

EFFECT OF SOME GROWTH SUBSTANCES AND CHEMICAL FERTILIZATION ON VEGETATIVE GROWTH AND CHEMICAL COMPOSITION OF *MATTHIOLA INCANA* L. PLANT

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ABSTRACT: A field experiment was carried out during two successive seasons of 2018/2019 and 2019/2020 in the Floriculture Farm of the Horticulture Department, Faculty of Agriculture, Benha University, Egypt to study the effects of spraying some growth substances (kinetin, salicylic acid, calcium thiosulfate and potassium silicate as well as, N.P.K chemical fertilization) on vegetative growth and chemical composition of *Matthiola incana* plants to increase and improve the quality of this plant as a bed gardens ornamentation. The obtained results showed that the tallest plants and the thickest plant stems were recorded by 100 ppm kinetin combined with NPK fertilization at high level treatment in both seasons. The heaviest fresh and dry weights of leaves/plant were recorded by 100 ppm kinetin-sprayed plants enriched with NPK fertilization at the highest level in both seasons. The highest number of branches and leaves/plant were recorded by 100 ppm kinetin-sprayed plants combined with NPK fertilization at high level in both seasons. The highest leaf N and total carbohydrates % were recorded by 100 ppm kinetin- sprayed plants provided with NPK fertilization at the highest level, whereas the richest leaf P % was registered by 200 ppm salicylic-sprayed plants combined with NPK fertilization at the highest level. While, the greatest leaf K % was scored by 6 cm³ potassium silicate-sprayed plants, supplemented with NPK fertilization at the highest level in both seasons. Conclusively, spraying *Matthiola incana* plants with kinetin at 100 ppm in addition to chemical fertilizer at 100 N: 200 P: 200 K kg/fed produced the best vegetative growth and quality of this plant.

Keywords: *Matthiola incana*, growth substances, chemical fertilization, growth and chemical constituents.

INTRODUCTION

Matthiola is a genus of the family Brassicaceae (Crucifera). The family has 13-19 tribes, 350 genera, and 3500 species worldwide (Onyilagho *et al.*, 2003). The common term "stock" is used to describe the species *M. incana* L., but it can also refer to the entire genus. It's a typical garden flower that comes in a wide range of colours. The stock is an unusual member of its family due to the beauty of the bloom and its pleasant sweet scent. Seeds are high in oils, with

omega-3-linolenic acid accounting for up to 65 percent of the oil. Omega-3-linolenic acid is one of the required fatty acids for optimal health (Heuer *et al.*, 2005). *Matthiola incana* L. is mostly utilized as a potted or fresh cut winter annual plant. From Spain to Turkey, and in the South to Egypt, this species is native to the Mediterranean Region and the Canary Islands. It produces spikes of double and single flowers in hues of rose, purple, pink, and white, fruits ranging in size from 4 to 16 cm in diameter, erect to spreading,

compressed without glands; stigma lacking noticeable horns (Gullen *et al.*, 1995). The double flowering types are used for decoration, their flowers are beautiful, and they have a pleasant perfume (EL-Quesni *et al.*, 2012). It's mostly used for planting in flowerbeds in various sorts of gardens, and it's become a lucrative floral crop (Hisamatsu *et al.*, 2000). Cytokinins are plant hormones that control the nacreous processes of growth and development. Kinetin (kin) delays senescence by inhibiting ethylene synthesis processes in flower tissues and lowering ethylene production in carnation flowers (Bosse and Van Staden, 1989). It also inhibits the activity of protein hydrolytic enzymes like lipooxygenase (Leshem *et al.*, 1979). When spraying Gaillardia plants with kinetin compared to the control treatment, El-Kinany *et al.* (2019) discovered that *Gaillardia pulchella* var. *pulchella* had the highest vegetative and blooming growth metrics.

Endogenous plant growth regulator salicylic acid (SA) has been discovered to cause a wide range of metabolic and physiological reactions in plants, impacting their growth and development. SA, being a natural and nontoxic phenolic molecule, has a lot of promise for reducing horticulture crop post-harvest losses. Salicylic acid, as a plant growth regulator, is crucial for plant growth and has been licensed for use in extending the vase life of cut flowers. This substance slows cell division and growth beneath the apex but has no effect on the meristem (Hedayat, 2001).

Calcium (Ca) is hypothesised to serve as an intracellular metabolic agent and as a secondary messenger in the transmission and transduction of various environmental signals (Harper *et al.*, 2004). This nutrient may directly affect various physiological processes due to its high affinity for calmodulin and other calcium-binding proteins (Hepler and Wayne 1985). One of the most important macronutrients for plant growth is calcium. It is not only necessary for the plant's cell walls to be built, but it

also helps the plant endure saline environments. Calcium is an immobile mineral, and deficiency occurs at the plant's terminating points and growing branch heads. This can cause a delay in the plant's flowering or occur at the same time as natal growth. Mohammed and Abood (2020) suggested spraying *Gerbera jamesonii* with calcium nitrate (500 mg l⁻¹) and salicylic acid to address this issue (75 mg l⁻¹). Number of leaves, leaf area, total chlorophyll, wet and dry weight of leaves, early blooming, number of inflorescences, peduncle diameter, and vase life were increased.

Silicon, a naturally occurring chemical element, has a beneficial influence on plant development and resistance. Its features include a positive impact on plant ionic equilibrium, a reduction in the toxic effects of excessive manganese and iron, and cell wall reinforcement. Silicon is either a required ingredient for plants to complete their life cycle or an optional component of the plant's life cycle. Many crops can benefit from adding silicon to their nutrition programs since it improves drought tolerance, strength, disease resistance, and postharvest keeping quality (Marschner *et al.*, 1997). In this regard, Attia and Elbohy (2019) found that spraying pot marigold plants (*Calendula officinalis* L.) with potassium silicate at an 8 cm³/l rate significantly increased plant height, number of branches, fresh and dry herb weights (g)/plant, number of flowers/plant, and leaf chemical composition when compared to a control treatment.

