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INFLUENCE OF SOME GROWTH SUBSTANCES AND CHEMICAL FERTILIZATION ON FLOWERING AND CHEMICAL COMPOSITION OF *MATTHIOLA INCANA* L. PLANT

Eman M. Abou El-Ghait; A.O. Goma; A.S.M. Youssef, and Asmaa M.A. El-Nemr
Hort. Dept., Fac. Agric., Moshtohor, Benha University, Egypt

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Corresponding author:
A.S.M. Youssef
ahmed.youssef@fagr.bu.edu.eg

ABSTRACT: Two field trials were conducted during two successive seasons of 2018/2019 and 2019/2020 in the Floriculture Farm of Horticulture Department, Faculty of Agriculture, Benha University, Egypt to study the effects of spraying with some growth substances (kinetin, salicylic acid, calcium thiosulfate and potassium silicate) and chemical fertilization (N.P.K) as well as their combinations on flowering and some chemical constituents of *Matthiola incana* L. plants to enhance flowering quality for gardens bed ornamentation. The obtained results showed that spraying plants with 100 ppm kinetin in addition to NPK fertilization at the highest level (100 N: 200 P: 200 K kg/fed) resulted in the highest values in both seasons in case of fresh and dry weights of inflorescence and flowering portion, length and diameter of the flowering portion, number, diameter and fresh weight of florets, flowering duration, leaf total chlorophylls and total indoles content. This treatment, on the other hand, recorded the lowest values of leaves total phenols content. Conclusively, it is recommended to spray *Matthiola incana* L. plants with kinetin at 100 ppm supplemented with NPK chemical fertilization at 100 N: 200 P: 200 K kg/fed to obtain the best flowering quality for export.

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

INTRODUCTION

Matthiola is a genus of the Brassicaceae Family (Crucifera) which, 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 inflorescences 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. Salicylic acid, 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. These substances 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 to spray *Gerbera jamesonii* with calcium nitrate (500 mg l^{-1}) and salicylic acid (75 mg l^{-1}) to address this issue. As a result of this treatment, the 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 8 cm^3/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 control treatment.

Plant nutrition is one of the most important variables that influence 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 increasing flower production, floral quality, and finnes in the form of plant. The nutrition content affects flower quality (Boodley, 1975). Quality 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 for various growth agents and chemical fertilization affect the vegetative growth and chemical composition of *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 flowering and chemical composition of *Matthiola incana* L. plants in order to improve flowering and chemical composition. A field experiment was conducted in the Floriculture Farm of 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 seeds were obtained from the United States of America. The weight of 1000 seeds is 1.5 g, the germination rate is 93%, and the purity of the seeds is 99%. Seeds were sown in plastic trays filled with growing medium containing peat moss + perlite (1:1 by volume) on September 20th in both seasons. 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 into the field.

Procedures for conducting experiments:

Well-uniform established seedlings of *Matthiola incana* cv. Katz White were planted in the field soil after 40 days from seed sowing (on November 1st of 2018 and 2019 for the first and second seasons, respectively). Before planting, the soil was ploughed, and sand was added to the soil at a rate of 4 m^3/108 m^2, as well as calcium superphosphate. The field was divided into plots, each experimental plot unit size (1 m^2) containing six plants in two rows, with three plants in each row. Within each plot, the plant spacing was 25 cm^2 between plants and 50 cm^2 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 as follows: 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% P_2O_5) 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% K_2O) 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 other five additions 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 addition, 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 cm^3/l) and potassium silicate at three concentrations, (zero, 4 and 6 cm^3/l) were applied. Application of kinetin, salicylic acid, calcium thiosulfate and potassium silicate were carried out as a foliar spray for 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 a distilled water only. Spraying was done in the first hours of the day before the sunrise.

The experiment's layout:

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 (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 the 70% flowering stage from each plot at the end of those studies on March 1st for both seasons (after 155 - 160 days from seeds sowing), and the following data were recorded:

Parameters of flowering:

Number of florets/inflorescence, diameter of floret per inflorescence (cm), fresh weight of floret (g), fresh weight of inflorescence per plant (g), dry weight of inflorescence per plant (g), flowering portion height per plant (cm), diameter of flowering portion per plant (cm), fresh weight of flowering portion per plant (g) and dry weight of flowering portion per plant (g).

