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Response of Vegetative Growth of Snapdragon Grown in Sandy Soil to Organic and Inorganic Fertilization

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ABSTRACT

This research was take place during the two successive growing seasons of 2022/2023 and 2023/2024, at the Floriculture Farm, Faculty of Agriculture, Minia University, to evaluate the effect of compost percentages (0, 5, 10 and 20 %, w/w) and mineral fertilization treatments (5.5, 11 and 16.5 g NPK/pot, 25 cm diameter) as well as their interactions on vegetative growth parameters of *Antirrhinum majus*, L.

All percentages of compost significantly increased vegetative growth parameters (plant height, stem diameter, number of branches and leaves/plant, leaf area, and plant and root system fresh and dry weights) relative to untreated plants. In all cases, 20% compost was significantly superior to other used treatments.

Mineral treatments significantly increased all aforementioned characters facing the check treatment. In all cases, the treatment of high dose, followed by medium dose gave high values without significant differences between them.

The best interaction treatment was supplying snapdragon plants with 20% compost in combination with 16.5 or 11 g mineral NPK/pot.

KEYWORDS: compost, mineral fertilization, snapdragon, vegetative growth.

1. INTRODUCTION

Antirrhinum majus L. commonly known as snapdragon or dog flower and in Egypt, it is called Hanak ElSabaa and it is belongings to the Scrophulariaceae family, is a perennial species indigenous to the Mediterranean area. In horticultural practices, however, it is often regarded as an annual plant, particularly when cultivated in gardens, as noted by Gleason and Cronquist in 1991.

Numerous researchers have focused on investigating the impact of organic fertilizers on various aspects of plant development, including growth. Organic matter plays a crucial role in this context, as it significantly influences the availability of nutrients for plants. Its properties enhance the nutrient content of the soil, facilitating absorption by plants, which in turn positively influences their growth and overall development (Tisdale *et al.*, 1997). In accordance with this interpretation those reported by Mjeed and Ali (2017), Sabah *et al.* (2019) and Mohamed and Elagabain (2021) *Antirrhinum majus*; Abdou *et al.* (2023a) on cineraria; Abdou *et al*. (2023b) on calendula and Singh *et al*. (2023) on chrysanthemum.

Mineral fertilization (NPK) is a vital role for plant growth if it added in adequate amount as such three macro-elements greatly influence growth. Nitrogen is a crucial macronutrient for plants, significantly influencing their growth. It is an essential component of nucleic acids and protoplasm, and it may enhance the synthesis of proteins, carbohydrates and amino acids. These compounds are vital for the production of phytohormones such as auxins, gibberellins, and cytokinins, which play a key role in promoting plant development. Phosphorus is an Important element that significantly influences plant growth and metabolic functions. It is integral to various physiological processes within plants, including energy metabolism, the formation of nucleic acids and cellular membranes, photosynthesis, respiration, nitrogen fixation, and the regulation of enzymes. Sufficient phosphorus availability is essential for promoting numerous developmental aspects of plants, such as root growth. Research indicates that the combination of phosphorus and potash leads to an optimal increase in nutrient absorption, primarily due to enhanced photosynthetic activity and facilitates the movement of sugars resulting from increased chlorophyll production and a larger leaf area (Belorker *et al*., 1992 and Ram, 2017).

This goal of this research was to study the effect of compost and mineral-NPK fertilization on the vegetative growth parameters of *Antirrhinum majus* L.

2. MATERIALS AND METHODS

This research was conducted over the two seasons of 2022/2023 and 2023/2024 at the Floriculture Farm of the Faculty of Agriculture, Minia University. The objective was to assess the effects of organic fertilization (compost) and inorganic fertilization (mineral) along with their interactions on the vegetative growth parameters of the *Antirrhinum majus*, L. plant.

Seedlings of snapdragon, measuring an average height of 5 cm and possessing three leaves, were transplanted on December 15th during the two growing seasons of 2022/2023 and 2023/2024. These seedlings were placed in plastic pots with a diameter of 25 cm, each filled with 4.30 kg of sandy soil. Initially, two seedlings were allocated per pot, but this was reduced to one seedling per pot after a two-week period. The physical and chemical characteristics of the soil utilized in this study were performed according to ICARDA (2013) and listed in Table (a).

