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EFFECT OF BA, NAA AND GAMMA IRRADIATION ON THE PRODUCTION OF THREE CULTIVARS OF CARNATION (*Dianthus caryophyllus* L) THROUGH TISSUE CULTURE

BY

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ABSTRACT

This investigation was carried out on three cultivars of carnation plant (Medea, Candela and Picaro), cultured on solid MS medium supplemented with 0.5, 1.0, 2.0 or 3.0 mg/l of BA in combination with NAA at the rate of 0.0 o.25, 0.50 and 1.0 mg/l. .After two months the optimal concentration of BA was chosen and explants were subcultured on shooting medium (MS) enriched with BA at (2.0 mg) and were exposed to gamma rays at 10, 20, 30 and 40 Gy.

The results indicated that maximum number of shoots of cvs. Medea and Candela were produced on MS medium enriched with 2.0 and 3.0 mg/l of BA without NAA, whereas the maximum number of shoots of cv. Picaro was obtained on medium enriched with 2.0 BA alone followed by 2.0 BA + 0.25 mg/l NAA. The cultivar Medea formed significantly longer shoots compared with the other two cvs. The growing of the explants from Medea and Picaro cultivars on MS medium containing 2.0 mg/l BA + 0.25 NAA gave the longest shoots. Callus formation of the Medea and Picaro was the best on MS medium supplemented with 0.5 mg/l BA +1.0 mg/l NAA, however the addition of BA at 3.0 mg/l showed no callus formation. Callus formation of the Candela was greatly increased with the application of NAA at 1mg/l +0.25 mg BA /l. The highest survival percentage (78.68%) was recorded with the cultivar Medea. The addition of BA at 0.5, 1.0 or 3.0 mg/l +0.5 NAA or BA at 2.0 mg/l+ 0.5 NAA to MS medium gave a significant increasing of the survival percentage and medium containing NAA alone reduced it to the minimum values.

Exposing the explants of the three carnation cvs. to gamma irradiation at the different doses decreased the average shoot number. The low dose of gamma rays (10 Gy), significantly increased the average shoot length. The cultivar Picaro, showed a significant increase in the shoot length with gamma irradiation at 30 Gy. Also, there was a significant difference in the formation of roots for all the carnation cultivars. Most of the irradiation treatments without or with NAA decreased the number and the length of roots.

Key words: Carnation, Dianthus, BA, NAA, gamma irradiation, In-vitro culture.

INTRODUCTION

Dianthus caryophyllus L. (carnation) is an important herbaceous perennial plant (Fam. Caryophyllaceae).Carnations are widely grown for cut flower production. The carnation plant can be propagated by seeds or cuttings, which limits the rapid introduction of new cultivars at affordable prices for growers, causing the introduction of new cultivars to take long time or years, so tissue culture technique can be considered as an alternative method to produce high quality and true to type plants, in a large scale, but this method requires specific conditions and the success is greatly influenced by the nature of culture medium used. It is well known that, the nutrient medium supplies the explants with the basic nutritional ingredients for continued growth. Adding cytokinins enhances shoot formation and branching of explants (George and Sherrington, 1984).

