

EFFECT OF NPK, POTASSIUM SILICATES APPLICATION AND MAGNESIUM SPRAY IN ROSE PLANTS

Rana Moussa Jawad ^{*1}  , Nazik Haki Khalil ²  

^{*1} Department of Horticulture and Landscape Design - College of Agricultural Engineering Sciences - University of Baghdad

ABSTRACT

A study was carried out on rose's transplants, orange-colored Wiener Charme variety, one and a half years old, in one of lath house of research station (B) belong to Department of Horticulture and Landscape Engineering / College of Agricultural Engineering Sciences / University of Baghdad, in spring and autumn seasons of 2022, and an experiment was carried out. A three-factor factorial within a randomized complete block design (RCBD). Factors included chemical fertilization (NPK) without fertilization (C₀), fertilization at 100% of fertilizer recommendation (C₁₀₀), and addition of potassium silicate at three levels; 0 (S₀) 200 mg.L⁻¹(S₂₀₀) 300 mg.L⁻¹ (S₃₀₀). Third factor was foliar spraying with Disper Mg solution as a source of magnesium (M) at concentrations of 0 (M₀) 0.75 g.L⁻¹ (M_{0.75}) and 1.5 g.L⁻¹ (M_{1.5}). Results showed that triple interaction (C₁₀₀M_{1.5}S₃₀₀) excelled in vegetative traits for two seasons of study with highest increase in leaves number, leaves area and leaves carbohydrates content (106.50-113.50 leaves, 46.92-67.76 dm² and 9.84 - 8.52%) respectively, same treatment also excelled in vase life, anthocyanin pigment, and total sugars (6.50 - 7.00 days, 274.8-311.3 mg.100 g, and 9.31– 10.17%) respectively.

Key words: carbohydrates, chemical content, flower, leaves, ornamental plants, vase life

***part of Ph.D. Dissertation for first authors.**



Copyright© 2025. The Author (s). Published by College of Agricultural Engineering Sciences, University of Baghdad. This is an open-access article distributed under the term of the Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cite.

Received: 26/2/2024, Accepted: 22/5/2024, Published: 30/4/2026

INTRODUCTION

Fertilizing rose bushes has a significant impact on improving growth characteristics and flowers quality, especially largest ones, in addition to using various compounds that have biologically active characteristics that improve productivity in plants and enhance their growth and development under normal conditions and under various conditions of stress, as they contain a number of organic compounds that are essential for plant and that stimulate its growth, increase utilization of nutrients, increase plant's efficiency, enhance its endurance, and increase its flowering (Hosseini, 2019; Rouphael and Colla. 2020). Rose plant needs frequent additions with plant nutrients for its growth, development, and good flower production. (Manimaran et al.,

2017) Pointed out mineral nutrient requirements of macro- and microelements for rose plants to ensure their growth and prosperity in every season, which must be comprehensive of macro- and microelements. Compound fertilizer (NPK) consists of appropriately chemically manufactured fertilizer materials as sources of nitrogen, phosphorus, and potassium. These elements are mixed together physically, and percentages for these three elements are written on bag or on fertilizer package. Percentages indicating its content of nitrogen (N), phosphorus (P₂O₅), and potassium (K₂O). This fertilizer can also be prepared in desired proportions according to type of plant, its growth stage, age, soil fertility and type, amount of water available, and irrigation method used. This fertilizer is

important due to importance of mineral elements present in it for plant growth and production (Al-Hadethi et al., 2020, Barlog et al., 2023). Several studies have been conducted to determine effect of NPK fertilizers in growth and flowering in rose plants, in an experiment that included adding four levels of humic acid and four fertilizer levels of NPK fertilizer, which were 0, 0.5, 1, and 1.5%, to rose plants *Rosa hybrida* L, Santrix variety, for two seasons, (El-Naggar and Imhmd (2023) found that addition at the level 1% was highest in plants height, leaves number, concentration of chlorophyll pigment, percentage of carbohydrates, for two experiment seasons. Conducted an experiment aimed to improve flower productivity and concentration of N, P, K elements in nutrient solution, and foliar application of plant growth promoters (PGP) on *Rosa Damascene* and found that NPK fertilizer significantly increased in number of flowers, Dry matter percentage and flower diameter in plants fed with a high nitrogen nutrient solution (N₂). Potassium silicate is a group of inorganic compounds composed of elements silicon, oxygen, and potassium, there is no single formula, because proportions between these elements are different, but most common of them is K₂SiO₃, which exists in form of a white crystalline solid (Ram, 2022). Potassium silicate compound activates internal resistance of plant against adverse climatic conditions, whether cold waves or extreme heat. The silicon element also works to strengthen root cells and increase their hardness, thus resisting penetration of fungal infections into them, regular use of compound reduces chances of fungal infection occurring and protects plant from environmental stresses, such as high temperature, frost, drought and salinity. Adding it also reduces chances of plant losing water and increases roots spread, in addition to being environmentally safe and suitable under organic farming systems. It also plays a role in preparing nutrients such as N, Ca, P, B, and Zn as a result of its role in increasing CEC, which makes nutrients it, makes plant more ready and also improves selective ratio of potassium to sodium (Abdul Munir et al., 2023 and Al-Hamadani and Joody,2021). This element also