The study was designed with 16 treatments, organized in a 4 x 4 configuration, and implemented as a split plot within a completely randomized design, featuring three replications. Each treatment comprised four pots, each containing four plants. The primary plots were designated for the four compost treatments (0, 5, 10 and 20% w/w), while the four mineral fertilization treatments (0, 5.5, 11 and 16.5 g NPK/ pot, 20:20:20) were assigned to the sub-plots.

Table a. The physical and chemical analyses of the sand soil used in the study.

Soil character	Values		Soil Character	Values	
	2022/2023	2023/2024		2022/2023	2023/2024
Physical properties:					
Sand (%)	92.22	93.40	**Total N (%)**	0.01	0.01
Silt (%)	6.68	5.13	**Available P (ppm)**	2.34	2.15
Clay (%)	1.10	1.47	**Extractable K (mg/100 g soil)**	0.63	0.69
Soil type	Sandy	Sandy			
Chemical properties:			**DTPA-Extractable nutrients:**		
pH (1:2.5)	8.24	8.39	**Fe (ppm)**	0.98	0.94
E.C. (dS/m)	1.22	1.24	**Cu (ppm)**	0.28	0.35
O.M. (%)	0.01	0.01	**Zn (ppm)**	0.29	0.26
$CaCO_3$ (%)	14.17	14.78	**Mn (ppm)**	0.46	0.57

Compost was incorporated into the experimental treatments during the pot filling process across two growing seasons. The physio-chemical characteristics of the compost (according to ICARDA, 2013), as indicated on the factory label, are detailed in Table (b).

Table b. The physio-chemical characteristics of the used compost* in the study during the two growing seasons.

Properties	Value	Properties	Value
Organic carbon (%)	26.7	Total P (%)	0.6
Humidity (%)	24	Total K (%)	1.2
Organic matter	46	Fe (ppm)	271
C/N ratio	15.7	Zn (ppm)	63
pH (1:2.5)	8.1	Mn (ppm)	128
E.C. (m. mhos/cm.)	5.2	Cu (ppm)	209
Total N (%)	1.7		

* Compost was supplied from El-Nile Factory (Egyptian company specializing in solid waste management)

Mineral fertilization was conducted utilizing a commercial formulation of Active Top, which comprises a balanced ratio of nitrogen, phosphorus, and potassium (N:P:K) at 20:20:20. This product was produced by the Ismailia for Chemical Manufacturing Company. The application of the treatments occurred on three separate occasions, with intervals of ten days commencing on January 10th.

At the end of the experiment of each season (first week of May), the vegetative growth parameter [plant height (cm), stem diameter (cm), number of branches and leaves per plant, leaf area (cm^2), and plant and root system fresh and dry weights (g)] were recorded.

Statistical analysis

The results obtained were organized into tables and subjected to statistical analysis using MSTAT–C (1986). Subsequently, the LSD test at a significance level of 0.05 was employed to compare the means of the different treatments.

3. RESULTS AND DISCUSSION

3.1. Vegetative growth parameters:

Data presented in Tables (1, 2 and 3) revealed that all percentages of compost (5, 10 and 20%, w/w) led to considerable increase in all studied vegetative growth parameters, via, plant height, stem diameter, number of branches and leaves/plant, leaf area and plant and root system fresh and dry weights facing untreated plants (control group) during both seasons. The highest overall values were obtained with 20% compost in both seasons. Such superior treatment increased all vegetative growth over the control by 18.73, 22.33, 18.38, 19.06, 18.53, 22.16, 22.13, 41.27 and 41.26% for plant height, stem diameter, number of branches, number of leaves, leaf area, plant fresh weight, plant dry weight, root system fresh and root system dry weight in the first season. Similar trends were observed in the second one.

Incorporating organic waste into the soil enhances its organic matter content and boosts both the population and activity of microorganisms. This practice also ensures a continuous supply of nutrients, thereby restoring the nutrient balance within the soil. Consequently, the organic matter introduced serves as an excellent resource for supplying nutrients to plants while simultaneously minimizing nutrient loss through leaching, as these nutrients are adsorbed onto the surfaces of the organic particles (Al-Showily and Hussein, 2022).