Plant nutrition is one of the most important variables that influences plant growth in a favourable way (Sharma and Kumar, 2012). Nutrient uptake must be taken into account when producing high-quality flowers. Inorganic nutrient management is a significant aspect of determining the ornamental value of plants. The most essential goals to attain in bedding and cut-flower production are to increase flower production, floral quality, and fineness in the

form of plants. The nutrition content affects flower quality (Boodley, 1975). Quality of flower production and a long flowering period are aided by the use of the right fertilizer combination. The most valuable vital elements for improving ornamental quality and flower production are nitrogen, phosphorus, and potassium (Kashif, 2001). In this regard, Abou El-Ghait *et al.* (2020) found that NPK chemical fertilization at 6 g/pot increased plant height, branch number/plant, fresh and dry weights of leaves/plant, number of flowers/plant, and leaf chemical composition, when compared to un-fertilized *Jasminum sambac* plants.

In this regard, the goal of this study was to investigate how far various growth agents and chemical fertilization affect the vegetative growth and chemical composition of the *Matthiola incana* plant.

MATERIALS AND METHODS

This trial was conducted to investigate the effects of spraying kinetin, salicylic acid, calcium thiosulfate, and potassium silicate, as well as chemical fertilization (N.P.K.), on the vegetative growth and chemical composition of *Matthiola incana* L. plants in order to improve the plant's vegetative growth and chemical composition. A field experiment was conducted in the Floriculture Farm of the Horticulture Department, Faculty of Agriculture, Benha University, Egypt for two consecutive seasons of 2018/2019 and 2019/2020 to meet the goals of the study.

Plant materials:

Matthiola incana cv. Katz White plants were used in this experiment. Seeds of *M. incana* (1000 seeds have the weight of 1.5 g) were obtained from the United States of America. The germination rate was 93% with a purity of 99%. On September, 20th in both seasons, seeds were sown in plastic trays filled with a prepared growing medium containing peat moss + perlite (1:1 by volume). The seedlings were sprayed with NPK (20:20:20) at 2 g/l three times a week after being placed in a plastic greenhouse for

30 days, then transferred to a lath house for 10 days. Seedlings with a height of 15-18 cm and a weight of 10-12 g with 6-8 leaves were transplanted to the field after 40 days from seed sowing.

Procedures for conducting experiments:

Well-established uniform seedlings of *Matthiola incana* cv. Katz White were planted in the field soil on November 1st of 2018 and 2019 (for the first and second seasons, respectively). Before planting, the soil was ploughed, and sand was added at a rate of 4 m³/108 m² to the soil, as well as calcium superphosphate. The field was divided into plots, with each experimental plot unit size (1 m²) containing six plants in two rows, and three plants in each row. Within each plot, the plant spacing was 25 cm² between plants and 50 cm² between rows. The plants were planted in well-irrigated soil that was irrigated at weekly intervals with a flood irrigation system to keep soil moisture at 65-70% of field capacity. In the first and second seasons, the textural class of the utilized soil was clay loam, with EC values of 0.82 and 0.79 dS.m⁻¹ and pH values of 7.46 and 7.78, respectively.

Treatments:

This study contained two factors. The first one was dealing with some chemical fertilization (N.P.K.) treatments, while the second one involved some growth substances treatments.

1. Chemical fertilizer (N.P.K.):

Ammonium nitrate (33% N) was used as a source of nitrogen at four levels (zero is considered as control, 50, 75 and 100 kg/fed), calcium superphosphate (46% P₂O₅) was used as a source of phosphorous at four levels (zero is considered as control, 100, 150 and 200 kg/fed), while potassium sulfate (48% K₂O) was used as a source of potassium at four levels (zero is considered as control, 100, 150 and 200 kg/fed). Plants were fertilized with 4 combination treatments from these previously mentioned fertilizers, control (without fertilization) for the first treatment, 50 kg/fed N + 100 kg/fed

P + 100 kg/fed K for the second one, 75 kg/fed N + 150 kg/fed P + 150 kg/fed K for the third one, and 100 kg/fed N + 200 kg/fed P + 200 kg/fed K for the fourth one. Calcium superphosphate was added before planting during soil preparation. Ammonium nitrate and potassium sulfate fertilizers were added to the soil six times. The first addition of ammonium nitrate was done after 7 days from transplanting the seedlings to the soil and then the other five doses were done at weekly intervals till the sixth addition. The first addition of potassium sulfate was done after 21 days from transplanting seedlings to the field and the second addition was given 21 days after the first one, while the third up to the sixth additions were given at 7 days intervals after the second addition.

2. Plant growth substances:

Kinetin at three concentrations (zero, 50 and 100 ppm), salicylic acid at three concentrations (zero, 100 and 200 ppm), Calcium thiosulfate at three concentrations (zero, 2 and 3 cm³/l) and potassium silicate at three concentrations (0.00, 4 and 6 cm³/l). Application of kinetin, salicylic acid, calcium thiosulfate and potassium silicate was carried out as foliar spray six times. The first spray was done after 40 days after transplanting the seedlings to the field soil and the plants were sprayed at weekly intervals after the first spray. Untreated plants (control) were sprayed with distilled water only. Spraying was done in the first hours of the day before sunrise.

Layout of the Experiment:

The experiment was designed as a factorial experiment in a randomized complete block design with 36 treatments representing combinations of nine different growth substances and four different rates of chemical fertilization at (9 growth substances treatments x 4 chemical fertilization levels) replicated three times (each replicate consisted of five beds with six plants per bed). When necessary, common agricultural procedures (irrigation,

manual weed control, etc.) were implemented.

Data recorded:

Three plants were randomly chosen at 70% flowering stage from each plot at the end of this study on March 1st for both seasons (after 155 - 160 days from planting the seeds), and the following data were recorded:

1. Parameters of vegetative growth:

Plant height (cm), stem diameter (cm), number of branches per plant, number of leaves per plant, fresh leaf weight (g), and dried leaf weight (g).

2. Chemical composition determinations:

For all trials, samples of leaves from the vegetative phase were obtained two weeks following the last treatment application. The samples were collected and forwarded to the laboratory without delay. To eliminate any residues, all samples were warped with a moist towel and then washed with distilled water. The leaf portions were then oven dried at 70 °C until they reached a consistent weight. The dry matter content was measured, and 2.0 g of dry matter was collected for N, P, K and total carbohydrate analysis.

Minerals %:

Dried samples of 0.2 g were prepared and the wet digestion procedure was performed as follows; concentrated sulphuric acid (5 ml) was added to the sample and the mixture was heated for 10 minutes and then 0.5 ml perchloric acid was added and heating was continued until a clear solution was obtained. The digested solution was qualitatively transferred to 100 ml then total N, P and K % were determined.