has a major role in ornamental plants, especially flowering plants, as adding silicon increases vases life and increases rigidity and flexibility of stem flower, as well as delaying decomposition of petals pigments, thus increasing marketing value of cut flowers, as well as increasing beauty of the flowers as a result of delaying degradation of its pigments (Kumari et al., 2023). Many studies were conducted to find out effect of potassium silicate in growth and flowering of ornamental plants, In a study conducted by (Hwang et al., 2005) on rose bushes, *Rosa hybrida* to determine effect of potassium silicate at a concentration of 200 mg.L⁻¹, by adding it soil, spraying, or both together, and comparing it to not adding, they found that soil addition had a significant effect on increasing flowers number and flower stem length compared to no addition. Abd El Gayed and Knany (2020) also found that potassium fertilizer was sprayed in three forms, potassium sulphate, potassium nitrate, and potassium silicate, and at three levels for each form, were 1, 2, and 3 ml.L⁻¹, and compared to not spraying, it had a significant effect on *Antirrhinum majus* L. plants for two seasons, especially spraying potassium silicate at level of 3 ml.L⁻¹, which gave a significant superiority in plant height, shoots number, chlorophyll pigment, and weight of fresh and dry plants in comparison with comparison plants and for two experimental seasons. Magnesium is one of elements that come directly in terms of importance after nitrogen, phosphate fertilizers, and potassium. Magnesium has been known as a nutritional element since 1860, and its forms available to plants in soil are the forms dissolved in water and exchangeable on colloids surfaces. It is likely to be found in a slowly available form and balanced with mutual part of it (Biswas, 2021). Magnesium is involved in many cellular physiological activities, especially transfers of active phosphate groups and activates ATP molecule. This element is an essential component of chlorophyll molecule; it constitutes approximately 2.7% of weight of molecule, so it has a major role in photosynthesis. Likewise, magnesium it participates in process of sugars forming and

transporting carbohydrates. It also contributes to process of regulating osmotic potential in plants, in addition to its role in stimulating formation of plant hormones. Because of movement of its diffusible part and its rapid transfer from old parts of plant to new growth, so symptoms of its deficiency appear on lower leaves of plant first, as it produces yellowing between leaves veins as a result of failure to build chlorophyll (Ferreira, 2023). There are a number of studies that aimed to determine effect of spraying magnesium on growth and flowering of ornamental plants, Pal and Mahajan (2017) conducted a study to determine effect of pruning and spraying with four levels of magnesium sulphate (10, 15, and 20 g.L⁻¹) for two seasons, in addition to spraying with water only on growth and flowering of rose (*Rosa damascena* Mill.) they found that spraying with magnesium sulphate had a significant effect in increasing flowers number and total number of flowers and reducing number of blind branches compared to not spraying. In another study, (Punitha et al., 2023) indicated that spraying carnation plants (*Dianthus caryophyllus* L.), with a number of nutrients, including 2.5 gm of magnesium sulfate, showed that spraying increased concentration of chlorophyll in leaves and their content of phosphorus, nitrogen, and potassium. This experiment aims to investigate effect of addition of NPK, potassium silicate and spraying Disper Mg on growth and flowering characteristics of rose plants.

MATERIALS AND METHODS

The experiment was carried out in spring and fall seasons of 2022 at research station (B) in one of shades belonging to Department of Horticulture and Landscape Engineering / College of Agricultural Engineering Sciences / University of Baghdad, with the aim of improving growth and flowering of shrub rose plant (Wiener Charme) cultivar by adding chemical fertilization with NPK fertilizer and Potassium silicates, in addition to foliar spraying with compound (Disper Magnesium). The experiment site was cleaned; soil was leveled, and covered with polyethylene to ensure cleanliness of site and prevent weeds growth, as well as to retain moisture. The

canopy was covered with saran to reduce intensity of light radiation. Factors of study experiment included addition of two levels of NPK (without addition (C₀) and 5 g. plant⁻¹ (C₁₀₀), potassium silicate was added with three levels; without added (S₀), adding at 200 mg.L⁻¹ (S₂₀₀) and adding at 300 mg.L⁻¹ (S₃₀₀). As for magnesium fertilizer treatments, they were sprayed in three levels; without sprayed (S₀), spraying at 0.75 g.L⁻¹ (M_{0.75}) and spraying at 1.5 g.L⁻¹ (M_{1.5}). A total of 216 plants were employed in factorial experiment in an RCBD since treatments were replicated three times (with four plants in each experimental unit). Elshookie and Wuhaib (1990) statistical analysis of the study's outcomes involved comparing averages using (L.S.D.) at 0.05. The following parameters were determined in experimental season:

1. Vegetative characteristics (leaves number, leaves area and leaves carbohydrates content according to (Joslyn, 1970)
2. Flowering characteristics (vase life, petals anthocyanin content according to (Abbas and Abbas, 1992) and petals sugars content according to (Joslyn, 1970).

