Bull. Fac. Agric., Cairo Univ.,59 (2008) 281-294.

RESPONSE OF *Oenothera biennis* var. *grandiflora* TO DIFFERENT COMPOST LEVELS VERSUS CHEMICAL FERTILIZATION

(Received: 11.8. 2008)

By
H. M.F. Swaefy , H. F.Y. Mohamed* and A.A. Mahmoud*

Ornamental Horticulture Department, Agricultural Botany Department of (Plant Physiology), Faculty of Agriculture, Cairo University, Giza, Egypt.*

ABSTRACT

Oenothera biennis var. *grandiflora* plants were treated with compost as organic fertilization in comparison with chemical fertilization during the two successive seasons of 2005/2006 and 2006/2007, in the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University. The compost was used at three rates of ($2m^3$), ($4m^3$) and ($6m^3$) /feddan combined with 50% of the chemical fertilizers at ($4m^3$), ($8m^3$) and ($12m^3$) feddan or without chemical fertilizers. Seeds were sown in 30-cm clay pots filled with a sandy soil. The results indicate that using $4m^3$ organic compost/feddan and 50% of chemical fertilizers gave the best vegetative growth, in addition to 30-50% increment in the number of flowers more than the traditional chemical fertilization. Compost at $4m^3$/ fed. had the superior effect on increasing fixed oil percentage with a value of 2.97% in the second season. GLC analysis of methylated fatty acids of large flower evening primrose (*Oenothera biennis* var. *grandiflora*) indicated that it had the same fatty acids obtained from evening primrose (*Oenothera biennis*). The major saturated fatty acid was palmitic which ranged from 4.45% in the plants treated with $2m^3$ compost/feddan plus 50%chemical fertilizers to 10.88% with $4m^3$compost/feddan plus 50%chemical fertilizers. Using compost fertilization considerably increased the total unsaturated fatty acids and linoleic acid was the major unsaturated fatty acid. The highest value 85.59% was obtained with the treatment of $8m^3$/feddan. Also, the treatments of combination between chemical fertilization and compost produced plants with high total sugar concentration compared to the plants treated with compost only. Data show that all compost levels increased phosphorus concentration in the leaves and roots. It was concluded that compost can improve plant production.

Key words: flowering plants, Oenothera biennis var. *grandiflora, organic fertilization and unsaturated fatty acids*

1. INTRODUCTION

Evening primroses are very popular ornamental plants used in the borders in gardens. The plants belong to family Onagraceae (Sniezko,1996). *Oenothera* has eighty species of annuals, biennials, and perennials native to N. America. The flowers open in the evening, hence the name "evening primrose", and are yellow in most species, but white, purple, pink or red in a few; there are four petals. Biennials evening primrose should be sown in late summer or early autumn to flower the following summer. Primrose is an alterative herb that regulates hormonal systems. The herb has medicinal uses such as eczema, acne, hyperactivity in children, rheumatoid arthritis, coronary artery disease. Oil is added to skin preparations and cosmetics. Often combined with vitamin E to prevent oxidation. Evening primrose oil is used to soften and replenish dry skin; seeds are ground for use in facial scrubs. Bown (1996) and Liu *et al.* (2003).

Oenothera biennis var. *grandiflora,* (L'Her) Torr. & A. Gray , has larger flowers and is best for the garden. It is a biennial grown as a hardy annual. Flowers are yellow turning gold, 1-2 in. (2.5-5.0 cm) wide. It has synonyms such as *Onagra grandiflora* (L'Her.) and *Oenothera lamarckiana* Ser. The common name is large flower evening primrose. It is a robust annual, blooms from

May to July. Primrose is easily grown even on the poorest soils (Bown, 1995).

The oil of evening primrose (*Oenothera* sp.) is an important source of gamma-linolenic acid (GLA). GLA [C18:3Δ6, 9, 12] is an unsaturated fatty acid in demand for its nutritional and pharmaceutical application. Mean seed oil content ranged from 7.3% to 21.7%. of the *Oenothera* species and the mean GLA levels ranged from 0.0% to 10.1%. (Balch *et al.*, 2003). However, Krol and Berbec (2004) found that the seed oil content of evening primrose was an average by 2.8% as a result of fertilizer application.

Evening primrose oil (EPO, linoleic acid+ gamma-linolenic acid) lowered total cholesterol concentrations (Fukushima *et al.*, 2001).

Seeds are used for poultry feeding at the rate of 2%. It shows a balance of saturated and unsaturated lipids in the egg yolk (Rapacz *et al.*, 2000).

Nowadays, it has become necessary to search for substitutes for chemical fertilizers. Compost fertilization aims to minimize the environmental pollution of chemical fertilizers.

Adding organic material such as compost in preparing new beds for planting offer plenty of food for the new plants to get a great start. Many investigators work on this aspect such as Ravi *et al.* (2006) found that application of farmyard manure, alone and in combination with biofertilizers and neem cake reduced the incidence of sucking pests of sunflower against the application of NPK synthetic fertilizers. El-Sherbeny *et al.* (2005) on *Sideritis montana* L. plants, found that using compost at different levels (0.0, 5.5, 11.0, 16.5 ton/fed.), significantly increased the vegetative growth characters and yield components. Oil percentage and yield/plant were greatly affected by compost fertilization and reached maximum values with its highest level .

Bugbee *et al.* (1991) on aster plant, Aflatuni *et al.* (1993) on marjoram (*Origanum vulgare*), oregano (*Origanum* sp.) and peppermint (*Mentha piperita*), Sreenivas *et al.* (1998) on *Callistephus chinensis* , Nethra *et al.* (1999) found that plant growth in media with compost was equal to, or better than, that in the control. Elsakov *et al.* (2001) worked on medicinal crops (*Arnica montana, Primula elatior* and *Calendula officinalis*) found that the fertilizer treatments included 50 t manure/ha increased the yields by 1.5-2 times. Adding compost increased aeration, available nutrient.

The aim of this study was to determine the individual effects of compost levels against chemical fertilizers on growth, flowering and oil production of *Oenothera biennis* var. *grandiflora*.

