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The physiological role of potassium and calcium spraying on 2 – productive characteristics of two potato varieties

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Abstract---An experiment was carried out in the forest area during the spring growing season 2021 to study the physiological role of calcium and potassium spraying some productive characteristics of two potato varieties. The experiment included three factors of 18 treatments. The first factor was two cultivars of imported potatoes Fandango and Sifra, second factor is calcium in three concentrations (0, 500, 100 mg. L^{-1}) the third factor was potassium in three concentrations (0, 2.5, 5 g. L^{-1}). The experiment was carried out in the field using the Split-Split_plot system within the RCBD design, the cultivars were placed in the main plots and calcium concentrations in the secondary plots, while the sub-sub plots included potassium concentrations and each treatment was repeated three times. The results showed that Sifra plants were significantly superior to Fandango plants in the total number of tubers, the yield of one plant, the total yield per unit area, the marketing yield of the plant, and the marketing yield of tubers per unit area. While the plants of the cultivar Fandango were significantly superior to the plants of the cultivar Sifra in total tuber weight. The treated plants with calcium at both concentrations of 500 and 1000 mg. L^{-1} had a significant increase in the average of total tuber weight, the yield of one plant and the total yield, while using calcium at a concentration of 500 mg. L^{-1} led to a significant increase in the marketing yield of the plant and the marketing yield of tubers per unit area compared to the control. The plants which treated with potassium achieved a significant increase in some yield characteristics represented in the total tuber weight, the yield of one plant and the total yield of tubers when using the concentration 2.5 g. L^{-1}. Significant effects appeared in the dual interference in many yield

characteristics, although there were no significant effects in some characteristics in the single effect of the three factors of this study.

Keyword---physiological, potassium, calcium spraying, productive characteristics, potato varieties.

Introduction

Potato (*Solanum tuberosum* L.) belongs to the solanaceae family and is among the four most important crops in the world after wheat, corn and rice. It considers one of the vegetable crops rich in nutrients which easily digestible. The percentage of dry matter in the tubers ranges from 15-29%, the starch 10-24%, proteins 1- 2%, carbohydrates 15%, and the percentage of mineral salts 1%, consisting mainly of potassium salts, phosphorous, magnesium and calcium (Hassan, 1999). The potato crop is also the first alternative to cereal crops in solving the global food problem (Aldouri and Zanzal, 2017). Plant growth and production are affected by many factors, including choosing the appropriate variety for the environmental conditions which prevailing in the production area (Daoud, 2013). In an experiment carried out by Ibrahim (2018) on two varieties of potato which were Alaska and Universa, the results showed that there were no significant differences between the two varieties in the yield characteristics represented by number of tubers, average of total tuber weight, the yield of one plant, the total yield and the marketing yield.

Haile et al. (2019) conducted a study on three potato cultivars: Local, Cuidene, and Jalene. They noticed that Jalene was significantly superior in number of tubers, average of tuber weight, total yield and marketing yield over the other two cultivars. The results of an experiment carried out by Issa et al. (2019) during the autumn season to study two potato cultivars Arizona and Fandango showed the superiority of Arizona cultivar and significantly in yield characteristics represented by the number of tubers, the yield of one plant, the total yield of the plant, the marketing yield of the plant and the marketing yield per unit area. Ali and others (2021) explained the effect of foliar spraying with potassium fertilizer in potato fields, as three sources of potassium were used: potassium chloride, potassium silicate and potassium nitrate at concentrations of 20,80,100% where all sources led to a significant increase in the average tuber weight and the total yield of one plant and the marketing yield per unit area. Stone et al. (2021) demonstrated in a study to show the effect of foliar spraying with potassium sulfate fertilizer at four concentrations of 0,1800,2200 and 2600 mg.

