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EFFECT OF GAMMA, LASER IRRADIATION AND PROGESTRONE ON GROWTH AND PHOTOSYNTHETIC PIGMENTS OF GERBERA

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ABSTRACT: This study was carried out during the two successive seasons of 2006-2007 in natural conditions at lath greenhouse of National Research Centre, to study the effects of different progesterone (prog.) concentrations (10, 20, and 30 ppm), gamma (γ) rays doses (100,150 and 250 rad), helium neon laser (He-Ne)exposure time (1, 5.5 and 11.5 min) and argon laser rays (Ar) exposure time (1, 7.5 and 15.5 min) or some interaction treatments between those treatments on vegetative growth parameters and photosynthetic pigments (Total chlorophyll and carotinoids contents in leaves) in small offshoots from healthy mother plants of *Gerbera jamesonii* cv Superba. The obtained data showed that all the single treatments of progesterone, gamma rays, laser irradiation and their interaction significantly increased vegetative growth, in most cases compared with untreated plants. The highest values in vegetative growth parameters (plant height, leaf area, fresh and dry weight of leaves, number of leaves...ect.), and (carotenoids & total chlorophyll) were obtained from treated plants with, the single treatments of progesterone at 30 and 20 ppm, as well as gamma irradiation at 150 rad, argon rays at 7.5 min and the interaction treatments (gamma ray at 150 rad + prog. at 20 ppm), (Ar at exposure time 15.5 min combined with both of prog. at 10 and/or 20 ppm) and the combined treatment (He-Ne at 5.5 min + prog. at 30 ppm).

Key words: Gerbera, growth parameters, chemical constituents, Gamma irradiation, laser rays, progesterone.

INTRODUCTION

Gerbera plant belongs to family Asteraceae, which is the largest family of flowering plants. Hansen (1985) mentioned that *Gebera jamsonii* flower is one of the most important cut flower and highly recommended for exportation. Nesom (2004) recorded that Gerbera is the fifth most used cut flower in the world (after rose, carnation, chrysanthemum, and tulip).

Steroidal sex hormones, which include androgens, estrogens and progesterone play an important role in the reproductive development of mammals. The presence of these substances in plants is a matter for debate, but it has been observed that selected steroids applied exogenously to plants have stimulated cell division (Geuns, 1978). The occurrence of steroid sex hormones in higher plants and its role in growth and sex expression was early mentioned by several investigators (Love and Love, 1945; Gawienowski *et al.*, 1971; Kopcewicz, 1971 and 1972 ; Geuns, 1978). In vitro El-shamy (2002) on bougainvillea recorded that progesterone increased the vegetative growth.

Gamma rays belong to ionizing radiation and interact to atoms or molecules to produce free radicals in cells. These radicals can damage or modify important components of plant cells and have been reported to affect differentially the morphology and biochemistry of plant depending on the irradiation level. Although no conclusive explanations for the stimulatory effects of low dose of gamma radiation are available until now, papers support a hypothesis that low dose irradiation will induce the growth stimulation (Kim *et al.*, 2004).

As for laser, the term laser is an acronym for light amplification by stimulated emission of radiation. It is a device that emits energy in electromagnet spectrum in the form of non-ionizing radiation which can be delivered in different modes Levine (1963). Laser was used widely as pre-sowing seed treatments to increase seed germinations and seedling growth (Govil *et al.*, 1991; Cai *et al.*, 1994 and 2000).The aim of this work was to study the effect of gamma and laser irradiation and some bioregulators treatments on the growth.

MATERIALS AND METHODS

This study was carried out during the two successive seasons of 2006-2007 under natural conditions at lath greenhouse of National Research Centre, to study the effect of different progesterone (prog.) concentrations (10, 20, and

30 ppm), gamma (γ) rays doses (100,150 and 250 rad), helium neon laser (He-Ne) exposure time (1, 5.5 and 11.5 min) and argon laser rays (Ar) exposure time (1, 7.5 and 15.5 min) or some interaction treatments between those treatments as follows; Prog. at 10ppm + He-Ne for 1 min, Prog. at 10ppm + He-Ne for 5.5 min, Prog. at 10ppm +He-Ne for 11.5 min, Prog. at 20ppm + He-Ne for 1 min, Prog. at 20ppm + He-Ne for 5.5 min, Prog. at 20ppm+He-Ne for 11.5 min, Prog. at 30ppm + He-Ne for 1 min,Prog. at 30ppm + He-Ne for 5.5 min, Prog. at 30ppm+ He-Ne for 11.5 min , Prog. at 10ppm + Ar for 1 min, Prog. at 10ppm + Ar for 7.5 min, Prog. at 10ppm + Ar for 15.5 min, Prog. at 20ppm + Ar for 1 min, Prog. at 20ppm + Ar for7.5 min, Prog. at 20ppm + Ar for 15.5 min, Prog. at 30ppm + Ar for 1 min, Prog. at 30ppm + Ar for 7.5 min and Prog. at 30ppm + Ar for 15.5 min, Prog. at 10ppm + γ at 100 rad, Prog. at 10ppm + γ at 150 rad, Prog. at 10ppm + γ at 250 rad, Prog. at 20ppm + γ at 100 rad , Prog. at 20ppm + γ at 150 rad , Prog. at 20ppm + γ at 250 rad, Prog. at 30ppm + γ at 100 rad, Prog. at 30ppm + γ at 150 rad and Prog. at 30ppm + γ at 250 rad on vegetative growth characters of *Gerbera jamesonii* cv Superba.

