

EFFECT OF GAMMA AND MICROWAVE IRRADIATIONS ON SOME DRY FLOWER PLANTS.

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ABSTRACT

Helichrysum bracteatum L. and *Statice sinuata* L. seeds were cultivated during two successive seasons "2004-2005 and 2005-2006" to induce some variations in vegetative growth and flowering characteristics by exposing seeds to either gamma rays at 0, 1, 2, 4 or 8 krad or microwave power at 195 watt for 1, 2 or 4 minutes. Seed germination %, some vegetative growth parameter, some flowering characters and some chemical constituents of the treated plants were determined.

Data showed that most of the studied parameters were affected by the applied treatments. It was also evident that the effect of the same treatments can have different response in the studied plants. This could have some ornamental considerations.

INTRODUCTION

Helichrysum bracteatum, L. (straw flower) and *Statice sinuata*, L. (Sealavander) are two of the most important annual plants used in garden and as cut dry flowers. Gamma irradiation and microwave treatments was the most effective factors for improving plant production. Gamma irradiation at low doses were reported to stimulate plant growth, although it was harmful at high doses for several ornamental plants such as *Datura metel* (Hussein et al., 1995); *Hibiscus subdariffa* (El-Sherbeny et al., 1997), chamomile (Youssef and Moussa 1998) and *Solidago altissima* (Sayed et al., 2005). Moreover, Gamma and microwave radiations treatments exhibited a pronounced effect on some biochemical constituents, such as pigments, indoles and phenol concentrations in some ornamental plants, such as *Yucca* and *Philodendron* (Youssef 2003), carnation (El-Shafie et al., 1987), *Tagetes erecta*, *Zinnia elegans* and *Callistephus chinensis* (Zaharia et al., 1991), gladiolus cvs. Peter Pears and Mascagni (El-Esawy 1995), *Delphinium ajacis* and *Matthiola incana* (Noby, 2002). This investigation aimed to

study the effects of gamma and microwave irradiation treatments on *Helichrysum bracteatum* L. and *Statice sinuata*.

MATERIALS AND METHODS

Two experiments were carried out during two seasons of 2004-2005 and 2005-2006 in the experimental farm Flor. Hort. Res. Inst. A.R.C. Egypt on *Helichrysum bracteatum* and *Statice sinuata* to study the effect of gamma irradiation and microwave on some vegetative growth, some flowering traits and some chemical composition. Chemical and physical properties of the experimental soil were determined using the method of Champan and Pratt (1978) before planting. Data are shown in Tables (A and B).

Table (A): Particle size distribution of the nursery soil

Depth cm	Coarse sand %	Fine and %	Silt %	Clay %	Texture
0 - 30	1.5	27.25	29	42.25	Clay

Table (B): Chemical analysis of the investigated soil

Depth cm	Mmh/cm ³ 25°C	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁺	Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺
0-30	0.37	2.28	2.4	1.0	2.15	1.41	1.32	2.73	0.09

- Dry seeds of the two plants were irradiated at the Middle Eastern Regional Radioisotope Center for the Arab Countries, Dokki, Giza using gamma cell (Co 60) at 0, 1, 2, 4 or 8 krad for 6 min and 14 sec.
- A microwave oven Model # Mo6T (single phase, 22 V. 50 Hs., 1.3 kw output at a frequency of 2450 MHz) was used for 1,2 or 4 min using 390 watts.
- Treated seeds were sown in the nursery on 1st October for both seasons. Sand and peatmoss (1:1 v:v) were used as a germinating medium.
- Seedlings "40 days old" were transplanted to field beds on 10th November in each season.
- In each bed, seedlings were planted individually in rows, 50 cm apart, at 25 cm spacing.
- Three replicates of each treatment were used with 15 plants for each replicate.

- Normal agricultural practices "irrigation, cultivation, etc" were carried out.
- The following data was recorded:

1. Seed germination percentage:

2. Vegetative growth:

Plant height (cm.), plant diameter (mm), number of branches per plant, number of leaves per branch, leaf area (cm²) and fresh and dry weights of plant (g).

3. Flowering:

Number of stalks, stalk length (cm), florets diameter (cm), rachis length (cm) and number of florets per stalk.

4. Chemical composition

Chlorophyll a, b and carotenoids (mg/g f.w) were determined in the leaves according to Saric *et al.*, (1979). Total indoles were determined according to Selim *et al.*, (1978). Total phenolic compounds were determined according to Daniel and George (1972).

