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EFFECT OF RADIATION ON VEGETATIVE GROWTH, STIMULATION OF FLOWERING AND CHEMICAL CONSTITUENTS OF *Tagetes erecta* CULTIVATED UNDER COMPOST FERTILIZATION

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ABSTRACT

Field experiments were conducted during two successive seasons 2004 and 2005 to investigate the effect of various doses of gamma irradiation on growth, flowering and chemical constituents of *Tagetes erecta* plants cultivated under different levels of compost. The results revealed that the high compost levels had a pronounced effect on vegetative and flowering growth than the low ones. The total carotenoids, anthocyanins, total polyphenols and essential oil content of both herb and flowering heads showed more accumulation with high compost level as compared with the low level.

Gamma irradiation at various doses up to 6 K-rad, stimulated significantly the growth and flowering characters as well as different chemical constituents. The highest gamma dose (8 K-rad) in general, had a contrast effect, which inhibited most of these characters. The interaction between high compost level and gamma irradiation at the dose of 6 k-rad resulted in the maximum mean values of growth parameters,i.e. plant height, branches number, fresh and dry weight of herb and flowers. Similarly, the content of total carotenoids and total polyphenols in the herb, essential oil percentage and yield of the herb and flowers, gave the highest accumulation values with the same treatment, *i.e.,* high compost level (7ton/Fed.) + 6 k-rad gamma irradiation.

Key words: e*ssential oil, fertilizer , radiation, Tagetes erecta.*

1. INTRODUCTION

Tagetes erecta L. (African marigold) belongs to the *Asteraceae* family and is considered one of the most important medicinal and aromatic plants for its biological active products, *i.e.,* carotenoids, essential oil and flavonoids.The carotenoid is used as food colorant, food additives (Hadden *et al*., 1999) and possessing anticancer and anti-ageing properties. The essential oil is used as anti-microbial, anti-fungal, nematicidal and insecticidal (El-Gengaihi *et al*., 1996, Mejia *et al*., 1997 and Ray *et al*., 2000). It is also used to relieve ulcers, piles, eye diseases, chiropody skin, bone end and nail as well as to purify the blood (Khan *et al*., 1996). Moreover, it is employed normally in flavoring beverages, perfumery, candies and ice cream (Furia and Bellance, 1971).

Compost fertilizer has beneficial effects such as increase the cation exchange capacity of soils, thus increase the availability of certain nutrients such as Ca, Mg and K. Compost also helps neutralize and buffers soil pH (A grower's Guides, 1999). In addition, compost improves many soil properties as water retention capacity, aeration, drainage and prosity structure which result in good plant growth and production (Khandkar and Nigem, 1996, and Herrera, *et al*., 1997). The promotion effects for various growth characters and chemical constituents due to applying different organic compost or sludge, were recorded by several researchers on many medicinal and aromatic plants, Aly (2003) on *Lupinus termis*, Naguib (2003) on *Chamomilla recutita*, Aziz and El-Sherbeny (2003) on *Dracocephalum moldavica*. El-Sherbeny *et al*. (2005) on *Siderites montana* and Khalil and El Sherbeny (2005) on three *Mentha* species.

Using gamma rays for medicinal and aromatic plants received lesser activities than for cultivated field and horticultural crops. Pre-sowing radiated seed is one of the most successful tools to improve yield production and active substances. Gamma radiation is an effective method to induce mutations, which increase genetic variability with homozygous genotypes of self fertilized crops (Khalil *et al*. 1986). The stimulative effect of gamma radiation on growth and secondary products of various mediecinal and aromatic plants was reported by several researcher, such as El Sherbeny *et al*., (1992) on *Coriandrum sativum*, Youssef and Moussa (1998) on *Chamomile recutita*, Youssef *et al*. (2000) on geranium and Khalil *et al*. (2001) on fennel, caraway and black cumin.

This investigation was planned to study the effect of various levels of compost fertilizer and gamma irradiation on growth and chemical constituents of *Tagetes erecta* L. plant.

2. MATERIALS AND METHODS

Seeds of *Tagetes erecta* were gamma irradiated using the Co^{60} source to apply the doses of 0, 2, 4, 6 and 8 K-rad. The seeds were obtained from the Medicinal and Aromatic Plants Division, Horticultural Research Institute, Agricultural Research Centre, Egypt. The treated seeds were sown in beds on 15^{th} March 2004 and 2005 in the first and second seasons respectively at the experimental station of N.R.C. at Shalakan, Qalubia Governorate. The soil was analyzed from the depth of 0-20 cm and the properties are presented in Table (1). After 45 days, uniformal seedlings were transplanted. The distance between hills was 25 cm and the plot size was $12m^2$ with 25cm between plants.

