Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864 **doi: 10.21608/SJFOP.2023.316711**

IMPACT OF VERMICOMPOST AND BENZYLADENINE ON GERANIUM PLANTS QUALITY

Boshra A. El-Sayed, T.M. Noor El-Deen, Randa I. Diab and O.A. Abdelsadek

Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., Agric. Res. Center, Egypt

Scientific J. Flowers & Ornamental Plants, 10(2):151-161 (2023).

Received:
15/4/2023
Accepted:
3/5/2023

Corresponding author:
Randa I. Diab
randa_ebrahem@yahoo.com

ABSTRACT: This experiment was conducted in 2021 and 2022 seasons at the experimental nursery of Hort. Res. Inst., ARC, Giza, Egypt with the aim to investigate the influence of vermicompost at 0, 5 and 10 g/pot as a soil addition before planting and benzyladenine (BA) as a foliar spray at 0, 500 and 1000 mg/l five times individually or in a combination on vegetative growth, flowering and some chemical contents of *Pelargonium zonale* plants. Both vermicompost and BA treatments produced the highest values in most studied traits. As for the effect of interaction treatments, soil addition of vermicompost at 10 g/pot and foliar spraying with BA at 1000 mg/l was the most effective treatment for enhancing plant height (cm), branches and leaves number, root length (cm), fresh and dry weights of vegetative growth, and roots (g), number of flowers/plant, flowering stem length (cm), fresh and dry weights of flowers as well as total chlorophylls (mg/g f.w.), total carbohydrates, N, P and K percentages in both seasons. So, it is recommended to apply the interaction treatment of vermicompost at 10 g/pot as a soil addition and BA at 1000 mg/l as a foliar spray to enhance all vegetative growth, rooting, flowering and chemical constituents of *Pelargonium zonale* plants.

Keywords: *Pelargonium zonale*, vermicompost, BA, vegetative growth, flowering, chemical constituents

INTRODUCTION

Pelargonium zonale L. (Fam. Geraniaceae) is native to southern Africa. It can grow up to 1 meter tall in ideal conditions but can reach heights of up to 3 meters in suitable conditions. The leaves are large and palmately nerved, with a characteristic dark horseshoe-shaped mark. The branches are succulent and hairy when young, but become woody with age. The flowers are borne in clusters and can be pink, red, white, or bicolor (Turner, 1997). The *Pelargonium* genus is most commonly used for ornamental purposes. They are often grown in pots or other types of containers and can be used to brighten up a home or garden (White, 1993). Pelargonium species are grown for their colorful flowers, fragrant foliage, and exotic leaf shapes. In terms of ornamental purposes, the zonal hybrids are the most important members of the *Pelargonium* genus. Geraniums account for a significant portion of the market demand (Horn, 1994). Geraniums are propagated, either by seeds or by vegetative methods (White, 1993).

Vermicompost is a bio-fertilizer with eco-friendly, ecological and cost-effective properties. It also enhances the soil biology, chemistry and physics. Vermicompost improves the soil's physical properties such as aggregation, structure and aeration. It also provides nutrients in forms that plants can use, such as nitrates, phosphates, calcium and potassium. Vermicompost boosts the soil's microbial diversity, population and activity. It also increases the soil's ability to retain moisture. Vermicompost is rich in vitamins, enzymes and hormones that are beneficial for

plants. It also promotes the growth and activity of earthworms in the soil (Singh *et al*., 2010). Vermicomposting is a process of composting organic waste using earthworms. It has been shown to be effective in processing a variety of materials e.g. sewage sludge and wastewater solids, materials from breweries, waste of paper, residues of urban and wastes of food and animal (Olle, 2019). Vermicompost could be applied not only on food crops but also on ornamental plants as reported by Cruz *et al.* (2018) on gladiolus, Moghimi *et al.* (2018) on smoke tree (*Cotinus coggygria* Scop.), Karagöz *et al.* (2019) on gladiolus, Sendhilnathan *et al.* (2020) on *Dianthus caryophyllus* L. 'White Liberty', Rashidha *et al.* (2021) on *Aglaonema commutatum* 'Silver Frost' and Ashour *et al.* (2023) on *Calliandra haematocephala*

Besides the organic compounds that occur naturally inside the plant body that called hormones, there are other modifiers of plant development are synthesized by chemists and utilized commercially. All of the products, either naturally occurring or commercially synthesized, are given the name of growth regulators. Cytokinins are one of these compounds with the principal role of the plant involving division and many other plant growth processes (Ingels, 2010). Baghele *et al.* (2016) on *Rosa hybrida* 'Poison', Singh and Bala (2018) on chrysanthemum, Tandel *et al.* (2018) on *Adhatoda zeylanica*, Alwan and Sadiq (2019) on *Ranunculus asiaticus*, Yoon *et al.* (2019) on three Hosta taxa, Kaya *et al.* (2019) on gerbera, El-Ghait *et al.* (2020) on *Jasminum sambac*, Ashour *et al.* (2020) on *Dracaena marginata*, Saadawy *et al.* (2020) on *Rhaphiolepis umbellate*, Kasem and Helaly (2021) on *Syngonium podophyllum*, Wang *et al.* (2022) on *Rosa hybrida* 'Carolla' and Ara *et al.* (2023) on chrysanthemum.