Statistical analysis:

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

RESULTS AND DISCUSSION

First experiment (A):

Effect of gamma radiation on seed germination, some vegetative growth, some flowering characters and some chemical composition of *Helichrysum bracteatum* and *Statice sinuata*.

A.1. Germination:

Data in Fig. (1) showed that, gamma irradiation at 2 k rad significantly increased the parameter in the two season as compared with all treatments in *Helichrysum* and *Statice* plants. Doses of 1 and 8 k rad caused a significant decrease in germination percentage of the two plants in the two seasons.

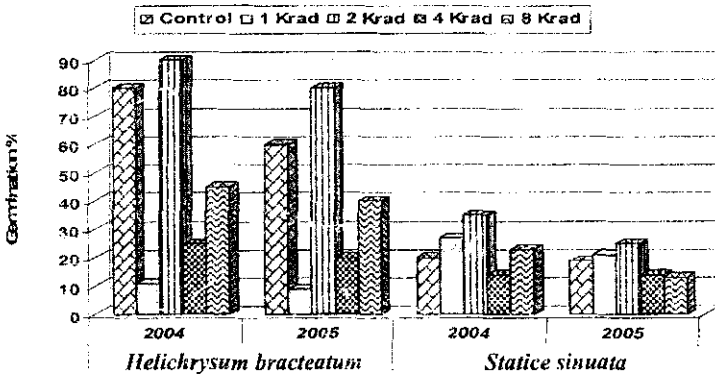


Fig (1): Effect of gamma radiation on seed germination of *Helichrysum bracteatum* and *Statice sinuata* plant during 2004 and 2005.

A.2.1. Vegetative parts fresh weight:

Data of Table (1) showed that gamma radiation treatments at 1 & 2 and 4 K rad of *Helichrysum* significantly increased fresh weight. This was observed in both seasons. However, gamma radiation treatments at 8 K rad did not have any significant effect on fresh weight as compared with the control.

Data also showed that the same trend was observed with *Statice* plants. The highest significant increase was observed with the 2K rad treatment followed by the 4 K rd and finally the 1 k rad treatment. The lowest values were obtained with the 8 K rad treatment.

A.2.2. Vegetative part dry weight:

Data in Table (1) showed that, vegetative parts, dry weight was influenced by gamma irradiation. Doses of 1, 2 and 4 K rad significantly increased the vegetative parts dry weight in the first season as compared to the control. The maximum increase was achieved at 1 k rad in both species plants *Statice* plants responded to gamma irradiation treatments more than *Helichrysum* plants.

A.2.3. Plant height:

Plant height of *Helichrysum* and *Statice* plants were significantly influenced by all treatments when compared to the control in both seasons. The tallest plants resulted from the dose of

1 K rad as shown in Table (1) in *Helichrysum* in both seasons, while the dose of 4 K rad caused the same effect on *Statice* plants in the two seasons. The shortest plants in *Helichrysum* and *Statice* resulted from the dose of 8 K rad treatment.

Table (1): Effect of gamma radiation on some growth parameters of *Helichrysum bracteatum* L. and *Statice sinuata* L. during 2005 and 2006 seasons.