RESULTS AND DISCUSSION

Effects of addition NPK fertilizer, potassium silicate and spraying with magnesium and their interaction on leaves number, leaves area and leaves carbohydrates content in rose plants: Data concerning effect of treatments on leaves number, leaves area and leaves carbohydrates content are listed in Tables (1, 2 and 3). The data cleared that, NPK chemical fertilizers at 5 g.L⁻¹(C₁₀₀) significantly increased in leaves number of 92.78 and 103.05 leaf.plant⁻¹, leaves area of 54.44 and 58.67 dm² and leaf carbohydrates content of 8.77 and 7.84 % for two seasons, respectively while lower values of these traits was in C₀ treatment. Tables (1,2 and 3) also shows that potassium silicate application, showed significant superiority in increased in leaves number of 90.75 and 98.75 leaf.plant⁻¹, leaves area of 55.15 and 57.61 dm² and leaf carbohydrates content of 9.30 and 8.08 % for two seasons, respectively. Magnesium spray especially spraying at 15 g.L⁻¹ excelled in increasing of leaves number of 90.43 and 99.98 leaf.plant⁻¹, leaves area of 53.36 and 58.31 dm² and leaf carbohydrates

content of 8.78 and 7.97 % for two seasons, respectively. The interactions between NPK and potassium silicate application significantly affected in these traits especially interaction treatment (C₁₀₀S₃₀₀) and gave highest increased in leaves number of 98.33 and 108.66 leaf.plant⁻¹, leaves area of 60.67 and 63.33 dm² and leaf carbohydrates content of 9.57 and 8.31 % for two seasons, respectively. Interactions between NPK fertilizers and magnesium spray significantly affected especially when interaction treatment (C₁₀₀M_{1.5}) and gave 98.33 and 108.91 leaf.plant⁻¹ as increased in leaves number, 58.96 and 63.09 dm² as leaves area and 9.03 and 8.07 % as leaf carbohydrates content for two seasons, respectively. Interaction between potassium silicate treatments and magnesium spray especially interaction treatment (S₃₀₀M_{1.5}) as it gave highest leaves number of 97.75 and 100.75 leaf.plant⁻¹, leaves area of 59.65 and 62.44 dm² and leaf carbohydrates content of 9.50 and 8.39 % for two seasons, respectively. Triple interactions between study factors had a significant effect in these traits. This increase in studied vegetative growth characteristics (Tables 1-3) can be attributed to role played by chemical fertilizer NPK in plant's physiological processes. This role comes by encouraging work of enzymes and transferring products of photosynthesis process, such as carbohydrates (Table 3). In addition to role of this fertilizer in cell division and elongation, which greatly affects

nutritional status of plants and their vegetative growth in general, addition of this compound fertilizer also led to an increase in the absorption of elements from the soil (Khalil, 2023), which is reflected positively in vegetative characteristics. These results also indicated that adding potassium silicate had a significant effect in increasing the vegetative growth characteristics of rose bushes. This may be due to role of silicon in maintaining good water content by partially closing stomata and reducing transpiration processes, in addition to increasing readiness of nutrients and then increasing cell division and elongation, thus increasing vegetative growth (Zargar et al., 2019). These results may also be due to spraying magnesium, as this element is involved in many cellular physiological activities, especially transfer reactions of active phosphate groups and activates ATP molecule. This element is an essential component of chlorophyll molecule, which means an increase in process of photosynthesis and construction of carbohydrates. Consequently, this increase in characteristics of vegetative growth occurs. Magnesium also participates in process of forming sugars and transporting carbohydrates. It also contributes to process of regulating osmotic potential in plant, in addition to its role in stimulating formation of plant hormones, which contribute to increasing vegetative growth of shrub rose plants (Adnan et al., 2021; Ferreira, 2023).