Table (1) :Physical and chemical properties of the experimental soil.

Properties	First season (2004)	Second season (2005)
Sand %	48.8	50.8
Silt %	28.0	26.0
Clay %	23.2	23.2
Soil Texture	Sandy Loam	Sandy Loam
pH	8.20	8.05
E.C.(mmhos/cm)	0.68	0.88
Soluble Ions (Soil Paste) meq / liter		
Ca^{++}	1.10	1.19
Mg^{++}	0.89	0.76
Na^{+}	2.22	2.31
K^{+}	0.18	0.21
Co_3^{-}	0.15	0.21
HCO_3^{-}	0.68	0.66
CL^{-}	2.00	2.32
So_4^{-}	1.12	1.14
Available Elements (ppm)		
Total N	130	160
P	20.1	38.2
K	222.4	223.8
Fe	80	71
Mn	7.1	8.9
Zn	0.95	1.10
Cu	2.02	1.91

The two compost levels (3.5 and 7 ton/fed.) were added and mixed with the soil 15 days before sowing. Compost fertilizer was produced by Green Valley for Organic Products Co., S.A.E. and its chemical analysis is shown in Table (2). Thus, the experiment included ten treatments representing two compost levels *i.e.(*3.5 and 7 ton/fed.) and five irradiation doses (0, 2, 4, 6 and 8 K-Rad).

The treatments were arranged in a split block design with four replicates, where the compost levels were designated as main plots and the gamma irradiation occupied the sub plots. The common agricultural practices of growing *Tagetes erecta* were applied during both seasons as recommended.

At flowering stage (15^{th} August) the following growth characters were recorded:

1. Plant height (cm).
2. No. of branches per plant.
3. Fresh and dry weight of herb (Kg/plant and tons/fed.).
4. Fresh and dry weight of flowers (Kg/plant and ton/fed.).

5. Total carotenoid content in herb and flowers (mg/gm dry weight) as described by Moran (1982).
6. Anthocyanin percentage of herb and flower, using the method recorded by Zheng and Wang (2003).
7. Total polyphenol percentage of herb and flower was estimated using the method of A.O.A.C. (1990).

Essential oil of fresh herb and flowers (%, ml/plant and flowers (%, ml/plant and L/fed.) was determined according to the Egyptian Pharmacopeia (1984).

2.1. Spectrometry (GC/MS) analysis

Oil components for six treatments included low compost level (Comp1), Comp 1 + 5 Krad, Comp 1 + 8 Krad, high compost level (Comp 2), compost 2 + 6 Krad and Comp 2 + 8 Krad were subjected to spectrometry (GC/Ms) analysis. GLC analysis was carried out on a varian Gas chromatograph (Walnut Creek, California, USA) equipped with finnigan mat SS9 700 (Thermo Inst., USA) mass spectrometer and a 30 m x 0.25 mm. DB-5 capillary column film thickness (J&W scientific, USA). The column temperature was programmed from 50°C (for 3 min.) at a rate of 7°C/min to 250°C with 10 min isothermal hold. The injector temperature was 220°C and transition time temperature was 250°C. The carrier gas was helium and the column head pressure was 10-15 psi. Components were identified by matching of their mass spectra with those recorded in the MS library and further confirmed by injecting the authentic samples of different compounds with the volatile oil and by comparison of the mass spectra with those of reference compounds or with published data.

2.2. Statistical analysis

The average of the two growing season results were subjected to standard analysis of variance procedure recorded by Snedecor and Cochran (1989). The value of LSD was recorded whenever the calculated "F" value was significant at 5% level.

Table(2): Chemical Analysis of the Experimental Compost.

Characters	Content (Value)
Wet %	35
O.M %	70
pH	7.24
E.C. (mmohs /cm)	2.1
C/N ratio	23:01
Organic carbon %	25.8
N %	1.2
P %	0.8
Mg %	____
Fe ppm	790
Mn ppm	190
Cu ppm	37.1
Zn ppm	65

3. RESULTS AND DISCUSSION

3.1. Vegetative growth characters

Data presented in Table (3) indicate that various growth characters of *Tagetes erecta* were were improved with using high compost level (7 Ton/Fed.) than the low one (3.5 ton/fed.). Thus, application of 7 ton/fed. compost increased the mean values of plant height and number of branches to 8.7 % and 6.5%, respectively over those of the low level. The differences between mean values of both compost levels were significant. Meanwhile, the promotion effect of high compost level on herb fresh weight per plant and feddan recorded 24.6% and 23.93% more than the low one. Moreover, significant increase in the accumulation of dry weight of herb/ feddan was shown with the applied 7 ton/fed compost, that recorded 23.4% in comparison with low level.

