

# EFFECT OF SPRAYING WITH SALICYLIC ACID AND THE LEAVES EXTRACT OF MORINGA ON THE VEGETATIVE AND FLOWERING GROWTH OF COMMON SNAPDRAGON (*Antirrhinum majus* L.)

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## ABSTRACT

The experiment was conducted in the winter season 2020-21 in the lath house belonging to the College of Agriculture / University of Basra. The study targeted the effect of spraying with salicylic acid (SA) at a concentration of (0, 70, 140 mg.L<sup>-1</sup>) and Moringa leaf extract at a concentration of (0, 10, 20) g L<sup>-1</sup> in the vegetative and flowering growth of *Antirrhinum majus* L. The results showed that spraying with salicylic acid at a concentration of 140 mg L<sup>-1</sup> and Moringa leaf extract, at a concentration of 20 g L<sup>-1</sup> was significantly excelled in most of the studied traits and included (plant height, stem diameter, number of leaves, leaf area, fresh and dry weights of vegetative growth, number of florets, length of inflorescences and flowering period. The fresh and dry weights of the florets, the number of roots, and the soft and dry weights of the root system compared to the control plants. The effect of the interaction between the two factors was significant in most of the studied traits. (plant height 29.83 cm, stem diameter 3.29 mm , number of leaves 122.33 leaves.plant<sup>-1</sup>, leaf area 21.94 cm<sup>2</sup>, fresh and dry weights of vegetative growth (21.53, 3.70 g), number of florets 12.97 florets, length of inflorescences 10.17 cm and flowering period 31.67 day, The fresh and dry weights of the florets (4.41,0.72 g), the number of roots 49..67 root.plant<sup>-1</sup>, and the fresh and dry weights of the root system(2.15,0.78 g) compared to the control plants.

**Keywords:** *Antirrhinum majus*; salicylic acid; moringa leaf extract.

## INTRODUCTION

*Antirrhinum majus* is a widespread ornamental plant in gardens, because of suitability of its

flowers for cutting. The genus *Antirrhinum* is a member of the family Scrophulariaceae. One of the most important and widespread species is *Mijus* [1], it's a perennial herbaceous plant and is

treated as a winter annual plant. The plant is standing, some of its cultivars may reach a height of 0.5-100 cm, It is branched from the base of the stem, its leaves are oval, simple, with a tapered edge, are petiole, and its flowers are in spike inflorescences that open from the flowering to the top, and single or double florets, including pink, yellow, red, and purple [2,3] seeds in a very small oval, black capsule [4], inflorescences are harvested when half to one-third of the florets open. Salicylic acid (SA) is due to a wide range of plant phenols obtained from many plant sources and the starting compound for salicylic acid for its production inside plants is Cinnamic acid. [5,6] and it is one of the plant hormones because of its physiological roles in the growth and flowering of plants and the absorption of ions where it affects the movement of stomata and the production of ethylene [7,8]. It also works to accelerate the formation of chlorophyll and carotene pigments, accelerate photosynthesis and increase the activity of some important enzymes [9]. The concentration of 10 mg L<sup>-1</sup> significantly increased the number of leaves [10] showed that spraying *Tagetes erects* with SA resulted in a significant increase in fresh and dry weights and root length, Al-Taey et al., [11] mention that Salicylic acid has been alleviated the negative effect of Salinity furthermore, Salicylic acid has been improving all studied growth indicators, [12] mention to the role of Salicylic acid is considered a growth regulator affecting the biological processes within plants including the activity of the anti-oxidation enzymes. [13] indicated that *Narcissus poeticus* was sprayed with SA at concentrations of (0, 20, 40, 80) mg. L<sup>-1</sup>, where the concentration was 80 mg.L<sup>-1</sup> of it significantly increased plant height and leaf area, The percentage of chlorophyll, the fresh weight, the number of flowers, the diameter of the flower, the number of bulbs, and the fresh and dry weights of the bulbs. [14] indicated that spraying chrysanthemum plants *Calendula officinalis* L. with salicylic acid in three concentrations (0, 60, 120) mg.L<sup>-1</sup> resulted in a concentration of 120 mg.L<sup>-1</sup> to significantly increase the vegetative growth which included (Plant height, number of lateral branches, main stem diameter, fresh and dry weights of the vegetative growth), Also, there was a significant increase in the trait of flowering growth, which included (the number of inflorescences, the diameter of the flower stalk,

the number of petals and the diameter of inflorescences) compared to the control plants, [15] indicated that treatment of *Eruca sativa* L. plant with 10 mg.L<sup>-1</sup> of (SA) led to a significant increase in growth parameters.

