Effect of foliar calcium fertilizer and nano-chitosan on the growth of rose seedlings

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Abstract

This study was carried out during the spring agricultural season for the period from December 2021 to June 2022 in Baghdad governorate and in one of the private nurseries (Al-Rafidain Nursery) in the Zayouna area to study the effect of spraying with calcium and nano-chitosan on the growth, flowering and storage capacity of the Anglina rose bush. The experiment included The first two factors, calcium and included three levels of fertilizer (the comparison without adding fertilizer, concentration 150 mg. L^{-1}, concentration 200 mg. L^{-1}) and spraying with 500 ml of fertilizer per seedling and between spraying with calcium and chitosan for three days, and the second factor spraying With nano-chitosan and at four levels (the comparison without addition, 50, 100 and 150) mg. $Litre^{-1}$ and the experiment were designed as a factorial experiment with three replications according to the complete random sectors (R.C.B.D). The second experiment was stored, keeping flowers in the refrigerator at a temperature of 5 ° C in polyethene bags with a complete random design (CRD). Then the results were compared with the LSD multinomial test to compare the averages at 5%.

Foliar spraying with calcium at a concentration of 200 mg. L^{-1} led to a significant increase and superiority in the vegetative and chemical growth characteristics represented in the total carbohydrate content of leaves .Foliar spraying of nano-chitosan at a concentration of 150 mg. L^{-1}led to the superiority in vegetative and chemical characteristics and the total carbohydrate content of leaves. The interaction between the two studied workers showed a significant effect in improving the chemical properties, as the spraying treatment with a concentration of 200 mg. $L^{-1}$and nano-chitosan at a concentration of 150 mg. $L^{-1}$was significantly superior to the carbohydrate content of leaves of 21.497 mg.100 mg. L^{-1}. Fresh weight, the percentage of phosphorous in the leaves was 0.326%, and the percentage of potassium was 2.637%.

Introduction

The rose belongs to the Rosaceae family, and the genus Rosa contains 200 species and more than 30,000 varieties. These numbers are increasing as the Research Center in the Netherlands produces more than 80 varieties per year (Esselink et al., 2003, Senapati and Rout, 2008; Ahmed et al., 2010), where Flowers constitute the spirit of gardens in their multiplicity of shapes, colors and fragrances, as they convey to us the message of nature that God has bestowed upon us. It is one of the most famous and important ornamental plants, which traces its genetic origins back to about ten wild species, most of which originated through cross-breeding. The origins of commercial roses go back to gigantean Rosa and Chinensis Rosa, which crossed China before 1800 BC.

The industrial uses of roses are numerous. Its essential oil extracted by distillation of petals is used in several fields as perfumes for soap and cosmetics and as flavouring for

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food as in tea (Khan and Rehman, 2005). Rose water is a medicinal substance for eye infections alone or with some ointments (Hassanein, 2010). The Arabs are the first to use fragrant rose water and make jam from it. The first China-style geometric gardens (Nadeem et al., 2011).

The rose plant has been famous as the king of flowers. It has been described as one of nature's most beautiful creations, the highest arrangement of cut flowers and the most prominent flowers traded in the world, and its participation in 51% of the global flower market, and the market value of global flower cultivation is estimated at 11 billion US dollars (Bhagat et al., 2019 and John et al. 2020).

Red roses and their types are dominant in the world of export flowers for cut flowers and are considered desirable due to their lightweight when exported. The ease of production from shrubs and if taken care of them, they do not need to be renewed throughout the year, that is to renew their cultivation annually; roses bloom all year in spring and autumn except for some The cold and very hot months (Al-Chalabi and Al-Khayat, 2013).

Calcium delays ripening and ageing, increases hardness, prolongs storage life and reduces the occurrence of physiological disorders and putrefaction during storage. Calcium is a divalent positive ion found in the inner and outer parts of cells, and the bulk of calcium is present in the apoplast, forming a complex with the cell wall and the plasma membrane. The calcium in the cell walls is necessary to protect the plasma membrane from the harmful effects of low pH, salinity, toxic ions and imbalance. Balances nutrients and maintains the integrity of the cell structure and wall, and acts as a binder in the form of calcium pectate (Shrinath, 2004).

