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EFFECT OF LIGHT INTENSITY AND AMINO ACID TRYPTOPHAN ON THE GROWTH AND FLOWERING OF AMARYLLIS (*HIPPEASTRUM VITTATUM*, HERB.) PLANTS

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ABSTRACT

A pot experiment was conducted on Amaryllis (*Hippeastrum vittatum*, Herb.) during the two successive seasons 2006/2007 and 2007/2008 in the Nursery of the Alexandria University, Alexandria, Egypt, to study the effect of light intensity, amino acid "tryptophan" at 0.0, 50, 100 and 150 ppm and their combination on growth, flowering and chemical composition of leaves and bulbs of *Hippeastrum vittatum*, Herb. plants. The results indicated that planting *Hippeastrum vittatum*, Herb. under plastic-house condition with average light intensity of 450-500 lux significantly reduced vegetative growth and flowering with little effect of amino acid "tryptophan" concentrations on vegetative growth and chemical composition of leaves and bulbs. On the other hand, planting *Hippeastrum vittatum*, Herb. under full sun light condition (open field) with applying amino acid tryptophan at the different concentrations(0.0, 50,100,150 ppm) during the growing season, improved vegetative growth , flowering , bulbs production and chemical composition parameters (number of leaves / plant at flowering time, leaf length and width (cm), total leaf fresh and dry weight / plant (g), number of days to flowering, number of flowering stalk / plant, flower stalk length , flower stalk diameter , number of florets / flower stalk, bulbs diameter, bulbs fresh and dry weight (g), number of new bulblets, total chlorophyll content and total

carbohydrates content). In general, full sun light condition and spraying the plants with 150 ppm tryptophan is the best treatment for growth and flowering of *Hippeastrum vittatum*, Herb. plants.

Key words: Amaryllis *Hippeastrum vittatum*, Flowering Bulbs, Amino acids , Tryptophan, Light intensity , cut flowers.

INTRODUCTION

Hippeastrum vittatum, Herb.(Amaryllidaceae**)** occupies an important position as one of the most important and economic cut flower crops all over the world and can be planted in beds, in edging and borders along the paths or sides, in pots or indoor, as a foliage and flowering pot plant in a time where is nearly a lack of other flowers. It is a hardy herbaceous perennial growing from bulbs and seeds. The role of amino acid *i.e* .(tryptophan) in stimulating the growth and activating plants were studied by Phillips (1971) who stated that several alternative roles of IAA synthesis exist in plants all starting from amino acids also function in the synthesis of other organic compound , such as protein, amines, purine and primidines,alkaloids, enzymes, terpenoids and others (Goss,1973). The beneficial effect of amino acids on new cell production through restoring the specific enzymes for protein synthesis has been stated by Levitt (1980). Amino acids and light intensity are considered two of the most important factors affecting ornamental plants. Several investigators studied the effects of amino acids on ornamental plants i.e., Haridy (1986) on *Catharanthus roseus,* L showed that plant fresh and dry weights were increased by tryptophan application at 100 ppm. Plant height as well as number of branches/plant was not significantly affected by application of tryptophan. Hassan (1997) indicated that foliar spraying of tryptophan at 50,100 and150 ppm on *Narcissus tazetta* plant resulted in improving vegetative growth measurements and caused significant increase in the parameters of peduncle(number, length, fresh and dry weights).Also, the different concentrations caused early flowering and significant increase in number of florets, diameter and fresh weight of florets per plant. The best results in this concern were obtained with the higher concentrations .Wahba *et al.,* (2002) on

Antholyza aethiopica, showed that tryptophan and aspartic acid at 25,50 and 75 ppm for each increased number of leaves , leaf width , number of flower / spike ,fresh weight of spike ,number of corm / plant ,diameter, fresh and dry weights of corms /plant. but the highest value was obtained by tryptophan at 75 ppm .Talaat *et al.,* (2005) reported that tryptophan increased plant height , branch number , fresh and dry weights of leaves and increased chlorophyll(a and b), caretonoids ,protein and alkaloids contents of *Catharanthus roseus*,L plants . With respect to the effects of light intensity on ornamental plants. Hassan (1974) found that a positive relationship between total energy received by chrythanthemum plant and their vegetative growth , flowering and flowering controlling . Choi *et a*l., (1991) studied the effects of shading on growth and flowering characteristics and bulb production of *Lycoris radiate*. They mentioned that shading delayed flowering and shortened its duration. Bulb yield was highest with 35% shade and lowest with 95% shade. Yim and Kim (1995) investigated the effects of shading on the vegetative growth *Zoysia japonica* Steud. Leaf length was increased with shade intensity up to 75%. Stolon and rhizome growth was decreased with shading. Shoot, stolon + rhizome, and root dry weight were reduced by all shade treatments. Huh *et al*., (1998) reported that a high light intensity (full sunlight) enhanced the quality of flowers of amaryllis (*Hippeastrum hybridum*). Bell and Danneberger (1999) studied the effects of exposing creeping bentagrass *Agrostis palustris* cv. "Penncross" turf to full sun and shade. They noticed that permanent shade caused a decrease in colour and shoot density. Moreover, concentrations of chlorophyll a and b, were decreased under permanent shade compared with full sun. Clark *et al*., (2002) studied the effects of light intensity on the cut flower production of *Cyrtanthus elatus*. Shade delayed flowering and decreased the number of stems per bulb.