Plant extracts contain many nutrients that are important for the growth and production of other plants, where they participate in the metabolic processes [16]. The lack of these elements causes a physiological imbalance as a result of the nutritional imbalance that occurs due to environmental conditions, soil quality, or fertilization methods [17]. The *Moringa oleifera* Lam belongs to the Moringaceae family, which is native to the Himalayas in northwestern India, and it is a nutritious plant that has medicinal, agricultural and industrial uses [18]. The importance of using moringa leaves is due to their high concentrations of compounds and nutritional components, where it contains high amounts of proteins and antioxidant compounds such as phenols and vitamins B1, B2, B3, and C [17] and also contains nutrients such as calcium, potassium, iron and phosphorous. Copper, sulfur, magnesium, sodium and zinc [18].

Moringa leaf extract has different effects on biological and physiological activities of the plant, where it works to accelerate the growth of young plants, strengthen plants, improve plant resistance to insects and diseases, increase the number of roots and extend the life of the leaf, as well as its role in increasing growth indicators such as plant height and leaf area, total number of leaves of the plant, the fresh and dry weights, the number of branches, the length of the roots and the strength of the seedling when adding Moringa leaf extract at different levels [19].

This study aims to know the effect of spraying with salicylic acid and Moringa leaf extract on the vegetative and flowering traits of *Antirrhinum majus* L.

## MATERIALS AND METHODS

The experiment was conducted in green house of the College of Agriculture, Basra University in 2020-21 The seeds were sown on October 1, 2020 with 209 pits in Staedopur plates and dimensions

(2.5 x 1 x 7 cm) after filling them with peat moss. Then the seedlings were transferred after the formation of four real leaves on them after a month had passed from cultivation to larger pots with different sizes. Table 1 shows some of the physical and chemical traits of the soil used in the experiment. All plants used in the experiment were fertilized with N-P-K (20-20-20) neutral fertilizer at a concentration of 1 g L<sup>-1</sup>, at an average of 150 ml plant<sup>-1</sup> once every 10 days. the fertilization come to an end when beginning of the formation of the flower bud. The experiment included a study of the effect of two factors, namely:

**First: spraying with salicylic acid at concentrations that are:**

- A- Control: distilled water plus three drops of the diffuser (Tween 20).
- B- 70 mg L<sup>-1</sup>: 70 mg of salicylic acid was weighed and dissolved in 5 ml of ethanol alcohol, the volume was then completed to a liter of distilled water with the addition of three drops of the diffuser (Tween 20).
- C- 140 mg. L<sup>-1</sup>: 140 mg of salicylic acid was weighed and dissolved in a little ethyl alcohol, then the volume was completed to a liter of distilled water with the addition of three drops of the diffuser (Tween 20).

**Second: spraying with Moringa leaf extract at concentrations that are:**

- A- Control: The spray was sprayed with distilled water plus three drops of the diffuser (Tween 29)
- A- B - 10 g. L<sup>-1</sup>.
- B- 20 g. L<sup>-1</sup>.

Dry Moringa leaves were brought from one of the nurseries and crushed, then the weights of 10 and 20 g were taken from them, and one liter of distilled water was added to each of them at a temperature of 50 degrees Celsius and put at room temperature 25 degrees Celsius for a period of 24 hours. Include three drops of the diffuser (Tween 20). After a week of cultivation in the pots, salicylic acid and moringa leaf extract were used by spraying the leaves of the plants until complete wetness using a manual sprinkler with a capacity of 2 L. It was sprayed early in the morning on the

Vegetative growth with three sprays, and the period between one spray and another was 15 days.