Treat K rad	Fresh weight (g)		Dry weight (g)		Plant height (cm)		Stem diameter (mm)		Branch number		Leaf number		leaf area (cm ²)	
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
	season	season	season	season	season	season	season	season	season	season	season	season	season	season
<i>Helichrysum bracteatum</i>														
Cont.	22.83 D	24.44 C	8.27 B	10.23 A	85.33 B	60.00 B	0.63 A	0.73 A	4.56 B	1.00 A	15.00 A	24.33 A	20.00 A	21.83 A
1	98.00 A	119.9 A	15.04 A	17.47 A	90.00 A	68.33 A	0.70 A	0.63 A	5.66 A	1.00 A	15.00 A	19.67 B	19.67 A	21.33 A
2	42.31 C	44.23 BC	13.64 AB	13.46 A	85.67 B	60.67 B	0.66 A	0.80 A	1.00 C	1.00 A	15.00 A	19.33 B	19.67 A	21.67 A
4	66.67 B	69.66 B	10.00 AB	11.63 A	84.00 B	58.00 B	0.63 A	0.73 A	1.00 C	1.00 A	15.00 A	16.33 C	19.33 A	21.80 A
8	30.33 CD	32.46 C	9.33 AB	10.28 A	66.33 C	55.00 B	0.56 A	0.66 A	1.00 C	1.00 A	15.00 A	19.33 B	22.00 A	24.00 A
L.S. D	13.88	4.298	6.25	0.512	3.64	5.87	0.40	0.59	0.37	0.002	5.37	2.64	10.29	11.74
<i>Statice sinuata</i>														
Cont.	40.43 D	50.98 D	12.80 C	20.61 C	39.00 B	50.33 B	0.50 A	0.53 A	3.00 A	3.00 C	15.33 A	10.66 A	58.00 D	60.50 C
1	104.70 C	216.3 C	48.93 A	97.28 A	40.00 B	54.50 B	0.50 A	0.53 A	6.00 A	5.33 BC	18.00 A	10.66 A	93.33 B	100.0 B
2	130.00 A	308.2 A	34.17 B	61.38 B	46.67 AB	60.50 AB	0.60 A	0.60 A	6.67 A	9.00 AB	18.00 A	10.33 A	115.00 A	175.0 A
4	118.30 B	236.3 B	35.37 B	68.27 B	50.67 A	71.67 A	0.50 A	0.50 A	7.00 A	12.33 A	19.66 A	11.00 A	96.67 B	101.7 B
8	37.60 D	40.15 D	14.93 C	24.81 C	40.33 B	55.67 B	0.60 A	0.60 A	6.00 A	4.67 BC	20.33 A	11.00 A	69.00 C	75.87 C
LSD	10.500	12.12	10.820	13.25	9.170	13.35	0.206	0.206	0.245	0.465	5.720	3.190	4.300	22.13

Means followed by the same letter are not significantly different according to Duncan multiple range test at 5% level.

A.2.4. Stem diameter:

Data in Table (1) revealed that all gamma irradiation treatments had no different significant on plant diameter in both plants in the two seasons.

A.2.5. Branch number per plant:

Data in Table (1) indicted that, the dose of 1 K rad treatment in *Helichrysum* out numbered all doses of 2, 4 and 8 K rad in the

first season. However, all gamma irradiation treatments had no significant effect on this character in the second seasons. On the other hand, 4 K rad treatment gave higher values with non-significant differences among all treatments in the *Statice* in the first season. However, in the second season, both the 2 and 4 K rad treatments had significantly high values than the control. Only the 4 K rad treatment was significantly higher than the 1 and 8 K rad treatments.

A.2.6. Leaf number per branch:

From the presentation in Table (1) data indicted that, no significant differences in this character was noticed in the first season in *Helichrysum*. However in the second season all treatments of gamma irradiation significantly reduced number of leaves compared to the control. The lowest significantly different value in this respect was in the 4 K rad treatment. Meanwhile, treated *Statice* plants with gamma irradiation (1, 2, 4 and 8 rad) had no significant effect of number of leaves as compared with the control in both seasons.

2.7. Leaf area:

It was clear from data in Table (1) that, the dose of 8 K rad treatment increased the leaf area in *Helichrysum* with non-significant differences between all treatments in the both seasons, however, the significantly highest values were obtained from the treatment of 2 K rad in *Statice* plants in the two seasons as compared to the other treatments in addition to the control treatments.

These results of growth parameters were in agreement with those obtained by Venkatachalam and Jayabalan (1997) on *Zinnia elegans*, El-Sherbeny *et al.*, (1997) on *Hibiscus sabdariffa*, Youssef and Moussa (1998) on chamomile, Youssef *et al.*, (2000) on geranium, Noby (2002) on *Delphinium ajacis* and *Matthiola incana*, youssef (2003) on *Yucca* and *Philodendron*, and Sayed *et al.*, (2005) on *Solidago*.

The stimulative effect of the low doses of gamma rays irradiation on growth, may be attributed to the increase in cell length or cell number and size shifting in metabolism which promoted the stimulating effect of phytohormones on biosynthesis of nucleic acids (Pitrimovae, 1979).

A.3. Flowering traits:

A.3.1. Effect on stalk length:

The obtained results in Table (2) proved that, treated *Helichrysum* plants with gamma rays irradiation at 1 K rad dose in the first season and 1 and 2 KR treatments in the second season significantly increased stalk length compared to the control. Whereas, the tallest stalk of *Statice* resulted from the treatments of 2, 4 and 8 K rad with non-significant differences between themselves in the first season compared to untreated plants, while in the second season the dose of 2 K rad cleared significant highest increments compared with the control.