Chitosan is a natural polymer and has been used in many physiological studies to know its effect on plant growth (Aranaz et al., 2009; Odat et al.,2021), the product of acetylation of chitin from the outer shell of oysters, shrimp, lobster, crab and cell walls of fungi. It is the main component of cells and their exoskeletons (Gooday). , 1990), Chitosan increases the absorption of nutrients and chlorophyll content. It increases the rate of photosynthesis, which is reflected in plant growth by increasing essential nutrients and water absorption and increasing enzyme activity. It is possible to increase the plant's tolerance to drought by maintaining the water balance in the plant and the activity of the metabolism process Photosynthesis also has an effect similar to that of growth regulators Malekpoor et al. (2016) and Salachna et al. 2017). Increasing the production and quality of flowers and completing the shape of the plant are among the crucial goals in producing commercial flowers, given the importance of the plant in terms of economic and aesthetic terms, its viability as cut flowers and the possibility of storing it.

The study aims at The effect of spraying calcium and nano-chitosan on the growth and production of cut flowers for roses, improving rose flowers' storage and marketing ability under cold storage conditions.

Material and Method

Experiment site:

This experiment was carried out in the governorate of Baghdad and one of the private nurseries (Al-Rafidain Nursery) in the Zayouna region during the agricultural season 2021/2022. The one-year-old seedlings were taken from the red-coloured Angelina rose shrub plants, grown in small (plastic) pots in Qatar. 10 and a height of 15, with heights ranging between (40-50) cm and the number of branches (2-3) branches.

A uniform pruning process was carried out for all seedlings, where the branches were cut 30 cm above the soil's surface, and weak, dry and flowering branches were removed. All service operations were carried out by removing weeds and bushes. The first fertilization was carried out a month after transferring the plants. It was fertilized with the balanced NPK fertilizer 20:20 20: American origin, at a rate of 1 gm per litre, and was added with irrigation water every 20 days (Al-Batal, 2010). As for irrigation, it was according to the needs of the plant.

Control:

A preventive program was implemented to prevent insect and fungal diseases, and the insecticide WDG 40%, produced by HERO, was used once at a concentration of 1 gm l-1, and the fungicide NATIVO 75% at a concentration of 1 gm. 1 liter spray, and it was noticed that there was an infection with red spiders at the beginning of the spring season. Greenhouses were controlled with the arachnid pesticide ZAMETIN 3.6% at a concentration of ml. L^{-1}

Experiment design and studied factors:

A factorial experiment was applied in the nursery using a Completely Randomized Block Design (R.C.B.D) with three replicates. Each replicate contains 12 treatments (3 X 4) resulting from the interaction of three Ca levels with four levels of nano-chitosan Ch. For each experimental unit, 3 plants, each sector contains 36 seedlings with a total of 108 pots for the experiment. The averages of the studied traits were compared using the L.S.D polynomial at the 5% probability level (Al-Rawi, 2000).

The flowers were collected from the treatments separately and used later in the storage experiment. The flowers were picked when they reached the closed bud stage (tight-bud stage), i.e. when the first two petals opened and for the current spring season (Baleyegn et al., 2012).The study included the effect of spraying treatments with calcium and nano-chitosan on growth and flowering, and included two factors:

The first factor: spraying with calcium at three levels:

1. Spraying with distilled water only (comparison). Ca 0

2. Calcium spray at a concentration of 150 mg 0 L^{-1}. Ca 150

3. Spraying with calcium at a concentration of 200 mg 0 L^{-1} Ca 200

The first spraying process was conducted on 10/2/2022 for the current spring agricultural season, as the seedlings were sprayed with calcium at two concentrations (150, 200) mg 0 liter-1. The spraying process was carried out until full wetness was reached, in the early morning.