**Table 1. Some of the physical and chemical properties of the soil used in the experiment**

Unites	Values	Properties
dS.m <sup>-1</sup>	1.40	Electrocardiogram (EC)
---	7.40	Soil reaction degree (pH)
g.Kg <sup>-1</sup>	1.17	Total nitrogen (N)
g.Kg <sup>-1</sup>	0.28	Ready phosphorous (P)
g.Kg <sup>-1</sup>	7.8	Ready Potassium
	2.18	Organic matter%
Soil separators		
g.Kg <sup>-1</sup>	730	sand
g.Kg <sup>-1</sup>	218	silt
g.Kg <sup>-1</sup>	52	Clay
Sandy Clay		Soil Texture

**Observations**

**First: Indicators of vegetative growth**

Measurements of vegetative growth indicators were taken for all the plants of the experiment after they reached the stage of flowering as follows:

- Plant height (cm): It was measured by a metric ruler.
- Main stem diameter (mm)
- The total number of leaves (leaf. plant<sup>-1</sup>)
- The leaf area of the plant (cm<sup>2</sup>)
- Fresh weight of Vegetative growth (g)
- Dry weight of Vegetative growth(g)

**Second: Indicators of flowering growth**

- Number of florets (flower. Plant<sup>-1</sup>)
- The inflorescences length (cm)
- Fresh weight of florets (g)
- Dry weight of florets (g)
- Flowering period (day)

**Third: Indicators of root growth**

- Number of roots (root. plant<sup>-1</sup>)
- fresh weight of the root system (g)
- dry weight of the root system (g)

The treatments were assigned to experimental units with randomized complete block design

(RCBD) in factorial arrangements. The observations were analyzed using analysis of variance with the least significant difference test (LSD) by comparing the averages at a probability level of 0.05 [20].

**Table 2. Physical and chemical properties of peat moss**

Unites	Values	Traits
g.L <sup>-1</sup>	6.7-5.9	pH
g.L <sup>-1</sup>	0.8-0.5	Salt content
g.L <sup>-1</sup>	140-50	N
g.L <sup>-1</sup>	170-80	P <sub>2</sub> O <sub>5</sub>
g.L <sup>-1</sup>	185-70	K <sub>2</sub> O

## RESULTS AND DISCUSSION

### Vegetative Growth

#### Plant height

The results in Table 3 show that spraying with salicylic acid at a concentration of 140 mg.L<sup>-1</sup> was significantly excelled plant height as compared to the plant treated with 70 mg. L<sup>-1</sup> and control plants, respectively. This is due to the role of salicylic acid in increasing the content of Auxin and cytokines [21] and the increase in cell division in the deep meristem of the roots [22] and its positive reflection on the transport of well-processed carbohydrates, which affected vegetative growth traits. This result is with the findings of [23] on the narcissus plant. As for the effect of the bi-interaction of the same table, the plants sprayed with salicylic acid 140 mg .L<sup>-1</sup> significantly excelled and Moringa leaf extract, 20 gm.L<sup>-1</sup>, the plant height reached 29.83 cm, compared to the minimum height of 16.33 cm for plants that were not sprayed.

#### Total number of leaves (leaf.plant<sup>-1</sup>)

The results in Table 3 showed that spraying plants with both salicylic acid and extract of moringa leaves, and the interaction between them had a significant effect on the number of total leaves of the plant, where the plants that were sprayed with salicylic acid at a concentration of 140 mg. Liter -1 was excelled .The total number of plant leaves reached 105.78 leaves.plant<sup>-1</sup> compared to the lowest number of leaves, 71.44 leaves.plant<sup>-1</sup> was plants that were not sprayed. The reason may be

due to the role of salicylic acid in increasing the efficiency of the photosynthesis process due to the increased absorption of CO<sub>2</sub> in the plastids [24]. This leads to the provision of the necessary materials to build new tissues and increase the vegetative growth or the accumulation of nutrients, which stimulates the plant to increase the number of leaves formed on the plant [21]. The reason may be due to what this extract contains of the nutrients (macro and micronutrients) in it that activate the biological and metabolic processes that take place inside the plant and increase its effectiveness in carrying out the photosynthesis process that leads to an increase in vegetative growth [25].