A.3.2. Number of flowering stalks/branch:

Data in Table (2) revealed that this parameter had the same trend as previously mentioned for the parameter of stalk length of *Helichrysum*. In the first season the dose of 1 K rad had the highest number as compared to the control. However, these differences was significant. On the other hand, in the second season, data in the same table indicated that, the number of stalks was significantly increased by the 1 K rad treatment. There were no significant differences between the other treatments and the control.

Plants the doses of 2 and 4 K rad significantly increased the number of stalks in the first and second seasons. The lowest values were obtained with the 8 K rad treatment.

A.3.3. Florets diameter:

Florets diameter was not significantly affected by pre-sowing gamma irradiation as shown from data in Table (2) of *Helichrysum* plant through the two seasons.

A.3.4. Rachis length:

Data in Table (2) indicated that rachis length per inflorescence of the *Statice* plants was significantly increased by the 1 and 2 K rad treatments and by the 2 K rad treatment only in the first and second seasons, respectively.

A.3.5. Number of florets/stalk:

Data in Table (2) showed that, all treatments of gamma irradiation increased number of florets per stalk in *Statice* plants

with non-significant differences among themselves or the control in the first season. However, in the second season the doses of 1 or 2 K rad gave the highest significant values as compared with the control treatment. However, there were no significant differences between themselves. It was noticed that, the dose of 8 K rad gave the lowest value of all studied treatments.

These results of flowering parameters agreed with those obtained by El-Esawy (1995) on *Gladiolus*, De et al., (1997) on rose and Noby (2002) on *Delphinium ajacis* and *Matthiola incana*.

Table (2): Effect of gamma radiation on flowering of *Helichrysum bracteatum* L. and *Statice sinuata* L. during 2005 and 2006 seasons.

Treat K rad	<i>Helichrysum bracteatum</i>						<i>Statice sinuata</i>							
	Stalk length (cm)		Number of stalks		Florets diameter (cm)		Stalk length (cm)		Number of stalks		Rachis length (cm)		Number of florets/ stalk	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cont.	27.00 B	17.00 B	7.66 A	6.00 BC	3.16 A	4.00 A	9.33 A	18.33 B	2.00 B	12.33 C	5.67 AB	6.07 AB	6.00 A	9.67 C
1	37.00 A	23.33 A	8.66 A	15.33 A	3.50 A	4.16 A	12.67 A	20.00 AB	3.67 AB	18.00 BC	7.17 A	9.17 A	7.67 A	12.33 A
2	28.00 B	23.33 A	8.00 A	12.67 AB	3.56 A	4.20 A	15.00 A	24.67 A	5.00 A	30.00 AB	6.25 A	7.00 AB	8.00 A	13.33 A
4	28.00 B	19.67 AB	6.66 A	10.00 ABC	3.73 A	4.13 A	15.00 A	22.00 AB	4.00 A	40.67 A	5.44 AB	6.90 AB	6.50 A	11.00 B
8	27.33 B	17.50 AB	5.66 A	5.33 C	3.50 A	3.93 A	15.00 A	18.33 B	3.67 AB	11.67 C	3.67 B	5.67 B	7.67 A	10.67 BC
L.S.D	3.84	6.19	3.324	0.555	0.59	0.69	7.46	5.58	1.786	1.543	2.18	3.35	2.85	1.00

Means followed by the same letter are not significantly different according to Duncan multiple range test at 5% level.

A.4. Chemical composition:

A.4.1. Chlorophyll (a) and (b) content:

It appeared from data in Table (3) that, chlorophyll (a) content in *Helichrysum* leaves was significantly increased when plants were treated with 1 K rad of gamma irradiation. However, chlorophyll (b) content was significantly increased at applications of 2, 4 and 8 K rad.

Table (3): Effect of gamma radiation on chemical composition of *Helichrysum bracteatum* L. and *Statice sinuata* L. during 2005 and 2006 seasons.

Treat (K rad)	<i>Helichrysum bracteatum</i>				
	Chlorophyll A (mg/g f.w.)	Chlorophyll B (mg/g f.w.)	Carotenoids (mg/g f.w.)	Total phenols (mg/g f.w.)	Total indols (mg/g f.w.)
Control	0.342 b	0.125 d	0.344 b	3.72 e	0.620 e
1	0.624 a	0.123 e	0.530 a	9.76 a	2.277 a
2	0.397 b	0.142 b	0.403 ab	7.30 c	1.660 b
4	0.378 b	0.131 c	0.365 ab	7.27 d	0.730 d
8	0.447 b	0.162 a	0.452 ab	7.76 b	1.420 c
L.S.D	0.168	0.0019	0.178	0.0019	0.0019
	<i>Statice sinuata</i>				
Control	0.272 bc	0.86 a	0.220 c	0.75 e	4.720 d
1	0.325 b	0.123 d	0.277 b	1.47 c	4.870 c
2	0.213 d	0.096 e	0.178 d	2.13 a	4.603 e
4	0.459 a	0.139 c	0.365 a	2.04 b	5.847 b
8	0.109 e	0.34 b	0.110 e	1.06 d	6.280 a
L.S.D	0.06	0.002	0.002	0.002	0.10

