EFFECT OF SOME CULTURAL PRACTICES ON THE GROWTH AND CHEMICAL CONTENTS OF *HEDERA ELIX* VAR. VARIEGATA II. EFFECT OF NITROGEN FERTILIZATION AND GA_3 SPRAYING

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ABSTRACT

The effects of N fertilization rates and GA_3 spraying on the growth and chemical composition of *Hedera helix* var. variegata (ivy) were studied in pot experiments during two successive seasons (2002 and 2003). For this purpose, rooted cuttings of the plant were planted in 25 cm pots filled with peatmoss : vermiculite mixture (1:1:v/v). Developed plants were left to grow under seran house with 60% shading and supplied with 0,1,2 and 4 g/pot of ammonium nitrate (33.5% N) and sprayed with 0, 125 and 250 ppm of GA_3 in twelve combinations. The obtained results showed that N application at 4 g/pot or GA_3 at 250 ppm alone, significantly increased the different plant growth parameters, as well as, N,P,K% and chlorophyll content with insignificant increase in total carotenoids content compared with the control. The highest level of ammonium nitrate (4 g/pot) as combined with GA_3 at 250 ppm had the most significant effects on increasing plant height, number of vines/plant, plant leaf area and produced the largest fresh and dry weights/plant, as well as, N,P,K, chlorophyll a,b and total chlorophyll contents. The interaction of N at 2 g/pot and GA_3 at 250 ppm gave the highest values of the total number of leaves/plant, as well as, fresh and dry weight of roots/plant. All treatments insignificantly increased the total carotenoids content in plant leaves compared with the control. Conclusively, this study recommend the use of ammonium nitrate at 4 g/pot combined with GA_3 at 250 ppm for *Hedera helix* production, which gave the best results.

Key words : Cultural practices - *Hedera helix* - Nitrogen fertilization - GA_3 spraying

INTRODUCTION

Foliage plants attracted great interest and demand due to their special sort and beauty and hence contribution in interior decoration. *Hedera helix* var. variegata (English ivy) belongs to Family Araliaceae is an evergreen long-lived decorative plant with variegated leaves. Ivies are used as indoor plants which easily grown climbing or in hanging baskets, pots, topiaries, and represent as one of the most important foliage species being widely grown in Egypt. It has a pronounced ability to grow with supports across walls, tree trunk cover or around peatmoss filled wire netting for indoor decoration. More recently, variegated cultivars have been used extensively as component plants in mixed combination hanging baskets and planters. It is important to keep such plants healthy and showy by providing favourable conditions for their growth. Nitrogen is known to be required by foliage plants in higher rates than other elements (Joiner *et al.* 1981) and is considered a key element for their growth (Conover, 1980). Holcomb *et al.* (1993) reported that an adequate *Hedera helix* growth was obtained with 50 mg N/litre using a 20-10-20 or 20-19-18 NPK formulation. Also, El-Ashry and Sliman (1999) found that high N (2 g) and P_2O_5 (1.5 g)/pot as ammonium sulphate and calcium superphosphate respectively, significantly increased leaf number and leaf area of *Peperomia obtusifolia, Hedera helix* plant length and *Chlorophytum comosum* plant height and its leaf number. This treatment increased P and K % in different species leaves, while increased N% in *Hedera helix* leaves compared with the control. El-Fouly (1994) illustrated that using 1,2 and 3 g N/pot of ammonium nitrate, ammonium sulphate and urea respectively, for 9 months pepromia plants produced with the highest number and the heaviest fresh weight of leaves, while the lowest level of ammonium nitrate (1 g N/pot) was the most effective level for increasing dry weight of leaves, roots, stems and leaf pigments content. There was a marked accumulation of N and P% in plant leaves due to the application of ammonium nitrate at 2 g N/pot. El-Gendy *et al.* (1995) mentioned that high spliletted levels of N (13.62 and 18.15 g/pot) as ammonium sulphate caused an increase in *Dracaena draco* plant

height and numbers of both leaves and roots when compared with the control. Abou Dahab (1996) reported that supplying *Brassaia arboricola* cv. Gold Capella with ammonium sulphate at 5 g/30 cm pot monthly produced the highest values of plant height, stem diameter, number of leaves and fresh and dry weights of plants. Treating the plants with ammonium sulphate at 5 or 10 g/pot or ammonium nitrate at 3 or 6 g/plant increased the chlorophyll a and b and carotenoids content in plant leaves, as well as, N and P% in the different plant parts. Saleh *et al.* (1998) showed that the highest level of krystalon (15-5-30) or ammonium nitrate at 2 g/L had the most promising and significant effect on increasing number of leaves/plant, plant height and branches number/plant of *Ficus benjamina*. This level of both fertilizers also increased chlorophyll a,b and total chlorophyll content, as well as, N,P and K% in plant tissues. Saleh *et al.* (2000) also reported that using urea at 1 g/L or krystalon at 2 g/L, significantly increased plant height, leaf number, leaf length and width and stem diameter of pothos (*Epipremnum pinnatum*) plant. The same rates of urea or krystalon increased also chlorophyll a,b and total chlorophyll contents, as well as, N,P and K% in plant leaves. David *et al.* (2003) stated that begonia growth was significantly influenced by N fertilization as shoot dry mass was increased with increasing N rate up to 120 mg N/L.

