Effect of Fertilization type and spraying with sulfur amino acids on three broccoli cultivars' physiological and vegetative indicators.

Sura Abdul Kareem Mohammed **Fouad Abass Salman**

College of Agriculture - University of Kufa

fouad.alibraheemi@uokufa.edu.iq

Abstract

The experiment was conducted for the autumn agricultural season (2021-2022) in one of the private fields in the Al-Azzawiya area - Al-Musayyab district, north of the centre of Babylon province. The experiment included three factors: The first was three broccoli plants' hybrids (F1 Polo, Jassmine F1 and Tokita 2004 F1). The second factor: Fertilization treatments (comparative treatment (without fertilization) and humic spraying at an average of 4 ml. L^{-1} and the addition of bacteria at an average of 25 g. $Plant^{-1}$ and the mixture of humic fertilizer + bacteria at the same levels of fertilizer mentioned) and the third factor: the spraying of sulfur amino acids compared (without fertilization) and (Methionine and Cystine at 150 $mg.L^{-1}$ for each), the experiment was conducted using a randomized complete block design according to the Split-Split Plot system and with three replications and the averages were compared. According to Duncan's Multiples Range Test, at a probability level of 0.05, The results showed a significantly excelled between the cultivars in most indicators of vegetative growth.

In contrast, the Jassmine cultivar excelled in plant height of 65.06 cm, stem diameter of 23.77 mm, and vegetative dry weight of 299.0 g. $plant^{-1}$, compared to Tokita 2004 and Polo cultivars, which recorded a significant decrease in Most indicators of vegetative growth. The fertilizer mixture (humic + bacteria) excelled in the leaves' total chlorophyll content of 70.50 mg. 100^{-1} fresh weight compared to other fertilization treatments decreased these indicators. As for the amino acid, Methionine recorded excelled in the leaves content of total chlorophyll 70.48 $mg.100^{-1}$ fresh weight.

Key words: Broccoli, organic fertilization, bio fertilization, amino acids, growth indicators.

Introduction

Broccoli (Brassica oleracea var. Italica Plenck) is a plant that needs a moderate or semi-cool temperature. It belongs to the cruciferous family (Brassicaceae). This plant is grown to obtain its inflorescences that are eaten in the phase of the vegetative flowering buds with their thick, soft buds. It is one of the most profitable crops of this family in nutritional value and the most widely used in therapeutic terms, as it contains many vitamins and minerals (29). It is also rich in Brufen and beta-carotene; its leaves are a source of polyphenols, fats and fibres (27). Specialists have increased their interest in the production of vegetable crops and work to improve them using the best breeding methods. The yield and cultivation of broccoli are greatly affected by the type of variety grown (18). The cultivar is considered good if it has several characteristics, including being suitable for the environment in which it will be grown, resistant to prevalent diseases and high productivity (3). Many researchers have tended to encourage and support organic production, characterized by a low percentage of nitrates and oxalates so that it does not exceed healthy limits, as well as high economic production, especially in developed countries (2 and 4). Recent studies have tended to reduce the added quantities of mineral fertilizers by using means that increase their readiness in the soil and their

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absorption by the plant quickly to increase production.

One of the most important means is biofertilization (28). It is one method that aims to reduce the irrational use of mineral fertilizers, reduce sources of environmental pollution and production costs, and increase soil fertility and crop quality (11). Whereas biofertilizer is a substance that contains microorganisms that colonize the terrestrial biosphere when applied to seeds or soil. (21), Amino acids are the basic unit for forming proteins and hormones in the plant. Treating the plant with amino acids has an influential role in building such compounds inside the plant, regulating the activities of vital metabolism and activating antioxidants, which increases the plant's resistance to the stresses to which the plant is exposed (25 and 8). It is also involved in the construction of many active compounds in plants by secondary metabolic processes that occur within their vital interactions. Therefore, the research aims to know the extent of the response of different genotypes (broccoli plant hybrids) under organic and biological fertilization conditions and its reflection on physiological and vegetative indicators.