Determining chemical composition:

On the 1st of April for both seasons (after 125 - 130 days from planting the seeds), three plants were randomly chosen at 5% flowering from each plot during both seasons and the following data were recorded:

1. Pigments content (mg/100 g of fresh weight):

Chlorophylls a, b and carotenoids were determined in fresh leaf samples (mg/100 g FW) by using the colorimetric method (A.O.A.C, 1990).

2. Total indoles and phenols contents:

Total indoles and phenols contents were determined in fresh leaf samples (mg/100 g FW) by using the colorimetric method (A.O.A.C, 1990).

Statistical analysis:

All obtained data during both seasons of this study were subjected to analysis of variance as a factorial experiment in R.C.B.D., LSD at 0.05 level of property method was used to compare the differences between means according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Flowering growth parameters:

1. Fresh and dry weights of inflorescence (g):

Data listed in Tables (1 and 2) clear that all tested sprays of growth substances succeeded in increasing the fresh and dry weights of *Matthiola incana* inflorescence (g) as compared with un-sprayed plants in both seasons. In this regard, 100 ppm kinetin-sprayed plants gave the highest values of these parameters, followed by kinetin at 50 ppm in both seasons. On the other hand, there was a positive correlation

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

Growth substances (B)	1st season					2nd 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	52.52	74.93	90.13	101.08	79.66	53.63	76.41	90.17	98.63	79.71
Pot. Silic. 4 cm^3/l	88.86	130.87	148.58	171.40	134.92	88.37	130.20	144.33	171.22	133.53
Pot. Silic. 6 cm^3/l	96.26	131.29	156.59	172.89	139.25	94.92	133.33	154.62	176.11	139.74
Ca thio. 2 cm^3/l	78.42	122.02	136.74	145.26	120.61	79.11	118.14	137.06	146.40	120.17
Ca thio. 3 cm^3/l	87.04	130.10	145.44	167.01	132.39	85.89	127.28	145.37	170.51	132.26
Sal. acid 100 ppm	66.59	102.35	131.55	144.01	111.12	68.60	104.35	134.33	145.13	113.10
Sal. acid 200 ppm	76.46	116.63	140.27	157.63	122.74	78.56	124.35	145.71	156.13	126..18
Kinetin 50 ppm	91.66	130.65	158.96	183.13	141.10	95.34	133.68	155.07	180.99	141.27
Kinetin 100 ppm	102.05	137.42	163.35	186.13	147.23	106.38	137.82	163.69	183.88	147.94
Mean	82.20	119.58	141.29	158.72		83.42	120.61	141.15	158.77	
LSD at 0.05	A= 12.4		B= 18.6		A×B= 37.2	A= 11.7		B= 17.6		A×B=35.1

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

Table 2. Effect of some growth substances and chemical fertilization on dry weight of inflorescence (g)of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	8.08	14.58	17.29	18.89	14.71	7.51	14.16	17.17	18.61	14.36
Pot. Silic. 4 cm^3/l	16.81	18.81	21.78	25.78	20.79	16.44	19.28	22.24	25.62	20.89
Pot. Silic. 6 cm^3/l	17.22	19.13	23.77	26.14	21.56	18.24	20.23	23.45	26.86	22.19
Ca thio. 2 cm^3/l	13.10	18.85	21.09	22.33	18.84	15.24	18.94	20.44	23.52	19.53
Ca thio. 3 cm^3/l	14.48	19.36	22.60	25.25	20.42	16.95	19.86	23.13	24.77	21.17
Sal. acid 100 ppm	14.76	17.86	20.27	21.90	18.69	13.83	17.85	21.25	22.34	18.81
Sal. acid 200 ppm	16.49	18.94	22.24	23.91	20.39	15.03	18.14	22.57	22.40	19.53
Kinetin 50 ppm	16.99	19.71	23.69	28.78	22.29	17.35	19.96	22.86	27.59	21.94
Kinetin 100 ppm	18.42	20.73	25.01	28.83	23.24	19.21	20.63	23.87	28.77	23.12
Mean	15.15	18.66	21.97	24.64		15.53	18.78	21.88	24.49	
LSD at 0.05	A=2.04		B= 3.06		A×B= 6.12	A= 2.21		B= 3.32		A×B= 6.64

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

between the inflorescence fresh and dry weights values and fertilization levels, so the values of these parameters increased as the level of fertilization increased until reached the maximum increase at the highest level (100 N: 200 P : 200 Kg/fed). This trend was true in both seasons.

