The impact of peat moss and sheep manure compost extracts on marigold (*Calendula officinalis* L.) growth and flowering

Alaa E. Hasan, Karim M. Bhiah* & Mushtaq T. H. Al-Zurfy
Faculty of Agriculture, University of Kufa, Iraq
** Corresponding author: kbhiah@gmail.com, karimm.bhiah@uokufa.edu.iq*

Abstract

A nursery experiment was carried out during 2011 - 2012 at Najaf, Iraq, to determine the response of marigold plant to organic fertilisers and their extracts. A factorial experiment was conducted involving three factors (2 x 4 x 2) namely, type of compost (the extracts of peat moss and sheep manure), concentrations of foliar application (0%, 20%, 40% and 60%), and the mixed in soil and foliar application. The results showed that the type of organic fertiliser and the application method significantly affected vegetative growth (leaf number/plant, shoot dry weight, leaf chlorophyll content, and carbohydrate leaf content), and flowers parameters (length of the flower stem, flower number/plant, and flower diameter). This study showed that compared to the other fifteen treatment conditions, the application of extract of sheep manure applied at 40% concentration and as a foliar spray produced superior results on both vegetative growth and flower parameters.

Keywords: Organic fertiliser, peat moss, sheep manure, Iraq.

Introduction

Marigold (*Calendula officinalis* L.) is an annual, herbaceous plant. It belongs to the family Asteraceae. Roots are a white yellowish to light brown color with a length of about 20 cm and a thickness of 7 mm and carry many root hairs. Stems are long and strong, 50 cm in length. Leaves are simple, elongated, spoon-shaped, dark green in color and 20 cm in length (Muley et al. 2009). The original home of the plant is the basin of the Mediterranean and it grows wild in southern and central Europe and the Netherlands. Marigold is the third most important cut flower in the global market after roses and carnations. The flowers of the plant come in different colours. They are in high demand inf the holiday season during Easter and Mother's Day (Biondo & Noland, 2000). Marigold flowers are a rich source of a natural yellow to orange dye, helenien (a dipalmitate ester of axanthophylls), which is in high demand by national and international companies, and this plant has been used for medicinal purposes (Ali & Hasan, 2013). The plant is also used as a spice and a tea (Ćetković, 2003; Isaac, 1994).

Flowering of marigold plants under short photo-periods, however there is a long flowering period. The plants can be used in various situations in the home garden and in landscaping. It is one of the best plants for rock gardens, borders, flower beds and balcony plantings (Golestani et al., 2013).

Organic farming is one of the practices to make the production system more sustainable without adverse effects on the natural resources and the environment (Kochakinezhad et al., 2014; Ram et al. 2014). It not only maintains soil fertility but also conserves soil moisture (Yadav et al., 2014). Many studies have demonstrated that organic residues can be used with outstanding results (e.g. Kononova, 1966; Tan, 1986). Organic fertilisers and their extracts enhance soil fertility via improved nutrient retention and cycling and also plays an essential role in growth and yield (Khalid & Shafei, 2005).

The use of organic matter plays an essential role in the growth and development of marigold plants (Elhindi, 2012). It positively affects vegetative growth parameters including plant height, stem diameter, fresh and dry shoot weight, as well as flower parameters, including flower number per plant, flower height, and flower size of the plant (Shadanpour, 2011), and it increases the availability and absorption of the essential nutrient elements, such as Fe^{2+}, Mg^{2+} and NH^{4+} cations, which are necessary for enzyme activation and chloroplast and chlorophyll formation (Elhindi, 2012).

Adding different organic fertilisers to the soil or to a plant as a foliar application resulted in increased growth and flowering characters of *Borago officialis* plant (Ezz El-Din & Hendawy, 2010). Application

of organic fertilisers or their extracts also have positive effects on plant growth, dry matter yield and root development (Gharib et al., 2008; Ram et al., 2014). Addition of cow manure vermicompost at the 40% level resulted in high growth values of marigold plant (Rahbari, 2013). The purpose of this study is to determine the effects of the type of organic matter (peat moss and sheep manure), concentration of organic matter extractions, and the application method, on improving the growth, flowering and flower qualities of marigold plants.