Meantime, Al-Juboory and Williams (1992) found that spraying BA + GA_{4+7} significantly increased branch number and length of *Hedera helix* compared with the control. The growth rate of plants treated with 50 or 100 mg GA_{4+7}/L in combination with 50 to 200 mg BA/L produced commercially acceptable plants. Jongho *et al.* (1997) stated that GA_3 at 50 mg/litre increased *Codiaeum variegatum* plant height, internodal length, peptiole length, leaf length and width and leaf area compared with the control. Abou Taleb and Kandeel (2002) showed that using GA_3 at any level of 50, 100 and 200 ppm, significantly increased poinsettia (*Euphorbia pulcherrima*) plant height and number of branches/plant, while decreased chlorophyll content in plant leaves compared with the control. Whereas, Saadawy *et al.* (2003) on roses plants found that the highest records in the number of leaves/plant, number of bottom breaks, as well as, leaf content of chlorophyll a,b and petal content of carotenoids resulted by using GA_3 at 150 ppm. On the other

hand, Almulla (1989) showed that the addition of fulifertil fertilization at 4 g/L as combined with spraying GA_3 at 200 ppm increased plant height, number of leaves, fresh and dry weight of vegetative growth and chemical composition of both *Codiaeum variegatum* and *Sanchezia nobilis* plants.

The aim of this study was to find out the most suitable treatment of N fertilization rate and GA_3 concentration in combination that gives the best vegetative growth, N,P,K and photosynthetic pigments contents of *Hedera helix* var. variegata grown in pots containing peatmoss + vermiculite (1:1) mixture.

MATERIALS AND METHODS

The present study was conducted at the Experimental Farm, Faculty of Agriculture, Ain Shams University, Shoubra El-Kheima, Cairo, Egypt during the two seasons of 2002 and 2003. It was planned to investigate the response of *Hedera helix* var. variegata to different nitrogen fertilization rates, GA_3 concentrations and their combinations to justify the most suitable treatment for maximum growth performance of this plant.

Terminal rooted cuttings of the plant were grown for 2.5 months in a nursery before subjecting to experimentation. On May 1st of both seasons, the plants were transplanted into 25 cm pots (one plant/pot) packed with a mixture of peatmoss + vermiculite (1:1 v/v), which seemed to be the best growing medium for this plant (Kandeel and Abd El-Gayed 2004). The medium was analyzed before planting according to the methods described by Page (1982) and Westerman (1990) as shown in Table (1). Plants were placed under a seran house allowing 60% shading, then pinched one week later to give more branches (vines).

Plants were fertilized with: 0,1,2 and 4 g/pot of ammonium nitrate (33.5% N) or sprayed with GA_3 (Gibberellic acid) as Berlex tablets which is produced by I.C.I. Company, England at: 0, 125 and 250 ppm concentrations. Twelve treatments representing N fertilization rates, Gibberllic acid (GA_3) sprays and their combinations were prepared for this study. The experiment was arranged in a factorial complete randomized design with three replicates, as each replicate contained 5 pots.

One month after transplanting, nitrogen fertilization was applied at monthly intervals as seven equal doses (from June 1st till Dec. 1st), while, GA_3 was applied as a foliar spray three times at 2 months intervals (at the beginning of June, August and October) starting one day after N fertilization during the two growing seasons. A wetting agent (Tween 20) at 0.05% was added to GA_3 solution just before application to reduce solution surface tension. GA_3 spray solution was applied till the solution run off the plant foliage. Control plants were sprayed with distilled water. The plants under different treatments (including the control) were monthly fertilized in 6 doses (from June 7th till Nov. 7th) during the two growing seasons with a constant rate of 4 and 2 g/pot of calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O), respectively. The plants were watered whenever they needed.

At the end of Dec. of the two growing seasons (2002 and 2003), data were recorded on the different vegetative growth parameters and the fresh and dry weight of roots/plant, as well as, leaf content of N,P,K and photosynthetic pigments.

The nutrients content of N,P and K in the ground samples of dry plant leaves were determined after wet digestion. The microkjeldahl method was used to determine N% according to A.O.A.C. (1990), and the method of Chapman and Pratt (1978) for P and K contents.

Chlorophyll a and b, as well as, carotenoids content were estimated in plant leaf samples (mg/g fresh weight) as discribed by A.O.A.C. (1990).

Data of different vegetative and root growth characters recorded at the two growing seasons were tabulated and statistically analyzed according to Snedecor and Cochran (1981).

Table (1): Chemical analysis of a mixture of peatmoss + vermiculite (1:1) as a growing medium for *Hedera helix* var. variegata before planting.

pH	EC ds/m	Soluble anions (meq/L,)			
		HCO_3^{2-}	CO_3^{2+}	Cl^-	SO_4^{2+}
6.22	0.65	0.32	-	3.28	2.90
Soluble cations (meq/L.)				Available nutrients (mg/100 g growing medium)	
Ca^{2+}	Mg^{2+}	Na^+	K^+	N	P
1.30	0.68	4.07	0.45	6.13	0.45

RESULTS AND DISCUSSION

1. Effect of N fertilization and GA_3 spraying on plant growth:

1.1. Vine length :

Data in Table (2) show that application of N or GA_3 at any of the tested levels, significantly increased height of *Hedera helix* plant compared with the control during the first season. The highest rate of N fertilization (4 g/pot) as ammonium nitrate or GA_3 (250 ppm) gave taller plants compared with the other N or GA_3 levels. However, there were significant differences between each two respective levels of N or GA_3 treatments. Similar trend was noticed with the second season (Table, 4).