The aim of this study was to investigate the effect of vermicompost and benzyladenine (BA) application on vegetative growth, flowering and chemical contents of *Pelargonium zonale* as a pot plant.

MATERIALS AND METHODS

A pot experiment was carried out at the experimental nursery of Horticulture Research Institute, ARC, Giza, Egypt during 2021 and 2022 seasons to investigate the influence of vermicompost at 0, 5.0 and 10.0 g/pot as a soil drench before planting and BA as a foliar spray at 0, 500 and 1000 mg/l concentrations, individually or in a combination on the performance of *Pelargonium zonale* L. plants.

Plant material:

On March 15th of both seasons, three-month-old geranium transplants were planted in plastic pots with 20 cm diameter filled with a mixture of clay and sand in a 1:1 ratio by volume (about 2.5 kg of growing medium and one transplant per pot). The specifications of the medium used are shown in Table (a).

Experimental layout:

The transplants were arranged in a two factor completely randomized design as described by Gomez and Gomez (1984). Vermicompost represented factor A with three levels, while BA foliar spraying represented factor (B) with three levels. So, this experiment contained nine treatments each one had three replicates with nine transplants/replicate.

Treatments:

Three levels of vermicompost (0.0, 5.0 and 10.0 g/pot) were mixed with the pot

Table a. The physical and chemical analyses of the used sand and clay.

Soil type	Particle size distribution (%)				S.P.	pH	E.C. (dS/m)	Cations (meq/l)				Anions (meq/l)		
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Sand	80.70	10.31	1.35	7.64	22.72	7.76	2.31	15.42	6.97	15.64	0.62	2.43	9.15	22.04
Clay	7.09	20.33	31.96	40.62	40.22	8.04	2.20	10.16	4.72	16.99	0.59	5.54	5.68	20.43

growing medium once before planting. While, benzyladenine (BA) was applied as a foliar spray till run-off at three levels (0, 500 and 1000 mg/l), five times at monthly intervals beginning after one month from transplanting (in mid-April). The combined treatments between vermicompost and BA were applied to form 9 treatments. Both vermicompost (commercial product in fine granules form) and BA were obtained from commercial producers in Egypt.

Data recorded:

At the end of this study (mid of September) the following data were recorded: plant height (cm), number of branches and leaves, root length (cm), fresh and dry weights of vegetative growth, and roots (g). Also, the number of flowers, flowering stem length (cm), and fresh and dry weights of flowers were recorded.

At the end of the second season, samples of fresh and healthy leaves were collected from the plants' middle part to determine total chlorophylls (a + b) and carotenoids (mg/g f.w.) as described by Wellburn and Lichtenthaler (1984), while in dry leaves sample, the percentages of total carbohydrates, N, P and K were determined according to Herbert *et al.* (1971), Jackson (1973), Cottenie *et al.* (1982) and Jackson (1973), respectively.

Statistical analysis:

Analysis of variance (ANOVA) for the two factor completely randomized design model (according to Gomez and Gomez, 1984) by using the MSTAT-C computer software package was utilized for analyzing the obtained data. While to compare means, Duncan's multiple range tests (Duncan, 1955) was used to compare the obtained means.

RESULTS AND DISCUSSION

1. Effect of vermicompost:

It is clear that all studied traits were affected positively by vermicompost application (Tables, 1 and 2). The highest level of vermicompost at 10 g/pot produced the highest values in terms of vegetative growth characteristics with the highest significant values as recorded 18.81 and 22.22 cm for plant height, 3.22 and 3.56 for number of branches, 10.67 and 12.67 for number of leaves, 12.51 and 15.21 cm for root length, 16.30 and 19.72 g for fresh weight of vegetative growth, 8.12 and 9.77 g for dry weight of vegetative growth, and 11.23 and 13.69 g for roots fresh weight and 6.00 and 7.36 g for roots dry weight in both seasons, respectively.

The same trend was observed in the case of flowering parameters (Table, 3), as the highest significant values were obtained by 10 g/pot recording 2.00 and 2.44 flowers/plant, 9.07 and 10.99 for flowering stem length, 4.34 and 5.28 for fresh weight of flower and 1.99 and 2.39 for dry weight flower in both seasons, respectively.

As for the response of chemical constituents to different vermicompost levels, it is obvious in Table (4) that the application of vermicompost at 10 g/pot resulted in the highest values of total chlorophylls (1.075 mg/g f.w.), carotenoids (0.291 mg/g f.w.), total carbohydrates (12.14%), N (2.18%), P (0.48%) and K (2.05%).

