Iraqi Journal of Market Research and Consumer Protection
(2025) 17(3): 284-295.
DOI:
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المجلة العراقية لبحوث السوق
وحماية المستهلك

EFFECT AZOTOBACTER, MYCORRHIZAE, VERMICOMPOST, AND SPRAY NPK ON QUALITY CHARACTERISTICS OF C.V HELAWANI GRAPE.

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Received 13/ 9/ 2023, Accepted 14/ 11/ 2023, Published 30/ 6/ 2025

ABSTRACT

The experiment was carried out in one of private orchards of Diyala during two seasons (2022- 2023) on grape vines at 15 years old, to study effect of adding bacterial and fungal biofertilizers, vermicompost fertilizer, and foliar applied mineral fertilizer Nitrogen, phosphorus and potassium (NPK) on growth and production characteristics on cv. Helwani grape vines. Experiment was carried out in a randomized complete block design (RCBD) arranged as a split plot with three factors with Three replicates, experimental unit included one tree with the total number of 72 trees for the experiment. First factor included the addition of biofertilizers which included: without inoculation (M0), inoculation with 400 g of fungi (M1), inoculation with 200 g of bacterial (M2) and inoculation with both bacteria and fungi (M3). Second factor included the addition of organic fertilizer with three treatments, without addition (N0), adding 5 kg/ tree^{-1} (N1) and adding 7 kg/tree^{-1} (N2), and the third factor included foliar applied mineral fertilizer NPK as two treatments, without spraying (F0) and Spraying with 2.5 ml L^{-1} of fertilizer (F1). Four foliar applications were applied at 30-day intervals when leaves reached full expansion. Results showed significant impact by the triple interaction treatment M3N2F1 on the treats quality by TSS, total acidity, anthocyanin, carbohydrate and nitrogen in the cans by giving it the highest values for these treats, 18.25%, 19.90%, 0.461%, 0.485%, 98.41, 92.24 mg100g^{-1}, 19.37%, 22.13% and 0.048%, 0.066% for both seasons respectively.

Keywords: Mycorrhiza, Azotobacter, organic, foliar, Chemical.

تأثير الازوتوباكتر والمايكورايزا والفيرميكمبوست والرش بالـــ *NPK* في الصفات النوعية للعنب صنف حلواني

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الخلاصة

نفذت التجربة في احدى بساتين العنب الخاصة في محافظة ديالى خلال الموسمين (2022 – 2023) على كرمات العنب وبعمر15سنة لدراسة تأثير اضافة السماد الحيوي البكتيري والفطري والسماد العضوي والرش بالسماد المعدني NPK على بعض الصفات الانتاجية للعنب صنف حلواني ، بتصميم القطاعات العشوائية الكاملة (RCBD)حسب ترتيب الالواح المنشقة وبثلاث عوامل وثلاث مكررات تضمن اللوح الرئيس السماد الحيوي واللوح الثانوي التداخل بين التسميد العضوي والمعدني وتشمل الوحدة التجريبية على شجرة واحدة ويبلغ عدد الأشجار 72 شجرة وتضمن العامل الاول اضافة

[*] **This article is taken from the doctoral dissertation of the first researcher.**

الاسمدة الحيوية ورمز لها (M) باربعة معاملات هي M0 من دون تلقيح ،M1 اضافة الفطر 400 غم /شجرة،M2 اضافة البكتريا 200غم /شجرة ،M3 التداخل بين الفطر والبكتريا والعامل الثاني اضافة السماد العضوي ورمز له (N) بثلاث معاملات N0 بدون اضافة وN1 اضافة 5 كغم/ شجرة وN2 اضافة 7 كغم/ شجرة والعامل الثالث الرش بالسماد المعدني NPK بمعاملتين هي F0 بدون رش وF1 رش اشجار العنب حتى البلل بتركيز 2.5 غم /لتر بأربعة رشات بين رشة واخرى ثلاثين يوما ابتداء من وصول الاوراق مرحلة الاتساع الكامل،اظهرت النتائج تفوق معاملة التداخل الثلاثي M3N2F1 في الصفات النوعية المتمثلة بالمواد الصلبة الذائبة الكلية والحموضة الكلية والكربوهيدرات والنتروجين في القصبات باعطائها أعلى القيم لهذه الصفات اذ بلغت 18.25% و19.90% و0.461% ،0.485% و98.41 ،92.24 ملغم 100غم $^{-1}$ و 19.37% ، 22.13% و0.048% و0.066% للموسمين بالتتابع .

