Effect of Calcium Chloride and Gibberellic Acid on the Vegetative Growth of Two Cultivars of Gladiolus *Gladiolus hybrid* L.

Effect of Calcium Chloride and Gibberellic Acid on the Vegetative Growth of Two Cultivars of Gladiolus *Gladiolus hybrid* L.

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Abstract. This study was conducted inside the wooden canopy of the Department of Horticulture and Landscape Engineering / College of Agriculture and Forestry / University of Mosul during the agricultural season 2022-2023. To study the effect of spraying with different concentrations of calcium chloride (0, 500, 1000) mg. L^{-1} and spraying with gibberellic acid at concentrations of (0, 100, 200) mg. L^{-1} and the interaction between them in vegetative of two cultivars of Gladiolus *Gladiolus hybrid.* L .They are Nova lux with yellow flowers and Trader Lux with red flowers . The corms were planted on 17/3/2022, then sprayed 30 days after planting the corms with three sprays and three concentrations of calcium chloride (0,500, 1000) mg.L^{-1} The plants were also sprayed with gibberellic acid, with three sprays and three concentrations (0, 100, 200), The period between one spray and another was two weeks. The spraying was done with gibberellic acid after 35 days of planting the corms. The study was carried out using a factorial experiment in the design of completed randomized sectors R.C.B.D within split plots with three replications, each experimental unit included (7) cormat for each replicate. The research results of were analyzed statistically with the (SAS) program and tested statistically using Duncan's multinomial test at the probability level of 0.05. It was found that the red cultivar recorded the largest plant height, which reached 129.905 cm, the largest leaf length, which reached 102.584 cm, and the largest number of leaves, which reached 9,980 leaves. $Plant^{-1}$, and the largest leaf area of the plant, amounting to 401.656 cm^2. $plant^{-1}$, and the largest dry weight of the leaves, amounting to 12.567 g. The yellow variety plants also recorded the largest values for the percentage of total chlorophyll in the plant, which amounted to 0.984%. The treatment with gibberellic acid at a concentration of 200 mg also resulted. L^{-1} led to a significant increase in all studied traits.

Keywords. Gibberellic Acid, Vegetative Growth, Gladiolus X hortulanus L.

1. Introduction

Gladiolus X hortulanus L belongs to the Iridaceae family. It is the largest genus in this large and diverse family, which includes about 92 genera, and consists of 260 species It is a monocotyledonous plant characterized by the growth of one terminal bud. It is native to southern and central Africa, Asia Minor, and southern Europe. Its name goes back to the Latin word (Gladius), which means little sword, concerning the sword-shaped shape of the leaves. As for the name of the species, hortulanus, it

is due to the fact that all Gladiolus varieties are hybrids, and there are no pure varieties [1,2]. Gladiolus bulbs are considered one of the annual summerbulbs in the prevailing climatic conditions in Iraq. Bulbs can be grown with two spring and autumn grapes, and an be produced throughout the year by planting them under controlled conditions [3]. The production of the flowers of the Gladiolus plant does not require high costs to produce its flowers, and the cultivation of its corms is easy, Its flowers have many different colors, in addition to the shape of flowers, which are distinguished by their beauty, regular sitting on the axis of the inflorescence, and the suitability of its flowers for commercial picking [4]. Claudiols reproduce sexually by planting seeds, and are used in the case of developing new varieties with good specifications, and vegetatively by growing corms to produce creams or to produce flowers, and may resort to the propagation of gladioli by tissue cultureto produce plants free from viral diseases that threaten commercial production and their use In breeding and improvement programs for new crosses with desirable characteristics [5-7]. Calcium chloride is one of the essential compounds in regulating growth and development in plants, in addition to its involvement in forming the cell wall. It also affects the integrity of the cell wall and is the last barrier before cell separation [8,9]. It was also found that the treatment with calcium chloride caused an increase in the different vegetative and flowering growth characteristics [10]. Ca++ is considered a universal second messenger and has long been considered the second messenger in many signaling cascades, including cell wall defense signals [11]. Calcium has an important role in preserving the structure of the plant cell and making it strong and cohesive by achieving The cell membrane stability[12,13]. Hence, the role of calcium is evident in improving the quality standards of flowers during the vegetative and flowering growth stages. Calcium works to reduce the effects of salt stress on the plant, increase the hardness and thickness of the cell wall and strengthen the stem. Syphilis, maintaining the water balance in flowers, preventing the bending of the flower neck, incomplete blooming of the flower, reducing the aging rate and prolonging the flowering life [14,15]. Gibberellic acid GA3 is known for its role in the elongation of axial organs (stems, petioles and inflorescences) and the development of flowers in Lilium [16,17]. Treatment with gibberellin plays an essential role in enhancing various processes during plant development, early and induced flowering, increasing plant height, number of leaves, chlorophyll content, yield and quality across multiple flowering crops such as allium, tulip, gladioli and freesia [18-20].