This increase in plant height may be due to the effect of nitrogen on vegetative growth through its enhancement of metabolic activities including protein synthesis in particular and hence new cells formation, GA_3, on the other hand, promoted cells division and elongation (Mengel, 1984) as a result of stimulating auxin action in plant tissues (Kuraish and Muir, 1963). Similar findings were reported by El-Ashry and Sliman (1999) on *Hedera helix* and *Chlorophytum comosum*, Jongho *et al.* (1997) on *Codiaeum*

variegatum, Saleh *et al.* (1998) on *Ficus benjamina* and Saleh *et al.* (2000) on pothos (*Epipremnum pinnatum*).

This conclusion was confirmed by the most significant increase in vine length of *Hedera helix* plants grown with the highest level of N fertilization as combined with the highest concentration of GA_3, which gave the tallest plants during the first season being 85.33 cm compared to 57.33 cm for the control plant (Table, 3). In the second season, nearly a similar trend was noticed (Table, 5), which the tallest plants (79.83 cm) was obtained with the interaction between N and GA_3 at highest levels compared to 54.33 cm for the control.

These results are confirmed by Almulla (1989) on *Codiaeum variegatum* and *Sanchezia nobilis* and Poole and Conover (1992) on *Dracaena sanderiana* and *Philodendron erubescens*.

1.2. Number of vines/plant :

Data presented in Tables (2 & 4) revealed generally, that during both growing seasons, N application at medium or high levels (2 and 4 g/pot), significantly increased number of vines/plant compared with the untreated ones. Whereas, using the low level at 1 g/pot failed to reach significancy.

On the other hand, data showed that during the first season, the higher the GA_3 concentration (250 ppm), the higher was the number of vines produced per plant (Table, 2). This concentration, significantly increased the number of vines carried by *Hedera helix* plant compared with the control, whereas, using 125 ppm gave similar performance to control plants. During the second season (Table, 4), both concentrations of GA_3 (125 or 250 ppm), significantly increased the number of vines/plant over the untreated ones, with superiority of the 250 ppm concentration. These results can be explained as mentioned by Henny and Norman (1999) who reported that GA_3 had an effect on apical dominance at higher concentrations, as there was a significant linear and quadratic increase in the number of vines per plant of *Syngonium podophyllum*.

The highest N level combined with that of GA_3 induced the highest number of vines/plant being 6.67 during each seasons compared with 4.00 and 3.67 for the control in the first and the second seasons, respectively (Tables 3 & 5).

The studies of Al-Juboory and Williams (1992) on *Hedera helix*, Saleh *et al.* (1998) on *Ficus benjamina*, El-Ashry and Sliman (1999) on peperomia and Abou Taleb and Kandeel (2002) on poinsettia came to a similar conclusion.

1.3. Number of leaves/plant :

Addition of N at any level, significantly increased the number of leaves produced per plant compared with the untreated ones during both seasons (Tables 2 and 4). This effect may be due to the higher metabolic efficiency of nitrogen for plant which induce more leaves initiation and development.

GA_3 spraying at 125 or 250 ppm, significantly increased the number of leaves/plant compared with the unsprayed ones in both seasons (Tables 2 & 4). According to Mengel (1984), GA_3 promotes cell division and elongation, so increased the number of plant nodes and consequently the plant produce more leaves.

Addition of the medium level of N at 2 g/pot combined with the highest GA_3 concentration at 250 ppm, generally had the most significant effects on total number of leaves/plant, followed by using N at 4 g/pot plus GA_3 at 250 ppm during the two seasons (Tables 3 & 5). Similar results were obtained by El-Ashry and Sliman (1999) on *Hedera helix* and *Peperomia obtusifolia*, Almulla (1989) on *Codiaeum variegatum* and *Sanchezia nobilis*, Abou Dahab (1996) on *Brassaia arboricola*, Saleh *et al.* (1998) on *Ficus bejamina*, Saleh *et al.* (2000) on pothos and Saadawy *et al.* (2003) on roses.

1.4. Leaf area/plant :

Nitrogen application at any level, significantly increased leaf area/plant compared with the control (Tables 2 & 4), with superiority of 4 g N/pot rate. Leaf area also significantly increased due to increasing GA_3 concentration, being mostly pronounced at 250 ppm. In this concern, Hayashi (1961) stated that the

photosynthetic activity of the whole plant increased due to the application of GA_3. Also, GA_3 increased both cell division and elongation and consequently plant leaf area.