The promotion of plant growth in respect to compost application may be rendered to the releasing of nutrients in a slow rate, the adaptation of soil pH and by increasing the natural use of water efficiency. Moreover, compost may cause more excretion of direct enzymatic or hormonal effect on plant root and various parameters of growth (Raviv, 1994).

The stimulation effect of compost application was reported by many researchers *i.e*., Naguib (2003) on *Chamomilla recutita*, El-Sherbeny *et al*., (2005) on *Siderites montana* and Khalil, and El-Sherbeny (2005) on *Mentha* species.

Gamma irradiation applied at different doses showed various effects on vegetative growth characters Table (3). The doses from 2 K-rad up to 6 K-rad caused gradual promotive effect on plant height, number of branches as well as fresh and dry weights of herb. Otherwise, the highest dose (8 K-rad) showed a marked decrease in plant height, number of branches and herb dry weight per plant. Thus, the maximum mean values for different vegetative growth parameters were recorded at the level of 6 K-rad gamma rays dose,at which the improvement in the different parameters reached 12.3%, 15.3%, 37.9%, 35.3%, 35.2% and 35.3% for plant height, number of branches, herb fresh and dry weights per plant and per feddan over the control treatment, respectively. In this connection, several researchers reported that a high dose of gamma rays have a harmful effect while the low doses stimulate plant growth, yield component and chemical constituents *e.g*. El-Sherbeny *et al*. (1992) on *Coriandrum sativum*, Abou Zeid *et al*.

(1996) on *Ricinus communis*, Youssef *et al*. (2000) on *Pelargonium graveolenus*. However, Youssef and Moussa (1998) revealed that gamma irradiation rays up to 15 K-rad stimulated significantly growth parameters including plant growth, number of branches, fresh and dry weight of *Chamomilla recutita* plants.

Concerning the interaction between compost levels and gamma ray doses, the data in Table (3) revealed that the highest improvement in the various studied growth characters was that of 6 K-rad gamma ray combined with 7 ton/fed compost. On the contrary, the lowest mean values for the same characters were obtained from using gamma ray at 8 K-rad dose as interacted with compost at the rate of 3.5 ton/fed. These results may be due to the inhibitor effect of the high doses of gamma ray on vegetative growth.

3.2. **Flowering**

It is evident from the data in Table (4) that using compost fertilizer at the high level was more effective than that added at the low level for promoting flower fresh and dry weights of *Tagetes erecta* plants. The values recorded reached 7.8%, 18.5%, 8.8% and 8% over that recorded for the low level. Moreover, it is noticed that the only significant effect on flower yield was recorded with the application of 7 ton/fed compost. The beneficial effect of increasing compost rate on flower yield coincides with Naguib (2003) on chamomile, who reported that raising compost level from 40Kg N/Fed to 80Kg N/fed, improved flower yield reaching 5.2%. On the other hand, Badran *et al*. (2001) on *Tropaeolium majus* revealed that increasing N levels induced an adverse effect on flowering by delaying its date. These results are reasonable, since plant growth, branching, photosynthesis and food reserves in the plant, are necessarily reflected on the improvement of flower weights.

Gamma irradiation at the rates from 0 to 8 K-rad produced gradually significant increments in flower fresh and dry weights, per plant and feddan (Table 4). The maximum main value for flower weight was obtained with 6 K-rad reaching 23.4%, 37.1% for fresh weight (kg/plant and ton/fed.); 28.4% and 42% dry weight (gm/plant and kg/fed.), respectively over unirradiated plants. Similarly, negligible increments for flower parameters resulted from irradiated plants with 8 Krad dose. In this connection, El-Kholy (1984) on *Hyoscyamus muticus* found that irradiation doses of 5 and 15 K-rad increased flower dry weight with 20% and 37% respectively, more than the control, while using a higher dose, of gamma rayes (20 K-rad) depressed the dry weight with 26% less than the control. Moreover, Youssef and Moussa (1998) revealed that subjecting chamomile seeds to gamma irradiation up to 15 K-rad significantly stimulated flower head yield.