Furthermore, data presented in Tables (1 and 2) indicated that all the interactions between growth substances and chemical fertilization levels statistically increased inflorescence fresh and dry weights of *Matthiola incana* plants as compared with untreated plants in both seasons. In this concern, the heaviest fresh (186.13 and 183.88 g) and dry inflorescence (28.83 and 28.77 g) were recorded by 100 ppm kinetin-sprayed plants supplemented with NPK fertilization at the highest level treatment in the first and second seasons, respectively.

2. Fresh and dry weights of flowering portion (g):

Tables (3 and 4) show that all tested sprays of growth substances succeeded in increasing the fresh and dry weights of *Matthiola inccan* flowering portion 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 the kinetin at 50 ppm in both seasons.

It was interesting to observe that there was a positive correlation between the fresh and dry weights of flowering portion and chemical fertilization treatments. So, as the highest level of chemical fertilization increased the fresh and dry weights of flowering portion increased up to the maximum increase at the high level of chemical fertilization in both seasons (Tables, 3 and 4). In this regard, the heaviest fresh and dry weights of the flowering portion were recorded by 100 ppm kinetin-sprayed plants and fertilized with the highest level of NPK fertilization in both seasons.

3. Length and diameter of flowering portion (cm):

Data exhibited in Tables (5 and 6) declare that all tested growth substances and chemical fertilization treatments as well as their interactions increased the length and diameter of the flowering portion as compared with un-treated plants in both seasons. In this concern, the increment in the length and diameter were parallel to the applied concentration of kinetin and fertilization levels, so the highest concentration of kinetin or the highest level of fertilization significantly scored the highest length and diameter of flowering portion values when compared with un-treated plants in both seasons. In general, the tallest (33.33 and 22.00 cm) and thickest (9.76 and 9.93 cm) flowering portion were recorded by 100 ppm kinetin-sprayed plants joined with NPK fertilization at the highest level in the first and second seasons, respectively.

4. Number, diameter and fresh weight of florets:

Data presented in Tables (7, 8 and 9) clear that all tested growth substances treatments increased number, diameter and fresh weight of florets compared with un-treated plants in both seasons. In this concern, 100 ppm kinetin-sprayed plants scored the highest values of these parameters in both seasons. In parallel, number, diameter and fresh weight of floret increased with all tested levels of chemical fertilization, particularly the highest level in both seasons.

In brief, all interactions between growth substances and chemical fertilization treatments succeeded in increasing the number, diameter and fresh weight of floret as compared with control in the two seasons. In this sphere, the highest values of these parameters were scored by 100 ppm kinetin-sprayed plants supplemented with NPK fertilization at the high level in the first and second seasons, respectively.

Table 3. Effect of some growth substances and chemical fertilization on fresh weight of flowering portion (g) of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	42.96	59.52	68.68	78.34	62.36	40.44	65.54	69.36	73.96	62.32
Pot. Silic. 4 cm^3/l	55.20	87.96	92.84	101.30	84.32	58.04	81.02	102.14	104.12	86.32
Pot. Silic. 6 cm^3/l	57.42	94.26	103.14	114.14	92.24	60.10	103.14	112.28	116.90	98.10
Ca thio. 2 cm^3/l	54.08	89.32	91.54	99.76	83.66	57.28	87.96	89.40	101.52	84.04
Ca thio. 3 cm^3/l	54.86	92.54	98.96	103.72	87.52	58.26	95.48	96.76	106.12	89.14
Sal. acid 100 ppm	50.48	69.22	81.82	87.32	72.20	52.42	73.92	77.34	86.06	72.42
Sal. acid 200 ppm	53.22	89.74	91.66	93.70	82.08	55.00	87.76	93.00	96.08	82.96
Kinetin 50 ppm	63.62	99.08	102.76	108.78	93.56	60.40	106.48	107.04	110.50	96.10
Kinetin 100 ppm	64.58	105.02	106.24	118.28	98.52	67.68	109.90	116.34	119.64	103.38
Mean	55.14	87.40	93.06	100.58		56.62	90.12	95.96	101.64	
LSD at 0.05	A= 7.45		B= 11.18		A×B= 22.35	A= 6.74		B= 10.11		A×B= 20.22