2. Effect of benzyladenine:

Foliar spraying with benzyladenine at 1000 mg/l resulted in the highest values for all studied traits (Tables, 1-3). The recorded values were 21.24 and 25.37 cm for plant height, 4.11 and 4.67 for number of branches, 12.11 and 14.33 for number of leaves, 13.76 and 16.72 cm for root length, 19.49 and 23.58 g for fresh weight of vegetative growth, 9.20 and 11.15 g for dry weight of vegetative growth, and 12.62 and 15.39 g for roots fresh weight, 5.38 and 6.54 g for roots dry weight, 2.67 and 3.33 flowers/plant, 10.77 and 13.03 for flowering stem length, 4.98 and 6.01 for flower fresh weight and 2.31 and 2.80 for flower dry weight.

The same results were obtained by the same concentration (1000 mg/l) on all studied chemical constituents (Table, 4). The values were 1.210 mg/g f.w. for total chlorophylls,

Table 1. Effect of vermicompost and foliar spraying with benzyladenine and their interaction on some vegetative growth and root characteristics of *Pelargonium zonale* during the first and second seasons.

Benzyladenine (B)	Vermicompost (A)							
	Cont.	Verm. 5 g/pot	Verm. 10 g/pot	Means (B)	Cont.	Verm. 5 g/pot	Verm. 10 g/pot	Means (B)
	1st season				2nd season			
				Plant height (cm)				
BA 0.0 mg/l	13.67 f	14.17 f	14.67 ef	14.17 c	16.73 g	16.67 g	17.33 fg	16.91 c
BA 500 mg/l	15.37 de	16.37 d	17.60 c	16.44 b	18.33 ef	19.30 de	20.67 cd	19.43 b
BA 1000 mg/l	18.40 c	21.17 b	24.17 a	21.24 a	22.17 c	25.27 b	28.67 a	25.37 a
Means (A)	15.81 c	17.23 b	18.81 a		19.08 c	20.41 b	22.22 a	
				No. branches				
BA 0.0 mg/l	1.33 f	1.67 ef	2.00 d-f	1.67 c	1.67 e	1.67 e	2.00 de	1.78 c
BA 500 mg/l	2.33 c-e	2.67 b-d	3.00 bc	2.67 b	2.33 de	2.33 de	3.00 cd	2.56 b
BA 1000 mg/l	3.33 b	4.33 a	4.67 a	4.11 a	3.67 bc	4.67 ab	5.67 a	4.67 a
Means (A)	2.33 b	2.89 a	3.22 a		2.56 b	2.89 ab	3.56 a	
				No. leaves				
BA 0.0 mg/l	7.00 g	7.67 fg	8.00 ef	7.56 c	8.00 g	8.67 fg	9.33 ef	8.67 c
BA 500 mg/l	8.67 de	9.00 d	10.33 c	9.33 b	10.00 de	10.33 d	12.33 c	10.89 b
BA 1000 mg/l	11.00 bc	11.67 b	13.67 a	12.11 a	13.00 bc	13.67 b	16.33 a	14.33 a
Means (A)	8.89 c	9.44 b	10.67 a		10.33 b	10.89 b	12.67 a	
				Root length (cm)				
BA 0.0 mg/l	8.60 g	9.47 f	10.27 e	9.44 c	10.64 g	11.61 fg	12.37 ef	11.54 c
BA 500 mg/l	10.37 e	11.20 d	12.03 c	11.20 b	12.75 de	13.63 d	14.73 c	13.70 b
BA 1000 mg/l	12.27 c	13.77 b	15.23 a	13.76 a	14.84 c	16.79 b	18.53 a	16.72 a
Means (A)	10.41 c	11.48 b	12.51 a		12.74 c	14.01 b	15.21 a	

Mean values by the same letter do not significantly differ according to Duncan's multiple range test at 5% level of probability.

Table 2. Effect of vermicompost and foliar spraying with benzyladenine and their interaction on fresh and dry weights of vegetative growth and roots of *Pelargonium zonale* during the first and second seasons.

