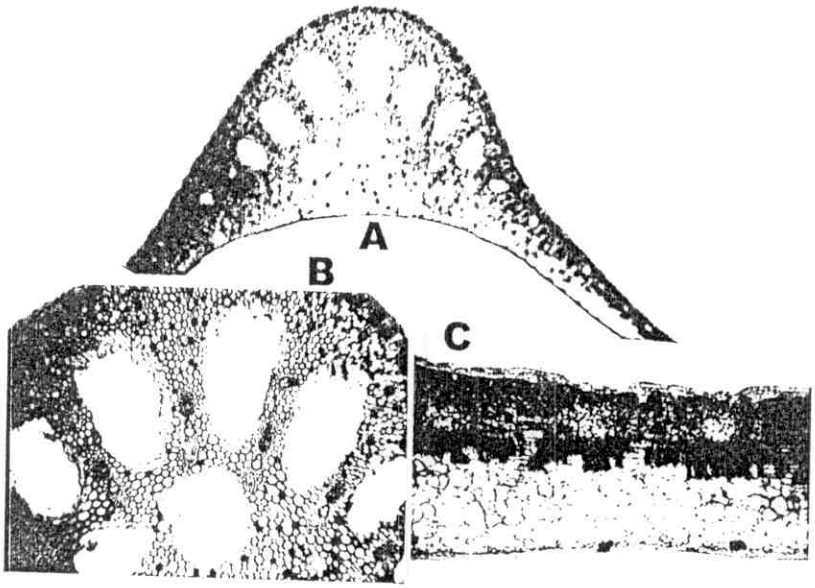


Fig. (4): Transverse sections through the leaf blade of *Strelitzia reginae* plants as affected by sprayed the plants with PP_{333} at 200 ppm.

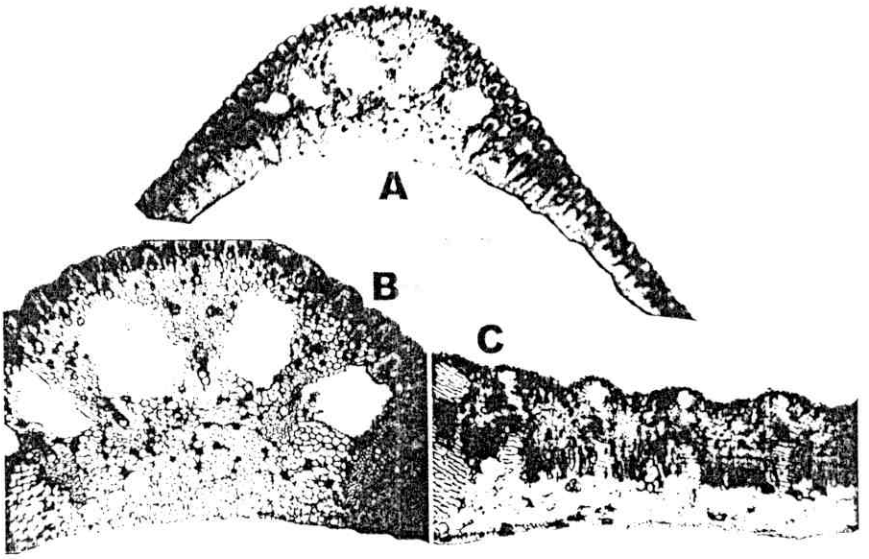


Fig. (5): Transverse section through the leaf blade of *Strelitzia reginae* plants as affected by drenched the soil with PP_{333} at 100 ppm.

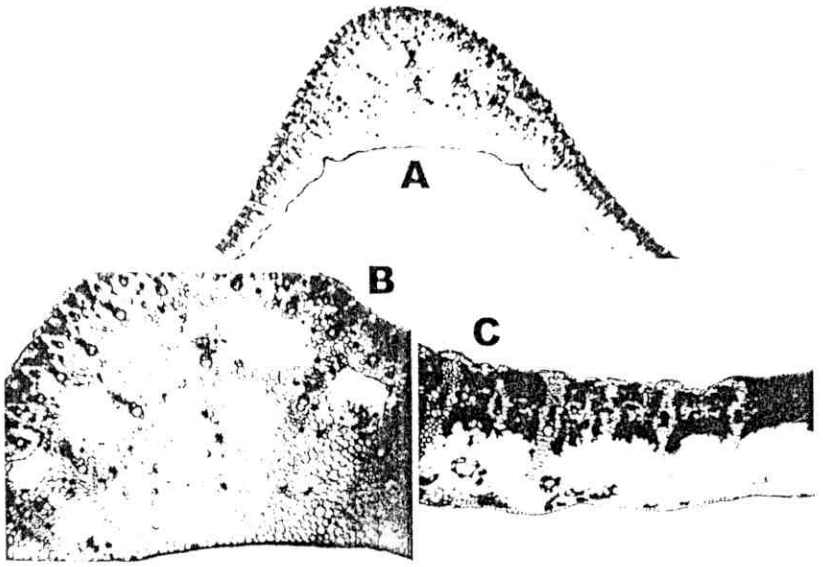


Fig. (6): Transverse section through the leaf blade of *Strelitzia reginae* plants as affected by drenched the soil with CCC at 2000 ppm.

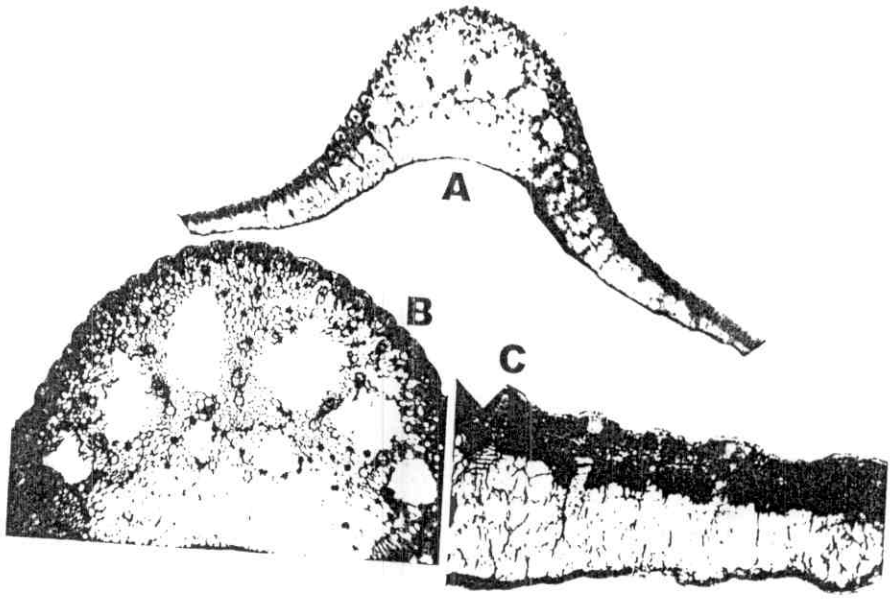


Fig. (7): Transverse section through the leaf blade of *Strelitzia reginae* plants as affected by sprayed the plants with uniconazole at 100 ppm.

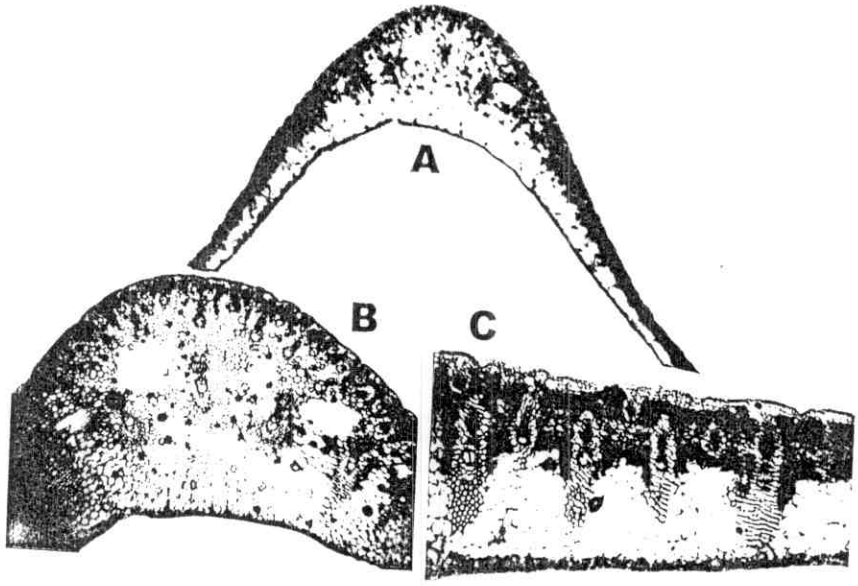


Fig. (8): Untreated plant (control).

Also, it could be noticed that each of sprayed PP_{333} at 200 ppm and at 100 ppm applied with drench method appeared to be the most effective treatments for inducing the thickest xylem as they recorded 176.4 and 157.2µm when compared either with other treatments or control, yet, PP_{333} at 300 ppm and CCC at 200 ppm applied with drench method gave the lowest value in this respect as they gave 106.8 and 120.0 µm, respectively. Additionally, data presented in Table (42) cleared that all selected treatments of growth retardants resulted in highly increments in the thickness of phloem. However, using the drench method of PP_{333} at 300 ppm showed its superiority for increasing phloem thickness followed by spraying PP_{333} at 200 ppm as they recorded 153.6 and 148.8 µm, respectively.

Increasing of xylem and phloem tissues means that the passage of crude nutrients and water from soil to leaves as well as the passage of sugar and other bioconstituents from leaves to other plant parts are being improved **(Marschner, 1995).** That is directly could be reflected upon the vigorous growth of such treated plants.

As for the leaf blade traits, data presented in Table (42) exhibited that all selected treatments of growth retardants resulted in highly increases in the thickness of lamina and mesophyll (µm) as compared with control. Anyway, among the selected treatments of growth retardants, sprayed PP_{333} at 200 ppm resulted in the greatest thickness of lamina and mesophyll as it recorded 662.4 and 622.8 µm, followed by using the treatment of drenched soil with PP_{333} at 300 ppm which gave

627.6 and 583.2 µm, respectively compared with 314.4 and 279.6 for control.

With regard to the thickness of upper and lower epidermis, data presented in Table (42) indicated that drenched soil with PP_{333} at 200 ppm is being the most promising treatment for increasing the thickness of upper and lower epidermis as it recorded 31.2 and 20.4, respectively, when compared with other treatments. On the contrary, the lowest mean values in this respect was obtained by using the treatment of drenched soil with PP_{333} at 100 ppm as it gave 14.4 and 9.6 µm for upper and lower epidermis thickness, respectively.

With regard to the nature of different applied treatments of growth retardants upon the histological features of leaf blade (lamina), data obtained are of great interest. Since, increasing the thickness of lamina at any of the applied treatments of growth retardants (e.g. was nearly two times more than control with spraying PP_{333} at 200 ppm); is of great economic value regarding the decorative view. That means that leaves having such characteristics should be has great longevity comparing with other plants with low values of lamina thickness.

On the other hand, increasing of mesophyll thickness to reach nearly more than two times of control with sprayed plants with PP_{333} at 200 ppm, also, are of great interest. Since, that means more chloroplasts are being created in such wide mesophyll thickness. In this respect more chloroplasts could be reflected upon the efficiency of photosynthesis itself. Thereby, more assimilates are being created and then translocated to other

plant parts causing the greening of formed leaves. Here, increasing of green color with wide lamina thickness gave good decorative characteristics and long duration of such leaves. Furthermore, all of that could be reflected upon the improvement of formed flowers characteristics.

In general, increasing each of midrib and lamina thickness as well as phloem and xylem tissues are being mainly direct response for the alteration the profile of endogenous phytohormones, i.e., cytokinins, auxin, gibberellins and abscisic acid to be in favor of tissues development and accelerating their morphogenesis. The pervious results are in conformity with those of **Wanas (1996)** who mentioned that treated Wheat plants with pp_{333} at 10 and 50 ppm increased blade thickness mesophyll tissue thickness and phloem tissue thickness.

In general, of all obtained results; those of achieving more dwarf plants of *S. reginae* with many formed flowers (Fig. 9-12) could be considered as pioneer results in this field. Since, treatments of pp_{333} at 200 and 300 ppm (applied either by spry or drench method) gave a good display of flowering pot of bird of paradise plant with optimum vegetative and flowering characteristics from the commercial point of view when compared either with other treatments e.g. uniconazole at 100 ppm (Fig. 13) or control (Fig. 14).

Fig. (9): Paclobutrazol at 300 ppm (applied by spray method)

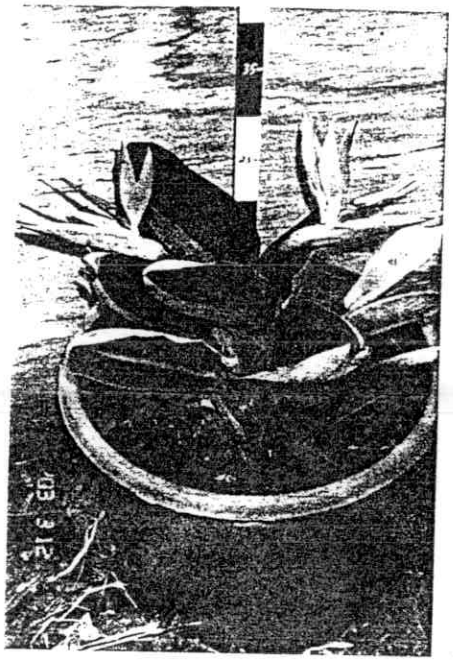


Fig. (10): Paclobutrazol at 300 ppm (applied by drench method)

Fig. (11): Paclobutrazol at 200 ppm (applied by drench method)

Fig. (12): Paclobutrazol at 200 ppm (applied by spray method)

Fig. (13): Unionazole at 100 ppm (applied by spray method)

Fig. (14): Control.

IV.1.B- Seedlings study:

The effect of some chemical substances on vegetative growth, flowering and chemical composition of *Strelitzia reginae* seedlings raised from seeds.

IV.1.B.1-Vegetative growth measurements:

1- Number of offsets per plant:

According to data presented in Table (43) on number of offsets per plant as affected by tryptophan, stimufol and their combinations, it could be concluded that all stimufol treatments i.e., 2, 4 and 6 g / L (applied as drench method; 500 ml/pot) showed a little increment upon the mean number of offsets/plant as they caused non-significant increases in this parameter when compared with the control plants in both seasons, with the exception of sitmoful at 4 g/L in the second season which gave a significant increase (1.32 offsets/plant) when compared to the control (1.00 offset/plant). These results may be due to the role of stimufol on supplying the growing buds with the required nutrients for accelerating growth, and hence forming more offsets. On the other hand, it was clear that all tryptophan treatments i.e., 100 and 200 ppm (applied as spray method) had a highly significant increase (with the exception of tryptophan treatment at 200 ppm in the first season which resulted in negligible increment in this parameter as it gave value (1.01 offset/plant) near to those of the control (1.00 offset/plant) which did not reach the level of significance) upon the number of offsets produced by treated plant, especially with treatment at 100ppm of tryptophan which recorded 1.32 and 1.66 offsets/

Table (43): The effect of some chemical substances on No. of offsets and plant height of seedlings of *Strelizia reginae* Ait. raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		No. of offsets/plant		Plant height (cm)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		1.00	1.10	40.33	43.33
Stimufol at 2 g/L (S_1)		1.01	1.23	45.00	48.46
Stimufol at 4 g/L (S_2)		1.10	1.32	48.33	61.00
Stimufol at 6 g/L (S_3)		1.01	1.23	46.38	61.67
Tryptophan at 100 ppm (T_1)		1.32	1.66	48.33	54.00
Tryptophan at 200 ppm (T_2)		1.01	1.36	45.29	51.67
$S_1 + T_1$		1.19	1.32	60.67	74.17
$S_1 + T_2$		1.10	1.19	49.00	56.17
$S_2 + T_1$		1.17	1.27	42.67	50.67
$S_2 + T_2$		1.26	1.44	42.82	52.62
$S_3 + T_1$		1.21	1.49	47.72	50.57
$S_3 + T_2$		1.21	1.40	43.83	56.33
LSD	at 5%	0.125	0.217	6.52	8.80
	at 1%	0.233	0.371	8.95	11.68

plant when compared with 1.00 and 1.10 offsets/plant for control in the first and second seasons, respectively.

As for the effect of combined treatments between stimufol and tryptophan, it was obvious that all combined treatments succeeded in increasing the number of offsets per plant in both seasons. However, the combined treatment of stimufol at 4 g/L + tryptophan at 200 ppm (S_2 + T_2) in the first season and the treatment of stimufol at 6 g/L + tryptophan at 100 ppm (S_3 + T_1) in the second season gave a high significant increase in this parameter as they registered 1.26 and 1.49 offsets / plant, respectively. On the other hand, the combined treatment between stimufol at 2 g/L and tryptophan at 200 ppm (S_1 + T_2) had a non significant increase in this parameter as it gave 1.10 and 1.19 offsets/plant in the first and second seasons, respectively.

Generally, the greatest number of offsets/plant was obtained by using tryptophan at 100 ppm (T_1) in both seasons.

2- Plant height (cm):

The data obtained on plant height as affected by stimufol and tryptophan treatments are shown in Table (43). These results may be discussed as follow: All treatments of stimufol increased plant height in both seasons. The differences were not significant for treated plants with the low and high rates of stimufol as they gave 45.00 and 46.38 (cm) whereas, the medium rate of stimufol (4 g/L) gave a significant increase in this parameter as it recorded 48.33 cm in the first season. While, in the second season the differences were not significant for treated plants with the low level of stimufol (2 g/L) which recorded 43.33 cm, while

the medium and high concentrations of 4 and 6 g/L gave high significant increases as they registered 61.00 and 61.67 cm, respectively.

With respect to the effect of tryptophan treatments, results showed that all tested applications of tryprophan increased plant height in both seasons, especially the low rate (100 ppm) which resulted in significant increase as it recorded 48.33 and 54.00 cm in the first and second seasons, respectively. As for the combined treatments between stimufol and tryptophan rates, it could be concluded that all treatments succeeded in increasing plant height especially using the treatment of stimufol at 2 g/L + tryptophan at 100 ppm (S_1+T_1) which resulted in high significant increment in this parameter as it recorded 60.67 and 74.17 cm followed descendingly by using the treatment of stimufol at 2 g/L + tryprophan at 200 ppm in the first season and stimufol at 6 g/L + tryptophan at 200 ppm in the second season. Besides, the treatment of stimufol at 6 g/L + tryptophan at 100 ppm (S_3 + T_1) in the first season and the treatments of stimufol at 2 g/L + tryptophan at 200 ppm (S_1 + T_2) and the treatment of stimufol at 4 g/L + tryptophan at 200 ppm (S_2 + T_2) in the second season, significantly increased the plant height of *S. reginae* seedlings raised from seeds. On the other hand, the remaining treatments of stimufol and tryptophan resulted in negligible increments in this parameter as they gave values near to those of the control which did not reach the level of significance in both seasons.