On the other hand, the interaction between compost levels and gamma irradiation (Table 4), revealed that the highest increase in flower weight was found with the combined treatment of high compost level (7.0 ton/ fed.) with a dose of 6 K-rad gamma rays.

3.3. Chemical constituents

3.3.1 Carotenoid content

Total carotenoid content (mg/g dry wt.) in both herb and flower of *Tagetes erecta* plants, attained similar trend in response to compost levels as well as gamma irradiation doses Table (5). The higher compost level was more effective for more accumulation of cartooned content than the lower one , the differences between the two compost levels reached 8.87% for herb and 18.4% for flowers. The improvement in carotenoid content was similar to the results reported by El-Ashry *et al*. (1997) on *Peperomia obtusifolia*. In addition Khalil *et al*. (2002) on *Tagetes erecta*, revealed that carotenoid pigment of herb or flower increased as compost level lincreased , and significant increment was found as a result of adding 7 ton/ fed.

On the other hand, irradiated plants with gamma doses up to 6 K-rad stimulated the herb and flower carotonoid content, while the higher dose (8 K-rad) prohibited carotenoid accumulation. The present data revealed that the better treatment of 6 K-rad for herb and 4 K-rad for flower, produced an increment in the carotenoid content, reached 19.5% and 11.41%, respectively, over the control.

Anthocyanin percentage of both herb and flowers as affected by compost and/or gamma irradiation is shown in Table (5). The data showed that using high compost level induced remarkable effect on increasing the anthocyanin percentage in herb and flowers higher than the low level, and the difference between the two levels reached 3.8% and 6.8% for both organs, respectively.

Concerning anthocyanin percentage as affected by gamma rays, it is clear that there was a gradual stimulation by increasing gamma irradiation doses. Thus, the highest gamma dose (8 K-rad) regardless of the level of compost, produced the highest increment which reached 17.8% and 14.9% for herb and flower, respectively, more than the control plant.

Table (3): Effect of gamma irradiation and compost application on plant height, No. branches/plant and herb fresh and dry weights Kg per plant and ton per feddan of *Tagetes erecta* plant. (mean of two seasons).

Characters / Treatments			Plant height cm	No. of Branches /plant	Herb F.W.		Herb D.W.	
					Kg/plant	Ton/fed	Kg/plant	Ton/fed
Compost 3.5 ton/fed	k-rad	0	78.30	13.47	2.19	39.37	0.51	9.08
		2	81.00	14.10	2.33	41.83	0.54	9.66
		4	84.50	15.30	2.64	47.64	0.60	10.97
		6	87.30	15.80	2.84	50.99	0.65	11.85
		8	79.60	11.70	2.22	40.16	0.51	9.23
Mean value of compost			82.14	14.07	2.44	44.00	0.56	10.16
Compost 7 ton/fed	k-rad	0	84.70	14.30	2.54	46.04	0.59	10.60
		2	89.70	15.70	3.10	55.45	0.72	12.73
		4	94.90	16.00	3.17	56.99	0.78	13.13
		6	95.70	16.70	3.66	64.69	0.83	14.83
		8	81.80	12.20	2.75	49.50	0.37	11.43
Mean value of compost			89.36	14.98	3.04	54.53	0.65	12.54
Mean value of Gamma irradiation k-rad		0	81.50	13.88	2.37	42.70	0.55	9.84
		2	85.35	14.90	2.71	48.64	0.63	11.20
		4	89.70	15.65	2.90	52.32	0.69	12.05
		6	91.50	16.25	3.25	57.84	0.74	13.34
		8	80.70	11.95	2.48	44.83	0.44	10.33
L.S.D. 5%	Compost		0.15	0.02	0.02	0.06	N.S.	0.01
	Irradiation		1.87	0.11	0.10	0.45	0.02	0.16
	C x I		2.64	0.15	0.14	0.63	0.03	0.22

Table (4): Effect of gamma irradiation and compost application on flower fresh and dry weights Kg per plant and ton per feddan on *Tagetes erecta* (mean of two seasons).