Materials and Methods

Experiment location:

The experiment was conducted in one of the private fields in the Al-Azzawiya area - Al-Musayyab district (40 km) north of the Babylon province center during the autumn season (2021-2022).

Before planting, soil samples were taken from the field to study some physical and chemical traits for both seasons, randomly and from different areas, with depths ranging from 0-30 cm.

Table 1: Physical and chemical characteristics of field soil before planting.

Traits	Values	Units
pH	8.0	- - -
EC . electrical conduction	4.5	$dS.m^{-1}$
Organic matter	1.13	%
Available nitrogen	13.4	$mg.kg^{-1}$
Available phosphorous	5.6	$mg.kg^{-1}$
Available potassium	192.0	$mg.kg^{-1}$
bulk density	1.13	$g.cm^{-3}$
sand	600	$g.kg^{-1}$
silt	245	$g.kg^{-1}$
clay	155	$g.kg^{-1}$

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The soil of the field designated for the experiment was prepared using agricultural machinery after removing the growing plants and weeds, then carrying out the tillage process, smoothing and levelling well and homogeneously. Then the land was divided into three replicates, to include each replicator 36 experimental units. As one unit represented a terrace with dimensions of .75 x 2.50 m (length x width), the area of the experimental unit was 1.87 m 2. The distance between the terrace and the other was 1.5 m, leaving a distance of 1 m between the units as an insulator to prevent confusion between transactions.

Seedling preparation and planting:

Seeds are supplied from certified sources TOKITA2004F1), POLOF1 and (JASSMINEF1). The seeds were sown on 25/8/2021 in cork dishes filled with peat moss in one of the private nurseries in the project area in Al-Musayyib District, Babylon province, located one seed for each eye inside a canopy covered with a green saran cover clamp to reduce sunlight while providing suitable conditions for the growth of seedlings After the seedlings reached the stage of four to five true leaves; they were transferred in the afternoon to the field on 6/10/2021. The planting was conducted inside the terraces, with ten seedlings distributed on both sides of the line for each experimental unit. The distance between one line and another is 50 cm, and between one plant and another is 50 cm. Service, irrigation and control operations were performed as recommended (9). The drip irrigation system was used twice a week in the early stages of seedling and then according to the needs of the plant and the environmental conditions. The experiment included three factors: The first factor: three hybrids of broccoli, which are (Polo F1, Jassmine F1 and Tokita 2004 F1), and the second factor: fertilization treatments (control treatment (without fertilization) and humic spray at an average of 4 ml.L-1 and the addition of bacteria By 25 g. Plant-1 and the mixture of humic fertilizer + bacteria at the same levels of fertilizer mentioned)and the third factor: the spraying of sulfur amino acids compared (without fertilization) and (Methionine and Cystine at 150 mg.L-1 for each), the experiment was carried out using a randomized complete block design according to the Split-Split Plot system and with three replications and the averages were compared. According to Duncan's Multiples Range Test, at a probability level of 0.05. The following experimental measurements were recorded:

1- Plant height (cm): The plant height was measured in the stage of maturity of curd using the metric tape from the area of contact of the stem with the soil (the crown area) to the highest height of the leaves of the plants taken for the experimental units.

2- Number of leaves (leaf. plant^{-1}): The number of whole leaves for each plant selected for the experimental units was calculated in the stage of maturity of the curd.

3- Leaf area (dm^2. Plant^{-1}): It was measured according to the method mentioned by (30).

4- Stem diameter of the (mm): The stem diameter was measured using Vernier at a height of 1 cm from the area of contact of the plant with the soil (the crown area), for the plants taken randomly from the experimental units in the stage of maturity of curd.

5- The dry weight of the vegetative group (g.plant^{-1}): Three plants were extracted from each experimental unit and the root system was separated from it, then placed in large paper bags for the purpose of air drying for three weeks in a dark room. Then the samples were placed in the electric oven at a temperature of 68°C until the weight was stable and then the dry weight was calculated.