During both seasons, similar offshoots of gerbera plants with 2-3 leaves were obtained from healthy mother plants. One offshoot was cultivated in each pot (30 cm diameter and 50 cm depth) contained a mixture of sand and clay (1:1,v/v). Progesterone solution was prepared by dissolving it in Tween 20 then diluted with water to obtain the required concentrations. The offshoots were subjected to gamma irradiation treatments (γ) at Middle Eastern Regional Radia Isotop Centre for Arab Countries, Dokki, Cairo, Egypt by using a Co^{60} source on 23 Marsh during both saesons. Laser irradiation treatments emitted from the slandered device was generally characterized in terms of power in units of watts (w) and milli Watts (Mw).Helium-neon lasers of power was 20 Mw while argon (Ar)laser of power was 15 Mw were used for red and green light irradiation respectively.

The offshoots which exposed to gamma radiation and progesterone treatments were transplanted on 23 March in both seasons, the solutions of growth regulators progesterone in distilled water were sprayed twice, the first was 15 days after transplanting and the other four weeks later. While the shoots which exposed to laser

treatments, were transplanted on 26 March. All plants received the same irrigation rate and fertilization doses. At flowering stage plant sample were collected to estimate growth parameters.

The following vegetative growth parameters were recorded gviz., plant height (cm), number of leaves/plant, number of offshoots/ plant, leaf area (cm^2), leaves fresh weight (g) and leaves dry weight (g). Also, total chlorophyll and carotenoids concentrations were determined according to Saric *et al.* (1976).

The statistical layout of this experiment was completely randomized block design. Each treatment contained three replicates and each replicate contained three pots. The recorded data were statistically analyzed, and the means were compared using Duncan multiple rang test at 5% according to Duncan (1955).

RESULTS AND DISCUSSION

Effect of Progesterone, Gamma and Laser Irradiation and Some of Their Interaction Treatments.

Plant height

It could be observed from data presented in Table 1 that, progesterone treatments at 10, 20 and 30 ppm significantly increased plant height as compared to the untreated plants. Progesterone at 10 ppm induced increases of 39.80% and 11.09% over the control, 20ppm recorded 41.88% and 12.71% increases over the control, whereas, 30 ppm achieved 50.03 and 7.14 % increases over the control, during both seasons, respectively. There were no significant differences between the three progesterone concentrations.

In this respect, Hagagy *et al.* (1999) on papaya seeds found that soaking of seeds in 5.0 mg/l progesterone resulted in enhancement of plant height. Concerning to gamma rays treatments treated plants with gamma rays at (150 and 250 rad significantly increased in both seasons compared with control plants. As for the effect of Ar rays treatments on plant height, the obtained results showed that the higher mean values was obtained from treated plants with Ar_2, Ar_3 in the first and the second season, respectively. However, He-Ne treatments tended to record in general significant higher values in the first season with one exception of He-Ne_2 and a lower value was recorded in the second season as compared with the control and other treatments. As for the

Table 1. Effect of progesterone, gamma radiation, helium neon, argon, and some of their interaction between progesterone and irradiation treatments on plant height, number of leaves and leaf area of *Gerbera iamasonii* plants during the two seasons of 2006 and 2007