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

Table 4. Effect of some growth substances and chemical fertilization on dry weight of flowering portion (g) of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	5.54	11.04	11.94	13.78	10.56	5.94	8.98	12.30	13.66	10.22
Pot. Silic. 4 cm^3/l	9.70	14.82	16.06	17.80	14.58	10.98	16.44	17.00	18.12	15.62
Pot. Silic. 6 cm^3/l	10.16	16.68	16.88	18.72	15.60	11.48	17.60	18.04	18.86	16.48
Ca thio. 2 cm^3/l	7.86	14.68	15.64	17.38	13.88	9.94	15.64	16.00	17.70	14.82
Ca thio. 3 cm^3/l	9.60	15.86	16.38	18.14	14.98	10.74	16.10	16.66	18.14	15.40
Sal. acid 100 ppm	7.66	12.32	13.04	14.00	11.74	9.26	13.82	13.94	14.88	12.96
Sal. acid 200 ppm	8.14	14.84	15.84	16.18	13.74	9.94	14.32	14.66	17.30	14.04
Kinetin 50 ppm	11.16	16.98	17.60	19.38	16.28	11.60	17.14	18.36	19.70	16.70
Kinetin 100 ppm	11.40	17.38	17.80	19.88	16.60	12.42	18.56	19.12	20.12	17.54
Mean	9.02	14.94	15.68	17.24		10.24	15.40	16.22	17.60	
LSD at 0.05	A= 1.17		B=1.76		A×B= 3.51	A= 1.23		B=1.85		A×B= 3.69

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

Table 5. Effect of some growth substances and chemical fertilization on flowering portion length (cm) plant of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	16.66	18.50	18.83	19.33	18.33	16.50	18.33	18.66	19.50	18.24
Pot. Silic. 4 cm^3/l	18.50	19.16	19.66	19.83	19.28	18.66	19.00	19.33	19.66	19.16
Pot. Silic. 6 cm^3/l	19.66	19.81	20.33	20.50	20.07	19.33	19.83	20.00	20.16	19.83
Ca thio. 2 cm^3/l	17.83	19.00	19.66	20.66	19.28	18.66	18.66	19.50	20.00	19.20
Ca thio. 3 cm^3/l	19.00	19.66	20.16	21.00	19.95	19.50	19.83	20.33	20.33	19.99
Sal. acid 100 ppm	18.16	19.83	20.33	21.00	19.83	17.66	20.00	20.33	20.66	19.66
Sal. acid 200 ppm	19.16	20.16	21.16	21.33	20.45	18.33	20.50	20.66	21.66	20.28
Kinetin 50 ppm	19.50	19.83	20.16	21.66	20.28	19.83	20.00	20.50	21.66	20.49
Kinetin 100 ppm	20.50	20.83	21.33	33.33	23.99	20.50	20.50	20.66	22.00	20.91
Mean	18.77	19.64	20.18	22.07		18.77	19.62	19.99	20.62	
LSD at 0.05	A= 0.78		B= 1.19		A×B= 2.34	A= 0.69		B=1.04		A×B=2.08

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

Table 6. Effect of some growth substances and chemical fertilization on diameter of flowering portion (cm) of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	6.88	8.06	8.20	8.26	7.85	6.40	8.00	8.10	8.43	7.73
Pot. Silic. 4 cm^3/l	7.76	8.60	9.26	9.43	8.76	8.43	8. 66	9.26	9.43	8.94
Pot. Silic. 6 cm^3/l	8.10	8.63	9.50	9.70	8.98	8.56	8. 73	9.33	9.50	9.03
Ca thio. 2 cm^3/l	7.43	8.50	8.60	8.66	8.29	7.56	8.40	8.66	9.00	8.40
Ca thio. 3 cm^3/l	7.83	8.83	8.96	9.33	8.73	8.00	8.76	9.10	9.16	8.75
Sal. acid 100 ppm	7.00	8.33	8.33	8.40	8.01	7.50	8.38	8.66	8.70	8.31
Sal. acid 200 ppm	8.06	8.50	8.66	9.16	8.28	7.84	8.60	8.83	9.00	8.56
Kinetin 50 ppm	8.22	8.83	9.50	9.60	8.59	8.66	8.96	9.53	9.70	9.21
Kinetin 100 ppm	8.83	9.16	9.46	9.76	9.30	9.10	9.33	9.83	9.93	9.54
Mean	7.79	8.60	8.97	9.14		8.00	8.64	9.03	9.20	
LSD at 0.05	A= 0.27		B= 0.41		A×B=0.82	A= 0.21		B=0.32		A×B= 0.64