The objectives of the present study were: 1) to investigate the effect of the application four concentrations of amino acid "tryptophan" under two different light intensity i.e., open field and plastic-house conditions and their interaction on the vegetative growth, flowering parameters and bulbs production of *Hippeastrum vittatum*, Herb.plants, 2) to evaluate the effect of these treatments on total chlorophyll of leaves and bulbs carbohydrates content.

MATERIALS AND METHODS

The study was conducted at the Nursery of Alexandria University, Alexandria, Egypt throughout the two growth seasons of 2006/07 and 2007/08.

Uniformed bulbs of *Hippeastrum vittatum*, cv. Minerva**)** with an average weight of 150 g and 6 cm in diameter were chosen for the present investigation. Bulbs were cultivated in clay pots of 30 cm diameter (one bulb / pot) filled with medium of sandy loam on 1st Oct, in the first and second season . Analysis of some chemical and physical properties of the used medium were carried out according to Page *et al.* (1982) and are presented in Table(1)

Table (1): Some physical and chemical Properties of the growing medium

Property	Results of Analysis
Sand, %	69.1
Silt, %	17.7
Clay, %	13.2
Textural Class	Sandy Loam
WHC, %	16.22
EC, dS m^{-1} *	2.17
pH *	8.10
$CaCO_3$, %	3.91
CEC, $cmol_c$ kg^{-1}	18.51
Total Nitrogen, g kg^{-1}	1.81

* Measured in the soil paste extract.

The Amaryllis plants (*Hippeastrum vittatum*, cv. Minerva) were divided into two groups, the first group was put under plastic and saran house (shading) allowing maximum light intensity of 450 -500 flux throughout the growing season. Whereas, the second group was settled in open field condition (full sun light) with a maximum light intensity of 8000 -10000 lux. The open field (full sun) and plastic house conditions (shading) of temperature and relative humidity measured during the growing seasons 2006/07 and 2007/08, are illustrated in Table (2).

Table (2). Averages of monthly temperature and relative humidity (R.H.) of the study under open field (full sun) and plastic and saran house (shading) measured during the two experimental periods in 2006/07-2007/08.

Months of growing seasons (2006/07)	Open field		Plastic house		Months of growing seasons (2007/08)	Open field		Plastic house	
	Temp. (ºC)	R.H. (%)	Temp. (ºC)	R.H. (%)		Temp. (ºC)	R.H. (%)	Temp. (ºC)	R.H. (%)
Oct. 2006	27	69	34.6	76.5	Oct. 2007	28	68.5	34.7	77
Nov. 2006	26	68	34	76.2	Nov. 2007	26	67	34	76.5
Dec. 2006	22	65	28	75.3	Dec. 2007	23	66	28.2	75.6
Jan. 2007	20	64	26	75	Jan. 2008	20.4	64	26	75
Feb. 2007	20.5	65.7	26.5	75	Feb. 2008	20	64.5	26.2	74
Mar. 2007	21.9	66	27.4	75.3	Mar. 2008	21.6	65	27.6	75.5
Apr. 2007	23.6	66	28.5	76	Apr. 2008	23.8	65	28.7	75
May, 2007	27	69	32.5	77	May, 2008	27.4	71.8	31.5	76.5

The plants were sprayed three times with the amino acid "Tryptophan" at concentrations of 0.0 (control), 50, 100 and 150 ppm. The first addition was added after45 days from the planting, the second was added after one month from the first one and the third was added one month after the second one in both seasons. All the plants under the experiment received 3 g/ pot monthly of a complete mineral fertilizer 19:19:19: (N: P_2O_5: K_2O) as dressing application starting from 1st November in both seasons(2006/07 and 2007/08) until reaching the flowering stage . The experiment was terminated on 30th June for both seasons (2006/07 and 2007/08)**.**

The experimental lay-out was designed to provide randomized complete blocks in factorial type containing three replicates. Each replicate contained eight treatments (2 light intensity x 4 amino acid tryptophan). Five plants were used as a plot for each treatment in the replicate.