Characters / Treatments			Flower F.W		Flower D.W.	
			Kg/plant	Ton/fed	Kg/plant	Ton/fed
Compost 3.5 ton/fed	k-rad	0	0.44	7.57	0.070	1.090
		2	0.49	8.58	0.077	1.294
		4	0.55	9.67	0.087	1.353
		6	0.60	10.65	0.090	1.722
		8	0.47	8.47	0.075	1.248
Mean value of compost			0.51	8.99	0.080	1.342
Compost 7 ton/fed	k-rad	0	0.49	8.57	0.078	1.242
		2	0.52	9.45	0.083	1.322
		4	0.59	10.57	0.093	1.483
		6	0.63	11.48	0.100	1.591
			0.54	9.57	0.084	1.371
Mean value of compost			0.55	9.93	0.087	1.402
Mean value of Gamma irradiation k-rad		0	0.46	8.07	0.074	1.166
		2	0.50	9.01	0.080	1.308
		4	0.57	10.12	0.090	1.418
		6	0.61	11.06	0.095	1.656
		8	0.50	9.02	0.079	1.310
L.S.D. 5%	Compost		N.S.	0.09	N.S.	N.S.
	Irradiation		0.01	0.33	0.003	0.029
	C x I		0.02	N.S.	N.S.	0.040

In this context, El-Sherbeny *et al*., (1997) on *Hibiscus sabdariffa,* indicated that doses of gamma rays raised gradually anthocyanin content and yield with increasing levels with a peak at 4k-rad and the increase fell at 8k-rad irradiation.

The interaction between compost levels and various applied irradiation doses revealed clear promotive effect on the accumulation of anthocyanin. The maximum mean values were recorded with low compost level combined with 8 K-rad for herb , while the interaction between high compost level interaction with 8 K-rad was effective on the flowers. The stimulation effect of compost gamma irradiation or the combination between them on anthocyanin content, may be explained that these treatments induce more of its precursors or increased its synthesis or decreased its destruction.

3.3.2. Total polyphenols

Data presented in Table (5) cleared that *T. erecta* flowers contained a higher percentage of polyphenol than the herb. This result is similar to that obtained by Moldovan and Hodisan (2004) on *T. patula*. Otherwise, application of the high level of compost increased the accumulation of total polyphenol in the herb, whereas, application of the low level increased polyphenol content of the flowers.

On the other hand, radiation doses had a gradual promotion effect on total polyphenol percentage, thus increasing dose level, caused corresponding increment in herb and flower total polyphenol percentage. The maximum values for stimulation of polyphenol in the herb and flowers were found with exposing plants to 8 K-rad gamma irradiation which reached 23.0% and 8.4%, for herb and flowers respectively over the control. Meanwhile, the low gamma irridiation dose (2 K-rad) increased the content of polyphenols by 6.8% and 1.43% for both herb and flowers, respectively, over the un-irradiated plants.

Concerning the interaction of compost combined with gamma irradiation doses on polyphenols percentage of *Tagetes erecta* plant, the data in Table (5) showed that the highest mean value of polyphenol increased in herb which obtained with compost at the level of 7 ton/fed combined with the highest gamma dose (8 K-rad), while for the flowers, the low compost level +8 K-rad irradiation produced the highest polyphenol percentage.

3.6. Essential oil percentage and yield

Table (6) revealed that the higher compost level was more favourable for improveding the essential oil percentage and yield (per plant and fed) than the lower one. The variable values of herb and essential oil flower yield per feddan between the two compost levels applied reached about 23.4% and 16.2%, respectively. Such finding was obtained by Naguib (2003) on chamomile, El-Sherbeny *et al*. (2005) on *Siderates Montana.* They found that essential oil percentage and yield were significantly increased by compost level increase from 5.5 ton till 16.5 ton/fed. However, El-Khawwas (2002) on black cumin, indicated that nitrogen may stimulate the synthesis of oil through the physiological processes of biochemical synthesis. The enhancement of oil yield may be due to the increment of oil percentage and /or herbs and flowers yield/plant

Otherwise, irradiation doses had a promotive effect at all doses used on herb and flower essential oil percentage or yield per plant and feddan. The stimulation increased gradually from 0 K-rad up to 6 K-rad, then decreased slightly at 8 K-rad. Thus, the highest mean values of essential oil percentage and yield for herb and flower were obtained as a result of irradiation with 6 K-rad dose. In this concern Zheljazkov *et al*., (1996), on mint and corniment reported that irradiation of seedlings with 1000 rad, increased essential oil by 10%. Moreover, Srivastova and Tyagi (1986) on palmarosa, and Youssef and Moussa (1998) on chamomile

The interaction between high compost level (7.0 ton/ fed.) and 6 K-rad gamma irradiation Table (6) gave the maximum value for essential oil percentage and its yield of herb and flowers, reaching 89.6% and 25.48 L/fed.