Lastly, the tallest plant was obtained by using the combined treatment of stimufol at 2 g/L + tryptophan at 100 ppm in both seasons. The aforementioned results of stimufol are in

conformity with those obtained by **Maximoos (1985)** on *Lathyrus odoratus*, **Chaturvedi *et al.* (1988)** on Gladiolus cv. Sylvia, **Abou El-Ghait (1993)** mentioned that fertilized *S. reginae* plants with urea or ammonium nitrate as a source of nitrogen significantly increased plant height especially with using the high level (120 kg/fed.), **Abou-Dahab (1996)** on Schefflera and **Abd El- Hafez (2000)** on *Yucca filamentosa*, mentioned that stimufol fertilizer at 0.5, 1.0 and 1.5 g/L applied as soil drench or foliar spray significantly increased plants height. The aforementioned results of tryptophan are in agreement with those obtained by **El-Sherbeny and Hassan (1987)** on Datura, **Mohamed *et al.* (1992)** on *Alpinia nutans* and **Youssef (2000)** who indicated that using tryptophan at 25, 50 and 100 ppm increased plant height of *S. reginae* seedlings.

3- Number of leaves per plant:

It is quite evident that the number of leaves per plant was positively responded to the all levels of stimufol and tryptophan in both seasons. Data tapulated in Table (44) showed that all applied levels of stimufol showed a little increment upon the mean number of leaves per plant as they caused a non significant increase in this parameter when compared with the control in both seasons, with the exception of stimufol at the medium rate (4 g/L) in the second season which gave a significant increase (10.33 leaves / plant) when compared to the control (7.66 leaves / plant). In addition, both treatments of tryptophan significantly increased the number of leaves per plant, with the exception of tryptophan at 200 ppm in the first season as it caused a non significant increase in this parameter.

Table (44): The effect of some chemical substances on No. of leaves and leaf area of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		No. of leaves/plant		Leaf area (cm^2)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		6.33	7.66	105.7	122.3
Stimufol at 2 g/L (S_1)		7.66	9.66	110.4	118.7
Stimufol at 4 g/L (S_2)		8.33	10.33	157.0	173.6
Stimufol at 6 g/L (S_3)		7.66	9.66	129.3	130.3
Tryptophan at 100 ppm (T_1)		10.00	13.00	144.7	152.3
Tryptophan at 200 ppm (T_2)		7.66	10.67	151.0	166.0
$S_1 + T_1$		9.00	10.33	168.3	179.5
$S_1 + T_2$		8.33	9.33	160.2	172.7
$S_2 + T_1$		8.83	10.00	166.0	175.8
$S_2 + T_2$		9.50	11.34	109.7	121.0
$S_3 + T_1$		9.16	11.67	120.0	129.4
$S_3 + T_2$		9.16	11.00	137.0	144.3
LSD	**at 5%**	1.83	2.70	9.51	10.69
	at 1%	2.49	3.67	12.93	14.53

As for the combined treatments between stimufol and tryptophan treatments, data showed that all treatments increased the number of leaves per plant in both seasons with significant differences in most cases. So, the treatment of stimufol at 4 g/L + tryptophan at 200 ppm showed a high significant increase in this parameter as it recorded 9.50 and 11.34 leaves/plant compared with 6.33 and 7.66 leaves / plant for control in the first and second seasons, respectively. Similarly, the treatment of stimufol at 6 g/L + tryptophan at 100 ppm ($S_3 + T_1$) resulted in highly significant increases in this parameter as it registered 9.16 and 11.67 leaves/plant followed descendingly by using the treatment of stimufol at 6 g/L + tryptophan at 200 ppm ($S_3 + T_2$) which recorded 9.16 and 11.00 leaves / plant in the first and second seasons, respectively.

These results may be due to the role of stimufol on supplying the growing buds with the required nutrients for accelerating growth, and hence forming more leaves.

Finally, the greatest number of leaves per plant was obtained by spraying *S. reginae* seedlings with the low rate of tryptophan (100 ppm) in both seasons. The aforementioned results of stimufol are in parallel with those obtained by **Criley (1984), Kawabata *et al.* (1984)** on *S. reginae* seedlings, pointed out that when the seedlings were fertilized with controlled release 14N: 6P: 12K fertilizer the number of leaves and offsets were increased, **Misiha and Kamel (1987), Abo El-Ghait (1993), Vanderbruggen (1965), Abdel-Wahid (1995), El-Shoura and Hosni (1996)** on *S. reginae*, **El-Ashry (1998)** in pot experiments, fertilized *S. reginae* seedlings with kristalon (19:

19: 19 NPK) at 4.0, 8.0 and 12g / pot bimonthly increased the number of leaves and offsets / plant, and **Siraj and Ali (1998)** on *S. reginae*. The aforementioned results of tryptophan are in line with those obtained by **El-Sherbeny and Hassan (1987)** on Datura, **Mohamed *et al.* (1992)** mentioned that sprayed *Alpinia nutans* plants with tryptophan at 50 and 100 ppm increased the number of leaves and offsets per plants, **Hassan (1997)** on *Narcissus tazetta*, and **Youssef (2000)** on *S. reginae*.

4- Leaf area (cm^2):

Data presented in Table (44) indicated that the medium and high rates of stimufol resulted in highly significant increments in this parameter especially using the medium rate (4 g/L) which registered 157.0 and 173.6 cm^2 compared with 105.7 and 122.3 cm^2 for control in the first and second seasons respectively. Whereas, the low rate 2 g/L resulted in negligible effect in this parameter as it gave values near to those of the control which did not reach the level of significance in both seasons. On the other hand, stimufol at the high rate (6 g/L) occupied intermediate position between the previously two mentioned treatments. This may be due to the effect of stimufol as a complete fertilizer which supplies the new formed leaves with their required nutrients necessary for healthy growth.

In addition, the two levels of tryptophan produced a highly significant increment in this parameter as they recorded 144.7 and 152.3 cm^2 for tryptophan at 100 ppm and 151.0 and 166.0 cm^2 for tryptophan at 200 ppm in the first and second seasons, respectively.

Concerning the effect of combined treatments between stimufol and tryptophan treatments, data obtained in Table (44) showed that the largest leaf area per plant was produced on plants treated with the treatment of stimufol at 2 g/L + tryptophan at 100 ppm (S_1 + T_1) which registered 168.3 and 179.5 cm^2 in the first and second seasons, respectively. Similarly the treatment of stimufol at 4 g/L + tryptophan at 100 ppm (S_2 + T_1) gave a highly significant increment in this parameter, followed descendingly by using the treatment of stimufol at 2 g/L + tryptophan at 200 ppm (S_1 + T_2) in both seasons. This may be due to the combined effects of both tryptophan as a precursor of indole acetic acid which induces cell division and enlargement, in addition to the effect of stimufol as a complete fertilizer supplying the plant with the required nutrients necessary for healthy growth.

Conclusively, the highest mean value of leaf area of *S. reginae* seedlings was produced by using the treatment of Stimufol at 2 g/L + tryptophan at 100 ppm (S_1 + T_1) in both seasons. The aforementioned results of stimufol coincided with those obtained by **Misiha and Kamel (1987)**, **Abdel-Wahid (1995)**, **El-Ashry (1998)**, **Zaky (1998)**, **Youssef (2000)** on *S. reginae,* and **Abd El- Hafez (2000)** on *Yucca filamentosa*, stated that stimufol at 0.5, 1.0 and 1.5 g/L applied as soil drench or foliar spray increased the mean leaf area / plant.

5- Length of leaf petiole (cm):

Dta presented in Table (45) revealed that the length of leaf petiole as affected by various treatments of stimufol and tryptophan ranged from 11.33 and 12.40 cm to 19.00 and 22.00

Table (45): The effect of some chemical substances on length and top thickness of leaf petiole of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		Length of leaf petiole(cm)		Thickness of top leaf petiole (cm)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		13.00	15.77	0.400	0.433
Stimufol at 2 g/L (S_1)		15.23	16.97	0.520	0.566
Stimufol at 4 g/L (S_2)		17.32	20.33	0.553	0.700
Stimufol at 6 g/L (S_3)		15.67	18.27	0.493	0.600
Tryptophan at 100 ppm (T_1)		15.62	18.13	0.513	0.633
Tryptophan at 200 ppm (T_2)		11.33	12.40	0.580	0.700
$S_1 + T_1$		19.00	22.00	0.560	0.666
$S_1 + T_2$		16.17	21.17	0.480	0.550
$S_2 + T_1$		12.31	14.40	0.520	0.633
$S_2 + T_2$		15.42	20.90	0.450	0.483
$S_3 + T_1$		16.00	17.07	0.490	0.533
$S_3 + T_2$		16.67	21.00	0.506	0.533
LSD	**at 5%**	2.96	3.93	0.050	0.131
	at 1%	4.02	4.78	0.069	0.178

cm in the first and second seasons, respectively. The shortest leaf petiole resulted from treated *S. reginae* seedlings with tryptophan at 200 ppm, the differences among this treatment and control treatment were non significant as the plants under such treatments had nearly close leaf petiole length values in both seasons. On the other hand the low rate of stimufol (2 g/L) and tryptophan (100 ppm) failed to induce a significant increment in this parameter in both seasons. While, the longest leaf petiole of *S. reginae* seedlings was obtained by using the treatment of stimufol at 2 g/L + tryptophan at 100 ppm ($S_1 + T_1$). Also, using the treatment of stimufol at 2 g/L + tryptophan at 200 ppm ($S_1 + T_2$) showed a high significant increase in this parameter (especially in the second season) as it registered 16.17 and 21.17 cm in the first and second seasons, respectively. Besides, the treatment of stimufol at 6 g/L + tryptophan at 200 ppm ($S_3 + T_2$) caused a significant increase in this parameter as it recorded 16.67 and 21.00 cm compared with 13.00 and 15.77 cm for control in the first and second seasons, respectively. The remaining treatments of stimufol and tryptophan occupied intermediate position between the previously mentioned treatments in both seasons. These results may be due to the combined effects of both tryptophan as a precursor of indole acetic acid which induces cell division and enlargement, in addition to the effect of stimufol as a complete fertilizer supplying the plant with the required nutrients necessary for healthy growth.

Abstractly, the longest leaf petiole of *S. reginae* seedlings was obtained by using the treatment of stimufol at 2 g/L +

tryprophan at 100 ppm (S_1 + T_1), whereas the shortest leaf petiole was obtained by spraying *S. reginae* seedlings with tryptophan at 200 ppm in both seasons.

6- Thickness of top leaf petiole:

Data on the thickness of top leaf petiole as affected by stimufol and tryptophan treatments are given in Table (45). Data showed that application of stimufol at various rates were found to increase the thickness of top leaf petiole with significant increases in all cases especially at the medium rate (4 g/L) which gave 0.553 and 0.700 cm in the first and second seasons, respectively. Similarly, the two rates of tryptophan (100 and 200 ppm) significantly increased this parameter as they gave 0.513 and 0.633 cm for tryptophan at 100 ppm and 0.580 and 0.700 for tryptophan at 200 ppm in the first and second seasons, respectively.

Referring to the combined treatments between stimufol and tryptophan rates, it is worthy to notice that using the treatment of stimufol at 2 g/L + tryptophan at 100 ppm (S_1 + T_1) caused a high significant increment in this parameter as it recorded 0.560 and 0.666 cm, followed descendingly by using the combined treatment of stimufol at 4 g + tryptophan at 100 ppm (S_2 + T_1) which recorded 0.520 and 0.633 cm in the first and second seasons, respectively.

Briefly, the highest value of thickness of top leaf petiole was obtained by using the treatment of tryptophan at 200 ppm in both seasons.

7- Fresh weight of leaf petiole (g):

Data tabulated in Table (46) showed that the fresh weight of leaf petiole was affected by various treatments of stimufol and tryptophan in both seasons. So, all tested rates of stimufol significantly succeeded in increasing the fresh weight of leaf petiole especially the medium rate (4 g/L) which resulted in highly increases in this parameter as it recorded 3.34 and 4.86 (g) in the first and second seasons, respectively. Similarly, using the high application of stimufol (6 g/L) showed a significant increase in this parameter as it gave 3.03 and 3.80 (g) in the first and second seasons, respectively. In addition, the two levels of tryptophan significantly increased the fresh weight of leaf petiole as they registered 2.90 and 4.93 (g) for tryptophan at 100 ppm and 2.35 and 3.73 (g) for tryptophan at 200 ppm in the first and second seasons, respectively.

Concerning the effect of combined treatments between stimufol and tryptophan levels, data in Table (46) showed that the treatment of stimufol at 2 g/L + tryptophan at 100 ppm (S_1 + T_1) resulted in a highly significant increment in this parameter as it gave 3.90 and 5.03 g compared with 1.90 and 2.65 g for control in the first and second seasons, respectively. Similar trend was obtained by using the treatment of stimufol at 2 g/L + tryptophan at 200 ppm (S_1 + T_2) which gave 2.92 and 4.43 g as well as the treatment of stimufol at 6 g/L + tryptophan at 200 ppm (S_3 + T_2) which resulted in highly increments in this parameter as it recorded 3.10 and 4.60 g in the first and second seasons, respectively.

Table (46): The effect of some chemical substances on fresh and dry weights of leaf petiole of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		Fresh weight of leaf petiole (g)		Dry weight of leaf petiole (g)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		1.90	2.65	0.340	0.469
Stimufol at 2 g/L (S_1)		2.83	3.64	0.503	0.633
Stimufol at 4 g/L (S_2)		3.34	4.86	0.613	0.823
Stimufol at 6 g/L (S_3)		3.03	3.80	0.540	0.706
Tryptophan at 100 ppm (T_1)		2.90	4.93	0.520	0.833
Tryptophan at 200 ppm (T_2)		2.35	3.73	0.413	0.763
$S_1 + T_1$		3.90	5.03	0.700	0.880
$S_1 + T_2$		2.92	4.43	0.520	0.756
$S_2 + T_1$		2.30	3.56	0.410	0.596
$S_2 + T_2$		2.71	4.03	0.480	0.790
$S_3 + T_1$		2.80	3.46	0.510	0.586
$S_3 + T_2$		3.10	4.60	0.550	0.812
LSD	at 5%	0.367	0.98	0.041	0.127
	at 1%	0.499	1.28	0.056	0.208

These results may be due to the combined effects of both tryptophan as a precursor of indole acetic acid which induces cell division and enlargement, in addition to the effect of stimufol as a complete fertilizer supplying the plant with the required nutrients necessary for healthy growth.

Shortly, the heaviest fresh weight of leaf petiole was obtained by using the treatment of stimufol at 2 g/L + tryptophan at 100 ppm ($S_1 + T_1$) in both seasons.

8- Dry weight of leaf petiole (g):

The data obtained on dry weight of leaf petiole as affected by using some treatments of stimufol and tryptophan are presented in Table (46).

The results of the dry weight of leaf petiole attained a parallel trend with the fresh weight of leaf petiole results, with some little differences in the level of significances. In general, the heaviest dry weight of leaf petiole was obtained by using the treatment of stimufol at 2 g + tryptophan at 100 ppm ($S_1 + T_1$) in both seasons. These results may explain the importance of stimufol as a complete fertilizer in the synthesis processes of reversed food which leads, of course, to increase their dry matter.

The aforementioned results of stimufol are contaminant with those obtained by **Criley (1984), Kawabata *et al.* (1984), Abou El-Ghait (1993)** on *S. reginae*, **Hassan and Abou-Taleb (1995)** on *Alocacia reginae*, **Abdel-Wahid (1995), El-Askry (1998)** on *S. reginae*, **Abd El- Hafez (2000)** on *Yucca filamentosa* and **Youssef (2000)** who mentioned that fertilized *S.*

reginae with Ca at 100 and 200 ppm or Mg at 50 and 100 ppm increased the length, thickness of leaf petiole and their fresh and dry weights. The aforementioned results of tryptophan are in conformity with those obtained by **Mohamed *et al.* (1992)** on *Alpinia nutans*, **Youssef (2000)** on *S. reginae,* and **Hendawy (2000)** on *Echinaceae purpurea* found that spraying tryptophan at 100 ppm and 150 ppm increased the fresh and dry weights of leaves.

9- Length of leaf blade (cm):

The results obtained for the length of leaf blade were averaged and exhibited in Table (47). They could be summarized as follow:

S. reginae seedlings treated with stimufol at 2 g/L + tryptophan at 100 ppm ($S_1 + T_1$) showed the longest leaf blade as it registered 20.80 and 26.90 cm compared with 16.53 and 19.67 cm for control in the first and second seasons, respectively. Similarly, using the medium application of stimufol (4 g / L) significantly increased the length of leaf blade as it registered 20.73 and 25.00 cm followed descendingly by using the treatment of stimufol at 6 g/L in the first season and stimufol at 4 g/L + tryptophan at 100 ppm (combined treatment) in the second season, respectively. On the other hand, the remaining treatments of stimufol and tryptophan resulted in negligible increment in the length of leaf blade as they gave values near to those of the control which did not reach the level of significance in both seasons. As for the effect of stimufol, this may be due to the stimulatory effect of the macro and micro nutrients elements on the cell division of the meristematic tissues of leaves and

Table (47): The effect of some chemical substances on length and width of leaf blade of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		Length of leaf blade (cm)		Width of leaf blade (cm)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		16.53	19.67	8.00	7.83
Stimufol at 2 g/L (S_1)		17.47	20.83	8.0	7.60
Stimufol at 4 g/L (S_2)		20.73	25.00	10.30	8.60
Stimufol at 6 g/L (S_3)		19.00	21.40	9.06	7.76
Tryptophan at 100 ppm (T_1)		18.43	22.67	8.16	7.60
Tryptophan at 200 ppm (T_2)		18.87	22.87	8.40	8.23
$S_1 + T_1$		20.80	26.90	9.10	9.06
$S_1 + T_2$		18.63	25.13	9.23	9.03
$S_2 + T_1$		18.70	24.00	9.80	9.76
$S_2 + T_2$		17.37	22.83	7.73	7.50
$S_3 + T_1$		17.90	21.50	8.30	8.16
$S_3 + T_2$		17.37	23.23	7.96	8.26
LSD	at 5%	3.57	5.52	1.35	1.28
	at 1%	N.S	N.S	1.84	N.S

encouraging metabolism in these cells. Shortly, the tallest leaf blade of *Strelitzia reginae* seedlings was obtained by using the treatment of stimufol at 2 g/L + tryptophan at 100 ppm ($S_1 + T_1$) in both seasons.

10- Width of leaf blade (cm):

Data in Table (47) showed that all treatments of stimufol and tryptophan induced slight effects in this parameter in the first season with non significant differences compared to control plants, with the exception of the treatment of stimufol at 4 g/L which resulted in a highly significant increase in this parameter as it registered 10.30 cm compared with 8.00 cm for control. Moreover, the treatment of stimufol at 4 g/L + tryptophan at 100 ppm ($S_2 + T_1$) significantly increased the width of leaf blade as it recorded 9.80 cm. On the contrary, the picture was completely changed in the second season (2002), hence all treatments of stimufol and tryptophan resulted in negligible effects in this parameter as they gave values near to those of the control which did not reach the level of significance, only the treatment of stimufol at 4 g/L + tryptophan at 100 ppm ($S_2 + T_1$) resulted in a significant increase in this parameter as it gave 9.76 cm. On the reverse, the lowest mean values of this parameter was obtained by using the treatment of stimufol at 4 g/L + tryptophan at 200 ppm ($S_2 + T_2$) as it gave 7.73 and 7.50 cm, but the differences between this treatment ($S_2 + T_2$) and control were non significant in both seasons. In summary, the widest leaf blade of *S. reginae* seedlings was obtained by using the treatment of stimufol at 4 g/L in the first season and the treatment of ($S_2 + T_1$) in the second one.