Many workers pointed out the effect of cytokinins, auxins as well as gamma irradiation on shoot formation and rooting of many ornamental plants, on carnation, Can and Koc (1992) found that high BA level (5.0 mg/l) increased the number of shoots and NAA at 2.0 mg/l gave better root development. Muhb and Pal (1995) on carnation cvs Royal Crimson, and Candy obtained the highest number of shoots with low BA (0.5 mg/l) and NAA did not promote shoot. Ilahi et al. (1995) obtained good shoot proliferation with 1.0, 2.0 and 3.0 mg/l BA. Tsay (1998) on carnation cv Opale, mentioned that shoot production was increased with increasing BA concentration (from 0.0 to 4.0 mg/l),but increased shoot verification and 0.5 or 1.0 mg/l BA was ideal for mass propagation. Witomska, and Gadamska (1995) on *Limonium caspium* obtained best shoot production with low level of NAA. On Anthurium plants, Somaya *et al.* (1998) found that MS medium enriched with 1 mg/l BA +0.25 mg/l NAA increased the number of roots. Choudhury and Garg (1999) on carnation cvs. Red Corso and Prime Minister,obtained the best shoot proliferation and elongation with 0.5 mg BA /l + 0.2 mg NAA /l. Adding, 0.25 mg/l NAA to medium increased the number of roots. Concerning the effect of irradiation, Cassells *et al.* (1993) on carnation plants, stated that x-irradiation at the low dose changed leaf shape. Debasis *et al.* (1999) on16 Chrysanthemum cvs.stated that plantlets exposed to gamma irradiation at 1.5 and 2 krads grew vigorously and flowered true to the floret colour type. Venkatachalam *et al.* (1999) on ground nut, found that exposing the calli to 0 to 250 Gy gamma rays stimulated the shoot formation and plant regeneration capacity increased with increasing gamma rays dose. Omer *et al.* (1999) on sunflower found a significant increase in protein, carbohydrates, DNA, and reduction in callus weight with increased doses of irradiation. Kozlowska (1994) on cymbidium plants found that the exposition dose 0.8 kr proved to stimulate the growth and development of protocorms, the dose 20.0 kr totally inhibited the growth. Predieri and Edoardo (2000) on plum reported that microcuttings originated from shoots irradiated with 30 and 40 Gy showed a reduced rooting capacity. Datta *et al.* (2005) on *Chrysanthemum morifolium* cvs. Flirt, Puja, Maghi and Sunil, treated the explants with 500 and 1000 rad gamma rays and cultured on MS medium supplemented with different concentrations and combinations of growth regulators. They found that the frequency of direct shoot regeneration decreased in gamma-ray-treated florets. Radiation effect was found on plant height, size of leaf and flower.

This study was conducted to determine the effects of BA as well as NAA at different concentrations as well as gamma rays treatments on in-vitro propagation of three cultivars of carnation plant.

MATERIALS AND METHODS

This investigation was carried out in Plant Tissue Culture Lab of Natural Products Department, Nat. Cent. For Radiation Res. and Tect, Nasr city, Cairo. and Faculty of Agric., Cairo Univ., during 2004. Shoot tip explants (0.5 cm, length) from three cultivars of carnation (*Dianthus caryophyllus* L.) namely: Medea, Candela and Picaro, were washed in soap water for 30 min. and rinsed with running tap water for two hour and sterilized by 30% chlorox (sodium hypochlorite). The explants were cultured on jars containing solid Murashige and Skoog (MS) medium at full strength, supplemented with agar (7.0 gm /l) and sucrose (30 gm/l and supplemented with 6-benzyladenine (BA) at 0.0, 0.5, 1.0, 2.0 and 3.0 mg/l and *a*-naphthalene acetic acid (NAA) at 0.25, 0.50 and 1.0 mg/l. The jars were sterilized at 121°C for 20 min., and then the explants were cultured on the media and kept under the following conditions: Temp: 24±2°C day/ night. Photoperiod: 16 hrs light/ 8hrs' darkness, Illumination intensity: 3000 lux.

After two months the explants were transferred into shooting medium (MS) enriched with the optimal concentration of BA (2.0 mg/l). In relation to the irradiation studies, the explants in the jars were received four doses of gamma rays: 10, 20, 30, and 40 Gy. emitted from cobalt 60 source from unit gamma chamber 4000, after four weeks the jars were placed in the growth chamber at the following conditions: Temp: 24±2° C day/night. Photoperiod: 16 hrs light/8hrs' darkness fluorescent tubes, using Gro-Lux 20 Wm-2 as a source of light. Regenerated shoots were separated from the explants and transferred into jars containing salts at half strength of MS medium with NAA at 0.5 and 1.0 mg/l to induce roots. Every treatment consisted of 6 replicates.

Data recorded: number of shoots, shoot length, callus formation survival percentage, number of roots, root length and root weight.

Statistical analysis:

The obtained data were analyzed using completely randomized design (two factors). The Least Significant Difference (LSD) test was used for comparison among means according to the method of Steel and Torri (1980).

RESULTS AND DISCUSSION

Experiment (1): Effect of BA and NAA on the growth and development of of carnation

1-1 Number of shoots.

As shown in Table (1), regardless media composition, the cultivars Medea and Picaro formed number of shoots more significantly than Candela cultivar, which gave 2.22, 2.14 and 1.72 shoots, respectively. The addition of BA at different concentrations increased the shoot number compared with control and BA at 2.0 or. 03 mg/l without NAA produced the highest number of shoots/ explant. Increasing level of NAA to 1mg /l reduced the formation of shoots.

