

**EFFECT OF SOME MUTAGENS ON GROWTH OF *EPIPREMNUM PINNATUM*"*E. AUREUM*" BUNT PLANTS.**

BY

**Hanan M.A. Youssef**

Ornamental Plants Research Department, Hort. Res. Ins. Agric. Res Center.

**ABSTRACT**

**This** investigation was carried out during 2005/2006 and 2006/2007 seasons in the glass greenhouse of the Horticultural Research Institute, Giza, Egypt to study the possibility of inducing some variation in growth of *Epipremnum pinnatum* "*E. aureum*". One node cutting were subjected to sprayed with sodium azide and colchicine at 0.00, 0.002, 0.004 & 0.008 ppm, so irradiation by microwave rays at power 0.00, 1, 2 & 3 (0.00, 95, 195, & 280 watt) for 0, 1, 2 & 3 mint to induced some variation in growth, results showed that:

Untreated plant (control) gave the best stem diameter and number of roots. Sprayed sodium azide at 0.004 ppm leading to increased number of shoots and roots while spraying it at 0.008 ppm significantly increased number of leaves, leaf area, roots length and vegetative fresh & dry weights. While using colchicine at 0.002 ppm significantly increased dry weights of vegetative growth and roots. Meanwhile spraying colchicine at 0.004 ppm concentration caused a significantly increased in stem diameter, fresh weight of roots, chlorophyll a, b and carotenoids.

Treated with microwave at power 1 for 1 mint significantly increased leaf area and root length. While irradiation with microwave at power 2 for 1 mint was significantly increased number of roots, but using microwave rays for 2 mint significantly reduced fresh and dry weight of roots, while for 3 mint significantly increased number of shoots. Microwave at power 3 for 1 mint significantly increased chlorophyll and carotenoids but reducing fresh and dry weight of roots, while treated for 2 mint induced significantly increased plant height, number of leaves and vegetative fresh & dry weights. Sodium azide more effecting from colchicines in induced variation on growth of *Epipremnum pinnatum* "*E. aureum*" while microwave give more influenced in induced variation from sodium azide and colchicine. Electrophoretic analysis indicated that colchicine and sodium azide increased some band of protein, while microwave induced significantly increased in genetic variation of total bands of protein (16) compared with control (13), sodium azide (14) and colchicines (13).

**INTRODUCTION**

*Epipremnum pinnatum* plants, currently known as "*E. aureum*" is a very important ornamental foliage plant, used for indoor decoration for its beautiful coloration of leaves and good growth. The demand of this plant has been increased greatly due to the special kind of beauty and wide range of purposes can be used for in hangs as well as climbing on stick and in baskets.

Variations or mutations may be occurred naturally or induced either chemically by chemical mutagens or physically by irradiation electromagnetic waves microwave it was affirmed that subjecting the plants to various concentrations of sodium azide or colchicine for different duration treatments exhibited a pronounced fluctuation.

In the morphogenic parameter and in the endogenous biochemical substances of the obtained propagated plant as recorded for *Chrysanthemum* (Endo *et al.*, 1997); *Lily connecticut* (Han Dongsheny *et al.*, 1999); *Rhododeron hybrid* (Vainola, 2000); *Yucca elephentipes* & *Philodenderon scandens* (Youssef, 2003); *Populus alba* (Youssef &

Abou-Dahab, 2006) and *Solidago altissima* (Sayed *et al.*, 2007). Microwave (electromagnetic waves) induced morphological variation to several ornamental plants such as *Solidago altissima* (Sayed *et al.*, 2005) & *Helichrysum bracteatum* and *Statice sinuate* (Youssef and El-Bably, 2007).

## MATERIALS AND METHODS

The present work was carried out on *Epipremnum pinnatum* "E.aureum" at the glass greenhouse (Temperature 30-35°C) of the Horticulture Research Institute, A.R.C., Egypt, during tow seasons, 2005/2006 and 2006/2007 to induced some variation in growth.

### Plant material

Uniform rooted cuttings of *Epipremnum pinnatum* "E.aureum" was used in this investigation, plant (1-2 leaves and 3-5 cm height). On 21 August 2005 & 2006, rooted cutting of *Epipremnum pinnatum* "E. aureum" were planted in 8 cm plastic pots filled with a mixture of sand and peat moss at 1:3 as volume respectively and were taken care of in the glass greenhouse. The plants was divided into 16 treatments, each treatment included 36 plantlets in 3 replicate.