The data recorded for the vegetative growth parameters included; number of leaves / plant at flowering time, leaf length and width (cm), total leaf fresh and dry weight / plant (g). While, the flowering data included; number of days from planting time to shown color of the first flower, number of flowering stalk / plant, flower stalk

length , flower stalk diameter , number of florets / flower stalk,. In addition, the recorded data of the bulbs and bulblets were; bulbs produced diameter at the end of the experiment, bulbs fresh and dry weight (g) and number of new bulblets. The data recorded for the chemical composition included; Leaf total chlorophyll content (mg/100g L.F.W.) was determined according to the method described by Moran and Porath (1980) The total carbohydrate content in dried bulbs samples was determined according to Herbert *et al*., (1971).

The data were statistically analyzed according to the methods described by Snedecor and Cochran, (1981) using L.S.D. to compare between means of treatments.

RESULTS AND DISCUSSION

A- Vegetative growth characteristics:

1- Number of leaves / plant , leaf length and width (cm)

Data in Table (3) show significant increases in leaves number, leaf length and width values as a result of exposing the plants to full sun light condition. The high light intensity resulted in high rate of photosynthesis production which reflected on plant growth and its development which led to increase in number of leaves / plant, leaf length and width.

These results are in agreement with those of Huh *et al*., (1998) on amaryllis(*Hippeastrum hybridum*) and Huber and Schulz (1997). They found that 75% shading considerably reduced growth of *Lolium prenne, Poa pratensis* and *Festuca rubra*. These results might be due to the effect of low light intensity on the rate of photosynthesis process which reduced plant growth.

Regarding the amino acid tryptophan concentrations, they significantly increased leaves number, leaf length and width compared to the control. The concentrations of 150 ppm tryptophan gave the highest values of leaves number, leaf length and width compared to the other treatments of application. This result could be attributed to the beneficial effect of amino acids on new cell production through restoring the specific enzymes for protein synthesis (Levitt 1980). Similar results were obtained by Hassan

(1997) on *Narcissus tazetta* and Wahba *et al.,* (2002) on *Antholyza aethiopica,*bulbs.

For the interaction between light intensity and tryptophan there were highly significant differences were observed. The highest value of number of leaves, leaf length and width were obtained from plants grown under full sun condition and 150 ppm tryptophan concentrations, while the lowest values were obtained under plastic-house condition and without applying amino acid "tryptophan" in both seasons.

2- Total leaf fresh and dry weights / plant (g):

Data presented in Table (4) reveal significant decrease in total leaf fresh and dry weights as a result of grown the plants under plastic-house, while open field (full sun light) had significantly the greatest effect on total leaf fresh and dry weights. These results may be related to the reduction effect of low light intensity on the rate of photosynthesis and its products and the activity of plant uptake of minerals which reflected on fresh and dry weights of leaves.

Concerning tryptophan concentration, it was found that spraying either the concentration of 100 or 150 ppm amino acid "tryptophan" resulted in the greatest total leaf fresh and dry weights compared to the control in both seasons. However, the highest concentration of 150 ppm tryptophan was more effective than 50 and 100 ppm tryptophan. The higher concentrations of tryptophan may stimulate growth by increasing the leaves development and the size of photosynthesizing surface. These results are in accordance with those obtained by Hassan (1997) on *Narcissus tazetta* , Gomaa (2003) on *Crinum asiaticum* bulbs and Talaat *et al.,* (2005) with *Catharanthus roseus,*L plants.

The interaction between light intensity and amino acid "tryptophan" concentrations significantly affected total leaf fresh and dry weights. Applying100 or 150 ppm amino acid "tryptophan" under full sun light condition resulted in produce the greatest total leaf fresh and dry weights, while the plastic-house significantly reduced their values, either with or without tryptophan, in both seasons.

Table (3). Effect of light intensity, amino acid "tryptophan" and their interaction on number of leaves / plant , leaf length (cm) and leaf width (cm) of *Hippeastrum vittatum*, cv.Minerva plants during 2006/07 and 2007/08 seasons.

