PHYSIOLOGCAL STUDIES ON SOME ORNAMENTAL BULBS

1: Effect of nitrogen treatments on the vegetative growth, flowering, rhizomes productivity and chemical constituents of *Zantedeschia aethiopica*, L. and *Hedychium coronarium* koenig plants.

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ABSTRACT

Two separate experiments were carried out during two successive seasons (2000/2001 and 2001/2002) to study the effect of N treatments and spraying with GA_3 on growth, flowering, rhizome productivity and chemical composition of *Zantedeschia aethiopica* L. and *Hedychium coronarium* koenig plants. Using four levels of nitrogen (N_1=2, N_2=3, N_3=4 and N_4=5 g/plant of ammonium sulphate, respectively), phosphours (P=7. g/plant of calcium superphosphate) and potassium (K=4 g/plant of potassium sulfate were used in the two experiments. The mixture of fertilizers was added at four doses. The first three doses were added at one month interval beginning from 30 days after planting, while the fourth dose was applied after cutting of the flowering spikes then these plants are planted in sandy clay loam of pH 8.4.

From the obtained data it was found that the best treatments were 5 g of ammonium sulfate +7 g of calcium super phosphate + 4 g of potassium sulfate for *Zantedeschia aethiopica.* Also, it was found that the best treatment for *Hedycium coronarium* was 4 g. of ammonium sulfate + 7 g. of calcium superphoshate + 4g. of potassium sulfate, which gave the best results for the most studied parameters.

INTRODUCTION

The flowering ornamental bulbs are considered a group of the most beautiful adjuncts for garden decoration. They are used practically in landscape, production of commercial cut-flowers and act as a source of glorious colours, as well as some of such bulbs

have pleasant odour. Zantedeschia is commonly flowers of known as calla lily. It is a perennial herb grown for their ornamental corolla like spathe and sometimes for their variegated or spotted foliage. It grows very well in open in warm climate, but can be grown inside greenhouses also. The flowering season varies with the place. *Hedychium* (the large white flowers are sweet-scented), Fam. Zingiberaceae. Buttefly lily, Ginger lily, Garland flower, leafy, rhizomaous herbs allied to kaemferia and ginger, grown under glass and in the open far south. Flowers in treminal spike or thyrse; *Hedychiums* are strong-grown plants, very ornamental, both in foliage and in flower. They are essentially fall bloomers, although they may be made to bloom more or less continuously under glass. The common white-flowered species is *H. coronarium,* this requires warm house treatment for best results, although it often flowers well when plunged in a warm, half shady place in the open. garden plant (Omata *et al.*, 1991).

Goncalves *et al.* (1989) mentioned that plants received NP_2,O_5 and K_2O at 400, 800 and 400 kg/ha gave the best results and the results was affected by 3 fertilizing schedules 20+80+20, 40+80+40 or 20+40+40 g/m^2 of the *Hedychium gardnerinum.*

Badran *et al.* (1989) stated that, supplying calla plants with the low level (N 60, P 75, K 50) or high level (N 120, P 150, K 100) mostly improved the different vegetative growth characters and greatly increased number of offsets, fresh and dry weight of upper-ground parts and rhizome production per plant. Also, Clemens *et al.* (1998) applied N, P and K to *Zantedeschia aethiopica* cv. Starlight in the previous growth period. This treatment affected fresh weight, of shoot and development. In addition, plant survival during the initial growth period was higher at low N and P and at intermediate levels of K. The fresh weight of harvested tubers was higher at intermediate levels of N. as well as, number of flowers per unit area and tuber fresh weight were increased while, time to flowering was shortened at low N. Also, Ostertage and Verville (2002) demonstrated that fertilizer application with N reduced species richness at the young, N-limited site, but none of the nutrient additions altered species richness at the older. In addition, at the site with low N availability plots fertilized with NP and higher densities of the non-native ginger

(*Hedychium gardnerianum*). El-Bably (2003) on *Agapanthus africanus* studied the effect of seven different fertilization ratios (control, N_1, P_1, K, N_2P_2K, N_1P_2K, N_3P_1K, N_2P_1K, N_3P_2K where N_1, N_2 and N_3 = 6, 9 and 12 g ammonium sulfate, P_1 and P_2 = 3 and 6 g calcium superphosphate and K = 5 g potassium surphate), she found that all fertilization treatments significantly increased leaf length, leaves number/plant and fresh and dry weights over untreated plants. As well as, all fertilization treatments significantly increased spike length, spike diameter, fresh and dry weight of spike, florets number/spike, fresh and dry weight of florets over control.