2. MATERIALS AND METHODS

This investigation was conducted at the two successive seasons of 2005/2006 and 2006/2007, in the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, aiming to study the effect of organic compost on growth , flowering and oil production of *Oenothera biennis* var. *grandiflora* compared to mineral fertilization.

Seeds of *Oenothera biennis* var. grandiflora, were obtained from the above-mentioned Experimental Nursery. The plant was identified by Flora and Phyto-taxonomy Researches Department, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt.

Seeds were sown in 30-cm clay pots filled with a sandy soil. The mechanical and chemical analyses of the soil were carried out before planting according to Chapman and Pratt (1961). The soil texture of the experimental medium was sandy with the following properties: 32.5% coarse sand, 62.1% fine sand, 1.7% silt and 3.7% clay, E.C. 0.76 at dSm^{-1} , 7.4 pH, 0.43% $CaCO_3$, 19.8, 3.6 and 98.1ppm N, P (P_2O_5) and K (K_2O) respectively.

The organic compost having the properties shown below was used at three rates of ($2m^3$), ($4m^3$) and ($6m^3$) /feddan combined with 50% of the chemical

Chemical analysis of the compost used

Characters	Values
pH	8
E.C.(Electric conductivity)	4.82
Ammonium nitrogen	420ppm
Nitrate nitrogen	180ppm
Total nitrogen	1.7%
Organic substance	52.8%
Organic Carbon	30.6%
Ash	47.2%
C:N ratio	18:1
Total phosphorus	1.47%
Total potassium	3.43%

fertilizers or at ($4m^3$), ($8m^3$) and ($12m^3$) /feddan without chemical fertilizers.The compost was obtained from The Egyptian-Italian Co. for organic fertilizer and its derivatives, Egypt.

Mineral fertilization was at the rate of 300 kg ammonium sulphate (15.5% N), 200 kg calcium superphosphate (15.5 P_2O_5) and 100 kg potassium sulphate (48% K_2O) per feddan. The calcium monophosphate fertilizer was added at two portions, the first during preparation of the soil, the rest was added two months after transplanting during the two seasons,. Ammonium sulphate and potassium sulphate were added after 30 and 60 days from transplanting.

The experiment began on the 15th October in the two seasons. Germination was completed after 12 days. Plantlets were transplanted after one month from sowing.The layout of the experiment was a randomized complete blocks, with seven treatments and five replicates (6 pots in each replicate) in each season.

Plant height (cm), the number of branches/plant and the number of leaves were recorded twice; the first at vegetative growth stage and the second at full blooming. Number of flowers/plant was recorded at the beginning of flowering stage (the first week of March) and at full blooming (the second week of May). Also, at full blooming leaves, stems and roots fresh and dry weights (g/plant) were recorded for both seasons. Capsules were picked up periodically each week and calculated per plant then seed yield (g/plant) and fixed oil percentage were recorded in both seasons.

The data of the two seasons were subjected to the analysis of variance and L.S.D. values were obtained and the F values were checked at the 5% level (Snedecor and Cochran, 1982).

The method of A.O.A.C. (2000) was conducted for oil extraction from samples. The oils were saponified as reported by Vogel (1975). The methyl esters of fatty acids obtained from oil of samples and standard materials were analyzed with a Pye Unicam Series 304 gas chromatograph equipped with dual flame inoization detector and dual channel recorder. The separation of fatty acid methyl esters was conducted using a coiled glass column (1.5m/4mm) packed with Diatomite (100-120 mesh) and coated with 10% polyethylene glycol adipate (PEGA). The column oven temperature was programmed at 8°C /min from 70 to 190°C, then isothermally at 190°C for 25 min with nitrogen flow rate at 30 ml/min. In order to obtain dry the weight, the plant materials were chopped into small pieces and weighed then were kept in an electric fan oven at 70 °C for 48 hr. after that dry materials were ground into fine powder using an electric Wily Mill grinder, mixed thoroughly and packed in air tight glass containers and were kept for chemical analysis.

Determinations of total nitrogen, phosphorus and potassium were carried out on the barse dry material. The samples were digested in a mixture of sulfuric acid, salicylic acid hydrogen peroxide according to Linder (1944). Nitrogen was determined by using the modified "Micro Kjeldahl" apparatus of Parnas and Wagner as described by Pregl (1945). Phosphorus was determined spectrophotometerically by using stannous chloride method according to A.O.A.C., (1975). Potassium was determined using the flame photometer.

Total sugars in the different plant parts were determined by phosphomolybdic acid method according to A.O.A.C., (1975).

Determination of total free amino acids (FAA) for preparation of the ethanol extract, 0.2 grams of dry material were weighed and extracted with 25 ml of 70 % boiling ethanol for 10 min, then filtered through a centered glass funnel (G3). The residue was re-extracted and filtered twice with 70 % boiling ethanol, and then the volume was adjusted to 100 ml with 70 % ethanol. The total free amino acids were determined by using ninhydrin reagent, as described by Moor and Stein, (1954).

The colorimetric method of Folin-Denis as described by Swain and Hillis (1959) was employed for determination of the total soluble phenols.

3. RESULTS AND DISCUSSION

3.1. Vegetative growth characteristics

3.1.1 Plant height (cm), number of branches and number of leaves

The data presented in Table (1) show that during 2005/2006 and 2006/2007 growing seasons of *Oenothera biennis* var. *grandiflora* plant height was increased under all treatments compared to the full chemical

fertilizers treatment. It is also clear that, most of the compost levels had negative effect on the number of branches/plant except with the low and moderate rates of compost/fed plus 50% chemical fertilizers which gave better results compared with the full chemical fertilizers treatment. Regarding the effect of organic compost on the number of leaves/plant of large flower evening primrose, the results indicate that all the combinations between compost and chemical fertilizers had more beneficial effect than using compost alone. The obtained results are in agreement with Khalil *et al.* (2008) who studied 3 levels (6, 12 and 18m^3/fed.) on growth and productivity of bitter fennel and Egyptian sage. The results retrieved that all levels of compost significantly increased plant height, number of branches, fresh and dry weights of herb in fennel seeds and sage herb.