Number of leaves /plant							
First season (2006/07)				**Second season (2006/07)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**ight intensity (A)**		**Mean**
	Open field	**Plastic house**			**Open field**	**Plastic house**	
0.0 ppm	6.85	4.52	5.68	**0.0 ppm**	6.89	4.54	5.71
50 ppm	7.65	5.63	6.64	**50 ppm**	7.67	5.60	6.63
100 ppm	8.28	6.13	7.20	**100 ppm**	8.31	6.14	7.22
150 ppm	8.97	6.98	7.97	**150 ppm**	8.98	6.94	7.96
Mean	7.94	5.81		**Mean**	7.96	5.80	
L.S.D (0.05)	For A = 0.39 For B = 0.42			For A = 0.34 For B = 0.44 For (AxB) = .051			
Leaf length (cm)							
First season (2006/07)				**Second season (2007/08)**			
Tryptophan Conc. (B)	**ight intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**ight intensity (A)**		**Mean**
	Open field	**Shading**			**Open field**	**Plastic house**	
0.0 ppm	37.50	23.36	30.43	**0.0 ppm**	39.00	24.19	31.59
50 ppm	41.26	25.75	33.50	**50 ppm**	41.82	25.74	33.78
100 ppm	45.33	28.70	37.01	**100 ppm**	45.93	27.73	36.83
150 ppm	47.33	32.32	39.82	**150 ppm**	48.12	30.53	39.32
Mean	42.85	27.53		**Mean**	43.72	27.05	
L.S.D (0.05)	For A = 1.14 For B = 1.33			For A = 1.25 For B = 1.42 For (AxB) = 1.80			
Leaf width (cm)							
First season (2006/07)				**Second season (2007/08)**			
Tryptophan Conc. (B)	**ight intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**ight intensity (A)**		**Mean**
	Open field	**Plastic house**			**Open field**	**Plastic house**	
0.0 ppm	1.93	0.97	1.45	**0.0ppm**	1.96	1.00	1.48
50 ppm	2.45	1.23	1.84	**50 ppm**	2.47	1.25	1.86
100 ppm	3.13	1.68	2.40	**100 ppm**	3.17	1.66	2.41
150 ppm	3.65	2.29	2.97	**150 ppm**	3.65	2.28	2.96
Mean	2.79	1.54		**Mean**	2.81	1.55	
L.S.D (0.05)	For A = 0.33 For B = 0.36			For A = 0.28 For B = 0.32 For (AxB) = 0.43			

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 level of probability

Table (4). Effect of light intensity, amino acid "tryptophan" and their interaction on total leaf fresh and dry weight / plant (g) , of *Hippeastrum vittatum*, cv.Minerva plants during 2006/07 and 2007/08 seasons.

Total leaf fresh weight / plant (g)							
First season (2006/07)				Second season (2007/08)			
Tryptophan Conc. (B)	Light intensity (A)		Mean	Tryptophan Conc. (B)	Light intensity (A)		Mean
	Open field	Plastic house			Open field	Plastic house	
0.0 ppm	94.18	45.76	69.97	**0.0 ppm**	97.10	46.83	71.96
50 ppm	105.79	60.97	83.38	**50 ppm**	107.35	58.54	82.94
100 ppm	127.38	69.93	98.65	**100 ppm**	127.97	68.94	98.45
150 ppm	139.54	75.08	107.31	**150 ppm**	142.19	73.28	107.73
Mean	116.72	62.93		**Mean**	118.65	61.90	
L.S.D (0.05)	For A = 3.56 For B = 4.86 For (AxB) = 6.12			For A = 3.98 For B = 4.25 For (AxB) = 6.73			
Total leaf dry weight / plant (g)							
First season (2006/07)				Second season (2006/07)			
Tryptophan Conc. (B)	Light intensity (A)		Mean	Tryptophan Conc. (B)	Light intensity (A)		Mean
	Open field	Plastic house			Open Field	Plastic house	
0.0 ppm	21.34	11.36	16.35	**0.0 ppm**	21.64	11.34	16.49
50 ppm	24.35	12.87	18.61	**50 ppm**	24.00	12.91	18.45
100 ppm	29.12	15.73	22.42	**100 ppm**	28.55	15.34	21.94
150 ppm	33.27	17.54	25.40	**150 ppm**	33.01	17.36	25.18
Mean	27.02	14.37		**Mean**	26.80	14.24	
L.S.D (0.05)	For A = 2.18 For B = 2.17 For (AxB) = 3.76			For A = 2.46 For B = 3.19 For (AxB) = 4.96			

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 level of probability

B- Flowering characteristics:

1- Number of days to flowering:

It is obvious from the tabulated data the clear effect of growing the plants under plastic house condition for increasing the time required from planting to flowering compared with that obtained from growing the plants under open field (full sun) condition (Table 5). The earliest flowers were obtained by cultivation under full sun light condition in both seasons. These results agree with those of Huh

et al., (1998) on amaryllis (*Hippeastrum hybridum*). Using the medium and highest concentrations of tryptophan treatment significantly decreased the number of days taken to flowering compared with that obtained from the other treatments in both experimental trials. Meanwhile, the other concentrations treatments gave about the same effect in this concern as indicated in Table (5) These results agree with those of Wahba *et al.,* (2002) on *Antholyza aethiopica,*bulbs .

Concerning the interaction, it could be concluded that receiving the plants either 100 ppm and /or 150 ppm tryptophan concentrations with plants grown under full sun light condition were the best treatments for reducing the number of days to flowering in both seasons as seen in Table (5).

2- Number of flowering stalk / plant, stalk length and diameter, florets number / stalk, **florets diameter (cm) and fresh weight (g)**:

As shown in Table (5 , 6 and 7) grown the plants under plastic house decreased the number of stalk per plant, stalk length and diameter, florets number / stalk, florets diameter and fresh weight while, open field (full sun) condition gave the highest records in both seasons.