Benzyladenine (B)	Vermicompost (A)							
	Cont.	Verm. 5 g/pot	Verm. 10 g/pot	Means (B)	Cont.	Verm. 5 g/pot	Verm. 10 g/pot	Means (B)
	1st season				2nd season			
	F.W. vegetative growth (g)							
BA 0.0 mg/l	10.07 g	11.27 fg	11.80 e-g	11.04 c	12.21 g	13.44 fg	14.58 ef	13.41 c
BA 500 mg/l	12.47 ef	13.20 de	14.37 d	13.34 b	15.13 ef	16.16 de	17.19 d	16.16 b
BA 1000 mg/l	16.70 c	19.03 b	22.73 a	19.49 a	20.06 c	23.29 b	27.38 a	23.58 a
Means (A)	13.08 c	14.50 b	16.30 a		15.80 c	17.63 b	19.72 a	
	F.W. roots (g)							
BA 0.0 mg/l	6.33 f	7.13 e	8.20 d	7.22 c	7.55 f	8.72 e	9.95 d	8.74 c
BA 500 mg/l	10.87 c	11.73 b	11.93 b	11.51 b	13.08 c	14.27 b	14.44 b	13.93 b
BA 1000 mg/l	11.97 b	12.33 b	13.56 a	12.62 a	14.60 b	14.89 b	16.68 a	15.39 a
Means (A)	9.72 c	10.40 b	11.23 a		11.75 c	12.63 b	13.69 a	
	D.W. vegetative growth (g)							
BA 0.0 mg/l	4.97 h	5.57 gh	6.03 fg	5.52 c	6.01 g	6.82 fg	7.24 f	6.69 c
BA 500 mg/l	6.40 ef	6.87 de	7.57 cd	6.94 b	7.84 ef	8.42 de	9.14 cd	8.47 b
BA 1000 mg/l	8.00 c	8.83 b	10.77 a	9.20 a	9.82 bc	10.69 b	12.94 a	11.15 a
Means (A)	6.46 c	7.09 b	8.12 a		7.89 c	8.64 b	9.77 a	
	D.W. roots (g)							
BA 0.0 mg/l	3.10 g	3.30 fg	3.53 ef	3.31 c	3.72 h	4.01 gh	4.27 fg	4.00 c
BA 500 mg/l	3.70 e	4.03 d	4.33 d	4.02 b	4.56 ef	4.85 de	5.24 d	4.88 b
BA 1000 mg/l	4.83 c	5.30 b	6.00 a	5.38 a	5.80 c	6.46 b	7.36 a	6.54 a
Means (A)	3.88 c	4.21 b	4.62 a		4.69 c	5.11 b	5.62 a	

Mean values by the same letter do not significantly differ according to Duncan's multiple range test at 5% level of probability.

Table 3. Effect of vermicompost and foliar spraying with benzyladenine and their interaction on some flowering characteristics of *Pelargonium zonale* during the first and second seasons.

Benzyladenine (B)	Vermicompost (A)							
	Cont.	Verm. 5 g/pot	Verm. 10 g/pot	Means (B)	Cont.	Verm. 5 g/pot	Verm. 10 g/pot	Means (B)
	1st season				2nd season			
				No. flowers				
BA 0.0 mg/l	0.33 g	0.67 fg	1.00 e-g	0.67 c	0.33 f	0.67 ef	1.00 d-f	0.67 c
BA 500 mg/l	1.33 d-f	1.67 c-e	2.00 b-d	1.67 b	1.67 c-f	2.00 b-e	2.33 b-d	2.00 b
BA 1000 mg/l	2.33 a-c	2.67 ab	3.00 a	2.67 a	2.67 a-c	3.33 ab	4.00 a	3.33 a
Means (A)	1.33 b	1.67 ab	2.00 a		1.56 b	2.00 ab	2.44 a	
				Flowering stem length (g)				
BA 0.0 mg/l	5.37 g	5.87 g	6.77 f	6.00 c	6.53 f	7.04 f	8.28 e	7.28 c
BA 500 mg/l	7.57 e	7.97 de	8.37 d	7.97 b	9.31 d	9.72 d	10.12 d	9.72 b
BA 1000 mg/l	9.47 c	10.77 b	12.07 a	10.77 a	11.42 c	13.10 b	14.56 a	13.03 a
Means (A)	7.47 c	8.20 b	9.07 a		9.09 c	9.95 b	10.99 a	
				F.W. flowers (g)				
BA 0.0 mg/l	1.00 e	2.03 de	3.30 cd	2.11 c	1.21 e	2.47 de	3.98 cd	2.55 c
BA 500 mg/l	3.33 cd	3.80 bc	4.03 bc	3.72 b	4.04 cd	4.73 bc	4.96 bc	4.58 b
BA 1000 mg/l	4.23 a-c	5.00 ab	5.70 a	4.98 a	5.10 a-c	6.05 ab	6.89 a	6.01 a
Means (A)	2.86 b	3.61 ab	4.34 a		3.45 b	4.41 ab	5.28 a	
				D.W. flowers (g)				
BA 0.0 mg/l	0.40 f	0.83 ef	1.30 de	0.84 c	0.50 f	1.02 ef	1.55 de	1.02 c
BA 500 mg/l	1.47 cd	1.53 cd	1.87 b-d	1.62 b	1.80 cd	1.87 cd	2.25 b-d	1.97 b
BA 1000 mg/l	1.93 bc	2.20 ab	2.80 a	2.31 a	2.33 bc	2.70 ab	3.38 a	2.80 a
Means (A)	1.27 b	1.52 b	1.99 a		1.54 b	1.86 b	2.39 a	

Mean values by the same letter do not significantly differ according to Duncan's multiple range test at 5% level of probability.