3.7. Essential oil constituent

The analysis of the essential oils obtained from herb and flowers of *Tagetes erecta* by GC/Ms Tables (7 and 8)showed 18 identified main compounds, representing 77.18% of the oil of the herb and 21 compounds accounting 74.93% of the flowers oils of *T. erecta*. The essential oil of both herb and flowers were characterized by large amounts of oxygenated components (as 1,8-cineole, linalool, geranyl acetate tagetone …..ext.). Moreover, the major components of the oil of herb were identified as; tagetone (24.96-30.17%) B-ocimene-y (9.36-14.32%), ocimenone (8.92-12.05%), B-ocimene-X (8.15-15.19%) and B-caryophellene (3.65-6.91%). On the other hand, the flower oil contained tagetone (18.65-25.00 %), B-ocemene-y (6.85-11.36%) ociminone (7.68-12.34%), caryophellen oxide (3.92-6.29%) and limonene (3.96-6.18%). Generally, it can be noticed that the oil of herb and flowers contained

Table (5): Effect of gamma irradiation and compost application on carotenoids, anthocyanines and total polyphenols of *Tagetes erecta* (mean of two seasons)-

Treatments \ Characters			Herb			Flowers		
			Carotenoid mg/g	Anthocyanin %	T-polyphenols %	Carotenoid mg/g	Anthocyanin %	T-polyphenols %
Compost 3.5 ton/fed	k-rad	0	0.866	1.15	3.37	2.34	1.26	5.58
		2	0.923	1.18	3.60	2.45	1.31	5.68
		4	0.956	1.22	3.75	2.55	1.33	5.60
		6	1.080	1.30	3.82	2.36	1.25	6.11
		8	0.855	1.42	3.80	2.27	1.40	6.20
Mean value of compost			0.936	1.25	3.66	2.39	1.31	5.83
Compost 7 ton/fed	k-rad	0	0.957	1.21	3.66	2.74	1.30	5.60
		2	0.984	1.29	3.92	2.90	1.34	5.66
		4	1.094	1.36	3.82	3.11	1.42	5.66
		6	1.100	1.36	4.22	3.00	1.40	5.85
		8	0.962	1.35	4.85	2.41	1.52	5.92
Mean value of compost			1.019	1.31	4.09	2.83	1.40	5.74
Mean value of Gamma irradiation k-rad		0	0.912	1.18	3.52	2.54	1.28	5.59
		2	0.954	1.24	3.76	2.68	1.33	5.67
		4	1.025	1.29	3.78	2.83	1.38	5.63
		6	1.090	1.33	4.02	2.68	1.33	5.98
		8	.909	1.39	4.33	2.34	1.46	6.06

Table (6): Effect of gamma irradiation and compost application on oil percentage and yield of herb and flowers of *Tagetes erecta*. **(Mean of two seasons).**

Treatments \ Characters			Essential oil of herb			Essential oil of flowers		
			%	ml/plant	L/fed	%	ml/plant	L/fed
Compost 3.5 ton/fed	k-rad	0	0.114	2.491	44.838	0.186	0.809	14.562
		2	0.125	2.906	52.306	0.194	0.945	17.006
		4	0.131	3.492	62.856	0.203	1.117	20.100
		6	0.140	3.966	71.388	0.215	1.286	23.149
		8	0.137	3.048	54.864	0.210	0.987	17.766
Mean value of compost			0.129	3.181	57.250	0.202	1.029	18.517
Compost 7 ton/fed	k-rad	0	0.116	2.966	53.388	0.198	0.960	17.285
		2	0.132	4.071	73.278	0.212	1.098	19.767
		4	0.139	4.401	79.218	0.228	1.334	24.008
		6	0.143	4.980	89.640	0.234	1.416	25.486
		8	0.141	3.878	69.804	0.217	1.163	20.936
Mean value of compost			0.134	4.059	73.066	0.218	1.194	21.496
Mean value of Gamma irradiation k-rad		0	0.115	2.729	49.113	0.192	0.885	15.924
		2	0.129	3.489	62.793	0.203	1.022	18.387
		4	0.135	3.947	71.037	0.216	1.225	22.053
		6	0.142	4.473	80.514	0.225	1.353	24.315
		8	0.139	3.463	62.334	0.214	1.075	19.351

Table (7): Effect of compost and irradiation doses on oil composition of *Tagets erecta* L. herb .