Rochelle *et al.* (1997) supplied *Hedychium gardnerianum* plants with 200 or 400 kg N/ha 200 or 400 kg K_2O/ha and 400 or 800 kg P_2O_5/ha with 25% N, 66% P_2O_5 and 50% K_2O applied at planting, 25% applied 60 days later, 25% N+30% P_2O_5 +30% K_2O applied 210 days after planting and a further 25% N applied 270 days after planting. They stated that rates of applied K_2O significantly increased rhizome length and shoot number while no significant effects on N or P were observed.

MATERIALS AND METHODS

This study was carried out at Kafr-Dochmeis, Gharbia Governorate and the Laboratory of Faculty of Agriculture, Kafr El-Sheikh, Tanta University, during 2000/2001 and 2001/2002 seasons, to investigate the effect of five different N fertilization treatments on growth, flowering, rhizome productivity and chemical constituents of *Zantedeschia aethiopica* L. and *Hedychium coronarium*, in two separate experiments as follows: Control N_1, N_2, N_3 and N_4 at the rates 0,2,3,4 and 5 g/plant of ammonium sulfate (20.5%), respectively Regarding P and K, 7.0 g/plant of calcium superphosphate (15.5% P_2O_5) and 4.0 g/plant of potassium sulfate (48.5% K_2O) were used. The mixture of fertilizers was divided into four equal amounts. The first three doses were added at one month interval from planting while the fourth was applied after cutting of spikes. The experiment was a completely randamized block design as five treatments with three replicates and each replicate contained four plants (12 plants for each treatment).

The following data were recorded for the two experiments.

1- Foliage or plant height.
2- Leaf area cm^2.
3- Number of leaves per main shoot.
4- Number of leaves per clump.
5- Total shoots number per clump.
6- Fresh and dry weight of upper ground parts per clump.
7- Fresh and dry weight of new offsets/clup.

Flowering traites.

1- Flowering date.
2- Inflorescences number of main shoot.
3- Inflorescences number of new shoots/clump.
4- Flowering shoots number/clump.
5- Stalk length and diameter (cm).
6- Inflorescences height and diameter.
7- Rachis length (cm).
8- Florets number/inflorscences.
9- Fresh and dry weights of flowering spike/spike.

Rhizomes productivity

1- Main rhizome length and diameter.
2- Rhizome size per clump. (by soaking in recorded size of water).
3- Number of rhizome per clump.
4- Number of tubercales per clump.
5- Fresh and dry weights of rhizomes/clump.

Chemical analysis:

1- Chlorophyll (a) and (b). (Chlorophylls (a) and (b) mg/g fresh weight of the third leaf were determined according to Moran (1982)).
2- Total carbohydrates. ((mg/g dry weight). Using colorimetric method given by Herbert *et al.* (1971)).
3- Nitrogen, phosphorus and potassium%.

Total nitrogen was determined using microkjeldhle method according to Piper (1947), phosphorus was colorimetrically determined according to Troug and Meyer (1939) while potassium was determined using the flamephotometer according the method described by Brown and Lilliland (1946).

Irrigation and agricultural practices were done for all experiments whenever needed.

Duncan's Multiple Range Test was used for the comparison between means of treatments for the all experiments according to Snedecor and Cochran (1972).

The physical and chemical analysis of experimental soil are shown in Tables (A and B).

Table (A): Physical analysis.

Caly %	Silt %	Fine sand %	Cross sand %	Texture
36.2	22.4	13.0	28.4	Sand clay loam

Table (B): Chemical analysis.

PH	Ec	Anions (Me g/L)				Cations (me g/L)			Average nutrient mg/kg soil			
	Ds/m	CO_3^-	HCO_3^-	CL^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+	N	P	K
8.4	4.16	0	5.79	14.98	19.84	11.74	5.27	23.13	0.4	24.3	8.4	53.8

RESULTS AND DISCUSSION

Vegetative growth:

1- Plant height:

Data in Table (1) showed that all N treatments significantly increased plant height of calla over the control during both seasons. The tallest plants resulted from the treatments of N_3 and N_4 in the first season, while in the second one the treatment of N_4 gave the tallest plants. The shortest plants were of control in both season.

