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Effect of biofertilizer application and aspartic acid spray on some vegetative and yield characteristics of apple trees

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Abstract

A field trial was carried out on 5 years-old apple trees (c.v. Kaghdi), grown in a private orchard in the Al-Muradiya district, Diyala governorate, Iraq, throughout the 2024 growing season to study the effects of biofertilizer FULZYME Plus application (0, 25 and 50 g per tree), and aspartic acid spray (0,50,100,and 150mg L-1) on some vegetative and yield characteristics. A factorial experiment with a randomized com-plete block design was used, with two factors (3*4) and two trees for each experi-mental unit. Data were analyzed using SAS and LSR test at 0.05 probability level. Results Indicated that applying biofertilizer at 50 gm per tree caused a considerable increase in carbohydrate content and leaf chlorophyll, fruit weight, fruit juice TSS, and sugar content, whereas it caused a significant reduction of titratable acidity. On the other hand, aspartic acid spray increased leaves' carbohydrate content, fruit weight, TSS, And the total sugar content of fruit juice. The interaction between biofertilizer application at 50 gm per tree and 150 mg L-1 of aspartic acid spray led to obtaining the highest leaf carbohydrate content, fruit weight, TSS, and total sugar in fruit juice.

Keywords: Biofertilizer, aspartic acid , apple trees

Introduction

Apple (*Malus domestica* Borkh.) represents one of the important commercial fruit plant species belonging to the family Rosaceae, widely grown in the world. It represents the most produced crop among fruit species that grow in temperate climates worldwide [1] World production reached about 94,144,358 tons in 2021 [2]. It is one of the widely consumed fruits, a rich phytochemicals source, and epidemiological studies linked apple consumption to lowering risks of some cancer types, asthma, cardiovascular disease, and diabetes [3].

The scarcity of arable land and the increase in population at the same time industrialization and urbanization have forced farmers to excessively use chemical fertilizer inputs for higher yields over the last few years, leading to decreased soil fertility, pollution, and serious environmental and health issues [4]. This situation has encouraged the adoption of modern technologies aimed at reducing damage, such as biofertilizers, which are considered a notably safer alternative and have shown promising success in mitigating the negative effects and risks associated with mineral fertilizers, while also contributing to improved soil properties and lower production costs.

Biofertilizers are characterized by their great effects, supplementary, and eco-friendly plant nutrient sources. In addition to that, they represent one of the important components of integrated management of nutrients and plant nutrition systems [5]. Biofertilizer effectiveness includes mobilizing sparingly available plant mineral nutrients in order to fertilizer (N), dissolve potassium (K), dissolve phosphorus (P) [6], and solubilize zinc [7].

There are 20 proteinogenic amino acid types, and the majority of them display stimulating effects on the growth of the plants in case of being applied at appropriate doses [8]. L-aspartic acid (Asp) is one of these types. It was enriched in the commonly utilized bio-stimulant products [9].

This study aimed to explore whether the leaf area, chlorophyll, carbohydrate content, and fruit quality of apple trees cv. Kaghadi are affected by the Biofertilizer application and aspartic acid spray alone or in combination with each other.

Materials and Methods

The experiment was conducted in a private orchard in the Al-Muradiya village, Diyala Governorate, on 5-year-old apple trees (c.v. Kaghadi) (3.5 x 4 m apart) to study the effects of applying the biofertilizer FULZYME Plus (0, 0.25 and 50 g per tree) on 20- March, and spraying aspartic acid at four concentration levels (0, 50, 100, and 150 mg/L) on 22- March,12- April, and 12-May, using a 100-liter sprayer. Routine orchard maintenance operations such as irrigation and weeding during the growing season. A factorial experiment with two factors (3 x 4) was conducted using a randomized complete block design (RCBD), replicated three times, with two plants representing each experimental unit. Results have been analyzed with the use Of the LSR test at 0.05 probability.

The studied characteristics:

1. Leaf area (cm^2): measured using the method that Rashid [10].
2. Leaves Chlorophyll content: Leaves Chlorophyll content: determined using acetone and the solution was read at wavelengths 663 and 645 with spectrophotometer [11].
3. Leaves Carbohydrate content: determined using Joslyn method [12].
4. Fruit weight (gm).
5. Total soluble solids in fruits juice (Brix %) .
6. Tiratable acidity (%)
7. Total sugar content of fruit juice (%); according in to [11]
8. Vitamin C ;calculated using the method of A.O.A.C. [11].