#### Leaf area (cm<sup>2</sup>)

Table 3 indicates that spraying plants with salicylic acid at a concentration of 70 and 140 mg. L<sup>-1</sup> did not differ significantly between them, so the leaf area for them was 16.22 and 16.56 cm<sup>2</sup>, which significantly excelled on the control plants, which had a leaf area of 13.68 cm<sup>2</sup>.The reason for this may be due to the result of spraying with salicylic acid and also the reason may be due to the role of salicylic acid in increasing the content of plants from other growth regulators, especially cytokinins and auxins, which leads to an increase in cell division and elongation and then an increase in growth and this was positively reflected in the increase of the leaf area of the plant, and it is agreed This result is with [23] on narcissus. Table 3 that the plants that were sprayed with salicylic acid were distinguished at a concentration of 140 mg.L<sup>-1</sup>with Moringa leaf extract, 20gm.L<sup>-1</sup> for its larger leaf area, which amounted to 21.94 cm<sup>2</sup>, compared to the minimum leaf area of 9.17 cm<sup>2</sup> for control plants.

#### Fresh weight of vegetative growth (g)

Table 3 showed that the plants sprayed with salicylic acid at a concentration of 140 mg.L<sup>-1</sup> was significantly excelled in the fresh weight of the Vegetative, where it reached 17.44 g on each of the plants that were sprayed with the same acid, but at a concentration of 70 mg.L<sup>-1</sup> and control plants, which amounted to 14.46 and 14.08 g, respectively, It may be due to an increase in the fresh weight of the vegetative growth as a result of spraying with salicylic acid to the fact that this

plant hormone promotes growth and then increases water absorption and absorption, which reflected positively on the lean weight of the shoot, as well as improving the water content of the plant and reducing transpiration [26]. The reason may be due to the role of the Moringa leaf extract to increase the vegetative growth because it contains important compounds and nutrients such as calcium, iron, zinc and phosphorous that are important in the process of cell division and elongation, which gave the largest vegetative total.

#### Dry weight of vegetative growth (g)

Table 3 indicate that the plants that were sprayed with salicylic acid at a concentration of 140 mg. L<sup>-1</sup> was significantly excelled in the dry weight of the Vegetative growth, where it reached 3.29 g, compared to the lowest weight of 2.44 g for the control plants. The reason may be due to the role of salicylic acid in increasing the growth of roots [27] its absorption of nutrients and the increase in photosynthesis, which is reflected in the increase in plant growth and its ability to produce dry matter in the plant.

The reason may be due to the increased concentration of Moringa leaf extract due to an increase in the strength of plant growth and

improved vegetative traits represented in the number of total leaves and the leaf area of the plant, which reflected positively on the increase in the efficiency of the photosynthesis process and thus the increase in the amount of carbohydrate and protein substances, which led to an increase in the dry weight of the vegetative growth.

#### Indicators of Flowering Growth

##### Number of florets (florets. Plant<sup>-1</sup>)

The results in Table 4 showed that spraying plants with salicylic acid had a significant effect in increasing the number of inflorescences formed on the plant, where the concentration 140 mg. L<sup>-1</sup> excelled on the rest of the treatments in the number of florets, reaching 10.68 florets. plant<sup>-1</sup> on each of the plants that were sprayed with salicylic acid at a concentration of 70 mg.L<sup>-1</sup> and control plants ,As the number of florets (8.60 and 8.57) florets. Plant<sup>-1</sup>, respectively, and the reason may be due to the role of this acid in increasing the products of the photosynthesis process, resulting in an excess of sugars that are available to separate the growth of the first flowering [28] or to its role in increasing auxins, which leads to an increase in auxins. It leads to an increase in the number of florets [29] and the acceleration of

**Table 3. The effect of spraying with salicylic acid and moringa leaf extract and their interactions on the vegetative growth of *Antirrhinum majus***