Treatments	Plant height (cm)		Number of leaves/ plant		Leaf area (cm^2)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cont	16.33 ij	21.00 l-q	5.66f	6.66de	64.21 m-o	66.60 kl
$prog_1$	22.83 a-f	23.33 e-j	8.00 a-e	8.00 a-d	66.63 l-n	94.09 b
$Prog_2$	23.17 a-e	23.67 d-i	9.00 ab	9.00 a	54.48 p	56.72 mn
$Prog_3$	24.50a-e	22.50 h-l	7.33b-f	8.00 a-d	74.42k	75.48gh
γ_1	16.00 j	21.50 j-o	6.66 d-f	8.00 a-d	76.27 jk	71.98 ij
γ_2	20.00 e-j	24.00 c-h	6.33 ef	8.00 a-d	80.66 hi	95.39 ab
γ_3	22.67 a-f	21.17 k-p	8.66a-c	7.33 b-e	67.18 l-n	54.32 n
Ar_1	22.00 c-h	22.67 g-l	8.00a-e	8.33 a-c	67.42 lm	69.09jk
Ar_2	22.33 b-g	21.83 j-o	8.66 a-c	8.66 ab	103.5 b	75.84 gh
Ar_3	20.17 e-j	23.00 f-k	7.33 b-f	7.66a-e	69.23 l	81.67 f
$He\text{-}Ne_1$	24.17 a-e	16.33 r	6.66 d-f	6.66 de	95.85 d	56.13 mn
$He\text{-}Ne_2$	18.33 f-j	20.67 m-q	7.00 c-f	7.33b-e	60.97 o	53.39n
$He\text{-}Ne_3$	24.00 a-e	19.67 p-q	7.66 a-e	6.33 e	85.21 fg	57.70 m
$\gamma_1 + Prog_1$	17.50 h-j	22.17 i-n	7.33 b-f	8.00a-d	68.45 l	75.77gh
$\gamma_2 + Prog_1$	16.00 j	19.33 q	8.33 a-d	8.66ab	63.7 no	69.48 j
$\gamma_3 + Prog_1$	20.33 e-j	20.33 n-q	7.66 a-e	7.66a-e	83.88 fg	76.69 g
$Ar_1 + Prog_1$	21.67d-h	20.67 m-q	7.33 b-f	8.00 a-d	95.10 de	85.41de
$Ar_2 + Prog_1$	27.08 a	25.67 bc	8.66 a-c	8.00 a-d	106.5 b	88.34 c
$Ar_3 + Prog_1$	22.00 c-h	21.33 k-p	8.00a-e	8.00 a-d	93.37 de	97.36 a
$He\text{-}Ne_1 + Prog_1$	25.67 a-d	25.33 b-d	9.33 a	8.66 ab	73.73 k	82.43 f
$He\text{-}Ne_2 + Prog_1$	24.33 a-e	22.67 g-l	7.66a-e	6.66 de	99.33 c	87.64 cd
$He\text{-}Ne_3 + Prog_1$	26.67 ab	25.67 bc	9.00 ab	7.00c-e	92.12 e	83.57ef
$\gamma_1 + Prog_2$	21.83 c-h	20.17 o-q	7.66 a-e	6.66 de	75.62jk	75.40 gh
$\gamma_2 + Prog_2$	20.00 e-j	19.67 p-q	7.33 b-f	8.00 a-d	74.92 i-k	71.54 ij
$\gamma_3 + Prog_2$	23.33 a-e	21.33 k-p	6.33e-f	7.00 c-e	83.92 f-h	88.14 cd
$Ar_1 + prog_2$	16.00 j	21.67 j-o	7.33 b-f	7.33 b-e	86.25 f	70.14 j
$Ar_2 + Prog_2$	20.33 e-j	20.67 m-q	9.33 a	8.66 ab	73.82 k	64.77 l
$Ar_3 + Prog_2$	22.33 b-g	22.33 h-m	8.00 a-e	8.33 a-c	87.19 f	86.95 cd
$He\text{-}Ne_1 + Prog_2$	26.33 a-c	25.00 b-e	7.66 a-e	7.66 a-e	103.4 b	92.89 b
$He\text{-}Ne_2 + Prog_2$	20.00 e-j	21.67 j-o	8.33 a-d	8.33 a-c	83.95 f-h	83.39 ef
$He\text{-}Ne_3 + Prog_2$	21.67 d-h	24.67 b-f	7.33 b-f	7.33 b-e	124.7 a	97.80 a
$\gamma_1 + Prog_3$	22.83 a-f	23.17 f-j	7.33 b-f	8.00 a-d	68.69 l	71.45 ij
$\gamma_2 + Prog_3$	22.83 a-f	22.83 g-l	6.66 d-f	8.66 ab	69.01 l	69.44 j
$\gamma_3 + Prog_3$	18.00 g-j	24.33 b-g	7.33 b-f	8.66ab	78.08 ij	77.80 g
$Ar_1 + Prog_3$	23.67 a-e	28.00 a	6.33 ef	6.33 e	80.63 hi	86.97 cd
$Ar_2 + Prog_3$	25.33 a-d	23.67 d-i	6.66 d-f	6.667 de	66.33 l-n	73.66 hi
$Ar_3 + Prog_3$	25.67 a-d	25.00 b-e	6.333 ef	6.333 e	57.00 p	64.00 l
$He\text{-}Ne_1 + Prog_3$	20.50 e-i	21.00 l-q	7.333 b-f	6.66 de	86.88 f	86.00 c-e
$He\text{-}Ne_2 + Prog_3$	25.17 a-d	26.00 b	7.667 a-e	8.00 a-d	84.85 fg	85.33 de
$He\text{-}Ne_3 + Prog_3$	21.74 c-h	23.33 e-j	7.333 b-f	6.66 de	82.08 gh	81.91 f

Prog.: Progesterone , $prog._1$:10 ppm , $prog_2$:20 ppm , $prog_3$:30 ppm, γ: Gamma radiation , γ_1:100 rad , γ_2:150 rad , γ_3:250 rad , He-Ne : helium-neon , $He\text{-}Ne_1$:1 min $He\text{-}Ne_2$:5.5 min , $He\text{-}Ne_3$: 11.5 min , Ar : Argon , Ar_1:1 min, Ar_2:7.5 min , Ar_3: 15.5 min

Data with the same letter vertically are not significant according to Duncan's multiple range test at 5 % level.

interactions between progesterone and gamma or laser irradiations. Ar laser (green light) at 7.5 min combined with progesterone at 10 ppm and Ar laser at 1 min combined with progesterone at 30 ppm induced the highest significant increases in plant height. Also the treatments, He-Ne_1 + prog.$_1$, He- Ne_3 + prog.$_1$, showed significant increase as compared to the control but there was no significant effect in between. He-Ne laser (red light) at 11.5 min. combined with progesterone at 10 ppm caused significant increases in plant height. The increases were 63.31 and 22.33 % over the control. Whereas He-Ne laser at 1 min. followed by progesterone at 20 ppm caused also significance increase, it was slightly lower.The increases reached 61.23 and 19.04 % over the control during both seasons, respectively. But insignificant effect in between

The interaction between argon laser and progesterone treatments were slightly lower. Argon laser at 15.5 min combined with progesterone at 30 ppm set off increases of 57.19 % and 19.04 % over the control during both seasons, respectively.

Finally, helium neon laser at 5.5 min. combined with progesterone at 30ppm caused increases by 54.13% and 23.80 % over the control during both seasons, respectively.

Number of leaves

The effect of progesterone, gamma, helium neon and argon laser rays treatments on number of leaves/plant are presented in Table 1 spraying plants with Progesterone significantly increased the number of leaves/plant progesterone at 20 ppm showed the highest significant increase, it caused 59.01% and 35.13 % increases over the control during both seasons, respectively. This finding was in accordance with El-Shamy (2002) he found that addition of progesterone to shoot tips culture medium containing 2.0 mg/l BA increased axillary leaves number/shoot especially with high progesterone concentrations (5 or 10 mg/l) and Hagagy *et al.* (1999) on papaya seeds found that soaking of seeds in 5.0 mg/l progesterone resulted in enhancement of leaves number. Gamma rays in general especially at 250 rad induced the higher increases, as it caused 52.93 % and 24.98 % increases over the control during both seasons, respectively. Similar effect was also noticed by Youssef and Zeinab (1998) on *Chamomilla recutita*, Singh *et al.* (1999) on carnation, Dilta *et al.* (2006) on *Chrysanthemum morefolium* and Khalaf (2008) on *Amaranthus caudatus.*

Argon laser rays at exposure time of 1 min enhanced the increases in leaf number / plant as it recorded 41.34 % and 25.07 % increase over the control during both seasons, respectively. In this regards it was mentioned by Wessam (2005) on sage plants.