The results agree with those obtained by Clark *et al.,* (2002) on *Cyrtanthus elatus* and Budryte *et al*., (1999) on some turf grasses. They noticed that increase the shading reduced the number of shoots of *Lolium prenne* and *Festuca rubra.* These results may be related to the effect of low light intensity on reduce the rate of most of vital processes of the plant.

Also, the results show that, tryptophan concentrations significantly affected the number of stalk/ plant, stalk length and diameter. The concentration 150 ppm tryptophan resulted in the highest records compared to the other concentrations in the first and second seasons. The results agree with those obtained by Hassan (1997) on *Narcissus tazetta* and Shoala (2000) on *Lavendula multifida* .

The interaction between light intensity and amino acid "tryptophan" was very effective on number of stems per bulb. Applying the highest concentrations of tryptophan under open field (full sun light) condition resulted in the highest number of stalk/ plant,

stalk length and diameter, florets number / stalk, florets diameter and fresh weight. However, grown the plants under plastic house condition and without spraying of tryptophan gave the lowest values of the previous flowering parameters.

Table (5). Effect of light intensity, amino acid "tryptophan" and their interaction on the number of day to flowering (day), number of flowering stalk / plant of *Hippeastrum vittatum*, cv.Minerva plants during 2006/07and 2007/08 seasons.

Number of days from planting to flowering (day)							
First season (2006/07)				**Second season (2007/08)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**Light intensity (A)**		**Mean**
	Open field	**Plastic house**			**Open field**	**Plastic house**	
0.0 ppm	210.48	217.76	214.12	**0.0 ppm**	211.13	219.24	215.18
50 ppm	203.75	214.58	209.16	**50 ppm**	203.75	215.00	209.37
100 ppm	192.48	212.11	202.29	**100 ppm**	190.39	212.24	201.31
150 ppm	187.43	209.24	198.33	**150 ppm**	187.32	209.38	198.35
Mean	198.53	213.42		**Mean**	198.15	213.96	
L.S.D (0.05)	For A = 2.12 For B = 3.68 For (AxB) = 6.01			For A = 2.27 For B = 3.79 For (AxB) = 6.32			
Number of flowering stalk / plant							
First season (2006/07)				**Second season (2007/08)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**Light intensity (A)**		**Mean**
	Open field	**Plastic house**			**Open field**	**Plastic house**	
0.0 ppm	1.57	1.10	1.33	**0.0ppm**	1.63	1.12	1.37
50 ppm	2.15	1.24	1.69	**50 ppm**	2.20	1.23	1.71
100 ppm	2.85	1.45	2.15	**100 ppm**	2.89	1.44	2.16
150 ppm	3.91	1.95	2.93	**150 ppm**	3.93	1.92	2.92
Mean	3.37	1.43		**Mean**	2.66	1.43	
L.S.D (0.05)	For A = 0.17 For B = 0.22 For (AxB) = 0.31			For A = 0.19 For B = 0.25 For (AxB) = 0.36			

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 level of probability

Table (6). Effect of light intensity, amino acid "tryptophan" and their interaction on flower stalk length (cm) Stalk diameter (cm) of *Hippeastrum vittatum*, cv.Minerva plants during 2006/07and 2007/08 seasons.

Flower stalk length (cm)							
First season (2006/07)				Second season (2007/08)			
Tryptophan Conc. (B)	Light intensity (A)		Mean	Tryptophan Conc. (B)	Light intensity (A)		Mean
	Open field	Plastic house			Open field	Plastic house	
0.0 ppm	48.95	26.39	37.67	**0.0 ppm**	48.98	24.37	36.67
50 ppm	59.38	30.89	45.13	**50 ppm**	57.94	29.35	43.64
100 ppm	63.27	34.19	48.73	**100 ppm**	64.62	34.29	49.45
150 ppm	68.08	37.35	52.71	**150 ppm**	68.78	36.69	52.73
Mean	60.10	32.20		**Mean**	60.08	31.17	
L.S.D (0.05)	For A = 1.89 For B = 2.52 For (AxB) = 3.22			For A = 2.39 For B = 3.13 For (AxB) = 3.58			
Stalk diameter (cm)							
First season (2006/07)				Second season (2006/07)			
Tryptophan Conc. (B)	Light intensity (A)		Mean	Tryptophan Conc. (B)	Light intensity (A)		Mean
	Open field	Plastic house			Open field	Plastic house	
0.0 ppm	1.75	1.33	1.54	**0.0 ppm**	1.69	1.35	1.52
50 ppm	1.93	1.59	1.76	**50 ppm**	1.98	1.55	1.76
100 ppm	2.26	1.77	2.01	**100 ppm**	2.29	1.76	2.02
150 ppm	2.58	1.80	2.19	**150 ppm**	2.58	1.82	2.20
Mean	2.13	1.62		**Mean**	51.44	1.62	
L.S.D (0.05)	For A = 0.16 For B = 0.22 For (AxB) = 0.27			For A = 0.13 For B = 0.20 For (AxB) = 0.25			

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 level of probability

Table (7). Effect of light intensity, amino acid "tryptophan" and their interaction on number of florets / flower stalk , flower diameter (cm) , and fresh weight of flower stalk (g) of *Hippeastrum vittatum*, cv.Minerva plants during 2006/07and 2007/08 seasons.