### The treatment of this experiment were as follows:

- 1- Control (Spray with distiller water).
- 2- Sprayed sodium azide and colchicine at 0.002, 0.004, and 0.008 ppm concentrations, in 21<sup>st</sup> October and sprayed again after month.
- 3- The plants exposed to electromagnetic waves by microwave at power 1, 2, 3 (95, 195, 280 watt) for 1,2,3 mint in 21 October.

### Data recorded:

The following data were recorded after 4 month from starting the treatments:

Plant height (cm), stem diameter (mm), number of shoots, number of leaves per plant, leaf area, (cm<sup>2</sup>) number 1 by CI-203 AREA METER, CID, INC, were recorded for

nine randomly selected plants. Number of roots and root length (cm<sup>2</sup>). These plants were dug out and the fresh & dry weights of vegetative growth and roots were determined.

### Chemical compositions:

Pigments content of chlorophyll a & b and carotenoids mg/g fresh weight were determined in leaves of plants according to Saric *et al.* (1967).

### Total protein in leaves:

Electrophoretic analysis was performed on leaves of the *Epipremnum pinnatum*, "E. aureum" SDS-PAGE of total protein extracts under non-reducing conditions was carried out in the discontinuous buffer system according to Laemmli (1970). Extraction was performed over-night using 0.2 mM Qtris-Hcl buffer, pH 6.8 containing 2% sodium dodecyl sulfate (SDS). After centrifugation at 10.000 rpm for 10 minutes, the supernatant was taken for loading on 12.5% polyacrylamid gel.

To determine the molecular weight of the migrated protein, the following marker proteins were used: Lysozyme (MW 14.2), Myoglobin (MW 18.4), Carbonic anhydrase (MW 35.00), Carbonic anhydrase Alcohol dehydrogenadse (MW 45.00), Bovin Serum Albumi (MW 66.2) and Galactoidase (MW 116.00)

### Statistical analysis:

The experiment was set in complete randomized design and data were subjected to statistical analysis according to Sendecor and Cochran (1982) and means between treatments were compared by L.S.D. method.

RESULTS AND DISCUSSION

Effect of sodium azide and colchicine on growth and chemical composition of *Epipremnum pinnatum* "E.aureum".

Growth parameter:

Table (1) and photo (1) show that sprayed sodium azide at 0.008 ppm, concentration was significantly increased plant height, number of leaves per shoot, leaf area and vegetative fresh and dry weight in the

tow season compared with all treatment. Meanwhile sprayed colchicine at 0.00&0.004 ppm was significantly increased plant diameter in the two seasons compared with all treatment. Sprayed Sodium azide at 0.004 ppm significantly increased number of shoots compared with untreated plants in both season.