Total nitrogen was measured by using the modified micro-kjeldahl method as described by Pregl (1945). Phosphorus was determined colourimetrically by spectronic (20) spectrophotometer using the method described by Trouge and Meyer (1939). While, potassium content was measured by

flame photometer according to Brown and Lilland (1946).

Total carbohydrates %:

Total carbohydrates % was determined in dry powder material according to Herbert *et al.* (1971).

Statistical analysis:

All data obtained during both seasons of the study were subjected to analysis of variance as a factorial experiment in R.C.B.D., LSD at 5% method was used to compare the difference between means according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Vegetative growth parameters:

1. Plant height:

Table (1) shows that all tested sprays of growth substances succeeded in increasing plant height of *Matthiola incana* plants as compared with un-sprayed plants in both seasons. In this respect, 100 ppm kinetin-sprayed plants gave the highest values in this concern, followed by kinetin at 50 ppm in both seasons. On the other hand, there was a positive correlation between the plant height values and fertilization levels, so the values of plant height increased as the level of fertilization increased until reaching the maximum increment with the highest level (100 N : 200 P : 200 K kg/fed). This trend was true in both seasons.

Moreover, data presented in Table (1) indicate that all the interactions between growth substances and chemical fertilization levels statistically increased plant height of *Matthiola incana* plants as compared with untreated plants in both seasons. In this concern, the tallest plants (129.0 and 130.0 cm) were recorded by 100 ppm kinetin combined with NPK fertilization at the highest level in the first and second seasons, respectively.

2. Stem diameter (cm):

Data presented in Table (2) declare that stem diameter was increased due to using all

tested growth substance treatments as compared with control plants in both seasons. Consequently 100 ppm kinetin-sprayed plants recorded the highest values in both seasons. Parallely, stem diameter increased with all tested levels of NPK fertilization, especially the highest level in both seasons.

In general, all interactions between growth substances and NPK fertilization treatments succeeded in increasing the stem diameter as compared with control in the two seasons. In this regard, the highest values of stem diameter (1.30 and 1.33 cm) were scored by 100 ppm kinetin-sprayed plants supplemented with NPK fertilization at the highest level in the first and second seasons, respectively.

3. Number of branches and leaves/plant:

Tables (3 and 4) declare that all tested growth substances and NPK fertilization treatments as well as their interactions increased number of branches and leaves/plant in both seasons. In this concern, the increment in branches and leaves number was parallel with the applied concentration of kinetin and fertilization levels, so the highest concentration of kinetin or the highest level of fertilization significantly scored the highest number of branches and leaves/plant when compared with control in both seasons. Generally, the highest number of branches/plant (4.00 and 4.00) and leaves/plant (129.32 and 128.00) were recorded by 100 ppm kinetin-sprayed plants combined with NPK fertilization at the highest level in the first and second seasons, respectively.

4. Fresh and dry weights of leaves (g):

Tables (5 and 6) revealed that all tested sprays of growth substances succeeded in increasing the fresh and dry weights of *Matthiola incana* plants as compared with un-sprayed plants in both seasons. In this respect, 100 ppm kinetin-sprayed plants gave the highest values, followed by the kinetin at 50 ppm in both seasons.

Table 1. Effect of some growth substances and chemical fertilization on plant height (cm) of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | | |
|----------------------------------|----------------------------|--------------------|--------------------|---------------------|------------|----------------------------|--------------------|--------------------|---------------------|----------|-----------|--|
| | Chemical fertilization (A) | | | | | Chemical fertilization (A) | | | | | | |
| | N.P.K (0:0:0) | N.P.K (50:100:100) | N.P.K (75:150:150) | N.P.K (100:200:200) | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100:100) | N.P.K (75:150:150) | N.P.K (100:200:200) | Mean (B) | | |
| Control | 79.33 | 85.33 | 88.33 | 93.66 | 86.66 | 80.33 | 85.66 | 88.66 | 91.00 | 86.41 | | |
| Pot. Silic. 4 cm ³ /l | 85.66 | 86.66 | 95.66 | 100.00 | 91.99 | 83.00 | 87.66 | 99.33 | 98.66 | 92.16 | | |
| Pot. Silic. 6 cm ³ /l | 89.33 | 91.00 | 96.66 | 104.66 | 95.41 | 87.66 | 92.00 | 98.66 | 104.66 | 95.74 | | |
| Ca thio. 2 cm ³ /l | 86.66 | 96.66 | 101.00 | 111.66 | 98.99 | 84.66 | 94.66 | 101.33 | 110.33 | 97.74 | | |
| Ca thio. 3 cm ³ /l | 93.66 | 101.33 | 105.33 | 114.00 | 103.99 | 94.66 | 100.00 | 104.00 | 114.66 | 103.33 | | |
| Sal. acid 100 ppm | 82.66 | 93.00 | 94.66 | 109.66 | 94.99 | 84.00 | 96.33 | 97.66 | 110.00 | 96.99 | | |
| Sal. acid 200 ppm | 84.33 | 95.66 | 110.33 | 119.33 | 102.41 | 86.33 | 100.00 | 106.33 | 121.00 | 101.91 | | |
| Kinetin 50 ppm | 86.00 | 100.66 | 112.66 | 122.66 | 105.49 | 87.00 | 101.00 | 111.33 | 123.00 | 105.58 | | |
| Kinetin 100 ppm | 91.66 | 106.33 | 121.66 | 129.00 | 112.16 | 93.66 | 109.00 | 122.00 | 130.00 | 112.16 | | |
| Mean | 84.44 | 86.587 | 102.92 | 111.62 | | 86.81 | 96.25 | 103.25 | 111.47 | | | |
| LSD at 0.05 | A= 8.23 | | B= 12.34 | | A×B= 24.69 | | A= 7.14 | | B= 10.70 | | A×B= 21.4 | |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