Number of florets / flower stalk							
First season (2006/07)				Second season (2007/08)			
Tryptophan Conc. (B)	Light intensity (A)		Mean	Tryptophan Conc. (B)	Light intensity (A)		Mean
	Open field	Plastic house			Open field	Plastic house	
0.0 ppm	2.50	1.39	1.94	**0.0 ppm**	2.43	1.39	1.91
50 ppm	3.17	1.57	2.37	**50 ppm**	3.19	1.54	2.36
100 ppm	3.31	1.95	2.63	**100 ppm**	3.36	1.96	2.66
150 ppm	3.85	2.21	3.03	**150 ppm**	3.87	2.12	2.99
Mean	3.21	1.78		**Mean**	3.21	1.75	
L.S.D (0.05)	For A = 0.24 For B = 0.27 For (AxB) = 0.36			For A = 0.23 For B = 0.27 For (AxB) = 0.36			
Flower diameter (cm)							
First season (2006/07)				Second season (2007/08)			
Tryptophan Conc. (B)	Light intensity (A)		Mean	Tryptophan Conc. (B)	Light intensity (A)		Mean
	Open field	Plastic house			Open field	Plastic house	
0.0 ppm	6.23	4.17	5.20	**0.0ppm**	6.22	4.20	5.21
50 ppm	6.69	4.53	5.61	**50 ppm**	6.73	4.49	5.61
100 ppm	7.21	4.79	6.00	**100 ppm**	7.30	4.79	6.04
150 ppm	7.73	4.98	6.35	**150 ppm**	7.76	4.93	6.34
Mean	6.96	4.62		**Mean**	7.00	4.60	
L.S.D (0.05)	For A = 0.13 For B = 0.17 For (AxB) = 0.20			For A = 0.11 For B = 0.15 For (AxB) = 0.19			
Fresh weight of flower stalk (g)							
First season (2006/07)				Second season (2007/08)			
Tryptophan Conc. (B)	Light intensity (A)		Mean	Tryptophan Conc. (B)	Light intensity (A)		Mean
	Open field	Plastic house			Open field	Plastic house	
0.0 ppm	161.32	84.96	123.14	**0.0 ppm**	163.02	85.13	124.07
50 ppm	165.89	93.54	129.71	**50 ppm**	167.23	94.76	130.99
100 ppm	178.36	98.10	138.23	**100 ppm**	175.94	97.35	136.64
150 ppm	185.27	104.35	144.81	**150 ppm**	186.38	105.00	145.69
Mean	172.71	95.24		**Mean**	173.14	95.56	
L.S.D (0.05)	For A = 4.03 For B = 5.67 For (AxB) = 7.52			For A = 3.21 For B = 4.01 For (AxB) = 5.68			

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 level of probability

C- bulbs and bulblets characteristics:

Data presented in Table (8 and 9) show the greatest effects of light intensity on bulbs and bulblets productivity. Plastic house (shading) condition decreased it to the least value. The low light intensity had inhibitory effects on bulbs and bulblets characteristics due to reduced the rate of photosynthesis process hence reduced the dry matter accumulation in plant organs. While, full sun increased its to the greatest value of bulbs and bulblets productivity such as bulbs diameter, bulbs fresh and dry weight and number of bulblets/ plant in both seasons. These results are in accordance with those of Yim and Kim (1995) on *Zoysia japonica*, . They found that shading at 55% or more reduced dry weight of root. The maximum increase in bulbs and bulblets characteristics was recorded with the concentrations of 150 ppm tryptophan. However, a medium value was recorded with 100 ppm tryptophan concentration compared with the control. Similar results were obtained by Hassan (1997) on *Narcissus tazetta*.

The significantly combined effect of light intensity and tryptophan concentrations on bulbs and bulblets. The highest values were detected with plants which received100 ppm and 150 ppm tryptophan under full sun light condition, while the lowest values were detected with plants grown under plastic-house without receiving any amino acid "tryptophan".

D- Chemical composition:

1- Leaf total chlorophyll content:

The results presented in Table (10) reveal significant effects of full sun light condition on total chlorophyll content. Shading reduced it to the least values. plants grown under the full sun light significantly increased these values in both seasons. This result might be reasonable since it is known that light stimulates chlorophyll synthesis (Salisbury and Ross, 1978). Similar results were obtained by Bell and Danneberg (1999) on *Agrostis palustris* turf. They mentioned that concentrations of chlorophyll a and b were decreased under permanent shade compared with full sun.