The best treatment observed in the two seasons was N fertilization at 4 g/pot conjugated with GA_3 at 250 ppm which showed the highest values with significant differences compared with the control (Tables 3 & 5). These results were in accordance with those obtained by El-Ashry and Sliman (1999) on *Hedera helix* and *Peperomia obtusifolia* and Jongho *et al.* (1997) on *Codiaeum variegatum.*

1.5. Fresh and dry weights/plant :

Data in Tables (2 & 4) illustrated that addition of N promoted the vegetative fresh and dry weights of *Hedera helix* plant over the untreated ones. Application of N at 2 and 4 g/pot, significantly increased both fresh and dry weight/plant, whereas, the lower level (1 g/pot) gave nearly the same weights as the control plants during the two seasons. Higher records were always obtained with 4 g N/pot compared with other N rates. In this respect, Bidwell (1974) reported that nitrogen is a component of many important organic compounds that play a vital role in growth and development. It is required for the production of proteins and formation of protoplasm for new cells, as well as, chlorophyll and cytochrome. Also, N enhances the production of amides, amino acids, nucleic acids, hormones and vitamins which activate the physiological processes, resulting in enhanced vegetative growth of the plant.

On the other hand, spraying GA_3 at any concentration, significantly increased the fresh and dry weights/plant compared with the control in both seasons (Tables 2 & 4), especially with the higher level at 250 ppm. This increase in plant weight might be attributed to the increase in other growth parameters, i.e. plant height, vines number and leaves number due to GA_3 application.

The largest fresh and dry weights/plant were recorded with the interaction between N at 4 g/pot and GA_3 at 250 ppm, followed by the 2 g N/pot conjugated with 250 ppm GA_3 which showed

Table (2) : Statistical main effects (means) of nitrogen fertilization rates and GA_3 concentrations on vegetative and root growth parameters of *Hedera helix* var. variegata during 2002 season.

Main effects of N or GA_3 treatments (means)		Plant height (cm)	No. of vines/ plant	No. of leaves/ plant	Leaf area/ plant (cm^2)	Fresh weight/ plant (g)	Dry weight/ plant (g)	Fresh weight of roots/ plant (g)	Dry weight of roots/ plant (g)
N	0	67.00	4.78	67.56	117.42	36.65	13.21	5.33	3.30
	1	70.94	5.11	75.78	124.61	38.27	14.19	6.25	3.91
	2	74.89	5.78	81.89	129.13	44.97	16.36	6.79	4.37
	4	78.44	6.00	83.11	142.33	49.70	17.50	7.02	4.47
L.S.D. at 5%		2.34	0.63	3.72	3.27	2.67	1.49	0.47	0.44
GA_3	0	65.54	4.92	70.33	106.10	37.47	13.36	5.72	3.57
	125	73.42	5.42	81.25	138.90	41.77	15.51	6.44	4.05
	250	79.50	5.92	79.67	140.11	47.95	17.07	6.88	4.42
L.S.D. at 5%		2.03	0.54	3.22	2.88	2.33	1.29	0.41	0.38

Table (3): Effect of nitrogen fertilization combined with GA_3 spraying on the vegetative and root growth parameters of *Hedera helix* var. variegata during 2002 season.

Treatments GA_3 (ppm)	N (g)	Plant height (cm)	No. of vines/ plant	No. of leaves/ plant	Leaf area/ plant (cm^2)	Fresh weight/ plant (g)	Dry weight/ plant (g)	Fresh weight of roots/ plant (g)	Dry weight of roots/ plant (g)
0	0	57.33	4.00	61.33	85.43	32.73	10.45	5.02	3.15
	1	62.67	4.67	67.00	98.52	34.27	11.96	5.31	3.34
	2	69.50	5.33	72.33	105.09	39.33	14.81	5.97	3.60
	4	72.67	5.67	80.67	135.36	43.53	16.23	6.58	4.18
125	0	70.17	5.33	73.00	130.91	36.72	13.97	5.50	3.47
	1	71.67	5.00	81.67	138.27	37.03	14.50	6.36	3.88
	2	74.50	5.67	86.33	141.15	44.50	16.42	6.75	4.29
	4	77.33	5.67	84.00	145.29	48.74	17.14	7.16	4.58
250	0	73.50	5.00	68.33	135.93	40.50	15.20	5.46	3.29
	1	78.50	5.67	78.67	137.03	43.50	16.11	7.08	4.51
	2	80.67	6.33	87.00	141.14	50.98	17.84	7.65	5.23
	4	85.33	6.67	84.67	146.33	56.83	19.14	7.33	4.65
L.S.D. at 5%		4.05	1.09	6.45	5.66	4.65	2.58	0.81	0.77

Table (4) : Statistical main effects (means) of nitrogen fertilization rates and GA_3 concentrations on vegetative and root growth parameters of *Hedera helix* var. variegata during 2003 season.

Main effects of N or GA_3 treatments (means)		Plant height (cm)	No. of vines/ plant	No. of leaves/ plant	Leaf area/ plant (cm^2)	Fresh weight/ plant (g)	Dry weight/ plant (g)	Fresh weight of roots/ plant (g)	Dry weight of roots/ plant (g)
N	0	64.44	4.89	67.56	114.34	36.56	12.86	5.33	3.50
	1	68.00	4.89	72.00	117.78	37.34	13.80	6.40	4.05
	2	71.33	5.44	77.78	126.07	42.55	15.36	6.66	4.25
	4	72.44	6.00	78.67	130.77	47.30	16.93	6.93	4.47
L.S.D. at 5%		2.92	0.63	2.45	3.35	2.84	1.13	0.72	0.43
GA_3	0	61.54	4.42	65.75	96.53	35.59	12.72	5.64	3.55
	125	71.46	5.67	77.08	133.81	40.14	14.94	6.45	4.19
	250	74.17	5.83	79.17	136.33	47.08	16.56	6.89	4.45
L.S.D. at 5%		2.53	0.54	2.13	2.90	2.46	0.98	0.62	0.37

Table (5): Effect of nitrogen fertilization combined with GA_3 spraying on the vegetative and root growth parameters of *Hedera helix* var. variegata during 2003 season.