The second factor: spraying with nano-chitosan at four levels:

1. Spraying with distilled water only (comparison). Ch0

2. Spraying with nano-chitosan at a concentration of 50 mg. L-1. Ch 50

3. Spraying with nano-chitosan at a concentration of 100 mg. L-1 Ch 100

4. Spraying with nano-chitosan at a concentration of 150 mg. L-1 Ch 150

After three days, the plants were sprayed with the first spray of the second treatment of nano-chitosan at three concentrations (50, 100, 150) mg.l-1. In the same way, nano-chitosan was obtained and the process was repeated four times between one spray and another 15 days, where a barrier was placed for each unit Experimental to prevent the spray from escaping to other treatments, using a 5 liter capacity hand sprayer.

Studied traits:
All measurements were taken for the studied traits when the plants reached the flowering stage and for all experimental units and included:

Characteristics of vegetative growth:

1. **The percentage of nitrogen %**: The element nitrogen was determined by the modified Kjeldal method using the Micro-Kjeldal apparatus (A.O.AC, 1975).

2. **The percentage of phosphorous, %:** The phosphorous element was determined using ammonium molybdate and vitamin C, and the reading was done with a Spectrophotometer at a wavelength of 620 nm (John, 1970).

3. **The percentage of potassium %:** Potassium was determined by a flame photometer according to the method (Al-Sahhaf, 1989).

4. **Calcium content in leaves %**: Calcium was determined by a flame photometer according to (Al-Sahhaf, 1989).

5. **Total carbohydrate content in leaves (mg. 100 gm-1):** Six leaves (third and fourth pair) were taken from each treatment during the flowering phase and placed in conditions and dried in an electric oven at a temperature of 70 °C for two days until the weight was stable and the samples were crushed and then The absorbance of the solutions was read by a spectrophotometer at a standard wavelength of 490 nm (Joslyn, 1970). Calculate the total standard carbohydrate from the following equation:

$$Carbothedrate\ (mlg.100\ g^{-1}) = \frac{Concentration}{1000 * 1\ ml * Sample\ Weight} * 100$$

RESULTS AND DISCUSSION

Characteristics of vegetative growth:

Nitrogen concentration in leaves (%):

Table (11) shows that there was no significant increase in the average treatment of calcium added in nitrogen concentration in the leaves, it was as follows: 2.662, 2.532, 2.280%, respectively. As for the addition of nano-chitosan in all treatments, the results also indicated that there were no significant differences in nitrogen concentration. In the leaves, which amounted to 2.563, 2.552, 2.480, and 2.369%, respectively, and the results of the interaction of the two fertilizers calcium and chitosan were no significant differences in the concentration of nitrogen in the leaves for all treatments, and the comparison treatment was the least valuable, as it amounted to 2.127 %.

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Table 1: Effect of spraying with calcium and nano-chitosan and the interaction between them on the percentage of nitrogen in leaves (%) of Angelina shrub rose plant

Calcium Avarage Ca	Chitosan levels (mg.l-1)				Calcium levels (mg.L^{-1})
	150	100	50	0	
2.280	2.417	2.397	2.180	2.127	0
2.532	2.547	2.597	2.503	2.480	150
2.662	2.727	2.663	2.757	2.500	200
	2.563	2.552	2.480	2.369	Average Chitosan Ch
Ca X Ch	Ch		Ca		L.S.D
0.1150	0.0664		0.0575		

Phosphorous concentration in leaves (%):

Among the known results in Table (2), there were significant differences between the fertilizer treatments in the concentration of phosphorous in the leaves. The calcium spray treatment with 200 mg. L^{-1} was superior by giving it the highest concentration of phosphorous, which amounted to 0.3092%, while the comparison treatment recorded the lowest concentration of phosphorus which reached 0.2675 %, and it was noted that spraying with nano-chitosan had no significant difference in the concentration of phosphorous in the leaves, as the spray treatment was 150 mg. Liter-1 recorded the highest concentration of 0.3000% compared to other treatments.