3.1.2 Leaves , stem and root fresh and dry weights

The data presented in Table (2) show that using organic compost manure alone significantly decreased leaves fresh and dry weights in both seasons compared to full chemical fertilizers treatment. While, adding 50% of the chemical fertilizers to the plants which received organic compost manure at different levels caused significant increase in leaves fresh and dry weights in most cases compared to full chemical fertilizers treatment. The highest leaves fresh and dry weights were obtained with the lowest level of compost combined with 50% chemical fertilizers with values 91.94 and 13.23g in the first season and 59.73 and 8.15 g in the second season.

It is clear that the combination between compost and 50% chemical fertilizers gave better results on stem fresh and dry weights than using any of the compost levels alone in both seasons.

Regarding the effect of organic compost on root fresh and dry weights of *Oenothera biennis* var. *grandiflora* ,the results in Table (2) indicate that the middle level of compost plus 50% chemical fertilizers gave the best root fresh and dry weights (21.28 and 5.91 g) in the first season,while it gave the best result without adding chemical fertilizers in the second season with values (14.23 and 5.00 g). Such results are in the same line with many researches on different plants such as Nethra *et al.* (1999) on *Callistephus chinensis.* they found that highest the number of leaves were recorded after the application of 10 ton vermicompost/ha + 100% NPK.This significantly increased the fresh and dry weights of *Sideritis montana* L. herb during vegetative growth and flowering stages. Aflatuni *et al.* (1993) noticed that the herb dry matter yields of marjoram (*Origanum vulgare*), oregano (*Origanum* sp.) and peppermint (*Mentha piperita*) were greater with composted manure .

3.1.3. Number of flowers/plant

As *Oenothera biennis* var. *grandiflora* plants are important for flower borders in the garden , the data on flower number per plant were taken twice as shown in Table (3).

The results indicate that using compost either with or without the chemical fertilizers increased the number of flowers/ plant at the beginning of the flowering stage compared to full chemical fertilizers in most cases in both seasons.

At full blooming stage, using organic compost alone caused significant decrease in the number of flowers/plant compared to full chemical fertilizer treatment in both seasons. Also, increasing compost levels without adding chemical fertilizers caused steady decrease in the number of flowers/plant.

Adding 50% of the chemical fertilizers to the plants received organic compost caused synergistic effect on increasing the number of flowers/plant in the second season. The increasing ratios were 18.3, 54.0 and 33.5% over the full mineral fertilization for the low, middle and high levels of compost, respectively.

In this respect, Sreenivas *et al.* (1998) on *Callistephus chinensis,* found that organic composts + NPK did not affect the time to flowering; the highest number of flowers/plant was recorded with FYM + NPK at the recommended level. Also, Nethra *et al.* (1999) on the same plant found that the best flower yield was recorded after the application of 10 ton vermicompost/ha + 100% NPK.

3.1.4. Capsules fresh and dry weights

The data presented in Table (4) show that using organic compost alone at the different levels had negative significant effect on capsule fresh and dry weights in both seasons.

Also, adding 50% chemical fertilizers to the plants which received organic compost caused insignificant decrease in capsule

Table (1): Effect of compost levels and chemical fertilization on plant height (cm), number of branches/plant and number of leaves/plant of *Oenothera biennis* var. *grandiflora* plants at vegetative and flowering stages in 2005/2006 and 2006/2007 seasons.

Treatment	First season					
	Plant height(cm)		No.branches/ plant		No. leaves/plant	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
100%NPK(Control)	38.67	78.67	3.3	6.0	35.33	55.33
2m^{3}compost/fed+50%NPK	37.33	81.33	4.3	9.3	39.00	63.00
4m^{3}compost/fed+50%NPK	41.00	99.67	4.6	4.6	32.67	59.00
6m^{3}compost/fed+50%NPK	41.00	88.00	2.0	8.3	33.33	57.00
4m^{3}compost/fed	38.33	89.00	2.6	7.3	40.67	50.67
8m^{3}compost/fed	38.67	69.33	1.3	3.0	35.33	42.00
12m^{3}compost/fed	41.33	81.00	2.6	3.0	35.33	45.33
LSD $_{0.05}$	5.54	12.77	1.9	2.9	4.69	12.28
	Second season					
100%NPK(control)	39.67	72.00	1.0	2.6	44.00	45.00
2m^{3}compost/fed+50%NPK	39.67	77.33	2.6	4.3	35.33	61.00
4m^{3}compost/fed+50%NPK	42.00	69.33	5.0	5.0	38.00	108.30
6m^{3}compost/fed+50%NPK	44.33	85.67	1.3	4.3	45.00	81.67
4m^{3}compost/fed	40.00	90.67	2.0	2.0	49.33	94.00
8m^{3}compost/fed	37.67	73.67	2.0	1.3	45.00	53.33
12m^{3}compost/fed	41.67	78.33	1.3	4.3	31.67	77.00
LSD($_{0.05}$)	4.21	7.42	1.4	1.1	7.75	10.53

1st = Vegetatives stage
2nd = Flowering stage

Table (2): Effect of compost levels and chemical fertilization on leaves, stem and root fresh and dry weights (g/plant) of *Oenothera biennis* var. *grandiflora* plants at flowering stage in 2005/2006 and 2006/2007 seasons.

Treatment	First season					
	Leaves fresh weight	Leaves dry weight	Stem fresh weight	Stem dry weight	Root fresh weight	Root dry weight
100%NPK(control)	48.19	8.40	68.4	10.92	9.36	1.95
2m^{3}compost/fed+50%NPK	91.94	13.23	113.9	20.39	17.60	3.57
4m^{3}compost/fed+50%NPK	50.98	11.62	93.12	13.74	21.28	5.91
6m^{3}compost/fed+50%NPK	45.21	8.12	92.67	18.33	18.99	3.97
4m^{3}compost/fed	31.42	7.69	38.00	7.73	11.57	2.64
8m^{3}compost/fed	15.88	3.69	50.22	8.29	8.51	1.68
12m^{3}compost/fed	29.72	5.78	42.40	9.27	6.47	1.64
LSD ($_{0.05}$)	8.77	2.19	10.07	3.50	3.69	1.45
	Second season					
100%NPK(control)	37.17	5.99	22.38	6.38	5.37	1.83
2m^{3}compost/fed+50%NPK	59.73	8.15	85.50	14.06	11.27	4.03
4m^{3}compost/fed+50%NPK	58.68	7.75	40.00	11.42	10.50	2.91
6m^{3}compost/fed+50%NPK	55.07	7.71	46.90	12.72	7.80	2.24
4m^{3}compost/fed	27.27	3.48	49.07	9.01	14.23	5.00
8m^{3}compost/fed	16.77	3.45	20.13	10.92	8.13	2.85
12m^{3}compost/fed	29.77	4.86	59.80	11.37	10.40	3.06
LSD ($_{0.05}$)	5.16	1.98	9.73	1.78	1.21	1.89