Table (1): Effect of BA and NAA on number of shoots /explant and shoot length (cm) of the three carnation cultivars.

Treatments (mg/litre)	No. of shoots			Mean (B)	Shoot length cm			Mean (B)
	Med.	Pic.	Cand.		Med.	Pic.	Cand.	
Control	0.51	0.66	0.59	0.59	1.16	0.88	1.00	1.01
1/4NAA	0.70	0.91	0.82	0.81	1.04	1.00	0.99	1.01
1/2NAA	0.71	0.88	0.77	0.79	0.90	1.21	0.81	0.97
1 NAA	0.49	0.65	0.79	0.64	0.82	0.71	0.66	0.73
1/2 BA + 0 NAA	0.92	1.22	0.91	1.02	1.11	1.33	1.32	1.25
1/2 BA+1/4NAA	1.22	1.70	0.99	1.30	1.09	1.12	1.41	1.21
1/2 BA + /2NAA	0.9	1.11	1.23	1.08	0.73	0.99	1.05	0.92
1/2 BA+ 1 NAA	0.53	0.66	0.59	0.59	0.79	0.68	0.60	0.69
1 BA + 0 NAA	1.91	2.31	2.66	2.29	1.11	1.44	0.70	1.08
1 BA+1/4NAA	1.80	1.72	1.40	1.64	1.09	1.11	1.41	1.20
1 BA+1/2NAA	1.73	1.93	0.91	1.52	0.99	1.34	1.39	1.24
1 BA+ 1NAA	1.06	0.97	1.10	1.04	1.00	0.97	1.11	1.03
2 BA + 0 NAA	5.14	4.98	4.16	4.76	1.97	1.03	0.99	1.33
2 BA+ 1/4NAA	4.30	4.10	3.16	3.85	2.2	1.91	1.13	1.75
2 BA + 1/2NAA	3.71	2.91	3.10	3.24	1.76	0.97	0.88	1.20
2 BA+ 1NAA	3.22	3.11	1.90	2.74	1.09	1.06	1.00	1.05
3 BA + 0 NAA	5.01	3.91	3.18	4.03	1.91	0.89	2.11	1.64
3BA+ 1/4NAA	3.70	3.12	2.22	3.01	1.82	0.91	1.04	1.26
3BA + 1/2NAA	4.11	3.91	2.22	3.41	1.10	1.19	0.91	1.07
3 A+ 1NAA	2.72	1.97	1.66	2.11	1.04	1.00	0.76	0.93
Mean (A)	2.22	2.14	1.72		1.24	1.09	1.06	
L.S.D at 5%								
For A (cultivars)	0.33				0.18			
For B (treatments)	0.45				0.27			
(Cv x Tr) For AB	1.56				0.40			

The interaction effect indicate that growing the explants of Medea cultivar on MS medium containing 2 or 3 mg/l BA gave the highest number of shoots/explant (5.14 and 5.01,respectively), whereas the highest number of shoots of Picaro cultivar was recorded with MS medium containing BA at 2mg/l without NAA. Growing Candela cultivar on MS medium containing 2.0 or 3.0 mg/l BA without NAA recorded the highest shoot formation (4.16 and 3.18 shoots) A similar findings were reported by Can ad Koc (1992) on carnation plants, who found high BA (5 mg/l) increased the number of shoots, whereas Muhb and Pal (1995) on cvs Royal Crimson, and Candy obtained the highest number of shoots with low BA (0.5 mg/l) and NAA did not promote shoot formation but increased shoot height. Also, on carnation plants, Ilahi, *et al.* (1995) obtained good shoot proliferation with 1, 2 and 3 mg/l BA. Tasy (1998) on carnation cv Opale, mentioned that shoot production increased with increasing BA concentration (from 0.0 to 4.0 mg/l), but increased shoot virtification El-Sawy and Bekheet (1999) on *Dieffenbachia picta* cv. Tropica. Found that BA at 1.0 or 2.0 mg/l was more effective for increasing the number of shoots. Also, El-Sawy *et al.* (2000) on *Dracaena* cv. Tricolour, obtained the largest number of shoots/explant with 4.0 mg/l of BA.

