Original Article

Response Of Two Cauliflower Cultivars Brassica Oleracea Var. Botrytis To Plant Spacing And Foliar Spraying With Nano-Boron Fertilizer

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Abstract

Summary

An experiment has been carried out in a vegetable field, College of Agriculture and Forestry / University of Mosul/ Tourist forest area , during the autumn growing season (2022) , The experiment included a study of three factors, the first was two cultivar of cauliflower (Narges and Ice ball). The second factor included three planting distances (35, 40, 45) cm between one plant and another. The third factoris Nano-boron fertilizer with three concentrations of 0, 30 and 60mg L^{-1} plants treated with Nano-boron fertilizer during three stages of plant growth: The first after two weeks of transplanting, the second and third stages with a 15-day interval between addition and another , thus the experiment involved 18 treatments (2 × 3× 3).arranged in a factorial experiment within split-plot using the Randomized Complete Block Design with three replicate , cultivars were placed in the main plots and the interaction between planting distancesand Nano-boron fetilizer in sub-plots . Results were statistically analysis and compared the means according to the Duncan multiple range test at a 5% probability level.

The result can be summarized as follow.

A- The plants of Narges cultivar showed significant superiority over the Ice ball cultivar in all vegetative growth traits except for plant height.

B- Plants planted at a distance of 45 cm were significantly superior compared to the other two distances in plant height, leaf area and contain of total chlorophyll in the leaves, the same distance also outperformed the plants grown at a distance of only 35 cm in the number of leaves.

C- The use of Nano-boron fertilizer at a concentration of 30 and 60 mg L^{-1} resulted in a significant increase in all vegetative growth characteristics compared to the control treatment.

Introduction

Cauliflower its scientific name is Brassica oleracea var. botrytis is one of the winter vegetable crops it is the second most important vegetable crop belonging to the Brassicaceae family. It is native to southern Italy and other areas in the Mediterranean basin, southern Europe. The cauliflower plant is grown in order to obtain its curd, which is the edible part of the plant. It is one of the vegetables that are very rich in niacin (0.7 mg / 100 g), and ascorbic acid (78 mg / 100 gm), and it is medium in its content of calcium (25 mg / 100 gm), And phosphorous (56 mg / 100 gm), iron (1.1 mg / 100 gm), and the pink disc consists of (91% moisture) and (27 calories per 100 gm), (2.7% protein), (0.2% fat), (5.3% total carbohydrates), (1% fiber), (Hassan, 1991), (Hassan, 1997) and (Al-Mohammadi and Al-Mishaal, 1989). Cauliflower also has medical benefits, as it

contains compounds that protect against bowel cancer, vitamin A, which is beneficial for bones, teeth and eyes, and a high percentage of fiber that helps build a healthy intestine , galactose that prevents the causes of colon disease, glucoraphanin, which keeps heart diseases away, indole 3 carbinol, which stops cancer in prostate cells, calcium, which is important for bones and teeth (Sharma et al., 2004). The total area cultivated with cauliflower in the world in 2019 amounted to about 1436.82 thousand hectares, and Iraq ranked seventh in the arab countries in the most cultivated arab countries in terms of area, which amounted to 990 hectares, and came in the thirteenth place in terms of production 7.19 thousand tons, while Iraq appended the list of arab countries in the sixteenth place in terms of productivity per unit area with 7266.93 $kg.ha^{-1}$ (Arab Organization for Agricultural Development, 2019). Which necessitates studying the reasons for the decline in productivity and trying to raise the productivity of the yield per unit area, as this can be achieved by using different methods and technologies in the agricultural field. Yeasmin etal. (2021) observed in their study in Bangladesh to evaluate the performance of two cauliflower cultivars, Bari Fulkopi-2 and Bari Kulkopi-1, that the plants of Bari Fulkopi-2 were significantly superior in plant height and leaf area. Tawfeeq and Abdulrhman (2021) indicated in one of the researches they conducted in Tikrit using two varieties of cauliflower Fuji Yama and White Cloud that the White Cloud cultivar had a significant superiority in leaf length, and no significant differences were observed between the two cultivars in the number of leaves, plant length, and leaf chlorophyll content. Al-Bakri (2022) studied the vegetative growth characteristics of two cauliflower hybrids (Ice ball and Raheq) in Mosul city, and noticed that the Ice ball hybrid plants were significantly superior in plant length, number of leaves, and percentage of dry matter in the leaves. An experiment was carried out by Al-Hakim (2006) in Al-Musayyib, the effect of two planting distances between plants (50 and 70) cm for two seasons,70 cm distance showed the highest significant value in the percentage of dry matter in the leaves for both seasons, and no significant differences were observed between the two distances in the number of leaves. In a study conducted by Rhman and others (2007) in Pakistan to determine the best planting distance between cauliflower plants among six planting distances (30, 35, 40, 45, 50, 55) cm, they noticed that the plants planted at a distance of 45 gave the highest significant value in height. Plant and number of leaves . Bancha eal. (2017), in their study that they conducted in Pakistan on cauliflower, using three planting distances (35, 45, and 55) cm between one plant and another, they found that plants planted at a distance of 55 cm were significantly superior in plant length and number of leaves. Dhakal etal. (2009) in their study on cauliflower that conducted in Nepal and using four levels of borax (0, 0.65, 1.3, 1.95) kg ha^{-1} that the addition of borax at the level of 1.3 kg ha^{-1} gave the highest significant value relative tothe two levels 0 and 0.65 kg ha^{-1} in the adjective of the total and marketable yield per unit area. Singh etal. (2011) indicated in a study they conducted in India on cauliflower when using six levels of boron (0, 1, 1.5,2, 2.5, 3) kg B ha^{-1}, in which they confirmed the significant superiority of the boron addition treatment at thelevel of 1.5 kg ha^{-1} on the length of the plant, the weight and diameter of the curds, the length of curd, total and marketing yield per unit area. Metwaly (2016) in Egypt also studied the effect of adding boric acid at three levels (0.4, 0.8, 1.2) kg $feddan^{-1}$ to the broccoli plant, and noted that adding 0.4 kg 1 feddan of boric acid gave the highest significant value in plant height and leaf area.

