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EFFECT OF SELENIUM AND BRASSINOLIDE ON GROWTH AND YIELD OF TWO BROCCOLI HYBRIDS, BRASSICA OLERACEA VAR. ITALIC

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Abstract

The experiment was carried out during the agricultural season (2021-2022) in one of the agricultural fields in the village of Tarjeel, Laylan district in Kirkuk governorate, and the experiment included the study of three factors, the first factor included spraying with selenium at concentrations (40, 30, 20 mg.L^{-1}) and the second factor spraying with brassinolide in concentrations 150, 100, 50 mg.L^{-1}) and factor III hybrids (Paraiso, Jassmine F1). The treatments were sprayed in two batches, the first spray 20 days after planting the seedlings on 1/9/2021, and the second spray 20 days after the first spray. The experiment included three replicates, and each replicate had 14 experimental units. The experiment was implemented according to the Split Plot Design system within the design of randomized complete sectors. R.C.B.D and the data were statistically analyzed according to the least significant difference L.S.D at the probability level of 0.05, where the results showed that spraying with selenium concentration (20 mg.L^{-1}) was significantly superior to the characteristic of the number of leaves, which amounted to 44.430 (leaf $^{-1}$) and also the concentration (40 mg.L^{-1}). for the weight of the lateral pink tablets (g), which reached 0.590 g, while the brassinolide at a concentration (100 mg.L^{-1}) was significantly superior in the relative content of chlorophyll in leaves and leaf area of one leaf, which reached (101,335CCI and 632.500 cm^2 leaves^{-1}) sequentially. While the Jasmine F1 hybrid showed significant superiority, the highest plant height was 75.524 cm, the number of leaves reached 49.733 leaves, the leaf area per leaf reached 693.400 cm^2 leaf^{-1}, and the lateral flower discs weighed 0.623 g), while the Hybrid Paraiso in traits (The weight of the main disc is 0.756 g and the relative content of chlorophyll in the leaves reached CCI98, 229). As for the dual interactions between the hybrid Jassmine F1 and spraying with selenium at a concentration of 20 mg.L^{-1}, it gave the highest plant height of 79.800 cm, while the hybrid Jassmine F1 and spraying with brassinolide at a concentration were superior. 100 mg.L^{-1} in (the leaf area of one leaf was 754.700 cm^2 leaf^{-1}, the number of leaves per plant was 54,330 leaf-^{1}, the height of the plant was 79.800 cm, and the weight of the lateral flower discs was 0.740 g). The Paraiso hybrid and spraying with brassinolide at a concentration of 100 mg.L^{-1} were significantly superior to the relative content of chlorophyll in the leaves, which recorded the highest rate of 120, 000 CCI.

Key words: broccoli, selenium, prasinolide, vegetative growth, yield.

Introdiction

Broccoli is a winter vegetable, Brassica oleracea var. İtalica, which belongs to the cruciferous family Brassicaceae, is an annual herbaceous plant similar to the morphology of cauliflower. It is one of the few plants spread in Iraq. It was known more than 2,700 years ago in the Mediterranean region and in the regions of Asia Minor. The Romans knew it since ancient times. The Italians planted it and crossed it. It is believed that they transmitted it To the United States of America in 1806 AD (Ouda and Mahadeen, 2008), broccoli is grown for its inflorescences, as it is the part that is eaten in the phase of the vegetative flowering buds with their thick, smooth stalks and is one of the richest vegetable crops of this family with high nutritional value and the most used in therapeutic terms (Thapa and Rair, 2012).

The demand for the crop by consumers has increased recently, as the demand for it in the global markets because of its high nutritional value and distinctive taste, which was proven by the increase in the cultivated area of the crop and the increase in production significantly in all global markets (Jing et al., 2011) as one of the crops with nutritional value Each 100 gm of the fresh weight of the pink disc contains 5.9 gm of sugars, 0.3 gm of fat, 3.6 gm of protein, 32 calories and 89.1 gm of water. It is low in free fats, sodium, and calories. It works to protect the human body from the risk of cancer because it contains Glucoraphanin against stomach cancer, as well as the compound Indole-3-carbinol that prevents breast and colon cancer, in addition, that it improves liver function when eating more than one meal per week, to enhance the body's immunity and reduce the risk of cancer diseases by 45% (Griffin., 2006). The demand for the crop by consumers has increased recently, as this demand has been witnessed in the global markets due to its high nutritional value and distinctive taste, this was proven by the increase in the cultivated area of the crop and the significant increase in production in all global markets (Jing et al., 2011).