L^{-1} a significant increase in the mean of number and weight of tubers, the total yield of one plant, the marketing yield of one plant and the total yield of tubers. Gumede (2017) found that when calcium nitrate was added to potato fields at rates of 1.1, 3.2 and 6.6 gm, all levels led to a significant increase in number of tubers, the average tuber weight, the total yield of one plant and the total yield of tubers. Seifu and Deneke (2017) found that the mean of number and weight of tubers, yield per plant, total and marketing yield of tubers were significantly increased when calcium nitrate and calcium chloride were added at rates 5, 10 and 15 g/plant to the planted potato. Ilyas et al. (2021) explained in a study the

effect of calcium chloride on potato plants at concentrations of 0.03, 0.06, 0.04 %, the concentration of 0.06 % only led to a significant increase in the number of tubers, the average tuber weight, the total yield of one plant and the total yield of tubers. The purpose of the study is:

- A study on behavior two imported potato cultivars to choose which one is the best in producing under the conditions of Mosul city.
- Improving the quantitative and qualitative characteristics and yield of plants by using foliar spraying with calcium and potassium.
- Finding the best concentration of calcium and potassium and which plants respond, and thus positively reflected on the yield characteristics.
- Finding the best interaction between the cultivars and the concentrations of calcium and potassium.

Materials and Methods

The experiment was carried out in the research field of the College of Agriculture and Forestry/Mosul University/ Forest Area during the spring growing season 2021. The land was prepared for cultivation then plowed the field. The experimental unit included three seedbeds with a length of 2.10 m and a width of 75 cm. Thus, the area of the experimental unit reached 4.725 m^2. The tubers were manually planted at a distance of 30 cm between one tuber and another, with 7 tubers per seedbed (21 plants per experimental unit) in total 63 plant per each treatment. The tubers were planted at a depth of 12-15 cm manually, and the surface irrigation was selected to irrigate the plants in the field. Agricultural service operations were conducted for all experimental units, including fertilization, weeding, export, preventive and curative control of diseases, insects and bushes. Urea fertilizer (46% N) was added at a rate of 400 kg. ha^{-1} and triple superphosphate (45% P_2O) at a rate of 600 kg. ha^{-1} Potassium sulfate (48% K_2O) at a rate of 400 kg. ha^{-1} (Al-Obaidi, 2005).

The fertilizer was added in three batches, the first after 15 days of planting and included all the phosphate fertilizer, the second after emergence and included half of the nitrogen fertilizer and all the potassium fertilizer, and the third after a month from the second and included the remaining half of the nitrogen fertilizer and the addition was in a trench under the plant. Experimental treatments included three factors, the first factor included two imported potato cultivars (Fandango and Sifra), the second factor included calcium chloride Ca (27.3%) with three concentrations (0,500, 1000) mg. L^{-1}. The third factor included potassium sulfate K_2SO_4 (50%) K_2O in three concentrations (0,2.5,5) g. L^{-1}. The plants were treated with calcium and potassium in three stages of plant growth: the first after completion of field emergence, the second and the third with an interval of 20 days between phase and another. As a result of the interaction between the levels of the studied factors, the number of treatments is 18 (3 x 3 x 2). The experiment was implemented in the field using the split-plot system within the RCBD design, where the cultivars were placed in the main plots and calcium chloride concentrations in the secondary sub-plots where the sub-sub-plots included potassium concentrations, and each treatment was repeated three times. The results were analyzed statistically by SAS program. The studied characteristics:

- Total number of tubers (tuber. plant^{-1}): It was calculated by dividing the total number of tubers per the experimental unit for three replicates by the number of plants per the experimental unit.
- Total tuber weight (g. tuber^{-1}): was calculated by dividing the yield of the experimental unit for the three replicates by the number of tubers which produced from it.
- The yield of the individual plant (g. plant^{-1}): It was calculated from the total yield of the experimental unit and according to the following equation.
  The yield of the individual plant= $\frac{\text{yield of expermintal unit}}{total\ number\ of\ plants\ per\ expermintal\ unit}$
- The total yield of tubers (ton. ha^{-1}): The total yield of tubers was calculated from the yield of the experimental unit according to the equation:
  The total yield of tubers $=\frac{total\ yield\ of\ expermintal\ unit}{area\ of\ expermintal\ unit} \times 10000\ m^2$
- The marketing yield of the plant (gm. plant^{-1}): The marketing yield of the plant included all the harvested tubers after excluding small tubers less than 25 grams, damaged and distorted, and calculated by the same formula for calculating the yield of the individual plant.
- Marketing yield of tubers per unit area (tons. ha^{-1}): The marketing yield included all harvested tubers after excluding infected, small and damaged tubers and calculating the weight of the remaining tubers (marketable) and it was calculated by the same formula for calculating the total yield.