Research aims:

Evaluation and behavioral study of two cultivar of cauliflower under the conditions of Nineveh Governorate, in order to choose which one is best suitable for cultivation under the conditions of the region, and to determine the best planting distance between plants in order to raise and improve productivity in quantity and quality, and to find the best concentration of Nano-boron fertilizer that plants respond to and affect the vegetative growth characteristics, and to find the best triple overlap between cultivars , planting distances and boron Nano fertilizer concentrations.

Materials and methods:

Table 1: Effect of cultivars, planting distances, Nano-boron fertilizer and the interaction between them on plant height (cm plant^{-1})

Cultivars	planting distances (cm)	Nano- boron fertilizer concentrations mg L^{-1}			Cultivars X Planting distances	Average effect of cultivars
		0	30	60		
Narges	35	70.54 j	70.99 i j	75.78 f g	72.44 d	73.73 b
	40	71.53 h - j	74.72 f -h	74.20 f - i	73.49 d	
	45	73.92 g - i	74.31 f - i	77.54 e f	75.26 c	
Ice ball	35	80.01 d e	81.14 c d	83.67 b c	81.61 b	83.56 a
	40	82.93 b - d	82.46 b – d	81.76 c d	82.38 b	
	45	83.48 b c	85.54 b	91.06 a	86.69 a	
cultivars X Nano- boron fertilizer	Narges	72.00 d	73.34 d	75.84 c	Average effect of planting distances	
	Ice ball	82.14 b	83.05 b	85.49 a		
Planting distances X Nano- boron fertilizer	35	75.28 E	76.06 d e	79.72 b	77.02 b	
	40	77.23 c - e	78.59 b c	77.98 b -d	77.93 b	
	45	78.70 b c	79.93 b	84.30 a	80.98 a	
Average effect of Nano- boron fertilizer		77.07 b	78.19 b	80.67 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. 60 mg.L

Studied traits:

1. Plant height
2. Number of leaves
3. Leaf area
4. Total chlorophyll content in leaves
5. The percentage of dry matter in leaves

Results and discussion:

Plant height (cm plant^{-1})

The results of the statistical analysis in Table (1) show that cultivar of Ice ball significantly superiority in plants height over Narges cultivar, as the plant height reached 83.56 and 73.73 cm, plant^{-1}, respectively, for each cultivar. While planting plants at a distance of 45 cm led to a significant increase in this trait compared to the distances of 35 and 40 cm, use of Nano-boron fertilizer at a concentration of 60 mg L^{-1} led to a significant increase in plant height compared to a concentration of 30 mg L^{-1} and the treatment of the control.