Table (3): Effect of compost levels and chemical fertilization on the number of flowers/ plant of *Oenothera biennis* var. *grandiflora* plants at the beginning of flowering stage and at full blooming in 2005/2006 and 2006/2007 seasons.

Treatment	No. flowers/plant	
	At the beginning of flowering stage	At Full blooming
	First Season	
100%NPK(Control)	25.0	201.0
2m^{3}compost/fed+50%NPK	48.0	169.7
4m^{3}compost/fed+50%NPK	69.3	263.3
6m^{3}compost/fed+50%NPK	61.0	167.3
4m^{3}compost/fed	33.0	122.5
8m^{3}compost/fed	19.7	108.7
12m^{3}compost/fed	14.0	78.0
LSD ($_{0.05}$)	11.21	25.03
	Second Season	
100%NPK(Control)	12.67	161.0
2m^{3}compost/fed+50%NPK	16.00	190.5
4m^{3}compost/fed+50%NPK	35.67	248.0
6m^{3}compost/fed+50%NPK	35.00	215.0
4m^{3}compost/fed	10.00	145.3
8m^{3}compost/fed	13.67	144.0
12m^{3}compost/fed	13.67	102.5
LSD ($_{0.05}$)	6.38	13.70

Table (4). Effect of compost levels and chemical fertilization on capsule fresh and dry weights (g/plant) of *Oenothera biennis* var. *grandiflora* plants in 2005/2006 and 2006/2007 seasons.

Treatment	Capsule fresh weight(g/plant)	Capsule dry weight(g/plant)
	First Season	
100%NPK(Control)	155.80	56.67
2m^{3}compost/fed+50%NPK	118.00	54.05
4m^{3}compost/fed+50%NPK	164.40	57.55
6m^{3}compost/fed+50%NPK	109.90	42.03
4m^{3}compost/fed	91.97	27.44
8m^{3}compost/fed	77.45	29.75
12m^{3}compost/fed	63.06	24.21
LSD($_{0.05}$)	12.05	10.33
	Second Season	
100%NPK(Control)	136.30	49.61
2m^{3}compost/fed+50%NPK	128.30	48.67
4m^{3}compost/fed+50%NPK	140.00	51.91
6m^{3}compost/fed+50%NPK	118.60	43.12
4m^{3}compost/fed	95.59	33.55
8m^{3}compost/fed	71.52	21.51
12m^{3}compost/fed	54.94	26.48
LSD ($_{0.05}$)	12.48	5.46

fresh and dry weights of *Oenothera biennis* var. *grandiflora* compared to the full chemical fertilization treatment, with one exception with the middle level of compost ($4m^3$/fed.) which had closely the same result obtained from full chemical fertilization treatment in both seasons.

These results agree with those obtained by Nethra *et al.* (1999) on *Callistephus chinensis*, they found that the best yield was recorded after application of 10 ton vermicompost/ha + 100% NPK.

3. 2. Seed yield per plant

The data shown in Table (5) indicate that organic compost treatments, regardless of its combination with chemical fertilizers or not, decreased the seed yield per plant with one exception with the treatment of using $4m^3$/feddan compost plus 50% chemical fertilizers which insignificantly increased seed yield/plant compared to the treatment of full chemical fertilizers, in both seasons. The above mentioned results are in harmony with those obtained by Kulkarni *et al.* (2002) recorded the highest sunflower seed yield by application of poultry manure followed by the application of FYM. Also, Krol and Berbec (2004) who treated the evening primrose with NPK found that the plants developed more capsules, as a result of fertilizer application.

3.3. Oil percentage

The results recorded in Table (5) show that fixed oil percentage was increased by using compost alone compared to any of the chemical fertilizer treatments either in full amount or 50% of it, in most cases, in both seasons.

It is clear that the low level of compost ($4m^3$/ fed.) has the superior effect on increasing fixed oil percentage with values 1.83% in the first season and 2.97% in the second season. Using $8m^3$ compost/feddan was the second beneficial treatment with values 1.31% and 2.39% in the first and second seasons, respectively.

The obtained results are in agreement with Krol (2001) who found that primrose plants contained much fat when grown on compost. Also, Krol and Berbec (2004) found that the seed oil content of evening primrose was on average by 2.8% as a result of fertilizer application.

3. 4. Fixed oil constituents

The percentage of large flower evening primrose indicated that it had the same fatty acids obtained from evening primrose (*Oenothera biennis*) . Grela *et al.* (1992) found that linoleic (53.9%), palmitic(13.5%), oleic(12.8%) and gamma-linolenic (11.7%) acids were the predominated in evening primrose oil seeds

Seven saturated and three unsaturated fatty acids were identified, including omega-6-fatty acids, which are linoleic [C18:2 all-cis-9, 12-octadecadienoic acid] and gamma-linolenic (GLA) [C18:3 all-cis-6, 9, 12-octadecatrienoic acid]. These acids are the main essential polyunsaturated fatty acids required in the human diet. Accordingly, in all treatments the major saturated fatty acid was palmitic which ranged from 4.45% in the plants treated with $2m^3$ compost/feddan plus 50%chemical fertilizers to 10.88% with $4m^3$compost/feddan plus 50%chemical fertilizers. The results show an increment, in most cases in the percentage of palmitic acid in response to the organic compost fertilization compared to the treatment of full chemical fertilizers.