Materials and methods

Plants were grown at a private nursery at Najaf, Iraq during 2011-12. The soil was silt loam in texture with a pH of 5.6 and an electrical conductivity of 2 dS/m. Seeds were planted in treated soil in 150mm diameter plastic pots, 200 mm deep. Each pot contained 1kg soil with one plant. The experiment was conducted using completely randomised design with three replicates per treatment, with three factors tested:

* 2 types of organic matter (sheep manure and peat moss),
* 4 concentrations of each extract (0%, 20%, 40% and 60%), and
* 2 application methods (mixed with soil and spray).

Fertilisation with NPK fertiliser (10:10:17) at the level of 1 g/pot was applied for all treatments. At the end of the experiment on March 15, 2012, the following data were recorded:

(1) number of leaves (leaves/plant),
(2) dry weight of shoot (g),
(3) total chlorophyll content in leaves (mg/100 g fresh weight) by acetone (Goodwin, 1976),
(4) carbohydrates content in leaves (mg/ mg dry weight) were estimated according to Duboies (1956),
(5) length of flower stem (cm),
(6) number of flowers (flowers per plant),
(7) flower diameter (mm), and
(8) number of petals (petals per flower).

Pots were laid out in a factorial design according to Steel & Torrie (1980), and the data was analysed using analysis of variance with SAS software. Significant differences were accepted at $P < 0.05$ level of probability. Differences between means were determined using least significant differences (LSD).

Results and discussion

Number of leaves

The type of organic matter and the application method significantly ($P < 0.05$) affected the number of leaves per plant. The sheep manure increased the number of leaves by 36% over the control. Using the extract of sheep manure as a foliar application at the 40% level maximised the number of leaves to 76% over the control (Table 1). This increase could be due to the content of sheep manure of organic N and the immobilisation process rather than that the organic matter increased the availability of some nutrients in the soil (Sabey & Hat, 1975). According to Hocking & Steer (1982), nitrogen plays an important role in protein components and enzymes and organises hormone activity which is important in cell division and stimulates biological processes. This may account for the higher number of leaves in the plants that were treated by sheep manure.

Table 1. Effects of organic matter (OM) and application method with different concentrations on number of leaves per plant.

Type of OM	Concentration of application (%)	Application method		Average of concentration	Average of OM
		Soil mix	Spray		
Peat moss	0	23.67	21.00	21.92	25.54
	20	25.67	23.67		
	40	25.33	32.00	26.58	
	60	30.33	22.67		
Sheep manure	0	22.00	21.00	31.17	28.50
	20	26.33	30.67		
	40	30.33	37.00	28.42	
	60	36.00	24.67		
Average of application method		27.46	26.59		
LSD: OM = 1.3, concentration = 2.6, application method = 1.3, interaction = 3.7					

Shoot dry weight

Table 2 shows the effect of organic matter on shoot dry weight (SDW). The application of sheep manure showed an increase ($P < 0.05$) of 14% over the peat moss treatment. Addition of the sheep manure at the 40% level showed the highest increase of 79% as compared to the control. Shoot DW was significantly ($P < 0.05$) affected by the interaction between organic matter, the application method and the concentration, which may be due to the humus in the sheep manure which carries a negative charge and associated cations and soil particles making fixed aggregations, reducing soil bulk density, enhancing soil structure and water-air relationship that will positively affect the activity of soil organisms leading to enhance root growth, which could result in better extraction of water and nutrients from the soil occupied by the roots (FAO, 1977).

Table 2. Effects of organic matter (OM) and application method with different concentrations on shoot dry weight (g).

Type of OM	Concentration of application (%)	Application method		Average of concentration	Average of OM
		Soil mix	Spray		
Peat moss	0	5.85	6.11	5.57	6.20
	20	6.19	5.29		
	40	7.00	6.87	5.81	
	60	7.01	5.28		
Sheep manure	0	5.97	4.36	8.02	7.09
	20	5.91	5.84		
	40	7.28	10.95	7.17	
	60	9.52	6.88		
Average of application method		6.84	6.45		
LSD: OM = 0.4, concentration = 1.3, application method = 0.4, interaction = 2.4					

Leaf chlorophyll content

The effect of the type of organic matter and the application method on chlorophyll content in leaves is presented in Table 3. The extract of sheep manure increased ($P < 0.05$) chlorophyll by 3% compared with the peat moss treatment. Chlorophyll content in leaves showed a significant ($P < 0.05$) interaction between organic matter, application method and concentration. Due to this interaction, marigold gave the highest Chlorophyll content in leaves with sheep manure applied sprayed at 40% (76.9 mg/100 g fresh weight). According to Elhindi (2012) organic matter includes essential nutrients for plant growth which has a positive effect for chlorophyll molecules and chloroplast formation. Organic acids and carbon dioxide have a role in enhancing the availability of some nutrients such as Mg which plays an important role in the formation of the chlorophyll molecule.