11- Fresh weight of leaf blade (g):

The data obtained on fresh weight of leaf blade (g) as affected by stimufol and tryptophan treatments are shown in Table (48). These results may be discussed as follows:

All applications of stimufol showed little effects upon the fresh weight of leaf blade as they caused non significant increments in this parameter when compared with the control in both seasons, with the exception of stimufol at medium application (4 g/L) which gave a high significant increase in this parameter as it gave 7.53 and 8.10 (g) compared with 5.13 and 5.71 (g) for control in the first and second seasons, respectively. In addition, the two levels of tryptophan significantly increased the fresh weight of leaf blade as they registered 7.53 and 8.10 (g) for tryptophan at 100 ppm, 6.23 and 7.86 (g) for tryptophan at 200 ppm in the first and second seasons, respectively. The differences among the two levels of tryptophan were non significant as the plants under such treatments had nearly close fresh weight values in both seasons. As for the effect of combined treatments between stimufol and tryptophan data in Table (48) showed that the treatmet of stimufol at 2 g/L + tryptophan at 100 ppm ($S_1 + T_1$) showed the superiority in this concern as it gave 8.13 and 8.40 (g) in the first and second seasons, respectively. Similarly, the treatment of stimufol at 4 g/L + tryptophan at 100 ppm ($S_2 + T_1$) resulted in a highly significant increase in this parameter as it gave 7.93 and 8.33 (g) in the first and second seasons, respectively. This may be due to the combined effects of both tryptophan as a precursor of indole acetic acid which induces cell division and enlargement, in

Table (48): The effect of some chemical substances on fresh and dry weights of leaf blade of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		Fresh weight of leaf blade(g)		Dry weight of leaf blade(g)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		5.13	5.70	1.16	1.33
Stimufol at 2 g/L (S_1)		5.33	5.60	1.15	1.33
Stimufol at 4 g/L (S_2)		7.53	8.10	1.61	1.90
Stimufol at 6 g/L (S_3)		6.23	6.10	1.35	1.46
Tryptophan at 100 ppm (T_1)		6.93	7.10	1.50	1.63
Tryptophan at 200 ppm (T_2)		7.16	7.86	1.52	1.80
$S_1 + T_1$		8.13	8.40	1.72	1.93
$S_1 + T_2$		7.66	8.10	1.63	1.86
$S_2 + T_1$		7.93	8.33	1.71	1.90
$S_2 + T_2$		5.23	5.63	1.14	1.20
$S_3 + T_1$		5.76	6.00	1.29	1.43
$S_3 + T_2$		6.50	6.70	1.44	1.53
LSD	at 5%	1.36	1.87	0.371	0.579
	at 1%	1.85	2.54	0.504	0.787

addition to the effect of stimufol as a complete fertilizer supplying the plant with the required nutrients necessary for healthy growth.

Finally, the heaviest fresh weight of leaf blade was obtained by treated *S. reginae* seedlings with the treatment of stimufol at 2 g/L + tryptophan at 100 ppm (S_1 + T_1) in both seasons.

12- Dry weight of leaf blade (g):

The data gained on dry weight of leaf blade as affected by stimufol and tryptophan treatments are presented in Table (48). Data on dry weight of leaf blade showed the similar trend as that of fresh weight of leaf blade in both seasons, with some little differences in the level of significance. Hence, the heaviest dry weight of leaf blade was obtained by using the treatment of stimufol at 2 g / L + tryptophan at 100 ppm (S_1 + T_1) followed descendingly by the treatment of stimufol at 4 g/L + tryptophan at 100 ppm (S_2 + T_1) in both seasons. These results may explain the importance of stimufol as a complete fertilizer in the synthesis processes of reversed food which leads, of course, to increase their dry matter.

The aforementioned results of stimufol are in parallel with those obtained by **Criley (1984), Kawabata *et al.* (1984)** on *S. reginae* seedlings, **Maximoos (1985)** on *Lathyrus odoratus*, **Abdel-Wahid (1995)** on *S. reginae*, **Abou-Dahab (1996)** on Schefflera, **El-Ashry (1998)** on *S. reginae*, **Abd El-Hafez (2000)** on *Yucca filamentosa* and **Youssef (2000)** on *S. reginae*, who found that using Ca at 100 and 200 ppm ot Mg at 50 and 100 ppm applied as a soil drench increased the length and

width of leaf blade and their fresh and dry weights. The aforementioned results of tryptophan are in agreement with those obtained by **Mohamed *et al.* (1992)** on *Alpinia nutans*, **Hassan (1997)** on *Narcissus tazetta,* **Youssef (2000)** on *S. reginae* and **Ahmed (2000)** on *Antholyza aethipica*, revealed that the application of tryptophan at 50 and 75 ppm increased the fresh and dry weight of leaves.

IV.1.B.2-Flower growth measurements:

1-Flowering date (months):

Data of the time to first flower showing color as an indicator of flower development by months determined from the beginning of experiment, March 1st in 2001, are shown in Table (49).

Data showed that all stimufol, tryptophan and their combinations succeeded in advancing the flowering date of *S. reginae* seedlings raised from seeds when compared with control which did not flower till the end of this experiment (December, 2003). However, the earliest flowering date was obtained by using the combined treatment between stimufol at 4g/L + tryptophan at 100 ppm ($S_2 + T_1$) which recorded the least time required for start flowering (18.00 months) followed by using the treatment of stimufol at 2g/L + tryptophan at 100 ppm ($S_1 + T_1$) which registered 20.17 months. On the other hand, the treatment of stimufol at 6g and the treatment of tryptophan at 100 ppm showed to be the least effective treatments for inducing early flowering as compared to other treatments. The differences between the abovementioned two treatments were non

Table (49): The effect of some chemical substances on some flower measurements at the beginning of flowering stage of *Strelitzia reginae* seedlings Ait. raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters / Treatments		Flowering date (months)	Flower stalk length (cm)	Flower stalk thickness cm)
Control		No flowering	No flowering	No flowering
Stimufol at 2 g/L (S_1)		22.13	34.73	0.853
Stimufol at 4 g/L (S_2)		23.10	65.47	0.930
Stimufol at 6 g/L (S_3)		34.13	58.13	0.913
Tryptophan at 100 ppm(T_1)		34.10	61.63	1.153
Tryptophan at 200 ppm (T_2)		21.13	49.40	0.950
$S_1 + T_1$		20.17	40.40	0.880
$S_1 + T_2$		30.17	51.07	0.890
$S_2 + T_1$		18.10	39.40	1.103
$S_2 + T_2$		30.03	46.77	0.926
$S_3 + T_1$		28.03	42.40	0.913
$S_3 + T_2$		22.17	63.10	0.850
LSD	at 5%	1.36	6.42	0.093
	at 1%	1.86	8.76	0.127

significant. The remaining treatments occupied intermediate place in this concern. This may be due to the role of these two chemicals; tryptophan and stimufol, on increasing the promoters in the plant tissues at the expense of the inhibitors to induce flowering.

The aforementioned results of stimufol are in conformity with those obtained by **Misiha and Kamel (1987)** on *S. reginae*, **Auda (1992)** on *Hippeastrum vittatum*, **Abdel-Wahid (1995)** on *S. reginae*, and **El-Ashry (1998)** mentioned that in pot experiments, fertilized *S. reginae* seedlings with kristalon at 12 g/pot, advanced flowering by about three months compared to control.

2-Flower stalk length (cm):

Data presented in Table (49) showed that the length of flower stalk as affected by various treatments of stimufol, tryptophan and their combinations ranged from 34.73 to 65.47 cm. The shortest flower stalk (34.73 cm) resulted from treated *S. reginae* seedlings with stimufol at 2g/L when compared with the other treatments. Similar trend was obtained by using the treatment of stimufol at 4g + tryptophan at 100 ppm ($S_2 + T_1$) and the treatment of stimufol at 2g + tryptophan at 100 ppm ($S_1 + T_1$) as they recorded 39.40 and 40.40 cm, respectively. While, the tallest flower stalk (cm) was obtained by using the treatment of stimufol at 4 g followed descendingly by using the treatment of stimufol at 6g + tryptophan at 200 ppm ($S_3 + T_2$), tryptophan at 100 ppm and stimufol at 6g as they gave 63.10, 61.63 and 58.13 cm, respectively. The other treatments took intermediate position in this connection. This may be due to the combined

effects of both tryptophan as a precursor of indole acetic acid which induces cell division and enlargement, in addition to the effect of stimufol as a complete fertilizer supplying the plant with the required nutrients necessary for healthy growth.

3-Thickness of flower stalk (cm):

The data obtained on the thickness of top flower stalk (cm) at the beginning of flowering stage as affected by some treatments of stimufol, tryptophan and their combinations, are presented in Table (49). The data showed that the maximum thickness of top flower stalk was obtained by using the treatment of tryptophan at 100 ppm as it registered 1.153 cm as compared to other treatments. Similar trend was obtained by using the treatment of stimufol at 4g + tryptophan at 100 ppm ($S_2 + T_1$) as it gave 1.103 cm. The differences between the prementioned two treatments were so small to be significant. On the other hand, the least mean values of the thickness of flower stalk was gained by treated *S. reginae* seedlings with the treatment of stimufol at 6g + tryptophan at 200 ppm ($S_3 + T_2$) which registered 0.850 cm. Similar trend was observed by using the application of stimufol at 2 g/L, $S_1 + T_1$ and $S_1 + T_2$ as they gave 0.853, 0.880 and 0.890 cm, respectively. The differences between the three abovementioned three treatments were so small to reach the level of significance. These results may explain the synergetic effect of both tryptophan and stimufol on enhancing plant growth which reflects on flower characteristics.

4-Length of flower spathe (cm):

The results obtained on the length of flower spathe (cm) at the beginning of flowering stage as affected by some

treatments of stimufol, tryptophan and their combinations (Table, 50) cleared that the longest flower spathe (cm) was obtained by treated *S. reginae* seedlings with stimufol at 2g as it gave 16.07 cm followed descendingly by using the treatment of tryptophan at 100 ppm which gave 15.53 cm. On the other side, the shortest flower spathe (cm) was gained by using the treatment of stimufol at 2g + tryptophan at 100 ppm ($S_1 + T_1$) which registered 14.07 cm, similar trend was obtained by using the treatments of stimufol at 6 g/L and the treatment of stimufol at 2g + tryptophan at 200 ppm ($S_1 + T_2$) as they gave 14.37 and 14.43 cm, respectively. The differences between the prementioned two treatments were non significant. This result may be interrupted by the importance of tryptophan for promoting cell division and the role of stimufol as a complete fertilizer for stimulating growth.

5-Width of flower spathe (cm):

According to data presented in Table (50), it is clear that treated *S. reginae* seedlings with tryptophan at 100 ppm approved to be most effective treatment for producing the highest mean value of flower spathe width as it gave 1.95 cm, followed descendingly by using the treatment of $S_2 + T_1$ which recorded 1.92 cm. The differences between the prementioned two treatments were so small to be significant. On the contrary, the least mean value of width of flower spathe was recorded by using the treatment of stimufol at 6 g/L which gave 1.79 g /cm. The other treatments took intermediate place compared with the prementioned treatments. The results of length and width of flower spath may be interrupted by the importance of tryptophan

Table (50): The effect of some chemical substances on some flower measurements at the beginning of flowering stage of *Strelitzia reginae* seedlings Ait. raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters / Treatments		Flower spathe length (cm)	Flower spathe width (cm)	No. of opening floret	Duration of flower on plant (days)
Control		No flowering	No flowering	No flowering	No flowering
Stimufol at 2 g/L (S_1)		16.07	1.84	4.13	35.60
Stimufol at 4 g/L (S_2)		15.23	1.89	4.46	38.83
Stimufol at 6 g/L (S_3)		14.37	1.79	4.23	36.17
Tryptophan at 100 ppm(T_1)		15.53	1.95	4.80	41.13
Tryptophan at 200 ppm (T_2)		14.97	1.85	4.60	39.93
$S_1 + T_1$		14.07	1.87	3.96	35.40
$S_1 + T_2$		14.43	1.83	4.26	36.20
$S_2 + T_1$		14.77	1.92	4.83	41.17
$S_2 + T_2$		14.80	1.82	4.30	37.17
$S_3 + T_1$		14.63	1.86	4.13	36.67
$S_3 + T_2$		15.13	1.81	3.96	33.73
LSD	at 5%	0.570	0.053	0.290	N.S
	at 1%	0.777	0.073	0.395	N.S

for promoting cell division and the role of stimufol as a complete fertilizer for stimulating growth.

6-Number of opening florets / flower:

The data obtained on the number of opening florets / flower as affected by some treatments of stimufol, tryptophan and their combinations, are presented in Table (50).

The results revealed that treated *S. reginae* seedlings with the treatment of S_2 + T_1 showed to be the most effective treatment for producing the greatest number of opening florets / flower as it gave 4.83 florets / flower followed by the treatment of tryptophan at 100 ppm which recorded 4.80 florets / flower. The differences between the prementioned two treatments did not reach the level of significance. On the other side, the least number of opening florets / flower was gained by using the treatments of S_1 + T_1 and S_3 + T_2 as they exhibited not only the same trend but also, registered the same exact values (3.96 florets / flower).

The remaining treatments occupied intermediate position as compared to the abovementioned treatments. This may be due to the effect of stimufol as a complete balanced fertilizer containing macro and micro nutrient elements, may promote the synthesis process in the new formed flowering buds and help them to hasten flowering.

7-Duration of flower on plant (days):

Data presented in Table (50) pointed out that the duration of flower on plant (days) of *S. reginae* seedlings in response to some treatments of stimufol, tryptophan and their combinations

gave a trend very close to that recorded for the number of opening floret / flower, i.e., the treatment of $S_2 + T_1$ showed its superiority over all treatments, followed descendingly by using the treatment of tryptophan at 100 ppm. On the contrary, the least mean values of duration of flower on plant (days) was obtained by using the treatment of $S_3 + T_2$. This may be due to the synergetic effect of both tryptophan, as a promotive agent and stimufol as a complete fertilizer supplying plants with their required nutrients for more carbohydrates and proteins production which are necessary for flower charms and fascination.

The aforementioned results of stimufol are in parallel with those obtained by **Shoushan *et al.* (1978)** on Amaryllis plants, **Misiha and Kamel (1987)** on *S. reginae*, **Abou El-Ghait (1993)** on *S. reginae* found that fertilizing the plants with urea or Ammonium nitrate as a nitrogen source, significantly increased the length and thickness of flower spathe, **Abdel-Wahid (1995), El-Shoura and Hosni (1996), El-Ashry (1998), Zaky (1998), Ali (1998)** and **Siraj and Ali (1998)** on *S. reginae*. The aforementioned results of tryptophan are in agreement with those obtained by **Hassan (1997)** on *Narcissus tazetta*, **Hendawy (2000)** on *Echinaceae purpurea*, **Ahmed (2000)** on *Antholyza aethiopica* and **Gomaa (2002)** who mentioned that spraying *Crinum asiaticum* plants with tyrosine and phenylalanin at rates of 50, 100 and 150 ppm succeeded in decreasing the number of days to start flowering, however, it increased the length and diameter of spike, as well as the number of floret per spike and duration of flower on plant.

IV.1.B.3- Root growth measurements:

1- Number of roots per plant:

Data obtained for the number of roots as affected by stimufol and tryptophan treatments of this work are presented in Table (51).

Data indicated that control plants registered the least number of roots per plant at all as they gave 5.00 and 7.00 roots/plant in the first and second seasons, respectively. Anyhow, all stimufol applications slightly increased the number of roots per plant with non significant differences in all cases in the two seasons. On the reverse the two levels of tryptophan (100 and 200 ppm) significantly increased the number of roots / plant. So, its averages were 7.46 and 7.32 in the first season, 11.67 and 10.78 roots/plant in the second one, respectively. Besides, the treatment of stimufol at 2 g/L + tryptophan at 100 ppm ($S_1 + T_1$) in the first season and the treatment of stimufol at 6 g/L + tryptophan at 100 ppm ($S_3 + T_1$) in the second season showed a significant increment in this parameter as they gave 7.42 and 11.00 roots/plant, respectively. The remaining treatments of stimufol and tryptophan resulted in negligible increments in this parameter as they gave values near to those of the control which did not reach the level of significance in both seasons.

Generally, the highest number of roots per plant was obtained by treated *S. reginae* seedlings with tryptophan at 100 ppm in both seasons.

Table (51): The effect of some chemical substances on some root measurements of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		No. of roots /plant		Mean length of roots/plant (cm)		Mean thickness of roots/plant(cm)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season	1st season	2nd season
Control		5.00	7.00	25.00	40.33	1.33	1.60
Stimufol at 2 g/L (S_1)		6.46	8.33	28.94	51.00	1.45	1.76
Stimufol at 4 g/L (S_2)		6.16	9.00	34.38	59.38	1.50	1.86
Stimufol at 6 g/L (S_3)		5.83	7.83	30.67	41.72	1.46	1.73
Tryptophan at 100 ppm (T_1)		7.46	11.67	37.57	61.33	1.40	1.76
Tryptophan at 200 ppm (T_2)		7.32	10.78	39.67	68.67	1.40	1.80
$S_1 + T_1$		7.42	9.33	38.37	61.00	1.53	1.70
$S_1 + T_2$		6.00	8.00	29.33	45.67	1.50	1.86
$S_2 + T_1$		6.43	9.24	32.23	50.31	1.36	1.83
$S_2 + T_2$		6.53	10.33	30.83	55.49	1.41	1.90
$S_3 + T_1$		7.00	11.00	33.64	59.53	1.40	1.80
$S_3 + T_2$		6.53	10.00	36.00	56.00	1.38	1.81
LSD	at 5%	2.04	3.42	5.77	9.24	0.177	0.160
	at 1%	2.77	4.46	7.85	12.57	0.241	0.218

2- Mean length of roots / plant (cm):

Data in Table (51) revealed that all applications of stimufol significantly increased the length of roots / plant in most cases. However, in the first season, only the medium application of stimufol (4 g/L) resulted in significant increment as it gave 34.38 cm, whereas the low and high applications of stimufol (2 and 6 g/L) gave 28.94 and 30.67 cm which were non significant when compared with the value gained by control (25.00 cm) in the first season. While, in the second season data obtained showed that both applications of stimufol at 2 and 4 g/L significantly increased this parameter as they gave 51.00 and 59.38 cm, respectively. Moreover, the two levels of tryptophan (100 and 200 ppm) resulted in highly significant increases in this parameter as they gave 37.57 and 61.33 cm for tryptophan at 100 ppm , 39.67 and 68.67 cm for tryptophan at 200 ppm in the first and second seasons, respectively.