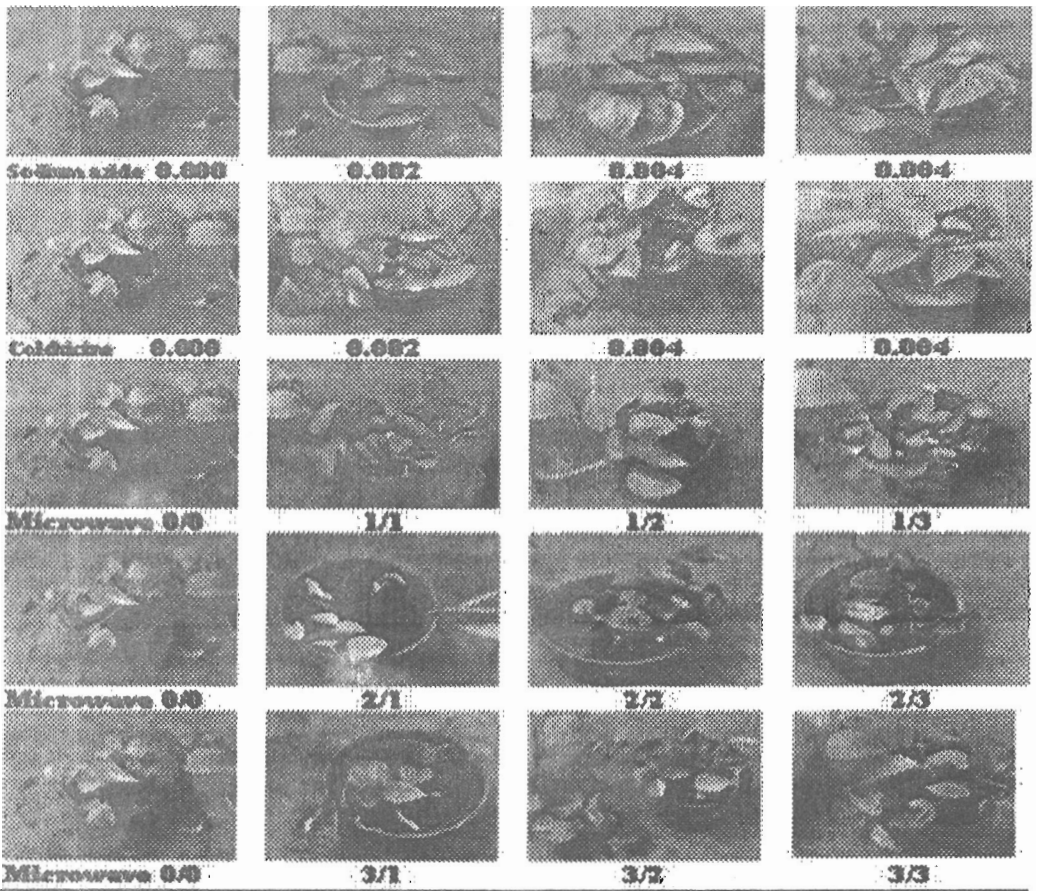


Photo (1): Effect of some mutagens on growth of *Epipremnum pinnatum* "E. aureum" Bunt: plants after tow month from application treatment.

While sprayed sodium azide at 0.00, 0.002 and 0.004 ppm significantly increased number of roots *Epipremnum pinnatum* "E. aureum" compared with colchicine in both seasons. However sprayed sodium azide at 0.008 ppm significantly increased root length as compared with the control treatments for both seasons.

Meanwhile sprayed colchicine at 0.004 ppm significantly increased root fresh weight, while sprayed colchicine at 0.002 ppm was significantly increased roots dry weight in the two seasons. Similar findings were reported by Youssef (2003) on *Yucca elephantips* and *philodendron scandens* Youssef and Abou-Dahab (2006) on *Populus alba* and Sayed et al. (2007) on *Solidago altissima* var "Tara".

Table (1): Effect of Sodium azide and Colchicine on vegetative growth and root characteristics of *Epipremnum pinnatum* "E.auraum" Bunt plants during 2005/2006 and 2006/2007 seasons

Treatments		Fresh weight (g)		Dry weight (g)		Roots fresh weight (g)		Roots dry weight (g)		Plant height (cm.)		Plant diameter (mm.)		Number of shoots		Number of leaves		Leaf area (cm <sup>2</sup> )		Number of roots		Root length (cm.)	
		1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.
Control		3.41 F	3.52 E	0.93 D	0.98 C	3.19 C	3.24 C	0.59 C	0.65 D	6.50 E	7.800 E	0.70 A	0.80 A	7.00 B	8.00 C	4.00 AB	5.00 BCD	31.50 C	32.03 C	7.00 A	8.00 A	20.33 B	22.00 B
Sodium azide	0.002	2.84 G	2.98 F	0.67 E	0.70 D	2.66 D	2.76 D	0.61 C	0.73 C	12.00 C	14.00 C	0.50 BC	0.63 BC	8.00 AB	9.00 ABC	2.00 C	4.00 D	36.00 B	38.00 B	7.00 A	9.00 A	16.00 C	18.00 C
	0.004	3.98 E	4.17 D	0.52 F	0.60 E	2.33 E	2.55 E	0.41 D	0.52 E	10.00 D	13.00 C	0.60 AB	0.77 A	8.00 AB	9.67 A	4.00 AB	6.00 AB	21.70 E	27.33 E	8.00 A	9.00 A	15.00 C	16.33 D
	0.008	6.71 A	7.01 A	1.010 C	1.22 A	1.98 F	2.16 F	0.23 E	0.39 F	26.67 A	29.33 A	0.50 BC	0.63 BC	1.00 C	1.67 D	5.00 A	7.00 A	48.46 A	50.00 A	4.00 BC	6.00 B	24.00 A	27.33 A
Colchicine	0.002	5.87 C	6.06 B	1.180 A	1.26 A	3.50 B	3.75 B	0.88 A	0.98 A	20.50 B	23.00 B	0.40 C	0.57 C	7.00 B	8.33 BC	3.00 BC	4.33 CD	35.00 B	36.67 B	5.00 B	6.67 B	12.20 D	14.00 E
	0.004	5.96 B	6.18 B	1.080 B	1.14 B	5.41 A	5.62 A	0.75 B	0.87 B	21.00 B	23.67 B	0.70 A	0.80 A	8.00 AB	9.00 ABC	5.00 A	5.67 ABC	26.67 D	30.00 D	3.00 C	4.00 C	22.00 AB	23.00 B
	0.008	4.27 D	4.63 C	0.5200 F	0.69 D	1.27 G	1.57 G	0.21 E	0.39 F	9.00 D	11.67 D	0.67 AB	0.70 AB	9.00 A	9.33 AB	4.00 AB	5.00 BCD	30.00 C	32.00 CD	4.00 BC	5.67 B	11.67 D	13.67 E
L.S.D 5%		0.004	0.138	0.018	0.079	0.057	0.079	0.057	0.039	1.78	1.189	0.178	0.113	1.690	1.143	1.910	1.391	2.760	2.013	1.910	1.327	2.020	1.185