Plant breeders aim to obtain hybrids and varieties with desirable agricultural characteristics for important agricultural crops through breeding and improvement programs and to know the extent to which they are adapted to the environmental conditions prevailing in that area in which the plant grows, so it requires the provision of new hybrids or varieties.

Selenium is one of the rare elements that have an effective role in raising the activity of the enzymatic antioxidants of water. It is also characterized by its association with amino acids and the formation of what is known as selenium proteins, which have the extraordinary ability to withstand cell membranes to water stress (Hassanuzzaman et al., 2010). Brassinolide is a plant steroid compound and is one of the latest discovered plant hormones, as it was previously believed that steroid hormones are found only in the animal kingdom as it is a complex hormonal system, but recent studies have proven its presence in concentrations in plants of the cruciferous family Brassicaceae, where many types of steroid hormones were found, which are similar to the structure of the hormone Testosterone in the watercress plant (Erucasativa Islam, 2014).

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Aim of the Study

To identify the effect of spraying with selenium and brassinolide on the growth characteristics and yield of two hybrids of broccoli in Kirkuk governorate.

Materials and Methods

The experiment was carried out during the agricultural season (2021-2022) in one of the private agricultural fields in the village of Tarjeel, Laylan district, in Kirkuk governorate, which is located on the longitude (44.526016) and latitude (35.382831), and for the period 1/9/2021 until 3/12/2021.

Preparing the Land and Planting Seedlings

The soil of the field was prepared by removing the growing bushes and large stones and then irrigating the field abundantly for the purpose of accelerating the growth of the remaining bushes and weeds and then removing them. Well adjusted. Then the field land was divided into three replicates, and each replicate contained the two hybrids randomly so that every 14 meters includes one hybrid, and each mezze is considered an experimental unit. And another 40 cm, leaving a distance of 1 m between each repeater, and then animal manure was added to all experimental units. The drip irrigation system was used to irrigate the plants in the field. The experiment was conducted according to a split-plot design in a randomized complete block design R.C.B.D.

Study Treatment

The first / 1. Spraying the shoots with selenium and brassinolide, and it includes seven concentrations:

a. 0 g liter^{-1} and symbolized by T1

b. Treatment of foliar spraying with selenium at a concentration of 20 mg.L^{-1} and its symbol T2

c. Treatment of foliar spraying with selenium at a concentration of 30 mg L^{-1} and symbolized by 3T

d. Treatment of foliar spraying with selenium at a concentration of 40 mg.L^{-1} and symbolized by 4T

e. Treatment of foliar spray with brassinolide at a concentration of 50 mg.L^{-1} and symbolized by 5T

f. Treatment of foliar spray with brassinolide at a concentration of 100 mg.L^{-1} and symbolized by T6

g. Treatment of foliar spray with brassinolide at a concentration of 150 mg.L^{-1} and symbolized by T7

Second /2. Two broccoli hybrids:

a. Camel (Paraiso) Japanese and symbolized by V1

b. Camel (Jasmine) is American and symbolizes 2V

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Studied Traits Include

A- Botanical characteristics include:

Plant Height (cm):

The height of all plants selected for the experimental units was measured using a tape measure from the area of contact of the stem with the soil to the top of the plant leaves and the average was extracted.

2. Number of Leaves (Leaf^{-1})

The number of all leaves of five selected plants was calculated for all experimental units and then the average was extracted for them.

3. Leaf area (cm_2 plant^{-1})

The leaf area was calculated by taking one leaf of the selected plant from the middle of the branches before harvesting the heads, and then the leaves were photographed with an electric cloning device, after that she cut the shape of the cloned leaf and then weighed it with a sensor scale.

Area of one leaf = (A3 reproduction leaf area x reproduced leaf weight) / (A3 reproduction leaf weight)

4. Measurement of the relative content of chlorophyll in leaves (CCI) Leaf content of chlorophyll was measured for five leaves of all selected plants by an electronic device (Chlorophell content meter) of USA-Hudson, with 10 readings from random places on the leaf and then extracting the average for it (Biber, 2007).

5. The yield of the side pink tablets (gm): The cumulative sum of the side discs of the experimental unit was divided by the number of selected plants (5).