As for the bilateral interaction between cultivars and planting distances, the results indicate that the highest significant value in plant height amounted to 86.69 cm Plant^{-1} recorded in Ice ball cultivar plants grown at a distance of 45 cm. Thus, this treatment significantly outperformed all treatments of this interaction. The results

of the interaction between cultivars and Nano-boron fertilizer indicate that the highest significant value in this trait was reached when the Ice ball cultivar plants overlapped with a high concentration of Nano-boron fertilizer amounted to 85.49 cm plant^{-1}.The results of the bilateral interaction between the planting distances and Nano-boron fertilizer showed that the highest significant value in this trait was 84.30 cm plant^{-1} found in the case of the bilateral interaction between the distance 45 and the concentration of Nano-boron 60 mg L^{-1}.The results of the triple interaction between the three studied factors show that the treatment of the triple interaction of the Ice ball plants grown at a distance of 45 cm when using Nanoparticles at a concentration of 60 mg L^{-1} was significantly superior to all treatments of this interaction, as the height of the plants of this interaction reached its maximum value, which amounted to 91.06 cm plant^{-1}.

2:- The number of leaves (leaf plant^{-1}).

The results of table (2) show the significant superiority of Narges cultivar plants over Ice ball cultivar plants in the number of leaves, which amounted to 24.67 and 23.51 plant^{-1} leaves, respectively, for each cultivar. Cultivation of plants at a distance of 40 and 45 cm led to a significant increase in this trait compared to cultivation on a distance of 35 cm, while the use of Nano-boron fertilizer at a concentration of 60 mg L^{-1} resulted in a significant increase in the number of leaves compared to the control treatment and a concentration of 30 mg L^{-1}, which did not differ significantly between them.

The highest significant value in the number of leaves was 25.11 leaves Plant^{-1} found in the case of bilateral interaction between plants of the Narges vultivar, which were planted at a distance of 45 cm. Thus, this treatment differed significantly with all distances for plants of the cultivar Ice ball. The binary interaction between the Narges variety and the use of Nanoparticles of boron at a concentration of 60 mg L^{-1} gave the highest significant value for the number of leaves, which amounted to 25.46 leaves plant^{-1}. Thus, this treatment differed significantly with all treatments of this interaction. The results of the bilateral interaction between planting distances and Nano-boron fertilizer showed the superiority of plants planted at a distance of 45 cm with a concentration of 60 mg L^{-1} of Nano-boron in which caused a significant increase in the number of leaves. In the triple interaction between the factors studied, the highest value of the number of leaves amounted to 25.91 found in the case of the triple interaction of plants of the Narges variety, which were planted at a distance of 45 cm and when spraying with a concentration of 60 mg L^{-1} of Nano-boron fertilizer.

Table 2: Effect of cultivars, planting distances, Nano-boron fertilizer and the interaction between them on The number of leaves (leaf plant-1).

Cultivars	Planting distances (cm)	Nano- boron fertilizer concentrations mg L^{-1}			Cultivars X planting distances	Average effect of the cultivars
		0	30	60		
Narges	35	23.52 f g	23.87 c - g	24.93 a - e	24.11 c - a	24.67 a
	40	24.32 b - f	24.48 f -b	25.53 a b	24.78 a b	
	45	24.47 f -b	24.97 a - d	25.91 a	25.11 a	
Ice ball	35	22.11 h	22.61 g h	23.61 d -g	22.78 d	23.51 b
	40	23.11 f – h	23.73 d -g	24.28 b -f	23.71 d c	
	45	23.55 e - g	23.47 f g	25.13 a - c	24.05 c b	
Cultivars X Nano- boron fertilizer	Narges	24.10 b	24.44 b	25.46 a	Average effect of planting distances	
	Ice ball	22.92 c	23.27 c	24.34 b		

Planting distances X Nano- boron fertilizer	**35**	**22.81 e**	**23.24 d e**	**24.27 b c**	**23.44 b**
	40	**23.72 c d**	**24.11 b - d**	**24.91 a b**	**24.24 a**
	45	**24.01 b - d**	**24.22 b c**	**25.52 a**	**24.58 a**
Average effect of Nano- boron fertilizer		**23.51 b**	**23.85 b**	**24.90 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:- Leaf area (cm^2 $plant^{-1}$)

The data presented in Table (3) indicate that the Narges cultivar plants were significantly superior to the Ice ball cultivar plants, as the leaf area reached 8725.3 and 8305.3 cm^2 $plant^{-1}$ for each cultivar respectively. While the plants grown at a distance of 45 cm were superior compared the plants grown at the distances of 35 and 40 cm, as well as the plants grown at a distance of 40 cm were significantly superior compared the plants grown at a distance of 35 cm, and the highest value in this characteristic was 9104.9 cm^2 $plant^{-1}$ at a concentration of 60 mg L^{-1} of Nano-boron fertilizer, and thus this treatment differed significantly with the rest of the treatments.