In the case of the unsaturated fatty acids, the results in Table (6) show that linoleic acid was the major component and increased by all treatments compared with full chemical fertilization treatment. It ranged from 31.67% for the full chemical fertilization treatment to 55.74% with fertilization treatment. It ranged from 31.67% for the full chemical fertilization treatment to 55.74% with $8m^3$compost/ feddan. The same trend was found in the case of linolenic acid which ranged from 5.0% with full chemical fertilization treatment to 8.97% with $8m^3$compost/feddan.

Concerning oleic acid, the data show a considerable decrease with the treatments received organic compost only while the plants received organic compost plus 50% chemical fertilizers had closely the same oleic acid percentage compared to full chemical fertilization treatment. Also, it is clear from the data in Table (6) that using compost fertilization considerably increased the total unsaturated fatty acids. The highest value 85.59% was obtained with the treatment of $8m^3$/feddan.

In this respect. the evening primrose oil contains 10% gamma-linolenic acid which is not found in many plants (Lacombe *et al.*, 1985). Also, Gibson *et al.*, (1992) studied 14 brands of evening primrose oil and found that gamma-linolenic acid (GLA) ranged between

Table (5). Effect of compost levels and chemical fertilization on seed yield/plant and fixed oil percentage of *Oenothera biennis* var. *grandiflora* plants in 2005/2006 and 2006/2007 seasons

	Seed yield(g /plant)	Oil %
	First Season	
100%NPK(Control)	25.39	1.25
2m^{3}compost/fed+50%NPK	22.28	1.26
4m^{3}compost/fed+50%NPK	27.80	1.28
6m^{3}compost/fed+50%NPK	15.20	1.27
4m^{3}compost/fed	18.38	1.83
8m^{3}compost/fed	11.80	1.31
12m^{3}compost/fed	12.84	1.19
LSD $_{(0.05)}$	4.40	0.22
	Second Season	
100%NPK(Control)	25.14	2.13
2m^{3}compost/fed+50%NPK	22.39	1.50
4m^{3}compost/fed+50%NPK	25.21	2.01
6m^{3}compost/fed+50%NPK	20.51	1.54
4m^{3}compost/fed	16.42	2.97
8m^{3}compost/fed	11.60	2.39
12m^{3}compost/fed	10.39	2.11
LSD$_{(0.05)}$	2.87	0.53

Table (6): Effect of compost levels and chemical fertilization on fatty acid percentage of seeds oil of *Oenothera biennis* var. *grandiflora* seeds in 2005/2006 season.

Fatty acids	1	2	3	4	5	6	7
Caprylic 8:0	0.20	1.54	0.90	1.04	0.23	0.11	0.91
Capric 10:0	0.14	0.11	0.15	0.12	0.31	0.26	0.31
Lauric 12:0	0.35	0.10	0.18	0.14	0.54	0.08	0.09
Myristic 14:0	0.47	0.35	0.5	0.52	0.55	0.08	0.36
Palmitic 16:0	6.16	4.45	10.88	8.46	8.53	10.26	9.9
Stearic 18:0	1.64	1.45	1.64	1.65	1.17	1.88	1.8
Oleic 18:1	34.24	36.82	33.49	37.44	21.12	20.88	25.36
Linoleic 18:2	31.67	32.10	37.75	35.86	52.22	55.74	52.04
Linolenic 18:3	5.00	5.03	6.03	6.11	8.15	8.97	6.65
Arachidic 20:0	4.23	4.48	4.62	6.64	Trac.	Trac.	Trac.
Saturated fatty acids	13.19	12.48	18.87	18.57	11.33	12.67	13.37
Unsaturated fatty acids	70.91	73.95	77.27	79.41	81.49	85.59	84.05
Total identified	84.10	86.43	96.14	97.98	92.82	98.26	97.42

1= 100%NPK (control)
2=2m^{3}compost/fed+50%NPK
3=4m^{3}compost/fed+50%NPK
4=6m^{3}compost/fed+50%NPK
5=4m^{3}compost/fed
6=8m^{3}compost/fed
7=12m^{3}compost/fed

1.9 to 10.5%. As well as, Kocourkova *et al.*, (1999) tested GLA content of *Oenothera biennis* from various sources. They found that GLA content was 9.9% in seeds from the UK and it was 4.7% in seeds from Opuva.

3.5.Chemical composition minerals

It has been illustrated from the data in Table (7) that compost at the rate $2m^3$/feddan combined with 50% NPK increased the concentration of N, P and K in the leaves, stems and roots of *Oenothera biennis* var.*grandiflora* plants compared to the control treatment in both seasons.

Data presented in the same Table exhibit the gradual decrease in N, P and K concentration in the stems and roots of *Oenothera* plants. Data show that all compost levels increased phosphorus concentration in leaves and roots either treated alone or combined with 50% NPK compared to the control. In this respect, concerning the effect of compost, Bugbee *et al.*, (1991) found that adding compost increased available nutrient of aster cv.Novi Belgii plant.

3.6.Total carbohydrates

Data in Table (8) point out that the combination between chemical fertilization and compost produced plants with high total carbohydrate concentration compared to the plants treated with compost only. In this respect, El-Sherbeny *et al.* (2005) on *Sideritis montana* L. plants, found that, the photosynthetic pigments and carbohydrate content were greatly affected by compost fertilization and reached the maximum values with its highest level .

3.7.Free amino acids (FAA)

It is clear from the results in Table (9) that the first and second levels of compost with 50% NPK had the highest values of FAA concentration in both samples in leaves and roots. It is important here to mention that all levels of compost with or without 50% NPK showed an increase in FAA in stems in both seasons.

Phenols

Regardless of the treatments under the present study, the data in Table(10) show that, the increase of phenol concentrations was observed in the stems in all treatments comparing to the control in both seasons.

Meanwhile, the first and second level of compost with NPK showd the highest values of phenol concentration in most cases. Generally, the data in Table (10) reveal that there are decreases in phenol concentration in the second season compared to the first one. On the other hand, the concentration of phenols was increased due to the same treatments in the first season.