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

Table 7. Effect of some growth substances and chemical fertilization on No. of florets/ inflorescence of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	13.33	15.33	15.66	17.66	15.49	12.33	15.33	16.00	16.66	15.08
Pot. Silic. 4 cm^3/l	17.33	18.00	18.33	18.66	18.08	17.33	17.33	18.00	18.00	17.66
Pot. Silic. 6 cm^3/l	18.00	18.66	19.00	19.33	18.74	18.00	18.33	18.66	19.33	18.58
Ca thio. 2 cm^3/l	16.66	17.00	17.33	17.66	17.16	17.00	17.66	17.66	18.33	17.66
Ca thio. 3 cm^3/l	17.33	17.66	18.33	18.66	17.99	18.00	18.33	18.66	19.00	18.49
Sal. acid 100 ppm	16.00	16.33	16.66	17.33	16.58	17.00	17.33	17.66	18.00	17.49
Sal. acid 200 ppm	16.66	17.00	17.66	18.66	17.49	17.33	17.66	18.00	18.66	17.91
Kinetin 50 ppm	18.33	18.66	18.66	20.33	18.99	18.33	18.66	19.00	19.33	18.83
Kinetin 100 ppm	18.66	19.00	19.66	20.66	19.49	19. 00	19. 33	19.66	20.33	19.58
Mean	16.92	17.51	17.92	18.77		17.14	17.77	18.14	18.62	
LSD at 0.05	A= 0.18		B= 0.27		A×B=0.54	A= 0.15		B=0.23		A×B= 0.46

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

Table 8. Effect of some growth substances and chemical fertilization on fresh weight of floret (g) of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	1.93	2.33	2.27	2.48	2.25	1.87	2.08	2.40	2.56	2.22
Pot. Silic. 4 cm^3/l	2.30	3.31	3.09	3.41	3.02	2.21	3.01	3.17	3.44	2.95
Pot. Silic. 6 cm^3/l	2.35	3.14	3.37	3.42	3.07	2.39	3.31	3.33	3.53	3.14
Ca thio. 2 cm^3/l	2.16	2.78	2.93	3.13	2.75	2.17	2.87	3.00	3.33	2.84
Ca thio. 3 cm^3/l	2.28	3.00	3.12	3.61	3.00	2.18	3.03	3.10	3.27	2.89
Sal. acid 100 ppm	1.86	2.45	2.52	2.60	2.35	1.93	2.47	2.56	2.76	2.43
Sal. acid 200 ppm	2.18	2.87	3.09	3.12	2.81	2.08	2.84	2.91	3.25	2.77
Kinetin 50 ppm	2.36	3.39	3.42	3.49	3.16	2.32	3.55	3.56	3.63	3.26
Kinetin 100 ppm	2.41	3.50	3.51	3.59	3.25	2.48	3.59	3.60	3.73	3.35
Mean	2.20	2.97	3.03	3.20		2.18	2.97	3.07	3.27	
LSD at 0.05	A= 0.11		B= 0.17		A×B=0.34	A= 0.13		B=0.20		A×B= 0.40

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

Table 9. Effect of some growth substances and chemical fertilization on diameter of floret (cm) of *Matthiola incana* L. plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	4.23	4.66	4.76	4.86	4.62	3.93	4.40	4.66	4.83	4.45
Pot. Silic. 4 cm^3/l	4.80	5.30	5.76	6.23	5.52	4.60	5.23	6.00	6.20	5.50
Pot. Silic. 6 cm^3/l	5.06	5.66	5.83	6.33	5.72	4.86	5.46	6.16	6.26	5.68
Ca thio. 2 cm^3/l	4.76	5.23	5.33	5.66	5.24	4.66	5.26	5.93	6.06	5.47
Ca thio. 3 cm^3/l	4.86	5.46	5.70	6.06	5.52	4.90	5.30	6.10	6.16	5.61
Sal. acid 100 ppm	4.66	4.96	5.16	5.60	5.09	4.60	4.66	5.33	5.60	5.04
Sal. acid 200 ppm	4.70	5.10	5.50	6.00	5.32	4.76	4.96	5.70	5.86	5.32
Kinetin 50 ppm	4.83	5.56	6.13	6.23	5.68	4.90	5.56	6.26	6.33	5.76
Kinetin 100 ppm	5.23	5.76	6.26	6.30	5.88	5.13	5.66	6.43	6.50	5.93
Mean	4.79	5.29	5.60	5.91		4.70	5.16	5.84	5.97	
LSD at 0.05	A= 0.14		B= 0.21	A×B=0.42		A= 0.18		B=0.27	A×B= 0.54	