The significant tallest plants of *Hedycium coronarium* as shown in Table (2) had observed for the control in the two seasons, respectively. Similar results were observed by Goncalves *et al.* (1989) on *Hedychium gardnerianum.*

The increase in foliage height owing to the addition of nitrogen fertilizer may be attributed to the nitrogen which constitute amino acids form which the protein is synthesized that participates in cell enlargement and cell division (Develin, 1975).

2- Leaf area:

It is obvious from data in Table (1) that with increasing nitrogen level in fertilizer treatments, the leaf area significantly increased on calla during the two seasons than control with one exception in case of the treatment of N_1. The highest values resulted from N4 followed by N_3 in the first season and N_4 in the second one. It is obvious form data in Table (2) that the leaf area/leaf of *Hedychium coronarium* significantly increased gradually as N levels increased during both seasons. The highest value resulted from N_4 against the lowest values for the control in the two seasons, respectively. These results are in harmony with those of Badran *et al.* (1989) on calla.

Table (1): Effect of nitrogen treatments on vegetative growth characteristics of *Zantedeschia aethiopica* L. plant during 2000/2001 and 2001/2002 seasons.

Treatments	Foliage Height (cm)	Leaf area (cm)	No. of Leave main shoot	No. of Leaves/ clump	Total shoots. Number/ clump	Upper ground parts/clump	
						F.W. (g)	D.W. (g)
First season							
Control	56.50 c	199.79 c	6.09 b	52.75 b	8.93 c	129.07 d	19.94 c
N_1	65.25 b	262.91 bc	6.25 b	60.75 b	11.67 b	260.50 c	31.93 c
N_2	71.58 a	314.36 ab	6.75 a	62.33 b	12.42 b	463.75 b	47.64 b
N_3	75.50 a	324.78 ab	6.75 a	69.92 ab	14.45 b	467.69 b	68.25 a
N_4	75.25 a	340.04 a	6.83 a	78.25 a	19.58 a	491.03 a	75.11 a
Second season							
Control	46.33 e	153.46 d	5.25 c	49.17 d	11.17 d	456.13 c	41.14 c
N_1	52.17 d	164.27 d	5.83 b	57.00 c	11.83 cd	457.50 c	41.17 c
N_2	57.83 c	188.88 c	6.00 b	60.08 bc	12.92 bc	504.94 bc	45.09 bc
N_3	62.83 b	219.41 b	6.17 ab	64.92 b	13.67 ab	583.11 b	52.48 b
N_4	75.92 a	272.72 a	6.50 a	77.00 a	14.50 a	895.61 a	80.36 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test.

3- Number of leaves per main shoot:

It appears from data in Table (1) that all N fertilizer treatments significantly increased number of leaves/main shoot of Zantedeschia over the control during both seasons, except for the treatment of N_1 in the first season. The highest values resulted from N_4, N_3 and N_2 in both seasons. With increasing nitrogen level in fertilizer treatments, number of leaves/main shoot of *Hedycium*

coronarium significantly increased over the control during both seasons, Table (2). The highest values resulted from N_4 followed by N_3 in the first and the second seasons against 9.92 and 9.00 leaves for the control in both seasons, respectively. Similar results were obtained by Badran *et al.* (1989) on calla and El-Bably (2003) on Agapanthus.

4- Number of leaves per clump:

Data in Table (1) indicated that, all treatments increased number of leaves per clump of *Zantedeschia* over control in both seasons. The highest values resulted from N_4 followed by N_3 in the first season and N_4 in the second one.

5- Main shoot diameter (cm.)

The obtained results in Table (2) revealed that with increasing N treatments the main shoot diameter of *Hedycium* increased over the control during the two seasons. Significant increment resulted from N_3 and N_4 and the lowest values resulted from the control in both seasons. Similar results were reported by Ahmad *et al.* (1995) on *Strlitzia regina* leaves petiole.

Total shoots number per clump

It is indicated from Table (1) that total shoots number per clump on calla was significantly influenced by all N treatments when compared to control in both seasons, except for the N_1 treatment in the second season. The highest total shoots number/clump resulted from N_4 in both seasons, while the control treatment gave the least values of seasons. Data in Table (2) indicated that the highest values of total shoots/clump of *Hedychium* resulted from N_4 in the first season and the highest values resulted from N_3 and N_4 in the second one. While, the control gave the lowest values in both seasons. The obtained findings are in agreement with those mentioned by many researchers such as Badran *et al.* (1989) on calla and Clemens *et al.* (1998) on *Zantedechia albomaculata.*

7- Fresh and dry weight of upper ground parts per clump:

It appears from data in Table (1) that high rate of N in used treatments had pronounced significant effects on fresh weight of

upper ground parts of *Zantedeschia* plants when compared with untreated ones in the two seasons. While, increasing N in the treatments caused a gradual increase in the dry weight of upper ground parts over the control in the two seasons. The significantly heaviest fresh weight resulted from the treatment of N_4, while the control gave the least values of with the two seasons. Meanwhile, the significantly increment in dry weight was the highest for the treatments of N_4 in both seasons, while the lowest values resulted from the control treatments in the two seasons. It appears from data in Table (2) that the significantly heaviest fresh weight of *Hedycium* plants resulted from N_4 while, the dry weight significantly increased in both seasons. The control gave lowest fresh and dry weights in both seasons. The obtained findings are in agreement with those mentioned by Goncalves *et al.* (1989) on *Hedychium*.

The increase in dry weight of upper ground parts with the increase in the added fertilization especially nitrogen may be attributed to the increase in fresh weight of the foliage parts. It is well known that nitrogen has outstanding importance, since it comprises 40-50% of the dry weight of the protoplasm in the plantcells. Nitrogen also takes part in chlorophyll composition and the constituents of proteins, hence, encourages the development of the vegetative growth (Bidwell, 1974).

8- Fresh and dry weight of new offsets/clump.

It is evident from Table (2) that both fresh and dry weights of new offsets on *Hedychium* increased significancy by increasing the N rates in used treatments. The significantly heaviest fresh and dry weight of new offsets per clump of *Hedychiam* plants resulted from N_4 while, the control gave the least value of fresh and dry weight/clump during the two seasons. Similar trend of results was obtained by Goncalves *et al.* (1989) on *Hedychium*.

Flowering traites:

1- Flowering date:

Data in Table (3) detected that the application of N in the all fertilizer treatments significantly enhanced the flowering time of

Table (2): Effect of nitrogen treatments on the vegetative growth characteristics of *Hedychium coronarium*, Koenig plant during 2000/2001 and 2001/2002 seasons.

Treatments	Plant height (cm)	Leaf area/leaf (cm^2)	Leaves number of main shoot	Main shoot diameter (cm)	Total shoots number /clump	Main shoot weight (g)		New offsets weight (g)/clump		Rhizomes weight (g)/clump	
						Fresh	Dry	Fresh	Dry	Fresh	Dry
First season											
Control	89.42 d	31.48 d	9.92 d	1.13 c	8.88 d	102.67 c	14.79c	225.67 e	34.68 e	572.78 e	89.53 e
N_1	105.33 c	38.68 c	10.75 c	1.27 c	10.66 c	131.00 d	19.89b	343.33 d	52.88 d	615.00 d	95.26 d
N_2	111.58 b	42.61 b	12.67 b	1.43 b	11.61 bc	143.00 c	23.33ab	460.67 c	71.59 c	651.66 c	103.50 c
N_3	115.50 b	45.65 b	1308 ab	1.70 a	12.77 b	155.00 b	23.41ab	561.66 b	85.80 b	856.66 b	117.63 b
N_4	122.67 a	52.51a	13.50a	1.80 a	15.05 a	161.67 a	24.15a	723.33 a	110.71 a	1181.11a	126.36 a
Second season											
Control	58.00 d	30.74 d	9.00 d	1.10 d	6.67 c	100.31 d	12.81c	312.50 e	46.91 e	385.00 d	67.41 e
N_1	60.50 cd	38.26 c	11.00 c	1.30 c	9.83 b	109.23 d	13.95c	379.17 d	56.81 d	491.50 d	76.21 d
N_2	62.83 c	40.92 c	11.33 bc	1.50 b	11.00 b	135.18 c	17.26b	415.00 c	62.73 c	712.50 c	87.90 c
N_3	70.33 b	47.40 b	11.83 b	1.90 a	13.00 a	145.41 b	18.57ab	504.17 b	76.53 b	912.50 b	102.03 b
N_4	77.00 a	54.08 a	12.67 a	1.93 a	13.67 a	159.59 a	21.38a	354.17 a	99.32 a	1525.00 a	137.67 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test.

calla plants during both seasons. Whereas, the earliest significant flowering resulted from the treatments of N_3. But the longest time to flower was recorded from the control in both seasons. Data in Table (4) pointed out that all N treatments significantly enhanced the flowering time of *Hedychium* plants during both seasons. Whereas, the earliest significant flowering period resulted from N_3, whereas the control treatment took the longest time to flower in both seasons. These results are in harmony with those of Rocelle *et al.*, (1997). On *Hedychium* and El-Bably (2003) on *Agapanthus africanus*.