Table 1. Effects of addition of NPK, potassium silicate and spraying with magnesium and their interaction on leaves number (leaf.plant⁻¹) in rose plants

Chemical fertilizer (C)	Magnesium spray (M)	Spring 2022				Fall 2022			
		Potassium Silicates (S)			C × M	Potassium Silicates (S)			C × M
		S ₀	S ₂₀₀	S ₃₀₀		S ₀	S ₂₀₀	S ₃₀₀	
C ₀	M ₀	73.25	76.50	80.00	76.58	78.00	83.00	87.50	82.83
	M _{0.75}	77.00	79.75	83.50	80.08	85.50	89.25	91.00	88.85
	M _{1.5}	77.25	80.75	89.00	82.33	89.00	96.25	88.00	91.08
C ₁₀₀	M ₀	84.75	87.00	91.50	87.75	88.50	97.00	102.0	95.53
	M _{0.75}	89.50	93.25	94.00	92.25	98.50	104.2	110.0	104.4
	M _{1.5}	87.25	101.2	106.5	98.33	104.5	108.7	113.5	108.9
LSD 5%			21.53		12.44		6.26		3.61
C × S					C		C × S		C
	C ₀	75.83	79.00	84.16	79.67	84.16	89.50	88.83	87.49
	C ₁₀₀	87.17	93.83	97.33	92.78	97.16	103.3	108.6	103.0
LSD 5%			12.44		7.18		3.61		2.09
M × S					M		M × S		M
	M ₀	79.00	81.75	85.75	80.83	83.25	90.00	94.75	89.33
	M _{0.75}	83.25	86.50	88.75	86.17	92.00	96.75	100.7	96.44
	M _{1.5}	82.52	91.00	97.75	90.43	96.75	102.6	100.7	99.98
LSD 5%			15.22		8.78		4.43		2.56
	S	81.50	86.41	90.75		90.60	96.46	98.75	
LSD 5%			8.78				2.56		

Table 2. Effects of addition of NPK, potassium silicate and spraying with magnesium and their interaction on leaves area (dm²) in rose plants

Chemical fertilizer (C)	Magnesium spray (M)	Spring 2022				Fall 2022			
		Potassium Silicates (S)			C × M	Potassium Silicates (S)			C × M
		S ₀	S ₂₀₀	S ₃₀₀		S ₀	S ₂₀₀	S ₃₀₀	
C ₀	M ₀	38.24	41.20	44.17	41.20	40.88	43.29	45.80	43.32
	M _{0.75}	40.16	42.98	50.35	44.49	44.28	46.91	52.73	47.97
	M _{1.5}	43.75	45.15	54.38	47.76	49.70	52.80	57.12	53.20
C ₁₀₀	M ₀	45.40	49.06	56.91	50.45	49.36	55.17	59.84	54.79
	M _{0.75}	49.22	52.26	60.19	53.89	53.84	58.15	62.39	85.12
	M _{1.5}	51.19	60.79	64.92	58.96	57.10	64.42	67.76	63.09
LSD 5%			5.57		3.21		4.70		2.72
C × S					C		C × S		C
	C ₀	40.71	43.11	49.63	44.48	44.95	47.66	51.88	48.61
	C ₁₀₀	48.60	54.04	60.67	54.44	53.43	59.25	63.33	58.67
LSD 5%			3.21		1.86		2.72		1.57
M × S					M		M × S		M
	M ₀	41.82	45.13	50.54	45.83	45.12	49.23	52.82	49.05
	M _{0.75}	44.69	47.62	55.27	49.19	49.06	52.53	57.56	53.05
	M _{1.5}	47.47	52.97	59.65	53.36	53.4	59.11	62.44	58.31
LSD 5%			3.97		2.28		3.33		1.92
	S	44.66	48.75	55.15		49.19	53.62	57.61	
LSD 5%			2.28				1.92		

Table 3. Effects of addition of NPK, potassium silicate and spraying with magnesium and their interaction on leaves carbohydrates content (%) in rose plants

Chemical fertilizer (C)	Magnesium spray (M)	Spring 2022				Fall 2022			
		Potassium Silicates (S)			C × M	Potassium Silicates (S)			C × M
		S ₀	S ₂₀₀	S ₃₀₀		S ₀	S ₂₀₀	S ₃₀₀	
C ₀	M ₀	7.49	7.98	9.00	8.15	7.08	6.87	7.39	7.11
	M _{0.75}	7.86	8.15	8.93	8.31	7.25	7.38	7.90	7.51
	M _{1.5}	8.13	8.30	9.16	8.53	7.48	7.86	8.26	7.87
C ₁₀₀	M ₀	7.71	8.84	9.22	8.59	7.18	7.75	8.05	7.66
	M _{0.75}	7.96	8.53	9.65	8.71	7.84	7.62	8.36	7.80
	M _{1.5}	8.29	8.96	9.84	9.03	7.66	8.02	8.52	8.07
LSD 5%		0.63		0.36		0.78		0.45	
C × S				C		C × S		C	
C ₀		7.82	8.14	9.03	8.33	7.27	7.37	7.85	7.50
C ₁₀₀		7.98	8.77	9.57	8.77	7.42	7.80	8.31	7.84
LSD 5%		0.36		0.21		0.45		0.26	
M × S				M		M × S		M	
M ₀		7.60	8.41	9.11	8.37	7.13	7.31	7.72	7.39
M _{0.75}		7.91	8.34	9.29	8.51	7.34	7.5	8.13	7.66
M _{1.5}		8.21	8.63	9.50	8.78	7.57	7.94	8.39	7.97
LSD 5%		0.45		0.26		0.55		0.32	
S		7.91	8.46	9.30		7.35	7.52	8.08	
LSD 5%		0.26				0.32			