Table 4. Effect of vermicompost and foliar spraying with benzyladenine and their interaction on some chemical constituents of *Pelargonium zonale* during the first and second seasons.

Benzyladenine (B)	Vermicompost (A)							
	Cont.	Verm. 5 g/pot	Verm. 10 g/pot	Means (B)	Cont.	Verm. 5 g/pot	Verm. 10 g/pot	Means (B)
	Total chlorophyll (mg/g f.w.)				Carotenoids (mg/g f.w.)			
BA 0.0 mg/l	0.460 i	0.977 h	0.984 g	0.807 c	0.176 h	0.170 i	0.257 f	0.201 c
BA 500 mg/l	1.005 f	1.016 e	1.044 d	1.022 b	0.264 e	0.209 g	0.303 d	0.259 b
BA 1000 mg/l	1.072 c	1.091 b	1.198 a	1.120 a	0.354 b	0.362 a	0.314 c	0.344 a
Means (A)	0.846 c	1.028 b	1.075 a		0.265 b	0.247 c	0.291 a	
	Total carbohydrates (%)				N (%)			
BA 0.0 mg/l	8.90 i	8.99 h	9.21 g	9.03 c	2.08 i	2.10 h	2.12 g	2.10 c
BA 500 mg/l	10.22 f	10.99 e	11.38 d	10.86 b	2.13 f	2.16 e	2.17 d	2.15 b
BA 1000 mg/l	12.28 c	14.28 b	15.82 a	14.13 a	2.19 c	2.21 b	2.24 a	2.21 a
Means (A)	10.47 c	11.42 b	12.14 a		2.13 c	2.16 b	2.18 a	
	P (%)				K (%)			
BA 0.0 mg/l	0.40 i	0.41 h	0.43 g	0.42 c	1.78 i	1.80 h	1.81 g	1.80 c
BA 500 mg/l	0.44 f	0.45 e	0.46 d	0.45 b	1.99 f	2.11 d	2.14 b	2.08 b
BA 1000 mg/l	0.52 c	0.54 b	0.56 a	0.54 a	2.05 e	2.13 c	2.19 a	2.12 a
Means (A)	0.45 c	0.47 b	0.48 a		1.94 c	2.01 b	2.05 a	

Mean values by the same letter do not significantly differ according to Duncan's multiple range test at 5% level of probability.

0.344 mg/g f.w. for carotenoids, 14.13% for total carbohydrates, 2.21% for N, 0.54% for P and 2.12% for K.

3. Effect vermicompost × benzyladenine:

The interaction between vermicompost and benzyladenine was significant on vegetative growth traits (Tables, 1 and 2), the mastery was to the combined treatment of vermicompost at 10 g/pot + BA at 1000 mg/l as recorded the highest values (24.17 and 28.67 cm for plant height, 4.67 and 5.67 for the number of branches, 13.67 and 16.33 for number of leaves, 15.23 and 18.53 cm for root length, 22.73 and 27.38 g for fresh weight of vegetative growth, 10.77 and 12.94 g for dry weight of vegetative growth, and 13.56 and 16.68 g for roots fresh weight and 6.00 and 7.36 g for roots dry weight) in both seasons, respectively.

The same trend was observed in the case of flowering parameters (Table, 3), as the highest significant values were obtained by 10 g/pot recording 3.00 and 4.00 flowers/plant, 12.07 and 14.56 for flowering stem length, 5.70 and 6.89 for flower fresh weight and 2.80 and 3.38 for flower dry weight in both seasons, respectively.

On the other hand, the combined treatment comprised vermicompost at 10 g/pot + BA at 1000 mg/l resulted in the

highest values for total chlorophylls (1.198 mg/g f.w.), total carbohydrates (15.82%), N (2.24%), P (0.56%) and K (2.19%). The exception in this regard was for carotenoids content which recorded the highest value (0.362 mg/g f.w.) by the combined treatment comprised of vermicompost at 5 g/pot + BA at 1000 mg/l.

Similar results were obtained by many authors regarding the positive effect of vermicompost e.g. Cruz *et al.* (2018) on gladiolus, Moghimi *et al.* (2018) on smoke tree (*Cotinus coggygria* Scop.), Karagöz *et al.* (2019) on gladiolus, Sendhilnathan *et al.* (2020) on *Dianthus caryophyllus* L. 'White Liberty', Rashidha *et al.* (2021) on *Aglaonema commutatum* 'Silver Frost' and Ashour *et al.* (2023) on *Calliandra haematocephala.*

To explain the positive role of vermicompost on plant growth Singh *et al.* (2020) reported that vermicompost can be used as a soil additive to enhance the growth and development of horticultural crops due to its ability to supply plants with nutrients in available forms, e.g. nitrates, exchangeable P, K, Ca and Mg as well as, it also has plant growth regulators. Also, Olle (2016) confirmed this role and emphasized that vermicompost is rich in macro- and micro-nutrients, beneficial soil microorganisms such as bacteria which are utilized in fixing nitrogen and solubilizing phosphate, humus, auxins, cytokinins and gibberellins. As well as it has very high porosity, aeration, drainage and water-holding capacity.