6- Total chlorophyll content of leaves (mg. 100gm^{-1} as a fresh substance): It was measured according to the method mentioned by (17). Then it was calculated according to the following equation:

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Total chlorophyll = 20.2 * D (645) + 8.02 * D (663) (V/W * 1000) *100

Results and Discussion

plant height (cm)

The results in Table (2) indicated significant differences in the plant height among the cultivars. The Jasmine cultivar excelled by giving the highest average plant height of 65.06 cm compared to Tokita 2004, which gave the lowest average plant height of 61.09 cm. It is also noted that the fertilizer combination (humic + bacteria) was superior by giving it the highest average plant height of 66.55 cm compared to other fertilization treatments. The control treatment was the lowest average plant height of 59.07 cm. The Methionine spraying treatment was significantly superior by giving it the highest average plant height of 63.81 cm compared with the control treatment, which showed the lowest rate of 62.07 cm. As for the triple interaction, the interaction between the Jassmine cultivar, the fertilizer combination (humic + bacteria), and the amino acid Methionine was significantly greater, giving the highest average plant height of 68.54 cm. Comparison with the triple interaction between Tokita 2004 cultivar and the control treatment of amino acids and the control treatment of fertilization, which gave the lowest average plant height of 54.67 cm.

Number of leaves (leaf.plant^{-1})

The results in Table (3) showed that the two cultivars Jassmine and Tokita 2004 excelled in increasing the leaves number to 23.13 and 23.19 leaves.plant^{-1} in sequence, while the number of leaves in the cultivar Polo decreased to the lowest average of 21.90 leaves.plant^{-1}.The fertilizer combination (humic + bacteria)excelled, which gave the highest average number of leaves reaching 23.97 leaves.plant^{-1}, compared to the control treatment that gave the lowest average number of leaves was 21.19 leaves.plant$^{-1.}$The spraying with the amino acid Methionine had significantly excelled by giving it the highest average number of leaves, which reached 23.32 leaves. Plant^{-1}. Compared with the control treatment, which gave the lowest rate for both seasons, it reached 22.24 leaves.plant$^{-1.}$ In the case of the triple interaction, the interaction between Jassmine cultivar and the fertilizer combination (humic + bacteria) and the amino acid Methionine was significantly excelled on the interaction between the cultivar Jassmine and the fertilizer combination (humic + bacteria) and the amino acid Methionine, which gave the highest average of the number of leaves reached 25.60 leaves. Plant^{-1}, in comparison with the triple interaction between Polo cultivar and the control treatment of amino acids and the control treatment of fertilization, which gave the lowest average of 19.49 leaves.plant^{-1}

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Table (2): Effect of cultivar , organic and biological fertilization, sulfur amino acid spray, and the interactions between them on plant height (cm)

Cultivars	Fertilization type	Sulfur amino acid spray			Cultivar× Fertilization type	Average cultivar
		control	Cystine	Methionine		
Polo	control	58.33 r	59.44 pq	60.16 n	59.31 h	62.85 b
	humic	60.62 m	62.60 k	62.67 k	61.96 g	
	bacteria	63.41 j	64.38 i	64.94 h	64.24 d	
	humic+bacteria	65.01 h	65.66 g	67.02 cd	65.89 c	
Jassmine	control	59.62 op	63.45 j	62.63 k	61.90 g	65.06 a
	humic	63.61 j	63.66 j	64.16 i	63.81 e	
	bacteria	66.33 ef	66.66 de	67.16 bc	66.72 b	
	humic+bacteria	67.33 bc	67.56 b	68.54 a	67.81 a	
Tokita 2004	control	54.67 u	56.11 t	57.23 s	56.00 i	61.09 c
	humic	59.00 q	59.40 pq	60.04 no	59.48 h	
	bacteria	61.12 l	62.52 k	65.17 h	62.94 f	
	humic+bacteria	65.81 g	65.97 fg	66.02 fg	65.93 c	

cultivar ×Sulfur amino acid spray	Polo	Jassmine	2004 Tokita	Average sulfur amino acid spray
control	61.84 g	64.22 c	60.15 i	62.07 c
Cystine	63.02 e	65.33 b	61.00 h	63.12 b
Methionine	63.70 d	65.62 a	62.11 f	63.81 a
Fertilization × Sulfur amino acid spray	control	Cystine	Methionine	Fertilization type average
control	57.54 l	59.66 k	60.01 j	59.07 d
humic	61.07 i	61.89 h	62.29 g	61.75 c
bacteria	63.62 f	64.52 e	65.76 d	64.63 b
humic+bacteria	66.05 c	66.40 b	67.19 a	66.55 a