Treatments	Concentration	Plant height (cm)	Main stem diameter (mm)	The total number of leaves (leaf. Plant <sup>-1</sup> )	The leaf area (cm <sup>2</sup> )	Fresh weight of Vegetative growth (g)	Dry weight of Vegetative growth (g)	
salicylic acid	0	19.86	2.32	71.44	13.68	14.08	2.44	
	70	22.06	2.43	80.44	16.22	14.46	2.71	
	140	26.28	2.91	105.78	16.56	17.44	3.29	
L.S.D		1.63	0.18	3.41	1.07	1.42	0.36	
Moringa leaf extract(g.L <sup>-1</sup> )	0	20.11	2.33	76.08	13.79	13.25	2.50	
	10	22.00	2.39	84.00	13.97	13.87	2.65	
	20	26.11	3.02	97.67	18.70	18.86	3.37	
L.S.D		1.63	0.18	3.41	1.07	1.42	0.36	
interaction between salicylic acid and Moringa leaf extract	0	0	16.33	1.51	45.00	9.17	7.69	1.96
		10	21.67	2.38	56.00	10.75	11.70	2.00
		20	20.17	3.29	94.00	13.58	13.39	2.12
	70	0	17.33	2.02	73.67	14.24	14.17	2.14
		10	21.33	2.36	78.00	16.03	15.75	2.48
		20	27.20	2.29	101.00	17.57	17.18	2.85
	140	0	22.33	2.04	84.00	17.27	17.14	2.32
		10	26.67	2.90	106.60	18.14	18.68	3.51
		20	29.83	3.14	122.33	21.94	21.53	3.70
	L.S.D 0.05		2.83	0.32	5.91	1.86	2.46	0.62

flower bud formation. As for the effect of spraying with Moringa leaf extract, it is clear from the same table that the plants that were sprayed with this extract at a concentration of 20 mg.L<sup>-1</sup> was significantly excelled in the number of florets, reaching 10.75. florets. Plant<sup>-1</sup> compared to the lowest number of florets, reached (8.62 and 8.48) florets. plant<sup>-1</sup> with plants that sprayed with the same extract, but at a concentration of 10g.L<sup>-1</sup> and plants that have not been sprayed. It may be due to the improvement of the flowering growth traits due to the spraying of the extract or perhaps the reason is due to the role of the elements involved in the synthesis of this extract in activating the work of enzymes, as well as cell division and building proteins, and thus an increase in the manufacture of nutrients that help in the growth of plant tissues, which was positively reflected in giving the best flowering [30].

#### **The length of inflorescence (cm)**

Spraying the plant with salicylic acid had a significant effect on the length of inflorescence, where the plants sprayed with this acid 140 mg.L<sup>-1</sup> was significantly excelled in the length of inflorescence, which reached 8.28 cm on each of the plants that were sprayed with the same acid, but at a concentration of 70 mg.L<sup>-1</sup> and the comparison plants, where the length of length of inflorescence reached (7.00 and 6.92) cm, respectively, The increase in the length of the inflorescence that was sprayed with this acid may be due to the increase in the content of auxins and cytokines because the auxins are one of the main factors in the cambium activity in higher plants and factor to increase the cell division of the meristematic cells in a large and rapid manner, which leads to an increase in the length of inflorescence [21]. Table 4 the significant effect of spraying with Moringa leaf extract on length of inflorescence , where the plants that were sprayed with Moringa leaf extract at a concentration of 20 mg .L<sup>-1</sup> excelled on the length of inflorescence of 8.73 cm compared to each of the plants sprayed with Moringa leaf extract, but at a concentration of 10 g.L<sup>-1</sup> and control plants. As the length of inflorescence reached (6.94 and 6.25) cm respectively, and the reason is due to what this extract contains in a high percentage of nutrients, as well as vitamins and amino acids, As it improved the trait of vegetative growth and was

positively reflected in the increase in the length of length of inflorescence,

#### **Flowering period (day)**

The results in Table 4 showed that salicylic acid had a significant effect on this trait, where the plants that were sprayed with this acid early at a concentration of 140 mg. L<sup>-1</sup> at the time of the emergence of the first flowering, where it needed 40.78 days compared to the plants that were sprayed with the same acid, but at a concentration of 70 mg. L<sup>-1</sup> and control plants which needed 44.89 and 47.67 days, respectively, The reason may be due to the role of salicylic acid in increasing the photosynthesis products, resulting in an excess of sugars that available to enhance the growth of the Flowering [31] or to its role in increasing auxins [21] which leads to the improvement of flowering traits. The reason may be due to Moringa leaves containing nutrients such as (Zn, Mn, Fe, K) and their role in increasing the activity of the photosynthesis process due to the increase in the number of total leaves and leaf area (Table 3) that together work to increase the production of carbohydrates and that these materials accelerate the Flower development, maturity, and early flowering.