Means followed by the same letter are not significantly different according to Duncan multiple range test at 5% level.

Application of gamma irradiation at 4 K rad gave the highest value of chlorophyll (a) content in the *Statice* leaves. This treatment significantly reduced chlorophyll (b) content as compared to the control. There were significant differences in this respect between different doses. The lowest chlorophyll (b) content was observed in the 2 K rad treatment. A positive correlation was found between gamma doses and pigments accumulation in *Delphinium* and *Mattiola*, Noby (2002).

A.4.2. Carotenoids content:

Data in the same Table (3) indicated that, treating the seed of *Helichrysum* with 1 K rad increased the leaf carotenoides content, while in the *Statice* plants the application of 4 K rad gave the most effective treatment compared to the other treatments.

A.4.3. Total phenols:

It is indicated from Table (3) that, total phenols were significantly increased by all doses in *Helichrysum* and *Statice* plants the most effective dose was 1 K rad and 2 K rad of the *Helichrysum* and *Statice* plants, respectively.

A.4.4. Total Indoles: ∞

A somewhat similar trend as the previous parameter as shown in Table (3), total indoles were significantly increased by all doses of gamma irradiation in both plants. The application of 1 K rad in *Helichrysum* gave the highest value. However, in the *Statice* plants the highest values was achieved by using 8 K rad.

Second experiment (B):

Effect of microwave on seed germination, some vegetative growth, some flowering characters and some chemical composition of *Helichrysum bracteatum* and *Statice sinuata*.

B.1. Germination:

Data in Fig. (2) indicated that, the microwave treatments, significantly reduced germination percentage of *Helichrysum* plants in the two seasons, whereas, 1 minute of microwave significantly decreased germination. Meanwhile, treated *Statice* plants with 4 minutes of microwave significantly increased germination %.

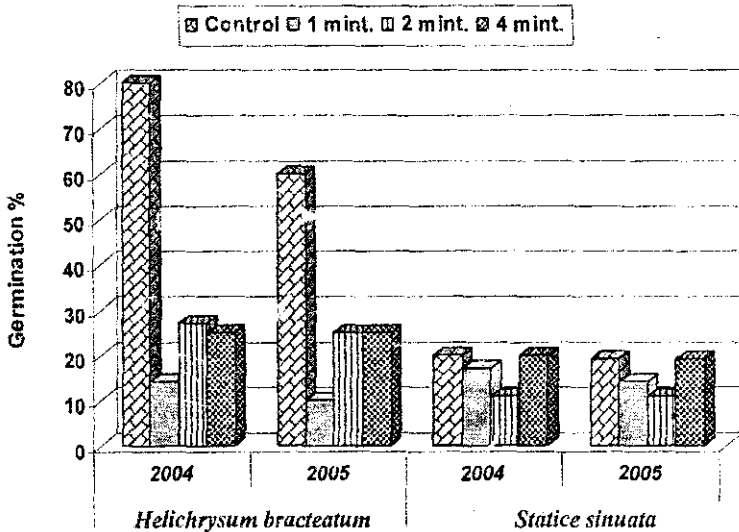


Fig (2): Effect of microwave radiation on seed germination of *Hylichrysum bracteatum* and *Statice sinuata* during 2004 and 2005 seasons.

B.2.1. Fresh weight:

It was observed from data in Table (4) that, fresh weight of *Helichrysum* and *Statice* plants was markedly influenced by all microwave irradiation treatments. The 2 minutes microwave treatment significantly increased the fresh weight of *Helichrysum*. However, fresh weight was significantly decreased by the 1 minute treatment as compared to the control or the others microwave treatments. This was no significant differences between the 4 minutes and the control treatments. The same trend was observed in both seasons in the *statice* plants. It was also noticed, that the highest significant effect on fresh weight was achieved from the 4 minutes treatment, followed by the 2 and 1 minute treatment as compared with the control in decreasing order.