2. Materials and Methods

The experiment was conducted inside the wooden canopy of the Department of Horticulture and Landscape Engineering - College of Agriculture and Forestry - University of Mosul, during the period from March 2022 to October 2022 to study the effect of spraying with calcium chloride and gibberellic acid and the interaction between them on the vegetative growth of two varieties of Gladiolus X hortulanus L. The experiment involved the study of three factors

2.1. The Varieties

The study included the response of two cultivars of Gladiolus X hortulanus L., Trader horn with red flowers and Nova lux with yellow flowers, to cultivation in the city of Mosul under wood canopy conditions. The corms were imported from the Netherlands by a company in Erbil governorate.

2.2. Calcium Chloride

Calcium chloride was sprayed on the shoots at three levels (0, 500 and 1000 mg). L^{-1}, by three sprays on the vegetative shoot until the wet stage, the first spraying was after a month of germination, and the period between one spraying and another was two weeks.

2.3. Gibberellic Acid(GA3)

Gibberellic acid, GA3, was added to the plant in three concentrations (0, 100, and 200 mg). L^{-1} by dissolving it with distilled water and then spraying it on the plant three times until the vegetation gets wet. The first spray was after (35) days of germination, and the period between one spray and another is two weeks.

2.4. Studied Traits

- Emergence speed (day)
- Plant height (cm)
- leaf length (cm)
- Number of leaves (leaf. plant^{-1})
- Leaf area of the plant (cm^2. plant^{-1})
- Dry weight of leaves
- Determination of total chlorophyll in acetone

3. Results and Discussion

3.1. Emergence Speed (Day)

The results of Table (1) regarding the period required for the emergence of green growths showed no significant differences between the two cultivars in the period needed for emergence, as it reached 26.211 days for the yellow variety Nova Lux, while it got 29.656 days for the red variety Trader Lux.

Table 1. Duration required for emergence (day) for two varieties of Gladiolus *Gladiolus hortulanus L.*

Varieties	Duration to emerge(day)
Nova lux	26.211a
Trader Lux	29.656 a

*Averages that share the same letter for each factor and each interaction do not differ significantly between them according to Duncan's polynomial test at the probability level (P<0.05).

3.2. Plant Height (cm)

The results of the statistical analysis in Table (2) showed that there were significant differences between the two cultivars in the characteristic of plant height, as the red cultivar plants recorded the highest height of 129.905 cm, while the yellow cultivar plants recorded a height of 117.744 cm, The spray was performed with calcium chloride at a concentration of 1000 mg. L^{-1} resulted in a significant increase in plant height, reaching 129.452 cm, compared to 117.802 cm in the comparison treatment, It was also found that spraying with gibberellic acid at a concentration of 100 and 200 mg. L^{-1} has led to a significant direct increase in plant height with an increase in concentration, reaching 123.542 and 127.264 cm, respectively, compared to 120.669 cm for plants of the control treatment.

On the other hand, the results of the bilateral interaction between the cultivar and calcium chloride showed the largest values of plant height when sprayed with calcium chloride, reaching 137.087 cm for the red cultivar plants treated with calcium chloride.This value decreased to 111.611 cm for the yellow cultivar plants not treated with calcium chloride, Also, the highest values for plant height were recorded, reaching 134.251 cm for the red cultivar plants treated with gibberellic acid, while it decreased to 114.297 cm for the yellow cultivar plants not treated with gibberellic acid. The interaction between calcium chloride and gibberellic acid showed that the highest values were 134.981 cm, compared to the comparison treatment, which amounted to 112.916 cm. Overall, the results of the triple interaction of the factors showed that spraying the red variety plants with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant value which amounted to 147.416 cm, This value decreased to the lowest and amounted to 102.786 cm for the yellow cultivar plants that were not treated with calcium chloride and gibberellic acid.