* The averages with the same letters have no significant differences between them according to Duncan's polynomial test and at the probability level of 0.05.

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Table (3): Effect of cultivar, organic and biofertilization, sulfur amino acid spraying, and the interactions between them on the number of leaves (leaf.plant^{-1})

cultivars	Fertilization type	Sulfur amino acid spray			cultivar× Fertilization type	average cultivar
		control	Cystine	Methionine		
Polo	control	19.49 m	20.99 j-m	21.16 i-l	20.55 e	21.90 b
	humic	20.44 lm	21.32 i-l	21.49 i-l	21.08 de	
	bacteria	22.08 e-l	22.66 c-j	22.88 b-i	22.54 c	
	humic+bacteria	22.33 d-k	23.58 b-f	24.33 a-c	23.41 ac	
Jassmine	control	21.44 i-l	21.50 i-l	21.70 h-l	21.55 d	23.13 a
	humic	21.80 g-l	22.38 d-k	23.72 b-e	22.63 c	
	bacteria	23.82 b-e	23.82 b-e	23.88 b-d	23.84 ab	
	humic+bacteria	24.48 ab	23.42 b-h	25.60a	24.50 a	
Tokita 2004	control	20.80 k-m	21.66 i-l	21.93 f-l	21.46 d	23.19 a
	humic	22.86 b-i	23.48 b-g	23.93 a-d	23.42 ac	
	bacteria	24.44 ab	22.60 c-j	24.60 ab	23.88 ab	
	humic+bacteria	22.93 b-i	24.48 ab	24.63 ab	24.01 ab	
cultivar ×Sulfur amino acid spray	Polo	Jassmine	2004 Tokita	Average sulfur amino acid spray		
control	21.08 d	22.88 ac	22.76 ac	22.24 b		
Cystine	22.14 c	22.78 ac	23.05 ab	22.66 b		
Methionine	22.46 ac	23.73 a	23.77 a	23.32 a		
Fertilization × Sulfur amino acid spray	control	Cystine	Methionine	Fertilization type average		
control	20.58f	21.38 ef	21.60 de	21.19 d		
humic	21.70 de	22.39 cd	23.05 bc	22.38 c		
bacteria	23.45 b	23.03 bc	23.79 b	23.42 b		
humic+bacteria	23.25 bc	23.83 b	24.85 a	23.97 a		

* The averages with the same letters have no significant differences between them according to Duncan's polynomial test and at the probability level of 0.05.

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Leaf area ($dm^2.plant^{-1}$)

The results of Table (4) showed the Tokita 2004 cultivar significantly excelled, which gave the highest average leaf area for both seasons, which amounted to 100.70 $cm^2.plant^{-1}$, in comparison with the cultivar Polo, which gave the lowest average leaf area of 96.88 $cm^2.plant^{-1}$, which did not differ significantly from the Jassmine cultivar .The fertilizer mixture (humic + bacteria)excelled which gave the highest average leaf area for both seasons, amounting to 109.09 $cm^2.plant^{-1}$, compared to the control treatment, which gave the lowest average leaf area of 87.92 $cm^2.plant^{-1}$While the treatment of Methionine and Cystine was significantly excelled by giving them the highest average leaf area of 100.29 and 99.12 $cm^2.plant^{-1}$, respectively, compared with the control treatment, which gave the lowest average of 95.82 $cm^2.plant^{-1}$.As for the triple interaction between the experimental factors, the interaction between Polo cultivar and the fertilizer combination (humic + bacteria) and the amino acid Methionine, which gave the highest average leaf area of 114.39 $cm^2.plant^{-1}$, compared with the triple interaction between Polo cultivar and the control treatment of amino acids and the control treatment of fertilization, which gave the lowest average of 79.16 $cm^2.plant^{-1}$.