From the treatment of bilateral interaction between cultivars and planting distances, it is clear that the Narges cultivar planted at a distance of 45 cm were significantly superior to the, reaching 9413 cm^2 $plant^{-1}$. Thus, this treatment was significantly superior to all other treatments for this interaction. As for the bilateral interaction between the cultivars and the concentrations of Nano-boron fertilizer, the results of the table indicate that the use of the concentration of 60 mg L^{-1} in Narges cultivar plants gave the highest significant value in the leaf area of each plant, which amounted to 9233.6 cm^2 $plant^{-1}$ From the results of the bilateral interaction between the planting distances and Nano-boron fertilizer, it is clear that the use of a concentration of 60 mg L^{-1} in plants grown at a distance of 40 , 45 cm and a concentration of 30 mg L^{-1} in plants grown at a distance of 45 cm outperformed all interaction coefficients for the comparison plants grown at all distances Generally, the highest significant value in this characteristic was found in the interaction treatment of using a concentration of 60 mg L^{-1} of Nano-boron fertilizer in plants grown at a distance of 45 cm. The results of the triple interaction between the studied factors show that the highest value in the leaf area amounted to 9501.8 cm^2 $plant^{-1}$ found in Narges cultivar plants grown at a distance of 45 cm and when using a high concentration of Nano-boron fertilizer.

Table 3: Effect of cultivars, planting distances, Nano-boron fertilizer and the interaction between them on Leaf area (cm^2 $plant^{-1}$) .

Cultivars	Planting distances (cm)	Nano- boron fertilizer concentrations mg L^{-1}			Cultivars X planting distances	Average effect of the cultivars
		0	30	60		
Narges	35	7170.8 i	7793.4 g h	8865.6 b - d	7943.2 c	8725.3 a
	40	8040.1 f g	9085.5 a - c	9333.3 a b	8819.6 b	
	45	9323.0 a b	9413.8 a b	9501.8 a	9412.9 a	
Ice ball	35	7113.8 i	8370.8 d -f	8699.1 c - e	8061.2 c	8305.3 b
	40	7423.5 h i	8155.3 e - g	8874.1 b - d	8151.0 c	
	45	8050.0 f g	8705.4 c - e	9355.8 a b	8703.7 b	
Cultivars X Nano- boron fertilizer	Narges	8178.0 c	8764.2 b	9233.6 a	Average effect of planting distances	
	Ice ball	7529.1 d	8410.5 c	8976.3 a b		
Planting distances X Nano- boron fertilizer	35	7142.3 f	8082.1 e	8782.3 b - d	8002.2 c	
	40	7731.8 e	8620.4 d	9103.7 a b	8485.3 b	
	45	8686.5 c d	9059.6 a - c	9428.8 a	9058.3 a	
Average effect of Nano- boron fertilizer		7853.5 c	8587.4 b	9104.9 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 ($P < 0.05$).

4:- Total chlorophyll content in leaves (mg / ml suspension)

The results of Table (4) indicate that Narges plants were significantly superior in total chlorophyll content in the leaves as compared to Ice ball plants, reaching 26.48 and 21.89 mg/ml suspension for each variety, respectively. The total chlorophyll content in the leaves increased with the increase of the planting distance, reaching the highest value of 29.31 mg/ml suspension when the plants were grown at a distance of 45 cm. The highest value in this characteristic was reached in the case of using a concentration of 60 mg L^{-1} of Nano-boron fertilizer, and thus this treatment differed significantly with the rest of the treatments.