1-2 Shoot length

The results shown in Table (1) indicated that there was a significant difference of the shoot length between carnation cultivars. The cultivar Medea formed significantly average of shoot length more than the other two cultivars, the shoot lengths were 1.24, 1.09 and 1.06 cm, for the cultivars Media, Picaro and Candela, respectively.

The addition of BA or NAA to MS medium had no significant effect on the shoot length (except for BA at 2or 3 mg/l + NAA at 0.25 mg/l). The interaction effect revealed that growing the explant of Medea cultivar in MS medium containing 2.0 mg/l BA + 0.25 NAA gave the longest shoots (2.2cm), whereas the longest shoots of Picaro cultivar was recorded with 2.0 mg/l BA + 0.25 NAA. Growing Candela cultivar on MS medium containing 2 or 3 mg/l BA + 0.25 NAA or BA at 3mg/l alone without NAA recorded the highest shoot length (1.41, 1.41 and 2.11 cm, respectively) In this regard, Muhb and Pal (1995) on carnation cvs Royal Crimson, and Candy found that NAA alone did not promote shoot, but the addition of NAA to media containing BA increased shoot height. Choudhury and Garg (1999) on carnation obtained the best elongation in cultivars Red Corso and Prime Minister on MS medium supplemented with 0.5 mg/l BA+ NAA at 0.2 mg/l

1-3 Callus formation

As shown in Table (2), callus formation of the Media cultivar was best on the medium supplemented with 1 mg/l NAA and medium containing 0.5 mg/l BA +1.0 mg/l NAA. Raising the level of BA to 3.0 mg/l showed no callus formation. The best result of the callus growth of the Picaro cultivar was recorded with the addition of 0.5 or 1.0 mg/l NAA and 0.5 BA +1.0 mg/l NAA. No callus growth was obtained when the explant were cultured on MS medium with the high level of BA (3.0 mg/l). A great increase in the callus growth of the Candela cultivar was recorded with the increase of NAA to 1mg/l with 0.25 mg/l BA. as well as in the two other cultivars, the Candela cultivar showed better callus growth on the medium supplemented with 1.0 mg/l NAA alone, also no callus formation was obtained with the high level of BA (3.0 mg/l). Similar findings were reported by Ilahi, *et al.* (1995) on carnation plants Sakr et al. (1999) on *Yucca elephantips.*

1-4 Survival %

Concerning the response of survival percentage to media composition (Table 2), the results clearly indicated that the highest survival percentage (78.68%) was recorded with the cultivar Medea, regardless the media.

The addition of BA at 0.5, 1.0 or 3.0 mg/l +0.5 NAA as well as BA at 2.0 mg/l+0.5 NAA in the MS medium were the most effective treatments in increasing the survival percentage compared with control and the other treatments. Culturing the carnation explants on media containing NAA alone reduced the survival percentage to the minimum values.

The interaction treatments showed that the highest survival percentages of the cultivars Medea and Picaro (93.11, and 91.10%, respectively) were recorded with MS medium containing 2 mg/l BA alone, whereas the survival percentage of the cultivar Candela was the highest with 3 mg/l BA followed by 1 mg/l BA+ 1mg/l NAA. A similar findings were reported by, El-Sawy and Bekheet (1999) on *Dieffenbachia picta* and Tsay (1998) on carnation cv Opale and Sakr *et al.* (1999) on *Yucca elephantips.*

Table (2): Effect of BA and NAA on callus formation and survival percentage of the three cultivars of carnation plants