6. The total yield of tubers (ton.ha^{-1}):

This characteristic was calculated according to the following law:

Total product = (empirical unit quotient) / (empirical unit area) × 10,000

The experimental unit yield = the average yield of one plant x the number of plants in the experimental unit.

Results and Discussion

• **Plant height:** The results of table (1) show that the comparison treatment gave the highest average plant height of 73,200 cm compared to spraying with brassinolide, which amounted to 70,430 cm at a concentration of 50 mg.L^{-1}, while Hybrid 2 excelled by recording the highest plant height of 75,524 cm compared with Hybrid 1 which recorded less The height of the plant reached 68.104 cm, while the binary interactions between treatments and hybrids showed the superiority of hybrid 2 and spraying with selenium at a concentration of 20 mg.L^{-1}, where the highest plant height was recorded at 79.800 cm compared with hybrid 1 and spraying with selenium at a concentration of 20 mg.L^{-1}, with the lowest plant height of 66.400 cm.

. Table (1) Effect of spraying with selenium and brassinolide and the interaction between them on the plant height of two broccoli hybrids (cm)

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Treatment	Level	Varieties		Average
		Hybrid 1	Hybrid 2	
Control		71.400	75.000	73.200
Selenium	**20** mg.L^{-1}	66.400	79.800	73.100
Selenium	**30** mg.L^{-1}	67.870	76.070	71.970
Selenium	**40** mg.L^{-1}	67.330	74.070	70.700
Brassinolide	**50** mg.L^{-1}	69.130	71.730	70.430
Brassinolide	**100** mg.L^{-1}	67.200	76.330	71.765
Brassinolide	**150** mg.L^{-1}	67.400	75.670	71.535
L.S.D 5%		1.940**		1.372**
Average Hybrid		68.104	75.524	
L.S.D 5%		3.398*		

The results from Table (2) indicate that the characteristics of the number of leaves of the plant were significantly affected in the treatment T2 when spraying the shoots with selenium, as the highest rate of the number of leaves was recorded, which amounted to 44,430 (leaf^{-1}), while the treatment of T5 recorded the lowest rate, which gave 39,100 (leaf of plant -^{1}), while Hybrid 2 outperformed by recording the highest average number of leaves that reached 49.733 (leaf^{-1}) compared with Hybrid 1 which recorded the lowest average number of leaves, which reached 34,770 (leaf $^{-1}$), while the binary interactions between treatments and hybrids showed Hybrid 2 and spraying with prasinolide at a concentration of 100 mg.L^{-1} were superior, as it recorded the highest average number of leaves per plant that reached 54,330 (leaf^{-1}) compared with Hybrid 1 and a treatment compared to recording the lowest average number of leaves per plant that reached 29.330 (leaf^{-1}).

Table (2) Effect of spraying with selenium and prasinolide and their interaction on the number of leaves in the two hybrids of broccoli (leaf^{-1}).

Treatment	Level	Varieties		Average
		Hybrid 1	Hybrid 2	
Control		29.330	50.470	39.900
Selenium	20 mg.L^{-1}	37.730	51.130	44.430
Selenium	30 mg.L^{-1}	37.730	47.730	42.730
Selenium	40 mg.L^{-1}	35.600	50.070	42.835
Brassinolide	50 mg.L^{-1}	33.330	44.870	39.100
Brassinolide	100 mg.L^{-1}	34.000	54.330	44.165
Brassinolide	150 mg.L^{-1}	35.670	49.530	42.600
L.S.D 5%		3.336**		2.359**
Average Hybrid		34.770	49.733	
L.S.D 5%		2.068**		

Leaf Area

We note from Table (3) that the characteristic of leaf area per leaf was significantly affected by treatment T6 when spraying the shoot with prasinolide, which recorded the highest average leaf area per leaf, which amounted to 632,500 (cm^2 leaf $^{-1}$), while the lowest comparison treatment was recorded, which gave 538,250 (cm^2 $leaf^{-1}$). While it showed the superiority of hybrid 2 by recording the highest average leaf area per leaf, which amounted to 693,400 (cm^2 $leaf^{-1}$) compared with hybrid 1, where the lowest average leaf area per leaf was 466,400 (cm^2 $leaf^{-1}$), while the binary interactions between transactions and hybrids showed The superiority of hybrid 2 and spraying with prasinolide at a concentration of 100 mg. L^{-1}, which recorded the highest rate of leaf area per leaf, which amounted to 754,700 (cm^2, $leaf^{-1}$) compared with hybrid 1 and spraying with selenium at a concentration of 40 mg. L^{-1}, as it recorded the lowest rate for leaf area per leaf, which amounted to 430.300 (cm^2) leaf $^{-1}$).