Table (4): Effect of microwave radiation on some vegetative growth parameters of *Helichrysum bracteatum* L. and *Statice sinuata* L. during 2005 and 2006 seasons.

Treatments	Fresh weight (g.)		Dry weight (g)		Plant height (cm)		Plant diameter (mm)		Branch number		Leaf number		leaf area (cm ²)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
<i>Helichrysum bracteatum</i>														
Cont.	22.83 b	24.44 b	8.27 c	10.23 c	85.33 a	60.00 a	0.63 a	0.73 a	4.66 a	1.00 a	15.00 a	24.33 a	20.00 a	21.83 a
1 min.	15.67 c	17.28 c	5.67 d	8.62 d	64.33 b	55.00 ab	0.56 a	0.66 a	1.00 b	1.00 a	13.00 a	22.00 a	18.67 a	22.47 a
2 min.	61.33 a	63.29 a	22.67 a	24.64 a	63.00 b	55.00 ab	0.46 a	0.56 a	1.00 b	1.00 a	18.33 a	24.67 a	20.00 a	22.63 a
4 min.	25.67 b	27.18 b	10.67 b	13.33 b	62.33 b	54.00 b	0.56 a	0.66 a	1.00 b	1.00 a	17.67 a	17.33 b	24.33 a	27.40 a
L.S.D	3.88	4.75	1.975	1.276	4.43	5.50	0.41	0.42	0.57	0.002	5.7	3.44	9.20	10.68
<i>Statice sinuata</i>														
Cont.	40.43 d	50.98 d	12.80 e	20.61 d	39.00 c	50.33 b	0.50 a	0.53 ab	3.00 b	3.00 c	15.33 a	10.66 a	58.00 c	60.50 b
1 min.	75.60 c	99.34 c	35.87 b	54.23 c	57.00 a	71.50 a	0.43 ab	0.56 ab	7.66 a	9.33 a	14.00 ab	10.00 a	74.67 a	92.17 a
2 min.	115.0 b	163.5 b	38.27 b	66.54 b	50.33 b	52.17 b	0.33 b	0.43 b	6.00 a	5.00 bc	11.66 c	7.66 a	60.33 c	62.33 b
4 min.	130.0 a	330.4 a	44.43 a	84.69 a	52.00 b	54.00 b	0.56 a	0.60 a	7.66 a	8.00 ab	13.66 b	10.66 a	66.33 b	76.67 ab
L.S.D	13.71	9.493	4.281	4.67	1.998	12.56	0.14	0.154	1.85	0.384	1.49	3.51	2.74	29.36

Means followed by the same letter are not significantly different according to Duncan multiple range test at 5% level.

B.2.2. Dry weight:

The same trend, with few exceptions, was observed as indicated for the fresh weight. However, the 3 minute microwave treatment of *Helichrysum* and 4 minutes microwave of *Statice* significantly increased dry weight as compared with the control in both seasons.

B.2.3. Plant height:

Data in Table (4) indicated that, the plant height of *Helichrysum* and *Statice* plants were affected by pro-sowing microwave irradiation treatments, where the average of plant height of *Helichrysum* was significantly reduced by the microwave treatments in the two seasons. However, the application of all treatments in the *Statice* significantly increased the plant height especially using 195 watt for 1 minute in the two seasons over the control.

B.2.4. Stem diameter:

The obtained results in Table (4) proved that, using microwave irradiation on *Helichrysum* plants for 1, 2 and 4 minutes has no significant differences between all treatments or control in both seasons. On the other hand, the application of microwave irradiation for 1 or 2 minutes reduced the stem diameter as compared to control with non-significant differences among the two treatments. The 2 minute treatment was significantly lower than the control in the first season. In the second season, only using microwave irradiation for 2 minute gave the lowest value compared to the other treatments or the control. However, using microwave irradiation for 1 or 4 minute increased the stem diameter over the control with non-significant differences between themselves.

B.2.5. Number of branches/plant:

Regarding the effect of microwave irradiation, data in Table (4) indicated that, the different treatments tended to reduced the number of branches in the first season in *Helichrysum* as compare with the control. However, in the second season microwave irradiation did not have any significant effect on branch number as compared with the control. A different trend in the *Statice* plants was observed, where all treatments had significantly higher

branches number in the first season. In the second seasons also, all treatments had pronounced significant effects on number of branches. The highest significant increase was observed with treating the plants with microwave irradiation for 1, 4 then 2 minutes treatments in decreasing order over the control.