Table 3. Effects of organic matter (OM) and application method with different concentrations on total leaf chlorophyll content (mg/100 g fresh weight).

Type of OM	Concentration of application (%)	Application method		Average of concentration	Average of OM
		Soil mix	Spray		
Peat moss	0	57.01	56.06	57.11	62.14
	20	57.28	62.75		
	40	64.81	64.38	60.16	
	60	72.68	62.18		
Sheep manure	0	56.28	59.11	66.86	63.74
	20	57.59	63.04		
	40	61.35	76.91	67.63	
	60	73.87	61.77		
Average of application method		62.61	63.27		
LSD: OM = 1.0, concentration = 2.5, application method = 1.0, interaction = 3.9					

Leaf carbohydrate content

Organic matter increased ($P < 0.05$) leaf carbohydrate content (Table 4). Sheep manure gave the highest rate (6.08 mg/g dry weight). Leaf carbohydrate content was significantly ($P < 0.05$) affected by the interaction between organic matter, application method and concentration. The magnitude of this increase was maximised in sheep manure at 40% concentration level as foliar application. It is believed that the fulvic acid consists of carbohydrate and amino acids (Chen et al., 2002) thus have these materials ready for absorption via the leaf surface. This result is in accordance with the findings of Tisdale et al. (1985) who reported that the addition of humic extracts increases the production of carbohydrates.

Table 4. Effects of organic matter (OM) and application method with different concentrations on leaf carbohydrate content (mg/g dry weight).

Type of OM	Concentration of application (%)	Application method		Average of concentration	Average of OM
		Soil mix	Spray		
Peat moss	0	4.17	4.37	4.22	5.17
	20	4.63	5.57		
	40	5.40	4.67	5.27	
	60	7.03	5.53		
Sheep manure	0	3.90	4.43	6.19	6.08
	20	4.93	5.93		
	40	5.63	9.07	6.83	
	60	8.13	6.63		
Average of application method		5.48	5.78		
LSD: OM = 0.3, concentration = 1.0, application method = 0.3, interaction = 1.8					

Length of flower stem

Flower stems of the plants was significantly ($P < 0.05$) influenced by the type of organic matter and the application method (Table 5). Peat moss addition increased the flower stem by 30% as compared to sheep manure. This may be because the organic extracts include organic N and increase the nutrient availability. This result coincides with that of Sabey & Hart (1975) who showed that the organic extract increased the nutrient availability.

Table 5. Effects of organic matter (OM) and application method with different concentrations on length of flower stem (cm).

Type of OM	Concentration of application (%)	Application method		Average of concentration	Average of OM
		Soil mix	Spray		
Peat moss	0	14.93	16.90	15.64	23.27
	20	16.53	17.77		
	40	17.17	19.23	18.10	
	60	19.67	17.93		
Sheep manure	0	15.10	15.63	19.63	17.93
	20	16.07	16.03		
	40	18.70	23.43	19.01	
	60	21.03	17.40		
Average of application method		17.40	18.04		
LSD: OM = 4, concentration = 5, application method = 4, interaction = 6					

Number of flowers per plant

The type of organic matter and the application method had a significant effect on the number of flowers per plant. The highest number (14.7) of flowers was in the pots treated with sheep manure. The number of flowers exhibited the maximal response with sheep manure applied at 40% as a foliar spray (Table 6). Increasing the number of flowers as a result of applying organic extracts (Shadanpour, 2011) may be due to the significant impact of the nutrients in the organic extracts in stimulating growth regulators, including auxins and gibberellins, that play an important role in increasing the proportion of the pollination through the control of transport nutrients toward the flowers (Sergeant, 1965).

Table 6. Effects of organic matter (OM) and application method with different concentrations on the number of flowers per plant.