Similarly, the treatments of stimufol at 2 g/L + tryptophan at 100 ppm ($S_1 + T_1$), stimufol at 6 g/L + tryptophan at 100 ppm ($S_3 + T_1$) and stimufol at 6 g/L + tryptophan at 200 ppm ($S_3 + T_2$) resulted in highly significant increases in this parameter as they gave 38.37 and 61.00, 33.64 and 59.53 and 36.00 and 56.00 cm in the first and second seasons, respectively. Conclusively, the longest mean root / plant was obtained by using the treatment of tryptophan at 200 ppm in both seasons.

3- Mean thickness of root per plant (cm):

The results obtained for the thickness of root were averaged and exhibited in Table (51). These results could be summarized as follows:

The mean thickness of the control root was 1.33 and 1.60 cm in the first and second seasons, respectively. However, all applications of stimufol (2, 4 and 6 (g)/L) showed little effects upon the mean thickness of root/plant as they caused non significant increases in this parameter when compared with the control in both seasons, with the exception of stimufol at the medium level (4 (g)/L) in the second season which gave a significant increase in this parameter as it registered 1.86 cm. Similarly, both levels of tryptophan increased the mean thickness of root / plant with non significant differences in both seasons, with the exception of tryptophan at 200 ppm in the second season which gave a significant increase (1.80 cm) when compared with control in the second season.

Generally, the highest mean values of the mean thickness of root / plant was obtained by using the treatment of stimufol at 2 (g)/L + tryptophan at 100 ppm ($S_1 + T_1$) in the first season and the treatment of stimufol at 4 (g) / L + tryptophan at 200 ppm ($S_2 + T_2$) (combined treatment) in the second season.

4- Fresh weight of roots per plant (g):

The data obtained on fresh weight of roots (g) as affected by stimufol and tryptophan treatments are shown in Table (52). These results may be discussed as follow: All applications of stimufol showed great effects upon the fresh weight of roots / plant as they caused high significant increases in this parameter when compared with control in both season, with the exception of stimufol treatment at 6 g/L in the second season which gave a non significant increase in this parameter as it gave 452.7 gcompared with 419.1 g for control in the second season.

Table (52): The effect of some chemical substances on fresh and dry weights of roots of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		Fresh weight of roots/plant (g)		Dry weight of roots/plant (g)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		251.3	419.1	12.53	25.47
Stimufol at 2 g/L (S_1)		301.0	593.0	15.07	30.40
Stimufol at 4 g/L (S_2)		321.9	603.3	15.78	36.20
Stimufol at 6 g/L (S_3)		281.0	452.7	13.73	27.43
Tryptophan at 100 ppm (T_1)		382.4	648.2	18.80	39.33
Tryptophan at 200 ppm (T_2)		372.0	664.0	18.60	39.97
$S_1 + T_1$		361.3	581.3	18.13	34.90
$S_1 + T_2$		292.0	482.0	14.53	28.93
$S_2 + T_1$		321.2	541.4	16.13	34.73
$S_2 + T_2$		331.6	631.3	16.53	37.90
$S_3 + T_1$		351.7	641.1	17.60	38.50
$S_3 + T_2$		342.7	611.0	17.17	36.87
LSD	at 5%	27.13	73.47	1.36	2.24
	at 1%	36.88	99.85	1.86	3.04

However, using the medium rate of stimufol (4 g/L) showed the superiority in this respect as it registered 321.9 and 603.3 g compared with 251.3 and 419.1 g for control in the first and second seasons, respectively. Moreover, similar trend was observed for the effect of tryptophan treatments on the fresh weight roots / plant, where the both levels (100 and 200 ppm) gave high records with highly significant differences as they gave 382.4 and 372.0 g in the first season, 648.2 and 664.0 g in the second one. The differences among both treatments of tryptophan were non significant as the plants under such treatments had nearly close root fresh weight values in both seasons.

Additionally, all combined treatments between stimufol and tryptophan gave a high significant increase in this parameter, with the exception of treatment of stimufol at 2 g/L + tryptophan at 200 ppm ($S_1 + T_2$) in the second season which caused a non significant increment in this parameter as it recorded 482.0 g. Lastly, the heaviest fresh weight of root/plant was obtained by using the treatment of tryptophan at 100 ppm in the first season and tryptophan at 200 ppm in the second season.

5- Dry weight of roots/plant (g):

The data obtained on dry weight of roots as affected by various treatments of stimufol and tryptophan are presented in Table (52).

The results of the dry weight of roots/plant attained a parallel trend with the root fresh weight results, with little differences in the level of significance. In general, the heaviest dry weight of roots was obtained by using the treatment of

tryptophan at 100 ppm in the first season and tryptophan at 200 ppm in the second season. Besides, the treatment of stimufol at 6 g/L + tryptophan at 100 ppm ($S_3 + T_1$) showed a high significant increment in this parameter as it gave 17.60 and 38.50 g in the first and second seasons, respectively. The aforementioned results of roots may be due to the combined effects of both tryptophan as a precursor of indole acetic acid which induces cell division and enlargement, in addition to the effect of stimufol as a complete fertilizer supplying the plant with the required nutrients necessary for healthy growth.

The aforementioned results of stimufol are coincided with those obtained by **Maximoos (1985)** on *Lathyrus odoratus*, **Auda (1992)** on *Hippeastrum vittatum*, **Abdel-Wahid (1995)** on *S. reginae*, **Korkar (1996)** on Croton plants, **El-Ashry (1998)**, **Youssef (2000)** on *S. reginae* and **Abd El- Hafez (2000)** revealed that using stimufol fertilizer at 0.5, 1.0 and 1.5 g/L applied as a soil drench or a foliar spray, increased the number, length, fresh and dry weight of roots / plant. The aforementioned results of tryptophan contaminant with those obtained by **Ahmed (2000)** on *Antholyza aethiopica*, **Hendawy (2000)** on *Echinaceae purpurea* and **Youssef (2000)** on *Strelitzia reginae* who showed that using tryptophan at 50 and 100 ppm increased the length, number and fresh and dry weights of roots / plant.

IV.1.B.4-Chemical composition measurements:

1- Leaf nitrogen content (%):

According to data shown in Table (53), it was obvious that all treatments of stimufol and tryptophan increased leaf

Table (53): The effect of some chemical substances on N, P, K and total carbohydrates content in leaves of seedlings of *Strelitzia reginae* Ait. raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		N (%)		P (%)		K (%)		Total carbohydrates (%)	
Seasons / Treatments		1st S.	2nd S.	1st S.	2nd S.	1st S.	2nd S.	1st S.	2nd S.
Control		1.36	1.56	0.210	0.223	1.13	1.23	12.43	14.53
Stimufol at 2 g/L (S_1)		1.83	1.96	0.250	0.273	1.40	1.76	16.47	18.70
Stimufol at 4 g/L (S_2)		2.03	2.13	0.270	0.280	1.26	1.63	16.17	17.47
Stimufol at 6 g/L (S_3)		1.90	1.83	0.233	0.253	1.53	1.36	17.13	16.13
Tryptophan at 100 ppm (T_1)		1.63	1.83	0.246	0.263	1.33	1.46	15.47	16.47
Tryptophan at 200 ppm (T_2)		1.83	2.06	0.260	0.253	1.53	1.56	17.50	19.93
$S_1 + T_1$		1.66	1.96	0.256	0.266	1.56	1.76	19.27	21.43
$S_1 + T_2$		1.63	1.83	0.253	0.266	1.63	1.66	15.63	15.90
$S_2 + T_1$		1.86	2.06	0.263	0.290	1.56	1.86	18.87	22.60
$S_2 + T_2$		1.73	1.86	0.263	0.276	1.56	1.73	16.50	19.23
$S_3 + T_1$		1.93	1.96	0.243	0.263	1.43	1.80	17.13	18.17
$S_3 + T_2$		1.73	1.96	0.253	0.273	1.63	1.56	17.93	20.70
LSD	at 5%	0.200	0.169	0.047	0.050	0.207	0.298	1.21	3.52
	at 1%	0.272	0.230	N.S	0.069	0.281	0.405	1.64	4.78

nitrogen content (%) in both seasons with significant differences in all cases.

All stimufol treatments showed a great increase in nitrogen content in leaves as compared to control plant. Since, the medium application of stimufol (4 g/L) was the most effective treatment for increasing leaf N % and gave 2.03 and 2.13 % compared with 1.36 and 1.56 % for control in the first and second seasons, respectively. Similarly, the two levels of tryptophan significantly increased this parameter especially the high rate (200 ppm) which recorded 1.83 and 2.06 % in the first and second seasons, respectively. Besides, all combined treatments between stimufol and tryptophan resulted in highly significant increases in this parameter, hence the treatment of stimufol at 6 g/L + tryptophan at 100 ppm (S_3 + T_1) showed a high significant increase in this parameter as it recorded 1.93 and 1.96 %, also the treatment of S_2 + T_1 gave a similar trend in this parameter as it gave 1.86 and 2.06 % in the first and second seasons, respectively.

Briefly, the highest leaf nitrogen content (%) of *S. reginae* seedlings was obtained by using stimufol at 4 g/L in the two seasons.

2- Leaf phosphorus content (%):

Data presented in Table (53) indicated that all tested applications of stimufol increased phosphorus content in leaves of *S. reginae* seedlings especially the medium application (4 g/L) which significantly increased leaf phosphorus content (%) as it gave 0.270 and 0.280 % compared with 0.210 and 0.223 % for

control in the first and second seasons, respectively. Additionally, the two levels of tryptophan succeeded in increasing the leaf phosphorus content (%) as they recorded 0.246 and 0.263 % for tryptophan at 100 ppm, 0.260 and 0.253 % for tryptophan at 200 ppm in the first and second seasons, respectively.

As for the combined treatments between stimufol and tryptophan, data obtained showed that the treatment of stimufol at 4 g/L + tryptophan at 100 ppm (S_2 + T_1) significantly increased this parameter as it registered 0.263 and 0.290 %, similar trend was obtained by using the treatment of stimufol at 4 g/L + tryptophan at 200 ppm (S_2 + T_2) which gave 0.263 and 0.276 % in the first and second seasons, respectively.

Lastly, the richest leaf phosphorus content was obtained by using the treatment of stimufol at 4 g/L in the first season and the treatment of stimufol at 4 g/L + tryptophan at 100 ppm (combined treatment) in the second season.

3- Leaf potassium content (%):

It is quite evident that leaf potassium content of *S. reginae* seedlings was positively responded to the all treatments of stimufol and tryptophan under this study in both seasons. It is obvious from data presented in Table (53) that all treatments of stimufol and tryptophan significantly increased leaf potassium content (%) in the first season, with the exception of stimufol at 4 g/L which resulted in a negligible increment in this parameter as it gave value (1.26%) near to those of the control which did not reach the level of significance. In addition, using the

treatment of stimufol at 2 g/L + tryptophan at 200 ppm ($S_1 + T_2$) and stimufol at 6 g/L + tryptophan at 200 ppm ($S_3 + T_2$) induced statistically the richest leaf potassium content (%) and exhibited not only insignificant variance between each other but also, showed typically the same value of this parameter as they recorded 1.63%. On the contrary, the picture was completely changed in the second season, hence the treatment of $S_2 + T_1$ (combined treatment) recorded the greatest leaf potassium content which registered 1.86% compared with 1.23% for control. Similarly, the treatment of $S_3 + T_1$ showed a high significant increase in this parameter as it gave 1.80%.

Conclusively, the greatest leaf potassium content (%) was obtained by using the treatment of $S_3 + T_2$ in the first season and the treatment of $S_2 + T_1$ (combined treatment) in the second season. The aforementioned results of stimufol are in conformity with those obtained by **Auda (1992)** on *Hippeastrum vittatum*, **Hanafy (1994)** on Roselle, **Hassan and Abou-Taleb (1995)** on *Alocacia reginae*, **El-Shoura and Hosni (1996)** on *S. reginae*, **Korkar (1996)** on Croton plants, **Abd El- Hafez (2000)** on *Yucca spp.* showed that stimufol at 0.5, 1.0 and 1.5 g/L applied as a soil drench or a foliar spray significantly increased N, P and K content in the leaves (%). The aforementioned results of tryptophan are in parallel with those obtained by **Gamal El-Din (1997)** on *Cymbopogen citrates*, **Ahmed (2000)** on *Antholyza aethopica* and **Hendawy (2000)** who mentioned that treated *Echinaceae purpurea* plant with tryptophan at 50, 100 and 150 ppm increased leaf N, P and K content.

4- Leaf total carbohydrates content (%):

It could be seen from data presented in Table (53) that total carbohydrates percentage in leaves of *S. reginae* seedlings was increased by using all treatments of stimufol and tryptophan with significant increases in most cases. However, all tested applications of stimufol resulted in highly significant increments in this parameter in the first season. The percentage of increase in total carbohydrates content in leaves due to the applications of stimufol in the first season was 32.50% for stimufol at 2 g/L, 30.08% for stimufol at 4 g/L and 37.81% for stimufol at 6 g/L. While, in the second season only the low rate of stimufol (2 g/L) which caused a significant increase in this parameter as it registered 18.70 % as compared to control which gave 14.53 %, meanwhile the medium and high applications of stimufol induced slight increases in this parameter with non significant differences compared to control plant. In addition, the two levels of tryptophan significantly increased total carbohydrates content in leaves of *S. reginae* seedlings in both seasons, with the exception of the low level of tryptophan (100 ppm) in the second season which gave a non significant increase (16.47 % when compared to control. Moreover, the treatment of stimufol at 2 g/L + tryptophan at 100 ppm (S_1 + T_1) resulted in a highly significant increase in this parameter as it recorded 19.27 and 21.43 % in the first and second seasons, respectively. Similarly, the treatment of S_2 + T_1 caused a great increase in this parameter as it registered 18.87 and 22.60 %, the same trend was obtained by using the treatment of S_3 + T_2 (combined treatment) which gave 17.93 and 20.70 % in the first and second seasons, respectively. These results may explain the role of stimufol as a

complete fertilizer in supplying the plants with their nutrients requirements and hence, increasing the photosynthesis rate which leads finally to more carbohydrates accumulation in plant organs.

Generally, the richest leaf total carbohydrates content was obtained by using the treatment of $S_1 + T_1$ in the first season and the treatment of $S_2 + T_1$ in the second one. The aforementioned results of stimufol are in line with those obtained by **Essa (1984)** on Baccara rose, **Misiha and Kamel (1987)** on *S. reginae*, **Al-Moulla (1989)** on Croton plants, **Auda (1992)** on *Hippeastrum vittatum*, **Hammad (1994)** on *Cupressus sempervirens*, **Shahin (1998)** on Crinum and Hemerocallis plants, and **Zaky (1998)** who indicated that fertilizing *S. reginae* plants with 750 kg N, 300 kg P and 200 kg K/fed./year gave the highest content of carbohydrates in the leaves. The aforementioned results of tryptophan are in agreement with those obtained by **Mohamed *et al.* (1992)** found that leaf total carbohydrates content of *Alpinia nutans* plants was increased by using tryptophan at 50 ppm, **Mohamed and Wahba (1993)** on *Rosmarinus officinalis*, and **Hendawy (2000)** on *Echinaceae purpurea* plant.

5- Leaf chlorophyll a content (mg/100 g FW):

Data obtained on chlorophyll a content in the leaves of *S. reginae* seedlings are presented in Table (54). Data of the first season indicated that all applications of stimufol significantly increased chlorophyll a content in the leaves, with the exception of the low application (2g/L) which resulted in non significant increment in this parameter when compared with control. Anyhow, the medium application (4g/L) showed the superiority

Table (54): The effect of some chemical substances on leaf chlorophyll a, b and carotenoids contents of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		Chlorophyll (a) (mg/100g FW)		Chlorophyll (b) (mg/100g FW)		Carotenoids (mg/100g FW)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season	1st season	2nd season
Control		110.8	115.3	83.33	85.00	29.83	31.00
Stimufol at 2 g/L (S_1)		120.7	125.7	91.52	94.13	33.00	37.61
Stimufol at 4 g/L (S_2)		127.6	131.8	94.67	98.39	35.36	40.33
Stimufol at 6 g/L (S_3)		125.7	120.3	94.62	90.42	33.69	35.67
Tryptophan at 100 ppm (T_1)		121.0	123.9	88.00	92.33	31.23	39.58
Tryptophan at 200 ppm (T_2)		123.7	134.0	92.33	95.00	38.33	42.29
$S_1 + T_1$		131.4	139.7	96.37	99.00	39.00	41.38
$S_1 + T_2$		125.0	128.2	93.92	95.33	35.14	37.23
$S_2 + T_1$		135.7	142.3	98.67	100.7	40.41	43.15
$S_2 + T_2$		129.5	132.0	97.00	96.67	37.33	39.00
$S_3 + T_1$		128.3	134.7	95.00	98.52	38.00	40.33
$S_3 + T_2$		130.7	137.6	95.41	99.00	39.16	40.59
LSD	at 5%	10.31	10.46	3.73	6.20	4.55	5.26
	at 1%	14.01	14.21	5.07	8.43	6.18	7.15

in this concern as it recorded 127.6 mg/100g FW compared with 110.8 mg/100 g FW for control in the first season, while in the second one, only the medium rate which registered a high significant increase in this parameter as it recorded 131.8 mg/100 g FW compared for 115.3 mg/100 g FW for control in the second season. With regard to tryptophan treatments, it was obvious that the low level increased chlorophyll a content in the leaves with non significant differences in both seasons, whereas the high rate obviously increased this parameter, the differences were significant in the first season and highly significant in the second one when compared to control values. As for, the combined treatments between stimufol and tryptophan. It was clearly that the all combined treatments resulted in highly significant increases in this parameter in both seasons, with the exception of the treatment of $S_1 + T_2$ which resulted in non significant increment in this parameter. However, the treatment of $S_2 + T_1$ gave the superiority in this respect as it recorded 135.7 and 142.3 mg/100g FW followed descendingly by using the treatment of $S_1 + T_1$ which recorded 131.4 and 139.7 mg/100 g FW in the first and second seasons, respectively. Similarly, the treatments of $S_2 + T_2$ and $S_3 + T_1$ resulted in highly increments in this parameter in both seasons. This may be due to the role of tryptophan as a promotive agent and stimufol as a source of nutrients necessary for stroma, lamella and grana development.

Abstractly, the greatest leaf chlorophyll a content was obtained by using the treatment of $S_2 + T_1$ (combined treatment) in both seasons.

6- Leaf chlorophyll b content (mg/100 g F.W):

According to data presented in Table (54) on leaf chlorophyll b content (mg/100 g FW) as affected by stimufol and tryptophan treatments, it could be concluded that all treatments of stimufol showed great effects upon the leaf chlorophyll b content in both seasons, with the exception of the high application (6 g/L) in the second season which resulted in a non significant increment in this parameter. However, the medium application of stimufol (4g/L) resulted in highly significant increases in this parameter as it recorded 94.67 and 98.39 mg/100 g FW compared with 83.33 and 85.00 mg/100 g FW in the first and second seasons, respectively. On the other hand, it was clear that the both levels of tryptophan induced great increases in this parameter, especially with the treatment at the level of 200 ppm which recorded 92.33 and 95.00 mg/100g FW in the first and second seasons, respectively. Additionally, the treatments of $S_2 + T_1$ and $S_1 + T_1$ resulted in highly significant increments in this parameter as they registered 98.67 and 100.70 mg/100 g FW, and 96.37 and 99.00 mg/100 g FW in the first and second seasons, respectively. Similarly, the treatments of $S_2 + T_1$, $S_3 + T_1$ and $S_3 + T_2$ (combined treatments) showed great increments in this parameter in both seasons.