2- Inflorescence number of main shoot:

Data in Table (3) cleared that the inflorescence number of main shoot of callla plants was significantly affect in the first season, while there were significant differences in the second one with application the N treatments.

In accordance with these results are those reported by Badran *et al.* (1989) on *Zantedeschia eathiopica.*

Table (3): Effect of nitrogen treatments on flowering characteristics of *Zantedeschia aethiopica* L. plant during 2000/2001 and 2001/2002 seasons.

Treatments	Flowering date (days)	No. of inflorescence /main shoot	No. of inflorescence of new shoots/clump	Flowering shoots No. clump	Stalk length (cm)	Stalk diameter (cm)	Inflorescence height (cm)	Inflorescence diameter (cm)	Flowering spike weight (g)/spike	
									F.W.	D.W.
First season										
Control	170.25 d	2.17 a	4.25 c	3.33 c	56.27 d	1.33 c	8.81 c	7.36 d	45.40b	1.84b
N_1	163.42c	2.33a	6.92bc	4.67b	61.65c	1.70b	9.56bc	8.14b	56.69a	2.07ab
N_2	150.75b	2.42a	6.50bc	4.42bc	63.76bc	2.07a	10.18ab	9.29a	59.49a	2.18ab
N_3	117.58a	3.00a	8.25ab	5.33ab	66.14ab	2.01ab	11.14a	9.42a	64.15a	2.59a
N_4	156.58b	2.25a	10.08a	6.08a	67.45a	1.91ab	10.78a	9.51a	60.94a	2.36ab
Second season										
Control	149.08d	2.75c	7.75c	4.75c	53.44c	1.35c	9.71c	9.41c	39.09b	3.52d
N_1	124.75c	3.08bc	8.83bc	4.92bc	58.99b	1.43c	10.05c	9.94b	44.24b	3.98d
N_2	119.58c	3.25b	9.67b	5.17b	60.71b	1.65b	10.31bc	10.02ab	56.97a	4.58c
N_3	108.17a	3.67a	12.50a	6.08a	61.86b	1.87a	11.40a	10.32ab	67.54a	6.07a
N_4	115.75b	3.25b	9.58b	5.42b	68.25a	1.86a	11.00ab	10.47a	61.46a	5.53b

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test.

3- Inflorescences number new shoots/clump:

It is clear from data in Table (3) that, all used treatments appreciably affected the inflorescences number of new shoots on calla plants over the control in both season.

The significantly highest number was obtained from N_4 followed by N_3 treatments in the first season N_3 in the second one against the lowest value for control treatment in both seasons.

Data in Tale (4) revealed that all fertilization treatments significantly increased in florescences number/clump in comparison with the control during the two seasons. In the first season the significantly highest number of *Hedychium* plants resulted from in both seasons. These results are in harmony with those of Clemens *et al.* (1998) on *Zantedeschia olbamaculala.*

4- Flowering shoots number/clump:

It is obvious from Table (3) that all treatments increased number of the flowering shoots/clump over control in both seasons. The significantly highest number on calla plants resulted from N_4 followed by N_3 treatments in the first season and N_3 in the second one.

5- Stalk length and diameter (cm):

Data in Table (3) indicated that, all N treatments significantly increased stalk length over control in both seasons. The longest stalks resulted from N_4 in both seasons. It is distinct from data in Table (4) that, the treatment of N_4 in seasons was superior to both the other treatments as it resulted in the longest stalks of *Hedychium* plants over the control, in both seasons.

Also, all N treatments significantly increased stalk diameter of calla plants in comparison with the control during the two seasons except for the treatment of N_1 in the second season. The highest significant value was obtained from the treatment of N_2 in the first season and N_3 in the second one, while the control treatment gave the thinnest stalk diameter in both seasons. The significantly highest values of *Hedychium* plants were obtained from N_4 followed by N_3 in the first season and N_4 in the second one. In accordance with these mention results were those reported

by Badran *et al.* (1989) on *Zanedschia* and El-Bably (2003) on *Antholyza aethiopica.*

6- Inflorescence height and diameter:

It is evident from Table (3) that all N levels increased both inflorescence height or diameter of calla plants over the control during both seasons. The highest value was obtained by N_3 while the greatest diameter resulted from N_4 with the first season. These results was parallel with those obtained by Abdel-Wahid (1995) on Strelitzia.