**-Chemical composition:**

**Total chlorophyll and carotenoids mg/g.:**

Data in Table (2) showed that the chlorophyll and carotenoids Content in leaves of *Epipremnum pinnatum" E. aureum"* was

significantly increased with colchicine at 0.004 ppm concentrations. Similar results were found by Youssef and Abou-Dahab (2006) on *Populus alba*, and Sayed *et al.* (2007) on *Solidago altissima*.

**Table (2): Effect of sodium azide and colchicine on chemical composition of *Epipremnum pinnatum "E. aureum"* Bunt plants during 2005/2006 and 2006/2007 seasons**

Treatment		Chlorophyll "a" (mg/g.)	Chlorophyll "b" (mg/g.)	Carotenoids (mg/g.)
Control		0.318 D	0.157 B	0.271 D
Sodium azide	0.002	0.298 E	0.900 D	0.263 E
	0.004	0.352 B	0.133 C	0.305 B
	0.008	0.337 C	0.170 B	0.299 C
Colchicine	0.002	0.261 F	0.640 E	0.245 G
	0.004	0.394 A	0.198 A	0.366 A
	0.008	0.248 G	0.104 D	0.257 F
L.S.D 5%		0.002	0.016	0.004

**Effect of Microwave irradiation on growth and chemical composition of *Epipremnum pinnatum "E. aureum"*.**

**Growth parameter:**

In this regard, data in Table (3) and photo (1) the irradiation with microwave at power 3 for 2 mint significantly increased plant height, number of leaves per shoots and vegetative fresh & dry weights of *Epipremnum pinnatum "E. aureum"* compared to the control in both season.

While all doses of microwave irradiation significantly reduced stem diameter compared with the untreated plants in both seasons. So irradiation *Epipremnum pinnatum "E. aureum"* with microwave at power 2 for 3 mint significantly increased number of shoots compared with the control in both seasons. So power 1 for 1 mint microwave rays irradiation treatment significantly increased leaf area and length of roots of *Epipremnum pinnatum" E. aureum "*for both seasons.

Also revealed that the effect of microwave radiation on the number of roots varied in *Epipremnum pinnatum" E. aureum"* plants. Microwave irradiation treatments at 0.00 and power 2 for 1 mint significantly increased number of roots in both season.

Root fresh & dry weights per plant were markedly influenced by microwave ray treatments. Data in Table (3) showed that irradiation with microwave rays at power 2 for 2 mint or power 3 for 1 mint was significantly reduced root fresh and dry weights as compared with the control treatments of *Epipremnum pinnatum "E. aureum"* for both seasons. These results of growth parameters were in agreement with those obtained by Sayed *et al.* (2005) on *Solidago altissima* and Youssef and El-Bably (2007) on *Helichrysum bracteatum* and *Statice sinuata*.

**Chemical composition:**

**-Total chlorophyll and carotenoids mg/g:**

Data in Table (4) cleared that the chlorophyll & carotenoids content in leaves of *Epipremnum pinnatum E. aureum* was significantly increased with microwave irradiation at power 3 for 1 mint. In this share, the earlier experiments conducted by Youssef (2003) on *Yucca elephantipes* and *Phiodendron scandens*; Youssef and El-Bably (2007) on *Helichrysum bracteatum* and *Statice sinuate* revealed that irradiation with microwave significantly affected the endogenous contents of pigments.