Stem Diameter (mm)

Table (5) results indicated a significant difference between the cultivars in stem diameter. The Jasmine cultivar excelled by giving the highest average stem diameter in both seasons, amounting to 23.77 mm, compared with the Tokita 2004 cultivar, which gave the lowest average of 21.33 mm. The fertilizer combination (humic + bacteria) excelled, which gave the highest average stem diameter of 23.99 mm, compared with the control treatment, which gave the lowest average stem diameter of 20.91 mm. It reached 23.06 mm compared to the control treatment, which gave the lowest rate of 22.16 mm. As for the triple interaction, the interaction treatment between the Jassmine cultivar and the fertilizer combination (humic + bacteria) and Methionine, which gave the highest average stem diameter of 25.44, was significantly excelled compared to the triple interaction between the Tokita 2004 cultivar and the control treatment of amino acids and between the treatment of amino acids. Comparison of fertilization, which gave the lowest average of 19.65 mm.

Dry weight of vegetative growth ($g.plant^{-1}$)

The results in Table (6) indicate that there is a significant difference between the cultivars in the dry weight of the vegetative growth, where the Jassmine cultivar was superior by giving the highest average dry weight of 299.0 $g.plant^{-1}$,Compared with the Tokita 2004 cultivar, which gave the lowest rate of 265.0 $g.plant^{-1}$. The fertilizer combination (humic + bacteria) was significantly excelled by giving it the highest dry weight average of 306.0 $g.plant^{-1}$, compared with the control treatment which gave the lowest rate of 222.0 and 266.0 $g.plant^{-1}$.The excelled of the amino acid Cystine, which gave the highest rate of dry weight was 293.0 $g.plant^{-1}$, compared with the control treatment, which gave the lowest rate of 277.0 $g.plant^{-1}$. The triple interaction was significantly superior, as the interaction between Polo and the fertilizer combination (Humic +) was superior. bacteria) and the amino acid Methionine, which gave the highest dry weight rate of 340.0 g. Plant-1,Compared with the triple interaction between Tokita 2004 cultivar and the control treatment of amino acids and the control treatment of fertilization, which gave the lowest average of 233.0 $g.plant^{-1}$.

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Table (4): Effect of cultivar, organic and biofertilization, sulfur amino acid spray, and the interactions between them on leaf area ($cm^2.plant^{-1}$)

cultivars	Fertilization type	Sulfur amino acid spray			cultivar× Fertilization type	average cultivar
		control	Cystine	Methionine		
Polo	control	79.16 n	89.17 j-n	86.85 k-n	85.06 h	96.88 b
	humic	86.36 l-n	101.43 d-i	85.93 mn	91.24 fg	
	bacteria	98.92 d-j	95.75 g-m	102.57 c-i	99.08 de	
	humic+bacteria	107.92 a-e	114.13 ab	114.39 a	112.15 a	
Jassmine	control	81.39 n	88.81 j-n	95.23 g-m	88.48 gh	97.67 b
	humic	96.86 e-l	93.82 h-m	93.03 i-m	94.57 ef	
	bacteria	104.40 a-h	104.48 a-h	97.49 d-k	102.13 cd	
	humic+bacteria	98.57 d-j	104.36 a-h	113.59 ab	105.51 bc	
Tokita 2004	control	85.87 mn	88.31 j-n	96.50 f-m	90.23 fgh	100.70 a
	humic	96.96 e-l	97.66 d-k	97.38 e-k	97.33 de	
	bacteria	105.93 a-g	103.30 b-i	107.63 a-e	105.62 bc	
	humic+bacteria	107.43 a-f	108.46 a-d	112.92 abc	109.61 ab	
cultivar ×Sulfur amino acid spray	Polo	Jassmine	2004 Tokita	Average sulfur amino acid spray		
control	93.09 c	95.31 bc	99.05 ab	95.82 b		
Cystine	00.12 ab	97.87 bc	99.44 ab	99.12 a		
Methionine	97.44 bc	99.84 ab	103.61 a	100.29 a		
Fertilization × Sulfur amino acid spray	control	Cystine	Methionine	Fertilization type average		
control	82.14 g	88.77 f	92.86 ef	87.92 d		
humic	93.39 ef	97.64 de	92.12 ef	94.38 c		
bacteria	103.09 cd	101.18 cd	102.56 cd	102.28 b		
humic+bacteria	104.64 bc	108.98 ab	113.64 a	109.09 a		