Table 2. Effect of spraying with calcium chloride and gibberellic acid and their interactions on plant height (cm) of two varieties of *Gladiolus hortulanus* L.

Varieties	Calcium	Gibberellins			Class average	Average calcium	Class calcium overlap
		0	100	200			
Nova lux	0	102.786 m	113.970 l	118.076 k	117.744 b	117.802 c	111.611 f
	500	119.206 j k	120.003 i j	120.210 i j		124.221 b	119.806 e

Varieties	Calcium	Gibberellins			Class average	Average calcium	Class calcium overlap
		0	100	200			
Trader lux	1000	120.900 h i	122.003 g h	122.546 f g	129.905a	129.452a	121.816 d
	0	123.046 f g	123.583 f	125.350 e			123.993 c
	500	127.426 d	128.496 d	129.986 c			128.636 b
	1000	130.650 c	133.196 b	147.416 a			137.087a
gibberellin average		120.669 c	123.542 b	127.264 a			
Class overlap x gibberellin							
Nova lux		114.297 f	118.658 e	120.277 d			
Trader lux		127.041 c	128.425 b	134.251 a			
Calcium x gibberellin interference							
0		112.916 h	118.776 g	121.713 f			
500		123.316 e	124.250 d e	125.098 c d			
1000		125.775 c	127.600 b	134.981 a			

*Averages that share the same letter for each factor and each interaction do not differ significantly between them according to Duncan's polynomial test at the probability level (P<0.05).

3.3. Leaf Length (cm)

By looking at the results of the statistical analysis in Table (3) regarding leaf length, we find that the cultivars varied significantly among themselves, as the red cultivar plants significantly outperformed the yellow cultivar plants and reached 102.584 cm compared to 89.344 cm for the yellow cultivar. The spray led with calcium chloride at a concentration of 1000 mg. L^{-1} significantly increased the leaf length as it reached 97.672 cm compared to 93.857 cm for the comparison treatment. It was also found that spraying with gibberellic acid at a concentration of 200 mg. L^{-1} led to a significant increase in leaf length, reaching 98.61 cm, compared to 93.754 cm for the comparison treatment. On the other hand, the results of the interaction between the cultivar and calcium chloride showed the largest values for leaf length when the plants were sprayed with calcium chloride, and it reached 104.208 cm for the red cultivar plants treated with a concentration of 1000 mg. L^{-1} of calcium chloride, and this value decreased to 87.739 cm for the yellow cultivar plants that were not treated with calcium chloride. Also, the largest values were recorded in the leaf length, which amounted to 105.464 cm, for the red cultivar plants treated with a concentration of 200 mg. L^{-1} of gibberellic acid, decreased to 87.968 cm for the yellow cultivar plants not treated with gibberellic acid. Also, the interaction between calcium chloride and gibberellic acid showed that the highest values were obtained and reached 100.527 cm, compared to the comparison treatment, which reached 90.175 cm.

The results of the triple interaction of the factors showed that spraying the red variety plants with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values, which amounted to 107.053 cm, while this value decreased to the lowest 85.267 cm for the yellow cultivar plants that were not treated with calcium chloride and gibberellic acid.

Table 3. Effect of spraying with calcium chloride and gibberellic acid and their interactions on leaf length (cm) for two varieties of Gladiolus hortulanus L.

Varieties	Calcium	Gibberellins			Class average	Average calcium	Class × calcium overlap
		0	100	200			
Nova lux	0	85.267 f	88.283 e f	89.667 d e f	89. 344 b	93.857 b	87.739 d
	500	89.103 d e f	86.767 e f	91.6 c d e		96.363 a	89.157 c d
	1000	89. 533 d e f	89.877 c –f	94 c d		97.672 a	91.137 c
Trader lux	0	95.083 c	100.833 b	104. 007 a b	102.584a		99.974 b
	500	100.967 b	104.41 a b	105. 333 a b			103.57 a
	1000	102. 517 a b	103.053 a b	107.053 a			104.208 a
gibberellin average		93.745 b	95.537 b	98.61a			
Class overlap x gibberellin							
Nova lux		87.968 d	88. 309 d	91.756 c			
Trader lux		99.522 b	102.766 a	105.464 a			
Calcium x gibberellin interference							
0		90.175 c	94.558 b	96.837 b			
500		95.035 b	95.588 b	98.467 a b			
1000		96.025 b	96.465 b	100.527 a			

*Averages that share the same letter for each factor and each interaction do not differ significantly between them according to Duncan's polynomial test at the probability level (P<0.05).