Table (3): Effect of Microwave on vegetative growth and root characteristics of *Epipremnum pinnatum* "E.aurum" Bunt plants during 2005/2006 and 2006/2007 seasons

Treatments		Fresh weight (cm.)		Dry weight (g)		Roots fresh weight (g)		Roots dry weight (g)		Plant height (cm)		Plant diameter (mm)		Number of shoots		Number of leaves		Leaf area (cm <sup>2</sup> )		Number of roots		Root length (cm)		
Power	Time	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.	1 <sup>st</sup> Se.	2 <sup>nd</sup> Se.
0.00	0.00	3.41	3.52	0.93	0.98	3.19	3.24	0.59	0.65	6.50	7.80	0.70	0.80	7.00	8.00	4.00	5.00	31.50	32.03	7.00	8.00	20.00	22.00	
	"Control"	F	C	B	B	A	B	B	B	F	F	A	A	C	C	A	A	B	B	A	A	C	B	
1	1	3.06	3.13	0.87	0.90	2.82	2.84	0.49	0.51	11.00	11.67	0.40	0.47	7.00	7.67	4.00	4.33	36.20	37.33	2.67	3.00	27.00	27.67	
		G	D	C	C	C	C	D	E	CD	D	C	D	C	CD	A	AB	A	A	D	F	A	A	
	2	3.72	3.81	0.43	0.54	2.61	2.78	0.46	0.55	7.00	8.00	0.60	0.67	13.00	13.67	4.00	4.33	21.30	22.33	6.00	6.67	10.00	10.67	
		E	C	H	F	D	D	E	C	F	F	AB	B	B	B	A	AB	D	E	AB	B	EF	DE	
	3	2.06	2.18	0.51	0.62	1.81	1.93	0.44	0.53	11.00	11.67	0.60	0.67	13.00	13.67	2.333	2.67	21.67	22.67	6.00	6.67	10.00	10.67	
		H	E	G	E	E	E	F	D	CD	D	AB	B	B	B	C	C	D	DE	AB	B	EF	DE	
2	1	1.99	2.02	0.29	0.32	1.84	1.94	0.29	0.36	10.00	10.67	0.50	0.57	7.00	7.67	2.67	3.00	26.33	27.00	7.00	7.667	11.00	11.67	
		I	E	J	H	E	E	G	F	DE	E	BC	BCD	C	CD	BC	C	C	C	A	A	E	D	
	2	2.06	2.07	0.37	0.38	1.43	1.54	0.23	0.34	7.00	7.67	0.53	0.60	12.00	13.00	2.67	3.00	18.83	19.67	4.00	4.67	15.00	15.67	
		H	E	I	G	F	F	H	G	F	F	BC	BC	B	B	BC	C	E	F	CD	DE	D	C	
	3	3.91	3.65	0.63	0.71	3.20	3.28	0.58	0.66	12.00	12.67	0.60	0.67	19.33	20.33	3.67	4.00	21.33	22.67	5.00	5.67	22.00	22.67	
		D	C	E	D	A	AB	B	B	C	C	AB	B	A	A	AB	B	D	DE	BC	C	B	B	
3	1	4.16	4.26	0.58	0.60	1.28	1.36	0.18	0.22	22.50	24.00	0.50	0.50	6.00	7.00	4.00	4.67	22.00	22.33	3.00	4.00	2.500	3.167	
		C	B	F	E	G	G	I	H	B	B	BC	CD	C	D	A	AB	D	E	D	E	H	G	
	2	7.90	8.03	1.37	1.47	2.78	2.89	0.53	0.56	35.17	37.67	0.50	0.60	12.00	13.00	4.00	5.00	23.27	23.83	4.00	5.00	9.00	9.83	
		A	A	A	A	C	C	C	C	A	A	BC	BC	B	B	A	A	D	D	CD	CD	F	E	
	3	4.36	4.52	0.84	0.90	3.13	3.30	0.62	0.69	9.00	11.00	0.50	0.60	12.00	13.00	2.33	3.00	23.25	23.67	3.00	4.00	7.50	8.167	
		B	B	D	C	B	A	A	A	E	DE	BC	BC	B	B	C	C	D	DE	D	E	G	F	
L.S.D 5%		0.054	0.312	0.017	0.024	0.054	0.054	0.017	0.017	1.534	0.757	0.163	0.109	1.687	0.879	1.218	0.946	2.123	1.496	1.492	0.891	1.401	1.025	