Table 2. Effect of some growth substances and chemical fertilization on stem diameter (cm) of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | | |
|----------------------------------|----------------------------|--------------------|--------------------|---------------------|-----------|----------------------------|--------------------|--------------------|---------------------|----------|-----------|--|
| | Chemical fertilization (A) | | | | | Chemical fertilization (A) | | | | | | |
| | N.P.K (0:0:0) | N.P.K (50:100:100) | N.P.K (75:150:150) | N.P.K (100:200:200) | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100:100) | N.P.K (75:150:150) | N.P.K (100:200:200) | Mean (B) | | |
| Control | 0.56 | 0.73 | 0.90 | 0.96 | 0.78 | 0.56 | 0.70 | 0.86 | 0.93 | 0.76 | | |
| Pot. Silic. 4 cm ³ /l | 0.63 | 0.83 | 0.93 | 1.06 | 0.86 | 0.60 | 0.80 | 0.83 | 1.00 | 0.80 | | |
| Pot. Silic. 6 cm ³ /l | 0.73 | 0.90 | 1.03 | 1.20 | 0.96 | 0.60 | 0.86 | 0.96 | 1.22 | 0.91 | | |
| Ca thio. 2 cm ³ /l | 0.80 | 0.90 | 1.00 | 1.06 | 0.94 | 0.76 | 0.83 | 1.00 | 1.06 | 0.91 | | |
| Ca thio. 3 cm ³ /l | 0.83 | 1.00 | 1.10 | 1.16 | 1.02 | 0.80 | 0.93 | 1.06 | 1.13 | 0.98 | | |
| Sal. acid 100 ppm | 0.96 | 1.00 | 1.03 | 1.06 | 1.00 | 0.96 | 1.00 | 1.03 | 1.06 | 1.01 | | |
| Sal. acid 200 ppm | 1.00 | 1.02 | 1.13 | 1.16 | 1.07 | 1.00 | 1.03 | 1.09 | 1.16 | 1.07 | | |
| Kinetin 50 ppm | 1.13 | 1.16 | 1.20 | 1.23 | 1.18 | 1.13 | 1.16 | 1.19 | 1.23 | 1.17 | | |
| Kinetin 100 ppm | 1.20 | 1.26 | 1.29 | 1.30 | 1.26 | 1.16 | 1.20 | 1.23 | 1.33 | 1.23 | | |
| Mean | 0.87 | 0.97 | 1.06 | 1.13 | | 0.84 | 0.94 | 1.02 | 1.12 | | | |
| LSD at 0.05 | A= 0.09 | | B= 0.14 | | A×B= 0.28 | | A= 0.07 | | B= 0.11 | | A×B= 0.22 | |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

Table 3. Effect of some growth substances and chemical fertilization on No. of branches/plant of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | | |
|----------------------------------|----------------------------|---------------------|---------------------|----------------------|-----------|------------------------|---------------------|---------------------|----------------------|----------|-----------|--|
| | Chemical fertilization (A) | | | | | | | | | | | |
| | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (B) | | |
| Control | 2.00 | 2.11 | 2.33 | 2.66 | 2.27 | 2.00 | 2.33 | 2.33 | 2.66 | 2.41 | | |
| Pot. Silic. 4 cm ³ /l | 2.00 | 2.33 | 2.66 | 3.00 | 2.49 | 2.33 | 2.33 | 2.66 | 3.00 | 2.83 | | |
| Pot. Silic. 6 cm ³ /l | 2.33 | 3.00 | 3.00 | 3.33 | 2.91 | 2.66 | 3.00 | 3.00 | 3.33 | 3.08 | | |
| Ca thio. 2 cm ³ /l | 2.00 | 2.66 | 2.33 | 2.66 | 2.41 | 2.33 | 2.33 | 2.66 | 3.66 | 2.57 | | |
| Ca thio. 3 cm ³ /l | 2.66 | 2.66 | 3.00 | 3.66 | 2.99 | 2.66 | 2.66 | 3.00 | 3.66 | 2.74 | | |
| Sal. acid 100 ppm | 2.33 | 2.33 | 2.66 | 3.00 | 2.58 | 2.00 | 2.33 | 2.33 | 2.66 | 2.41 | | |
| Sal. acid 200 ppm | 2.33 | 2.66 | 2.66 | 3.33 | 2.74 | 2.33 | 2.66 | 2.66 | 3.00 | 2.66 | | |
| Kinetin 50 ppm | 2.66 | 3.00 | 3.33 | 3.66 | 3.16 | 2.66 | 3.00 | 3.33 | 3.66 | 3.16 | | |
| Kinetin 100 ppm | 3.00 | 3.33 | 3.66 | 4.00 | 3.49 | 3.00 | 3.33 | 3.66 | 4.00 | 3.49 | | |
| Mean | 2.36 | 2.67 | 2.84 | 3.25 | | 2.44 | 2.66 | 2.84 | 3.29 | | | |
| LSD at 0.05 | A=0.12 | | B=0.18 | | A×B= 0.36 | | A= 0.13 | | B= 0.20 | | A×B= 0.40 | |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

Table 4. Effect of some growth substances and chemical fertilization on No. of leaves/plant of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | | |
|----------------------------------|----------------------------|---------------------|---------------------|----------------------|-----------|------------------------|---------------------|---------------------|----------------------|----------|---------|--|
| | Chemical fertilization (A) | | | | | | | | | | | |
| | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (B) | | |
| Control | 51.32 | 55.55 | 62.11 | 71.82 | 60.20 | 51.32 | 61.34 | 62.11 | 82.46 | 64.30 | | |
| Pot. Silic. 4 cm ³ /l | 56.00 | 66.77 | 79.80 | 91.98 | 73.63 | 66.00 | 69.10 | 79.80 | 91.98 | 76.72 | | |
| Pot. Silic. 6 cm ³ /l | 68.33 | 88.98 | 91.98 | 103.23 | 88.13 | 76.23 | 90.99 | 93.00 | 104.32 | 91.13 | | |
| Ca thio. 2 cm ³ /l | 52.66 | 72.69 | 66.77 | 80.67 | 68.19 | 62.11 | 65.24 | 78.89 | 109.80 | 79.01 | | |
| Ca thio. 3 cm ³ /l | 73.57 | 76.23 | 87.99 | 109.80 | 86.89 | 75.35 | 77.14 | 90.00 | 111.00 | 88.37 | | |
| Sal. acid 100 ppm | 59.78 | 60.58 | 70.03 | 84.00 | 68.59 | 54.66 | 64.44 | 65.24 | 75.35 | 64.92 | | |
| Sal. acid 200 ppm | 71.82 | 73.57 | 76.23 | 98.76 | 80.09 | 66.77 | 77.14 | 77.72 | 88.98 | 77.65 | | |
| Kinetin 50 ppm | 85.98 | 96.57 | 102.09 | 114.66 | 99.82 | 78.89 | 90.00 | 100.99 | 113.46 | 95.83 | | |
| Kinetin 100 ppm | 73.16 | 104.32 | 115.87 | 129.32 | 105.66 | 91.98 | 103.23 | 114.66 | 128.00 | 109.46 | | |
| Mean | 65.84 | 77.25 | 83.65 | 98.24 | | 69.25 | 77.62 | 84.71 | 100.59 | | | |
| LSD at 0.05 | A= 8.14 | | B=12.2 | | A×B= 24.4 | | A= 7.31 | | B= 11.0 | | A×B= 22 | |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