Table (3) Effect of spraying with selenium and prasinolide and their interaction on the leaf area of one leaf in two hybrids of broccoli (cm^2 $leaf^{-1}$).

Treatment	Level	Varieties		Average
		Hybrid **1**	Hybrid 2	
Control		433.100	643.400	538.250
Selenium	20 mg.L^{-1}	502.100	588.600	545.350
Selenium	30 mg.L^{-1}	430.600	667.200	548.900
Selenium	40 mg.L^{-1}	430.300	700.000	565.150
Brassinolide	50 mg.L^{-1}	479.800	661.100	570.450
Brassinolide	100 mg.L^{-1}	510.300	754.700	632.500
Brassinolide	150 mg.L^{-1}	466.400	693.400	579.900
L.S.D 5%		35.850**		25.350**
Average Hybrid		464.657	672.629	
L.S.D 5%		25.320**		

• Chlorophyll

We note from the results of Table (4) that the relative content of chlorophyll in leaves was significantly affected by the treatment when spraying the shoot with prasinolide at a concentration of 100 mg. L^{-1}, as the highest rate of relative content of chlorophyll in leaves was CCI101,335 compared to the comparison treatment that recorded the lowest rate For this trait, it reached 84.115CCI., and Hybrid 1 showed significant superiority, as the highest rate of relative chlorophyll content in leaves was CCI98,229, while Hybrid 2 recorded the lowest rate of CCI84,470.

In the binary interaction between hybrids and spraying, the significant effect was shown for hybrid 1 and spraying with prasinolide at a concentration of 100 mg. L^{-1} and hybrid 1 which recorded the highest rate of CCI120, 000, while hybrid 2 and

spraying with selenium at a concentration of 40 mg. L^{-1} recorded the lowest rate of CCI79.030.

Table (4) Effect of spraying with selenium and prasinolide and their interaction on the relative content of chlorophyll in leaves of broccoli hybrids

Treatment	Level	Varieties		Average
		Hybrid **1**	Hybrid 2	
Control		86.600	81.630	84.115
Selenium	20 mg.L^{-1}	81.970	88.770	85.370
Selenium	30 mg.L^{-1}	93.400	86.100	89.750
Selenium	40 mg.L^{-1}	92.100	79.030	85.565
Brassinolide	50 mg.L^{-1}	103.930	87.170	95.550
Brassinolide	100 mg.L^{-1}	120.000	82.670	101.335
Brassinolide	150 mg.L^{-1}	109.600	85.470	97.535
L.S.D 5%		7.517**		5.315**
Average Hybrid		98.229	84.406	
L.S.D 5%		7.830*		

• Main Disc Weight

In Table (5), the results indicate that the comparison treatment gave the highest average for the weight of the main tablet, which amounted to 0.864 g, compared to spraying with prasinolide with a concentration of 1 mg.L^{-1}, which amounted to 0.481 g. Compared with hybrid 2, which recorded the lowest rate for this trait, it reached 0.740 g. The significant effect of the two interactions between treatments and crosses shows the significant effect of control treatment and hybrid 2, which gave the highest rate, which reached 0.930 g, compared to spraying with pracinolide at a concentration of 1 mg.L^{-1} and hybrid 2 which recorded the lowest the average amounted to 0.525 g.

Table (5) Effect of spraying with selenium and prasinolide and overlap between them on the weight of the main disc in the two hybrids of broccoli (gm).

Treatment	Level	Varieties		Average
		Hybrid **1**	Hybrid 2	
Control		0.797	0.930	0.864
Selenium	20 mg.L^{-1}	0.640	0.735	0.688
Selenium	30 mg.L^{-1}	0.824	0.872	0.848
Selenium	40 mg.L^{-1}	0.759	0.654	0.706
Brassinolide	50 mg.L^{-1}	0.856	0.525	0.691
Brassinolide	100 mg.L^{-1}	0.716	0.821	0.769
Brassinolide	150 mg.L^{-1}	0.700	0.645	0.673
L.S.D 5%		0.102**		0.072**
Average Hybrid		0.756	0.740	
L.S.D 5%		Ns		

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• Average weight of the Side Discs

The data from Table (6) indicate the moral effect of spraying the foliage with selenium at a concentration of 40 mg.L^{-1} as it gave the highest average weight of the lateral pink discs, which was 0.593 g. Significantly in this trait, it gave the highest value of 0.623 g in comparison with hybrid 1, which recorded the lowest value for this trait and was 0.475 g.