Results and Discussion

The results as shown in tables (1 and 3-6) indicate that the plants of the cultivar Sifra were significantly superior to the plants of the cultivar Fandango in the total number of tubers, the yield of one plant and the total yield, and the marketing yield of the plant, which reached to 1000.02 g. plant^{-1} and the highest marketing yield of tubers per unit area. While the plants of the cultivar Fandango were significantly superior to the plants of the cultivar Sifra in total tuber weight table (2). As for the effect of calcium on the total number of tubers, the results indicate that there was no significant effect of both concentrations 500 and 1000 mg. L^{-1} of calcium on the total number of tubers compared to untreated plants. As for the total tuber weight, using of calcium at both concentrations 500 and 1000 mg. L^{-1} led to a significant increase compared to the control. The use of calcium at the concentration of 500 mg. L^{-1} led to giving the highest significant value in the traits of yield per plant and total yield, which were 1105.69 gm. plant^{-1} and 49.142 tons. ha^{-1} tables (3-4) compared to plants treated with the concentration of 1000 mg. L^{-1} of calcium and control.

The effect of potassium as results shown that the plants treated with the concentration of 2.5 g. L^{-1} of potassium were significantly superior to plants treated with concentration 5 g. L^{-1} of potassium in the following characteristics: total number of tubers, total tuber weight, yield per plant, and total yield tables (1-4), while potassium did not significantly affect with both concentrations on the characteristics of the marketing yield of the plant and the marketing yield of tubers per unit area. The results of the dual interference between cultivars and calcium show that plants of Sifra cultivar which treated with calcium were

significantly superior to plants of Fandango cultivar in the following characteristics: total number of tubers, yield per plant, total yield, market yield of plant and marketing yield of tubers per unit area. The highest total number of tubers per plant was 16.66 tuber. plant^{-1} was obtained in the interference of Sifra variety with the concentration of 500 mg. L^{-1} of calcium. The two highest significant values in the characteristics of the marketing yield of the plant and the marketing yield of tubers per unit area were 1034.69 gm. Plant^{-1} and 45.986 tons. ha^{-1} respectively and it were found in plants of the cultivar Sifra at 1000 mg. L^{-1} of calcium. The highest significant value in total tuber weight was found in plants of the cultivar Fandango at 500 mg. L^{-1} of calcium, which was 75.03 g. tuber $^{-1}$.

The results of the dual interference between cultivars and potassium indicate that in the trait of total number of tubers, Sifra cultivar plants were significantly superior to the control and when potassium was used at both concentrations of 2.5 and 5 g.L^{-1} with all treatments of the variety Fandango, where the highest total number of tubers was 16.98 tubers. plant^{-1} was found in control. As for the total tuber weight, all the treatments of this dual interference between the two cultivars Fandango and Sifra with potassium were significantly superior to the control of Sifra cultivar. The treatments of this dual interference between Fandango and Sifra cultivars with potassium were significantly superior to the control plants of Sifra cultivar. As shown in tables (3 and 4) that the two highest significant values in the yield of one plant and the total yield reached to 1143.33 gm. plant^{-1} and 50,815 tons. ha^{-1} of the cultivar Sifra at 2.5 gm. L^{-1} of potassium. In addition, the two highest significant values for the marketing yield of the plant and the marketing yield of tubers per unit area were 1019.14 gm. Plant^{-1} and 45.295 tons. ha^{-1} it was found in plants of the cultivar Sifra at 5 g.L^{-1} of potassium.

As for the dual interference between calcium and potassium, the results shown that the treatment of dual interference when using calcium at the concentration of 500 mg. L^{-1} and without potassium gave the highest total number of tubers 16.57 tubers. plant^{-1} and the two highest significant values of the marketing yield of the plant and the marketing yield of tubers per unit area were 1006.85 g. plant^{-1} and 44,749 tons. ha^{-1}. The interaction treatment between calcium at concentration 1000 mg. L^{-1} and potassium at concentration 2.5 g. L^{-1} gave the highest significant value in the tuber weight characteristic, which reached to 79.08 g. tuber^{-1}. The highest significant values in yield per plant and total yield reached 1129.99 g. plant^{-1} and 50.222 t. ha^{-1} were obtained in treated plant with calcium at concentration 500 mg. L^{-1} and potassium at 2.5 g. L^{-1}.