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

5. Duration of flowering:

Data in Table (10) indicate that kinetin at both concentrations achieved the highest flowering duration, followed by potassium silicate at 6 cm/l in both seasons. opposite un-treated plants scored the lowest values of this parameter in most cases by salicylic acid at 100 ppm in the two seasons. The remained treatments occupied an intermediate position between the aforementioned treatments in both seasons. Concerning the effect of chemical fertilization, data in Table (10) show that the duration of flowering was increased in the two seasons, due to the three used levels of chemical fertilization over those of control plants, with superiority for the high level (100 N : 200 P : 200 K kg/fed) in the two seasons. As for the interaction effect between growth substances and chemical fertilization treatments, data in the same Table (10) reveal that all the combinations between growth substances and chemical fertilization succeeded in increasing the flowering duration of Matthiola plant in both seasons. Generally, the combined treatment between kinetin at 100 ppm and chemical fertilization at the highest level gave the highest flowering duration as it scored 65.00 and 66.66 days, in the first and second seasons, respectively.

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 to act as a sink in which nutrients from other parts of the plant are drawn (Salisbury and Ross, 1974).

Chemical constituents:

1. Leaves total chlorophylls and indoles contents (mg/100 g fw):

Data listed in Tables (11 and 12) show that all tested treatments of growth substances, chemical fertilization and their combinations succeeded in increasing leaves

Table 10. Effect of some growth substances and chemical fertilization on duration of flowering (day) of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	25.66	28.33	35.00	38.33	29.33	26.66	28.66	33.66	39.33	32.07
Pot. Silic. 4 cm^3/l	32.66	38.33	42.33	46.66	39.99	38.00	40.33	43.66	47.00	42.24
Pot. Silic. 6 cm^3/l	38.88	41.00	44.00	48.66	43.13	41.00	43.00	47.66	49.33	45.24
Ca thio. 2 cm^3/l	34.66	35.00	38.00	43.66	37.83	34.00	36.66	39.33	42.66	38.16
Ca thio. 3 cm^3/l	36.66	38.66	41.33	45.00	40.41	38.66	39.66	43.00	45.66	41.74
Sal. acid 100 ppm	29.00	32.66	35.00	39.66	34.08	30.00	32.00	36.33	38.33	34.16
Sal. acid 200 ppm	33.33	35.66	38.66	41.00	37.16	33.33	35.66	39.00	41.00	37.24
Kinetin 50 ppm	40.00	47.00	50.00	55.33	48.08	42.00	48.00	51.33	58.00	49.83
Kinetin 100 ppm	43.66	54.33	58.66	65.00	55.41	45.66	52.00	60.00	66.66	56.08
Mean	34.94	38.99	42.55	47.03		36.59	39.55	43.77	47.55	
LSD at 0.05	A= 3.17		B= 4.76		A×B=9.51	A= 2.87		B=4.31		A×B= 8.62

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

Table 11. Effect of some growth substances and chemical fertilization on total chlorophylles (mg/100 g fw) of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	119	128	139	156	136	113	125	136	152	132
Pot. Silic. 4 cm^3/l	128	134	151	168	145	125	135	148	164	143
Pot. Silic. 6 cm^3/l	134	141	158	175	152	131	139	155	172	149
Ca thio. 2 cm^3/l	126	137	143	163	142	127	129	144	161	140
Ca thio. 3 cm^3/l	131	140	147	167	146	129	133	150	168	145
Sal. acid 100 ppm	124	134	148	165	143	121	132	142	167	141
Sal. acid 200 ppm	129	139	150	171	147	126	137	149	170	146
Kinetin 50 ppm	136	145	162	179	156	134	141	160	176	153
Kinetin 100 ppm	141	148	168	186	161	139	146	169	184	160
Mean	130	138	152	170		127	135	150	168	
LSD at 0.05	A= 6.14		B= 15.7		A×B=31.3	A= 5.29		B=7.94		A×B= 15.9