* The averages with the same letters have no significant differences between them according to Duncan's polynomial test and at the probability level of 0.05.

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Table (5): Effect of cultivar, organic and biological fertilization, sulfur amino acid spray, and the interactions between them on stem diameter (mm)

Cultivars	Fertilization type	Sulfur amino acid spray			Cultivar× Fertilization type	Average cultivar
		control	Cystine	Methionine		
Polo	control	19.90 G	20.77 C	21.83 x	20.83 k	22.78 b
	humic	22.00 t	22.60 s	22.75 q	22.45 g	
	bacteria	23.00 p	23.60 l	24.03 i	23.54 e	
	humic+bacteria	24.06 h	24.35 f	24.48 e	24.30 b	
Jassmine	control	20.86 B	21.94 v	23.06 o	21.95 h	23.77 a
	humic	23.43 m	23.84 k	24.00 j	23.76 d	
	bacteria	24.06 h	24.28 g	24.50 d	24.28 c	
	humic+bacteria	24.85 c	25.00 b	25.44 a	25.10 a	
Tokita 2004	control	19.65 H	20.00 F	20.20 E	19.95 l	21.33 c
	humic	20.55 D	21.08 A	21.42 z	21.02 j	
	bacteria	21.53 y	21.90 w	21.95 u	21.79 i	
	humic+bacteria	22.00 t	22.63 r	23.12 n	22.58 f	

cultivar ×Sulfur amino acid spray	Polo	Jassmine	2004 Tokita	Average sulfur amino acid spray
control	22.24 f	23.30 c	20.93 i	22.16 c
Cystine	22.83 e	23.76 b	21.40 h	22.66 b
Methionine	23.27 d	24.25 a	21.67 g	23.06 a
Fertilization × Sulfur amino acid spray	control	Cystine	Methionine	Fertilization type average
control	20.14 l	20.90 k	21.70 j	20.91 d
humic	21.99 i	22.51 h	22.72 g	22.41 c
bacteria	22.86 f	23.26 e	23.49 d	23.20 b
humic+bacteria	23.64 c	23.99 b	24.35 a	23.99 a

* The averages with the same letters have no significant differences between them according to Duncan's polynomial test and at the probability level of 0.05.

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Table (6): Effect of cultivar, organic and biofertilization, sulfur amino acid spray and the interactions between them on the dry weight of the vegetative total of the plant (g.plant^{-1})

cultivars	Fertilization type	Sulfur amino acid spray			cultivar× Fertilization type	average cultivar
		control	Cystine	Methionine		
Polo	control	242.0 C	298.0 k	267.0 v	269.0 j	290.0 b
	humic	280.0 r	275.0 t	272.0 u	276.0 h	
	bacteria	259.0 x	309.0 f	297.0 l	288.0 f	
	humic+bacteria	319.0 d	325.0 b	340.0 a	328.0 a	
Jassmine	control	248.0 B	320.0 c	287.0 p	285.0 g	299.0 a
	humic	313.0 e	292.0 o	300.0 j	302.0 c	
	bacteria	325.0 b	306.0 g	303.0 h	312.0 b	
	humic+bacteria	295.0 m	293.0 n	301.0 i	296.0 d	
Tokita 2004	control	233.0 F	257.0 z	237.0 E	243.0 l	265.0 c
	humic	241.0 D	258.0 y	254.0 A	251.0 k	
	bacteria	280.0 r	276.0 s	261.0 w	273.0 i	
	humic+bacteria	285.0 q	301.0 i	298.0 k	295.0 e	
cultivar ×Sulfur amino acid spray	Polo	Jassmine	2004 Tokita	Average sulfur amino acid spray		
control	275.0 f	295.0 d	260.0 i	277.0 c		
Cystine	302.0 b	303.0 a	273.0 g	293.0 a		
Methionine	294.0 e	298.0 c	263.0 h	285.0 b		
Fertilization × Sulfur amino acid spray	control	Cystine	Methionine	Fertilization type average		
control	241.0 l	292.0 e	264.0 k	266.0 d		
humic	278.0 h	275.0 j	276.0 i	276.0 c		
bacteria	288.0 f	297.0 d	287.0 g	291.0 b		
humic+bacteria	300.0 c	307.0 b	313.0 a	306.0 a		