As for the effect of the triple interference between the studied factors (varieties, calcium and potassium) on the characteristic of the total number of tubers, the results indicate that the highest value in this trait was 17.49 tubers. plant^{-1} was obtained in the interference between Sifra cultivar and calcium at 500 mg. L^{-1} and untreated with potassium. The highest significant value in the total tuber weight was 84.90 g. tuber 1- It by interference between plants of the cultivar Fandango and 1000 mg. L^{-1} of calcium and 2.5 g. L^{-1} of potassium. The highest significant values of the yield of one plant and the total yield were 1189.07 g. plant^{-1} and 52.848 tons. ha^{-1}, found in plants of the cultivar Sifra treated with 500 mg. L^{-1} of calcium and 2.5 g. L^{-1} potassium. The two best significant values achieved in the

characteristics of the marketing yield of the plant and the marketing yield of tubers per unit area at triple interference between Sifra plants and 500 mg. L^{-1} calcium and potassium 5 g. L^{-1} reached to 1080.76 g. $plant^{-1}$ and 48,034 tons. ha^{-1} respectively for each trait.

Table 1
Effect of cultivar, calcium and potassium and the interference between them on the total number of tubers (tuber. $plant^{-1}$)

Cultivars	Calcium Con. (mg.L^{-1})	Potassium Con. (g.L^{-1})			Cultivar × Calcium	Average effect of cultivar
		0	2.5	5		
Fandango	0	11.49 e	16.04 ab	13.95 cd	13.83 b	13.68 b
	500	15.64 a-c	14.35 bc	12.43 de	14.14 b	
	1000	14.64 bc	12.57 de	12.04 e	13.08 b	
Sifra	0	16.06 ab	17.47 a	15.57 a-c	16.37 a	16.50 a
	500	17.49 a	15.28 bc	17.21 a	16.66 a	
	1000	17.38 a	15.92 ab	16.13 ab	16.48 a	
Cultivar × Potassium	Fandango	13.92 b	14.32 b	12.81 c	Average effect of Calcium	
	Sifra	16.98 a	16.22 a	16.30 a		
Calcium × Potassium	0	13.78 c	16.76 a	14.76 bc	15.10 a	
	500	16.57 a	14.82 bc	14.82 bc	15.40 a	
	1000	16.01 ab	14.25 c	14.09 c	14.78 a	
Average effect of Potassium		15.45 a	15.27 a	14.55 a		

Table 2
Effect of cultivar, calcium and potassium and the interference between them on total tuber weight (gm. $tuber^{-1}$)

Cultivars	Calcium Con. (mg.L^{-1})	Potassium Con. (g.L^{-1})			Cultivar × Calcium	Average effect of cultivar
		0	2.5	5		
Fandango	0	70.42 b-d	60.54 d	68.5 b-d	66.49 b	71.71 a
	500	75.22 a-c	74.86 a-c	75.00 a-c	75.03 a	

	1000	67.35 b-d	84.90 a	68.63 b-d	73.63 a	
Sifra	0	63.77 bc	61.56 bc	68.68 b-d	64.67 b	68.15 b
	500	61.94 bc	78.02 ab	69.44 b-d	69.80 ab	
	1000	63.33 bc	73.26 a-d	73.36 a-d	69.98 ab	
Cultivar × Potassium	Fandango	70.10 a	73.43 a	70.71 a	Average effect of Calcium	
	Sifra	63.02 b	70.95 a	70.49 a		
Calcium × Potassium	0	67.09 cd	61.05 d	68.59 b-d	65.58 b	
	500	68.58 b-d	76.44 ab	72.22 a-c	72.41 a	
	1000	65.34 cd	79.08 a	70.99 a-c	71.81 a	
Average effect of Potassium		67.10 b	72.19 a	70.60 ab		

* The averages that share the same alphabetic letter for each factor and each interference do not differ significantly among themselves according to Duncan's polynomial test at the probability level (P≤ 0.05).