Finally, the richest leaf chlorophyll b content was obtained by using the treatment of $S_2 + T_1$ (combined treatment) in both seasons.

7- Leaf carotenoids content (mg/100 g F.W):

According to data presented in Table (54), it was clear that all stimufol applications in the first season slightly increased leaf carotenoids content with non significant differences, with the exception of the medium application (4 g/L) which significantly increased this parameter as it recorded 35.36 mg/100 g FW compared with 29.83 mg/100 g FW for control, while in the second one, the differences were significant, highly significant and non significant due to the applications of 2, 4 and 6 g/L, respectively as they recorded the values of 37.61, 40.33 and 35.67 mg/100 g FW comparing with 31.00 mg/100 g FW for control.

With regard to tryptophan treatments, it was obvious that the level of tryptophan at 100 ppm increased carotenoids content in leaves with non significant differences in the first season, and highly significant in the second one, whereas the high level (200 ppm) induced highly significant increases in this parameter as gave 38.33 and 42.29 mg/100 g FW in the first and second seasons, respectively. As for the effect of combined treatments between stimufol and tryptophan, it was noticed that all combined treatments significantly increased this parameter especially using the treatment of $S_2 + T_1$ which recorded 40.41 and 43.15 mg/100 g FW followed descendingly by using the treatments of $S_3 + T_2$ and $S_1 + T_1$ in both seasons. Shortly, the greatest leaf carotenoids content was obtained by using the treatment of $S_2 + T_1$ in both seasons. The aforementioned results of stimufol coincided with those obtained by **Hanafy (1994)** on Roselle plants, **Hassan and Abou-Taleb (1995)** on *Alocacia*

reginae, **Abou-Dahab (1996)** on Schefflera, **Korkar (1996)** on Croton, **Shahin (1998)** on Crinum and Hemerocallis, and **Youssef (2000)** who recorded that Ca at 100 and 200 ppm or Mg at 50 and 100 ppm applied as a soil drench significantly increased chlorophylls (a, b) and carotenoids content in the leaves of *S. reginae* plants. The aforementioned results of tryptophan contaminant with those obtained by **Gomaa (2003)** who pointed out that treated *Crinum asiaticum* plants with tyrosine and phenylalanin at rates of 50, 100 and 150 ppm increased leaf chlorophylls (a, b) and carotenoids content.

8- Leaf total phenols content (mg/100 g FW):

The average data of the total phenols content of *S. reginae* seedlings leaves as affected by the treatments of this work are shown in Table (55). In general, data revealed that total phenols content in the leaves (mg/100 g F.W) showed a great reduction in this parameter as a result of treating plants with stimufol and tryptophan treatments in both seasons, except for stimufol at 6 g/L in the second season which resulted in non significant decreases in this parameter. However, all tested stimufol applications decreased leaf total phenols content especially the medium application which showed a great reduction in this parameter as it registered 84.67 and 90.67 mg/100 g F.W in the first and second seasons, respectively. On the other hand, the two levels of tryptophan resulted in highly significant decreases in this parameter as they gave 101.0 and 98.00 mg/100 g F.W for the low level of tryptophan (100 ppm) and 84.31 and 85.19 mg/100 g F.W for the high level of tryptophan (200 ppm) in the first and second seasons, respectively. Regarding the effect of

Table (55): The effect of some chemical substances on total phenols and total indoles of *Strelitzia reginae* Ait. seedlings raised from seeds during two successive seasons of 2001-2002 and 2002-2003.

Characters		Total phenols (mg/100g FW)		Total indoles (mg/100g FW)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		115.7	111.0	142.0	145.0
Stimufol at 2 g/L (S_1)		91.37	95.00	164.8	181.0
Stimufol at 4 g/L (S_2)		84.67	90.67	175.6	180.7
Stimufol at 6 g/L (S_3)		104.7	110.3	173.3	175.3
Tryptophan at 100 ppm (T_1)		101.0	98.00	186.0	185.3
Tryptophan at 200 ppm (T_2)		84.31	85.19	185.4	194.3
$S_1 + T_1$		89.62	82.43	185.7	206.1
$S_1 + T_2$		94.57	92.37	190.8	194.7
$S_2 + T_1$		85.00	80.67	182.9	214.0
$S_2 + T_2$		86.67	91.00	171.0	178.3
$S_3 + T_1$		88.00	92.35	186.0	182.7
$S_3 + T_2$		81.00	90.29	193.7	205.2
LSD	**at 5%**	6.13	6.32	9.40	15.25
	at 1%	8.34	8.59	12.79	20.73

combined treatments between stimufol and tryptophan, it was obvious that all combined treatments significantly decreased leaf total phenols content in both seasons. This may be due to the role of these two chemicals; tryptophan and stimufol, on increasing the promoters in the plant tissues at the expense of the inhibitors.

Conclusively, the least value of leaf total phenols content was obtained by using the treatment of $S_3 + T_2$ in the first season and $S_2 + T_1$ in the second one. The aforementioned results of stimufol are in conformity with those obtained by **Auda (1992)** on *Hippeastrum vittatum*, **Hammad (1994)** on *Cupressus sempervirens* and **Shahin (1998)** who reported that all applied treatments of Greenzit fertilizer (1, 3 and 5 ml/L) significantly decreased total phenols content in the leaves of *Crinum longiflorum* and *Hemerocallis aurantiac* plants.

9- Leaf total indoles content (mg/100 g F.W):

The data obtained on leaf total indoles content of *S. reginae* seedlings as affected by stimufol and tryptophan treatments are presented in Table (55).

The results of the total indoles content in leaves of bird of paradise seedlings raised from seeds attained a reverse trend with the leaf total phenols content results, with little differences in the level of significance. In general, the leaf total indoles content of control were 142.0 and 145.0 mg/100 g F.W in the first and second seasons, respectively. Moreover, data showed that all treatments of stimufol and tryptophan increased total indoles in the leaves in the two seasons with high significant differences in all cases. Generally, in the first season, the greatest leaf total

indoles content was obtained by using the treatments of $S_3 + T_2$ and $S_1 + T_2$ (combined treatments) as they registered 193.7 and 190.8 mg/100 g F.W, respectively. While in the second season the highest total indoles content in leaves was obtained by using the treatments of $S_2 + T_1$ and $S_1 + T_1$ (combined treatments). The aforementioned results of stimufol are in agreement with those obtained by **Auda (1992)** on *Hippeastrum vittatum*, **Hammad (1994)** on *Cupressus sempervirens* and **Shahin (1998)** who reported that all applied treatments of Greenzit fertilizer (1, 3 and 5 ml/L) significantly increased total indoles content in the leaves of *Crinum longiflorum* and *Hemerocallis aurantiac* plants.

***Endogenous phytohormones:**

Due to the earliness of first flower appearance in different applied treatments i.e., stimufol, tryptophan and their combinations; the treatment of stimufol at 4 g/L + tryptophan at 100 ppm ($S_2 + T_1$) gave the greatest earliness comparing with all other treatments. Therefore this treatment is chosen for endogenous phytohormones determination.

As shown in Table (56) the treatment of $S_2 + T_1$ gave a greatest increase of endogenous GA_3 that reached 306.001 mg/100 g FW comparing with 39.060 mg/100 g FW for control treatment. That means endogenous GA_3 in leaves of plants treated with $S_2 + T_1$ exceeded more than 7 fold when compared with that control leaves.

Also, for the endogenous auxin level, it was obviously increased in leaves of this treatment to reach nearly hundred

Table (56): Endogenous phytohormones in the leaves of *S. reginae* seedlings as affected by the treatment of Stimufol at 4g/L+ tryptophan at 100 ppm.

Measurement / Treatments	GA_3 mg/100 g FW	IAA mg/100 g FW	ABA mg/100 g FW	
S_2+T_1	306.001	90.238	3.143	
Control	39.060	0.948	2.091	
Measurement / Treatments	Zeatin mg/100 g FW	Kinetin mg/100 g FW	Benzyladenine mg/100 g FW	Total cytokinins
S_2+T_1	0.9673	2.3694	13.2650	16.6018
Control	1.5039	4.5117	41.311	47.3265

times more than in the control one. Since, IAA level was 0.948 mg/100 mg FW in leaves of untreated plants, yet it rose to reach 90.238 mg/100 g FW in treated plants.

As for endogenous ABA it was also slightly increased in treated leaves that reached to 3.143 mg/100 g FW. Meanwhile, it was 2.091 mg/100 g FW in untreated leaves.

With regard to the endogenous total cytokinins as well as it's fractions as indicated in Table (56) clearly it could be noticed that increment of either its total or fractions in case of untreated leaves when compared with treated ones.

In general, the above mentioned data clearly indicated that the applied treatments altered the profile of endogenous phytohormones. Since, increase of each of GA_3, auxin and ABA in leaves of treated plants was existed, yet the only reduction of endogenous cytokinin obtained with the applied treatment.

Considering this data it could be concluded that the alteration of endogenous phytohormones is being in favor of flowering evocation. Also, of interest that highest increase in endogenous GA_3 with the applied treatment because that could be a direct all starting endogenous factors for the starting of flowering process **(Marschner, 1995).**

Moreover, such treatment ($S_2 + T_1$) not only characterized with obvious earliness of flowering but also, improved other many vegetative characteristics and chemical composition of *S. reginae* seedlings. So, for the above mentioned facts the earliness of flowering under the conditions of such treatment ($S_2 + T_1$) could be expected (Fig, 15). The pervious results are

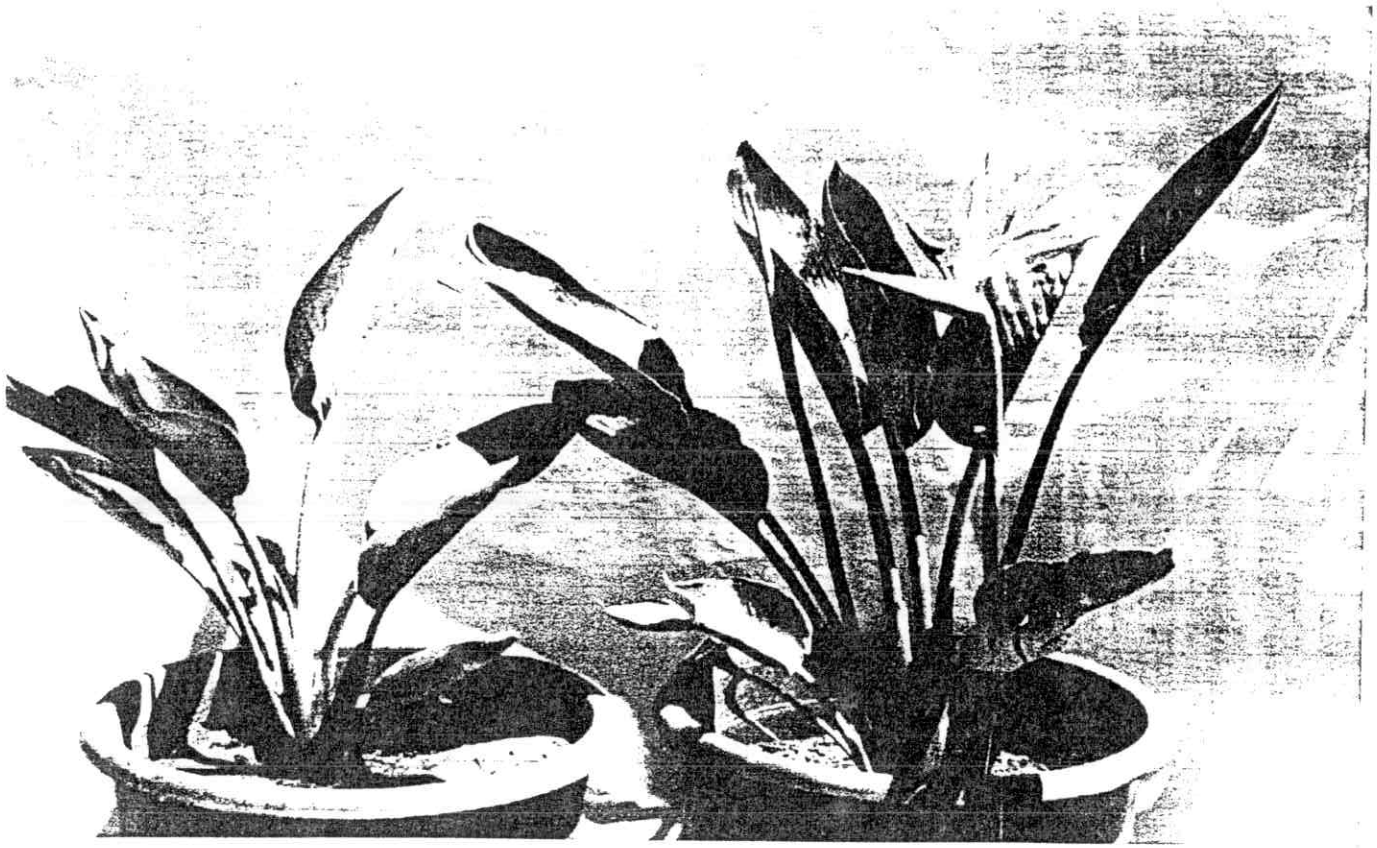


Fig. (15): Control (untreated plant)

Stimoful at 4 g/ L + Tryptophan at 100 ppm

contaminant with those of **Abou El Ghait (1993)** who mentioned that treating *Epipremnum aureum* plants with kristtalon fertilizer at the rates of 0.5 and 2.5 g/L as a soil drench increased leaf GA_3 and auxins contents. Similar trend was obtained by **Abd El- Hafez (2000)** on *Yucca filamentosa*, who stated that treated the plants with stimufol at 0.5, 1.0 and 1.5 g/L increased leaf GA_3 and auxin contents.

IV.2- Second part: Field experiments:

The effect of some growth regulators on vegetative growth, flowering and chemical composition measurements of *Strelitzia reginae* plants.

IV.2.1-Vegetative growth measurements:

1- Number of offsets per plant:

It is quite evident that number of offsets per plant was positively responded to the all growth regulator treatments under this study. Data obtained in Table (57) showed that plants sprayed with kinetin at the medium rate (50 ppm) gave the highest number of offsets per plant as it gave 14.52 as compared to control which gave 9.02 offsets per plant in the first season. Also, kinetin at 100 ppm resulted in a highly significant increase in the number of offsets per plant (13.92) and ranked the second in this concern. Moreover, PP_{333} at 100 ppm caused a highly significant increase in the number of offsets per plant and gave 13.62 followed descendingly by using the medium rate of PP_{333} (50 ppm) and GA_3 at 200 ppm in the first season. While, in the second season the highest number of offsets per plant was obtained by using kinetin at 100 ppm which recorded 12.88 followed descendingly by spraying the plants with kinetin at 50 ppm. Moreover, GA_3 at 200 ppm ranked third in this concern as it gave 12.29. Irrespective control, the lowest number of offsets per plant was recorded by using the low rate of GA_3 (100 ppm) in both seasons.

Table (57): The effect of some growth regulators on No. of offsets and plant height of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters / Seasons / Treatments		No. of offsets/plant		Plant height (cm)	
		1st season	2nd season	1st season	2nd season
Control		9.02	10.06	106.3	111.0
Kinetin	25 ppm	12.13	11.83	115.0	116.7
	50 ppm	14.52	12.75	116.7	130.0
	100 ppm	13.92	12.88	121.0	131.7
GA_3	100 ppm	9.19	10.56	113.3	120.3
	200 ppm	12.13	12.29	128.3	123.3
	300 ppm	11.96	12.25	129.7	133.7
Paclobutrazol	25 ppm	10.90	11.41	96.67	101.7
	50 ppm	12.64	11.66	88.33	91.67
	100 ppm	13.62	12.21	83.33	84.33
Thiourea	1000 ppm	10.05	10.98	117.0	116.7
	2000 ppm	10.69	11.28	117.7	115.0
	3000 ppm	11.92	11.62	108.3	110.0
LSD	at 5%	1.65	0.625	9.29	6.40
	at 1%	2.23	0.844	12.54	8.63

These results might explain the role of kinetin in inducing cell division **(Cheema and Sharma, 1982)** and its ability to overcome the apical dominance of many plants and hence, stimulate the lateral buds to develop into an entire new plant **(Salisbury and Ross, 1974).** These results coincided with those attained by **Criley (1988)** who mentioned that sprayed Strelitzia, Alpinia and Heliconia plants with PBA at 100 ppm increased the number of offsets / plant. Similar results were obtained by **Youssef (2000)** on *S. reginae*. Concerning the effect of GA_3 the data obtained in this work are in agreement with those of **Desouky (1994)** on *S. reginae*, **Reddy *et al.* (1997)** on *Polianthes tuberosa*, and **Salama (2003)** who found that spraying *S. reginae* plants with GA_3 at 300 ppm increased the number of offsets per plant.

2- Plant height (cm):

Data presented in Table (57) showed that the highest values of plant hieght was resulted from using GA_3 at 300 ppm in both seasons which recorded 22.01 and 20.45% more than control in the first and second seasons, respectively. Also, the high rate of kinetin showed a high significant increase in plant height in both season, whereas the lowest values was resulted from spraying the plants with PP_{333} at the high rate (100 ppm) in both seasons. Moreover, all tested applications of PP_{333} significantly decreased plant height; the decrease was in parallel to the applied concentration, since decreases were 21.60, 16.90 and 9.06% less than control with 100, 50 and 25 ppm respectively in the first season and 24.03, 17.41 and 8.38% in the

second one. The remaining treatments of growth regulators gave in-between values in this concern in both seasons.

The results of kinetin are in conformity with those of **Abou-Zeid and El-Shereef (1978)** on Gladiolus, **Kandeel (1989)** on *Ocimum basilicum*, **Reddy *et al.* (1997)** on *Polianthes tuberosa*, **Hendawy (2000)** on *Echinaceae purpurea* and **Youssef (2000)** who revealed that spraying kinetin at 100 and 200 ppm increased plant height of *S. reginae*. The results of GA_3 are in parallel with those attained by **Das *et al.*, (1992)** on *Hemerocallis aurantiaca*, **Singh *et al.* (1994), Desouky (1994)** on *S. reginae*, **Reddy *et al.* (1997)** on tuberose, **Zaky (1998)** on *S. reginae*, **Devendra *et al.* (1999)** on tuberose, **Dantuluri *et al.* (2002)** on *Lilium moculatum* and **Gomaa (2003)** who mentioned that using GA_3 at 50, 100 and 150 ppm increased the plant height of *Dahlia pinnata*.