Our results go parallel with those obtained by Mjeed and Ali (2017), Mohamed and Elagabain (2021) and Sabah *et al*. (2019) on snapdragon; Sharifian *et al*. (2014) and Abdou *et al*. (2023b) on calendula; Marashi *et al*. (2021) on zinnia plant; Kumar *et al*. (2022) on gladiolus; Abdou *et al*. (2023a) on cineraria; Nair *et al*. (2023) on *Tagetes patula*; Malik *et al*. (2023), Mann *et al*. (2023) and Shalaby *et al*. (2023) on *Tagets erecta*; and Singh *et al*. (2023) on chrysanthemum.

With respect to mineral fertilization, data in the same Tables demonstrated that all tested abovementioned parameters were significantly increased due to supplying *Antirrhinum majus* with 5.5, 11 and 16.5 g NPK/pot as compared to control in both seasons. It is noticed that the increase in the mineral fertilization doses led to augmenting aforementioned parameters without significant differences between the high and medium dose of NPK mineral fertilization. So, the medium dose of mineral fertilization significantly increased over the control by 15.21, 26.26,

Table 1. Response of plant height, stem diameter and branches number/plant of snapdragon to compost percentages, mineral fertilization and their interactions in the two growing seasons (2022/2023 and 2023/2024).

Mineral fertilization treatments (g/pot)	Compost percentages treatments (A)									
	0%	5%	10%	20%	Mean (B)	0%	5%	10%	20%	Mean (B)
	The 1st season (2022/2023)					The 2nd season (2023/2024)				
	Plant height (cm)									
Control	53.1	57.3	60.2	63.2	58.5	54.2	58.4	61.4	64.5	59.6
5.5 g NPK	55.7	60.1	63.1	65.1	61.0	56.8	61.3	64.4	66.4	62.2
11 g NPK	60.7	65.6	69.5	73.7	67.4	61.9	66.9	70.9	75.2	68.7
16.5 g NPK	63.1	68.2	72.3	74.5	69.5	64.4	69.6	73.7	76.0	70.9
Mean (A)	58.2	62.8	66.3	69.1		59.3	64.1	67.6	70.5	
L.S.D. at 5 %	A: 2.8		B: 2.2		AB: 4.4	A: 2.9		B: 2.3		AB: 4.6
	Stem diameter (cm)									
Control	0.88	0.96	1.03	1.08	0.99	0.91	0.99	1.06	1.11	1.02
5.5 g NPK	0.97	1.06	1.13	1.19	1.09	1.00	1.09	1.16	1.23	1.12
11 g NPK	1.12	1.22	1.30	1.37	1.25	1.15	1.26	1.34	1.41	1.29
16.5 g NPK	1.15	1.24	1.31	1.38	1.27	1.18	1.28	1.35	1.42	1.31
Mean (A)	1.03	1.12	1.19	1.26		1.06	1.15	1.23	1.29	
L.S.D. at 5 %	A: 0.05		B: 0.03		AB: 0.06	A: 0.06		B: 0.04		AB: 0.08
	Branches number/plant									
Control	16.2	17.6	18.5	19.1	17.9	16.6	18.0	19.0	19.6	18.3
5.5 g NPK	21.4	23.3	24.5	25.3	23.6	21.9	23.9	25.1	25.9	24.2
11 g NPK	28.0	30.5	32.1	33.0	30.9	28.7	31.3	32.9	33.8	31.7
16.5 g NPK	28.1	30.7	32.3	33.3	31.1	28.8	31.5	33.1	34.1	31.9
Mean (A)	23.4	25.5	26.9	27.7		24.0	26.2	27.5	28.4	
L.S.D. at 5 %	A: 0.8		B: 0.3		AB: 0.6	A: 0.9		B: 0.3		AB: 0.6

72.62, 9.23, 35.40, 34.31, 40.35, 184.53 and 166.26% in the first season for plant height, stem diameter, number of branches, number of leaves, leaf area, plant fresh weight, plant dry weight, root system fresh and root system dry weight, respectively. Similar trends were recorded in the second one.