3.4. The Number of Leaves (leaf. plant^{-1})

The results of table (4) showed significant differences between the two cultivars in the characteristic of the number of leaves, as the red cultivar plants recorded the largest significant values, amounting to 9.98 leaves. Plant $^{-1}$ for 9,445 leaves. plant^{-1} for yellow variety plants, Also, spraying with calcium chloride at a concentration of 1000 mg. L^{-1} to give the highest values amounted to 10.033 paper. Plant^{-1} against 9,435 leaves. plant^{-1} for the control treatment, and it was also found that spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest values, amounting to 10.14 leaves. Plant^{-1} against 9.356 leaves. plant^{-1} for comparison treatment, On the other hand, the results of the interaction between the cultivar and calcium chloride showed that the largest values for the number of leaves was obtained when the plants were sprayed with calcium chloride, which reached 10,293 leaves. Plant^{-1} of the red variety plants was treated with a concentration of 1000 mg. L^{-1} of calcium chloride and decreased to 9.182 leaves. plant^{-1} of yellow cultivar plants not treated with calcium chloride, The largest values were recorded in the number of leaves, which amounted to 10,547 leaves. Plant^{-1} of the red variety plants was treated with a concentration of 200 mg. L^{-1} of gibberellic acid, while it decreased to 9.179 leaves. plant^{-1} of yellow cultivar plants not treated with gibberellic acid, The results of the interaction between calcium chloride and gibberellic acid also showed that when plants were sprayed with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} recorded the largest significant values, amounting to 10.59 leaves. Plant^{-1}, while the lowest values were 9.045 leaves. plant^{-1} for comparison plants, While the results of the triple interaction of the factors showed that spraying the red variety plants with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values, which amounted to 10,807 papers.

Plant^{-1}, while this value decreased to the lowest and amounted to 9 leaves. Plant^{-1} for plants of the same variety that were not treated with calcium chloride and gibberellic acid.

Table 4. Effect of spraying with calcium chloride and gibberellic acid and their interactions on the number of leaves (leaf.plant^{-1}) of two varieties of *Gladiolus hortulanus* L.

Varieties	Calcium	Gibberellins			Class average	Average calcium	Class × calcium overlap
		0	100	200			
Nova lux	0	9.09 e f	9.083 e f	9.373 d e f	9.445b	9.435b	9.182c
	500	9.137 e f	9.55 c -f	9.453 c - f		9.67a	9.38c
	1000	9. 31 d e f	9.633 c d e	10.373 a b		10.033a	9.772b
Trader lux	0	9 f	9.63 c d e	10.433 a b	a 9.980		9.688b
	500	9. 58 c - f	9.9 b c d	10.4a b			9.96b
	1000	10.02 b c	10.053 b c	10.807 a			10.293a
gibberellin average		9. 356 c	9.642 b	10.14a			
Class overlap x gibberellin							
Nova lux		9.179 d	c d9.422	b c 9.733			
Trader lux		c 9.533	b 9.861	a 10.547			
Calcium x gibberellin interference							
0		9.045 d	9.357 c d	9.903 b			
500		9.358 c d	9.725 b c	9.927 b			
1000		9.665 b c	9.843 b	10.59 a			

*Averages that share the same letter for each factor and each interaction do not differ significantly between them according to Duncan's polynomial test at the probability level (P<0.05).