Rachis length (cm):

The high levels of nitrogen significantly gave the longest rachis in both seasons as shown in Table (4). In the first season the highest value on rachis length of *Hedychium* resulted form N_3 followed by N_4 however, the control gave the shortest rachis. The lengthening of both the spikes and rachis may be due to the primitive effects of minerals especially nitrogen on increasing the division of plant tissues. This is in line with the results of Singh (2000) on *Polianthes tuberosa.*

Table (4): Effect of nitrogen treatments on flowering characteristics of *Hedychium coronarium,* Koenig plant during 2000/2001 and 2001/2002 seasons.

Treatments	Flowering date (days)	Inflorescence No/clump	Main stalk length (cm)	Main stalk diameter (cm)	Rechis length (cm)	Florets No/ inflorescence	Flowering spike weight (g)	
							Fresh	Dry
First season								
Control	143.39 d	5.16 c	93.77 e	1.09 d	6.84 d	7.94 d	115.95 d	10.29 d
N_1	137.44 c	7.05 b	107.08 d	1.17 c	8.60 c	9.89 c	130.06 c	11.51 c
N_2	134.89 c	7.61 b	111.20 c	1.28 b	9.03 bc	13.46 b	136.74 bc	12.70 b
N_3	114.16 a	8.89 a	118.50 b	1.42 a	10.31 a	19.50 a	179.87 a	16.62 a
N_4	122.94 b	7.11 b	133.11 a	1.45 a	9.72 ab	18.49 a	143.80 b	13.1 b
Second season								
Control	153.33 d	6.00 c	62.47 d	1.23 e	6.23 e	7.36 e	112.69 c	10.12 c
N_1	150.33 d	6.50 bc	64.77 d	1.31 d	7.51 d	8.61 d	136.14 b	12.25 b
N_2	139.16 c	7.17 ab	67.65 c	1.50 c	8.63 c	11.16 c	142.47 b	12.82 b
N_3	105.00 a	7.83 a	76.52 b	1.99 b	1052.a	20.70 a	176.45 a	18.89 a
N_4	121.50 b	7.33 a	80.43 a	2.12 a	9.35 b	19.45 ab	170.67 a	15.36 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test.

8- Florets number/inflorescence:

Data in Table (2) revealed that the significantly highest number of florets of *Hedychium* was obtained from N_3 followed by N_4 in the two seasons. While, the control recorded the least values in both seasons.

9- Fresh and dry weights of flowering spike/spike (g):

From the data in Table (3) in may be indicated that, all treatments increased fresh and dry weight of flowering spike of calla plants over the control during the two seasons. The values in descending order for the treatments of N_3, N_4, N_2 and N_1 with non-significant differences (among them) in the first season, while in the second one the treatment of N_3, N_4 and N_2 however the control gave the least value for both seasons.

From the data in Table (4) the significantly heaviest fresh and dry weight of *Hedychium coronarium* resulted from N_4 followed by N_3 in both seasons over the control. The obtained findings are in agreement with those mentioned by El-Bably (1998) and Nasr (2000) on tuberose.

Rhizome productivity:

1- Main rhizome length and diameter (cm):

Data in Table (5) showed that all N treatments increased both rhizome length and rhizome diameter of calla plants in comparison to the control. The largest length resulted from the treatment of N_4 in the first season while the increment of rhizome diameter was significant in case of N_3 only. In the second season the treatment of N_4 gave the largest rhizome length. Meanwhile, the N_4 treatment resulted in the thickest rihizomes and the smallest diameter resulted from the control treatment in both seasons. These results are in harmony with those of Badran *et al.* (1989) on calla.

2- Rhizome size per clump:

From Table (5) it is clear that, all N treatments significant increased rhizome size per clump on calla plants over the control during the two seasons, except for N_1 and N_2 in the second season,

which gave a non-significant increase. The lowest values of rhizome size were resulted from the control in the two seasons.

Table (5): Effect of nitrogen treatments on rhizome productivity of *Zantedeschia aethiopica* L. plant during 2000/2001 and 2001/2002 seasons.