Treatments Conc. mg/litre	Callus formation			Survival %			Mean (B)
	Medea	Picaro	Candela	Medea	Picaro	Candela	
Control	-	-	-	60.22	60.00	79.11	66.44
1/4NAA	+	-	+	72.11	66.11	73.71	70.64
1/2NAA	+	++	+	59.63	71.90	60.30	63.94
1 NAA	++	++	++	66.60	60.42	70.39	65.80
1/2 BA + 0 NAA	-	-	-	70.40	66.41	66.13	67.65
1/2 BA+1/4NAA	-	+	-	63.30	69.22	90.32	74.28
1/2 BA + /2NAA	+	+	+	89.70	83.11	81.14	84.65
1/2 BA+ 1 NAA	+	++	+++	70.11	77.19	56.39	67.89
1 BA + 0 NAA	-	-	-	78.80	56.35	60.20	65.11
1 BA+1/4NAA	-	-	-	87.11	66.15	76.11	76.45
1 BA+1/2NAA	++	+	-	92.23	79.04	89.29	86.85
1 BA+ 1NAA	+	++	+	81.14	73.19	91.00	81.77
2 BA + 0 NAA	-	-	-	93.11	91.10	52.19	78.80
2 BA+ 1/4NAA	-	-	-	91.00	81.91	87.14	86.68
2 BA + 1/2NAA	+	-	+	79.11	68.18	63.06	70.11
2 BA+ 1NAA	+	+	+	88.09	77.04	77.14	80.75
3 BA + 0 NAA	-	-	-	91.90	51.91	61.60	68.47
3BA+ 1/4NAA	-	-	-	79.81	72.89	67.18	73.29
3BA + 1/2NAA	-	-	-	86.60	87.13	89.14	87.63
3 A+ 1NAA	-	-	-	72.76	70.90	91.33	78.33
Mean A				78.68	71.50	74.14	
L.S.D at 5%							
(For A) cultivars					2.58		
(For B) treatments					4.68		
(For AB) Cv x Tr					6.99		

Exp.2 Effect of gamma irradiation and NAA on the growth and development of of carnation

2-1. Shooting and rooting

This experiment (Tables 3 and 4) was done to study the effect of gamma irradiation on the shoot formation and the effect of NAA added to MS 1/2 salt strength on root formation of the irradiated carnation cultivars.

2-2 Number of shoots.

As shown in Table (3) and Fig. (1), the results clearly indicated regardless the gamma irradiation treatments, there was a significant difference in the formation of shoots among the carnation cultivars, the cultivars Picaro and Candela formed significantly more shoots/explant than cultivar Medea, the shoots number averages were 4.48, 4.06 and 2.54, respectively.

On the other hand, exposing the carnation explants to gamma irradiation at the different doses decreased the shoot number compared with control but the decrease was in proportional with rate of dose. Gamma irradiation at the dose of 40 Gy reduced the number of shoots/explant to 2.746 against 4.11 for the control.

The interaction effect of gamma irradiation and the carnation cultivars indicated that exposing the explants of the cultivars Medea and Picaro to gamma irradiation with different doses decreased the shoot number compared with control and the decrease was in proportional with rate of dose, whereas the cultivar Candela showed an other trend where exposing it to gamma irradiation at 20 Gy increased significantly the shoot formation (6.04 shoots/explant) as compared with control (4.11shoots /explant). In this regard, Muhb and Pal (1995) on carnation cvs Royal Crimson, and Candy found also the addition of NAA did not promote shoot formation. Debasis *et al.* (1999) on 16 Chrysanthemum cvs stated that plantlets exposed to gamma irradiation at 1.5 and 2 krad grew vigorously Venkatachalam, et al. (1999) on groundnut, found that exposing the calli to 0 to 250 Gy gamma rays stimulated the shoot formation. Omar, et al. (1999) on sunflower found a attributed the reduction in shoot and callus weight with increased doses of irradiation to the reduced amount of endogenous growth regulators, especially the cytokines. Kozlowska (1994) on cymbidium plants found that the exposition dose 0.8 kr proved to stimulate the growth and development of protocorms, the dose 20.0 kr totally inhibited the growth.

2-3 Shoot length

Concerning the effect of cultivars on shoot length, regardless media composition, the results shown in Table (3), clearly indicated that there was a significant difference in the shoot length between the cultivar Picaro and the other two cultivars, the carnation cultivars, the shoot length average of this cultivar reached 2.44 cm against 1.66 and 1.44 cm for Medea and Candela cultivars, respectively. On the other hand, regardless the effect of cultivars, exposing the carnation explants to gamma irradiation at low dose (10 Gy), increased insignificantly the shoot length compared with control and the other doses reduced it.

The interaction effect indicate that exposing the explants of the Medea cultivar to the different doses of gamma irradiation decreased the shoot length compared with control and the decrease reached the level of significance with the doses of 30 and 40 Gy, in case of cultivar Picaro, there was a significant increase in the shoot length with the treatment of 30 krad and significant decrease in the shoot length with the treatment of 40 krad as compared with control (4.11 shoots/ explant). The low dose of gamma irradiation formed insignificantly longer shoots more than the control, and the other doses reduced it. A similar finding was

reported by Debasis, *et al.* (1999) on some Chrysanthemum cvs. stated that plantlets exposed to low gamma irradiation dose grew vigorously. Omer, *et al.* (1999) on sunflower found a reduction in growth with increased doses of irradiation Kozlowska (994) on cymbidium plants found that the exposition dose 20.0 krad totally inhibited the growth.