Treatments / Components	3.5 ton/fed compost			7 ton/fed compost		
	0 k rad	6 k rad	8 k rad	0 k rad	6 k rad	8 k rad
Hydrocarbons:						
pinene	0.72	0.38	0.32	0.50	0.15	0.94
Limonene	3.71	2.99	3.70	3.91	4.40	2.98
ocimene-x	8.15	12.23	11.35	13.32	9.61	15.19
ocimine-y	10.37	10.55	12.14	11.16	14.32	9.36
p-cymene	1.51	1.00	0.94	0.88	1.77	1.22
Terpinolene	1.06	2.64	2.87	3.17	3.06	3.95
Naphthaline	1.35	0.67	1.00	0.84	0.03	0.85
caryophyllene	4.15	5.71	3.81	4.14	3.65	6.91
Germacrene-D	1.04	0.95	1.50	0.68	2.04	2.22
cadinine	1.61	0.83	2.00	0.99	1.68	1.30
Totalhydrocarbons %	**33.69**	**37.95**	**39.63**	**39.60**	**40.71**	**44.92**
Oxygenated :						
1,8-cineole	0.64	0.47	0.28	0.28	0.55	0.79
Linalool	0.72	0.95	1.08	0.74	1.96	2.30
Geranyl acetate	0.43	0.67	1.36	1.05	1.22	2.34
Tagetone	30.17	28.33	25.55	29.24	32.04	24.96
D-verbenone	1.20	0.82	0.42	2.19	7.82	2.80
Ociminone	8.92	10.04	9.44	11.13	12.48	12.65
Thymol	0.88	0.51	0.76	0.85	1.00	1.57
Caryophellene oxide	0.53	0.80	1.03	1.90	1.84	2.51
Total oxygenated %	**43.49**	**42.59**	**39.92**	**47.38**	**54.91**	**49.92**
Total identified %	**77.18**	**80.54**	**79.55**	**86.98**	**95.62**	**94.84**

Table (8): Effect of compost and irradiation doses on oil main components of *Tagets erecta* L. flowers.

Treatments / Components	3.5ton/fed compost			7ton/fed compost		
	0 krad	6 krad	8 krad	0 krad	6 krad	8 krad
Hydrocarbons:						
pinene	0.12	0.08	0.14	0.22	0.07	--
Camphene	0.16	0.24	0.32	0.19	0.11	--
myrcene	0.73	0.81	0.88	1.25	1.02	1.08
Limonene	4.72	3.96	5.00	4.95	8.18	5.17
ocimene-x	7.11	10.71	9.22	10.32	7.98	6.24
ocimine-y	10.25	11.36	9.34	6.85	9.33	9.50
p-cymene	1.06	1.35	1.13	0.78	0.57	0.31
Terpinolene	2.88	1.21	3.17	3.60	5.66	0.90
Naphthaline	0.24	0.18	0.35	0.74	--	--
Copaene	1.97	2.60	0.93	2.25	2.17	0.56
caryophyllene	2.61	3.00	1.89	3.54	3.90	0.99
Santalone	1.34	1.15	2.40	2.11	3.82	1.78
Germacrene-D	0.95	1.13	1.55	1.04	2.25	2.39
cadinene	1.84	3.92	3.63	4.26	1.94	2.50
Total hydrocarbons %	**35.98**	**41.70**	**39.99**	**42.10**	**45.00**	**31.22**
Oxygenated :						
1,8-cineole	1.33	2.18	1.80	1.05	1.63	0.99
Linalool	0.92	4.95	3.53	3.24	2.72	3.55
Geranyl acetate	0.36	1.40	1.62	2.20	1.63	1.47
Tagetone	18.65	25.00	19.03	21.00	23.20	20.48
D-verbenone	3.72	4.64	4.75	3.65	2.97	5.80
Ociminone	7.68	10.25	10.68	11.85	12.02	12.34
Thymol	-	-	-	-	-	-
Caryophellene oxide	6.29	5.30	4.50	3.92	4.86	6.00
Total oxygenated %	**38.95**	**53.72**	**45.91**	**48.91**	**49.03**	**50.63**
Total identified %	**74.93**	**95.42**	**85.90**	**91.01**	**94.03**	**81.85**

the same components but they differed in their relative percentages. The oil of herbs contained higher amount of tagtone, and caryophellene, whereas the oil of flowers contained higher concentration of limonene, caryophellene oxide and 1.8- cineol. In this respect, Sefidkon *et al*. (2004) identified thirty-three components in leaf and stem oil and 34 components in flowers oil of *T. erecta*, while Singh *et al*. (2002) identifyied 26 components accounting for 89% of total oil of the same plant.