Table 3
The effect of cultivar, calcium and potassium and the interference between them on the yield of the individual plant (g. plant^{-1})

Cultivars	Calcium Con. (mg.L^{-1})	Potassium Con. (g.L^{-1})			Cultivar × Calcium	Average effect of cultivar
		0	2.5	5		
Fandango	0	805.89 f	971.33 cd	952.81 c-e	910.01 c	974.49 b
	500	1170.85 ab	1070.90 a-d	931.76 d-f	1057.84 b	
	1000	985.06 cd	1061.71 a-d	820.14 ef	955.64 c	
Sifra	0	1019.80 b-d	1074.71 a-d	1064.21 a-d	1052.91 b	1117.51 a
	500	1083.50 a-d	1189.07 a	1188.04 a	1153.54 a	
	1000	1095.37 a-c	1166.21 ab	1176.69 a	1146.09 a	
Cultivar × Potassium	Fandango	987.27 b	1034.65 b	901.57 c	Average effect of Calcium	
	Sifra	1066.23 ab	1143.33 a	1142.98 a		
Calcium ×	0	912.85 d	1023.02 bc	1008.51 cd	981.46 c	

Potassium	500	1127.18 a	1129.99 a	1059.90 a-c	1105.69 a
	1000	1040.22 a-c	1113.96 ab	998.41 cd	1050.86 b
Average effect of Potassium		1026.75 b	1088.99 a	1022.27 b	

Table 4
Effect of cultivar, calcium and potassium and the interaction between them on the total yield of tubers (ton. ha^{-1})

Cultivars	Calcium Con. ($mg.L^{-1}$)	Potassium Con. ($g.L^{-1}$)			Cultivar × Calcium	Average effect of cultivar
		0	2.5	5		
Fandango	0	35.817 f	43.170 cd	42.347 c-e	40.445 c	43.311 b
	500	52.038 ab	47.596 a-d	41.412 d-f	47.015 b	
	1000	43.781 cd	47.187 a-d	36.451 ef	42.473 c	
Sifra	0	45.325 b-d	47.765 a-d	47.298 a-d	46.796 b	49.667 a
	500	48.156 a-d	52.848 a	52.802 a	51.268 a	
	1000	48.683 a-c	51.831 ab	52.297 a	50.937 a	
Cultivar × Potassium	Fandango	43.879 b	45.984 b	40,070 c	Average effect of Calcium	
	Sifra	47.388 ab	50.815 a	50.799 a		
Calcium × Potassium	0	40.571 d	45.468 bc	44.823 cd	43.620 c	
	500	50.097 a	50.222 a	47.107 a-c	49.142 a	
	1000	46.232 a-c	49.509 ab	44.374 bc	46.705 b	
Average effect of Potassium		45.633 b	48.399 a	45.434 b		

*The averages that share the same alphabetic letter for each factor and each interference do not differ significantly among themselves according to Duncan's polynomial test at the probability level (P≤ 0.05).

Table 5
Effect of variety, calcium and potassium and the interference between them on the marketing yield of the plant (g. plant^{-1})

Cultivars	Calcium Con. (mg.L^{-1})	Potassium Con. (g.L^{-1})			Cultivar × Calcium	Average effect of cultivar
		0	2.5	5		
Fandango	0	701.63 f	867.33 b-f	856.57 b-f	808.51 c	846.93 b
	500	1045.28 ab	900.66 a-e	814.93 c-f	920.29 b	
	1000	777.76 d-f	936.81 a-d	721.41 ef	811.99 c	
Sifra	0	915.28 a-e	960.04 a-d	927.66 a-d	934.33 b	1000.02 a
	500	968.42 a-d	1043.89 ab	1080.76 a	1031.03 a	
	1000	1005.09 a-c	1050.00 ab	1048.99 ab	1034.69 a	
Cultivar × Potassium	Fandango	841.56 c	901.60 bc	797.63 c	Average effect of Calcium	
	Sifra	962.93 ab	1017.98 a	1019.14 a		
Calcium × Potassium	0	808.46 b	913.69 ab	892.12 ab	871.42 b	
	500	1006.85 a	972.28 a	947.84 a	975.66 a	
	1000	891.42 ab	993.40 a	885.20 ab	923.34 ab	
Average effect of Potassium		902.24 a	959.79 a	908.39 a		

Table 6
Effect of cultivar, calcium and potassium and the interference between them on the marketing yield of tubers per unit area (ton. ha^{-1})