Table (4): Effect of Sodium azide and Colchicine on chemical composition of *Epipremnum pinnatum* "E.auraum" Bunt plants during 2005/2006 and 2006/2007 seasons

Power	Time	Chlorophyll "a" (mg/g.)	Chlorophyll "b" (mg/g.)	Carotenoids (mg/g.)
0.00	0.00	0.318 B	0.157 B	0.271 C
(Control)				
1	1	0.279 B	0.680 E	0.261 D
	2	0.328 B	0.130 C	0.287 B
	3	0.174 B	0.330 F	0.179 H
2	1	0.310 B	0.081 D	0.081 B
	2	0.306 B	0.128 C	0.128 B
	3	0.202 B	0.039 F	0.039 G
3	1	1.171 A	0.298 A	0.290 A
	2	0.273 B	0.075 E	0.075 E
	3	0.220 B	0.071 DE	0.071 F
L.S.D 5%		0.163	0.012	0.005

**Total protein: Effect of sodium azide, colchicine and microwave treatment on approximate molecular and intensity of protein bands.**

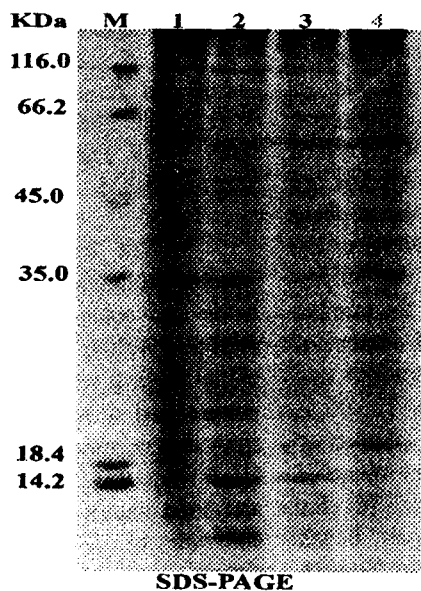
Protein banding patterns in *Epipremnum pinnatum* "E. aureum" of four control, sodium azide, colchicine, and microwave were analysed by SDS polyacrylamide gel electrophoresis under reducing conditions. The approximate molecular weight (MW) and intensity of electrophoretic protein bands are presented in Table (5) and illustrated in photo (2) show that protein banding patterns of the control, sodium azide, colchicine and microwave showed some differences in the number and density of the bands. The total number of the bands in the profiles of all genotypes was 19 representing MW., ranging from 116.00 to 10.00 daltons. However, the total number of bands detected for each –was in the range of 13 (for control and colchicine) to 16 (for microwave). There are ten common bands (No. 1, 2, 4, 6, 11, 12, 13, 16, 18, and 19) with MW. 116.00, 70.00, 60.00, 50.00, 36.00, 30.00, 24.00, 18.00, 12.00 and 10.00 dalton

respectively) found in all protein profiles of different control, sodium azide, colchicine and microwave. The bands number 1,4,11,16 and 18 were intensively evidenced, while number 13 and 19 were lightly presented in microwave was characterized by four specific bands No. 3, 5, 8 and 15 with MW. 64.00, 54.00, 44.00 and 20.00 dalton, while the number 17 was absent. The bands number 13 and 18 were faint in all control, sodium azide, colchicine and microwave.

This behaviour may indicate some genetic relationship between control, sodium azide and colchicine than to the microwave. Abd EL-Wahab (1994) mentioned that somaclonal banana variant plants obtained in tissue culture had a specific protein band different from that normal plants. Also Zhu and Lawes (1990) reported that different banding patterns and band intensities were obtained for several cultivars of kiwifruit and showed some promise for distinguishing between male and female veins.