It is clear from the data in Tables (7 and 8) that various compost levels as well as irradiation doses caused variable effects on the major constituents of essential oil of herb or flower. The maximum values of tagetone and B-ocimene were obtained as a result of applied compost at the rate of 7.0 Ton/Fed combined with gamma irradiation at 6 K-rad doses for herb or 3.5 ton/fed compost + 6 K-rad irradiation for flower. Otherwise, the percentage of total hydrocarbon compounds for herb or flower increased with all different fertilizer or irradiation treatments compared with the low level, with one exception for flowers. Similarly, the percentage of total oxygenated compound for flowers increased with the application of various levels of compost and irradiation. On the contrary, for herb, the low compost level interaction with 6 K-rad or 8 K-rad irradiation decreased the total oxygenated compounds %. It is worthy to notice that the total identified components of essential oil of herb or flower, increased with various applied treatments as compared with applied low compost fertilizer alone**.**

Concerning the differences in volatile oil constituents of herb or flowers as a result of different treatments, it may be attributed to the effect of nitrogen levels on the enzymatic systems responsible for the biosynthesis of these classes of compounds (El-Saeid *et al*. 1996). Several investigators stated that higher compost levels improved the identified compounds *i.e.* Khalil *et al*. (2002) on *Tagetes erecta*, Khalil and El-Sherbeny (2005) on Mentha species. In addition, several studies showed various effects of different doses of irradiation on essential oil constituents, *i.e.,* Zheljazkor *et al*. (1996) on mint, they found that doses of 200, 500 and 1000 R increased menthone-14 by 12, 19 and 14%, respectively, compared to the untreated plants. Similarly, Moussaid *et al*., (2004) revealed that 2 Kg y irradiation caused higher D-limonene % than 1 KG y or control, while Linalool, methyl anthranilate and 3, 7- dimethyl 2, 6 octadienal decreased as dose irridiation increased for orange peel essential oil.

Conclusion

From the previously discussed results, it might be concluded that application of 7 ton/fed. compost fertilizer combined with gamma irradiation rays at the dose of 6 K-rad is recommended for producing the maximum yield of herb and flowers and consequently oil percentage, yield and chemical parameters of *Tagetes erecta* plants.

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تأثير الإشعاع على النمو الخضرى وتنشيط والنمو الزهرى والمحتوى الكيماوى لنبات القطيفة (*Tagetes erecta*) المنزرع تحت ظروف التسميد بالكمبوست

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ملخص

أجريت تجربة حقلية خلال موسمين متتاليين 2004-2005 لدراسة تأثير جرعات مختلفة من أشعة جاما على النمو والإزهار والتركيب الكيماوي لنباتات القطيفة المسمدة بمستويات مختلفة من الكمبوست. وتشير النتائج إلى أن المستوى المرتفع من سماد الكمبوست أعطي تأثيرا منشط للنمو الخضري والزهري مقارنة بالمستوى المنخفض. كما أدي الي زيادة تراكم الكاروتينات الكلية والأنثوسيانين و عديدات الفينولات وكذلك الزيت الطيار في كلا من العشب والأزهار مقارنة بالمستوى المنخفض.

أدت معاملة بذور نباتات القطيفةبأشعة جاماً بالمستويات المختلفة والمتدرجة حتى 6 كيلو راد إلى تنشيط صفات النمو الخضري والزهري تنشيطاً معنوياًبالاضافة لجميع المكونات الكيماوية المدروسة. أما المستوى المرتفع من الاشعاع (8 كيلو راد) فقد أدي في معظم الأحيان إلى تأثير عكسي حيث ثبطت معظم هذه الصفات. ولوحظ أن التداخل بين المستوى المرتفع من الكمبوست مع الإشعاع بجرعة 6 كيلو راد يؤدي إلى أعلى قيم لصفات النمو متمثلاً في طول النبات وعدد الأفرع والوزن الطازج والجاف لكلاً من العشب والأزهار. وبالمثل فإن الكاروتينات الكلية وعديد الفينولات في العشب والزيت الطيار لكلاً من العشب والأزهار أعطت أعلى تراكم باستخدام المعاملة السابقة (7طن/فدان كمبوست + 6 كيلو راد اشعاع).

المجلـــة العلميـــة لكليـــة الزراعـــة – جامعـــة القـــاهرة – المجلـــد (58) العـــدد الأول (ينـــاير 2007) :46-56.