Table 5. Effect of some growth substances and chemical fertilization on fresh weight of leaves/plant (g) of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | |
|----------------------------------|----------------------------|---------------------|---------------------|----------------------|-----------|------------------------|---------------|---------------------|---------------------|----------------------|----------|
| | Chemical fertilization (A) | | | | | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (B) |
| | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | | | | | | | |
| Control | 45.08 | 67.47 | 101.63 | 127.38 | 85.39 | 39.34 | 70.62 | 105.80 | 126.58 | 85.58 | |
| Pot. Silic. 4 cm ³ /l | 80.24 | 102.19 | 154.83 | 228.09 | 141.33 | 87.93 | 104.96 | 140.34 | 241.50 | 143.68 | |
| Pot. Silic. 6 cm ³ /l | 96.46 | 140.64 | 186.21 | 276.19 | 174.87 | 99.03 | 141.06 | 197.43 | 285.94 | 180.86 | |
| Ca thio. 2 cm ³ /l | 67.42 | 153.74 | 139.98 | 183.83 | 136.24 | 80.87 | 129.57 | 164.99 | 276.36 | 162.94 | |
| Ca thio. 3 cm ³ /l | 89.82 | 157.52 | 221.28 | 273.80 | 185.60 | 96.63 | 164.92 | 221.19 | 290.97 | 193.42 | |
| Sal. acid 100 ppm | 56.64 | 116.38 | 143.05 | 185.07 | 125.28 | 63.52 | 122.48 | 142.26 | 171.57 | 124.95 | |
| Sal. acid 200 ppm | 93.99 | 169.44 | 151.48 | 233.29 | 162.05 | 75.42 | 183.19 | 149.86 | 211.62 | 155.02 | |
| Kinetin 50 ppm | 125.20 | 156.78 | 217.34 | 332.73 | 208.01 | 136.72 | 155.82 | 220.17 | 339.02 | 212.93 | |
| Kinetin 100 ppm | 159.63 | 183.64 | 271.60 | 374.28 | 247.28 | 157.47 | 179.22 | 256.93 | 378.60 | 243.05 | |
| Mean | 90.49 | 138.64 | 176.37 | 246.07 | | 92.99 | 139.09 | 177.66 | 258.01 | | |
| LSD at 0.05 | A= 16.0 | | B=24.3 | | A×B= 48.3 | | A= 7.14 | | B= 10.7 | | A×B=21.4 |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

Table 6. Effect of some growth substances and chemical fertilization on dry weight of leaves/plant (g) of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | |
|----------------------------------|----------------------------|---------------------|---------------------|----------------------|-----------|------------------------|---------------|---------------------|---------------------|----------------------|-----------|
| | Chemical fertilization (A) | | | | | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (B) |
| | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | | | | | | | |
| Control | 7.76 | 12.87 | 16.86 | 22.84 | 15.08 | 8.06 | 14.72 | 16.40 | 23.14 | 15.58 | |
| Pot. Silic. 4 cm ³ /l | 14.06 | 22.43 | 29.71 | 41.76 | 26.99 | 16.93 | 22.22 | 22.84 | 40.83 | 25.70 | |
| Pot. Silic. 6 cm ³ /l | 16.96 | 29.31 | 36.51 | 47.21 | 32.39 | 22.74 | 27.87 | 29.46 | 49.38 | 32.36 | |
| Ca thio. 2 cm ³ /l | 11.18 | 22.74 | 24.88 | 33.83 | 23.15 | 14.37 | 21.20 | 27.93 | 45.93 | 27.35 | |
| Ca thio. 3 cm ³ /l | 15.34 | 24.97 | 32.34 | 48.42 | 30.26 | 16.54 | 26.04 | 37.95 | 51.27 | 32.95 | |
| Sal. acid 100 ppm | 9.45 | 15.54 | 24.84 | 35.22 | 21.26 | 9.42 | 15.61 | 27.16 | 35.45 | 21.91 | |
| Sal. acid 200 ppm | 12.04 | 17.68 | 27.87 | 42.09 | 24.92 | 12.97 | 18.32 | 32.87 | 41.49 | 26.41 | |
| Kinetin 50 ppm | 19.41 | 37.11 | 44.48 | 59.65 | 40.16 | 21.51 | 29.01 | 41.89 | 60.93 | 38.33 | |
| Kinetin 100 ppm | 26.76 | 45.58 | 51.38 | 66.92 | 47.66 | 26.37 | 39.72 | 48.45 | 67.20 | 45.43 | |
| Mean | 14.77 | 25.35 | 36.27 | 44.21 | | 16.54 | 23.85 | 31.66 | 46.18 | | |
| LSD at 0.05 | A= 9.15 | | B= 13.2 | | A×B= 26.4 | | A= 8.62 | | B= 12.9 | | A×B= 25.9 |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

It was interesting to notice that there was a positive relationship between the fresh and dry weights of leaves/plant and chemical fertilization treatments. Hence, as the level of chemical fertilization was increased the fresh and dry weights of leaves were increased up to the maximum increment at the highest level of chemical fertilization in both seasons (Tables, 5 and 6). In this respect, the heaviest fresh and dry weights of leaves/plant were recorded by 100 ppm kinetin-sprayed plants enriched with the highest level of NPK fertilization in both seasons.