3.5. Leaf Area of the Plant (cm^2)

When looking at the data of Table (5), it is clear that there is a significant difference between the two cultivars of Caladolus plant in the characteristic of the leaf area of the plants, as the red variety plants recorded the largest significant values, amounting to 401.656 cm ^{2}. Plant^{-1} for 317.680 cm^2. plant^{-1} for yellow variety plants, The spray led with calcium chloride at a concentration of 1000 mg. L^{-1} to give the largest significant values amounted to 407.192 cm2. plant^{-1} against 294.399 cm^2. plant^{-1} for comparison treatment, spraying with gibberellic acid at a concentration of 200 mg.L^{-1} resulted in obtaining the highest significant values, which amounted to 379.68 cm^2. plant^{-1} against 333.85 cm^2. plant^{-1} for comparison treatment, The interaction between the cultivar and calcium showed the largest significant values for the characteristic of leaf area when the plants were sprayed with calcium chloride, and reaching 454.018 cm^2. Plant^{-1} of the red variety plants was treated with a concentration of 1000 mg, L^{-1} of calcium chloride, and decreased to 264.593 cm^2. plant^{-1} of yellow cultivar plants not treated with calcium chloride, The largest values were also recorded in the paper area, which amounted to 420.81 cm^2. plant^{-1} of the red variety plants sprayed with a concentration of 200 mg. L^{-1} of gibberellic acid, while it decreased to 302.82 cm^2. Plant $^{-1}$ for yellow cultivar plants not treated with gibberellic acid. It was also clear from the interaction between calcium chloride and gibberellic acid when spraying plants with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values, which amounted to 441.94 cm^2. Plant^{-1}, while this value decreased to the lowest amounting to 278.21 cm^2.

plant-1 for comparison plants, The results of the triple interaction of the factors showed that spraying the red variety plants with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values which amounted to 500.04 cm^2. $plant^{-1}$, while this value decreased to the lowest amounting to 255.49 cm^2. Plant $^{-1}$ of the yellow variety plants was not treated with calcium chloride and gibberellic acid.

Table 5. Effect of spraying with calcium chloride and gibberellic acid and their interactions on plant leaf area (cm^2. $plant^{-1}$) of two varieties of *Gladiolus hortulanus* L.

Varieties	Calcium	Gibberellins			Class average	Average calcium	Class × calcium overlap
		0	100	200			
Nova lux	0	255.49 j	259.18 i j	279.11 h i j	317.680b	294.339c	264.593e
	500	312.87 f -j	318.67 f –j	352.70 d -h		377.413b	328.080d
	1000	340.10 d -i	357.18 d -h	383.83 c –g		407.192a	360.366c
Trader lux	0	300.93 g -j	331.01 f -j	340.67 d –i	401.656a		324.204d
	500	387.05 c-f	471.49 a b	421.70 a -d			426.746b
	1000	406.66 b –e	455.35 a b c	500.04 a			454.018a
gibberellin average		333.85 b	365.48 a	379.68a			
Class overlap x gibberellin							
Nova lux		302.82 c	311.68c	338.55 b c			
Trader lux		364.88 b	419.28a	420.81a			
Calcium x gibberellin interference							
0		278.21 d	295.10 d	309.89 c d			
500		349.96 b c	395.08 a b	387.20 a b			
1000		373.38 b	406.26 a b	441.94 a			

*Averages that share the same letter for each factor and each interaction do not differ significantly between them according to Duncan's polynomial test at the probability level (P<0.05).

3.6. Leaves Dry Weight (g)

The results shown in Table (6) indicated significant differences between the two cultivars of the Gladiolus plant in the characteristic of the dry weight of the leaves, as the red cultivar plants recorded the largest significant values, amounting to 12.567 g. $Plant^{-1}$ compared to 10.653 g. $plant^{-1}$ for yellow variety plants, It was obtained when spraying with calcium chloride at a concentration of 1000 mg. L^{-1} had the highest values, amounting to 12.701 grams. $plant^{-1}$ in exchange for 10.145 g. $Plant^{-1}$ for the control treatment, as sprayed with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values, amounting to 12.523 gm. $Plant^{-1}$ compared to 10.543 g. $plant^{-1}$ for comparison-treated plants, While the results of the interaction between the cultivar and calcium chloride showed the largest significant values of the dry weight of the leaves when the plants were sprayed with calcium chloride, which amounted to 13.838 g. Plant $^{-1}$ of the red variety plants were treated with a concentration of 1000 mg. L^{-1} of calcium chloride was reduced to 9.528 g. $plant^{-1}$ of yellow cultivar plants not treated with calcium chloride, The highest values were also recorded in the dry weight of the leaves, which amounted to 13.460 g. $Plant^{-1}$ of the red variety plants was sprayed with a concentration of 200 mg. L^{-1} of gibberellic acid, while it decreased to 9.435 g. $Plant^{-1}$ of yellow cultivar plants not treated with gibberellic acid. One of the results of the interaction between calcium chloride and gibberellic acid is when plants are sprayed with calcium chloride at a concentration of