Table (3): Effect of gamma irradiation on number of shoots /explants and shoot length (cm) of the three carnation cultivars.

Treatments of gamma rays	No. of shoots			Mean (B)	Shoot length (cm)			Mean (B)
	Medea	Picaro	Candela		Medea	Picaro	Candela	
Control	4.69	5.77	4.11	4.856	2.19	2.55	1.60	2.113
10 Gy	1.91	5.11	4.09	3.703	1.98	2.46	2.00	2.146
20 Gy	1.70	4.22	6.04	3.986	1.80	2.00	1.09	1.630
30 Gy	2.33	4.10	3.09	3.173	1.00	3.71	1.11	1.940
40 Gy	2.06	3.20	2.98	2.746	1.33	1.50	1.42	1.416
Mean (A)	2.54	4.48	4.06		1.66	2.44	1.44	
L.S.D at 5%								
(For A cultivars)	0.53				0.38			
For B (treatments)	0.64				0.47			
For AB (Cv x Tr)	1.10				0.63			

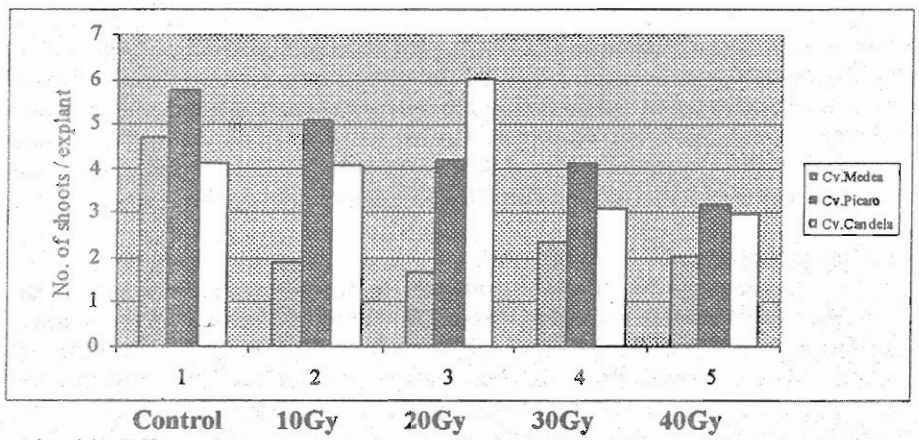

Fig. (1): Effect of gamma rays on number of shoots of carnation plant

2-4 Root number

As shown in Table (4), the results clearly indicated regardless media composition irradiation treatments, that there was a significant difference in the formation of roots among the carnation cultivars, the cultivar medea as well as Picaro cultivar formed significantly more roots/explant than Candela cultivar, the averages of root number were 2.031, 1.931 and 1.446, respectively. On the other hand, all irradiation treatment with or without NAA (expect 30 Gy +NAA at 1/2mg /l) decreased the roots number compared with control.

Table (4): Effect of NAA and gamma irradiation on number of roots, root length(cm) and fresh weight of roots (gm) of three cultivars of carnation.