In accordance with the obtained results exerted from this study, benzyladenine showed a great influence on the vegetative growth, flowering and chemical composition of *Pelargonium zonale.* Similar findings were reported in this regard, e.g. Currey and Erwin (2012) on 11 species of Kalanchoe, Carey *et al.* (2013) on *Salvia nemorosa* L. 'Caradonna', Baghele *et al.* (2016) on *Rosa hybrida* 'Poison', Abd Al Lateef and Hade (2018) on *Viola tricolor*, Singh and Bala (2018) on chrysanthemum, Tandel *et al.* (2018) on *Adhatoda zeylanica*, Alwan and Sadiq (2019) on *Ranunculus asiaticus*, Kaya *et al.* (2019) on gerbera, El-Ghait *et al.* (2020) on *Jasminum sambac*, Ashour *et al.* (2020) on *Dracaena marginata*, Saadawy *et al.* (2020) on *Rhaphiolepis umbellate*, Kasem and Helaly (2021) on *Syngonium podophyllum*, Wang *et al.* (2022) on *Rosa hybrida* 'Carolla' and Ara *et al.* (2023) on chrysanthemum. In this concern, Lee (2005) found that BA at 1500 mg/l was required to produce the highest number of branches of *Ardisia pusilla*, Grossman *et al.* (2015) demonstrated that BA at 600 ppm increased number of branches and flowers of three Echinacea cultivars, Kaya *et al.* (2019) showed that BA at 400 ppm application significantly increased stem diameter, Yoon *et al.* (2019) on three Hosta taxa reported that the highest number of leaves was obtained by applying BA at 1000 to 3000 mg/l.

All positive effects of BA could be attributed to its role in regulating cell division and proliferation, releasing the buds from inhibition, controlling apical dominance and the metabolism of carbohydrates by activating specific enzymes and enhancing RNA and protein production (Hopkins and Huner, 2009). This could also be, attributed to the stimulating effects on cell division and elongation, shoot initiation, nutrient mobilization, delaying of senescence and alternation apical dominance in plants (Werner and Schmülling, 2009).

In conclusion, it is recommended to apply the interaction treatment of vermicompost at 10 g/pot as a soil addition and BA at 1000 mg/l as a foliar spray to enhance all vegetative growth, rooting, and flowering parameters as well as chemical constituents of *Pelargonium zonale* grown as a pot plant.

REFERENCES

Abd Al Lateef, S. and Hade, S. (2018). The effect of foliar applications with gibberellic acid and benzyladenine on vegetative and floral growth of pansy plant (*Viola tricolor*). Journal of Agriculture and Veterinary Science, 11(3):12-17.

Alwan, N.M. and Sadiq, S.M. (2019). Influence of tuberous root soaking in Salicylic acid and foliar spray of plants with Benzyladenine on growth, flowering and tuberous root production of *Ranunculus asiaticus*. Plant Archives, 19(2):4137-4142.

Ara, K.A.; Kabir, K.; Rashid, M.T.; Sharifuzzaman, S.M. and Sadia, M.A. (2023). Influence of foliar application of growth regulators on vegetative growth and flowering of chrysanthemum. Bangladesh Journal of Agricultural Research, (47)1:69-80.

Ashour, H.A., Heider, S.M., and Soliman, M.M. (2023). Morphological and physiological responses of *Calliandra haematocephala* to water salinity stress and vermicompost. Ornamental Horticulture, 29(2):150-162.

Ashour, H.A.; El-Attar, A.B.E. and Wahab, M.M.A. (2020). Combined effects of NPK fertilizer with foliar application of benzyladenine or gibberellic acid on *Dracaena marginata* 'Bicolor' grown in different potting media. Ornamental Horticulture, 26(4):545-561.

Baghele, R.D.; Dhaduk, B.K.; Chawla, S.L. (2016). Effect of foliar spray of growth regulators and cow urine on flowering, quality and yield of rose (*Rosa hybrida*) cv. Poison under naturally ventilated polyhouse. International Journal of Tropical Agriculture, 34(6):1555-1558.

Carey, D.J.; Fair, B.A.; Buhler, W.; McCall, I. and Whipker, B.E. (2013). Growth control and flower promotion of Salvia with benzyladenine foliar sprays. Journal of Applied Horticulture, 15(2):87-89.