Type of OM	Concentration of application (%)	Application method		Average of concentration	Average of OM
		Soil mix	Spray		
Peat moss	0	7.33	11.00	10.50	11.92
	20	9.33	12.67		
	40	14.33	14.00	11.83	
	60	16.00	10.67		
Sheep manure	0	12.00	11.67	15.83	14.67
	20	12.33	13.00		
	40	14.67	20.33	15.00	
	60	18.33	15.00		
Average of application method		13.04	13.54		
LSD: OM = 0.4, concentration = 1.0, application method = 0.4, interaction = 2.3					

Flower diameter

Flower diameter (cm) was affected by the type of organic matter and the application method (Table 7). Marginal increase in flower diameter occurred with added sheep manure. Flower diameter of marigold plant showed an increase of 84% due to the interaction effect between organic matter, application method and concentration (maximum at 40% sheep manure foliar application), as compared to the control treatment (water spray). The organic extracts increase plant growth and enhance the flower characteristics.

Table 7. Effects of organic matter (OM) and application method with different concentrations on flower diameter (cm).

Type of OM	Concentration of application (%)	Application method		Average of concentration	Average of OM
		Soil mix	Spray		
Peat moss	0	2.40	2.40	2.37	3.10
	20	2.70	2.87		
	40	3.23	4.30	2.80	
	60	3.47	3.47		
Sheep manure	0	2.43	2.23	3.73	3.16
	20	2.40	3.23		
	40	3.27	4.10	3.63	
	60	4.27	3.33		
Average of application method		3.02	3.24		
LSD: OM = 0.1, concentration = 0.8, application method = 0.1, interaction = 1.6					

Number of petals per flower

Table 8 shows the positive impact of the type of organic matter and the application method on the number of petals per flower; the response to sheep manure and peat moss was not significantly different as a main effect ($P > 0.05$). There was a significant ($P < 0.05$) interaction between organic matter, application method and concentration (maximum at 40% sheep manure foliar application), in the number of petals per flower. The number of petals showed an increase of 74% (in the 40% sheep manure foliar application treatment) compared with the control.

Table 8. Effects of organic matter (OM) and application method with different concentrations on the number of petals per flower.

Type of OM	Concentration of application (%)	Application method		Average of concentration	Average of OM
		Soil mix	Spray		
Peat moss	0	23.33	23.33	22.33	27.08
	20	24.33	25.67		
	40	28.33	32.67	24.75	
	60	30.33	28.67		
Sheep manure	0	21.00	21.67	31.83	28.08
	20	24.00	25.00		
	40	28.67	37.67	31.42	
	60	36.33	30.33		
Average of application method		27.04	28.13		
LSD: OM = 1.0, concentration = 3.0, application method = 1.0, interaction = 3.7					

Conclusion

The outcome from this experimental study is that it is reasonable to conclude that the application of organic extracts (both peat moss and sheep manure), increased the plant characteristics measured: number of leaves per plant, shoot dry weight, leaf chlorophyll content, carbohydrate leaf content, length of flower stem, number of flowers per plant, flower diameter and number of petals per flower. These increases were higher when using sheep manure extract (except length of flower stem) rather than peat moss. For the sixteen treatments (2 x 4 x 2) in this study, compared to the other treatments, the application of sheep manure extract at a concentration rate of 40% as a foliar spray resulted in superior growth values and flower parameters of marigold plants.

References

Ali, E. F. & Hassan, F. A. 2013. Impact of foliar application of commercial amino acids nutrition on the growth and flowering of *Tagetes erecta* L. plant. Journal of Applied Sciences Research, 9(1): 652-657.

Biondo, R. J. & Noland, D. A. 2000. Floriculture: From Greenhouse Production to Floral Design. Interstate Publishers, Danville.

Ćetković, G. S., Sonja, M. Đ., Jasna, M., Čanadanović-Brunet & Vesna, T. T. 2003. Thin-layer chromatography analysis and scavenging activity of marigold (*Calendula officinalis* L.) extracts. Acta Periodica Technologica, 34: 1-148.

Chen, J., Baohua, G., Eugene, J., Leboeuf, Hongjun, P. & Sheng, D. 2002. Spectroscopic characterization of the structural and functional properties of natural organic matter fractions Chemosphere, 48: 59-68.

Duboies, M., Gilles, K., Hamilton, J., Robers, R. & Smith, F. 1956. Colorimetric method for determination of sugar and related substance. Analytical Chemistry, 28: 350-356.