The results of the bilateral interaction between cultivars and planting distances show that planting Narges plants at a distance of 45 cm has recorded the highest significant value in the total chlorophyll content in the leaves, which amounted to 33.27 mg / ml suspension. Thus, this treatment differed significantly with all treatments of this interaction except for Ice plants. ball planted at the same distance. The results of the bilateral interaction between cultivars and boron Nano-fertilizer show that Narges plants, when using a high concentration of boron Nano-fertilizer, recorded the highest significant value in this characteristic, which amounted to 31.04 mg / ml suspension, while the comparison plants of the Ice ball cultivar recorded the lowest value for this trait, amounting to 15.72 mg/ml suspension. As for the bilateral interaction between the

planting distance and Nano-boron fertilizer, it is noted that the highest total chlorophyll content in the leaves reached 40.09 mg / ml suspension in plants grown at a distance of 45 cm and when using a high concentration of Nano-boron fertilizer Thus, this treatment differed significantly with all treatments of this interaction, While the control plants grown at a distance of 35 cm recorded the lowest value for this trait, which amounted to 13.16 mg / ml suspension. From the results of this triple interaction between the three factors studied and for this characteristic, it is noted that the highest value in this characteristic amounted to 41.67 mg / ml suspension in Ice ball plants when planting at a distance of 45 cm with the use of a high concentration of Nano-boron fertilizer Thus, this treatment differed significantly with most of the treatments of this interaction.

Table 4: Effect of cultivars, planting distances, Nano-boron fertilizer and the interaction between them on Total chlorophyll content in leaves (mg/ml suspension)

Cultivars	Planting distances (cm)	Nano- boron fertilizer concentrations mg L^{-1}			Cultivars X planting distances	Average effect of the cultivars
		0	30	60		
Narges	35	19.26 d - g	19.6 d - g	26.38 c - f	21.75 b	26.48 a
	40	20.7 d - g	24.35 c - f	28.22 b – e	24.42 b	
	45	26.78 c - f	34.52 a - c	38.52 a b	33.27 a	
Ice ball	35	7.07 h	10.53 g h	16.22 f - h	11.27 c	21.89 b
	40	17.73 e - h	30.02 b - d	24.83 c - f	24.19 b	
	45	22.35 d - f	26.55 c - f	41.67 a	30.19 a	
Cultivars X Nano- boron fertilizer	Narges	22.25 b	26.16 a b	31.04 a	Average effect of planting distances	
	Ice ball	15.72 c	22.37 b	27.57 a b		
Planting distances X Nano- boron fertilizer	35	13.16 f	15.07 e f	21.3 c – e	16.51 c	
	40	19.22 d - f	27.18 b c	26.53 b – d	24.31 b	
	45	24.57 b - d	30.53 b	40.09 a	31.73 a	
Average effect of Nano- boron fertilizer		18.98 c	24.26 b	29.31 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 ($P < 0.05$).

5:- Percentage of dry matter in the leaves (%)

The results of Table (5) show that Narges plants were significantly superior compared to Ice ball plants in the percentage of dry matter in the leaves, as this percentage reached 15.70 and 13.89%, respectively, for each cultivars, no significant differences appeared between the plants cultivated at all distances in this trait .

The use of Nano-boron fertilizer at a concentration of 60 mg L^{-1} resulted in a significant increase in this characteristic compared to the control treatment and a concentration of 30 mg L^{-1}.

As for the bilateral interaction between cultivars and planting distances, the highest percentage of dry matter in the leaves was 16.47% in Narges cultivars, which were grown at a distance of 40 cm. Thus, this treatment differed significantly with Ice ball plants, which were planted at a distance of only 35 cm, which recorded the lowest value in this trait amounted to 12.87%. The results of the bilateral interaction between the cultivars and the Nano-boron fertilizer show that the highest significant value in this trait amounted to 17.18% found in the plants of the Narges cultivar when using a high concentration of Nano-boron fertilizer , while the lowest value was 12.45% in the comparison treatment of Narges cultivar plants. The results of the bilateral interaction between planting distances and Nano-boron fertilizer show that the highest percentage of dry matter in the leaves amounted to 17.81% when treating the overlap between plants grown at a distance of 40 cm and when using a concentration of 60 mg L^{-1} of Nano-boron fertilizer.The results of the triple interaction between the studied factors indicate that the highest value of the percentage of dry matter in the leaves amounted to 18.29%, which was reached in Narges cultivar plants grown at a distance of 40 cm and when adding a concentration of 60 mg L^{-1} of Nano-boron fertilizer.