3- Number of leaves per plant:

The results obtained for the number of leaves per plant were averaged and exhibited in Table (58). They could be summarized as follows:

Most tested applications of growth regulators significantly succeeded in increasing the number of leaves per plant as compared to control in both seasons. Anyway, the greatest number of leaves was statistically produced with using the medium and high rate of kinetin in both seasons. Moreover, all tested applications of PP_{333} succeeded in increasing the number of leaves per plant especially at the high rate (100 ppm) which gave a highly significant increment in this parameter. The

Table (58): The effect of some growth regulators on No. of leaves/plant and Leaf area (cm^2) of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters / Seasons / Treatments		No. of leaves/plant		Leaf area (cm^2)	
		1st season	2nd season	1st season	2nd season
Control		70.67	79.67	235.7	242.3
Kinetin	25 ppm	95.0	93.67	321.3	318.3
	50 ppm	113.7	101.0	372.7	371.7
	100 ppm	109.0	102.0	371.7	381.0
GA_3	100 ppm	72.00	83.67	312.0	321.0
	200 ppm	95.00	97.33	336.0	353.3
	300 ppm	93.67	97.00	353.3	355.0
Paclobutrazol	25 ppm	85.33	90.33	279.0	273.3
	50 ppm	99.00	92.33	256.3	260.0
	100 ppm	106.7	96.67	206.3	203.3
Thiourea	1000 ppm	78.67	87.00	223.3	225.0
	2000 ppm	83.67	89.33	216.7	218.3
	3000 ppm	93.33	92.00	193.0	200.0
LSD	at 5%	12.96	4.95	11.89	11.58
	at 1%	17.49	6.68	16.03	15.62

percentage of increase was reached 50.98 and 21.34 % over control in both seasons. Besides, the other treatments of growth regulators gave in-between values in this concern.

Such increment may be due to the synergistic effect of kinetin, as a growth regulator which induces cell division and differentiation of the leaves. As noticed by **Criley (1988)** on *S. reginae*, **Al-Moulla (1989)** on Croton, **Manoly (1989)** on tuberose, **Auda (1992)** on *Hippeastrum vittatum*, **Reddy *et al.* (1997)** on *Polianthes tuberosa*, **Shahin (1998)** on Crinum and Hemerocallis and **Youssef (2000)** who mentioned that spraying *S. reginae* plants with kinetin at 100 and 200 ppm produced the greatest number of leaves / plant. The results of GA_3 go on line with those attained by **Bhattacharjee (1984)** on *Dahlia variabilis*, **Choudhary (1987)** on *Polianthes tuberosa*, **Pal and Das (1990)** in *Lilium longiflorum*, **Desouky (1994)** on *S. reginae*, **Reddy *et al.* (1997)** on *Polianthes tuberosa*, **Zaky (1998)** on *S. reginae*, **Tawila (2000), Tiwari and Singh (2002)** on tuberose and **Salama (2003)** who mentioned that treated *S. reginae* plants with GA_3 at 300 ppm increased the number of leaves per plant.

4- Leaf area (cm^2):

Data presented in Table (58) exhibited that all tested concentrations of growth regulators significantly affected leaf area of *Strelitzia reginae* plants in both seasons. Meanwhile, all concentrations of kinetin, GA_3 and PP_{333} significantly increased the leaf area of *S. reginae* plants in both seasons, with the exception of PP_{333} at the high rate (100 ppm) which significantly

decreased leaf area in both seasons. The percentages of decrease due to pp_{333} at 100 ppm were 12.47 and 16.10% less than the control in the first and second seasons, respectively. Anyway, the highest mean value of leaf area was induced by those plants sprayed with kinetin at 50 ppm in the first season and kinetin at 100 ppm in the second season. Moreover, all studied concentrations of GA_3 significantly increased the leaf area of *S. reginae* plants. The increase of leaf area was progressively increased with the increasing of GA_3 concentrations in both seasons. On the reverse, all applied concentrations of thiourea significantly decreased the leaf area of plants in both seasons.

The aforementioned results of kinetin are in harmony with those attained by **Kandeel (1989)** on *Ocimum basilicum*, **Maximoos (1993)** who mentioned that treated *Gerbera jamesonii* plants with kinetin at the rates of 25, 50 and 100 ppm increased leaf area, similar results were obtained by **Youssef (2000)** on *S. reginae*. The results of GA_3 are in parallel with those of **Desouky (1994)** and **Zaky (1998)** on *S. reginae*, **Salama (2003)** who mentioned that spraying *S. reginae* plants with GA_3 at 300 ppm induced the largest mean leaf area per plant.

5- Length of leaf blade (cm):

Data presented in Table (59) indicated that all treatments of growth regulators affected the length of leaf blade in both seasons. Anyhow, the tallest leaf blade of *S. reginae* plant was recorded by using the high rate of GA_3 (300 ppm) which gave 44.00 and 45.57 cm followed descendingly by those treated with

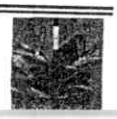


Table (59): The effect of some growth regulators on length and width of leaf blade of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Length of leaf blade (cm)		Width of leaf blade (cm)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		35.33	38.33	9.33	10.00
Kinetin	25 ppm	37.33	38.33	11.57	11.77
	50 ppm	41.00	39.90	12.97	12.53
	100 ppm	42.33	42.90	13.67	13.77
GA_3	100 ppm	34.33	37.23	9.83	10.67
	200 ppm	39.33	41.07	10.83	11.57
	300 ppm	44.00	45.57	11.17	11.63
Paclobutrazol	25 ppm	34.00	36.17	11.33	11.73
	50 ppm	33.00	34.33	11.60	12.57
	100 ppm	30.33	28.40	12.67	12.93
Thiourea	1000 ppm	29.33	29.10	7.83	9.06
	2000 ppm	26.33	28.67	7.66	9.90
	3000 ppm	25.33	25.50	8.83	9.76
LSD	at 5%	4.43	4.28	1.46	1.34
	at 1%	5.98	5.77	1.98	1.82

kinetin at the high rate (100 ppm) as it gave 42.33 and 42.90 cm in the first and second seasons, respectively. While, the low and medium rates of PP_{333} induced only little decrease in this parameter with non significant differences compared to the control plants in the two seasons, whereas the high level of PP_{333} (100 ppm) gave a highly significant decrease in the length of leaf blade as it gave 30.33 and 28.40 cm in the first and second season, respectively. On the contrary, all tested applications of thiourea gave a highly significant decrease in the length of leaf blade. The maximum reduction of leaf blade length was obtained by using the high rate of thiourea. The percentages of reduction were 28.30 and 33.47% less than control plants in the first and second seasons, respectively. The remaining treatments occupied intermediate position in this respect.

These results may be interpreted by the importance of kinetin for promoting cell division **(Cheema and Sharma, 1982).**

6- Width of leaf blade (cm):

According to data presented in Table (59), it could be concluded that all tested applications of kinetin and PP_{333} significantly succeeded in increasing the width of leaf blade. The increases of leaf blade width were in parallel to the applied concentration, so, the high rates of kinetin and PP_{333} gave the highest values as an average in both seasons, as they gave 13.67 and 13.77 for kinetin at 100 ppm, 12.67 and 12.93 cm for pp_{333} at 100 ppm as compared to control which gave 9.33 and 10.00 cm in the first and second seasons, respectively. Also, GA_3 at the

medium and high rates significantly increased the width of leaf blade in both seasons. On the reverse, all concentrations of thiourea succeeded in decreasing the width of leaf blade in both seasons. These results may be interpreted by the importance of kinetin for promoting cell division **(Cheema and Sharma, 1982).**

7- Fresh and dry weights of leaf blade (g):

Data tabulated in Table (60) indicated that all tested applications of growth regulators affected the fresh weight of *S. reginae* leaves in both seasons. Anyhow, the heaviest fresh weight of leaf blade was recorded by using the medium and maximum rates of kinetin in the first and second seasons. Additionally, the high rate of GA_3 (100 ppm) significantly increased the fresh weight of leaf blade as it gave 29.50 and 31.47 g followed descendingly by using the medium rate of GA_3 (50 ppm) and the low rate of PP_{333} (25 ppm) in both seasons. Whereas, the high rate of PP_{333} (100 ppm) in the second season significantly decreased the fresh weight of leaf blade as it gave 18.17 g. Moreover, the high and medium rates of thiourea registered the lowest mean values in this parameter as they gave 13.83 and 15.00 g, 14.53 and 17.10 g in the first and second seasons, respectively.

These results might be due to the role of kinetin on promoting protein synthesis, increasing cell division and enlargement. With respect to the effect of some growth regulator treatments on the leaf blade dry weight of *Strelitzia reginae*, data in the same Table indicated that the dry weight of leaf blade was

Table (60): The effect of some growth regulators on fresh and dry weights of leaf blade of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Fresh weight of leaf blade (g)		Dry weight of leaf blade (g)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		19.03	25.63	4.23	5.66
Kinetin	25 ppm	27.83	26.50	6.40	6.23
	50 ppm	32.93	31.90	7.66	7.36
	100 ppm	32.27	33.67	7.50	8.00
GA_3	100 ppm	21.83	24.20	4.70	4.86
	200 ppm	27.77	30.10	6.53	7.06
	300 ppm	29.50	31.47	6.90	7.13
Paclobutrazol	25 ppm	27.03	28.47	6.20	6.33
	50 ppm	25.13	22.40	5.96	4.80
	100 ppm	20.67	18.17	5.80	4.56
Thiourea	1000 ppm	18.53	20.30	4.53	4.70
	2000 ppm	14.53	17.10	3.06	3.90
	3000 ppm	13.83	15.00	2.70	3.10
LSD	at 5%	4.76	5.36	1.27	1.36
	at 1%	6.42	7.93	1.71	1.48

in line with those results obtained with fresh weight of leaf blade in both seasons of study. The abovementioned results of kinetin are in harmony with those attained by **Al-Badawy (1982)** on *Adonis autominalis*, **Al-Moulla (1989)** on Croton, **Kandeel (1989)** on *Ocimum basilicum*, **Khalafalla *et al.* (1995)** on *Dahlia pinnata*, **Hendawy (2000)** on *Echinaceae purpurea* and **Youssef (2000)** who pointed out that treated *S. reginae* plants with kinetin at 100 and 200 ppm increased the length and width of leaf blade as well as their fresh and dry weights. The aforementioned results of GA_3 are in parallel with those attained by **Desouky (1994)** on *S. reginae*, **El-Sallami (1997)** on *Narcissus tazetta* and **Zaky (1998)** who stated that treated *S. reginae* with GA_3 at 300 ppm increased the length and width of leaf blade and their fresh and dry weights.

9- Length of leaf petiole (cm):

Data presented in Table (61) showed that kinetin at the high rate (100 ppm) showed to be the most promising treatment in increasing the length of leaf petiole in the first season as it gave 49.33 cm against 43.00 cm for control. On the contrary, all tested treatments of PP_{333} significantly decrease the length of leaf petiole in both seasons. Additionally, the shortest leaf petiole per plant was obtained by spraying *S. reginae* plants with the medium rate of PP_{333} (50 ppm) as it gave 31.00 and 32.17 cm in the first and second seasons, respectively. The other tested treatments of growth regulators occupied in-between position.

These results may be interpreted by the importance of kinetin for promoting cell division **(Cheema and Sharma, 1982)**

Table (61): The effect of some growth regulators on length and thickness of leaf petiole of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Length of leaf petiole(cm)		Thickness of top leaf petiole(cm)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		43.00	44.33	1.00	0.96
Kinetin	25 ppm	46.67	49.13	1.23	1.08
	50 ppm	46.67	57.17	1.13	1.10
	100 ppm	49.33	65.27	1.13	1.20
GA_3	100 ppm	42.33	41.43	1.13	1.06
	200 ppm	46.33	48.67	1.16	1.01
	300 ppm	43.67	56.57	1.13	1.13
Paclobutrazol	25 ppm	34.33	36.33	1.16	1.10
	50 ppm	31.00	32.17	1.23	1.20
	100 ppm	32.00	32.23	1.30	1.26
Thiourea	1000 ppm	42.33	43.73	1.10	0.93
	2000 ppm	44.67	45.77	1.03	1.01
	3000 ppm	44.00	44.33	1.06	1.06
LSD	at 5%	5.76	7.13	0.149	0.139
	at 1%	7.77	9.26	0.201	0.191

10- Thickness of top leaf petiole (cm):

Concerning the effect of some growth regulators treatments on the thickness of top leaf petiole, the results presented in Table (61) showed that the highest values of this parameter were obtained by spraying *S. reginae* plants with PP_{333} at the high rate (100 ppm) which gave 1.30 cm as compared to control as it recorded 1.00 cm in the first season, also, PP_{333} at 50 ppm and kinetin at 25 ppm ranked second in this concern and gave the same value in the first season (1.23 cm). While in the second season PP_{333} at 100 ppm showed the superiority in this concern as it gave 1.26 cm as compared to control which gave 0.96 cm. Also, the high rate of kinetin (100 ppm) and medium rate of PP_{333} (50 ppm) significantly increased the thickness of top leaf petiole as they recorded the same value (1.20 cm).

These results may be interpreted by the importance of kinetin for promoting cell division **(Cheema and Sharma, 1982)**

11- Fresh and dry weights of leaf petiole (g):

Data in Table (62) indicated that all kinetin rates induced progressive increments in the fresh weight of leaf petiole of *S. reginae* in both seasons with high significant differences as compared to the control. However, the heaviest fresh weight of leaf petiole was obtained by using the low rate of kinetin (25 ppm) in the first season as it gave 36.00 g and the high rate of kinetin (100 ppm) in the second one which gave 45.10 g. Moreover, GA_3 at the medium rate (50 ppm) significantly increased this parameter as it gave 31.47 and 36.00 g in the first

Table (62): The effect of some growth regulators on fresh and dry weights of leaf petiole of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Fresh weight of leaf petiole (g)		Dry weight of leaf petiole (g)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		25.57	28.27	3.63	4.33
Kinetin	25 ppm	36.00	40.67	5.70	7.16
	50 ppm	34.27	37.63	5.43	6.60
	100 ppm	35.00	45.10	5.56	8.06
GA_3	100 ppm	28.33	30.53	4.50	5.06
	200 ppm	31.47	36.00	4.96	6.06
	300 ppm	29.90	37.57	4.63	6.16
Paclobutrazol	25 ppm	20.90	23.07	3.20	3.36
	50 ppm	17.73	19.10	2.23	2.40
	100 ppm	18.60	19.27	2.33	2.53
Thiourea	1000 ppm	26.10	30.57	3.60	4.76
	2000 ppm	26.40	34.00	3.83	5.56
	3000 ppm	27.03	34.73	4.30	5.76
LSD	at 5%	4.45	7.39	0.695	1.80
	at 1%	6.00	9.60	0.938	2.43

and second seasons, respectively. While, the lowest mean value in this concern was obtained by using the medium rate of PP_{333} (50 ppm) as it gave 17.73 and 19.10 g as compared to control which recorded 25.57 and 28.27 g in the first and second seasons, respectively.

These results might be due to the role of kinetin on promoting protein synthesis, increasing cell division and enlargement **(Cheema and Sharma, 1982)**

As for the effect of some growth regulators treatments on the dry weight of leaf petiole of *S. reginae* plants, results obtained in Table (62) revealed that the dry weight of leaf petiole showed the similar trend as that of fresh weight of leaf petiole in both seasons.

The aformentioned results of GA_3 concerning the vegetative growth measurements may be due to GA_3 may cause cell elongation by the induction of enzymes that weaken the cell walls. Also, the mechanism by which gibberellins might stimulate cell elongation is that the hydrolysis of starch resulting from the production of GA_3 induced α-amylase which might increase the concentration of sugars, thus raising the osmotic pressure in the cell sap so that water enters the cell and tends to stretch it **(Macleod and Millar, 1962).** The aforementioned results of kinetin are in conformity with those attained by **Runkova (1985)** on *Dhalia pinnata*, **Criley (1988)** on Strelitzia, Alpinia and Heliconia, **Auda (1992)** on *Hippeastrum vittatum*, **Maximoos (1993)** on *Gerbera jamesonii* and **Youssef (2000)** who indicated that sprayed *S. reginae* plants with kinetin at 100

and 200 ppm increased the length and thickness of leaf petiole and their fresh and dry weights. The aforementioned results of GA_3 are in agreement with those attained by **Desouky (1994)** and **Zaky (1998)** on *S. reginae*, and **Salama (2003)** who mentioned that spraying *S. reginae* plants with GA_3 at 300 ppm induced the largest mean leaf area per plant.

IV.2.2- Flower growth measurements:

1-Number of flowers per plant:

It is quite evident that the number of flowers per plant was positively responded to the all growth regulators concentrations under this study. Data tabulated in Table (63) indicated that all tested applications of growth regulator significantly increased the number of flowers per plant in both seasons. The greatest number of flowers per plant was recorded by spraying *S. reginae* plants with the medium rate of PP_{333} (50 ppm) which gave 18.20 flowers per plant as compared to the control in the first season which gave 9.40 flowers per plant. Moreover, kinetin applied at 50 ppm gave the second value in this respect (17.87 flowers/plant) followed descendingly by using kinetin and PP_{333} at the high rates as they gave 16.37 and 16.27 in the first season, respectively. While, in the second season the highest mean number of flowers produced on plants was obtained for the treated plants with the high rate of kinetin (100 ppm) as it registered 17.57 flowers / plant compared to 9.13 flowers / plant of control in the second season. Also, PP_{333} and thiourea at the high rates produced high significant increases in

Table (63): The effect of some growth regulators on No. of flowers, vase life an flowering date of *Strelitzia reginae* Ait. plants during two successive season of 2001-2002 and 2002-2003.

Characters		No. of flowers/plant		Vase life (days)		Flowering date (days)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season	1st season	2nd season
Control		9.40	9.13	15.00	13.67	240.7	246.3
Kinetin	25 ppm	15.30	14.10	16.33	18.33	239.7	244.7
	50 ppm	17.87	15.10	22.00	20.33	235.3	236.3
	100 ppm	16.37	17.57	17.67	21.67	232.3	239.7
GA_3	100 ppm	12.60	11.53	18.00	20.33	233.7	236.3
	200 ppm	13.43	12.13	19.33	17.67	225.3	229.3
	300 ppm	14.57	13.90	17.00	19.00	217.7	220.7
Paclobutrazol	25 ppm	15.50	14.23	14.67	14.33	244.7	249.0
	50 ppm	18.20	15.27	18.33	17.00	250.3	254.7
	100 ppm	16.27	17.37	19.33	15.33	259.3	267.0
Thiourea	1000 ppm	11.77	10.77	14.33	16.00	240.7	245.0
	2000 ppm	12.70	13.47	15.67	15.67	251.3	269.7
	3000 ppm	14.93	16.00	16.67	14.00	265.0	261.3
LSD	at 5%	1.67	1.31	1.76	2.99	5.60	3.17
	at 1%	2.26	1.77	2.72	4.73	7.55	4.28

the number of flowers per plant as they recorded 17.37 and 16.00 flowers / plant in the second season.