In this respect, Harb *et al.* (2005) found that, phenolic compounds may have indirect effect on the physiological process through more non-specific effects on intermediately metabolism, *i.e.*, phenolic compounds are capable to inhibit ATP synthesis in the mitochondria (Stenlid, 1970). On the other hand, there was another indirect effect mentioned by Ravi *et al.*(2006) that the organic amendment (farmyard manure, vermicompost and neemcake) increased the total phenols in sunflower plants and also the activity of enzymes polyphenol oxidase (catechol oxidase) and peroxidase, which might be responsible for the reduced pest incidence.

3.9.Effect of compost and chemical fertilization on chemical composition in seed of evening primrose

Data presented in Table (11) show that during 2005-2006 and 2006-2007 growing seasons, phosphorus, total carbohydrates, FAA and phenol concentrations in seeds were increased under all treatments. Meanwhile, the increase in N and potassium concentration show under the first and second levels of compost with 50% NPK.

In this respect, Krol and Berbec (2004) illustrated that increasing fertilizer application resulted in a higher seed yield and oil content in seed of evening primrose (*Oenothera biennis* L.)

Conclusion

It can be concluded that compost can improve plant growth. Most beneficial effects induced by composts are due to the activities of microorganisms in the rhizosphere, the area of the soil immediately surrounding the roots. Some of these microorganisms produce plant growth hormones and simulate plant growth directly.

It could be recommended to use $4m^3$ organic compost/feddan and 50% of mineral fertilizers, to get the best vegetative growth, in addition to 30-50% increment in number of flowers more than the traditional chemical fertilization program of *Oenothera biennis* var. *grandiflora* plants. Also, using $8m^3$

Table (7): Effect of compost levels and chemical fertilization on NPK concentration (mg/gm dry weight) of *Oenothera biennis* var. grandiflora plants in leaves, stem and root during 2005/2006 and 2006/2007 seasons.

Treatment	Leaves					
	First season			Second season		
	N	P	K	N	P	K
100%NPK(Control)	26.04	0.63	1.58	12.87	1.24	1.53
2m^{3}compost/fed+50%NPK	28.57	0.78	1.78	24.45	1.41	1.70
4m^{3}compost/fed+50%NPK	13.80	0.78	1.75	28.12	1.52	1.70
6m^{3}compost/fed+50%NPK	15.73	0.54	1.95	12.69	0.78	1.61
4m^{3}compost/fed	15.28	1.66	1.16	18.74	1.91	1.53
8m^{3}compost/fed	16.27	1.39	1.10	15.48	1.96	1.53
12m^{3}compost/fed	21.69	1.74	1.95	19.03	2.04	1.56
	Stems					
Treatment	First season			Second season		
	N	P	K	N	P	K
100%NPK(Control)	15.17	0.79	1.63	10.59	0.98	2.84
2m^{3}compost/fed+50%NPK	18.74	1.80	2.24	3.10	2.23	2.88
4m^{3}compost/fed+50%NPK	14.77	0.30	2.85	7.13	0.98	2.04
6m^{3}compost/fed+50%NPK	14.60	1.60	3.31	4.23	0.72	2.26
4m^{3}compost/fed	17.95	0.35	2.24	3.12	0.27	1.70
8m^{3}compost/fed	8.63	0.46	1.72	5.62	0.23	1.39
12m^{3}compost/fed	6.`42	0.36	1.60	2.98	0.25	1.78
	Roots					
Treatment	First season			second season		
	N	P	K	N	P	K
100%NPK(Control)	13.23	0.34	2.63	7.36	0.32	1.05
2m^{3}compost/fed+50%NPK	14.99	0.88	2.38	7.65	0.49	1.46
4m^{3}compost/fed+50%NPK	5.62	1.01	1.95	3.55	1.36	1.36
6m^{3}compost/fed+50%NPK	8.66	1.30	1.83	2.84	0.84	1.46
4m^{3}compost/fed	6.10	1.25	1.77	2.75	1.68	1.07
8m^{3}compost/fed	4.77	0.93	1.16	4.69	1.03	1.10
12m^{3}compost/fed	3.41	0.99	1.43	3.92	1.05	1.32

Table (8): Effect of compost levels and chemical fertilization on total carbohydrate concentration (mg/gm dry weight) of *Oenothera biennis* var. *grandiflora* plants during 2005/2006 and 2006/2007 seasons

Treatment	First season			second Season		
	Leaves	Stem	Root	Leaves	Stem	Root
100%NPK(Control)	56.46	37.63	32.70	33.41	24.32	43.90
2m^{3}compost/fed+50%NPK	50.18	52.10	40.10	33.47	28.69	45.50
4m^{3}compost/fed+50%NPK	58.56	44.16	38.85	39.42	26.86	47.87
6m^{3}compost/fed+50%NPK	56.00	30.85	52.48	31.36	23.87	44.58
4m^{3}compost/fed	42.05	14.72	16.51	17.02	19.58	27.39
8m^{3}compost/fed	44.99	53.70	19.39	26.24	30.21	32.51
12m^{3}compost/fed	51.39	40.13	37.76	22.66	16.51	39.94

Table (9): Effect of compost levels and chemical fertilization on free amino acid concentration (mg/g dry weight) of *Oenothera biennis* var. *grandiflora* plants during 2005/2006 and 2006/2007 seasons.

Treatment	First season			Second season		
	Leaves	Stem	Root	Leaves	Stem	Roots
100%NPK(Control)	1.71	0.77	0.88	0.48	0.39	0.59
2m^{3}compost/fed+50%NPK	1.88	1.15	0.98	0.76	0.67	1.09
4m^{3}compost/fed+50%NPK	1.74	0.83	0.80	0.32	0.48	0.44
6m^{3}compost/fed+50%NPK	0.61	1.77	1.93	0.43	0.52	0.76
4m^{3}compost/fed	0.35	2.69	0.78	0.40	0.80	0.89
8m^{3}compost/fed	1.57	0.93	0.40	0.83	0.95	0.57
12m^{3}compost/fed	1.79	0.82	0.27	0.55	0.89	0.38

Table (10): Effect of compost levels and chemical fertilization on phenols concentration (mg/gm dry weight) of *Oenothera biennis* var. *grandiflora* plants during 2005/2006 and 2006/2007 seasons.