Treatments Conc. mg/litre	No.of roots			Mean	Length of roots cm			Mean	Fresh weight of roots gm			Mean
	M	P	C		M	P	C		M	P	C	
NAA 0.0 mg/l	4.00	4.33	2.66	3.663	10.33	16.00	8.00	11.44	0.04	0.05	0.07	0.053
NAA 0 mg/l +10 Gy	2.66	3.00	1.66	2.440	3.83	9.66	0.83	4.773	0.40	0.06	0.05	0.170
NAA 0 mg/l +20 Gy	3.66	2.33	1.33	2.440	2.50	4.50	1.33	2.777	0.35	0.09	0.04	0.160
NAA 0 mg/l +30 Gy	2.33	1.33	1.33	1.663	3.66	2.16	1.00	2.273	0.19	0.24	0.09	0.173
NAA 0 mg/l +40 Gy	1.33	1.33	1.66	1.440	6.33	1.66	0.83	2.940	0.07	0.16	0.04	0.090
NAA 0.5 mg/l+0 Gy	3.00	1.66	3.33	2.663	2.33	3.00	3.33	2.887	0.22	0.11	0.09	0.140
NAA 0.5 mg/l+10 Gy	3.00	1.33	1.33	1.887	8.33	3.50	1.50	4.443	0.28	0.07	0.10	0.150
NAA 0.5 mg/l+20 Gy	6.33	1.66	2.00	3.330	8.66	6.33	2.33	5.773	0.19	0.21	0.08	0.160
NAA 0.5 mg/l+30 Gy	4.33	3.33	3.33	3.663	10.66	10.83	8.33	9.940	0.15	0.22	0.10	0.157
NAA 0.5 mg/l+40 Gy	2.66	1.33	3.66	2.550	1.83	2.33	5.33	3.163	0.12	0.09	0.09	0.100
NAA 1.0 mg/l + 0 Gy	2.66	3.00	1.33	2.330	2.50	8.33	2.33	4.387	0.23	0.07	0.12	0.140
NAA 1.0 mg/l+10 Gy	1.33	2.33	1.66	1.773	0.83	4.00	1.00	1.943	0.20	0.11	0.15	0.153
NAA 1.0 mg/l+20 Gy	2.33	1.66	2.66	2.217	1.16	1.66	2.66	1.827	0.22	0.21	0.10	0.177
NAA 1.0 mg/l+30 Gy	0.66	7.00	0.66	2.773	0.33	3.33	0.50	1.387	0.17	0.17	0.15	0.163
NAA 1.0 mg/l+40 Gy	0.33	3.00	0.33	1.220	0.16	3.00	0.16	1.107	0.10	0.09	0.06	0.083
Mean (A)	2.031	1.931	1.446		3.172	4.015	1.973		0.146	0.098	0.067	
For A (cultivars)	0.45				0.85				0.031			
For B (treatments)	0.68				2.70				0.074			
For AxB	0.64				4.04				0.111			

Carnation cvs : M: Medea, P: Picaro , C: Candela

The interaction effect indicated that Medea cultivar which treated with 20 or 30 krad and 0.5 mg/l NAA significantly increased the number of roots. The Picaro explants treated with 30 Gy +1 mg/l NAA significantly formed more roots than the control and other treatments. The highest number of roots/explant of Candela cultivar was recorded with MS medium containing NAA at 0.5 mg/l without exposed to the different doses of gamma rays. In this regard, Can ad Koc (1992) on carnation plants found that medium containing NAA at 2.0 mg/l showed better root development. On Anthurium plants, Somaya, *et al.* (1998) found that the addition of 0.25 mg/l NAA increased the number of roots; also, Choudhury and Garg (1999) on carnation cultivars Red Corso and Prime Minister found that the addition of 0.25 mg/l NAA increased the number of roots. Kozlowska (1994) on cymbidium plants found that the exposition dose 0.8 krad proved to stimulate the growth and development of protocorms, the dose 20.0 krad totally inhibited the growth. Predieri and Edoardo (2000) on plum reported that microcuttings originated from shoots irradiated with 30 and 40 Gy showed a reduced rooting capacity.

2-5 Root length

Concerning the effect of gamma and NAA on the root length average, the results (Table 4), clearly indicated that, the two carnation cultivars Medea and Picaro was more significant of root length average than Candela. On the other hand regardless cultivars, all treatments of gamma rays alone or combined with NAA reduced the root length, and the reduction was more pronounced with the high dose of NAA.

The interaction effect revealed that there were slight increases in the root length average of both Medea and Candela cultivars which may due to the application of 0.5 mg/l NAA +30 Gy than the control and other treatments. In this regard, Can ad Koc (1992) on carnation plants found that MS medium supplemented with high BA (5.0 mg/l) increased the number of shoots and medium containing NAA at 2.0 mg/l showed better root development. Predieri and Edoardo (2000) on plum reported that shoots irradiated with 30 and 40 Gy showed a reduced rooting capacity.

2-6 Fresh weight of roots

As shown in Table (4), the cultivar Medea formed more significant heavier root average (0.146 gm) than the other two cultivars; the averages root weight were 0.098 and 0.066gm, respectively. On the other hand, all irradiation treatment with or without NAA increased the fresh weight of roots as compared with control.