Treatments GA_3 (ppm)	N (g)	Plant height (cm)	No. of vines/ plant	No. of leaves/ plant	Leaf area/ plant (cm^2)	Fresh weight/ plant (g)	Dry weight/ plant (g)	Fresh weight of roots/ plant (g)	Dry weight of roots/ plant (g)
0	0	54.33	3.67	57.00	81.20	30.11	9.53	5.11	3.17
	1	59.50	4.00	61.67	86.69	33.27	11.69	5.52	3.45
	2	65.83	4.67	69.33	104.01	36.56	13.72	5.63	3.53
	4	66.50	5.33	75.00	114.22	42.43	15.95	6.32	4.06
125	0	68.67	5.67	74.33	128.73	37.24	13.23	5.62	3.86
	1	72.67	5.33	76.67	131.15	36.37	13.81	6.57	4.14
	2	73.50	5.67	78.67	136.33	41.45	15.80	6.64	4.25
	4	71.00	6.00	78.67	139.01	45.50	16.92	6.97	4.51
250	0	70.33	5.33	71.33	133.10	42.33	15.83	5.25	3.45
	1	71.83	5.33	77.67	135.50	42.38	15.91	7.12	4.55
	2	74.67	6.00	85.33	137.87	49.63	16.57	7.71	4.97
	4	79.83	6.67	82.33	139.09	53.98	17.93	7.50	4.83
L.S.D. at 5%		5.07	1.09	4.25	5.80	4.92	1.97	1.24	0.74

significant differences compared with the control during both growing seasons (Tables 3 & 5). This result could be attributed to speculation that N fertilizers and spraying with GA_3, significantly activate physiological processes including mineral efficiency and cell size (Humphries and French, 1981). Similar findings were reported by Al-Juboory and Williams (1992), Holcomb *et al.* (1993) and El-Ashry and Sliman (1999) on *Hedera helix*, Almulla (1989) on *Codiaeum variegatum* and *Sanchezia nobilis*, Abou Dahab (1996) on *Brassaia arboricola* and David *et al.* (2003) on begonia.

1.6. Fresh and dry weight of roots/plant :

The different N levels had significant effects on fresh and dry weight of roots/plant in both seasons (Tables 2 & 4). The higher records were noticed with N application at 4 g/pot. Spraying GA_3 at 125 or 250 ppm also, significantly increased fresh and dry weight of roots/plant compared with the control plants.

Meanwhile, the largest fresh and dry weight of roots/plant was produced due to the interaction between N at 2 g/pot and GA_3 at 250 ppm. The second higher values were noticed with N at 4 g/pot with GA_3 at 250 ppm during both seasons (Tables 3 & 5). These results agreed with those obtained by El-Fouly (1994) on *Peperomia obtusifolia*.

2. Effect of N fertilization and GA_3 spraying on chemical contents of plant leaves :

2.1. Effect on N, P and K contents :

Application of N fertilization generally, increased the plant leaves content of N, P and K% compared with the unfertilized ones in the two seasons (Table, 6). Nitrogen addition at any rate, significantly increased N% in plant leaves compared with the untreated plants. The highest rate of N (4 g/pot) was the only rate that significantly increased both P and K% in plant leaves over the control during the two seasons.

Table (6): Statistical main effects (means) of nitrogen fertilization rates and GA_3 concentrations on N,P and K (%) in leaves of *Hedera helix* var. variegata during 2002 and 2003 seasons.

Main effects of N or GA_3 treatments (means)		N		P		K	
		2002	2003	2002	2003	2002	2003
N	1	2.53	2.52	0.43	0.45	1.50	1.46
	2	2.65	2.64	0.50	0.51	1.53	1.55
	4	2.77	2.81	0.53	0.54	1.55	1.62
L.S.D. 5%		0.17	0.18	0.09	0.11	0.09	0.11
GA_3	0	2.36	2.37	0.42	0.41	1.43	1.43
	125	2.45	2.46	0.45	0.47	1.55	1.54
	250	2.87	2.84	0.55	0.55	1.54	1.58
L.S.D. at 5%		0.18	0.16	0.09	0.08	0.10	0.10

Table (7): Effect of nitrogen fertilization combined with GA_3 spraying on N, P and K (%) in leaves of *Hedera helix* var. variegata during 2002 and 2003 seasons.