Helium neon laser ray mostly increased the number of leaves/plant with insignificant differences between exposure time.The highest increament over the control plants was recorded by the medium time exposure (5.5 min), it created 23.67 % and 10.06 % increases over the control during both seasons, respectively. The previous results are agree with that of Atanasova (1983) and Hassan (2000) on wheat plants.

As for the interaction between argon laser at time exposure of 7.5 min combined with progesterone at medium concentration (20ppm) effectuated increase number of leaves/plant, as it induced 64.84 and 30.03 % over the control during both seasons, respectively. Helium neon laser at 1 min. followed by spraying with progesterone at 10 ppm treatment resulted in increasing the number of leaf/plant, it recorded 64.84 % and 30.03 % over the control. Whereas, helium neon laser at 5.5 min. exposure followed by spraying with progesterone at 20 ppm resulted in 47.17 % and 25.07 % increases over the control in two seasons respectively. Argon rays laser at time exposure 7.5 min combined with progesterone at 10 ppm showed significant increases in number of leaves/plant. It gave 53.00 % and 20.12 % over the control. The treatments Ar_1+$prog_1$,A_3+$prog_1$,He-Ne_1+$prog_1$ and He-Ne_2+$prog_3$ showed similar effect but without insignificant in between.

Leaf area

Data in Table 1 show that progesterone at 30 ppm superinduced increases in leaf area as compared to control. It recorded 15.90and 13.33 % over the control during both seasons, respectively. This result hold true with the finding of El-Shamy (2006) who mentioned that stimulatory effect of using progesterone up to 20 mg/l enhanced leaf length. Gamma rays at 150 rad gave the highest leaf area compared with control and the other doses of gamma. The recorded increments were 25.61 % and 43.22 % over the control during both seasons, respectively. The recorded data are in harmony with those obtained by Singh *et al* (1999) in vitro on carnation plants.

The obtained data also revealed that all Ar rays laser showed significant increases in both seasons in comparison with the control. The highest values were obtained from treated plants with Ar_2 (7.5 min).On the contrary, He-Ne rays laser at 5.5 min. recorded decrease compared to the control in both seasons. As for the interaction treatments between progesterone spray and laser rays treatments, Helium neon laser at 11.5 min. combined with progesterone at 20ppm superinduced the highest significant increases in leaf area. It recorded 94.20 % and 46.84 % increase over the control during both seasons, respectively, followed by the lowest dose of helium neon laser at 1 min combined with progesterone at 20 ppm. The seedlings subjected to He-Ne laser at 5.5 min and sprayed with progesterone at 10 ppm showed significant increases in leaf area. It recorded 54.69 % and 31.59 % increases over the control during both seasons, respectively. Ar laser rays at 15.5 min. when combined with spraying with progesterone at 10 ppm gave the highest leaf area compared with control and the others exposure time treatments. It generated 45.41 % and 46.18 % increases over the control during both seasons, respectively.

Number of offshoots/plant

It is evident from the Table 2 that, in general, spraying seedling with progesterone solution enhanced branching. This increase was reached to the significant value with 20 ppm. It inspired increases 200 % and 100 % over the control during both seasons, respectively. Concerning the effect of progesterone, it was found that addition of progesterone to shoot tips culture medium containing 2.0 mg/l BA increased axillary shoots number, especially with high progesterone concentrations (5 or 10 mg/l). Similar trend was recorded with single node pieces (El-Shamy, 2002). Also, Hagagy *et al.* (1999) on papaya seeds found that soaking of seeds in 5.0 mg/l progesterone resulted in enhancement of branches number.

Gamma ray at 150 rad radiation came to pass increases of 166% and 50.37 % over the control during both seasons, respectively. These results are in agreement with those reported by Venkatachalan and Jayabalon (1997) on Zinnia, Datta *et al.* (1985) on chrysanthemum, Dilta *et al.* (2006) on *Chrysanthemum morifolium* and Dubey *et al.* (2007)

Table 2. Effect of progesterone, gamma radiation, helium neon, argon, and some of their interaction between progesterone and irradiation treatments on number of offshoots, leaves fresh weight and leaves dry weight. of *Gerbera iamasonii* plants, during the two seasons of 2006 and 2007