The results in the same table show the significant effect of the interference, as the nano-chitosan treatment achieved 150 mg. L-1 and spray with calcium 200 mg. L-1 gave it the highest concentration, which amounted to 0.3267%, while the treatment without adding the lowest concentration was recorded, which amounted to 0.2567%.

Potassium content of leaves (%):

The results presented in Table (13) show that there are significant differences between the calcium spray treatments in the potassium concentration in the leaves compared with the control treatment. The calcium spray treatment was superior to 200 mg. L-1 recorded the highest significant values of 2,623% compared to the treatment without spraying, which recorded the lowest value of 1.460%.

As for the addition of nano-chitosan, it was noted that there were no significant differences between the treatments.The results also showed significant differences between the interaction treatments, where the calcium spray treatment of 200 mg L-1 with nano-chitosan 150 mg L-1 recorded the highest concentration of potassium in the leaves, which amounted to 2.637 % compared to the comparison treatment that achieved the lowest value, which amounted to 1.410 %.

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Table 2: Effect of spraying with calcium and nano-chitosan and the interaction between them on the percentage of phosphorous in leaves (%) of Angelina shrub rose plant

Calcium Avarage Ca	Chitosan levels (mg.l-1)				Calcium levels (mg.L^{-1})
	150	100	50	0	
0.2675	0.2667	0.2700	0.2767	0.2567	0
0.2792	0.3067	0.2867	0.2733	0.2500	150
0.3092	0.3267	0.3167	0.3000	0.2933	200
	162.2	153.6	172.4	139.6	Average Chitosan Ch
Ca X Ch	Ch		Ca		L.S.D
0.03160	n.s		0.01580		

Table 3 :Effect of spraying with calcium and nano-chitosan and the interaction between them on the percentage of potassium in leaves (%) of Angelina shrub rose plant

Calcium Avarage Ca	Chitosan levels (mg.l-1)				Calcium levels (mg.L^{-1})
	150	100	50	0	
1.460	1.507	1.513	1.410	1.410	0
1.817	1.090	1.827	1.837	1.630	150
2.623	2.637	2.617	2.770	2.467	200
	2.040	1.986	2.006	1.836	Average Chitosan Ch
Ca X Ch	Ch		Ca		L.S.D
0.2240	N.S		0.1120		

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The total carbohydrates content of the leaves (mg. 100 gm - 1 fresh weight):

The following table (4) results indicate the superiority of the spray treatment with calcium 200 mg. L^{-1}compared to other treatments, where the highest content of carbohydrates in leaves was 20,093 mg, 100 g^{-1}Fresh weight, and it differed significantly from the control treatment and gave the lowest carbohydrate content of the leaves was 14.070 mg 100 g^{-1}. Fresh weight, but when spraying with nano-chitosan at a concentration of 150 mg. L^{-1}, it gave the highest carbohydrate content in leaves 17.576 mg 100 g^{-1}. mushy

The results showed the interaction between the two treatments of spraying with calcium at a concentration of 200 mg. $L^{-1}$and nano-chitosan at a concentration of 150 mg. L^{-1}gave the highest carbohydrate content in leaves which was 21.497 mg 100 g^{-1} fresh weight and differed significantly from all other treatments. The control treatment gave the lowest carbohydrate content in leaves and it was 13.247 mg 100. g^{-1}fresh weight.

Table 4: Effect of spraying with calcium and nano-chitosan and their interaction on the total carbohydrate content of leaves (mg. 100 g^{-1} fresh weight) of Angelina rose bush.

Calcium Avarage Ca	Chitosan levels (mg.l-1)				Calcium levels (mg.L^{-1})
	150	100	50	0	
14.070	15.140	13.850	14.043	13.247	0
15.966	16.090	17.077	15.473	15.223	150
20.093	21.497	20.387	20.093	18.393	200
	17.576	17.104	16.537	15.621	Average Chitosan Ch
Ca X Ch	Ch		Ca		L.S.D
0.5629	0.3250		0.2815		

Calcium content in leaves (%):

We note from the results of Table (5) that the significant differences between the calcium treatments in its concentration in leaves have increased compared to without addition, so the treatment of 200 mg. L^{-1} was superior by recording values of 1.108% compared to the treatment without addition, which recorded the lowest value of 0.959 %.