Effects of addition NPK fertilizer, potassium silicate and spraying with magnesium and their interaction on vase life, petals anthocyanin content and petals sugars content in rose plants: Data concerning effect of treatments on vase life, petals anthocyanin and sugars content are listed in Tables (4, 5 and 6). Data cleared that, NPK chemical fertilizers at 5 g.L⁻¹(C₁₀₀) significantly increased in vase life of 5.25 and 5.83 day, anthocyanin content of 257.7 and 284.3 mg.100g and sugars content of 8.42 and 9.05 % for two seasons, respectively while lower values of these traits was in C₀ treatment. Tables (4,5 and 6) also shows that potassium silicate application, showed significant superiority in increased in vase life of 5.33 and 5.92 day, anthocyanin content of 255.0 and 293.5 mg.100g and sugars content of 8.59 and 9.51 % for two seasons, respectively. Magnesium spray especially spraying at 15 g.L⁻¹ excelled in

increasing of vase life of 5.42 and 5.83 day, anthocyanin content of 252.2 and 283.9 mg.100g and sugars content of 8.42 and 9.20 % for two seasons, respectively. Interactions between NPK and potassium silicate application significantly affected in these traits especially interaction treatment (C₁₀₀S₃₀₀) and gave highest increased in vase life of 5.92 and 6.50 day, anthocyanin content of 268.3 and 304.8 mg.100g and sugars content of 8.97 and 9.77 % for two seasons, respectively. Interactions between NPK fertilizers and magnesium spray significantly affected especially when interaction treatment (C₁₀₀M_{1.5}) and gave highest increased in vase life of 5.92 and 6.25 day, anthocyanin content of 264.2 and 294.5 mg.100g and sugars content of 8.67 and 9.43 % for two seasons, respectively. Interaction between potassium silicate treatments and magnesium spray especially interaction treatment (S₃₀₀M_{1.5}) as it

gave highest increased in vase life of 6.00 and 6.25 day, anthocyanin content of 262.9 and 302.3 mg.100g and sugars content of 8.85 and

10.06 % for two seasons, respectively. Triple interactions between study factors had a significant effect in these traits.

Table 4. Effects of addition of NPK, potassium silicate and spraying with magnesium and their interaction on vase life (day) in rose plants

Chemical fertilizer (C)	Magnesium spray (M)	Spring 2022				Fall 2022			
		Potassium Silicates (S)			C × M	Potassium Silicates (S)			C × M
		S ₀	S ₂₀₀	S ₃₀₀		S ₀	S ₂₀₀	S ₃₀₀	
C ₀	M ₀	3.25	3.75	3.75	3.58	3.75	4.50	5.25	4.50
	M _{0.75}	3.75	4.50	5.00	4.42	4.50	5.00	5.25	4.92
	M _{1.5}	4.50	4.75	5.50	8.92	4.75	6.00	5.50	5.42
C ₁₀₀	M ₀	3.75	4.25	5.25	4.42	4.25	5.00	5.75	5.00
	M _{0.75}	4.75	5.50	6.00	5.42	5.50	6.50	6.75	6.25
	M _{1.5}	5.00	6.25	6.50	5.92	5.25	6.50	7.00	6.25
LSD 5%			0.54		0.31		0.81		0.47
C × S					C		C × S		C
C ₀		3.83	4.33	4.75	4.30	4.33	5.17	5.33	4.94
C ₁₀₀		4.50	5.33	5.92	5.25	5.20	6.00	6.50	5.83
LSD 5%			0.31		0.18		0.47		0.27
M × S					M		M × S		M
M ₀		3.50	4.00	4.5	4.00	4.00	4.75	5.50	4.75
M _{0.75}		4.25	5.00	5.50	4.91	5.00	5.75	6.00	5.58
M _{1.5}		4.75	5.50	6.00	5.42	5.00	6.25	6.25	5.83
LSD 5%			0.38		0.22		0.57		0.33
S		4.17	4.83	5.33		4.67	5.58	5.92	
LSD 5%			0.22				0.33		

The tables indicate an increase in anthocyanin pigment and sugars concentration in flowers of plants fertilized with chemical fertilizer NPK. This is due to positive association of sugars and anthocyanin with nitrogen and potassium, as well as percentage of dry matter in leaves and concentration of chlorophyll in them. This may explain positive effect of improving vegetative growth characteristics due to these fertilizers. Increasing efficiency of photosynthesis process, which is represented by vegetative and floral characteristics (Al-Mashhadani et al., 2019). These results may

also be due to spraying magnesium, as this element is involved in many cellular physiological activities, especially the reactions of transferring effective phosphate groups and activating the ATP molecule. This element is an essential component of the chlorophyll molecule, which means an increase in the process of photosynthesis and the construction of carbohydrates. Consequently, this increase occurred in the characteristics of the flowers and their content of anthocyanin pigment and sugars.