Treatments GA_3 (ppm)	N (g)	N		P		K	
		2002	2003	2002	2003	2002	2003
0	0	2.03	2.01	0.38	0.35	1.35	1.29
	1	2.35	2.38	0.42	0.41	1.44	1.43
	2	2.49	2.47	0.42	0.45	1.45	1.48
	4	2.57	2.63	0.46	0.44	1.48	1.50
125	0	2.23	2.18	0.44	0.43	1.52	1.49
	1	2.37	2.42	0.39	0.45	1.55	1.47
	2	2.54	2.51	0.47	0.48	1.57	1.58
	4	2.65	2.74	0.49	0.51	1.55	1.63
250	0	2.61	2.59	0.45	0.44	1.48	1.51
	1	2.87	2.75	0.49	0.49	1.51	1.49
	2	2.92	2.95	0.61	0.59	1.57	1.58
	4	3.09	3.06	0.63	0.66	1.61	1.72
L.S.D. at 5%		0.22	0.25	0.11	0.12	0.15	0.19

Spraying plants with GA_3 at 250 ppm, significantly increased N and P% in *Hedera helix* leaves compared with 0 or 125

ppm GA_3, K% was significantly increased in plant leaves due to 125 or 250 ppm concentrations compared with the control in both seasons (Table, 6).

The highest and significant increases in N,P and K% in Hedera leaves were produced from the interaction between N at 4 g/pot and GA_3 at 250 ppm during the two seasons (Table, 7).

N fertilization is known to play an important role in the accumulation of N,P and K in plant leaves, especially with high concentration of GA_3, which enhances some metabolic activities in the plant (Mengel 1984). These results were confirmed by El-Ashry and Sliman (1999) on *Hedera helix* and *Peperomia obtusifolia*, Abou Dahab (1996) on *Brassaia arboricola*, Saleh *et al.* (1998) on *Ficus benjamina* and Saleh *et al.* (2000) on pothos.

2.2. Effect on photosynthetic pigments :

Nitrogen application markedly affected chlorophyll a, b, as well as, total chlorophyll content in *Hedera helix* plant leaves (Table, 8). The medium and high nitrogen rates (2 and 4 g/pot), significantly increased chlorophyll a, b and total chlorophyll content in plant leaves, while the lower N level (1 g/pot) showed insignificant effect compared with the control. This was achieved during the two growing seasons.

Again, using 250 ppm GA_3, significantly increased chlorophyll a, b and total chlorophyll content in plant leaves, whereas, 125 ppm concentration failed to give significant response in both seasons (Table, 8).

The interaction between N at 4 g/pot and GA_3 at 250 ppm gave the most significant increases in this connection, while the least records were observed in control plants (Table, 9). On the other hand, it is evident that N, GA_3 or their combinations insignificantly increased the total carotenoids content in plant leaves compared with the untreated plants in both seasons. Similar findings were mentioned by El-Fouly (1994) on *Peperomia obtusifolia*, Saleh *et al.* (1998) on *Ficus benjamina*, Saleh *et al.* (2000) on pothos and Saadawy *et al.* (2003) on roses.

Table (8) : Statistical main effects (means) of nitrogen fertilization rates and GA_3 concentrations on chlorophyll and carotenoids content (mg/g fresh weight) in leaves of *Hedera helix* var. variegata during 2002 and 2003 seasons.

Main effects of N or GA_3 treatments (means)		Chlorophyll a		Chlorophyll b		Total chlorophyll		Carotenoids	
		2002	2003	2002	2003	2002	2003	2002	2003
N	0	1.40	1.37	0.78	0.71	2.19	2.08	0.42	0.40
	1	1.44	1.44	0.77	0.79	2.21	2.22	0.45	0.46
	2	1.54	1.53	0.88	0.91	2.42	2.44	0.47	0.49
	4	1.59	1.60	0.96	0.89	2.55	2.49	0.48	0.53
L.S.D. at 5%		0.10	0.12	0.07	0.09	0.11	0.16	NS	0.06
GA_3	0	1.42	1.39	0.78	0.77	2.20	2.16	0.43	0.43
	125	1.47	1.46	0.82	0.81	2.29	2.27	0.45	0.44
	250	1.60	1.61	0.94	0.89	2.54	2.50	0.48	0.45
L.S.D. at 5%		0.09	0.10	0.06	0.07	0.10	0.14	NS	NS

Table (9): Effect of nitrogen fertilization combined with GA_3 spraying on chlorophyll and carotenoids content (mg/g fresh weight) in leaves of *Hedera helix* var. variegata during 2002 and 2003 seasons.

Treatments GA_3 (ppm)	N (g)	Chlorophyll a		Chlorophyll b		Total chlorophyll		Carotenoids	
		2002	2003	2002	2003	2002	2003	2002	2003
0	0	1.35	1.24	0.67	0.61	2.02	1.85	0.41	0.39
	1	1.39	1.28	0.70	0.73	2.09	2.01	0.41	0.42
	2	1.48	1.49	0.85	0.89	2.33	2.38	0.45	0.43
	4	1.45	1.53	0.92	0.86	2.37	2.39	0.45	0.47
125	0	1.41	1.35	0.79	0.70	2.20	2.05	0.42	0.40
	1	1.37	1.44	0.75	0.77	2.12	2.21	0.44	0.43
	2	1.52	1.51	0.83	0.88	2.35	2.39	0.48	0.49
	4	1.56	1.54	0.91	0.87	2.47	2.41	0.46	0.43
250	0	1.45	1.53	0.89	0.82	2.34	2.35	0.43	0.41
	1	1.57	1.59	0.85	0.86	2.42	2.45	0.49	0.43
	2	1.62	1.60	0.97	0.95	2.59	2.55	0.47	0.45
	4	1.75	1.73	1.05	0.93	2.80	2.66	0.53	0.49
L.S.D. at 5%		0.20	0.17	0.14	0.11	0.22	0.19	NS	NS

Generally, it could be concluded that the best growth performance of *Hedera helix* var. variegata in association with higher nutrients uptake and photosynthetic pigments content could be obtained from using 4 g ammonium nitrate/pot combined with 250 ppm of GA_3 for plants grown in a mixure of peatmoss and vermiculite (1:1 v/v).