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As for the addition of chitosan, we note that there is a significant difference between the treatments and that the treatment of chitosan 150 mg. L^{-1} is the highest than the rest of the treatments and was 1.121%, and the treatment of no addition was the lowest, amounting to 1.099%.

The results showed that there were no significant differences between the other interaction treatments, where the treatment of calcium 200 mg. L^{-1} with the addition of nano-chitosan 50 mg. L^{-1} recorded the highest concentration of calcium in the leaves and amounted to 1.247 % compared to the comparison treatment that achieved the lowest value, which amounted to 0.883 %.

Table 4: Effect of spraying with calcium and nano-chitosan and their interaction on the Calcium content leaves of Angelina rose bush.

Calcium Avarage Ca	Chitosan levels (mg.l-1)				Calcium levels (mg.L^{-1})
	150	100	50	0	
0.959	1.017	1.030	0.907	0.883	0
1.077	1.133	1.067	1.070	1.037	150
1.198	1.213	1.227	1.247	1.107	200
	1.121	1.108	1.074	1.009	Average Chitosan Ch
Ca X Ch	Ch		Ca		L.S.D
0.1091	0.0630		0.0545		

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DISCUSSION

Calcium plays a physiological role in regulating the functions of plant cells. It is a multi-nutrient element, as its soluble form affects many physiological activities during the stages of plant growth and, in turn, affects the quality of the crop (Easterwood, 2002).

One of the positive effects of the role of calcium may be attributed to the increase in the concentration of other elements such as N, P, K, and Ca in the leaves, as in the table (1,2,3,5), because calcium works to improve the construction of the cell wall, including the tissues of the roots, followed by the improvement of active absorption of the elements and in turn leads to an increase in their concentration inside the plant, the ability of some plants to invest calcium is low and highly sensitive to its deficiency (Al-Sahaf, 1989). Its ability to absorb water and dissolved ions are positively reflected in plants' growth and flowering (Bustrom, 2008; Lateef et al.,2021). Calcium links pectin with protein at the cell wall's cell membranes and connects neighbouring cells to be more durable and less permeable.

The stimulating effect of the growth process is due to adding mineral fertilizers to the plant’s supply of nutrients to produce more carbohydrates and proteins for vegetative and flowering growth, where potassium plays a role in the physiological functions inside the plant (AL-Taey et al.,2018) . However, it does not enter into any organic compound or cell composition. The plant plays the role of opening and closing stomata. It is considered a basic activator of the enzymes accompanying the representation of carbohydrates and peptide bonds. It plays the role of a catalyst in many physiological and vital processes, including regulating the movement of solvents and the absorption of nutrients (AL-Taey and Burhan,2021) , as in Table (4) and its transfer to leaves and flowers, thus improving the characteristics of flowers (Idris, 2009).

The results of tables (1,2,3,5), as well as the role of chitosan in increasing the content of nutrients in leaves as a result of spraying with chitosan, is due to its role in increasing soluble phenols, amino acids, auxins and sugars in leaves that positively affect the increase in photosynthesis (Badan, 2013) and this was significantly affected by the increase in the leaves content of nitrogen, phosphorous, potassium and calcium.

CONCLUSIONS

1. The foliar spraying of calcium and chitosan led to an improvement in growth indicators, including vegetative ones, from the percentage of (N.P.K and Ca), the percentage and percentage of carbohydrates in
2. The best concentration used was 200 mg l-1, as well as nano-chitosan at a concentration of 150 mg. L-1, and the

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interaction between the treatments gave the best results, as it affected all the studied traits, and this indicates the production of cut flowers, an increase in the number of flowers and an improvement in their quality specifications.

3. The interactions between the studied factors had a positive moral effect in improving most of the studied traits.

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