Table (1): Physical and chemical characteristics of experiment soil

EC $dS.m^{-1}$	pH	Available nutrient			Organic material	Texture
		N $g.kg^{-1}$	P $g.kg^{-1}$	K $g.kg^{-1}$		
2.8	7.31	3.6	6.3	3.40	7.5	Loamy sandy

Results and discussion

The results show in Table 1 the following:

Leaf area (cm2)

No significant differences were noted biofertilizer application treatments in Leaf area.

Leaves chlorophyll content (mg.100g^{-1})

The result Indicated that in (Table 2) that Biofertilizer application treatments at 50 g trees gave a highest mean leaves chlorophyll content was achieved 77.58 (mg.100g^{-1}) compared to the control treatment, which gave the lowest contant (71.88 mg.100g-1).

Leaves Carbohydrate content

Biofertilizer application treatments at 50 g differs significantly from the other treatments where the mean leaves Carbohydrate content 14.71 % compared to 12.03 % for untreated trees (table 2).

Fruit weight (gm)

The result Indicated that in (Table 2) that biofertilizer application treatments at 50 g trees gave a highest mean fruit weight was achieved 50.47g compared to the control treatment, which gave the lowest weight (46.07 g).

Tiratable acidity (%)

The results in Table 2 show a decrease in the tiratable acidity content of the in fruits juice with increasing biofertilizer application concentration. The lowest content was 1.19% when 50 g was application to the tree, while the control treatment gave the highest average of 1.315 % .

Total soluble solids in fruits juice (Brix %)

A significant difference in Total soluble solids in fruits juice increase, when biofertilizer application at 50 g trees (15.42%), compared to 13.59% for untreated plants.

Total sugar content of fruit juice (%)

A significant difference in total sugar content of fruit juice increase(table1), when biofertilizer application 50g trees (13.36%), compared to 11.20 % for untreated plants.

Vitamin C in fruits juice (%)

No significant differences were noted biofertilizer application treatments in Vitamin C in fruits juice.

The results in Table 2 show an increase in some of the average growth characteristics studied, possibly to supporting bio-fertilizer effects may be a result of the microorganism's effect in increasing root activity in the rhizosphere, initiating harmonic activity, and, therefore, increasing plant nutrient uptake [13 , 14] Several studies reported supporting these results.

Table (2): Effect of Biofertilizer application on some vegetative and yield characteristics of apple trees

Bio-fert. (g tree^{-1}	Leaf area (cm^2)	Chlo. (mg.100 g$^{-1)}$	Carbohy-drates (%)	Fruit Weigh t (g)	TA (%)	TSS (Brix %)	Total Sug-ars (%)	Vit.C . (%)
0	35.2 4 a	71.88b	12.03c	46.07b	1.315a	13.59c	11.20 c	13.59 a
25	35.2 6 a	76.54a	14.01b	47.47b	1.245a b	14.58b	11.97 b	14.02 a
50	37.8 0 a	77.58 a	14.71a	50.37a	1.195b	15.42a	13.36 a	14.13 a

Similar letters within the same column indicate no significant difference between the means at a significance level of 0.05.

Leaf area (cm^2)

No significant differences were noted Asparatic acid treatments in Leaf area.

Leaves chlorophyll content: (mg.100g^{-1})

No significant differences were noted Asparatic acid treatments in leaves chlorophyll content.

Leaves Carbohydrate content

Asparatic acid spray at 150 mg.L^{-1} differs significantly from the other treatments where the mean leaves Carbohydrate content 13.97 % compared to 12.79% for untreated trees (table2).

Fruit weight (gm)

The result Indicated that in (Table 3) that Asparatic acid sprays at 150 mg.L-1 gave a highest mean fruit weight was achieved 49.27g compared to the control treatment, which gave the lowest weight (26.47 g).

Tiratable acidity in fruits juice (%)

No significant differences were noted Asparatic acid treatments in Tiratable acidity**.**

Total soluble solids in fruits juice (Brix %

) A significant difference in Total soluble solids in fruits juice increase, when Asparatic acid was sprayed at 150 mg.L-1 (14.97%), compared to 14.02% for untreated plants.

Total sugar content of fruit juice (%)

A significant difference in Total sugar content of fruit juice increase(table2), when Asparatic acid was sprayed at 150 mg.L-1 (12.95%), compared to 11.56% for untreated plants.

Vitamin C in fruits juice (%)

No significant differences were noted Asparatic acid treatments in Vitamin C in fruits juice.

Results in Table 3 showed a positive increase in leaves' carbohydrate content, fruit weight, juice TSS, and sugar content related to increasing aspartic acid spray cons.

This may be due to the promoting effects of this amino acid on the protection of plant cells from oxidation and all stresses, in addition to the enhancement of proteins bio-synthesis, plant pigments, natural hormones like IAA, gibberellin, and cytokinins, which is reflected in stimulating vegetative growth, chemical structure of the fruits, and productivity [15].