Table (5): Approximate molecular weight and intensity of protein bands in *Epipremnum pinnatum* "E. aureum"(SDS-PAGE)

No of bands	MW.x10 <sup>3</sup>	1 (control)	2 (sodium azide)	3 (colchicine)	4 (microwave)
1	116.00	++	++	++	++
2	70.00	]++	]++	+	]++
3	64.00	-	-	-	F
4	60.00	]++	]++	]++	]++
5	54.00	-	-	-	F
6	50.00	++	++	+	++
7	46.00	+	-	+	++
8	44.00	-	-	-	F
9	42.00	+	+	-	+
10	38.00	-	F	F	-
11	36.00	]++	]++	]+	]++
12	30.00	++	++	+	++
13	24.00	]+	]+	]+	]+
14	22.00	-	++	-	-
15	20.00	-	-	-	+
16	18.00	]++	]++	]+	]++
17	14.00	++	+++	++	-
18	12.00	]F	]F	]F	]F
19	10.00	]F	]++	]F	]F
<b>Total number of bands</b>		13	14	13	16
<b>Fant band=F Band intensity=+,++ and +++ Absent band=-</b>					

Photo (2): Approximate molecular weight and intensity of protein bands in *Epipremnum pinnatum* "E. aureum"



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تأثير المعاملة ببعض المطفرات على نمو البرنس

هنان محمد أحمد يوسف

قسم بحوث الزينة وتقسيم الحدائق - معهد بحوث البساتين - مركز بحوث الزراعة = الجيزة

أجريت هذه التجربة بصوبة معهد بحوث البساتين خلال موسمين متتاليين ٢٠١٥/٢٠١٦ و ٢٠١٦/٢٠١٧ بهدف استحداث تباينات في نمو البرنس ذلك عن طريق استخدام بعض المطفرات الكيماوية (الصوديوم أزيد والكولتسين) بتركيزات صفر، ١، ٢، ٤، ٨، ١٦، ٣٢ جزء في المليون والطبيعية (الميكروبيف بجرعات صفر و ١ و ٢ و ٣ و ٩ و ٢٥ و ٩٥ و ١٩٥ و ٢٨٥ وات' لفترات زمنية مختلفة (١ و ٢ و ٣ دقائق)، وكانت النتائج كالتالي:

- ١ = وجد أن النباتات الغير معاملة (الكنترول) أدى لزيادة سمك الساق وعدد الجذور .
- ٢ = أدى الرش بالصوديوم أزيد بتركيز ١، ٢، ٤، ٨، ١٦، ٣٢ لزيادة عدد الاوراق والجذور بينما الرش بتركيز ٩٥، ١٩٥، ٢٨٥ أدى لزيادة عدد الاوراق ومساحة الورقة وطول الجذر والوزن الطازج والجاف للنمو الخضري.

- ٣- أدت المعاملة بالكولتسين بتركيز ٠,٠٠٢، لزيادة الوزن الجاف للنمو الخضري والجزري في حين وجد أن الرش بتركيز ٠,٠٠٤ جزء في المليون أدى لزيادة سمك الساق والوزن الطازج للجزور وكورفيل اب وكذلك الكاروتينات .
- ٤- المعاملة بالميكرووف بقرى ١ لمدة دقيقة أدى لزيادة مساحة الورقة وطول الجذر.
- ٥- المعاملة بالموجات الكهرومغناطيسية (الميكرووف) بقرى ٢ لمدة دقيقة أدى لزيادة عدد الجذور في حين أن المعاملة لمدة ٢ دقيقة قلل الوزن الطازج والجاف للجزور بينما المعاملة لمدة ٣ دقائق زاد عدد الأفرع.
- ٦- المعاملة بقرى ٣ للميكرووف لمدة دقيقة أدت لزيادة كل من الكلورفيل والكاروتين وقلل الوزن الطازج والجاف للجزور بينما المعاملة بنفس القرى لمدة ٢ دقيقة أدى لزيادة طول النبات وعدد الأوراق وكذلك الوزن الطازج والجاف للنمو الخضري .
- ٧- من النتائج السابقة وجد أن الصوديوم يزيد أكثر تأثير في أحداث التباينات في النمو الخضري و الجزري للبتس من الكولتسين وكذلك التشيع بالميكرووف أكثر تأثير في أحداث هذه التباينات من الصوديوم يزيد والكولتسين .
- ٨- بالتقريد الكهربى للبروتينات الكلية وجد أن الكولتسين أدى لزيادة بعض الحزم البروتينية، بينما الصوديوم يزيد أدى لحدوث بعض التغيرات مقارنة بالكنترول في حين أن المعاملة بالميكرووف أدت لحدوث تغيرات وراثية حيث زادت الحزم البروتينية "١٦ حزمة" مقارنة بالكنترول "١٣ حزمة" الصوديوم يزيد "١٤ حزمة" والكولتسين "٣ حزمة".