Treatments	Main rhizome diameter (cm)	Main rhizome length (cm)	Rhizome size/ clump (cm^3)	No. of rhizome/ clump	No. of tubercales/ clump	Rhizome weight (g)/clump	
						Fresh	Dry
First season							
Control	4.08 b	7.14 c	300.75 e	8.93 c	86.33 c	390.47 d	103.17 d
N_1	3.97b	7.31 b	601.58c	10.47bc	102.75 c	403.59d	113.34 d
N_2	4.42b	8.20b	539.67d	11.22b	154.17b	698.17c	176.10 c
N_3	5.59a	9.11ab	724.00b	13.35b	199.25ab	905.58b	242.05 b
N_4	4.90ab	9.31a	773.42a	17.88a	230.17a	1301.34a	358.09 a
Second season							
Control	4.38e	9.25c	436.50b	10.63cd	75.25c	575.23 b	69.25 b
N_1	4.86d	9.83bc	553.92	11.17d	140.50b	664.40 b	79.58 b
N_2	5.24c	10.25b	644.67ab	11.52b	144.08b	781.19ab	93.96 ab
N_3	5.54b	11.08a	851.08a	11.87ab	167.08a	959.26 a	114.15 a
N_4	6.13a	11.42a	859.00a	12.60a	170.50a	981.57 a	117.79 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test.

3- Number of rhizome per clump:

Data in Table (5) showed that all N treatments increased number of rhizomes per clump of calla plants over the control in both seasons. The highest increment in the first season was obtained from the treatment of N_4. While, in the second one the corresponding values were obtained from the treatments of N_4 and N_3. The control recorded the least value of rhizomes/clump in both seasons. These results are conformity with those observed by El-Maadawy (1988) on tuberose.

4- Number of tubercales per clump:

From Table (5) it is clear that, all N treatments significantly increased number of tubercales/clump on calla plants over the control in both seasons. The highest increments were obtained from N_4. These results are in harmony with those observed by El-

Maadawy (1988) on tuberose and El-Bably (2003) on *Antholyza* and *agapanthus*.

5- Fresh and dry weight of rhizomes/clump:

Data in Table (5) indicated that all N treatments increased significantly both fresh and dry weights of rhizomes/clump of calla plants over control in both seasons. The heaviest fresh weight resulted from N_4 against the lightest weight for the control. Data in Table (5) revealed that the significant heaviest weight of *Hedychium* plants resulted from N_4 when compared to the other treatments and the control in both seasons. Meanwhile, the significantly heaviest dry weight resulted from N_4 when compared to the other treatments. This is in line with the findings of other workers as El-Maadawy (1988) on *Polianthes tuberosa* and El-Bably (2003) on Agapanthus.

Chemical constituents:

1- Chlorophyll (a) and (b)

It is clear from Tables (6 and 7) that all N treatments exhibited remarkable significant effect on chlorophyll (a) and (b) of calla leaves over control during both seasons. The highest significant chlorophyll (a) and (b) values resulted from N_3 in the two seasons for both plants.

While the lowest significant value recorded for the control treatment in both seasons. Similar findings were obtained by Badran *et al.* (1989) on calla.

2- Total carbohydrates:

From the data in Table (6) it can be indicated that all N treatments significantly increased total carbohydrates content in the leaves of calla over the control during the two seasons. The highest value was obtained from treatment of N_4 in both seasons with non-significant differences between the other N treatments. However the control treatment gave the least value. All fertilization treatments in Table (7) significantly increased total carbohydrates content in the leaves of *Hedychium*. The results are in harmony with those of Abdel-Wahid (1995) and El-Bably (2003) on *Polianthes tuberosa* and *Strelitizia reginea*.

Table (6): Effect of nitrogen treatments on chemical constituents of *Zantedeschia aethiopica* L. plant during 2000/2001 and 2001/2002 seasons.

Treatments	Chlorophyll (a) (mg/g. F.W.)	Chlorophyll (b) (mg/g. F.W.)	Total carbohydrates (mg/g D.W.)	N%	P%	K%
First seasons						
Control	1.23 d	0.21 d	10.34 c	1.38 d	0.13 e	1.12 c
N_1	1.43 c	0.32 c	11.18 b	1.49 c	0.22 c	1.34 b
N_2	1.59 b	0.39 b	11.25 b	1.52 c	0.26 b	1.55 ab
N_3	1.83 a	0.47 a	12.41 a	1.68 b	0.30 ab	1.64 a
N_4	1.64 b	0.42 ab	12.63 a	1.85 a	0.34 a	1.69 a
Second season						
Control	1.37 c	0.27 d	11.25 c	1.44 c	0.29 b	1.28 c
N_1	1.42 c	0.36 c	11.45 b	1.48 bc	0.31 b	1.38 b
N_2	1.69 b	0.42 bc	11.60 b	1.61 b	0.27 b	1.46 ab
N_3	1.81 a	0.51 a	12.31 a	1.90 a	0.31 b	1.54 a
N_4	1.73 ab	0.45 ab	12.38 a	2.03 a	0.37 a	1.48 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test.