Treatment	First season			Second season		
	Leaves	Stem	Root	Leaves	Stem	Roots
100%NPK(Control)	2.52	1.51	2.42	1.89	1.38	1.11
2m^{3}compost/fed+50%NPK	2.87	2.82	2.98	1.99	1.66	1.17
4m^{3}compost/fed+50%NPK	2.77	2.79	2.48	1.98	1.81	1.35
6m^{3}compost/fed+50%NPK	1.54	2.02	1.26	1.24	1.48	1.43
4m^{3}compost/fed	2.19	2.14	2.79	1.28	1.61	0.89
8m^{3}compost/fed	1.37	2.12	1.17	1.10	1.59	1.26
12m^{3}compost/fed	1.61	2.17	1.02	1.23	1.64	1.13

Table (11): Effect of compost levels and chemical fertilization on NPK, total carbohydrates, phenols and free amino acids concentrations (mg/gm dry weight) of *Oenothera biennis* var. grandiflora plants in seed as mean of 2005/2006 and 2006/2007 seasons.

Treatment	Chemical composition					
	N	P	K	Total carbohydrates	Free amino acids	Phenols
100%NPK(Control)	17.13	0.24	1.92	20.29	0.36	1.12
2m^{3}compost/fed+50%NPK	18.43	0.66	1.97	24.45	0.61	1.28
4m^{3}compost/fed+50%NPK	17.79	0.73	2.02	24.00	0.38	1.26
6m^{3}compost/fed+50%NPK	12.72	1.36	1.92	25.09	0.38	1.43
4m^{3}compost/fed	7.98	1.73	1.53	28.67	0.63	1.31
8m^{3}compost/fed	11.45	0.38	1.61	29.06	0.61	1.99
12m^{3}compost/fed	7.58	2.68	1.75	29.97	0.41	1.67

compost/feddan led to the highest oil percentage and unsaturated fatty acids in the large flower evening primrose seeds.

4.REFERENCES

Aflatuni A., Palevitch D. and Putievsky E. (1993): The effect of manure composted with drum composter on aromatic plants. Acta Hort., 344:63-68.

A.O.A.C. (1975). Official Methods of Analysis of the Association of Official Analysis Chemists, 12th. ed., published by A.O.A.C., Washington. D.C.200044.

A.O.A.C. (2000): Official Methods of Analysis of the Association of Official Analytical Chemist. 14th ed Washington, D.C.

Balch S.A., McKenney. C.B. and Auld D.L. (2003): Evaluation of gamma-linolenic acid composition of evening primrose (*Oenothera*) species native to Texas. American Society for Horticultural Science .July 2003(vol.38, No.4).

Bown D. (1995): Growing Herbs. Dorling Kindersley, London, page 50.

Bown D. (1996): Encyclopedia of Herbs and Their Uses. Dorling Kindersley, London, page 49, 167, 318 and 319.

Bugbee G.J., Frink C.R. and Migneault D. (1991): Growth of perennials and leaching of heavy metals in media amended with a municipal leaf, sewage sludge and street sand compost .Journal of Environmental Horticulture. 9(1): 47-50.

Chapman H. D. and Pratt P. F. (1961): Methods of Soil, Plants and Water Analysis. University of California, Division of Agricultural Sciences. pP.60-69.

Elsakov G.V., Gorelova A.P. and Mironova R.A. (2001): Role of fertilizers in cultivating medicinal crops north of the Arctic circle .Agrokhimiya. (2): 40-45.

El-Sherbeny, S.E., Khalil M.Y. and Naguib N.Y. (2005): Influence of compost levels and suitable spacings on the productivity of *Sideritis montana,* L. plants recently cultivated under Egyptian conditions.Bull.Fac. Agric., Cairo Univ.,56: 373-392.

Fukushima M., Shimada; K. Ohashi T., Saitoh H., K.Sonoyama; Sckikawa M. and M. Nakano (2001): Investigation of gene expressions related to cholesterol metabolism in rats fed diets enriched in n-6 or n-3 fatty acid with a cholesterol after long-term feeding using quantitative-competitive RT-PCR analysis. Journal of Nutritional Science and Vitaminology, 47(3): 228-235.

Gibson R.A., Lines D.R. and Neumann M.A. (1992): Gamma linolenic acid (GLA) content of encapsulating evening primrose oil products. Lipids 27(1): 82-84.

Grela E,.Korol W and Lipiec A. (1992): Nutrients in oil-cake of evening primrose seeds. Biuletyn-Informacyjny-Przemysu-Paszowego. 31(2): 45-56.

Harb E.M.Z., Hanafy Ahmed A.H., El-Shihy O.M. and Bayerly R.M.S. (2005). Effect of gamma irradiation on increasing salinity tolerance of micropropagated plants. Bull. Fac. Agric., Cairo Univ., 56(1): 55-88.

Khalil M. Y., Kandil M.A.M. and Swaefy Hend M.F. (2008).Effect of three different compost levels on fennel and salvia growth characters and essential oils. Research Journal of Agriculture and Biological Sciences, 4(1):34-39, INSInet Publication.

Kocourkova B., Havel J. and Slesingerova T. (1999): Biennial evening primrose (*Oenothera biennis* L.) - an important source of gamma linolenic acid in the Czech Republic. Acta Universitatis Agriculturae et Silviculturae Mendelianae-Brunensis, 47(1): 39-47.

Krol B. and Berbec, S. (2004): Effect of mineral fertilization on development and seed yield of evening primrose (*Oenothera biennis* L.). Annales Universitatis Mariae Curie Skodowska Sectio E, Agricultura, 59(4): 1731-1737.

Krol B. (2001): The effect of substrate type and method of seeding on the growth and development of evening primrose (*Oenothera biennis* L.). Annales Universitatis Mariae Curie Skodowska Sectio EEE, Horticultura. (Supplementum) 9 : 99-105.

Kulkarni S.S.,Ramesh Babu and Pujari B.T.(2002):Growth, yield and yield parameters of sunflower as influenced by organic manures, biofertilizers and micronutrients under irrigation.

Karanataka Journal of Agricultural Sciences, 15 (2) : 253-255.