These results might be interpreted according to the direct role of cytokinins on flowering induction processes in the flowering meristems and their ability to overcome the dominance of the main flowering shoot. Also, these results might explain the role of kinetin in inducing cell division **(Cheema and Sharma, 1982)** and its ability to overcome the apical dominance of many plants and hence, stimulate the lateral buds to develop into an entire new plant **(Salisbury and Ross, 1974).** Such results are in conformity with those of **Tjia (1986)** on *Zantedeschia elliottiana*, **Yue *et al.* (1988)** on Dutch Iris "Blue Majic", **Maximoos (1993)** on *Gerbera jamesonii*, **Khalafalla *et al.* (1995)** on *Dahlia pinnata*, and **Hendawy (2000)** on *Echinaceae purpurea* who found that treated the plants with kinetin at rates of 100, 200 and 300 ppm increased the number of flowers per plant. The aforementioned results of GA_3 are in harmony with those attained by **Biswas (1983)** on *Polianthes tuberosa*, **Dua *et al.* (1984)** on Gladiolus, **Hassan *et al.* (1985)** on Anemone and Ranunculus, **Tjia (1986)** on *Zantedeschia elliottiana*, **Choudhary (1987)** on *Polianthes tuberosa*, **Pal and Das (1990)** on *Lilium longiflorum*, **Das et *al.*, (1992)** on *Hemerocallis aurantiaca*, **Reiser *et al.* (1993)** on *Zantedeschia spp* **Wankhede *et al.*, (2002)** on *Polianthes tuberosa* and **Salama (2003)** who mentioned that treated *S. reginae* plants with GA_3 at 300 ppm increased the number of flowers per plants.

2-Vase life of flower (days):

The data obtained on the vase life of flowers are presented in Table (63). It was clear from data that kinetin at medium rate (50 ppm) caused in the first season a high significant increment as it recorded 22.00 days compared to 15.00 days for control, also GA_3 at 200 ppm and PP_{333} at 100 ppm resulted in highly significant increases in this parameter as they gave the same value in this concern (19.33 days) in the first season. Whereas, in the second season, the highest mean values of vase life was obtained by using kinetin at the high rate (100 ppm) as it gave 21.67 days compared to 13.67 days for control. Moreover, kintin at 50 ppm and GA_3 at 100 ppm showed highly significant increments in this parameter as they registered the same value (20.33). On the other hand, all concentrations of thiourea resulted in negligible increment in the vase life of *S. reginae* flowers as they gave values near to those of the control which did not reach the level of significance.

These results may explain the role of cytokinins on promoting proteins and pigments synthesis and their ability to delay senescence and withdraw sugars and other solutes from older parts of a plant to the new organs **(Salisbury and Ross, 1974).** In the same line **Leopol and Kawase (1964)** stated that cytokinins stimulate the movement of sugars, starch, amino acids and many other solutes from mature organs to primary tissues of other ones. Nevertheless, the means by which cytokinins exert their beneficial effect on cut flowers was not yet certain, but the application of these materials has been shown to reduce water stress damage in carnation **(Paulin and Muloway, 1979),**

improved water uptake and maintained water turgidity in roses **(Mayak and Halevy, 1977),** reduced respiration rates in carnation, Anthurium and chrysanthemum **(Shirakawa *et al.*, 1964)** and inhibited ethylene production and reduced sensitivity to ethylene in carnation **(Eisinger, 1977).** These results are in parallel with those of **Auda (1992)** on *Hippeastrum vittatum*, **Nagaraja and Gowda (1998)** on tuberose, and **Shahin (1998)** who found that treated Crinum and Hemerocallis plants with kinetin at 50 and 75 ppm increased the vase life of flower. The aforementioned results of GA_3 are in harmony with those attained by **Dalal *et al.* (1999)** indicated that sprayed *Polianthes tuberosa* plants with GA_3 at 40 ppm increased vase life.

3-Flowering date (days):

Data of the time for 50% flowering as an indicator of flowering earliness or retardants (delaying) by days determined from the beginning of start treatments March, 1st in the two seasons, are shown in Table (63).

Data revealed that all kinetin treatments induced non significant precocity in this parameter in the first season except the treatment of 100 ppm kinetin which significantly resulted in early flowering by about 8.4 days when compared with control. The opposite was the right in the second season as all kinetin treatments caused a highly significant earliness in flowering, except for the low rate of kinetin (25 ppm) which resulted in non significant earliness in flowering. Moreover, all treatments of GA_3 resulted in highly significant earliness in flowering by about 7, 15.4, and 23 days in the first season and 10, 17, 25.6 days in the second season for 100, 200 and 300 ppm, respectively. On

the other hand, all treatments of PP_{333} and thiourea succeeded in delaying the flowering in both seasons, with the exception of the low rates. However, the greatest earliness in flowering was obtained by using the treatment of GA_3 at the high rate (300 ppm) in both seasons, while the highest delaying in the flowering date was obtained by using the treatment of thiourea at the high rate (3000 ppm) in the first season and the medium rate (2000 ppm) in the second one, as they delayed the flowering by about 24.3 and 23.4 days over than control in the first and second seasons, respectively.

The abovementioned results of kinetin are in agreement with those attained by **Tjia (1986)** on *Zantedeschia elliottiana*, **Auda (1992)** on *Hippeastrum vittatum*, **Khalafalla (1995)** on *Dahlia pinnata* and **Shahin (1998)** on *Crinum longiflorum* and *Hemerocallis aurantiaca*, who mentioned that sprayed the plants with kinetin at 50 ana 75 ppm significantly accelerated flower opening as compared to control.

The abovementioned results of GA_3 are in conformity with those attained by **Bhattacharjee (1984)** on *Dahlia variabilis*, **Cocozza (1985)** on Freesia, **Tjia (1986)** on *Zantedeschia elliottiana*, **Pal and Das (1990)** on *Lilium longiflorum*, **Ved *et al.*, (1998)** on Gladiolus, **Pascal *et al.*, (1998)** on *Rannunculus asiaticus*, **Treder *et al.*, (1999)** on *Cyclamen persicum*, and **Tiwari and Singh (2002)** on *Lilium maculatum*, mentioned that treated the plants with GA_3 at 200 ppm exhibited the earliest flowering as compared to control.

4- Fresh and dry weights of floret (g):

Data presented in Table (64) on the fresh weight of the first opened floret on flower spathe showed that all tested concentrations of the growth regulators increased the fresh weight of floret in the first season, with the exception of thiourea at the low rate (100 ppm) which decreased the fresh weight of floret (3.86 g). The heaviest fresh weight of floret (5.70 g) was obtained by treated *S. reginae* plants with the high rate of GA_3 (300 ppm), while using kinetin at 100 ppm ranked the second value in this concern and recorded 5.36 g in the first season. While, the heaviest floret fresh weight in the second season was obtained by using kinetin at the medium rate (50 ppm) as it recorded 5.83 g followed descendingly by using the high rate of kinetin and GA_3 as they registered 5.70 and 5.50 g in the second season, respectively. Additionally, all tested applications of PP_{333} significantly increased floret fresh weight in both seasons, especially at the low rate (25 ppm) which gave 4.86 and 5.26 g in the first and second seasons, respectively.

These results might be explained according to the role of kinetin on promoting protein synthesis, cell division and enlargement **(Cheema and Sharma, 1982)**

Similary, the results of the dry weight of floret (Table, 64) attained a parallel trend with the fresh weight results, with little differences in the level of significances. In general the heaviest dry weight of floret was obtained by using the high rate of GA_3 (300 ppm) in both seasons as it recorded 0.706 and 0.703 g in the first and second seasons, respectively. On the contrary, the

Table (64): The effect of some growth regulators on fresh and dry weights of the first opening floret of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Floret F. W (g)		Floret D. W (g)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		3.96	4.13	0.463	0.473
Kinetin	25 ppm	4.86	5.36	0.606	0.663
	50 ppm	5.16	5.83	0.616	0.696
	100 ppm	5.36	5.70	0.650	0.690
GA_3	100 ppm	4.03	4.70	0.530	0.636
	200 ppm	4.30	4.63	0.580	0.620
	300 ppm	5.70	5.50	0.706	0.703
Paclobutrazol	25 ppm	4.86	5.26	0.540	0.580
	50 ppm	4.76	4.80	0.583	0.590
	100 ppm	4.70	5.03	0.560	0.600
Thiourea	1000 ppm	3.86	4.00	0.443	0.456
	2000 ppm	4.06	3.93	0.460	0.450
	3000 ppm	4.40	4.03	0.493	0.453
LSD	at 5%	0.342	0.589	0.074	0.052
	at 1%	0.462	0.795	0.100	0.071

lowest dry weight of floret was recorded by sprayed *S. reginae* plants with the low rate of thiourea (1000 ppm) as it gave 0.443 and 0.456 g compared to 0.463 and 0.473 g for control.

These results might be explained according to the role of kinetin on promoting proteins, soluble and non-soluble sugars synthesis, or may be due to the ability of kinetin for making the treated area to act as a sink into which nutrients from other parts of the plant are drawn **(Salisbury and Ross, 1974).**

6-Length of flower stalk (cm):

Data presented in Table (65) indicated that the length of flower stalk as affected by various treatments of growth regulators treatments ranged from 60.23 and 58.70 to 103.7 and 108.1 cm in the first and second seasons, respectively. The lowest values resulted from treated *S. reginae* plants with the high rate of PP_{333} (100 ppm) in both seasons. Additionally, all rates of PP_{333} significantly decreased flower stalk length; the decrease was in parallel to the applied concentration, hence, the decreases were 25.2, 18.83 and 14.69 % less than control with 100, 50 and 25 ppm in the first season and 25.63, 21.45 and 17.36 % in the second one, respectively. Whereas, the longest flower stalk was obtained by using the high rate of GA_3 (300 ppm) as it gave 103.7 and 108.1 cm in the first and second seasons, respectively. Also, GA_3 at 200 ppm and kinetin at the high rate (100 ppm) showed a high significant increase in the length of flower stalk as they recorded 100.2 and 105.4, 98.47 and 100.1cm in the first and second seasons, respectively. Besides, thiourea treatments induced a high significant increase

Table (65): The effect of some growth regulators on length and thickness of flower stalk of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Length of flower stalk (cm)		Thickness of top flower stalk (cm)	
Treatments \ Seasons		1st season	2nd season	1st season	2nd season
Control		80.53	78.93	1.13	1.16
Kinetin	25 ppm	88.53	93.57	1.50	1.50
	50 ppm	93.53	96.47	1.50	1.53
	100 ppm	98.47	100.1	1.70	1.63
GA_3	100 ppm	93.37	95.23	1.20	1.26
	200 ppm	100.2	105.4	1.26	1.36
	300 ppm	103.7	108.1	1.23	1.30
Paclobutrazol	25 ppm	68.70	65.23	1.33	1.30
	50 ppm	65.37	62.00	1.40	1.43
	100 ppm	60.23	58.70	1.50	1.46
Thiourea	1000 ppm	102.3	100.0	1.16	1.23
	2000 ppm	97.93	101.2	1.13	1.23
	3000 ppm	95.47	91.93	1.10	1.16
LSD	at 5%	10.03	13.30	0.105	0.091
	at 1%	13.53	17.95	0.142	0.123

in this parameter especially the low rate in the first season and the medium rate in the second one as they gave 102.3 and 101.2 cm respectively.

The increments in flower stalk length as a result of kinetin application may be due to the increment in cell division and enlargement as mentioned by **Cheema and Sharma, 1982.**

7-Thickness of top flower stalk (cm):

Data presented in Table (65) revealed that the thickness of top flower stalk of *S. reginae* plants was affected by kinetin and PP_{333} treatments at different concentrations. Since, all kinetin and PP_{333} treatments caused a great increase in the thickness of flower stalk in both seasons. The increases in this parameter were progressively increased with increasing the concentration used. Therefore, kinetin and PP_{333} at the high rates produced the highest mean values in this parameter as they recorded 1.70 and 1.63, 1.50 and 1.46 cm in the first and second seasons, respectively. Also, all concentrations of GA_3 increased the thickness of flower stalk in both seasons.

Besides, all tested treatments of thiourea resulted in negligible effect in this parameter as they recorded values near to those of the control.

These results may be interpreted by the importance of kinetin for promoting cell division **(Cheema and Sharma, 1982)**

8-Fresh and dry weights of flower stalk (g):

Data presented in Table (66) showed that all tested applications of kinetin induced progressive increases in the fresh weight of flower stalk with high significant differences as compared to control in both seasons. Since, the heaviest fresh weight of flower stalk was obtained by using the high rate of kinetin which registered 108.0 and 107.0 g in both seasons. Moreover, all rates of thiourea induced a high significant increment in the fresh weight of flower stalk, especially the low rate (100 ppm) as it gave 96.27 and 97.50 g in both seasons. Additionally, all treatments of GA_3 induced a high significant increase in this parameter, the increase was in parallel to the applied concentration, so the high rate of GA_3 produced the best results in this concern as it gave 91.73 and 99.60 g in both seasons. On the opposite, the lowest fresh weight of flower stalk was obtained by using PP_{333} treatments. The reduction in the fresh weight of flower stalk was reached the maximum with PP_{333} treatment at the high rate (100 ppm). The percentage of decreases was 23.07 and 22.53% less than control in the first and second seasons, respectively.

These results might be explained according to the role of kinetin on promoting protein synthesis, or may be due to increasing the length and thickness of flower stalk as mentioned before.

Concerning the dry weight, data in the same Table showed that the response of flower stalk dry weight of *S. reginae* plant to the effect of some growth regulators treatments followed

Table (66): The effect of some growth regulators on fresh and dry weights of flower stalk of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Fresh weight of flower stalk (g)		Dry weight of flower stalk (g)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		72.70	68.97	8.26	8.10
Kinetin	25 ppm	90.33	92.63	9.36	9.60
	50 ppm	92.07	94.20	9.53	9.76
	100 ppm	108.0	107.0	11.30	11.13
GA_3	100 ppm	87.90	89.77	8.63	8.96
	200 ppm	88.70	91.30	8.96	9.10
	300 ppm	91.73	99.60	9.00	9.50
Paclobutrazol	25 ppm	66.50	64.93	7.36	7.13
	50 ppm	61.30	56.90	6.70	6.53
	100 ppm	55.93	53.43	6.30	6.13
Thiourea	1000 ppm	96.27	97.50	9.40	9.83
	2000 ppm	96.13	94.93	9.66	9.40
	3000 ppm	94.13	91.63	9.60	9.20
LSD	at 5%	10.45	10.49	1.19	1.24
	at 1%	14.10	14.15	1.60	1.67

nearly the same trend previously detected with flower stalk fresh weight in both seasons.

These results might be explained according to the role of kinetin on promoting proteins, soluble and non-soluble sugars synthesis, or may be due to the ability of kinetin for making the treated area to act as a sink into which nutrients from other parts of the plant are drawn **(Salisbury and Ross, 1974).** The abovementioned results of kinetin are in harmony with those attained by **Runkova (1985)** on *Helenium sp* and *Dahlia pinnata*, **Tjia (1986)** on *Zantedeschia elliotiana*, **Nabih and Sakr (1991)** on Freesia, **Auda (1992)** on *Hippeastrum vittatum*, **Maximoos (1993)** on *Gerbera jamesonii*, **Khalafalla *et al.* (1995)** on *Dahlia pinnata*, **Shahin (1998)** who mentioned that treated Crinum and Hemerocallis plants with kinetin at 50 and 75 ppm significantly increased the length and thickness of flower stalk as well as their fresh and dry weights. The aforementioned results of GA_3 are in parallel with those attained by **Hradilik and Fiserova (1987)** and **Song *et al.* (1991)** on *Cyclamen persicum*, **Leena *et al.*, (1992)** on Gladiolus cv. Friendsip, **Das *et al.*, (1992)** on *Hemerocallis aurantiaca*, **Preeti *et al.* (1997)** and **Ved *et al.* (1998)** on tuberose, and **Zaky (1988)** who mentioned that treated *S. reginae* with GA_3 at 300 ppm increased the length and thickness of flower stalk and their fresh and dry weights.

10-Length of flower spathe (cm):

Data on flower spathe length of *Strelitzia reginae* as affected by using some treatments of growth regulators are given in Table (67).

Table (67): The effect of some growth regulators on length and width of flower spathe of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Length of flower spathe (cm)		Width of flower spathe (cm)	
Treatments \ Seasons		1st season	2nd season	1st season	2nd season
Control		16.73	17.53	2.60	2.66
Kinetin	25 ppm	20.47	18.90	3.13	3.23
	50 ppm	22.57	21.43	3.20	3.20
	100 ppm	20.50	22.00	3.13	3.30
GA_3	100 ppm	22.23	20.80	3.03	3.10
	200 ppm	24.53	24.07	3.13	3.20
	300 ppm	22.30	23.27	2.96	3.00
Paclobutrazol	25 ppm	18.37	17.50	2.96	3.00
	50 ppm	16.77	16.33	3.10	3.06
	100 ppm	16.07	15.23	3.16	3.13
Thiourea	1000 ppm	18.43	23.13	2.63	2.86
	2000 ppm	19.27	22.23	2.76	2.73
	3000 ppm	20.20	20.90	2.83	2.90
LSD	at 5%	1.04	2.56	0.129	0.138
	at 1%	1.40	3.45	0.174	0.187

The data showed that all treatments of GA_3 resulted in a high significant increase in this parameter. Anyhow, the longest flower spathe of *S. reginae* was registered by using the medium rate of GA_3 (200 ppm) as it gave 46.62 and 37.31% increases more than control, followed descendingly by using the high rate of GA_3 (300 ppm) which recorded 22.30 and 23.27 cm compared to 16.73 and 17.53 cm for control in the first and second seasons, respectively. Also, kinetin at 50 ppm in the first season and thiourea at 2000 ppm in the second season ranked the third in this respect as they gave 22.57 and 22.23 cm respectively. Moreover, all tested applications of thiourea significantly increased the length of flower spathe especially at the high rate in the first season and the low rate in the second season. Additionally, all treatments of PP_{333} showed little effects upon the length of flower spathe as they caused non significant effects in this parameter when compared to control in both seasons, with the exception of PP_{333} at 25 ppm in the first season which gave a significant increase (18.37 cm) when compared to the control (16.73 cm).

11-Width of flower spathe (cm):

Data in Table (67) exhibited that all treatments of kinetin, GA_3 and PP_{333} significantly increased flower spathe length of *S. reginae* plants in both seasons. However, all rates of kinetin gave a high significant increase in this parameter especially the medium rate in the first season and the high rate in the second one as it recorded 3.20 and 3.30 cm respectively. Meanwhile, the differences between the three tested kinetin concentrations were lacking from the statistical standpoind. In addition all tested

applications of GA_3 significantly increased the width of flower spathe, among GA_3 treatments, the level of 200 ppm which registered the superiority in this parameter as it recorded 3.13 and 3.20 cm in the first and second seasons, respectively.

As for PP_{333} treatments data showed that width of flower spathe increased progressively with the increasing of PP_{333} levels. So, the high rate of PP_{333} (100 ppm) produced the highest mean values in this parameter as it recorded 3.16 and 3.13 cm in the first and second seasons, respectively. Furthermore, all thiourea treatments significantly increased the width of flower spathe with the exception of thiourea at the low rate (1000 ppm) in the first season and the medium rate (2000 ppm) in the second one.