Treatments	Number of offshoots/plant		Leaves Fresh Weight (g)		Leaves Dry Weight (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cont	1.00 fg	1.33 d-f	40.73 o-p	43.36 st	9.767 mn	9.817 rs
$prog_1$	2.00 c-f	2.00 b-e	53.63 l-m	106.72 d	12.32 j-k	25.7 d
$Prog_2$	3.00 a-c	2.66 a-d	65.92 e-h	1118.72 b	15.42 e-g	28.75 b
$Prog_3$	1.66 d-f	3.33 ab	96.48 a	124.37 a	23.06 a	30.35 a
γ_1	3.33 ab	1.33 d-f	73.58 cd	64.29 l-n	17.17 cd	15.07lm
γ_2	2.66 a-d	2.00 b-e	76.53 c	67.40 kl	18.14 c	15.84 kl
γ_3	1.33 ef	2.33 a-e	75.17 c	64.67 l-n	17.77 c	15.16 lm
Ar_1	1.00 fg	1.33 d-f	38.72 pq	47.08 rs	8.690 o	10.79qr
Ar_2	2.00 c-f	1.66 c-e	68.57 ef	86.85 g	16.14 ef	20.68 g
Ar_3	1.66 d-f	2.33 a-e	67.22 e-g	81.53 hi	15.71 e-g	19.45 hi
$He\text{-}Ne_1$	0.00 g	1.33 d-f	56.87 j-m	36.18 uv	13.21 i-k	8.033 uv
$He\text{-}Ne_2$	1.33 ef	1.33 df	47.52 n	66.49 lm	10.98 l	15.41 lm
$He\text{-}Ne_3$	0.00 g	0.00 f	44.95 n	32.78 v	10.27 lm	7.16 v
γ_1+ $Prog_1$	2.00 c-f	1.66 c-e	56.90 j-m	50.60 qr	13.22 i-k	11.64 pq
γ_2+ $Prog_1$	1.66 d-f	3.00 a-c	36.75 pq	37.73 u	8.183 o	8.423 t-u
γ_3 + $Prog_1$	2.00 c-f	2.00 bc	73.13 cd	79.70 i	17.45 cd	18.91 i
Ar_1+ $Prog_1$	2.33 b-e	3.667 a	96.98 a	83.92 gh	23.24 a	19.95 g-i
Ar_2+ $Prog_1$	1.66 d-f	2.00 b-e	61.98 hi	61.07 np	14.82 gh	14.24 mo
Ar_3+ $Prog_1$	3.00 a-c	3.33 a-b	84.80 b	86.21 g	20.20 b	20.55 gh
$He\text{-}Ne_1$+ $Prog_1$	1.33 ef	3.66 a	54.78 lm	99.06 e	12.67 jk	23.78 e
$He\text{-}Ne_2$+ $Prog_1$	0.00 g	2.33 a-e	68.14 ef	62.57 m-o	16.07 ef	14.62 mn
$He\text{-}Ne_3$+ $Prog_1$	1.00 fg	2.33 a-c	44.20 no	44.35 st	10.07 lm	10.35 rs
γ_1+ $Prog_2$	2.33 b-e	1.00 ef	65.88 eh	87.57 g	15.45 e-g	20.90 g
γ_2+ $Prog_2$	1.00 fg	3.33 a-b	52.62 m	75.22 j	12.14 k	17.74 j
γ_3+ $Prog_2$	1.66 d-f	1.33 d-f	69.95 de	70.97 k	16.49 de	16.73 jk
Ar_1+$prog_2$	2.00c-f	2.33 a-e	53.13 lm	57.43 p	12.27 k	13.32 o
Ar_2+$Prog_2$	1.33 ef	2.66 a-d	39.90 pq	65.23 ln	8.987 no	15.29 lm
Ar_3+$Prog_2$	2.33 b-e	3.33 ab	59.60 ik	93.65 f	13.90 hi	22.31 f
$He\text{-}Ne_1$+ $Prog_2$	0.00 g	2.33 a-e	55.25 km	51.90 q	12.78 jk	11.96 p
$He\text{-}Ne_2$+ $Prog_2$	3.66 a	2.00 b-e	64.33 fh	85.53 g	15.13 fg	20.45 gh
$He\text{-}Ne_3$+ $Prog_2$	1.66 d-f	2.00 b-e	63.40 gi	93.15 f	15.21 fg	22.27 f
γ_1+ $Prog_3$	1.00 fg	1.66 c-e	26.68 s	79.53 i	5.687 q	18.84 i
γ_2+ $Prog_3$	1.66 d-f	2.33 a-e	66.33eh	112.75 c	15.57 e-g	27.18 c
γ_3+ $Prog_3$	1.33 ef	2.33 a-e	36.12 qr	45.10 st	8.017 o	10.27 rs
Ar_1+ $Prog_3$	2.66 a-d	2.66 a-d	66.65 e-g	46.46 s	15.68 e-g	10.90 p-r
Ar_2+ $Prog_3$	0.00 g	0.00 f	32.25 r	41.75 t	7.060 p	9.433 st
Ar_3+ $Prog_3$	0.00 g	2.00 b-e	57.40 j-l	59.59 op	13.38 ij	13.89 no
$He\text{-}Ne_1$+ $Prog_3$	3.00 a-c	1.00 ef	46.95 n	43.72 st	11.05 l	9.917 rs
$He\text{-}Ne_2$+ $Prog_3$	2.33 b-e	2.66 a-d	46.78 n	58.79 op	10.69 lm	13.68 no
$He\text{-}Ne_3$+ $Prog_3$	1.66 d-f	3.00 a-c	59.91 ij	64.33 l-n	13.98 hi	15.38 lm

Prog. : Progesterone , $prog_1$:10 ppm , $prog_2$:20 ppm , $prog_3$:30 ppm , γ: Gamma radiation ,γ_1:100 rad , γ_2:150 rad , γ_3:250 rad , He-Ne : helium-neon , $He\text{-}Ne_1$:1 min , $He\text{-}Ne_2$:5.5 min , $He\text{-}Ne_3$: 11.5 min , Ar : Argon , Ar_1:1 min. , Ar_2:7.5 min. , Ar_3: 15.5 min..
Data with the same letter vertically are not significant according to Duncan's multiple range test at 5 % level

on okra using gamma ray. Both laser types did not show significant increase in offshoot production compared with control. Generally, it could be observed that the highest number of offshoots/plant were recorded when plants were exposed to laser irradiation followed by spraying with progesterone.

Concerning the combined effect between gamma ray and progesterone, it was found that spraying plants with progesterone slightly enhancing the production of offshoots which suppressed by gamma irradiation.