Lacombe A, Quenot O., Grignac P., Graille J., Pina M. and Garnier P. (1985): An attempt to produce gamma-linolenic acid from cultivated evening primrose (genus *Oenothera*). Oleagineux, 40(1): 35-40.

Linder R. C. (1944). Rapid analytical methods for some of the more common inorganic conistituents of plant tissues. Plant Physiol, 19 (1): 76-79.

Liu,Q.X., Wei M., Zhu L.Q., Me G.M. and Vang Y. (2003): Domestication of *Oenothera* as a new oil plant. International Atomic Energy Agency Technical Documents IAEA TECDOCS, 13(9): 117-122.

Moor S. and Stein, W. H. (1954). A modified ninhydren reagent for the photometric determination of amino acids and related compounds. J. Biol. Chem., 211: 907-913.

Nethra N.N., Jayaprasad, K.V. and Kale R.D. (1999): China aster [*Callistephus chinensis* (L.) Ness] cultivation using vermicompost as organic amendment . Crop Research Hisar. 17(2): 209-215.

Pregl F. (1945). Quantitative-Organic Micro-analysis. 4th. ed. J. and A. Churchill. Led. London.

Rapacz J.M., Janik A.and Gumuka M. (2000): Effect of diet composition on the fatty acid profile in egg yolks of crossbred laying hens. Roczniki Naukowe Zootechniki, (8): 171-175.

Ravi M., Dhandapani N., Sathiah N. and Murugan M. (2006): Influence of organic manures and fertilizers on the incidence of sucking pests of sunflower, *Helianthus annuus* L.. Annals of Plant Protection Science. Society of Plant Protection Science, New Delhi, India., 14(1) 41-44.

Snedecor W. G. and Cochran G. W. (1982). Statistical Methods. Iowa State Univ., Press., Ames, Iowa, USA., 507. pp.

Sniezko R.(1996): Pollen tube branching in the ovary of five species of *Oenothera* . Acta Societatis Botanicorum Poloniae, 65(1/2): 111-116.

Sreenivas K.V, Narayanagowda J.V. and Narayanaswamy P. (1998): Effects of different organic manures on growth and flower yield of China aster . Karnataka Journal of Agricultural Sciences, 11(3): 858-861.

Stenlid G. (1970): Flavonoids as inhibitors of the formation of adenosine triphosphate in plant mitochondria. Phytochemistry, 9: 2251-2256.

Swain T. and Hillis W. F. (1959). The quantitative analysis of phenolic constituent. J. Sci., Food Agric., 10:63-69.

Vogel A.J. (1975). A Text Book of Practical Organic Chemistry.3rd. ed. p.969-971, English Language Book Society and Longman Group Ltd. London.

إستجابة نبات الأونثيرا لمستويات مختلفة من الكمبوست مقارنة بالتسميد الكيميائى

هند مصطفى فهمى على سويفى و هناء فتوح يوسف محمد* و عبير عبد الرحمن محمود*

قسم بساتين الزينة – كلية الزراعة – جامعة القاهرة – الجيزة – مصر
*فرع فسيولوجيا النبات – قسم النبات الزراعى – كلية الزراعة– جامعة القاهرة

ملخص

تم معاملة نباتات الأونثيرا بالكمبوست كسماد عضوى مقارنة بالتسميد الكيميائى خلال موسمين متتالين ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ فى المشتل التجريبى بقسم بساتين الزينة– كلية الزراعة جامعة القاهرة. تم استخدام الكمبوست عند ثلاثة معدلات ٢م^{3} و٤م^{3} و٦م^{3}/ فدان بالإضافة الى ٥٠% من الأسمدة الكيميائية و عند ٤م^{3} و٨م^{3} و١٢م^{3}/ فدان بدون الأسمدة الكيميائية. زرعت البذور فى أصص فخار ٣٠سم مملؤة بتربة رملية. أشارت النتائج إلى أن إستخدام الكمبوست العضوى ٤م^{3}/ فدان و ٥٠% من الأسمدة المعدنية أعطى أفضل نموخضرى علاوة على ٣٠– ٥٠% زيادة في عدد الأزهار أكثر من السماد الكيميائى التقليدى. أدى استخدام الكمبوست عند ٤م^{3}/ فدان إلى تأثير فائق على زيادة نسبة الزيت الثابت بقيمة ٢,٩٧% فى الموسم الثانى. أظهر التحليل الكيميائى (باستخدام جهاز التحليل الغازي الكروماتوجرافي) للأحماض الدهنية المميثلة للأونثيرا ذات الأزهار الكبيرة *Oenothera biennis* var. *grandiflora* أن بها نفس الأحماض الدهنية المشبعة التى تحتويها الأونثيرا العادية *Oenothera biennis*. و كان حمض البالمتيك هو الحمض الدهنى الغالب الذى تراوح بين ٤,٤٥% فى نباتات معاملة بمعدل ٢م^{3} كمبوست/ فدان بالاضافة الى ٥٠% أسمدة كيميائية إلى ١٠,٨٨% مع ٤م^{3} كمبوست/ فدان بالاضافة الى ٥٠% أسمدة كيميائية. أدى إستخدام الكمبوست كسماد عضوى إلى زيادة ملحوظة فى الأحماض الدهنية الكلية غير المشبعة و كان حمض اللينوليك هو الحمض الدهنى غير المشبع الغالب تم الحصول أعلى قيمة من الأحماض الدهنية الكلية غير المشبعة عليها كانت (٨٥,٥٩%) مع معاملة ٨م^{3}/ فدان. أنتجت معاملات الأضافة بين التسميد الكيميائى و الكمبوست نباتات ذات تركيز عالى من السكريات الكلية مقارنة بالنباتات المعاملة بالكمبوست فقط. توضح البيانات أن كل مستويات الكمبوست تزيد من تركيز الفوسفور فى الأوراق و الجذور. و يمكن أن نستنتج من ذلك أن الكمبوست يحسن استجابة النبات وانتاجهوالنمو الخضرى.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (٥٩) العدد الرابع (أكتوبر ٢٠٠٨):٢٨١-٢٩٤ .