Table 5. Effects of addition of NPK, potassium silicate and spraying with magnesium and their interaction on petals anthocyanin content (mg.100 gm) in rose plants

Chemical fertilizer (C)	Magnesium spray (M)	Spring 2022				Fall 2022			
		Potassium Silicates (S)			C × M	Potassium Silicates (S)			C × M
		S ₀	S ₂₀₀	S ₃₀₀		S ₀	S ₂₀₀	S ₃₀₀	
C ₀	M ₀	221.6	226.0	231.6	226.4	234.2	247.1	263.3	248.2
	M _{0.75}	228.7	235.0	242.7	235.4	250.1	261.5	290.0	267.2
	M _{1.5}	233.0	236.9	245.6	238.5	254.6	272.2	293.5	273.4
C ₁₀₀	M ₀	240.4	248.8	267.2	252.1	252.8	269.3	300.5	274.2
	M _{0.75}	252.5	225.2	262.9	256.8	269.7	281.3	302.8	284.6
	M _{1.5}	255.6	262.3	274.8	264.2	280.7	292.0	311.3	294.5
LSD 5%			21.39		12.35		27.02		15.61
	C × S				C		C × S		C
C ₀		227.7	245.9	239.9	237.8	246.3	260.2	282.2	262.9
C ₁₀₀		249.5	255.4	268.3	257.7	267.5	280.8	304.8	284.3
LSD 5%			12.35		7.13		15.61		9.01
	M × S				M		M × S		M
	M ₀	231.0	237.4	249.4	239.2	243.5	258.2	281.9	261.2
	M _{0.75}	240.6	245.1	252.8	246.1	259.9	271.4	296.4	275.9
	M _{1.5}	244.3	249.6	262.9	252.2	267.4	282.1	302.3	283.9
LSD 5%			15.13		8.73		19.11		11.03
S		238.6	243.8	255.0		256.9	270.5	293.5	
LSD 5%			8.73				11.03		

Table 6. Effects of addition of NPK, potassium silicate and spraying with magnesium and their interaction on petals sugars content (%) in rose plants

Chemical fertilizer (C)	Magnesium spray (M)	Spring 2022				Fall 2022			
		Potassium Silicates (S)			C × M	Potassium Silicates (S)			C × M
		S ₀	S ₂₀₀	S ₃₀₀		S ₀	S ₂₀₀	S ₃₀₀	
C ₀	M ₀	7.39	7.58	8.00	7.66	7.56	7.94	8.49	8.00
	M _{0.75}	7.64	7.90	8.25	7.93	7.79	9.16	9.28	8.74
	M _{1.5}	7.92	8.18	8.39	8.16	8.14	8.82	9.95	8.97
C ₁₀₀	M ₀	7.99	8.10	8.42	8.17	8.18	8.82	9.11	8.70
	M _{0.75}	7.78	8.26	9.19	8.41	8.05	9.02	10.04	9.04
	M _{1.5}	8.16	8.54	9.31	8.67	8.38	9.74	10.17	9.43
LSD 5%			0.66		0.38		0.30		0.17
	C × S				C		C × S		C
C ₀		7.65	7.89	8.21	7.92	7.83	8.64	9.24	8.57
C ₁₀₀		7.98	8.30	8.97	8.42	8.20	9.19	9.77	9.05
LSD 5%			0.38		0.22		0.17		0.10
	M × S				M		M × S		M
	M ₀	7.69	7.84	8.21	7.91	7.87	8.38	8.8	8.35
	M _{0.75}	7.71	8.08	8.72	8.17	7.92	9.09	9.66	8.89
	M _{1.5}	8.04	8.36	8.85	8.42	8.26	9.28	10.06	9.20
LSD 5%			0.47		0.27		0.20		0.12
S		7.81	8.09	8.59		8.02	8.92	9.51	
LSD 5%			0.27				0.12		

CONCLUSION

The results in this study indicate that fertilization with NPK, potassium silicate, as well as foliar spraying with a magnesium-containing compound in the triple treatment (C100M1.5S300), had a positive synergistic effect on both vegetative growth characteristics and floral quality, increased the efficiency of plants in improving their physiological performance, photosynthesis, and metabolic activity. Accordingly, this interrelated strategy of the study factors can be adopted as a practical and applied approach to maximizing rose productivity and ornamental value under similar growth conditions.