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

Table 12. Effect of some growth substances and chemical fertilization on total indoles (mg/100 g fw) of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	214	249	271	280	254	219	246	273	283	255
Pot. Silic. 4 cm^3/l	234	260	276	290	265	231	262	281	287	265
Pot. Silic. 6 cm^3/l	239	268	279	294	270	236	265	286	289	269
Ca thio. 2 cm^3/l	219	251	273	286	257	226	249	276	284	259
Ca thio. 3 cm^3/l	226	259	276	287	262	231	256	279	286	263
Sal. acid 100 ppm	231	256	275	282	261	230	257	274	286	262
Sal. acid 200 ppm	234	258	277	286	264	237	261	278	288	266
Kinetin 50 ppm	246	271	282	296	274	249	273	289	291	276
Kinetin 100 ppm	251	279	289	299	280	256	278	291	296	280
Mean	233	261	278	289		235	261	281	288	
LSD at 0.05	A= 12. 7		B= 19. 1		A×B=38. 2	A= 11.4		B=17.1		A×B= 34.2

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

total chlorophylls and indoles (mg/100 g fw) as compared with control in both seasons. In this concern, the highest leaf total chlorophylls content (186 and 184 mg/100 g fw) and the richest leaves total indoles content (299 and 296 mg/100 g fw) were recorded by 100 ppm kinetin-sprayed plants supplemented with chemical fertilization at the highest level in the first and second seasons, respectively. Additionally, kinetin at 50 ppm and potassium silicate at 6 cm/l supplemented with the highest level of chemical fertilization induced high increments in this concern in the two seasons.

2. Leaves total phenols content (mg/100 g fw):

Data shown in Table (13) indicates that all tested growth substances treatments decreased leaves total phenols content, with superior for kinetin and potassium silicate treatments as compared with un-treated plants in both seasons. Also, the decrements of leaves' total phenols content were parallel to the increase of chemical fertilization level to reach the maximum decrease at the highest level in both seasons. Generally, all resulted interactions between growth substances and chemical fertilization treatments statistically decreased the values of this parameter as compared with control in both seasons. In this respect, the lowest values of leaves' total phenols content (112 and 108 mg/100 g fw) were recorded by 100 ppm kinetin-sprayed plants supplemented with NPK fertilization at the highest level, in the first and second seasons, respectively.

On contrary, the highest values of leaves' total phenols content were gained by those sprayed plants with tap water and received no chemical fertilization treatments as they recorded 194 and 191 mg/100 g fw in the first and second seasons, respectively. The remained treatments occupied an intermediate position between the abovementioned treatments in the two seasons of this study.

Table 13. Effect of some growth substances and chemical fertilization on leaves total phenols content (mg/100 g fw) of *Matthiola incana* plant during 2018/2019 and 2019/2020 seasons.

Growth substances (B)	1st season					2nd 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	194	176	137	123	158	191	179	131	120	155.25
Pot. Silic. 4 cm^3/l	187	169	132	120	152	186	154	129	115	146
Pot. Silic. 6 cm^3/l	186	163	131	118	150	183	149	128	113	143
Ca thio. 2 cm^3/l	189	173	134	121	154	189	162	130	119	150
Ca thio. 3 cm^3/l	187	171	132	119	152	188	159	127	117	148
Sal. acid 100 ppm	192	168	134	119	153	187	168	129	118	151
Sal. acid 200 ppm	191	165	133	118	152	187	163	128	116	149
Kinetin 50 ppm	186	159	129	117	148	181	146	126	111	141
Kinetin 100 ppm	181	156	124	112	143	178	141	121	108	137
Mean	188	167	132	119		186	158	128	115	
LSD at 0.05	A=13.3		B= 20.0		A×B= 40.0	A= 11.9		B= 17.9		A×B= 35.7