Concerning tryptophan treatments, a gradual increase was observed in total chlorophylls content with increasing amino acid tryptophan concentrations from low to high concentrations compared

with the control treatment. This result agrees with those obtained by Talaat *et al.,* (2005) on *Catharanthus roseus*,L plants.

The interaction between light intensity and tryptophan concentrations had significant affected total chlorophyll content. Full sun light in combination with different concentrations of tryptophan treatments resulted in the highest content of the total chlorophylls. On the other hand, plants grown under plastic-house without using any tryptophan gave in the lowest values. However, increasing concentrations of tryptophan under shading resulted in some increases in total chlorophylls content.

2- Total carbohydrates contents in bulbs:

Data in Table (10) show significant increment in total carbohydrates content in plants grown under open field (full sun light), compared to those grown under plastic house (shading). This result might be due to the increase in vegetative growth and chlorophyll content which resulted in more photosynthetic products, (Salisbury and Ross, 1978).

These results are in agreement with those obtained by Qian and Engelke (1999). They reported that shading reduced total non-structural carbohydrate content. Regarding the tryptophan treatments, they significantly affected total carbohydrates content. The highest value was recorded with using 150 ppm, tryptophan compared to the control in both seasons. These results are in accordance with those of Wahba *et al.,* (2002) on *Antholyza aethiopica*,bulbs .

Concerning the interaction, it was found that applying 150 ppm, tryptophan concentrations under full sun light condition gave the highest content of carbohydrates. While, 150 ppm, tryptophan concentrations under shading condition resulted in some increase in total carbohydrates content.

Table (8). Effect of light intensity , amino acid "tryptophan" and their interaction on bulb diameter (cm) and bulb fresh weight (g) of *Hippeastrum vittatum*, cv.Minerva plants during 20006/07 and 2007/08 seasons.

Bulb diameter (cm)							
First season (2006/07)				**Second season (2006/07)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**Light intensity (A)**		**Mean**
	Open field	**Plastic house**			**Open field**	**Plastic house**	
0.0 ppm	6.20	6.05	6.12	**0.0 ppm**	6.36	6.07	6.21
50 ppm	6.59	6.13	6.36	**50 ppm**	6.61	6.10	6.35
100 ppm	7.62	6.29	6.95	**100 ppm**	7.59	6.30	6.94
150 ppm	7.97	6.42	7.19	**150 ppm**	7.96	6.44	7.20
Mean	7.09	6.23		**Mean**	7.13	6.23	
L.S.D $_{(0.05)}$	For A =0.09 For B = 0.13			For A = 0..08 For B = 0.11 For (AxB) = 0.19			
Bulb fresh weight (g)							
First season (2006/07)				**Second season (2007/08)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**Light intensity (A)**		**Mean**
	Open field	**Plastic house**			**Open field**	**Plastic house**	
0.0 ppm	167.48	132.19	149.83	**0.0 ppm**	169.49	133.92	151.70
50 ppm	187.38	157.26	172.32	**50 ppm**	188.12	155.30	171.71
100 ppm	198.95	172.39	185.67	**100 ppm**	197.95	171.74	184.84
150 ppm	210.28	193.46	202.05	**150 ppm**	208.37	190.11	199.24
Mean	191.02	163.82		**Mean**	190.98	162.77	
L.S.D $_{(0.05)}$	For A = 3.28 For B = 5.67 For (AxB) = 7.20			For A = 2.09 For B = 3.82 For (AxB) = 5.63			

L.S.D$_{(0.05)}$ = Least significant differences at 0.05 level of probability

Table (9). Effect of light intensity , amino acid "tryptophan" and their interaction on bulb dry weight (g) and number of bulblets / plant of *Hippeastrum vittatum*, cv.Minerva plants during 20006/07 and 2007/08 seasons.

Bulb dry weight (g)							
First season (2006/07)				**Second season (2007/08)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**Light intensity (A)**		**Mean**
	Open field	**Plastic house**			**Open field**	**Plastic house**	
0.0 ppm	36.83	26.28	31.55	**0.0ppm**	36.79	25.97	31.38
50 ppm	39.27	29.15	34.21	**50 ppm**	38.26	29.50	33.88
100 ppm	44.54	33.18	38.86	**100 ppm**	44.31	33.95	39.13
150 ppm	48.00	38.93	43.46	**150 ppm**	46.92	36.13	41.52
Mean	42.16	31.88		**Mean**	41.57	31.39	
L.S.D (0.05)	For A = 1.71 For B = 2.41			For A = 1.12 For B = 1.57 For (AxB) = 2.52			
Number of bulblets/ plant							
First season (2006/07)				**Second season (2007/08)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**Light intensity (A)**		**Mean**
	Open field	**Plastic house**			**Open field**	**Plastic house**	
0.0 ppm	1.65	1.03	1.34	**0.0 ppm**	1.67	1.00	1.33
50 ppm	1.72	1.15	1.43	**50 ppm**	1.75	1.14	1.44
100 ppm	1.88	1.22	1.55	**100 ppm**	1.86	1.19	1.52
150 ppm	2.20	1.29	1.74	**150 ppm**	2.15	1.27	1.71
Mean	1.86	1.17		**Mean**	1.86	1.15	
L.S.D (0.05)	For A = 0.04 For B = 0.06			For A = 0.03 For B = 0.04 For (AxB) = 0.07			