ACKNOWLEDGEMENT

We confirm that all Figures and Tables in the manuscript are original to us. Additionally, any Figures and images that do not belong to us have been incorporated with the required permissions for re-publication, which are included with the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR/S DECLARATION

Conflicts of Interest: None. - We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re publication attached with the manuscript. - Ethical Clearance: The project was approved by the local ethical committee in University of Baghdad, Iraq.

AUTHOR'S CONTRIBUTION STATEMENT

REFERENCES

Abbas, M. F. and M. J, Abbas. 1992. Care and storage of practical fruits and vegetables. Ministry of Higher Education and Scientific Research. University of Basra. Dar Al-Hekma Press, Iraq.

Abd El Gayed, M. E., & Knany, R. E. 2020. Effect of foliar application of different potassium forms on the growth and flowering of snapdragon (*Antirrhinum majus* L.) Plants. Journal of Plant Production, 11(11), 1035-1040.
[https://DOI: 10.21608/jpp.2020.122660](https://doi.org/10.21608/jpp.2020.122660)

Abdul Munir, F. D.; Sulaiman, Z., Ahmad, K., Abd, M. Y., Samad, M. R. A., & Salisu, M.

A.A. 2023. Comprehensive Review on the Potential Effect of Silicon Fertilizer and its Significance for Agriculture. International Center for Research and Resources Development Journal . 4(2):149-178.
[https:// DOI: 10.53272/icrrd.v4i2.5](https://doi.org/10.53272/icrrd.v4i2.5).

Adnan, M; Tampubolon, K., ur Rehman, F., Saeed, M. S., Hayyat, M. S., Imran, R, Tahir and Mehta, J. (2021). Influence of foliar application of magnesium on horticultural crops: A review. Agrinula: Jurnal Agroteknologi dan Perkebunan, 4(1): 13-21.
<https://doi.org/10.36490/agri.v4i1.109>;

Al-Hadethi, Mustafa E.A; Fadia H. Taha and Shamil M. Abbood.2020. Effect of compost prepared from plant residues on olive transplants growth. International Journal of Agricultural and Statistical Sciences. 16 (Supplement 1): 1385-1389.

Al-Hamadani, Z. A. A. and A. T. Joody . 2021. Effect of sewage and silicon fertilization on the growth of peach trees. Plant Archives, 21(1): 1395-1398.

Al-Mashhadani, T.A; Sawsan A. Abdullatif and Rasmi M. Hamad.2019. Effect of *Azospirillum brasilense*, water type and potassium in the growth and flowering of the gladiolus plant. Plant Archives.19 (2): 2637-2649.

Barlog, P; J, Moir; L, Hlisnikovsky and X, He. 2023. Improving Fertilizer Use Efficiency, Methods and Strategies for the Future. MDPI, Books.
https://mdpires.com/bookfiles/book/8432/Improving_Fertilizer_Use_EfficiencyMethods_and_Strategies_for_the_Future.pdf

Biswas, D.R. 2021. A Text of Fertilizers. New Indian Publishing Agency. New Delhi-110034, India.

El-Naggar, A and Imhmd, G. F. M. 2023. Influence of humic acid and mineral nutrition on the growth, yield of flowers and the chemical constituents of *Rosa hybrida*, L. Scientific Journal of Flowers and Ornamental Plants, 10 (1): 17-26.
https://journals.ekb.eg/article_297081.html.

Elsahookie, M.M and K.M, Wuhaib. 1990. Design and Analysis of experiments. Univ. Of Bagh. Dar al hekma.pp.488.

Ferreira, L.D.S; V. de Souza Oliveira; J. J. de Paula Marchiori; T. C, Ferreira; A. Cl. B,