Table (3): Effect of aspartic acid spray on some vegetative and yield characteristics of apple trees

Aspar-tic acid (mgL^{-1})	Leaf area (cm^2)	Chlo. (mg.. $100g^{-1}$)	Carbohy-drates (%)	Fruit Weigh t (g)	TA (%)	TSS (Brix%)	Total Sug-ars (%)	Vit. C. (%)
0	34.80 a	75.84 a	12.79b	46.47 b	1.253 a	14.02c	11.56 b	13.90 a
50	37.04 a	76.45 a	13.80a	47.90a b	1.222 a	14.32bc	11.65 b	13.81 a
100	35.59 a	75.22 a	13.77a	48.25a	1.272 a	14.81ab	12.55a	13.65 a
150	36.98 a	73.83 a	13.97a	49.27a	1.260 a	14.97a	12.95a	14.30 a

Similar letters within the same column indicate no significant difference between the means at a significance level of 0.05.

The results show in Table 4 the following:

Leaf area (cm^2)

No significant differences were noted the interaction between biofertilizer application and aspartic acid spray

acid treatments in Leaf area.

Leaves chlorophyll content ($mg.100g^{-1}$)

No significant differences were noted the interaction between biofertilizer application and aspartic acid spray in leaves chlorophyll content.

Leaves Carbohydrate content

The interaction between biofertilizer application (50 g trees) and aspartic acid spray at 150 mg. L^{-1} differs significantly from the other treatments where the mean leaves Carbohydrate content 14.88% % compared to 10.67% for untreated trees (table3).

Fruit weight (gm)

The result Indicated that in (Table 4) that interaction between biofertilizer application (50 g trees) and aspartic acid spray at 150 $mg.L^{-1}$ gave a highest mean fruit weight was achieved 51.34 g compared to the control treatment, which gave the lowest weight (43.38).

Tiratable acidity (%)

No significant differences were noted interaction between biofertilizer application (50 g trees) and aspartic acid spray at 150 mg. L^{-1} treatments in Tiratable acidity.

Total soluble solids in fruits juice (Brix %)

A significant difference in total soluble solids in fruits juice increase, when interaction between biofertilizer application (50 g trees) and aspartic acid spray at 150 mg. L^{-1} (15.69%), compared to 12.67% for untreated plants.

Total sugar content of fruit juice (%)

A significant difference in Total sugar content of fruit juice increase(table2), when interaction between biofertilizer application (50 g trees) and aspartic acid spray at 150 mg. L^{-1} (13.99%), compared to 10.27% for untreated plants.

Vitamin C in fruits juice (%)

No significant differences were noted the interaction between biofertilizer application and aspartic acid spray treatments in Vitamin C in fruits juice.

Table (4): Effect of Biofertilizer application and aspartic acid spray on some vegetative and yield characteristics of apple trees

Biofert (g tree^{-1})	Aspartic acid mgL^{-1}	Leaf area (cm^2)	Chlo. (mg.100 g^{-1})	Carbo. (%)	Fruit weight (g)	TA (%)	TSS (Brix %)	Total Sugars (%)	Vit. C. (%)
0	0	33.01a	73.65a	10.67e	43.38 e	1.413a	12.67e	10.27 e	13.68a
	50	36.96a	74.80a	12.70bc	46.23de	1.263a	13.33de	10.11 e	13.69a
	100	33.92a	74.13a	12.35d	47.42cd	1.256a	13.98cd	11.94 cd	13.10a
	150	37.09a	64.96b	12.41d	47.26cd	1.326a	14.39bcd	12.47 bc	13.92a
25	0	33.22a	77.09a	13.37bcd	46.32de	1.176a	14.25bcd	11.24 d	13.96a
	50	38.08a	76.44a	13.86abc	46.46d	1.210a	14.38bcd	11.95 bc	13.97a
	100	34.61a	75.37a	14.20ab	47.90bcd	1.363a	14.85abc	12.32 bc	14.19a
	150	35.14a	77.26a	14.61ab	49.21a-d	1.233a	14.85abc	12.39 bc	13.95a
50	0	38.17a	76.77a	14.33ab	49.71abc	1.170a	15.13abc	13.16 ab	14.08a
	50	36.09a	78.11a	14.85a	51.00ab	1.193a	15.25ab	12.90 bc	13.77a
	100	38.24a	76.17a	14.77a	49.42a-d	1.196a	15.61a	13.39 ab	13.66a
	150	38.69a	79.28a	14.88a	51.34a	1.220a	15.69a	13.99 a	15.03a

Similar letters within the same column indicate no significant difference between the means at a significance level of 0.05.

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