#### **Fresh weight of florets (g)**

Table 4 shows a significant increase in the fresh weight of the florets of plants that were sprayed with salicylic acid at a concentration of 140 and 70 mg.L<sup>-1</sup>, which reached (3.62 and 3.27) g, compared to the control plants, where its fresh florets weighed 2.83 g. The reason is due to the ability of salicylic acid to increase the retention of moisture of the florets while increasing their water content [22], which reflected positively on the soft weight of the florets. Moringa leaf extract had a significant effect on this trait.

#### **Dry weight of florets (g)**

Table 4 shows the excelled of plants sprayed with 140 mg. L<sup>-1</sup> was significant, where the dry weight of the florets was 0.56 g on each of the plants that were sprayed with the same acid, but at a concentration of 70 mg.L<sup>-1</sup> and the control plants, where the dry weight was (0.35 and 0.30) g, respectively. The reason for this may be due to

the improvement of the vegetative growth traits (Table 3) due to the spraying of salicylic acid.

The reason may be due to the increase in dry matter in the florets where a result of spraying them with the extract of moringa leaves to its role in increasing the growth of the root system represented by its number (Table 5), which led to an increase in the transfer of nutrients to The Vegetative growth, which leads to an increase in carbohydrate synthesis, which reflected positively on the increase in the dry weight of the florets.

### Root Growth Indicators

#### Number of roots (root. Plant<sup>-1</sup>)

Table 5 showed that spraying plants with salicylic acid has a significant effect on this trait, where the plants significantly excelled on those sprayed with a concentration of 140 mg.L<sup>-1</sup> in salicylic acid at average of 38.44 roots.Plant<sup>-1</sup> compared to 70 mg.L<sup>-1</sup> in the same acid and control plants and the average number of roots was (32.78 and 28.44) roots. plant<sup>-1</sup> respectively, The reason may be due to the strength of vegetative growth (Table 3), the increase in the efficiency of the photosynthesis process, food processing, its accumulation, and its transfer to the root system. Therefore, it increased the growth of root cells, their division and elongation, which led to an increase in this trait [32] As for the effect of spraying with Moringa leaf extract, it is clear from the same table that the plants that were sprayed with this extract at a concentration of 20g.L<sup>-1</sup>, it significantly excelled on the number of roots with an average of 39.22 roots.Plant<sup>-1</sup> compared to plants that were sprayed with a concentration of 10 g.L<sup>-1</sup> plants and control plants and the average of roots (30.56 and 29.89) roots. Plant<sup>-1</sup> respectively, the reason may be due to the role of this extract in increasing the activity of the photosynthesis process due to the increase in the number of leaves and the leaf area (Table 3), which ensures the presence of new traits in photosynthesis products to conducted vital activities in the plant and thus increase the growth of roots [18] and this ultimately reflects positively on the significant increase in the number of roots.

#### The fresh weight of the root system (g)

Table 5 showed that spraying plants with salicylic acid at a concentration of 140 mg. L<sup>-1</sup> significantly excelled on the fresh weight of the root system, with an average weight of 1.87 g, compared to the lowest fresh weight of root 1.67 g, for the control plants. The reason may be due to the role of salicylic acid in increasing vegetative growth (Table 3), the number of leaves and leaf area, which is reflected in the increase in photosynthesis products and then the carbohydrates needed for the growth of the root system and the increase in the fresh weight of the roots [33]. Table 5 shows that spraying plants with Moringa leaf extract at a concentration of 20 g.L<sup>-1</sup> significantly excelled in its fresh weight of the root system by 2.05 g, compared to the lowest weight of 1.46 g for the control plants. This is due to the fact that Moringa extract contains a group of vitamins that play a role in cell division and increase their size through processes including expansion and enlargement of cells, and then this led to an increase in the lean weight of the root system [29].