Leaves fresh and dry weights

It could be observed from data presented in Table 2 that progesterone treatments significantly increase the leaves fresh weight and dry weights of gerbera plants. Leaves fresh and dry weights were significantly increased with increasing progesterone concentration. the highest concentration up to (30 ppm). It recorded 136.87 % and 186.83 % increases over the control during both seasons, respectively. This results hold true with the finding of El- Shamy (2006) who mentioned that stimulatory effect of a foliar spray of progesterone on Amaryllis bulblet fresh weight was increased significantly as progesterone concentration increased, being its maximum at 5 or 10 mg/l progesterone.

As for the interaction treatments it could observed that the highest values were recorded with Ar_1+$prog_1$ treatment during the first seasons, while the treatment of γ_2 + $prog_3$ gave the highest value during the second season.

Total chlorophyll (mg/g fw)

It could be observed from data presented in Table 3 that, the treatments of progesterone and gamma irradiation resulted in decreasing the total chlorophyll concentration in both seasons.

On the other hand, argon laser irradiation showed slight increase when compared to the data of progesterone or gamma ray treatments.Whereas, He-Ne at dose exposure time at 11.5 min created significant increases. It reached 24.56 and 31.20 % over the control during both seasons, respectively. This finding was in accordance with Sebanek *et al.* (1989) on sunflower, Yi Ping Chen *et al.* (2005) on *Isatis indogotica* and Wessam (2005) on *Salvia fficinalis* using laser rays.

As for the interaction treatments, Ar at 1 min combined

Table 3. Effect of progesterone, gamma radiation, helium neon, argon, and some of their interaction between progesterone and irradiation treatments on total chlorophyll and carotenoids concentrations in *Gerbera iamasonii* leaves, during the two seasons of 2006 and 2007

Treatments	Total Chlorophyll concentration (mg/g. fw.)		Carotenoides concentration (mg/g. fw.)	
	1st season	2nd season	1st season	2nd season
Cont	1.079 ij	1.035 jk	1.270 cd	1.200 l
$prog_1$	1.039 kl	1.116 f	1.013 lm	1.053 r
$Prog_2$	0.607A	0.621v	0.7267 p	0.7300 y
$Prog_3$	0.671y	0.687t	0.8033 no	0.8067 w
γ_1	0.732 x	0.737 s	0.8767 n	0.7933 x
γ_2	0.7947 v	0.817q	0.9767 m	0.9600 t
γ_3	0.6536z	0.668 u	0.7467op	0.7367 y
Ar_1	1.025 k-m	1.020 kl	1.447 b	1.417 e
Ar_2	1.037k-m	1.080 g	1.297 c	1.283 gh
Ar_3	1.014 mn	0.959 o	1.143 g-j	1.127 n
$He\text{-}Ne_1$	1.021mn	1.018 jk	1.087 j-l	1.093 p
$He\text{-}Ne_2$	0.905 st	0.903 p	1.153 f-j	1.087 pq
$He\text{-}Ne_3$	1.344 b	1.358 b	1.433 b	1.463 d
γ_1+ $Prog_1$	0.7619 w	0.742 s	0.8367 n	0.8933 v
γ_2+ $Prog_1$	1.047 k	1.074 gh	1.197 d-h	1.277 h
γ_3 + $Prog_1$	0.919 rs	0.903 p	1.053 kl	1.077 q
Ar_1+ $Prog_1$	1.451a	1.450 a	1.580 a	1.670 a
Ar_2+ $Prog_1$	1.290 d	1.311 c	1.283 cd	1.417 e
Ar_3+$Prog_1$	0.924 q	0.889 p	0.9567 m	0.9900 s
$He\text{-}Ne_1$+ $Prog_1$	0.836 u	0.824 q	0.8567 n	0.8833 v
$He\text{-}Ne_2$+ $Prog_1$	1.138 h	1.116 f	1.283 c-d	0.3467 z
$He\text{-}Ne_3$+ $Prog_1$	1.270 e	1.313 c	1.540 a	1.523 c
γ_1+ $Prog_2$	0.974 p	0.966 o	1.107 i-k	1.097 p
γ_2+ $Prog_2$	0.895 t	0.886 p	1.153 f-j	1.110 o
γ_3+ $Prog_2$	1.157 g	1.106 f	1.253 c-e	1.237 i
Ar_1+ $Prog_2$	1.229 f	1.253 d	1.553 a	1.527 c
Ar_2+ $Prog_2$	1.157 g	1.155 e	1.277 cd	1.293 fg
Ar_3+ $Prog_2$	1.006 no	0.990 mn	1.210 c-g	1.163 m
$He\text{-}Ne_1$+ $Prog_2$	0.794 v	0.750 s	1.123 h-k	1.093 p
$He\text{-}Ne_2$+ $Prog_2$	0.998 o	0.998 lm	1.213 c-g	1.243 i
$He\text{-}Ne_3$+ $Prog_2$	1.064 j	1.058 hi	1.267 c-e	1.230 j
γ_1+ $Prog_3$	1.084 i	1.068 g-i	1.227c-g	1.157 m
γ_2+ $Prog_3$	0.786 v	0.796 r	0.7233 p	0.9433 u
γ_3+ $Prog_3$	0.953 q	0.990 mn	1.183 e-i	1.220 jk
Ar_1+ $Prog_3$	1.089i	1.068 g-i	1.077 j-l	1.300 f
Ar_2+ $Prog_3$	1.041 kl	0.993 mn	1.403 b	1.213 k
Ar_3+ $Prog_3$	1.157 g	1.0766 gh	1.237 c-f	1.230 ij
$He\text{-}Ne_1$+ $Prog_3$	1.0823 i	1.112 f	1.197 d-h	1.243 i
$He\text{-}Ne_2$+ $Prog_3$	1.322 c	1.333 c	1.567 a	1.647 b
$He\text{-}Ne_3$+ $Prog_3$	1.034 k-m	1.049 ij	1.253 c-e	1.150 m

Prog. : Progesterone , $prog_1$:10 ppm , $prog_2$:20 ppm , $prog_3$:30 ppm , γ: Gamma radiation , γ_1:100 rad , γ_2:150 rad , γ_3:250 rad , He-Ne : helium-neon , $He\text{-}Ne_1$:1 min , $He\text{-}Ne_2$:5.5 min. , $He\text{-}Ne_3$: 11.5 min. , Ar : Argon , Ar_1:1 min. , Ar_2:7.5 min , Ar_3: 15.5 min.