REFERENCES

Abou Dahab, T.A.M. (1996). Effect of growing media, nitrogen sources and commercial fertilizers on growth and chemical composition of *Brassaia arboricola* cv. Gold Capella plants. Ph.D. Thesis, Fac. Agric., Cairo Univ.

Abou Taleb, N.S. and A.M. Kandeel (2002). Improving growth and flowering of poinsettia by using GA_3 and Ethrel. J. Agric. Res. Tanta Univ., 28 (4): 482-495.

Al-Juboory, K.H. and D.J. Williams (1992). Effects of two growth regulators on lateral branching and shoot growth of English Ivy (*Hedera helix*). Plant Growth Regulator Society of America Quarterly (1991) 19 (1): 35-40 (C.F. Hort. Abst,. 62: 2161).

Almulla, A.M. (1989). Physiological studies on some greenhouse plants. Ph.D. Thesis, Fac. Agric., Ain Shams Univ.

A.O.A.C. (1990). Official Methods of Analysis of the Association of Official Analytical Chemists. Pub. A.O.A.C. INC. Suite 400, 2200, Wilson, Boulevard Arlington, Virginia, 22201, USA 15th Ed. Vol. I pp. 17-22 and 62-63.

Bidwell, R.G. (1974). Plant Physiology. MacMillan Publishing Co., Inc.New York, p. 496.

Chapman, H.D. and P.F. Pratt (1978). Methods of Analysis for Soils, Plants and Waters. Univ. California, Div. Agric. Sci. p. 161 and 201-202.

Conover, C.A. (1980). Foliage plants. I. Introduction to Floriculture, Roy A. Larson ed., Academic Press Inc., New York, USA p. 555-557.

David, M.; J. Swiader; K. Williams and D. Eastburn (2003). Nitrogen nutrition, but not potassium, affects powdery mildew development in Hiemalis Begonia. J. Plant Nutrition, 26 (1): 159-176.

El-Ashry, A.I. and Z.T. Sliman (1999). Effect of nitrogenous and phosphorus fertilization on growth and productivity of some foliage plants. Minufiya J. Agric. Res., 24 (3): 1079-1095.

El-Fouly, A.S. (1994). Physiological studies on *Peperomia obtusifolia* L. and *Scindopsus aureus* Schott plants. M.Sc. Thesis, Fac. Agric., Cairo Univ.

El-Gendy, W.M.N.; A.M. Hosni; S.E. Saleh and M.A. Zaghlool (1995). Effect of different levels of nitrogen fertilization on the growth of *Dracaena draco* (Drake). Annals Agric. Sci., Ain Shams Univ., Cairo 40 (2): 867-876.

Hayashi, T. (1961). The effect of gibberellin treatment on the photosynthetic activity of plants. 4th Int. Conf. on Plant Growth Regulation. The Iowa State Univ. Press, Ames,Iowa, USA.

Henny, R.J. and D.J. Norman (1999). Gibberellic acid-induced flowering of *Syngonium podophyllum* Schot "White Butterfly". Hort. Sci., 34 (4): 676-677.

Holcomb, E.J.; S. Gamez; D. Beattie and G.C. Elliott (1993). Efficiency of fertigation programs for Baltic ivy and Asiatic lily. Hort. Techn. (1992) 2 (1): 43-46 (C.F. Hort. Abst., 63 (6495).

Humphries, E.C. and S.A.W. French (1981). The physiology of leaf growth. Ann. Rev. Plant Physiol., 14: 385-410.

Joiner, J.N.; C.A. Conover and R.T. Poole (1981). Nutrition and Fertilization. I. Foliage plant production. Jaspar N Joiner (ed.), Prentice. Hall, New Jersey, USA, p. 229-268.

Jongho, S.; H. Jeong; K. Jungeun; P. Chunho; K. Beyounghwo; S. Jh.; J. Hong; K. Je; P. Ch. and K. Bh. (1997). Effect of light intensity, uniconazole and gibberellin on leaf variegation of *Codiaeum variegatum* "Yellow Jade". J. Korean Soc. Hort. Sci. 38 (3): 278-282.

Kandeel, A.M. and A.M. Abd El-Gayed (2004). Effect of some cultural practices on the growth and chemical contents of *Hedera helix* var. variegata. 1. Effect of plant growing media. Egypt. J. Appl. Sci.; 19 (5): 206-221.

Kuraish, S. and R.M. Muir (1963). Mode of action of growth retarding chemicals. Plant Physiol., 38: 19-24.