The obtained results might be due to the role of kinetin in promoting protein synthesis, increasing cell division and enlargement (Cheema and Sharma, 1982). Moreover, these results might be explained according to the role of kinetin in promoting proteins, soluble and non-soluble sugars synthesis, or may be due to the ability of kinetin for making the treated area act as a sink in which nutrients from other parts of the plant are drawn (Salisbury and Ross, 1974). The stimulating effect of fertilization treatments may be due to the role of mineral fertilization in supplying the plants with their required nutrients for more carbohydrates and protein production which are necessary for vegetative growth of the plants (Marschner, 1997).

Chemical constituents:

1. Leaf N, P and K %:

Tables (7, 8 and 9) show that all tested treatments of growth substances, chemical fertilization and their combinations succeeded in increasing leaf N, P and K % as compared with control in both seasons. In this concern, the highest leaf N % (1.96 and 1.98%) was recorded by 100 ppm kinetin-sprayed plants provided with NPK fertilization at the highest level in the first and second seasons, respectively, whereas the richest leaf P % (0.196 and 0.198%) was registered by 200 ppm salicylic-sprayed plants combined with NPK fertilization at the highest level in first and second seasons,

respectively. While, the highest leaf K % (1.68 and 1.73%) was scored by 6 cm³/l potassium silicate-sprayed plants supplemented with NPK fertilization at the highest level in the first and second seasons, respectively.

2. Leaf total carbohydrates %:

Data shown in Table (10) indicate that all tested growth substances treatments increased leaf total carbohydrates % as compared with untreated plants in both seasons. Also, the increments of leaf total carbohydrates % were in parallel to the increase of chemical fertilization level to reach the maximum increment at the highest level in both seasons. In general, all combined treatments between growth substances and chemical fertilization treatments statistically increased the values of this parameter as compared with control in both seasons. In this respect, the highest values of leaf total carbohydrates (17.90 and 18.40%) were recorded by 100 ppm kinetin-sprayed plants supplemented with NPK fertilization at the highest level, in the first and second seasons, respectively.

The explanation of the incremental effect of growth substances on growth and chemical constituents of *Matthiola* plant, it could be illustrated here on the basis that such growth substance treatments stimulated the endogenous cytokinins synthesis. Cytokinins activate a number of enzymes participating in a wide range of metabolic reactions in the leaves. These reactions included the maturation of pro-plastid into chloroplasts. Also, these results may explain the role of cytokinins in promoting protein and pigments synthesis and their ability to delay senescence and withdraw sugars and other solutes from older parts of a plant to the new organs (Salisbury and Ross, 1974). In the same line, Leopold and Kawase (1964) stated that cytokinins stimulate the movement of sugars, starch, amino acids and many other solutes from mature organs to primary tissues of other ones. Furthermore, it may be due to the role of kinetin in increasing the growth promoters in the plant

Table 7. Effect of some growth substances and chemical fertilization on leaf N % of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | | |
|----------------------------------|----------------------------|---------------------|---------------------|----------------------|-----------|----------------------------|---------------------|---------------------|----------------------|----------|-----------|--|
| | Chemical fertilization (A) | | | | | Chemical fertilization (A) | | | | | | |
| | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (B) | | |
| Control | 1.13 | 1.27 | 1.38 | 1.46 | 1.31 | 1.18 | 1.29 | 1.42 | 1.51 | 1.35 | | |
| Pot. Silic. 4 cm ³ /l | 1.29 | 1.36 | 1.43 | 1.64 | 1.43 | 1.32 | 1.35 | 1.46 | 1.73 | 1.46 | | |
| Pot. Silic. 6 cm ³ /l | 1.35 | 1.42 | 1.51 | 1.75 | 1.50 | 1.37 | 1.41 | 1.54 | 1.79 | 1.52 | | |
| Ca thio. 2 cm ³ /l | 1.24 | 1.32 | 1.41 | 1.62 | 1.39 | 1.27 | 1.34 | 1.47 | 1.68 | 1.44 | | |
| Ca thio. 3 cm ³ /l | 1.26 | 1.37 | 1.48 | 1.67 | 1.44 | 1.29 | 1.38 | 1.49 | 1.77 | 1.48 | | |
| Sal. acid 100 ppm | 1.18 | 1.30 | 1.39 | 1.54 | 1.35 | 1.21 | 1.29 | 1.48 | 1.63 | 1.40 | | |
| Sal. acid 200 ppm | 1.21 | 1.34 | 1.45 | 1.60 | 1.40 | 1.28 | 1.36 | 1.51 | 1.69 | 1.46 | | |
| Kinetin 50 ppm | 1.39 | 1.52 | 1.73 | 1.87 | 1.62 | 1.42 | 1.54 | 1.79 | 1.91 | 1.66 | | |
| Kinetin 100 ppm | 1.46 | 1.59 | 1.82 | 1.96 | 1.70 | 1.48 | 1.62 | 1.84 | 1.98 | 1.73 | | |
| Mean | 1.27 | 1.38 | 1.51 | 1.67 | | 1.31 | 1.39 | 1.55 | 1.74 | | | |
| LSD at 0.05 | A= 0.12 | | B= 0.18 | | A×B= 0.36 | | A= 0.11 | | B= 0.17 | | A×B= 0.33 | |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