Data with the same letter vertically are not significant according to Duncan's multiple range test at 5% level

with progesterone at 10 ppm increased the total chlorophyll concentration. The offered increases reached 34.47 % and 40.09 % over the control during both seasons, respectively. That was followed by argon at 7.5 min combined with progesterone at 10 ppm, which induced increases of 19.55 and 26.66 % over the control during both seasons, respectively.

In the same time He-Ne at 11.5 min combined with progesterone at 10 ppm gave rise to the increases of 17.70 and 26.85% over the control during both seasons, respectively.

The interaction between Ar at 1 min combined with 20 ppm concentration progesterone induced the increases to 13.90 % and 21.06 % over the control. However, Ar at 7.5 min combined with progesterone at 20 ppm induced the increases to 7.22 % and 11.59 % over the control during both seasons, respectively. On the other hand, the treatment of progesterone at 30 ppm exhibited decreases of 37.81 % and 33.62 % below the control during both seasons, respectively.

Carotenoids

Data in Table 3 show that, spraying plants with progesterone alone significantly decreased carotenoides concentration in gerbera leaves. Gamma irradiation treatments showed significantly similar decreases alone or when combined with progesterone at 10 ppm. This finding was in accordance with those obtained by Garg *et al.* (1977) who treated *Brassica juncea* seeds by gamma rays alone.

Argon laser irradiation at dose of 1 min time exposure significant increased carotenoids concentrations. It recorded 13.93 and 18.08 % increases over control during both seasons, respectively. The highest doses of He-Ne irradiation treatment significantly increased the carotenoids concentrations. The same effect was also noticed by Wessam (2005) on *Salvia fficinalis* using laser rays.

As for the interaction treatments, argon laser irradiation at 1 min when combined progesterone at 10 ppm showed the highest significant augmentation in carotenoids concentration. The overmuch reached 24.40 % and 39.16 % over the control during both seasons, respectively. This increment was reduced gradually as Ar laser exposure time increased, but it still significantly higher than control. The interaction between He-Ne at exposure time 11.5 min combined with progesterone at 10 ppm

significantly raised the carotenoides concentration. It reached 21.25 % and 26.91 over the control during both seasons, respectively. Also, He-Ne at 5.5 min time exposure when combined with progesterone at 30 ppm showed increases to reach 23.38 % and 37.25 % over the control during both seasons, respectively.

REFERENCES

Atansova, B. 1983. The effect of gamma rays, Laser irradiation and fast neutrons on the germinative and reproductive performance of SIM carnations. Gradinarskai Lozarska Nauka, 20(8): 61-66.

Cai, S.W., X.S. Zhao, F.T. Lu, and X.L. Ma. 1994. The influence of He-Ne laser irradiation on the active oxygen metabolism of corn seedlings. J. Laser, 21:767-769.

Cai, S.W., Z. Qi, and X.L. Ma. 2000. The effect of He-Ne laser irradiation on soluble protein synthesis of corn seedlings. J. Lasers, 27:284-288.

Datta, S.K., B.K. Banerji, and M.N. Gupta. 1985. Chrysanthemum Cultivar evolved by gamma irradiation. India. Journal of Nuclear Agriculture and Biology, 14 (4):160-164.

Dilta, B.S., Y.D. Sharma, S.R. Dhiman, and V.K. Verma. 2006. Induction of somatic mutations in chrysanthemum by gamma irradiation. International Journal of Agricultural Sciences 2(1):77-81.

Dubey, A.K., J.R. Yadav, and B. Singh. 2007. Studies on induced mutations by gamma irradiation in okra *Abelmoschus esculentus* L. Monch Progressive-Agriculture, 7(1/2): 46-48

Duncan, D.B. 1955. Multiple range and multiple F test. Biometrics 11:1-42.

El-Shamy, H.A. 2002 In vitro culture studies on bougainvillea plant. Ph.D. Thesis, Fac. Agric., Zagazig University.

El-Shamy, H.A. 2006. Effect of methyljasmonate, spermine, casein hydrolysate and progesterone on micropropagation of amaryllis (*Hippeastrum vittatum*). Zagazig J. Agric. Res., 33 (3): 413- 424.

Garg, O.K., G.R.S.S Kona, and A.N. Sharma. 1977. Response of mustard to pre-sowing gamma irradiation with special reference to total carbohydrate

content in leaves .Journal of Scientific Research of the Banaras Hindu University, 28(2):335-338.

Gawienowski, A.M., R.W. Cheney, and H.V. March. 1971. Some relations of sterols to plant growth. Phytochemistry, (10): 20-33.

Geuns, J.M.C. 1978. Steroid hormones and plant growth and development. Phytochemistry, (17): 1-14.

Govil, S.R., D.C. Agrawal, K.P. Rail, and S.N. Thaker. 1991. Physiological responses of *Vigna radiata* to nitrogen and argon laser irradiation. Indian J. Plant Physiol., 1: 72-76.

Hagagy, N.A., N.S. Zaied, and S.A. Khafagy. 1999. Preliminary studies on the effect of steroid sex hormones on papaya plants. Zagazig J. Agric. Res., 26 (3 A): 725-741.