It is interesting to observed that *Antirrhinum majus* responded to mineral fertilization without significant between 11 and 16.5 g NPK/pot, so, my advance to use the middle dose to reduce the environmental pollution. The ionic equilibrium within the soil plays a crucial role in providing essential nutrients for plant growth, while simultaneously reducing the need for extensive mineral fertilizers. This balance mitigates nutrient deficiencies and contributes to stronger root development by promoting increased dry weight and the growth of lateral roots. Additionally, it enhances the protein content of the plants and fosters a rise in soil microorganisms, as noted by Al-Khafajy *et al*. (2020) and Hussein *et al*. (2021).

Similar results on snapdragon were clarified by Mjeed and Ali (2017), Malik *et al*. (2019), Abd El Gayed and Knany (2020), Mohamed and Elagabain (2021) and Gulmezoglu *et al*. (2024); and on other ornamental plants such as *Dahlia spp.* (Ahmed *et al*., 2004); *Dianthus caryophyllus* (El-Naggar and El-Sayed, 2008); *Tagets spp.* (Bi *et al*., 2010 and Shyala *et al*., 2019); *Calendula officinalis* (Hashem, 2016); *Polianthes tuberosa* (Nain *et al*., 2018) and freesia (Altaee and Alsawaf, 2021).

The interaction effect between compost percentages and mineral fertilization treatments was significant for all vegetative growth parameters in both seasons. The highest values were obtained with compost at 20% plus 11 or 16.5 g NPK/pot in both seasons.

Table 2. Response of leaves number/plant, leaf area and plant fresh weight of snapdragon to compost percentages, mineral fertilization and their interactions in the two growing seasons (2022/2023 and 2023/2024).

Mineral fertilization treatments (g/pot)	Compost percentages treatments (A)									
	0%	5%	10%	20%	Mean (B)	0%	5%	10%	20%	Mean (B)
	The 1st season (2022/2023)					The 2nd season (2023/2024)				
Leaves number/plant										
Control	320.6	346.5	367.3	382.0	354.1	328.3	354.8	376.1	391.2	362.6
5.5 g NPK	334.7	361.5	383.2	398.5	369.5	342.7	370.2	392.4	408.1	378.3
11 g NPK	350.4	378.4	401.2	417.2	386.8	358.8	387.5	410.8	427.2	396.1
16.5 g NPK	353.8	382.1	405.0	421.2	390.5	362.3	391.3	414.7	431.3	399.9
Mean (A)	339.9	367.1	389.2	404.7		348.0	375.9	398.5	414.4	
L.S.D. at 5 %	A: 15.5		B: 5.1		AB: 10.2	A: 15.8		B: 4.2		AB: 8.4
Leaf area (cm^2).										
Control	3.93	4.25	4.5	4.71	4.35	4.01	4.34	4.59	4.80	4.43
5.5 g NPK	4.9	5.29	5.61	5.83	5.41	5.00	5.40	5.72	5.95	5.52
11 g NPK	5.33	5.75	6.11	6.35	5.89	5.44	5.87	6.23	6.48	6.00
16.5 g NPK	5.47	5.78	6.05	6.39	5.92	5.58	5.90	6.17	6.52	6.04
Mean (A)	4.91	5.27	5.57	5.82		5.01	5.37	5.68	5.94	
L.S.D. at 5 %	A: 0.24		B: 0.05		AB: 0.10	A: 0.25		B: 0.06		AB: 0.12
Plant fresh weight (g).										
Control	43.48	47.39	50.71	53.25	48.71	44.57	48.57	51.98	54.58	49.93
5.5 g NPK	54.80	59.73	63.94	67.14	61.40	56.17	61.22	65.54	68.82	62.94
11 g NPK	58.40	63.66	68.11	71.52	65.42	59.86	65.25	69.81	73.31	67.06
16.5 g NPK	59.75	65.11	69.58	72.47	66.73	61.24	66.74	71.32	74.28	68.40
Mean (A)	54.11	58.97	63.09	66.10		55.46	60.45	64.66	67.75	
L.S.D. at 5 %	A: 2.90		B: 1.32		AB: 2.34	A: 3.08		B: 1.36		AB: 2.72

Table 3. Response of plant dry weight, root system fresh weight and root system dry weight of snapdragon to compost percentages, mineral fertilization and their interactions in the two growing seasons (2022/2023 and 2023/2024).