Table (7): Effect of nitrogen treatments on chemical constituents of *Hedychium coronarium*, Koenig plant during 2000/2001 and 2001/2002 seasons.

Treatments	Chlorophyll (a) (mg/g. F.W.)	Chlorophyll (b) (mg/g. F.W.)	Total carbohydrates (mg/g D.W.)	N%	P%	K%
First seasons						
Control	1.117 d	0.072 e	19.85 c	1.20 c	0.25 c	1.75 d
N_1	1.22 c	0.108 d	21.60 b	1.64 b	0.32 b	2.58 c
N_2	1.280 c	0.163 c	21.75 b	1.68 b	0.33 ab	2.63 b
N_3	1.598 a	0.290 a	23.50 a	1.79 a	0.34 ab	2.77 a
N_4	1.366 b	0.215 b	24.80 a	1.76 a	0.39 a	2.85 a
Second season						
Control	1.214 c	0.064 d	18.15 c	1.18 c	0.27 c	1.63 d
N_1	1.222 c	0.150 c	21.75 b	1.63 b	0.32 b	2.53 c
N_2	1.288 bc	0.155 c	21.38 b	1.60 b	0.32 b	2.61 b
N_3	1.483 a	0.360 a	25.50 b	1.81 a	0.34 ab	2.84 a
N_4	1.358 b	0.232 b	26.00 a	1.80 a	0.40 a	2.89 a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test.

3- Nitrogen, phosphorus and Potassium percentage:

Data in Table (6) revealed that, all fertilization treatments had pronounced effects on nitrogen, phosphorus and potassium percentage in the leaves of calla plants when compared with untreated ones. In the second season N_1 had a non-significant effect

on in nitrogen content, whereas, N_4 resulted in significant increase on phosphorus % against control with the second season. The lowest value resulted from the control treatments with the all doses of NPK during the two seasons. Data in Table (7) show that nitrogen % significantly increased for N_3 and N_4 in the two seasons. While, the control gave the lowest values in both seasons. The highest phosphpurs percentage in leaves of *Hedychium* resulted from N_4 followed by N_3 in both seasons. The control gave the least value. The highest significant values of potassium on *Hedychium* obtained from N_4 then N_3. While, the control gave the least value. These results are in harmony with those recorded by Badran *et al.* (1989) on calla.

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الملخص العربي

دراسات فسيولوجية علي بعض أبصال الزينة

١- تأثير معاملات التسميد النتروجيني علي النمو الخضري ، الازهار وإنتاج الريزومات والمحتوي الكيماوي لنباتات الكلا *Zantedeschia aethiopica* L. والهيدكيم *Hedychium coronarium*, koenig

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أجريت تجربتين منفصلتين خلال موسمي ٢٠٠٠/٢٠٠١ ، ٢٠٠١/٢٠٠٢ وذلك لدراسة معاملات التسميد لنيتروجيني علي النمو والازهار وإنتاج الريزومات والمحتوي الكيماوي لنباتات الكلا *Zantedeschia aethiopica* L. والهيدكيم *Hedychium coronarium* استخدم أربع مستويات من النيتروجين (ن١=٢ ، ن٢=٣ ، ن٣=٤ ، ن٤=٥ جم/نبات) من سماد سلفات أمونيوم أما الفوسفور أضيف بمستوى ثابت لكل المعاملات بواقع ٧ جم/نبات من سوبر فوسفات الكالسيوم والبوتاسيوم أضيف بواقع ٤ جم/نبات من البوتاسيوم.

وقد أضيف بفاصل زمني شهر بين كل دفعة والأخرى وقد أضيفت الدفعة الأولى بعد ٣٠ يوم من تاريخ الزراعة أما الدفعة الرابعة فقد أضيفت بعد قطف الأزهار. وقد تم زراعة النباتات في تربة طميية رملية وكانت درجة الـ pH ٨,٤.

من النتائج المتحصل عليها وجد أن معاملة النيتروجين ٥جم/نبات من سلفات الأمونيوم قد أعطت أفضل النتائج التى درست فى نبات الكلا.

وكذلك المعاملة ٤ جم/نبات سلفات أمونيوم أعطت افضل النتائج لنبات الهيديكيم.