1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values, which amounted to 14.215 g. $Plant^{-1}$, while this value decreased to the lowest, amounting to 9.086 gm. $Plant^{-1}$ for comparison plants, Overall, it can be said, through the results of the triple interaction of the factors, that spraying the red variety plants with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values, amounting to 15.360 gm. $Plant^{-1}$, while this value decreased to the lowest, amounting to 8.263 g. $Plant^{-1}$ of yellow cultivar plants not treated with calcium chloride and gibberellic acid.

Table 6. Effect of spraying with calcium chloride and gibberellic acid and their interactions on the dry weight of leaves (g. $plant^{-1}$) of two cultivars of *Gladiolus hortulanus* L.

Varieties	Calcium	Gibberellins			Class average	Average calcium	Class × calcium overlap
		0	100	200			
Nova lux	0	8.263 g	9.986 f	10.336 f	10.653b	10.145c	c 9.528
	500	9.923 f	11.323 e	11.353 e		11.983b	b 10.866
	1000	10.120 f	11.503 d e	13.070 b c		12.701a	b 11.564
Trader lux	0	9.910 f	10.860 e f	11.513 d e	12.567a		b 10.761
	500	12.350 c d	13.446 b	13.506 b			a 13.101
	1000	12.696 b c	13.460 b	15.360 a			13.838a
gibberellin average		10.543 c	11.763b	a 12.523			
Class overlap x gibberellin							
Nova lux		9.435 e	10.937 d	11.586 c			
Trader lux		11.652 c	12.588 b	13.460 a			
Calcium x gibberellin interference							
0		9.086 e	10.423 d	10.925 c d			
500		11.136 c	12.385 b	12.430 b			
1000		11.408 c	12.481 b	14.215 a			

*Averages that share the same letter for each factor and each interaction do not differ significantly between them according to Duncan's polynomial test at the probability level ($P<0.05$).

3.7. Determination of Total Chlorophyll in Acetone

The results obtained in Table (7) for the estimation of total chlorophyll in the leaves indicated that there were significant differences between the two cultivars, as the yellow cultivar plants recorded the largest significant values and amounted to 0.984, while the red cultivar recorded the lowest values and amounted to 0.796. The spraying was done with calcium chloride at a concentration of 1000 mg. L^{-1} to give the highest values, amounting to 1.131 compared to 0.65 for the comparison treatment. Also, spray with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values and amounted to 1.32 compared to 0.671 for the plants of the comparison treatmen. It became clear through the interaction between the variety and calcium chloride that the largest significant values were obtained for the characteristic of total chlorophyll when the plants were sprayed with calcium chloride and amounted to 1.104 for the plants of the red variety treated with a concentration 1000 mg. L^{-1} of calcium chloride, decreased to 0.441 for plants of the cultivar not treated with calcium chloride. Also, the highest values were recorded in total chlorophyll when sprayed with gibberellic acid

reaching 1.212 for yellow cultivar plants treated with a concentration of 200 mg. L^{-1} of gibberellic acid decreased to 0.603 for red variety plants not treated with gibberellic acid, and the results of the interaction between calcium chloride and gibberellic acid showed that when the plants were sprayed with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant values and amounted to 1.428, while this value decreased to the lowest and amounted to 0.472 for the comparison plants. The results of the triple interaction of the factors showed that spraying the yellow cultivar plants with calcium chloride at a concentration of 1000 mg. L^{-1} mixed with spraying with gibberellic acid at a concentration of 200 mg. L^{-1} gave the highest significant value and amounted to 1.537, in cotrast this value decreased to the lowest and amounted to 0.343 for the red variety plants not treated with calcium chloride and gibberellic acid.

Table 7. Effect of spraying with calcium chloride and gibberellic acid and their interactions on the determination of total chlorophyll of two cultivars of *Gladiolus hortulanus* L.