* The averages with the same letters have no significant differences between them according to Duncan's polynomial test and at the probability level of 0.05.

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Total chlorophyll content of leaves (mg. 100gm^{-1} fresh matter)

The results of Table (7) showed that the cultivars differed significantly in the total chlorophyll content of the leaves.Whereas Tokita 2004 cultivar significantly excelled by giving the highest average of chlorophyll content of leaves of 70.74 mg.100 g^{-1} fresh weight compared to Polo cultivar which gave the lowest chlorophyll content of 70.34 mg.100g^{-1} fresh weight.The excelled was significant in the fertilizer mixture (humic + bacteria), which gave the highest average of total chlorophyll content of leaves of 70.50 mg.100 g^{-1} fresh weight compared to the control treatment that gave the lowest average of 70.26 mg.100 g^{-1} fresh weight.The treatment of spraying with amino acid Methionine was significantly excelled by giving it the highest average of total chlorophyll content of leaves, which was 70.48 mg.100 gm-^{1} fresh weight, compared to the control treatment, which gave the lowest rate of 70.30 mg.100gm^{-1} fresh weight and in the case of the triple interaction, the interaction between Tokita 2004 cultivar and the fertilizer combination (humic + bacteria) and the amino acid Methionine was significantly excelled, which gave the highest average content of leaves of total chlorophyll of 70.73 mg.100 g^{-1} fresh weight, compared with the triple interaction between Polo cultivar. And between the comparison treatment of amino acids and the control treatment of fertilization, which gave the lowest average for both seasons, which was 70.16 mg.100 g^{-1} fresh weight.

From the previous, the results of the vegetative and physiological growth indicators shown in Tables (2), (3), (4), (5), (6), and (7) indicate that the varieties have a significant effect on the vegetative and physiological growth indicators, due to the different genetic structures of the cultivar and the interaction of genetic factors with the surrounding environment, and this will affect the performance of hybrids traits a large number of genes governs the quantitative traits. Their effect is on the secondary type, which makes them affected by the environment significantly, and this creates a second effect, which is the interaction between the environment and heredity, in addition to the presence of static genes (silent genes) whose effect can appear in a specific environment called (the gene-environment). Which positively affected the increase in strength of Vegetative and root growth (7 and 5 and 22), who confirmed that the genetic composition has a significant effect on the growth and yield of broccoli. The results of the above tables showed significant differences between the fertilization treatments. The fertilizer combination (humic + bacteria) significantly excelled on the vegetative growth indicators. This is due to the synergistic effect between humic and bacteria, as humic increases the permeability of cell membranes, photosynthesis and root growth (26). In addition to its indirect role in increasing the efficiency of available and added fertilizers or its direct role in improving all vital activities in the plant (23 and 13) and increasing the readiness of many nutrients for a more extended period until the late stages of plant growth and the entry of these elements, which in turn enter into building a molecule Chlorophyll, which is positively reflected on the efficiency of photosynthesis, which led to an increase in the concentration of nutrients in the plant's vegetative system (20 and 1), As well as the increase in cell division and its elongation, which increases plant height, leaf area, stem diameter and dry weight, and thus is reflected on the quantitative and qualitative yield indicators (12),