Table 8. Effect of some growth substances and chemical fertilization on leaf P % of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | | |
|----------------------------------|----------------------------|---------------------|---------------------|----------------------|------------|----------------------------|---------------------|---------------------|----------------------|----------|------------|--|
| | Chemical fertilization (A) | | | | | Chemical fertilization (A) | | | | | | |
| | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100 :100) | N.P.K (75:150 :150) | N.P.K (100:200 :200) | Mean (B) | | |
| Control | 0.118 | 0.146 | 0.169 | 0.173 | 0.151 | 0.120 | 0.145 | 0.166 | 0.179 | 0.152 | | |
| Pot. Silic. 4 cm ³ /l | 0.134 | 0.161 | 0.183 | 0.186 | 0.166 | 0.136 | 0.162 | 0.179 | 0.186 | 0.165 | | |
| Pot. Silic. 6 cm ³ /l | 0.139 | 0.169 | 0.184 | 0.189 | 0.170 | 0.142 | 0.166 | 0.185 | 0.189 | 0.170 | | |
| Ca thio. 2 cm ³ /l | 0.121 | 0.153 | 0.173 | 0.179 | 0.156 | 0.129 | 0.149 | 0.171 | 0.181 | 0.157 | | |
| Ca thio. 3 cm ³ /l | 0.126 | 0.158 | 0.176 | 0.181 | 0.160 | 0.134 | 0.153 | 0.175 | 0.183 | 0.161 | | |
| Sal. acid 100 ppm | 0.142 | 0.167 | 0.186 | 0.192 | 0.171 | 0.144 | 0.172 | 0.185 | 0.193 | 0.173 | | |
| Sal. acid 200 ppm | 0.149 | 0.175 | 0.192 | 0.196 | 0.178 | 0.148 | 0.176 | 0.190 | 0.198 | 0.178 | | |
| Kinetin 50 ppm | 0.126 | 0.148 | 0.172 | 0.180 | 0.156 | 0.128 | 0.151 | 0.170 | 0.186 | 0.158 | | |
| Kinetin 100 ppm | 0.129 | 0.153 | 0.174 | 0.184 | 0.160 | 0.136 | 0.156 | 0.176 | 0.186 | 0.163 | | |
| Mean | 0.131 | 0.158 | 0.178 | 0.184 | | 0.135 | 0.158 | 0.177 | 0.186 | | | |
| LSD at 0.05 | A= 0.007 | | B= 0.011 | | A×B= 0.022 | | A= 0.008 | | B= 0.012 | | A×B= 0.024 | |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

Table 9. Effect of some growth substances and chemical fertilization on leaf K % of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | | |
|----------------------------------|----------------------------|--------------------|--------------------|---------------------|-----------|------------------------|--------------------|--------------------|---------------------|----------|-----------|--|
| | Chemical fertilization (A) | | | | | | | | | | | |
| | N.P.K (0:0:0) | N.P.K (50:100:100) | N.P.K (75:150:150) | N.P.K (100:200:200) | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100:100) | N.P.K (75:150:150) | N.P.K (100:200:200) | Mean (B) | | |
| Control | 1.02 | 1.19 | 1.34 | 1.41 | 1.24 | 1.04 | 1.17 | 1.37 | 1.45 | 1.25 | | |
| Pot. Silic. 4 cm ³ /l | 1.16 | 1.30 | 1.49 | 1.64 | 1.39 | 1.19 | 1.32 | 1.48 | 1.68 | 1.41 | | |
| Pot. Silic. 6 cm ³ /l | 1.19 | 1.36 | 1.52 | 1.68 | 1.43 | 1.21 | 1.39 | 1.54 | 1.73 | 1.46 | | |
| Ca thio. 2 cm ³ /l | 1.06 | 1.21 | 1.36 | 1.43 | 1.26 | 1.06 | 1.19 | 1.39 | 1.48 | 1.28 | | |
| Ca thio. 3 cm ³ /l | 1.09 | 1.29 | 1.37 | 1.48 | 1.30 | 1.11 | 1.25 | 1.42 | 1.51 | 1.32 | | |
| Sal. acid 100 ppm | 1.11 | 1.22 | 1.38 | 1.46 | 1.29 | 1.09 | 1.24 | 1.40 | 1.50 | 1.30 | | |
| Sal. acid 200 ppm | 1.13 | 1.26 | 1.38 | 1.48 | 1.31 | 1.13 | 1.26 | 1.45 | 1.52 | 1.34 | | |
| Kinetin 50 ppm | 1.13 | 1.28 | 1.42 | 1.56 | 1.34 | 1.16 | 1.29 | 1.46 | 1.59 | 1.37 | | |
| Kinetin 100 ppm | 1.50 | 1.29 | 1.46 | 1.62 | 1.46 | 1.18 | 1.31 | 1.47 | 1.67 | 1.40 | | |
| Mean | 1.15 | 1.26 | 1.41 | 1.52 | | 1.13 | 1.26 | 1.44 | 1.57 | | | |
| LSD at 0.05 | A= 0.12 | | B= 0.18 | | A×B= 0.36 | | A= 0.10 | | B= 0.15 | | A×B= 0.30 | |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

Table 10. Effect of some growth substances and chemical fertilization on total carbohydrates % of *Matthiola incana* during 2018/2019 and 2019/2020 seasons.

| Growth substances (B) | 1 st season | | | | | 2 nd season | | | | | | |
|----------------------------------|----------------------------|--------------------|--------------------|---------------------|-----------|------------------------|--------------------|--------------------|---------------------|----------|-----------|--|
| | Chemical fertilization (A) | | | | | | | | | | | |
| | N.P.K (0:0:0) | N.P.K (50:100:100) | N.P.K (75:150:150) | N.P.K (100:200:200) | Mean (A) | N.P.K (0:0:0) | N.P.K (50:100:100) | N.P.K (75:150:150) | N.P.K (100:200:200) | Mean (B) | | |
| Control | 8.19 | 11.30 | 14.90 | 16.30 | 12.67 | 8.12 | 11.40 | 15.20 | 16.10 | 12.70 | | |
| Pot. Silic. 4 cm ³ /l | 10.30 | 13.90 | 16.20 | 17.80 | 14.55 | 11.10 | 14.30 | 16.50 | 18.10 | 15.00 | | |
| Pot. Silic. 6 cm ³ /l | 10.80 | 14.20 | 16.90 | 18.40 | 15.07 | 11.40 | 14.80 | 17.30 | 18.80 | 15.57 | | |
| Ca thio. 2 cm ³ /l | 9.21 | 11.80 | 15.20 | 16.50 | 13.17 | 8.62 | 11.90 | 15.60 | 16.70 | 13.20 | | |
| Ca thio. 3 cm ³ /l | 9.36 | 12.20 | 15.60 | 17.00 | 13.54 | 8.91 | 12.40 | 15.80 | 16.80 | 13.47 | | |
| Sal. acid 100 ppm | 9.62 | 11.80 | 16.00 | 16.80 | 13.55 | 9.32 | 12.10 | 16.00 | 17.10 | 13.63 | | |
| Sal. acid 200 ppm | 9.86 | 12.60 | 16.10 | 17.20 | 13.94 | 9.46 | 12.80 | 16.20 | 17.40 | 13.96 | | |
| Kinetin 50 ppm | 10.40 | 13.40 | 16.10 | 17.40 | 14.32 | 10.80 | 14.10 | 16.30 | 17.60 | 14.70 | | |
| Kinetin 100 ppm | 10.60 | 14.00 | 16.60 | 17.90 | 14.77 | 11.30 | 14.50 | 16.90 | 18.40 | 15.27 | | |
| Mean | 9.81 | 12.80 | 15.95 | 17.25 | | 9.89 | 13.14 | 16.20 | 17.44 | | | |
| LSD at 0.05 | A= 1.82 | | B= 2.73 | | A×B= 5.48 | | A= 1.63 | | B= 2.45 | | A×B= 4.89 | |

Pot. Silic.: potassium silicate; Ca thio.: calcium thiosulfate; Sal. acid: salicylic acid

tissues at the expense of the inhibitors. The stimulating effect of fertilization treatments may be due to the role of mineral fertilization in supplying the plants with their required nutrients for more carbohydrates and protein production which are necessary for vegetative growth and chemical composition of the plants (Marschner, 1997).