Varieties	Calcium	Gibberellins			Class average	Average calcium	Class × calcium overlap
		0	100	200			
Nova lux	0	0.6 hi j	1.023 c d e	0.953 d –g	0.984a	0.65c	0.859b
	500	0.71 g h i	0.957 d –g	1.147 b c d		0.89b	0.938b
	1000	0.903 d –g	1.03 c d e	1.537 a		1.131a	1.157a
Trader lux	0	0.343 k	0.463 j k	0.517 i j k	0.796b		0.441c
	500	0.723 hij	0.817 e -h	0.987 d e f			0.842b
	1000	0.743 f –i	1.25 b c	1.32 a b			1.104a
gibberellin average		0.671c	0.923b	1.077 a			
Class overlap x gibberellin							
Nova lux		0.738 d	1.003 b	1.212 a			
Trader lux		0.603 e	0.843 c d	0.941 b c			
Calcium x gibberellin interference							
0		0.472 d	0.743 c	0.735 c			
500		0.717 c	0.887 c	1.067 b			
1000		0.823 c	1.14 b	1.428 a			

*Averages that share the same letter for each factor and each interaction do not differ significantly between them according to Duncan's polynomial test at the probability level ($P<0.05$).

The data in Table (1) regarding the period required for the emergence of vegetative growths indicated that there were no significant differences between the two cultivars in the period required for emergence, and this may be explained by the occurrence of hormonal balance, especially gibberellic acid and abscisic acid, as well as the dormancy period and the amount of food storage in the corm [21], The results indicated in tables (2 and 3) related to plant height and leaf length, the superiority of red cultivar plants treated with a concentration of 1000 mg. L^{-1} In this direction, [22] mentioned that calcium plays an important role in mitotic cell division, which leads to the duplication of genetic material and thus an increase in the number of cells that participate in the delivery of instructions between cells and as a secondary messenger by linking calcium with calmodulin (calcium- modulated protein) It is a protein found in the cytosol that unites with calcium and the compound resulting from their union regulates many continuous metabolic activities in the cytosol and organelles such as cell division and elongation as the calcium ion participates in the formation of new cell walls. The leafy area has a special importance as it is the important part exposed to sunlight necessary for metabolism. This characteristic recorded significant differences between cultivars in this trait, the largest for the red variety[23], the results indicated in the table that there is an effect of calcium on the dry weight of the

leaf and the reason is due to the plant's supply of the element nitrogen, which leads to an increase in the efficiency of photosynthesis, an increase in the number of cells and their large size, and an increase in the growth rate, which leads to an increase in the dry weight of the plant as well On the role of potassium in carbohydrate metabolism and the activation of enzyme systems , the data in Table (7) indicate that the treatment with calcium chloride at a concentration of 1000 mg.L^{-1} recorded the highest significant increase in the chlorophyll estimate. Activated growth (gibberellic acid) [24]. This may be explained according to the role of calcium in enhancing the photosynthesis process and increasing its output of carbohydrates for the manufacture of plant pigments. Thus, the increase in pigments is related to the increase in carbohydrates [25].

As for the positive effects of gibberellins on the characteristics of vegetative growth, it can be said that they are due to the increase in the internal content of gibberellins, which encourages vegetative growth by stimulating active cell division and cell elongation in the apical meristem [26,27]. The other possible reason for the significant increase in the vegetative growth characteristics could be attributed to the effect of gibberellins on the activity of the photosynthesis process and thus increasing the efficiency of utilization of the products of the photosynthesis process by the plant. These results are also in line with those of [28-34].

Conclusions

In light of the obtained results, we conclude the following:

- The cultivar "Trader Lux" with red flowers had the highest plant height, leaf length, number of leaves, leaf area and leaf dry weight, and the second variety Nova Lux with yellow flowers recorded the highest percentage of chlorophyll in the leaves.
- It was treated with calcium chloride at a concentration of 1000 mg. L^{-1} indicated a positive effect on all traits under study compared to no supplementation.
- It was treated with gibberellic acid at a concentration of 200 mg. L^{-1} indicated a positive effect on all traits under study compared to no supplementation.
- The effect ofcombined combination of the study factors had a positive effect on improving the vegetative growth characteristics
- The joint cooperative effect of the study factors contributed positively to improving all the characteristics under study.

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