The two interactions between hybrids and spraying showed the significant effect of spraying with brassinolide at a concentration of 100 mg. L^{-1} and for hybrid 2 which recorded the highest value of 0.740g compared with spraying with brassinolide at a concentration of 150 mg. L^{-1}, which recorded the lowest value of 0.388g.

Table (6) the effect of spraying with selenium and prasinolide and the interaction between them on the average Weight of the side pink discs in broccoli (gm).

Treatment	Level	Varieties		Average
		Hybrid **1**	Hybrid 2	
Control		0.450	0.718	0.584
Selenium	**20**mg.L1	0.554	0.577	0.565
Selenium	30 mg.L^{-1}	0.456	0.692	0.574
Selenium	40 mg.L^{-1}	0.618	0.568	0.593
Brassinolide	50 mg.L^{-1}	0.489	0.474	0.481
Brassinolide	100 mg.L^{-1}	0.372	0.740	0.556
Brassinolide	150 mg.L^{-1}	0.388	0.590	0.489
L.S.D 5%		0.081**		0.057**
Average Hybrid		0.475	0.623	
L.S.D 5%		0.075*		

When discussing the results, it appears in Tables (2) and (6) that the spraying of selenium had a positive effect on increasing the averages of the studied traits and the superiority of the spray treatment with a concentration of 20 mg.L^{-1} as the response to this concentration was clear in the number of leaves and also the concentration of 40 mg.L^{-1} was significantly superior. The average weight of the side pink tablets is probably due to the fact that selenium acts as a linking factor between amino acids, especially the two acids (seleno-cysteine) and (seleno-methionine), which have the ability to bind with other amino acids, which increases the ability to increase the effectiveness of enzymes and increase the activity of Types of RNA and DNA, and this activity increases cell division, differentiation, growth, cell expansion, and increases vegetative growth (Claussen, 2004 and Nur et al., 2006).

Table (3) also showed significant differences for the characteristics of leaf area per leaf, where the plant was affected when the concentration of 100 mg per liter was used. It is believed that the increase in leaf area is due to the positive effect of brassinolide in stimulating the processes responsible for cell division and elongation (Shahbaz and Ashraf, 2007), also, the hormone prasinolide had a positive behavior in increasing the

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relative content of chlorophyll in the leaves in Table (4) when using a concentration of 100 mg.L^{-1}. This may be due to the active participation of brassinosteroids in transcription or translation (Mandava, 1988), which may increase the synthesis of chlorophyll during The path of the current study is that Homobrassinolides are associated with chlorophyll biosynthesis, mediated by the activation of certain genes (Ali et al., 2006) and these results agree with Shraida, A. S., & Almohammedi, (2021) and Al-Saedi, A. J., & Al-Mentafji (2017).

The hybrid plants (Jassmine) were significantly superior to the hybrid plants (Parasio) in most of the studied traits (plant height, number of leaves, leaf area, and average weight of lateral flower discs). The environment and thus the emergence of a discrepancy between the hybrids in the studied traits, and these results are consistent with the studies conducted by (Omer and Abdul, 2013) and (Al-Moussawi and Al-Birmani, 2017) and (Al-Salihi, 2019), and (Al-Bazini and Omar, 2019). (Hammad and Al-Jabari, 2019), and (Lateef et al., 2021).

Conclusion

Through the experiment, we found that the best concentrations of selenium used (30 and 40 mg.L^{-1}) as a spray for the vegetative group led to a significant increase in both (the number of leaves and the average weight of the lateral flower discs) and it was recommended to use selenium in these concentrations in the fields of broccoli cultivation in Kirkuk governorate.

The use of the hormone brassinolide in different concentrations led to a significant increase in most of the vegetative growth traits and the quantitative yield. On the rest of the used concentrations of brassinolide and it was recommended to use the hormone brassinolide in these concentrations in Kirkuk Governorate in order to improve the quantitative and qualitative yield.

The hybrid (Jassmine) was significantly superior in most of the vegetative traits and yield studied above compared to the hybrid (Parasio), which indicates the importance of adopting this hybrid for cultivating the broccoli crop in Kirkuk governorate with a recommendation to conduct other future studies to compare this hybrid with other new hybrids entering the country for the first time.

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