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Table (7): Effect of cultivar, organic and biofertilization, sulfur amino acid spray, and the interactions between them on the total chlorophyll content of leaves (mg.100gm^{-1} fresh weight)

cultivars	Fertilization type	Sulfur amino acid spray			cultivar× Fertilization type	average cultivar
		control	Cystine	Methionine		
Polo	control	70.16 y	70.19 x	70.29 s	70.22 k	70.34 c
	humic	70.23 w	70.33 q	70.38 n	70.32 i	
	bacteria	70.26 u	70.42 l	70.48 h	70.39 g	
	humic+bacteria	70.36 p	70.45 j	70.51 f	70.44 d	
Jassmine	control	70.19 x	70.23 w	70.33 q	70.25 j	70.37 b
	humic	70.27 t	70.36 p	70.42 l	70.35 h	
	bacteria	70.30 r	70.43 k	70.49 g	70.41 f	
	humic+bacteria	70.38 n	70.47 i	70.51 f	70.45 c	
Tokita 2004	control	70.25 v	70.29 s	70.41 m	70.32 i	70.47 a
	humic	70.33 q	70.43 K	70.53 e	70.43 e	
	bacteria	70.37 o	70.57 d	70.64 b	70.53 b	
	humic+bacteria	70.48 h	70.61 c	70.73 a	70.61 a	
cultivar ×Sulfur amino acid spray	Polo	Jassmine	2004 Tokita	Average sulfur amino acid spray		
control	70.26 i	70.29 h	70.36 f	70.30 c		
Cystine	70.35 g	70.37 e	70.48 b	70.40 b		
Methionine	70.42 d	70.44 c	70.58 a	70.48 a		
Fertilization × Sulfur amino acid spray	control	Cystine	Methionine	Fertilization type average		
control	70.20 l	70.24 k	70.35 h	70.26 d		
humic	70.28 j	70.38 g	70.45 e	70.37 c		
bacteria	70.31 i	70.48 d	70.54 b	70.44 b		
humic+bacteria	70.41 f	70.51 c	70.59 a	70.50 a		

* The averages with the same letters have no significant differences between them according to Duncan's polynomial test and at the probability level of 0.05.

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In addition to the role of bacteria in improving soil properties and increasing the readiness and absorption of many macro and micronutrients. Azotobacter bacteria can freely fix atmospheric nitrogen, and this meets some of the plant's need for this critical nutrient, which is included in the construction of the chlorophyll molecule, nucleic acids, RNA and DNA, and in the formation of Amino acids and proteins and their stimulation to produce plant hormones such as auxins, cytokinins and gibberellins (24) All of this may contribute to an increase in the dry weight of the plant and an increase in the growth of the vegetative system, as well as its role in improving the growth of the root system and increasing its density to produce some growth regulators and some materials containing micro-elements such as iron, and its reflection in increasing the size of the vegetative group (16 and 15).)From the results showed that the amino acids differed significantly in the traits of vegetative growth, and this is because sulfur amino acids work to increase the construction of secondary compounds and activate the enzymatic system of the plant, especially the oxidation and reduction system, increasing the ability of cells to divide and elongate, raise the efficiency of carbon metabolism and manufacture carbohydrates and proteins, which contribute in increased vegetative growth (19)Or, the reason may be attributed to its significant role in stimulating physiological and biochemical processes, as the amino acids Methionine and Cystine are then involved as units for building protein, boosting photosynthesis and building carbohydrates. (14) and (6) and (10), who confirmed that amino acids have a significant effect on vegetative and physiological growth indicators.

Conclusions

Based on the results obtained from the study, we can conclude the following:

1- The study showed the superiority of broccoli cultivar Jassmine in most indicators of vegetative growth (plant height, number of leaves, stem diameter).

2- The study revealed that fertilizing with the fertilizer combination (humic + Azotobacter) achieved significant positive results in most of the studied indicators, such as indicators of vegetative growth and chlorophyll content of leaves.

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