Cultivars	Calcium Con. (mg.L^{-1})	Potassium Con. (g.L^{-1})			Cultivar × Calcium	Average effect of cultivar
		0	2.5	5		
Fandango	0	31.184 f	38.548 b-f	38.070 b-f	35.934 c	37.641 b
	500	46.457 ab	40.029 a-e	36.219 c-f	40.902 b	
	1000	34.567 d-f	41.636 a-d	32.063 ef	36.088 c	
Sifra	0	40.679 a-e	42.669 a-d	41.229 a-d	41.526 b	44.445 a
	500	43.041 a-d	46.395 ab	48.034 a	45.823 a	

	1000	44.671 a-c	46.667 ab	46.622 ab	45.986 a	
Cultivar × Potassium	Fandango	37.403 c	40.071 bc	35.450 c	Average effect of Calcium	
	Sifra	42.797 ab	45.243 a	45.295 a		
Calcium × Potassium	0	35.931 b	40.608 ab	39.650 ab	38.730 b	
	500	44.749 a	43.212 a	42.126 a	43.363 a	
	1000	39.619 ab	44.151 a	39.342 ab	41.037 ab	
Average effect of Potassium		40.100 a	42.657 a	40.373 a		

*The averages that share the same alphabetic letter for each factor and each interference do not differ significantly among themselves according to Duncan's polynomial test at the probability level (P≤ 0.05).

The difference in the significant effect on the characteristics of the quantitative and qualitative yield may be due to the genetic differences between the two cultivars, as the characteristics of the quantitative and qualitative yield are controlled by genes of the cultivars (Mahmoud, 2003 and Taha, 2007). Our results are consistent with what was found by (Al-Ajili, 2021) and (Khudair, 2022) in the presence of significant differences between the cultivars in the characteristics of the quantitative and qualitative yield. The physiological role of calcium in increasing the vegetative characteristics represented by the relative chlorophyll content of leaves, plant height, number of stems and leaf area (the first part of this study) might be it is the most explanatory reason for the significant increases in many characteristics of the quantitative yield and thus increasing the efficiency of the photosynthesis process, which encourages an increase in the concentration of nutrients for the plant to the ideal limit for vegetative growth then transfer to the tubers, thus a strength in root growth and reflect that as a significant increase in the quantitative yield represented by total tuber weight and yield of one plant and the total yield with 500 and 1000 mg.L^{-1} of calcium tables (2, 3 and 4) and the marketing yield of the plant and the marketing yield of tubers per unit area with 500 mg.

L-1 Tables (5 and 6) compared to the control. In addition to the positive role of calcium in increasing the efficiency of the photosynthesis process (Nakata, 2003). Calcium has a role in activating a number of enzymes, including: Arginine Kinase, Adenosine Triphosphate, and Adenylate kinase (Abu Dahi and Younis, 1988 and Al-Sahaf, 1989). As well as for its positive role in building cell walls through its union with insoluble pectin and the formation of calcium pectate that increases the rigidity of cell walls (Van der, 1999), which helps in regulating the permeability of membranes to water and nutrients (David, 2007). Moreover, calcium helps stimulate the formation of proteins by increasing the amount of nitrate absorbed by the plant (Al-Nuaimi, 1999). The positive effects of calcium play an important role in regulating the physiological functions of the plant and thus improving the yield characteristics. These results are consistent with Lacascio et al. (1992), Berchotold et al. (1993), Ahmed et al. (1996), Heng (1999),

Al-Obaidi (2005) and Modisane (2007) that adding calcium to potato plants led to a significant increase in most of the quantitative yield traits.

As for the significant effect when using potassium on the traits of the studied quantitative and qualitative yield, it was noted by reviewing the results that there is a discrepancy in the significant differences caused by potassium according to the concentrations used with the characteristics of total tuber weight, yield of one plant and total yield in tables (2, 3 and 4), the plants significantly superior with potassium 2.5 g. L^{-1}. To sum up, the plants of the cultivar Sifra were significant superior in many characteristics of the quantitative yield compared to the plants of the cultivar Fandango, including the total number of tubers, the yield of one plant, the total yield of tubers, the marketing yield of one plant and the marketing yield of tubers per unit area, thus, there is a possibility to adopt this variety for the cultivation of the potato crop in Nineveh Governorate, this requires conducting future researches in order to compare this variety with other new varieties. The concentration of 500 mg. L^{-1} of calcium and 2.5 g.L^{-1} of potassium had the best significant roles in increasing the studied quantitative and qualitative yield characteristics, with the necessity of conducting future studies using effective concentrations and comparing them with the mentioned concentrations.

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