12-Fresh and dry weights of flower spathe (g):

Data presented in Table (68) indicated that all tested applications of kinetin gave a high significant increase in the fresh weight of flower spathe in the first season. So, the heaviest fresh weight of flower spathe was registered by treated *S. reginae* plant with the medium rate of kinetin (50 ppm) which gave 40.00 g compared to 28.33 g for control in the first season. Also, GA_3 significantly increased the fresh weight of flower spathe specially the medium rate (200 ppm) which recorded 38.34 g followed descendingly by using the low rate (100 ppm) in the first season. Moreover, all PP_{333} rates showed a significant increase in this parameter when compared with control, with the exception of PP_{333} at 100 ppm which gave a non significant increase in this parameter in the first season. This trend was true

Table (68): The effect of some growth regulators on fresh and dry weights of flower spathe of *Strelitzia reginae* Ait. plants during two successive seasons of 2001-2002 and 2002-2003.

Characters		Fresh weight of flower spathe(g)		Dry weight of flower spathe(g)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		28.33	33.33	3.43	4.24
Kinetin	25 ppm	37.67	34.33	4.83	4.53
	50 ppm	40.00	33.34	5.80	4.26
	100 ppm	36.70	36.32	4.70	4.62
GA_3	100 ppm	35.00	31.67	4.16	4.03
	200 ppm	38.34	36.61	4.90	4.50
	300 ppm	32.67	33.42	4.12	4.30
Paclobutrazol	25 ppm	34.29	33.42	4.31	4.26
	50 ppm	33.38	33.71	4.24	4.38
	100 ppm	31.33	34.00	3.96	4.32
Thiourea	1000 ppm	27.00	29.33	3.60	3.80
	2000 ppm	29.00	31.67	3.83	4.06
	3000 ppm	31.67	32.67	4.10	4.20
LSD	at 5%	4.31	3.96	0.572	0.370
	at 1%	5.81	N.S	0.771	N.S

in the first season while in the second season the picture was completely changed, since, all treatments of kinetin, GA_3 and PP_{333} failed to induce a significant effect in this parameter. Additionally, all test applications of thiourea in both seasons resulted in negligible effect in this parameter as they gave values near to those of the control which did not reach the level of significance, with the exception of thiourea at the low rate (1000 ppm) in the second season which gave 29.33 g compared to 33.33 g for control in the second season.

As for the dry weight of flower spath data presented in Table (68) showed that the results of the dry weight of flower spathe attained a parallel trend with the fresh weight of flower spathe results, with some little differences in the level of significances. In general, the heaviest flower spathe dry weight of *S. reginae* plant was obtained by using kinetin at 50 ppm in the first season which recorded 5.80 g followed descending by using the medium rate of GA_3 (200 ppm) which gave 4.90 g in the first season. While in the second season, all treatments of growth regulators failed to induced a significant effect, with the exception of kinetin at the high rate (100 ppm) which gave a significant increment in this parameter as it registered 4.62 g and thiourea at the low rate (1000 ppm which resulted in a significant decreasing in this parameter as it gave 3.80 g when compared to 4.24 g for control. The increments in flower spathe traits i.e., lenghth and width and their fresh and dry weights as a result of kinetin application may be due to the increment in protein synthesis, increasing cell division and enlargement **(Cheema and Sharma, 1982)**. Such results are in line with **El-Khyate**

(1987) on *Tagetes erecta*, **Nilimesh (1989)** on Gladiolus cv. Psittacinus, **Auda (1992)** on *Hippeastrum vittatum*, **Maximoos (1993)** on *Gerbera jamesonii*, **Khalafalla *et al.* (1995)** on *Dahlia pinnata* and **Shahin (1998)** on Crinum and Hemerocallis who showed that treated plants with kinetin at 50 and 75 ppm increased the first flower diameter and fresh and dry weights of flowers.

The effects of GA_3 on flower growth measurements may be due to gibberellins play a role in flowering, probably it is further elaborated into florigen by the plant. Hence, gibberellin can not be the same substance as florigen but at least it may act as its precursor. The propounder of (Florigen concept) florigen but made up of two substances, namely gibberllins and anthesins. The latter are considered to be nitrogen rich compounds **(Macleod and Millar, 1962).** Such results are in conformity with those attained by **Preeti *et al.* (1997)** on *Polianthes tuberosa*, **Ved *et al.* (1998)** on Gladiolus, **Zaky (1998)** on *S. reginae*, **Devendra *et al.* (1999)** and **Tawila (2000)** on *Polianthes tuberosa*, **Wankhede *et al.* (2002)** on *Polianthes tuberosa* and **Salama (2003)** who found that spraying *S. reginae* plants with GA_3 at 300 ppm increased the length of flower spathe and their fresh and dry weights.

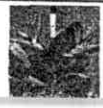
IV.2.2- Chemical composition measurements:

1-Leaf nitrogen content (%):

Data of leaf nitrogen content (%) in dried leaf of *S. reginae* are presented in Table (69).

Table (69): The effect of some growth regulators on N, P, K and total carbohydrate content in leaves of *Strelitzia reginae* Ait. plants during two successive season of 2001-2002 and 2002-2003.

Characters		N %		P %		K %		Total carbohydrates (%)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control		1.73	1.66	0.216	0.213	1.53	1.43	16.97	17.53
Kinetin	25 ppm	2.16	1.96	0.270	0.266	1.96	2.06	19.80	18.90
	50 ppm	2.33	2.63	0.296	0.283	2.33	2.10	21.57	17.23
	100 ppm	2.53	2.43	0.283	0.296	2.33	2.23	22.50	20.27
GA_3	100 ppm	2.10	1.96	0.263	0.253	2.06	2.13	17.23	16.53
	200 ppm	2.23	2.06	0.266	0.273	2.23	1.93	20.93	18.40
	300 ppm	2.33	2.43	0.280	0.280	1.86	2.16	19.47	19.83
Paclobutrazol	25 ppm	2.06	2.06	0.276	0.270	2.03	1.90	17.60	16.20
	50 ppm	2.13	2.33	0.286	0.273	2.16	2.23	20.17	19.93
	100 ppm	2.23	2.10	0.270	0.286	2.40	2.53	23.23	18.40
Thiourea	1000 ppm	2.03	1.83	0.266	0.250	1.80	2.16	15.33	19.17
	2000 ppm	1.96	2.03	0.263	0.263	1.96	1.96	15.47	17.60
	3000 ppm	1.83	1.90	0.283	0.276	1.90	1.83	16.06	17.93
LSD	at 5%	0.429	0.409	0.052	0.058	0.426	0.416	3.64	N.S
	at 1%	0.579	0.552	0.071	0.079	0.575	0.561	4.91	N.S



It was obvious that all treatments of growth regulators increased leaf nitrogen content in both seasons with significant differences in most cases. All kinetin treatments showed a great increase in N content in leaves as compared to control plants. So, the high rate of kinetin (100 ppm) in the first season and the medium rate in the second one were the most effective treatments for increasing leaf N% and gave 2.53 and 2.63%, respectively. Moreover, GA_3 at the high rate (300 ppm) resulted in highly significant increase in this parameter as it registered 2.33 and 2.43% in both seasons. Also, all rates of PP_{333} significantly increased leaf N% content in both seasons, especially using the high rate (100 ppm) in the first season and the medium rate in the second one as it recorded 2.23 and 2.33% respectively.

2-Leaf phosphorus content (%):

Data presented in Table (69) showed that all tested applications of growth regulator increased leaf phosphorus content in leaves of *S. reginae* plants in both seasons with significant differences in most instances. All rates of kinetin increased leaf phosphorus content (%) in both seasons as compared to control, meanwhile in the first season using kinetin at 50 ppm and kinetin at 100 ppm in the second season induced statistically the richest leaf phosphorus content and exhibited not only insignificant variance between each other but also, showed typically the same value of this parameter as they registered 0.296% in both seasons. Also, all GA_3 treatments significantly increased leaf phosphorus content (%) in both seasons. The increase in this parameter due to GA_3 treatments gradually

increased with increasing the concentration used. So, the high rate of GA_3 (300 ppm) gave the highest values (0.280 and 280%) compared with 0.216 and 0.213 % for control. In addition, all tested application of PP_{333} significantly increased leaf phosphorus content, among PP_{333} treatments, the medium rate (50 ppm) in the first season and the high rate in the second one as they gave 0.286 and 0.286 %, respectively. Additionally, all applications of thiourea increased leaf phosphorus content especially using the high level (3000 ppm) which recorded the greatest values in this concern as it gave 0.283 and 0.276 (%) in both seasons.

3-Leaf potassium content (%):

It is quite evident that leaf potassium content of *S. reginae* plant was positively responded to the all treatments of growth regulator under this study in both seasons. Data presented in Table (69) indicated that plants treated with the high rate of PP_{333} (100 ppm) resulted in the richest leaf potassium content as it registered 2.40 and 2.53 % compared with 1.53 and 1.43 % for control in the first and second season, respectively followed descendingly by using the high rate of kinetin (100 ppm) which recorded 2.33 and 2.23 % in both seasons. Irrespective control, the lowest leaf potassium content was obtained by using the low rate of thiourea (1000 ppm) in the first season and the high rate of thiourea (3000 ppm) in the second one as they gave 1.80 and 1.83 %, respectively. The remaining treatments of growth regulators gave inbetween values in this concern in both seasons.

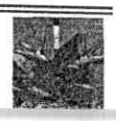


Table (70): The effect of some growth regulators on chlorophylls (a&b) and carotenoids of *Strelitzia reginae* Ait. plants during two successive seasons of 2000-2001 and 2001-2002.

Characters		Chlorophyll a (mg/100g Fw)		Chlorophyll b (mg/100g Fw)		Carotenoids (mg/100g Fw)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season	1st season	2nd season
Control		106.0	111.0	86.33	91.00	38.67	41.67
Kinetin	25 ppm	152.3	146.7	109.3	106.0	46.00	41.67
	50 ppm	166.7	163.3	114.7	115.0	46.77	48.00
	100 ppm	176.3	173.4	122.7	117.3	55.67	53.67
GA_3	100 ppm	147.6	151.7	102.3	103.9	43.00	45.67
	200 ppm	166.4	156.8	106.2	108.7	46.33	48.00
	300 ppm	151.7	162.3	118.7	115.0	48.33	46.67
Paclobutrazol	25 ppm	143.3	152.0	111.0	113.3	40.34	42.00
	50 ppm	171.7	166.0	123.7	118.7	50.00	47.67
	100 ppm	182.3	162.8	126.0	122.8	58.67	51.32
Thiourea	1000 ppm	143.3	146.7	113.3	111.5	51.69	51.67
	2000 ppm	132.3	136.0	102.3	105.7	49.65	52.31
	3000 ppm	118.3	102.0	99.35	88.43	48.67	41.00
LSD	at 5%	15.48	16.07	14.01	12.72	8.21	9.67
	at 1%	20.88	21.68	18.90	17.16	11.08	N.S

111.0 mg/100 g FW for control. Moreover, using the medium rate of PP_{333} (50 ppm) ranked the second in this concern as it recorded 166.0 mg/100 g FW followed descendingly by using the medium rate of kinetin and the high rate of PP_{333} as they registered 163.3 and 162.8 mg / 100 g FW in the second season, respictively. Besides, all tested applications of thiourea significantly increased the leaf chlorophyll a content with the exception of the high rate which resulted in negligible effect in this parameter as they gave values near to those of the control which did not reach the level of significance in both seasons.

6-Leaf chlorophyll b content (mg/100 g F.W):

According to data presented in Table (70) on leaf chlorophyll b content of *S. reginae* plants as affected by some treatments of growth regulators, it could be concluded that all treatments of growth regulators showed a great effects upon this parameter as they caused a significant increase in this parameter when compared with the control in both seasons, with the exception of thiourea at the high rate (3000 ppm) which resulted in negligible effect in this parameter as it gave values near to those of the control which did not reach the level of significance in both seasons. However, all studied applications of PP_{333} caused a high significant increase in leaf chlorophyll b content in both seasons, the increase was in parallel to the applied concentration, since, the high rate of PP_{333} (100 ppm) produced the richest leaf chlorophyll b content as it registered 126.0 and 122.8 mg/10 0g FW compared with 86.33 and 91.00 mg/100 g FW for control in the first and second seasons, respectively. In addition PP_{333} at 50 ppm gave a high significant increase and

ranked the second in this parameter as it recorded 123.7 and 118.7 mg/100 g F.W in both seasons. As for kinetin treatments, data showed that leaf chlorophyll b content increased progressively with the increasing of kinetin level. So, the high rate of kinetin (100 ppm) produced the greatest mean value in this parameter as it recorded 122.7 and 117.3 mg/100 g FW in both seasons. Moreover, all tested application of GA_3 significantly increased leaf chlorophyll a content.

7-Leaf carotenoids content (mg / 100 g F.W):

Data tabulated in Table (70) revealed that spraying *S. reginae* plants with the high rate of PP_{333} (100 ppm) in the first season gave the greatest leaf carotenoids content as it registered 58.67 mg / 100 g FW compared with 38.67 mg/100 g FW for control, also using kinetin at the high rate (100 ppm) gave a high significant increment in this parameter which recorded 55.67 mg/100 g FW followed descendingly by using the low rate of thiourea (1000 ppm) and the medium rate of PP_{333} (50 ppm) as they recorded 51.69 and 50.00 mg / 100 g FW in the first season, respectively. This trend was true in the first season only, while in the second one treated *S. reginae* plants with the high rate of kinetin (100 ppm) gave the superiority in this parameter as it recorded 53.67 mg/ 100 g FW compared with 41.67 mg / 100 g FW for control. Also, thiourea at 2000 ppm significantly increased leaf carotenoids content as it recorded 52.31 mg/100 g FW in the second season.

These results may interpret the role of kinins on promoting stroma lamella formation and grana and chlorophyll

appearance during normal leaf growth **(Harvey *et al.*, 1974).** Such results are in conformity with those of **Ivanova and Kapchina (1984)** on *Hyacinthus orientalis*, **Khalafalla *et al.* (1995)** on *Dahlia pinnata*, **Shahin (1998)** on Crinum and Hemerocallis plants and **Youssef (2000)** who recorded that spraying *S. reginae* plants with kinetin at 100 and 200 ppm increased leaf chlorophylls (a, b) and carotenoids content. The aforementioned results of GA_3 are in line with those obtained by **Desouky (1994)** on *S. reginae*, **Reddy *et al.* (1997)** on *Polianthes tuberosa,* **Gomaa (2003)** who mentioned that treated *Dahlia pinnata* plants with GA_3 at rates of 50, 100 and 150 ppm increased leaf chlorophylls (a, b) and carotenoids content.

8-Leaf total phenols content (mg/100 g FW):

Data tabulated in Table (71) revealed that the leaf total phenols content was affected by various concentrations of growth regulators. The lowest value of this parameter resulted from sprayed *S. reginae* plants with the high rate of kinetin (100 ppm). Additionally, using the medium rate of kinetin (50 ppm) significantly decreased leaf total phenols content as it gave 142.3 mg/100 g FW in the first season. Besides, all tested applications of GA_3 in the first season significantly decreased leaf total phenols content especially the medium rate 200 ppm) which recorded 132.0 mg/100 g FW. While, the highest leaf total phenols content in the first season was obtained by using the high rate of PP_{333} (100 ppm) followed descendingly by using the high rate of thiourea (3000 ppm) as it registered 175.3 mg/100 g FW. The remaining treatments occupied intermediate position between the previously mentioned treatments in the first season.

Table (71): The effect of some growth regulators on total phenols and total indoles of *Strelitzia reginae* Ait. plants during two successive seasons of 2000-2001 and 2001-2002.

Characters		Total phenols (mg/100g FW)		Total indoles (mg/100g FW)	
Seasons / Treatments		1st season	2nd season	1st season	2nd season
Control		161.7	172.3	262.3	251.7
Kinetin	25 ppm	152.3	162.3	272.0	267.0
	50 ppm	142.3	132.7	281.7	261.7
	100 ppm	121.0	152.1	283.0	281.4
GA_3	100 ppm	141.3	144.9	262.0	254.2
	200 ppm	132.0	135.7	291.3	296.1
	300 ppm	136.0	125.8	271.3	274.5
Paclobutrazol	25 ppm	165.8	160.1	230.4	240.7
	50 ppm	171.0	179.3	251.7	271.3
	100 ppm	181.2	179.4	202.0	221.0
Thiourea	1000 ppm	151.8	142.3	280.3	291.0
	2000 ppm	163.0	156.0	269.7	281.3
	3000 ppm	175.3	171.3	241.7	247.0
LSD	at 5%	16.92	21.91	25.73	24.98
	at 1%	22.83	29.55	34.70	33.70

This trend was true in the first season only, while in the second one, using the high rate of GA_3 resulted in the lowest value of leaf total phenols content as it recorded 125.8 mg/100 g FW compared with 172.3 mg/100 g FW for control. Moreover, using the medium rate of kinetin and GA_3 gave a high significant decrease in this parameter as they registered 132.7 and 135.7 mg/100 g FW, respectively. While the highest leaf total phenols content in the second season was obtained by using the high and medium rate of PP_{333} and exhibited not only insignificant variance between each other but also, showed approximately the same value of leaf total phenol content (179.4 and 179.3 mg/100 g FW).

The aforementioned results of kinetin are in agreement with those obtained by **Maximoos (1993)** on *Gerbera jamesonii* who mentioned that treated the plants with kinetin at 25, 50 and 100 ppm significantly decreased leaf total phenols content. Similar results were obtained by **Auda (1992)** on *Hippeastrum vittatum* and **Shahin (1998)** on Crinum and Hemerocallis.

9-Leaf total indoles content (mg/100 g FW):

Data on total indoles content in leaves of *S. reginae* plants as affected by some growth regulator treatments are given in Table (71) showed that using the medium rate of GA_3 (200 ppm) gave the highest leaf total indoles content as it recorded 291.3 and 296.1 mg/100 g FW compared with 262.3 and 251.7 mg/100 g FW for control in the first and second seasons, respectively. In addition, thiourea at the low and medium rate and kinetin at the high rate significantly increased leaf total indoles in the second

season. On the reverse, the lowest mean value in this respect was obtained by spraying *S. reginae* plants with the high rate of PP_{333} (100 ppm) which recorded 202.0 and 221.0 mg/100 g FW compared with control in both seasons. The remaining treatments occupied intermediate position between the previously mentioned treatments, as they resulted in nearly more or less similar values to those of the control which did not reach the level of significance in both seasons.

This may be due to the role of kinetin on increasing the promoters in the plant tissues at the expense of the inhibitors to induce flowering. In this concern, **Kenneth (1979)** reported that the total control of plant growth is vested not in a single hormonal type – that of auxin – but is shared by several specially auxins, cytokinins, gibberellins and ethylene and this further subjected to namely the phenols, flavons and absicsic acid. Such results are in conformity with those of **Maximoos (1993)** on *Gerbera jamesonii* who mentioned that treated the plants with kinetin at 25, 50 and 100 ppm significantly increased leaf total indoles content. Similar results were obtained by **Auda (1992)** on *Hippeastrum vittatum* and **Shahin (1998)** on Crinum and Hemerocallis. **The results of pp_{333} in this experiment may be discussed in the same way as previously mentioned in the first experiment.**