B.2.6. Number of leaves:

It was indicated from the same Table, that all treatments had no significantly different effects among themselves or the control in the first season in *Helichrysum* plants. However, the treatment of microwave for 1 minute gave the lowest value. Meanwhile in the second season the least value resulted from the application of the treatment at 4 minutes. On the other hand, the other treatments had no significant differences in-between or as compared to the control. The same Table indicated that, all treatments significantly decreased number of leaves of *Statice* plants as compared to the control in the first season. On the other hand, in the second one all treatments did not have any significant effect on leaves number.

B.2.7. Leaf area:

Data in Table (4) showed that, leaf area was not affected by microwave irradiation in *Helichrysum* plants in both seasons. Meanwhile, treating *Statice* plants with microwave for 1 minute significantly increased leaf area through the two seasons. As compared to untreated plants.

B.3. Flowering traits:

B.3.1. Stalk length:

It was observed from data in Table (5) that, treating *Helichrysum* plants with microwave irradiation for 1, 2 and 4 minutes significantly decreased stalk length only in the first season as compared to the control. However, in the second season, all treatments decreased stalk length with non significant differences between themselves and the control. Meanwhile, the application of the microwave irradiation for 1 or 4 minutes only increased the stalk length of *Statice* plants through the two seasons with non significant differences compared to the control.

B.3.2. Number of stalks:

Concerning the number of stalks, data in Table (5) indicated that, exposure period to microwave irradiation significantly decreased this character in *Helichrysum* plant in the first season. In the second season, treating the plants with microwave irradiation for 4 minutes increased the number of stalks with non-significant differences between all treatments and the control. On the *Statice* plants, the treatments with microwave irradiation for 1 or 4 minutes had the highest number of stalks as compared to the control. These differences were significant in the two seasons.

Table (5): Effect of microwave radiation on some flowering parameters of *Helichrysum bracteatum* L. and *Statice sinuata* L. during 2005 and 2006 seasons.

Treat.	<i>Helichrysum bracteatum</i>						<i>Statice sinuata</i>							
	Stalk length (cm)		Number of stalks		Florets diameter (cm)		Stalk length (cm)		Number of stalks		Rachis length (cm)		Number of florets/ stalk	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cont.	7.66 a	6.00 a	27.00 a	17.00 a	3.16 a	4.00 a	9.33 ab	18.33 a	2.00 c	12.33 b	5.66 a	6.06 a	6.00 a	9.66 a
1 min.	4.00 b	5.00 a	20.67 b	16.67 a	3.83 a	3.80 a	11.00 a	22.83 a	5.00 a	44.33 a	4.16 a	5.16 a	7.00 a	10.00 a
2 min.	3.00 b	4.33 a	9.66 c	16.00 a	3.16 a	3.66 a	8.00 b	17.17 a	3.00 b	14.67 b	3.50 a	4.83 a	4.00 b	7.33 a
4 min.	4.23 b	5.33 a	10.67 c	18.00 a	3.66 a	4.10 a	10.67 a	22.33 a	4.66 a	42.33 b	5.66 a	6.66 a	7.66 a	10.33 a
L.S.D	2.28	3.38	4.69	3.64	1.118	0.49	2.21	6.66	0.998	2.101	3.01	3.12	1.91	3.24

Means followed by the same letter are not significantly different according to Duncan multiple range test at 5% level.

B.3.3. Floret diameter:

Data in Table (5) revealed that, all treatments had no significant differences on floret diameter in the first and second seasons in *Helichrysum* plants as compared to the control.

B.3.4. Rachis length:

In this concern, data in the same Table (5) indicated that, the different treatments had no significant differences in both seasons in the *Statice* plants.

B.3.5. Number of florets/stalk:

Regarding the effect of microwave irradiation, on this traits, Table (5) showed that, the dose of microwave for 2 minutes

significantly decreased the number of florets/stalk in the first season, in the *Statice* plants, as compared to the other treatments and the control. However, in the second season all, treatments had no significant effect on the florets number compared to the control.

B.4. Chemical composition:

B.4.1. Chlorophyll (a) and (b) content:

Data in Table (6) showed that, the chlorophyll (a) and (b) content in the leaves of *Helichrysum* plants significantly increased by microwave treatment for 4 minutes. Moreover, there was significant increase in chlorophyll (a) content in the leaves of *Statice* plants with all microwave treatments. However, the application of all treatments significantly decreased chlorophyll (b) content.