- Bernabé; G.T. F, Boone; L. L. dos Santos Pereira and E, Carriço. (2023).The Nutrient Magnesium in Soil and Plant: A Review. *International Journal of Plant & Soil Science*.35 (8): 136-144.
[10.9734/ijps/2023/v35i82890](https://doi.org/10.9734/ijps/2023/v35i82890)
- Hosseini, M.; Kholdebarin, B.; Eshghi, S.; Jamali, B. and Roosta, H. 2019. Changes in Flower Quality and Plant Growth Substances of Rose cv. ‘Dolce Vita’ in Response to Different Nitrogen Sources in Soilless Culture. *Journal of Plant Nutrtnion*. 42(9):1047-1060.
<https://doi.org/10.1080/01904167.2019.1578373>.
- Hwang, S.J; H.M, Park and B.R, Jeong.2005. Effect of potassium silicate on the growth of miniature rose Pinocchio grown in Rockwool and its cut flower quality. *J. Japan. Soc. Hort. Sci.* 74(3):242-247.
<https://doi.org/10.2503/jjshs.74.242>
- Joslyn, M.A. 1970. Method in food analysis physical, chemical and instrumental. method of analysis 2nd ed. Academic press New York and London.
- Khalil, N.H. 2023. The effect of organic fertilization on leaf mineral content of three citrus species. *IOP Conf. Ser.: Earth Environ. Sci.* 1158 .042049.
<https://iopscience.iop.org/article/10.1088/1755-1315/1158/4/042049>.
- Kumari, P., Sharma, R., Panwar, S., Paul, S., & Banyal, N.2023. Silicon as vital element in flower crop production. *Journal of Plant Nutrition*, 46(11): 2747-2762.
<https://doi.org/10.1080/01904167.2022.2160739>
- Manimaran, P., Rajasekar, P., Rameshkumar, D., & Jaison, M. 2017. Role of nutrients in plant growth and flower quality of rose: A review. *Intl. J. Chemi. Stud*, 5 (6): 1734-1737.
<https://www.chemijournal.com/archives/?year=2017&vol=5&issue=6&ArticleId=1520>
- Pal, P.K and M, Mahajan. 2017. Pruning System and Foliar Application of MgSO₄ Alter Yield and Secondary Metabolite Profile of *Rosa damascene* under Rainfed Acidic conditions. *Front. Plant Sci.* 8:507.
<https://www.frontiersin.org/articles/10.3389/fpls.2017.00507/full>.
- Punitha, A., Geethalakshmi,I., Adeline Vinila, J.E., Sumathi, T., Jayavalli, R, Vadivel, N. 2023. Impact of foliar application on flower yield and quality in carnation. *Journal of Emerging Technologies and Innovative Research.* 10(3): 727-730.
<https://www.jetir.org/papers/JETIR2303283.pdf>.
- Ram, R.L. 2022. Current Research in Soil Fertility. AkiNik Publications169, C-11, Sector - 3, Rohini, Delhi-110085, India
<https://doi.org/10.22271/ed.book.1726>.
- Rouphael, Y. and G. Colla. 2020. Biostimulants in Agriculture. *Frontiers in Plant Science.* 11 (40):40-47.
<https://www.frontiersin.org/articles/10.3389/fpls.2020.00040/full>
- Zargar, S. M.; R. Mahajan; J. A. Bhat; M. Nazir and R. Deshmukh. 2019. Role of silicon in plant stress tolerance: opportunities to achieve a sustainable cropping system. *3 Biotech*, 9(3): 73.
<https://pmc.ncbi.nlm.nih.gov/articles/PMC6368905/>

تأثير اضافة NPK و سليكات البوتاسيوم و رش المغنيسيوم في نباتات الورد

رنا موسى جواد¹، نازك حقي خليل²

قسم البستنة وهندسة الحدائق – كلية علوم الهندسة الزراعية – جامعة بغداد، العراق.

المستخلص

نفذت دراسة على شتلات الورد الجوري صنف Wiener Charme ذو اللون البرتقالي بعمر سنة ونصف في إحدى ظلل المحطة البحثية (B) التابعة الى قسم البستنة وهندسة الحدائق / كلية علوم الهندسة الزراعية / جامعة بغداد، في موسمي ربيع وخريف 2022، وتم تنفيذ تجربة عاملية بثلاثة عوامل ضمن تصميم القطاعات كاملة المعشاة (RCBD)، تضمنت العوامل التسميد الكيميائي (NPK) بدون تسميد (C₀) التسميد بنسبة 100 % من التوصية السمادية (C₁₀₀)، إضافة سليكات البوتاسيوم بثلاثة مستويات 0 (S₀) 200 ملغم.لتر⁻¹ (S₂₀₀) 300 ملغم.لتر⁻¹ (S₃₀₀) ، اما العامل الثالث فكان الرش الورقي بمحلول مركب Disper Mg كمصدر للمغنيسيوم (M) بالتركيز 0 (M₀) 7.5 غم.لتر⁻¹ (M_{7.5}) 15 غم.لتر⁻¹ (M₁₅)، اظهرت النتائج تفوقت المعاملة (C₁₀₀M₁₅S₃₀₀) في عدد الاوراق والمساحة الورقية الكلية ومحتوى الأوراق من الكربوهيدرات (106.50 – 113.50 ورقة و 46.92–67.76 دسم² و 8.52 – 9.84 % بالتتابع، كما تفوقت المعاملة ذاتها في العمر المزهري و صبغة الانثوسيانين والسكريات الكلية (6.50 – 7.00 يوم ، 274.8 – 311.3 ملغم 100 غم⁻¹ و 9.31 – 10.17 % بالتتابع

الكلمات المفتاحية: الكربوهيدرات، المحتوى الكيميائي، الزهرة، الأوراق، نباتات الزينة، العمر المزهري.

*البحث مستل من أطروحة دكتوراه للباحث الأول.