Table 5: Effect of cultivars, planting distances, Nano-boron fertilizer and the interaction between them on the percentage of dry matter in the leaves **.**

Cultivars	Planting distances (cm)	Nano- boron fertilizer concentrations mg L^{-1}			Cultivars X planting distances	Average effect of the cultivars
		0	30	60		
Narges	35	15.23 a -f	14.32 b -f	16.21 a - e	15.25 a b	15.70 a
	40	14.66 a - f	16.47 a – d	18.29 a	16.47 a	
	45	13.81 b - f	15.32 a – f	17.04 a - c	15.39 a b	
Ice ball	35	12.32 f	12.79 d – f	13.49 c - f	12.87 b	13.89 b
	40	12.65 e - f	14.31 b – f	17.33 a b	14.76 a b	
	45	12.39 f	14.59 a – f	15.19 a - f	14.06 a b	
Cultivars X Nano- boron fertilizer	Narges	14.57 b	15.37 a b	17.18 a	Average effect of planting distances	
	Ice ball	12.45 c	13.90 b c	15.33 a b		
Planting distances X Nano- boron fertilizer	35	13.78 b c	13.55 b c	14.85 b c	14.06 a	
	40	13.66 b c	15.39 b c	17.81 a	15.62 a	
	45	13.10 c	14.95 b c	16.11 a b	14.72 a	
Average effect of Nano- boron fertilizer		13.51 b	14.63 b	16.26 a		

*The 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 ($P < 0.05$).

cultivar plants Which is represented by the number of leaves, leaf area, total chlorophyll content in leaves,

and percentage of dry matter Tables (2-5) compared to Ice ball plants, the differences in the genetic makeup of each cultivar and the extent of interaction of these genes with the surrounding environmental conditions, which results in differences between cultivars for each of these traits these results were consistent with what was mentioned by (Ibrahim (2007); Al-Rashdi (2012); Hossain etal. (2020)). As for the significant effect of planting distances on most of the vegetative growth characteristics represented by the height of the plant when planting at a distance of 45 cm, the number of leaves, the leaf area and the total chlorophyll content in the leaves when planting at a distance of 40 and 45 cm Tables (1-4) the reason for this may be due to the fact that cultivation over a wide distance leads to a lack of competition for water and nutrients, which is reflected significantly in plant growth and an increase in the amount of nutrients available, which leads to an increase in the number of leaves as a result of cell division and expansion. Thus, this significant effect is reflected on the leaf area ccultivating plants at a distance of 45 cm leads to an increase in their exposure to the falling sunlight, thus allowing the growth of the vegetative system in a wider field, and increasing the effectiveness of the photosynthesis process, and thus increasing chlorophyll, this is consistent with what was concluded (Al-Hamdani and Hadi (2017): Al-Zuhairi and Al-Hamdani (2017)) In the presence of significant differences in the characteristics of vegetative growth between planting distances. The results also showed the significant effect of boron Nano- fertilizer on all vegetative growth characteristics represented by plant height, number of leaves and percentage of dry matter in the leaves when using the concentration of 60 mg L^{-1} of this fertilizer and leaf area and total chlorophyll content in the leaves when using the concentration 30 and 60 mg L^{-1} this confirms the importance of using boron Nano-fertilizer in producing strong-growing plants that enable the plant or give it the characteristic of resistance to external conditions. In addition to what Nano-fertilizers possess from a huge surface area, they increase enzymatic activity and the speed of reactions, and then lead to an increase in biochemical reactions and cell divisions, in addition to the Nanoparticles reducing or inhibiting the formation of free oxygen radicals Reactive Oxygen Species (ROS) Which reduces oxidative damage, delays aging, and encourages vegetative growth of the plant (Al-Juthery etal., 2018). In addition tothe physiological role of boron, which has a role in controlling the degree of water absorption from the soil and the movement of sugars within the plant to its storage locations In addition to its effect on the absorptionof nitrogen, potassium and calcium in order to obtain an ideal growth for it Boron is closely related to the internal functions of the plant, for example, it delays the emergence of symptoms of calcium deficiency on the plant, although it does not perform the calcium function in the plant in order to obtain an ideal growth forit (Al-Wakil, 2013) This is consistent with the findings of (Meena etal. (2018); Metwaly (2016))

Conclusions :

1. Narges cultivar showed significant superiority in most of the vegetative growth characteristics.
2. Cultivation plants at a distance of 45 cm led to a significant increase compared to the other two distances in plant height, leaf area and total chlorophyll content in leaves. The same distance also outperformed the plants planted at a distance of only 35 cm in the number of leaves
3. The use of a high concentration of Nano-boron fertilizer 60 mg L^{-1} had a significant effect on all vegetative growth traits.

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