The interaction effect indicated that Medea cultivar which exposed to 10 or 20 Gy alone showed the heaviest roots, whereas treating the cultivar Picaro with 30 krad gave the heaviest roots. The highest average of root weight of Candela cultivar was recorded with MS medium containing NAA at 1.0 mg/l with the different doses of gamma rays (expect the dose of 40 Gy). In this regard, Predieri and Edoardo (2000) on plum reported that microcuttings originated from shoots irradiated with 30 and 40 Gy showed a reduced rooting capacity.

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تاثير البنزايل ادنين ونفثالين حمض الخليك والمعاملة باشعة جاما علي انتاجية ثلاثة اصناف من القرنفل خلال مزارع الانسجة

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أجرى هذا البحث علي ثلاثة اصناف من نبات القرنفل وهي ميديا، بيكارو ، كاندلا حيث زرعت المنفصلات النباتية لهذه الاصناف في بيئة موراشيجي وسكوج الصلبة المزودة بتركيزات من البنزايل ادنين وهي ٥و٠ ،١و٠، ٠و٠،٢و٣ مليجرام في اللتر من البيئة وكذلك نفثالين حمض الخليك بتركيزات من ٢٥و٠ ، ٥و٠ ، ٠و١ مليجرام في اللتر من البيئة – كما قد عرضت الافرع الناتجة من احسن بيئة الي الاشعاع بجرعات من اشعة جاما (مصدر كوبلت٦٠) بجرعات ١٠و٢٠و٣٠ و ٤٠ جراي.

واوضحت النتائج ان اعلي انتاج من الافرع للصنف ميديا والصنف كاندلا نتج من زراعة القمم الطرفية لهما علي بيئة مزودة ب ٢ او ٣ مليجرام من البنزايل ادينين بدون اضافة نفثالين حمض الخليك للبيئة بينما الصنف بيكارو اعطي اكبر عدد من الافرع علي البيئة المزودة ب البنزايل ادنين بتركيز ٢ مليجرام في اللتر او المضاف اليها ٢ مليجرام مع٢٥و٠ مليجرام نفثالين حمض الخليك وكانت افرع الصنف ميديا اطول معنويا من الصنفين الاخرين. كما ان زراعة الصنف ميديا وبيكارو علي بيئة مزودة ب٢ مليجرام بنزايل ادينين مع ٢٥و٠ مليجرام نفثالين حمض الخليك انتج افرع طويلة. كما ان احسن نمو للكالوس لكل من الصنف ميديا والصنف بيكارو نتج من الزراعة علي بيئة مزودة ب ٥و٠ مليجرام مع ١ مليجرام نفثالين حمض الخليك. وادي رفع تركيز البنزايل ادينين الي ٣ ملبيجرام الي منع تكوين الكالس واحسن نمو للكالس للصنف كاندلا نتج من الزراعة علي بيئة مزودة ب ١ مليجرام نفثالين حمض الخليك مع٢٥و٠ مليجرام بنزايل ادينين. كما ادي رفع تركيز البنزايل ادينين الي ٣ ملبيجرام الي منع تكوين الكالس واعطي الصنف ميديا اعلي نسبة مئو ية للبقاء في مزارع الانسجة بلغت٦٨و٧٨ %. كما ادي اضافة البنزايل ادينبن بتركيز ٥و٠ ، ١ او ٣ مليجرام مع نفثالين حمض الخليك بتركيز ٥و٠ مليجرام او المعاملة بالبنزايل ادينبن بتركيز ٢ مليجرام مع نفثالين حمض الخليك بتركيز ٥و٠ مليجرام الي زيادة نسبة الاجزاء الحية. واقل نسبة الاجزاء الحية للنموات الناتجة سجلت مع البيئة المزودة ب نفثالين حمض الخليك فقط. كما ادي تعرض الاجزاء النباتية الي الجرعات المختلفة من اشعة جاما نقص عدد الافرع المتكونة. كما ادت المعاملة بالجرعة المنخفضة لاشعة جاما ١٠ جراي الي زيادة معنوية في طول الافرع– كما اظهر الصنف بيكارو زيادة في طول الافرع مع المعاملة ب ٣٠ جراي – كما اظهرت الدراسة وجود اختلافات في الاستجابة لاشعة جاما من حيث تكوين الجذور ووجد ان معظم معاملات اشعة جاما مع او بدون اضافة نفثالين حمض الخليك ادت الي نقص عدد وطول الجذور المتكونة.