The aforementioned results of growth substances are in conformity with those reported by Youssef and Mady (2013) on *Aspidistra elatior*, Abd El Gayed (2019) on *Zinnia elegans* L. plants, Attia and Elbohy (2019) on pot marigold plants (*Calendula officinalis* L.), Mara (2017) on *Echinacea hybrids*, Mohamed (2017) on aster plant (*Symphotrichum novi-belgii* L.) cv. Purple Monarch, El-Kinany *et al.* (2019) on *Gaillardia pulchella* var. *pulchella*, Zheng *et al.* (2005) on chrysanthemum, Christos (2008) on oregano (*Origanum vulgares* ssp. *hirtum*), Kim *et al.* (2010) on *chrysanthemum morifolium*, Mirabbasi *et al.* (2013) on asiatic lily cv. Brunello, Armando *et al.* (2016) on lisianthus (*Eustoma grandiflorum*), Abou El-Ftough *et al.* (2018) on *Calendula officinalis* L., Elbohy *et al.* (2018) on *Zinnia elegans*, Mohammad Saeed *et al.* (2019) on gerbera, Abbass *et al.* (2020) on *Freesia hybrida*, Mohammed and Abood (2020) on *Gerbera jamesonii*, Saeed (2020) on *Gazania rigens* L. cv. Frosty Kiss, El-Kinany (2020) on *Viola wittrockiana*, and El-Ashwah (2020) on *Cortaderia selloana* plants.

The abovementioned results of fertilization are in harmony with those attained by Abd El-All (2011) on *Aspidistra elatior*, Summan *et al.* (2016) on *Salvia*, Abd El Gayed and Attia (2018) on *Celosia argentea*, Attia *et al.* (2018) on tuberose, Kwon *et al.* (2019) on *Platycodon grandiflorum*, Al-Rubaye and Khudair (2020) on gazania plant, Ashour *et al.* (2020) on *Dracaena marginata* 'Bicolor', Ghatas (2020) on *Coriandrum sativum* L. plant and Abou El-Ghait *et al.* (2020) on jasmine plant.

Conclusively, in order to produce good quality *Matthiola incana* L. plants it is preferable to spray the plants with kinetin at 100 ppm supplemented with mineral fertilization at 100 N: 200 P: 200 K kg/fed six times a year.

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تأثير بعض مواد النمو والتسميد الكيماوي على النمو الخضري والمحتوى الكيماوي لنبات المنثور

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أجريت هذه التجربة خلال موسمين متتاليين ٢٠١٨/٢٠١٩ و ٢٠١٩/٢٠٢٠ بمزرعة الزينة بقسم البساتين بكلية الزراعة جامعة بنها لدراسة تأثير الرش ببعض مواد النمو من مادة الكينتين وحمض الساليسيليك وثيوسلفات الكالسيوم وسيليكات البوتاسيوم وكذلك التسميد الكيماوي (النيتروجين والفوسفور والبوتاسيوم) على النمو الخضري والتركيب الكيماوي لنباتات المنثور لزيادة وتحسين جودة النبات لتزيين وتجميل الاحواض بالحدائق. أظهرت النتائج المتحصل عليها أن أطول النباتات وأكثرها قطراً للساق تم الحصول عليها بواسطة الرش بالكينتين بتركيز ١٠٠ جزء في المليون بالإضافة مع التسميد بالمستوى الأعلى من النيتروجين والفوسفور والبوتاسيوم في كلا الموسمين. كما تم تسجيل أكبر وزن للأوراق الطازجة والجافة/نبات أيضاً بواسطة الرش بالكينتين بتركيز ١٠٠ جزء في المليون بالإضافة مع التسميد بالمستوى الأعلى من النيتروجين والفوسفور والبوتاسيوم في كلا الموسمين. وكذلك أكبر عدداً للأفرع والأوراق/نبات تم تسجيلها بواسطة الرش بالكينتين بتركيز ١٠٠ جزء في المليون بالإضافة مع التسميد بالمستوى الأعلى من النيتروجين والفوسفور والبوتاسيوم في كلا الموسمين. كما أن أكبر محتوى للأوراق من النيتروجين والكاربوهيدرات تم الحصول عليها بواسطة الرش بالكينتين بتركيز ١٠٠ جزء في المليون بالإضافة مع التسميد بالمستوى الأعلى من النيتروجين والفوسفور

والبوتاسيوم في كلا الموسمين. بينما الأوراق الأكثر محتوى من الفوسفور تم الحصول عليها بواسطة الرش بـ حمض الساليسيليك بتركيز ٢٠٠ جزء في المليون بالإضافة مع التسميد بالمستوى الأعلى من النيتروجين والفوسفور والبوتاسيوم في كلا الموسمين. فيما تم الحصول على أعلى محتوى للبوتاسيوم في الأوراق بواسطة الرش الورقي بـ ٦ سم^٣ سيليكات البوتاسيوم بالإضافة مع التسميد بالمستوى الأعلى من النيتروجين والفوسفور والبوتاسيوم في كلا الموسمين. لذا، يوصى برش نباتات المنثور بالكينيتين عند ١٠٠ جزء في المليون والتسميد بالاسمدة الكيماوية (١٠٠ كجم نيتروجين: ٢٠٠ كجم فوسفور: ٢٠٠ كجم بوتاسيوم/فدان) للحصول على أفضل نمو زهري وجودة للأزهار من هذا النبات.