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

As for the explanation of the incremental effect of kinetin on the growth and chemical constituents of Matthiola plant, it could be illustrated here on the basis that kinetin treatments stimulated the endogenous cytokinins synthesis and there is an intimate relationship between cytokinins and chlorophylls metabolism in both excided or detached leaf disks and intact plants i.e., cytokinins retard chlorophylls degradation, preserve it and increase its synthesis (Devlin and Witham, 1983). Besides, cytokinins activate a number of enzymes participating in a wide range of metabolic reactions in the leaves. These reactions included the maturation of proplastid into chloroplasts. These enzymes could be divided into two groups according to their response to cytokinins. The first group of enzymes could be said to relate to chloroplast differentiation, while the second one could be related to cytokinin stimulated group (Kulaeva, 1979). Also, these results may explain the role of cytokinins on promoting proteins 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 Leopol 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 tissues at the expense of the inhibitors. In this concern, Kenneth (1979) reported that total control of plant growth is vested not in a single hormonal type – that of auxin – but is shared by several special auxins, cytokinins, gibberellins and ethylene and this further subjected to namely the phenols, flavons and absicsic acid. 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 proteins production which are necessary for vegetative, flowering 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 (*Symphyotrichum novi-belgii* L.) cv. Purple Monarch, El-Kinany *et al.* (2019) on *Gaillardia pulchella* var. *pulchella* , Zheng *et al.* (2005) on chrysanthemum plants, Christos (2008) on oregano (*Origanum vulgare*s ssp. *hirtum*), Kim *et al.* (2010) on *chrysanthemum morifolium*, Mirabbasi *et al.* (2013) on *Asiatic lily* cv. Brunello plant, Armando *et al.* (2016) on lisianthus (*Eustoma grandiflorum*), Abou El-Ftouh *et al.* (2018) on *Calendula officinalis* L., Elbohy *et al.* (2018) on *Zinnia elegans* plants, Mohammad Saeed *et al.* (2019) on gerbera, Abbass *et al.* (2020) on *Freesia hybrida* plants, Mohammed and Abood (2020) on *Gerbera jamesonii*, Saeed (2020) on *Gazania rigens* L. cv. Frosty Kiss, El-Kinany (2020) on *Viola wittrockiana*, El-Ashwah (2020) on *Cortaderia selloana* plants and Abou El-Ghait *et al.* (2021) on *Hippeastrum vittatum* plant.

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 plants, Kwon *et al.* (2019) on *Platycodon grandiflorum*, Al-Rubaye and Khudair (2020) on gazania plant, Ashour *et al.* (2020) on *Dracaena marginata* 'Bicolor', Abou El-Ghait *et al.* (2020) on jasmine plant and Abou El-Ghait *et al.* (2021) on *Hippeastrum vittatum* plant.

Conclusively, in order to produce good quality *Matthiola incana* 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.

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

إيمان مختار أبو رالغيط ، أنور عثمان جمعه ، أحمد سعيد محمد يوسف ، أسماء محمد عبدالسميع النمر

قسم البساتين ، كلية الزراعة ، جامعة بنها، مصر

أجريت تجربتان خلال موسمين متتاليين ٢٠١٩/٢٠١٨ و ٢٠٢٠/٢٠١٩ في مزرعة الزينة بقسم البساتين بكلية الزراعة جامعة بنها، مصر لدراسة تأثير الرش ببعض مواد النمو من مادة الكينيتين وحمض الساليسيليك وثيوسلفات الكالسيوم وسيليكات البوتاسيوم وكذلك التسميد الكيميائي (النيتروجين والفوسفور والبوتاسيوم) والتداخل بينهم على النمو الزهري والتركيب الكيماوي لنباتات المنثور لزيادة وتحسين جودة الأزهار لهذا النبات لتزيين وتجميل الأحواض بالحدائق.
أظهرت النتائج المتحصل عليها أن أكبر وزن للشمراخ الزهري والجزء المزهر الطازج والجاف تم تسجيلها بواسطة الرش بالكينتين بتركيز ١٠٠ جزء في المليون بالإضافة إلى التسميد بالمستوى الأعلى من النيتروجين والبوتاسيوم والفوسفور في كلا الموسمين. وتم تسجيل الجزء الأطول والأكثر سمكاً من الجزء المزهر بواسطة الرش بالكينتين بتركيز ١٠٠ جزء في

المليون بالإضافة إلى التسميد بالمستوى الأعلى من النيتروجين والبوتاسيوم والفوسفور في كلا الموسمين. وتم تسجيل أعلى قيم لعدد وقطر والوزن الطازج للزهيرات بواسطة الرش بالكينتين بتركيز١٠٠ جزء في المليون بالاضافة مع التسميد بالمستوى الأعلى من النيتروجين والبوتاسيوم والفوسفور في كلا الموسمين . أعطت المعاملة المشتركة بين الكينتين عند ١٠٠ جزء في المليون والمستوى الأعلى من التسميد الكيميائي من النيتروجين والبوتاسيوم والفوسفور أطول فترة إزهار للنباتات في كلا الموسمين. تم تسجيل أعلى نسبة من الكلوروفيل الكلي و الإندولات الكلية لمحتوى الأوراق عند الرش بالكينتين بتركيز ١٠٠ جزء في المليون بالاضافة إلى التسميد بالمستوى الأعلى من النيتروجين والفوسفور والبوتاسيوم في كلا الموسمين. 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 بغرض التصدير.