Mineral fertilization treatments (g/pot)	Compost percentages treatments (A)									
	0%	5%	10%	20%	Mean (B)	0%	5%	10%	20%	Mean (B)
	The 1st season (2022/2023)					The 2nd season (2023/2024)				
Plant dry weight (g).										
Control	8.70	9.48	10.14	10.65	9.74	8.96	9.76	10.45	10.97	10.03
5.5 g NPK	11.23	12.24	13.11	13.76	12.59	11.57	12.61	13.50	14.18	12.97
11 g NPK	12.21	13.30	14.23	14.95	13.67	12.57	13.70	14.66	15.39	14.08
16.5 g NPK	12.49	13.61	14.54	15.15	13.95	12.86	14.01	14.98	15.60	14.36
Mean (A)	11.16	12.16	13.01	13.63		11.49	12.52	13.40	14.04	
L.S.D. at 5 %	A: 0.61		B: 0.30		AB: 0.60	A: 0.63		B: 0.29		AB: 0.58
Root system fresh weight (g).										
Control	30.01	36.02	39.25	42.39	36.92	30.76	36.92	40.23	43.45	37.84
5.5 g NPK	50.91	61.09	66.59	71.92	62.63	52.18	62.62	68.25	73.72	64.19
11 g NPK	85.39	102.47	111.69	120.63	105.05	87.52	105.03	114.48	123.65	107.67
16.5 g NPK	86.10	103.32	112.62	121.63	105.92	88.25	105.90	115.44	124.67	108.57
Mean (A)	63.10	75.73	82.54	89.14		64.68	77.62	84.60	91.37	
L.S.D. at 5 %	A: 6.78		B: 1.11		AB: 2.22	A: 6.75		B: 1.15		AB: 2.30
Root system dry weight (g).										
Control	9.30	11.17	12.17	13.14	11.44	9.23	11.08	12.07	13.03	11.35
5.5 g NPK	16.29	19.55	21.31	23.01	20.04	15.65	18.79	20.48	22.12	19.26
11 g NPK	24.76	29.72	32.39	34.98	30.46	26.26	31.51	34.34	37.09	32.30
16.5 g NPK	24.97	29.96	32.66	35.27	30.72	26.48	31.77	34.63	37.40	32.57
Mean (A)	18.83	22.60	24.63	26.60		19.40	23.29	25.38	27.41	
L.S.D. at 5 %	A: 1.92		B: 0.55		AB: 1.10	A: 2.01		B: 0.64		AB: 1.28

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الملخص العربي

استجابة النمو الخضري لنبات حنك السبع المنزرع في التربة الرملية للتسميد العضوي وغير العضوي

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تم إجراء هذا البحث خلال موسمي النمو المتتاليين ٢٠٢٢/٢٠٢٣ و ٢٠٢٣/٢٠٢٤، بمزرعة نباتات الزينة بكلية الزراعة جامعة المنيا، لتقييم تأثير نسبة الكمبوست (٠ – ٥ – ١٠ – ٢٠٪، وزن/وزن) ومعاملات التسميد المعدني (٥.٥ – ١١ – ١٦.٥ جم NPK / أصيص، قطر ٢٥ سم) وكذلك التفاعلات بينهما على صفات النمو الخضري لنبات حنك السبع *Antirrhinum majus*.

أدت جميع نِسب الكمبوست المستخدمة إلى زيادة معنوية في صفات النمو الخضري (ارتفاع النبات، قُطر الساق، عدد الفروع والأوراق / نبات، مساحة الورقة، والأوزان الطازجة والجافة للنبات وللجذر) مقارنة بالنباتات غير المعاملة. في جميع الحالات، تفوقت معاملة إضافة الكمبوست بنسبة ٢٠٪ بشكل ملحوظ على جميع المعاملات الأخرى المستخدمة.

أدت معاملات التسميد المعدني إلى زيادة معنوية في جميع الصفات المذكورة أعلاه مقارنة بمعاملة الكنترول. وفي جميع الحالات أعطت معاملة التركيز العالي تليها معاملة التركيز المتوسط قيماً مرتفعة دون فروق معنوية بينهما.

وكانت أفضل معاملة تفاعل هي إمداد نباتات حنك السبع بـ ٢٠٪ كمبوست مع ١٦.٥ أو ١١ جرام NPK معدني/أصيص.

الكلمات المفتاحية: الكمبوست، التسميد المعدني، حنك السبع، النمو الخضري.