Elhindi, K. 2012. Evaluation of composted green waste fertigation through surface and subsurface drip irrigation systems on pot marigold plants (*Calendula officinalis* L.) grown on sandy soil. Australian Journal Crop Science, 6(8): 1249-1259.

Ezz EL-Din, A. & Hendawy, S. F. 2010. Effect of dry yeast and compost tea on growth and oil content of *Borago officinalis* plant. Research Journal of Agriculture and Biological Sciences, 6 (4): 424-430.

FAO 1977. Recycling of Organic Waste in Agriculture. FAO Soil Bulletin 40. United Nations Food and Agriculture Organization, Rome.

Golestani, M., Dolatkhahi, A. & Kazemi, F. 2013. Effect of planting dates on flowering period of *Calendula officinalis*, *Bellis perennis* and *Viola* sp. Advanced Crop Science, 3(8): 563-567.

Goodwin, T. W. 1976. Chemistry and Biochemistry of Plant Pigments. Academic Press, London.

Hocking, P.J. & Steer, B.T. 1982. Nitrogen nutrition of sunflower with special reference to nitrogen stress. Proceedings of 10th International Sunflower Conference, Surfers Paradise, March 1982. pp.73-75

Isaac, O. 1994. *Calendula officinalis* L. Die Ringelblum, portrait einer Arzeneipflanze. Zeitschrift Phytotherap., 16: 357-370.

Khalid, K. & Shafei, A. 2005. Productivity of dill (*Anethum graveolens* L.) as influenced by different organic manure rates and sources. Arab Universities Journal of Agricultural Sciences, 13(3): 901-913.

Kochakinezhad, H., Peyvat, Gh., Kashi, A., Olfati, J & Asadi, A. 2006. A comparison of organic and chemical fertilizers for tomato production. Journal of Organic Systems. 7(2): 14–25.

Kononova , M.M. 1966. Soil Organic Matter: its Nature, its Role in Soil Formation and in Soil Fertility. Pergamon Press, Oxford.

Muley, B., Khadabadi, S. & Banarase, N. 2009. Phytochemical constituents and pharmacological activities of *Calendula officinalis* Linn (Asteraceae) a review. Tropical Journal of Pharmaceutical Research, 8(5): 455-465.

Pamela, R. & Benny, F. 2005. Genetic engineering and organic production systems. California organic program. www.calfao.ca.gof/is/iandc.

Pyeatt, L. & Kretchun, T. 1984. Calendula as a warm season cut flower or landscape plant. Flower and nursery report for commercial growers - California University, Berkeley, Agricultural Extension Service, USDA, 5-6.

Rahbarl, M., Omidi, M. & Shahram, S. 2013. Organic transplant production of pot marigold in vermicompost-amended medium. Journal of Applied Science and Agriculture, 8(5): 548-55.

Ram, M; Davari, M. and Sharma, S. N. 2014. Direct, residual and cumulative effects of organic manures and biofertilizers on yields, NPK uptake, grain quality and economics of wheat (*Triticum aestivum* L.) under organic farming of rice-wheat cropping system. Journal of Organic Systems. 9(1): 16-30.

Sabey, B.R. & Hart, W.E. 1975. Land application of sewage sludge. Effect on growth and chemical composition of plant. Journal of Environmental Quality, 4: 252-256

Sergeant, J.A. 1965. The penetration of growth regulators into leaves. Annual Review of Plant Physiology, 16: 1-2.

Shadanpour, F., Mohammadi., T.A. & Hashemi, M.K. 2011. The effect of cow manure vermicompost as the planting medium on the growth of marigold. Annals of Biological Research, 2(6): 109-115.

Steel, R. & Torrie, J. 1980. Principles and Procedures of Statistics. McGraw Hill, New York.

Tan, K. 1986. Degradation of soil minerals by organic acids. In: Huang, P.M. & Schnitzer, M. (eds.) Interaction of Soil Minerals with Natural Organic and Microbes. Soil Science Society America, Madison.

Tisdale, S., Nelson , L.W.L., Beaton , J.D. & Havlin, J. 1997. Soil Fertility and Fertilisers, Prentice Hall, New York.

Yadav, D., Sood, P., Thakur, S., & Choudary, K. 2013. Assessing the training needs of agricultural extension workers about organic farming in the North-Western Himalayas. Journal of Organic Systems, 8(1):17-27