Mengel, K. (1984). The Physiology of Flowering Plants. Edward Arnold, London, p. 470,

Page, A.L. (1982). Methods of Soil Analysis. Part 2. p. 39-41. Chemical and Microbiological Properties. SSSP. INC., Madison, Wisconsin USA.

Poole, R.T. and C.A. Conover (1992). Leachate electrical conductivity and pH for ten foliage plants. J. Environ. Hort., 8 (4): 166-172 (C.F. Hort. Abst., 62: 2274).

Saadawy, F.M.; N. Abou Taleb and A.A. Gomaa (2003). Effect of pruning and growth regulators on rose growh and flowering. II. Gibberellic acid application. J. Agric. Res., Tanta Univ., 29 (2): 515-537.

Saleh, S.I.I.; Y.A. Hossoni and M.A. Darwish (1998). Effect of krystalon and ammonium nitrate on the growth and chemical composition of *Ficus benjamina* L. plants. Egypt. J. Hort., 25 (2): 167-178.

Saleh, S.I.I.; Y.A. Hossoni and M.A. Darwish (2000). Effect of urea and krystalon (19-19-19) on the vegetative growth and chemical composition of *Epipremnum pinnatum* "Auream" Bunt plants. Egypt. J. Hort. 27 (4): 497-511.

Snedecor, G.W. and W.G. Cochran (1981). Statistical Methods. 7th Ed., Iowa State Univ., Press, Ames. Iowa, USA.

Westerman, R.L. (1990). Soil Testing and Plant Analysis, 3rd Ed. Soil Sci. Soc. Amer., Inc. Madison, Wisconsin, USA, p. 55-60.

الملخص العربى

تأثير بعض المعاملات الزراعية على النمو والمحتوى الكيماوى لنبات الهيدرا (حبل المساكين)

٢- تأثير التسميد النيتروجينى والرش بحمض الجبريليك

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أجرى هذا البحث خلال موسمين متتاليين هما ٢٠٠٢ ، ٢٠٠٣ بمزرعة التجارب بكلية الزراعة - جامعة عين شمس - شبرا الخيمة ، لدراسة أثر التسميد النيتروجينى والرش بحمض الجبريليك على النمو والمحتوى الكيماوى لنبات الهيدرا . زرعت العقل المجذرة فى أصص رقم ٢٥ مملوءة بمخلوط من البيت موس + الفيرميكولايت بنسبة (١:١) حجماً ، ووضعت النباتات النامية تحت صوبة سيران توفر الظل بنسبة ٦٠% ، وبعد أسبوع من الزراعة فى الأصص ثم تطويش النباتات لإنتاج المزيد من الأفرع .

أضيف التسميد النيتروجينى بمعدلات : صفر ، ١ ، ٢ ، ٤ جرام/أصيص من نترات الأمونيوم (٣٣,٥% نيتروجين) وكذلك الرش بحمض الجبريليك بتركيزات : صفر ، ١٢٥ ، ٢٥٠ جزء فى المليون بمفرده أو مع المعدلات المختلفة من السماد النيتروجينى من خلال ١٢ معاملة مختلفة .

وقد تم إضافة السماد على ٧ دفعات بواقع دفعة كل شهر ، أما الرش بحمض الجبريليك فكان ٣ مرات بواقع مرة كل شهرين خلال كل موسم من مواسم النمو .

وأشارت النتائج المتحصل عليها إلى أن اضافة نترات الأمونيوم بمعدل ٤ جرام/ أصيص أو الرش بحمض الجبريليك بتركيز ٢٥٠ جزء فى المليون كل على حده أدى الى الحصول على زيادة معنوية لصفات نمو النبات المختلفة ، وكذلك زيادة محتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم والكلوروفيل بدرجة معنوية ، بينما كان محتوى أوراق النبات من الكاروتينويدات غير معنوى مقارنة مع النباتات غير المعاملة .

كما أوضحت النتائج أن استخدام المعدل العالى من نترات الأمونيوم (٤ جرام/أصيص) مع الرش بحمض الجبريليك بتركيز ٢٥٠ جزء فى المليون قد أدى الى الحصول على أفضل النتائج وبزيادة معنوية لكل من : طول النبات ، عدد الأفرع ، المساحة الورقية والوزن الطازج والجاف لكل نبات وكذلك

محتوى أوراق النبات من الكلوروفيل أ ، ب والكلوروفيل الكلى بالمقارنة مع الكنترول . فى حين أدى التفاعل بين النيتروجين بمعدل ٢ جرام/أصيص مع حمض الجبريليك بتركيز ٢٥٠ جزء فى المليون الى الحصول على أكبر قيم لعدد الأوراق الكلية / نبات وكذلك أكبر وزن طازج وجاف للجذور/ نبات . كما أدت جميع المعاملات الى زيادة محتوى الأوراق من الكاروتينويدات ولكن كانت الزيادة غير معنوية عندما قورنت مع الكنترول .

من نتائج هذا البحث يمكن التوصية بمعاملة نبات الهيدرا المنزرع فى مخلوط البيت موس + الفيرميكولايت بنسبة (١:١) حجماً بالتسميد بنترات الأمونيوم بمعدل ٤ جرام/أصيص مع الرش بحمض الجبريليك بتركيز ٢٥٠ جزء فى المليون حيث أعطت هذه المعاملة أفضل النتائج .