Hansen, V.A. 1985. Taxonomic revision of the genus Gerbera (Compositae, Mutisieae) sections Gerbera, Parva, Piloselloides (in Africa), and Lasiopus (Opera botanica. No. 78), ISBN 87-88702-04-9. Gerbera-Wikipedia, the free encyclopedia

Hassan, A.M. 2000. Biochemical genetic studies on some environmental Tolerance plants. M.Sc. Thesis, Fac. Agric., Cairo Univ.

Khalaf 2008. Effect of gamma irradiation on growth, flowering and Induced variability in. *Amaranthus cadatus* L. M.Sc. Thesis, Fac. Agric., Alex. Univ.

Kim, J.H., M.H. Kim, B.Y. Beak Chung, S.G. Wi and J.S. Kim. 2004. Alterations in the photosynthic pigments and antioxidant machineries of red peper (*Capsicum annuum* L.) seedlings from gamma irradiated seeds. J. Plant Biol., 47: 314-321.

Kopcewicz, J. 1971. Some possible physiological roles of sex steroid hormones in *Cucumis sativus*. Phytochemistry, (10): 1-14.

Kopcewicz, J. 1972. Growth hormones relations in bean seedlings. Phytochemistry, (11): 10-14.

Levine, A.K. 1963. Lasers. Amer. Scientist, 51:14-31.

Love, A. and D. Love. 1945. Experiments on the effects of animal sex hormones on

dioecious plant. Arkiv. For Botarik 32 A (13): 1-6.

Nesom, G.L. 2004. Response to "The Gerbera complex (Asteraceae, Mutisieae): to split or not to split" by Liliana Katinas. *Sida* 21:941-942.

Saric, M., R. Kastrori, R. Curic, T. Cupina, and T. Geric. 1976. Chlorophyll determination. Univ. Unoven Sadu parkikum is Fizicalagize Bilzaka, Beogard, Hauncna, Anjiga, 215.

Sebanek, J., J. Kralik, M. Hudeova, Klicova, K. Slaby, V. Psota, H. Vitkova, M. Olsenka, D. Kudova, S. Sterba, and J. Vancura. 1989. Growth and hormonal effects of laser on germination and rhizogenesis in plants. Providovedna Prace Ustavu Ceskoslovenske Akademie VedV Brne, 23 (9):49-69.

Singh, K.P., B. Singh, S.P.S. Raghava, R.L. Misra, and C.S. Kalia. 1999. In vitro induction of mutation in carnation through gamma irradiation. Journal of Ornamental Horticulture New Series, 2(2):107-110.

Venkatachalam, P. and N. Jayabalan. 1997. Effect of gamma rays on some qualitative and quantitative characters in Zinnia Elegans Jacq. Indian Journal of Genetics and Plant Breeding, 57(3):255- 261.

Wessam, M.S.E.A. 2005. Effect of laser on the growth and the active constituents of sage plant. M.Sc. Thesis, National Institute of laser, Cairo Univ.

Yi Ping Chen, Ming Yue, and Xun ling Wang. 2005. Influence of He-Ne laser irradiation on seeds thermodynamic parameters and seedlings growth of *Isatis indogotica*. Plant Science, 168: 601-606.

Youssef, A.A and M.A. Zeinab. 1998. Effect of gamma rays on growth and essential oil composition of chamomile (*Chamomilla recutita* L). Arab Universities Journal of Agricultural Sciences, 6(2): 301- 311.

تأثير أشعة جاما، الليزر والبروجيسترون على النمو الخضرى وصبغات البناء الضوئى فى الجربيرا

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تم تنفيذ هذة الدراسة خلال موسمى ٢٠٠٦ و٢٠٠٧ بالصوبة السلكية بالمركز القومي للبحوث بالدقي- الجيزة - مصر لدراسة تأثير ثلاث تركيزات مختلفة من البروجيسترون(١٠، ٢٠، ٣٠ جزء في المليون) وثلاث جرعات من أشعة الجاما (كويلت ٦٠) (١٠٠، ١٥٠، ٢٥٠) و ثلاث جرعات من أشعةهليوم نيون ليزر بزمن تعريض (١، ٥,٥، ١١,٥ دقيقة) وثلاث جرعات من أشعة الأرجون ليزر بزمن تعريض (١، ٧,٥، ١٥,٥ دقيقة) بالإضافة إلى بعض معاملات التداخل بين هذة المعاملات على صفات النمو الخضرى والصبغات الضوئية (المحتوى الكلى للكلورفيل والكاروتينات)، أظهرت النتائج ان كل المعاملات الفردية من البروجيسترون، الجاما والليزر ومعاملات التداخل أدت الى زيادة معنوية في صفات النمو الخضرى في معظم الحالات مقارنة بالكنترول، تم الحصول على أعلى القيم في صفات النمو الخضري (عدد الأوراق، و أرتفاع النبات،و مساحة الأوراق،و الوزن الطازج، والوزن الجاف للأوراق، والمحتوى الكلى للكلوروفيل والكاروتينات) من معاملة النباتات بالمعاملات الفردية من البروجيسترون (٢٠، ٣٠ جزء في المليون)، ومعاملة الإشعاع (جاما بجرعة ١٥٠ راد، و أشعة الأرجون بزمن تعريض ٧,٥ دقيقة) وكذلك معاملات التداخل (أشعة جاما ١٥٠ راد + بروجيسترون ٢٠ جزء في المليون و أشعة الأرجون بزمن تعريض ١٥,٥ دقيقة + بروجيسترون ١٠ أو ٢٠ جزء في المليون)، وأيضا (أشعة هليوم نيون بزمن تعريض ٥,٥ دقيقة + بروجيسترون بتركيز ٣٠ جزء في المليون).