B.4.2. Carotenoides content:

From the recorded data in Table (6), it can be concluded that, the treatment with microwave for 4 minutes gave the highest value of carotenoides content in *Helichrysum* leaves. However, there was no significant differences between the treatments and the control. On the other hand, in the *Statice* plants, all treatments significantly increased carotenoides content as compared to the control. The highest effect in this regard was obtained by the 1 minute treatment.

Several investigators found similar trends where a positive correlation was found between microwave and pigment accumulation in yucca and philodendron, **Youssef (2003)**.

B.4.3. Total phenols:

Data in Table (6) showed that, total phenols content was significantly increased with all microwave treatments in the leaves of both species plants as compared with the control. The highest significant increase was obtained in the 2 and 1 minutes in *Helichrysum* and *Statice* plants, respectively.

B.4.4. Total indoles content:

In Table (6) data proved that, treating *Helichrysum* plants with microwave irradiation for 1, 2 and 4 minute significant increased total indoles content in the leaves. It was noticed that, the

treatments for 1 or 2 minute gave the highest value. However, the highest increase was obtained by microwave at 2 minute for the Statice plants.

These results of total phenols and indoles content agree with those obtained by Youssef (2003) on *Yucca* and *Philodendron* and Sayed *et al.* (2005) on *Solidage*.

Table (6): Effect of microwave radiation on chemical composition of *Helichrysum bracteatum* and *Statice sinuata* during 2005 and 2006 seasons.

Treat.	<i>Helichrysum bracteatum</i>				
	Chlorophyll A (mg/g f.w.)	Chlorophyll B (mg/g f.w.)	Carotenoids (mg/g f.w.)	Total phenols (mg/g f.w.)	Total indols (mg/g f.w.)
Control	0.342 BC	0.125 C	0.344 A	3.720 D	0.620 B
1 min.	0.320 C	0.107 D	0.301 A	5.390 C	1.820 A
2 min.	0.536 AB	0.175 B	0.448 A	6.320 A	1.800 A
4 min.	0.625 A	0.198 A	0.525 A	6.140 B	1.190 AB
L.S.D	0.21	0.0019	0.517	0.09	0.69
Treat.	<i>Statice sinuata</i>				
	Chlorophyll A (mg/g f.w.)	Chlorophyll B (mg/g f.w.)	Carotenoids (mg/g f.w.)	Total phenols (mg/g f.w.)	Total indols (mg/g f.w.)
Control	0.272 D	0.862 A	0.220 D	4.72 B	0.75 D
1 min.	0.834 A	0.284 B	0.709 A	5.80 A	0.87 C
2 min.	0.651 B	0.187 C	0.624 B	0.84 D	1.86 A
4 min.	0.514 C	0.185 D	0.454 C	4.63 C	0.98 B
L.S.D	0.002	0.002	0.002	0.089	0.002

Means followed by the same letter are not significantly different according to Duncan multiple range test at 5% level.

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الملخص العربي

تأثير المعاملة بأشعة جاما و الميكروبيف على بعض نباتات الأزهار الجافة
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أجريت هذه التجربة على نباتات الهيليكريزم و الإستانس خلال الموسمين المتتاليين ٢٠٠٦/٢٠٠٥ بهدف محاولة إستحداث تباينات فى النمو و الإزهار لكلا النباتين و ذلك عن طريق تعريض البذور لجرعات مختلفة من أشعة جاما (صفر، ١، ٢، ٤، ٨ كيلوراد) و التعريض للميكروبيف بقوة 195 وات لفترات ١، ٢، ٤ دقيقة. و اظهرت النتائج انه عندما عوملت بذور الهيليكريزم و الإستانس بتعريضها لاشعة جاما بمعدل (١، ٢، ٤، ٨، كيلوراد) و الميكروبيف بقوة ١٩٥ وات لمدة ١، ٢، ٤ دقائق لانتاج بعض النباتات و تأثيره على بعض الصفات الخضرية و الزهرية. وقد تم تقدير النسبة المئوية لانبات و بعض صفات النمو الخضرى و الزهرى و بعض المواصفات الكيماوية للنباتات المعاملة و الكنترول. وقد أوضحت النتائج أن معظم النباتات التى تم قياسها قد تأثرت بالمعاملات المدروسة، وكان من الواضح أيضا أن تأثير نفس المعاملة قد اختلف بين النباتين تحت الدراسة فى بعض الحالات. ويمكن ان يكون لهذه الدراسة أهمية فى مجال الزينة.