Cottenie, A.; Verloo, M.; Kiekns, L.; Velghe, G. and Comer-lynek, R. (1982). Chemical analysis of plants and soil. Laboratory of Analytical and Agrochemistry, State University, Ghent, Belgium, 63 p.

Cruz, L.R.D.D., Ludwig, F., Steffen, G.P.K., and Maldaner, J. (2018). Development and quality of gladiolus stems with the use of vermicompost and *Trichoderma sp*. in substrate. Ornamental Horticulture, 24:70-77.

Currey, C.J. and Erwin, J.E. (2012). Foliar applications of plant growth regulators affect stem elongation and branching of 11 *Kalanchoe* species. HortTechnology, 22(3):338-344.

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

El-Ghait, E.M.A.; Youssef, A.S.M.; Mohamed, Y.F.Y.; Noor El-Deen, T.M. and Mohamed, H.I. (2020). Effect of benzyladenine and chemical fertilization on growth, flowering and chemical composition of *Jasminum sambac* plant. Scientific Journal of Flowers and Ornamental Plants, 7(4):379-391.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for agricultural research. John Wiley and Sons, New York, USA, 680 p.

Grossman, M.C.; Aiken, M.; Scoggins, H. and Latimer, J. (2015). Plant growth regulators affect branching and flowering in three Echinacea cultivars. Proc. the 42nd Annual Meeting of the Plant Growth Regulation Society of America, Kona, Hawaii, USA, pp. 127-133.

Herbert, D.; Phipps, P.J. and Strange, R.E. (1971). Chemical analysis of microbial cells. In: Norris, J.R. and Ribbons, D.W. (eds), Methods in Microbiology, Academic Press, USA, 5(8):209-344.

Hopkins, W.G. and Huner, N.P.A. (2009). Introduction to Plant Physiology, 4th Edition. John Wiley and Sons, Inc., USA, 528 p.

Horn, W. (1994). Interspecific crossability and inheritance in Pelargonium. Plant Breeding, 113(1):3-17.

Ingels, J.E. (2010). Ornamental Horticulture: Principles and Practices. Delmar, Cengage Learning, New York, USA, 687 p.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice-Hall of India Private Ltd. M-97, New Delhi, India, 498 p.

Karagöz, F.P.; Dursun, A.; Tekiner, N.; Kul, R. and Kotan, R. (2019). Efficacy of vermicompost and/or plant growth promoting bacteria on the plant growth and development in gladiolus. Ornamental horticulture, 25:180-188.

Kasem, M.M. and Helaly, A.A.E. (2021). Response of *Syngonium podophyllum* plant to some synthetic cytokinin types and concentrations as a foliar application. Scientific Journal of Flowers and Ornamental Plants, 8(3):321-334.

Kaya, A.S.; Aydinşakir, K. and Karagüzel, Ü.Ö. (2019). Assessment of GA_3 and BA application on gerbera cultivation in soilless culture. International Journal of Agriculture Environment and Food Sciences, 3(1):41-45.

Kaya, A.S.; Aydİnșakİr, K.; Karagüzel, Ü.Ö. (2019). Assessment of GA_3 and BA application on gerbera cultivation in soilless culture. International Journal of Agriculture, Environment and Food Sciences, 3(1):41-45

Lee, C.H. (2005). The use of 6-benzylaminopurine for lateral branching of *Ardisia pusilla*. Horticulture Environment and Biotechnology, 46(6):396-401.

Moghimi, B.A., Dehestani Ardakani, M., Shirmardi, M., and Momenpour, A. (2018). Effects of cow manure and vermicompost on growth characteristics of smoke tree (*Cotinus coggygria* Scop.) under salt stress under greenhouse. Iranian Journal of Forest and Poplar Research, 26(4):483-495.

Olle, M. (2016). The effect of vermicompost based growth substrates on tomato growth. Journal of Agricultural Science, 1(27):38-41.

Olle, M. (2019). Vermicompost, its importance and benefit in agriculture. Journal of Agricultural Science, 2:93-98.

Rashidha, C.K.; Sankar, M.; Sreelatha, U.; Anupama, T.V. and Prameela, P. (2021). Standardization of soilless growth media for raising potted ornamental foliage plants for export purpose. Journal of Tropical Agriculture, 59(1):118-123.

Saadawy, F.M.; El-Fouly, A.S.; Sayed, A.W. (2020). Effect of some hormonal treatments on growth and chemical composition of *Rhaphiolepis umbellata* shrub. Scientific Journal of Flowers and Ornamental Plants, 7(1):45-52.

Sendhilnathan, R.; Rakshana, J.; Rajkumar, M.; Sureshkumar, R. and Sivasankar, S. (2020). Effect of growing media and gibberellic acid on growth and yield of carnation (*Dianthus caryophyllus* L.) cv. white liberty. Plant Archives, 20(2):9525-9529.