#### Dry weight of the root system (g)

The Results of Table 5 showed the excelled of the plants that were sprayed with salicylic acid at a concentration of 140 mg.L<sup>-1</sup> was significant in its dry weight, as it reached 0.76 g compared to the lowest weight of 0.50 g for comparison plants, perhaps because when spraying plants with this acid, it led to the accumulation of materials produced from the photosynthesis process due to the increase in the leaf area (Table 3).Therefore, the foodstuffs processed in the leaves are directed to the roots for their growth and development, and then they are stored in the form of dry materials, which increases their dry weight [29]. As for spraying plants with Moringa leaf extract, the effect was significant in this trait, where the plants that were sprayed with this extract at a concentration of 20 gm . L<sup>-1</sup> significantly excelled on increased the dry weight of the root system, which was 0.68 g compared to the lowest weight of 0.45 g for the control plants. The reason may be due to the fact that this extract contained large quantities of potassium (Table 1). Which is of great importance in the process of photosynthesis, carbohydrate transport and protein building, which

**Table 4. The effect of spraying with salicylic acid and Moringa leaf extract and their interactions on the flowering traits of *Antirrhinum majus***

Treatments	Concentration	Number of florets (florets. inflorescences -1)	The inflorescences length (cm)	Flowering period (day)	Fresh weight of florets (g)	Dry weight of florets (g)	
salicylic acid	0	8.57	6.92	47.67	2.83	0.30	
	70	8.60	7.00	44.89	3.27	0.35	
	140	10.68	8.28	40.78	3.62	0.56	
L.S.D		0.79	0.49	2.44	0.24	0.04	
Moringa leaf extract(g.L-1)	0	8.48	6.25	47.85	2.53	0.34	
	10	8.62	6.94	45.21	3.19	0.40	
	20	10.75	8.73	40.00	3.99	0.52	
L.S.D		0.79	0.94	2.44	0.24	0.40	
interaction between salicylic acid and Moringa leaf extract	0	0	6.00	4.50	61.00	1.30	0.16
		10	7.74	6.46	51.33	2.89	0.26
		20	7.80	6.87	53.00	3.10	0.32
	70	0	8.00	7.04	42.00	3.10	0.32
		10	9.00	7.10	46.67	3.35	0.36
		20	10.32	7.33	42.33	3.56	0.42
	140	0	10.55	8.20	38.67	4.11	0.60
		10	11.18	8.93	34.33	4.31	0.62
		20	12.97	10.17	31.67	4.41	0.72
	L.S.D 0.05		1.37	0.85	4.23	0.41	0.08

**Table 5. The effect of spraying with salicylic acid and Moringa leaf extract and their interactions on the root system traits of *Antirrhinum majus***

Treatments	Concentration	Number of roots (root. Plant -1)	fresh weight of the root system (g)	dry weight of the root system (g)	
salicylic acid	0	28.44	1.67	0.50	
	70	32.78	1.69	0.51	
	140	38.44	1.87	0.67	
L.S.D		2.48	0.20	0.02	
Moringa leaf extract(g.L-1)	0	29.89	1.46	0.45	
	10	30.56	1.71	0.53	
	20	39.22	2.05	0.68	
L.S.D		2.48	0.20	0.02	
interaction between salicylic acid and Moringa leaf extract	0	0	20.33	1.27	0.03
		10	25.33	1.30	0.42
		20	28.31	1.34	0.44
	70	0	28.26	1.64	0.53
		10	30.00	1.74	0.56
		20	31.33	1.84	0.62
	140	0	38.00	2.11	0.68
		10	46.00	2.14	0.71
		20	49.67	2.15	0.78
	L.S.D 0.05		4.29	0.35	0.04

encouraged root growth and increased dry weight [34].

## CONCLUSION

The effect of the interaction between the two factors was significant in most of the studied traits. (plant height 29.83 cm, stem diameter 3.29 mm , number of leaves 122.33 leaves.plant<sup>-1</sup>, leaf area 21.94 cm<sup>2</sup>, fresh and dry weights of vegetative growth (21.53, 3.70 g), number of

florets 12.97 florets, length of inflorescences 10.17 cm and flowering period 31.67 day, The fresh and dry weights of the florets (4.41,0.72 g), the number of roots 49.67 root.plant<sup>-1</sup>, and the fresh and dry weights of the root system(2.15,0.78 g) compared to the control plants.

## COMPETING INTERESTS

Author has declared that no competing interests exist.



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