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 level of probability

Table (10). Effect of light intensity, amino acid tryptophan, and their interaction on leaf total chlorophylls content (mg/100 g fresh weight) and total carbohydrates content in bulbs (mg/g D.W.) of of *Hippeastrum vittatum*, cv.Minerva plants during 20006/07 and 2007/08 seasons.

Leaf total chlorophylls content (mg/100 g F.W.)							
First season (2003)				**Second season (2004)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**Light intensity (A)**		**Mean**
	Full sun	**Shading**			**Full sun**	**Shading**	
0.0 ppm	176.29	78.49	127.39	**0.0 ppm**	174.34	77.93	126.13
50 ppm	188.69	96.77	142.73	**50 ppm**	189.52	96.47	142.99
100 ppm	197.56	116.65	157.10	**100 ppm**	197.18	115.80	156.49
150 ppm	213.75	131.19	172.47	**150 ppm**	212.58	133.16	172.87
Mean	194.07	105.77		**Mean**	193.40	105.84	
L.S.D (0.05)	For A = 5.76 For B = 8.1 For (AxB) = 15.73			For A = 5.70 For B = 8.16 For (AxB) = 16.42			
Total carbohydrates in bulbs (mg/g D.W.)							
First season (2003)				**Second season (2004)**			
Tryptophan Conc. (B)	**Light intensity (A)**		**Mean**	**Tryptophan Conc. (B)**	**Light intensity (A)**		**Mean**
	Full sun	**Shading**			**Full sun**	**Shading**	
0.0 ppm	217.25	191.15	204.20	**0.0 ppm**	215.49	188.79	202.14
50 ppm	228.85	199.39	214.12	**50 ppm**	229.64	200.52	215.08
100 ppm	244.22	217.26	230.74	**100 ppm**	245.50	218.75	232.12
150 ppm	251.83	226.76	239.29	**150 ppm**	250.16	226.14	258.15
Mean	235.54	208.64		**Mean**	235.20	208.55	
L.S.D (0.05)	For A = 1.69 For B = 2.3 For (AxB) = 3.73			For A = 2.15 For B = 3.01 For (AxB) = 4.14			

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 level of probability.

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الملخص العربي

تاثير شدة الضوء والحامض الأميني تربتوفان على نمو وازهار نبات الأمريللس

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أجريت التجربة على نباتات الأمريللس المنزرعة فى الاصص خلال الموسمين 2007/2006 و 2008/2007 فى مشتل جامعة الأسكندرية بسموحة لدراسة تأثير شدة الضوء و الحامض الأميني تربتوفان بمعدل 0.0 ، 50 ، 100 و 150 جزء فى المليون و تأثيرهم المشترك على نمو و ازهار و انتاج الأبصال و محتوى الاوراق من عناصر الكلوروفيلات الكلية بالاضافة الى محتوى الأبصال من الكربوهيدرات الكلية.

و قد أظهرت النتائج أن زراعة نباتات الأمريللس تحت ظروف الصوب البلاستيك بمتوسط شدة اضاءة خلال موسم النمو 450- 500 لوكس قد سبب ضعف النمو الخضرى و الزهري مع تأثير طفيف التربتوفان على النمو الخضرى و المحتوى الكيماوى للاوراق و الريزومات تحت ظروف الاضاءة المنخفضة.

من ناحية أخرى فان زراعة نباتات الأمريللس تحت ظروف شدة اضاءة كاملة بالحقل مع رش النباتات بتركيز150 جزء في المليون من الحامض الأميني تربتوفان ثلاث مرات خلال موسم النمو قد حسن من صفات النمو الخضرى و الزهرى وانتاجية الأبصال (عدد الأوراق / نبات ، طول و عرض الورقة و الوزن الطازج و الجاف للاوراق ، و عدد الايام الازمة للوصول لمرحلة التزهير ، و عدد الحوامل الزهرية وأوزنها الطازجة والجافة ، عدد الزهيرلت وأقطارها و الوزن الطازج والجاف للأزهار ، و قطر الأبصال وأوزانها الطازجة والجافة وعدد البصيلات الجديدة) و كذلك محتوى الاوراق من الكلوروفيل الكلى و محتوى الأبصال من الكربوهيدرات الكلية.