Singh, A.; Omran, E.S. and Singh, G.S. (2020). Vermicomposting impacts on agriculture in Egypt. In: Omran, E.S. and Negm, A. (eds), Technological and Modern Irrigation Environment in Egypt, Springer Cham., Switzerland, pp. 181-203.

Singh, B.; Pathak, K.; Boopathi, T. and Deka, B. (2010). Vermicompost and NPK fertilizer effects on morpho-physiological traits of plants, yield and quality of tomato fruits (*Solanum lycopersicum* L.). Journal of Fruit and Ornamental Plant Research, 73(1):77-86.

Singh, T. and Bala, M. (2018). Effect of foliar spray of benzyl adenine, gibberellic acid and putrescine on post-harvest keeping quality of chrysanthemum. Agricultural Research Journal, 55(2):386-388.

Tandel, M.H.; Animasaun, D.A. and Ramar, K. (2018). Growth and phytochemical composition of *Adhatoda zeylanica* in response to foliar application of growth hormones and urea. Journal of Soil Science and Plant Nutrition, 18(3):881-892.

Turner, R.G. (1997). Botanica: The Most Complete Garden Encyclopedia Ever

Published. Barnes and Noble Books, New York, USA, 1007 p.

Wang, K.X.; Shen, Y.X.; Wang, H.; He, S.L.; Kim, W.S.; Shang, W.Q.; Wang, Z. and Shi, L.Y. (2022). Effects of exogenous salicylic acid (SA), 6-benzylaminopurine (6-BA), or abscisic acid (ABA) on the physiology of *Rosa hybrida* 'Carolla' under high-temperature stress. Horticulturae, 8(9):1-17.

Wellburn, A.R. and Lichtenthaler, H. (1984). Formulae and program to determine total carotenoids and chlorophylls a and b of leaf extracts in different solvents. Advanced Agricultural Biotechnology, 2(1):9-12.

Werner, T., Schmülling, T. (2009). Cytokinin action in plant development. Current Opinion in Plant Biology, 12(5):527-538.

White, J.W. (1993). Geraniums IV: The Grower's Manual. Batavia, Illinois, Ball. Pub., USA, 412 p.

Yoon, S.; Kim, Y.; Ryu, S.; Choi, H.; Kim, S. and Lee, S. (2019). Concentration and timing of exogenous foliar spray of benzyladenine and ethephon influence crown bud formation in three Hosta taxa. Horticultural Science and Technology, 37(5):559-570.

تأثير الفيرميكمبوست و البنزايل آدينين على جودة نباتات الجارونيا

بشره عبدالله السيد، طارق محمد نور الدين، أوسامة أحمد عبد الصادق، راندا إبراهيم دياب
قسم بحوث الزينه وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر

تم إجراء هذه التجربة خلال موسمي ٢٠٢١ و ٢٠٢٢ بمشتل معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر لدراسة تأثير الفيرميكمبوست بتركيز صفر، ٥ و ١٠ جم/اصيص كإضافة أرضية قبل الزراعة و بنزايل الآدينين كرش ورقي بتركيزات صفر، ٥٠٠ و ١٠٠٠ ملجم/لتر خمس مرات بفواصل زمنية مدتها شهر وكذلك معاملات التداخل بينهما على النمو والإزهار والمحتوى الكيماوي لنباتات الجارونيا المزروعة في أصص. أظهرت النتائج التي تم الحصول عليها أن كلاً من معملات الفيرميكمبوست وبنزايل الآدينين أحدثت أعلى القيم في معظم القياسات تحت الدراسة. معاملة التداخل بين الفيرميكمبوست بتركيز ١٠ جم/اصيص + بنزايل الآدينين بتركيز ١٠٠٠ ملجم/لتر كانت أكثر المعاملات تأثيراً حيث سجلت أعلى القيم لأغلب القياسات تحت الدراسة (ارتفاع النبات، عدد الأفرع والأوراق، طول الجذر، الأوزان الطازجة والجافة للمجموع الخضري والجذري، عدد الأزهار/نبات، طول الحامل الزهري، الوزن الطازج والجاف للأزهار، الكلوروفيلات الكلية، محتوى النبات من الكربوهيدرات الكلية، النيتروجين، الفوسفور والبوتاسيوم) في كلا موسمي الدراسة. لذلك فإنه يوصى بتطبيق الإضافة الأرضية بالفيرميكمبوست بتركيز ١٠ جم/اصيص كإضافة أرضية بالإضافة إلى الرش الورقي ببنزايل الآدينين بتركيز ١٠٠٠ ملجم/لتر خمس مرات بفواصل زمنية مدتها شهر لتحسين مواصفات النمو الخضري والزهري والمحتوى الكيماوي لنباتات الجارونيا المزروعة بالأصص.