الكلمات المفتاحية : المايكورايزا ، الازوتوباكتر ، عضوي ، رش، كيميائي.

INTRODUCTION

Grapes come back *Vitis vinifera*L. Belongs to the Vitaceae grape family, which includes 14 genera, the most important of which is the genus Vitis, which is widely cultivated in the world. This family includes more than 1,000 species, and grape bushes are perennial, but commercial production of grape farms usually lasts between 30 and 50 years (**Grigg *etal*.,2018**), the original homeland of grapes is Central Asia, while others confirm that it is the Mediterranean zone and the Caucasus. At present, grape species are widely spread in the subtropical and temperate regions (**Grassi &De lorenzis, 2021**), Grape fruit has a high nutritional value and has many uses, as its berries contain a high percentage of carbohydrates in the form of sugars, vitamins, proteins and organic acids, from a medical standpoint, grape berries are considered a substance that stimulates brain cells and heart muscles and strengthens the liver and kidneys. They contain a number of antioxidant compounds consisting of flavonoids and various plant pigments, which are concentrated in the skin of the grape seed (**Hanusovsky *et al*.,2020**) Considered as *Azotobacter* bacteria types of fixed bacteria of nitrogen According to studies, it has the ability to fix nitrogen to some extent it arrives8.73 kg ha-1 in the soil. However, the benefit of using *Azotobacter* goes beyond being a nitrogen-fixing bacteria, as it can produce plant hormones that can enhance the growth and elongation of plant roots, increase the branching of root hairs, and then effectively absorb nutrients by the roots (**Hindersah *et al*., 2020**). In addition to the beneficial effects of *Azotobacter* on plant growth, it synthesizes and secretes large quantities of active substances Biologically like B vitamins, nicotinic acid, pantothenic acid biotin heteroxins which enhances the growth of plant roots (**Patil *et al*., 2020**).

As for the main role of *Mycorrhiza* is in enhancing the absorption of water and nutrients, as they work through a symbiotic relationship with the plant roots, thus increasing the surface area of the roots and exploring larger areas for the presence of nutrients. By secreting phosphatase enzyme and organic acids, they are able to increase the solubility of phosphorus and its readiness for absorption, as the phosphatase enzyme helps in converting phosphorus unprocessed organic matter is converted into plant-ready mineral phosphorus, which is essential for plant growth and productivity. In addition, mycorrhizae may also facilitate the removal of toxins and organic and inorganic soil pollutants that may harm plant growth and productivity (**Bhantana *et al*., 2021**). Vermicompost helps improve the soil structure, texture, porosity, water retention ability, drainage, and aeration, in addition to reducing soil erosion. It enhances the

microbial activity of the soil, adds beneficial microbes, and reduces the occurrence of pests and diseases in plants. It also contains many micronutrients. The study also showed the positive effect of vermicompost when applied alone or when used with microbes, plant growth regulators, or biofertilizers as part of integrated nutrient management (**Makkar *et al*., 2022**),foliar fertilization is a measure of increase in productivity and quality, foliar fertilizers provide a surplus of fertilizing elements, especially secondary macro elements NPK, Studies have also shown that the absorption and assimilation of nutrients is usually more rapid and efficient through the leaves than through the roots, especially if they are not ready in the soil, in addition to their slow transport through the root system (**Malhotra & *et al*., 2020**). The study aims to strengthen trees and increase vegetative growth and productivity in quantity and quality.

MATERIALS AND METHODS

This experiment was carried during two seasons (2022 - 2023) on the vines of Helwani cultivar, 15 years old, and it is a table variety that is successfully cultivated in these areas. The distance between one vine and another ranges (1.5) m and between one line and another (5) m, using method of raising on wires, identical vines were randomly selected, and winter pruning of these trees was conducted at the beginning of January, leaving (10) canes for every tree and (8) eyes for each stalk, service operations, such as irrigation, weeding, and insect control, were carried out equally for all treatments, some of the leaves were also removed by a process called leafing twice during one season, and watery branches were also removed for all treatments, with the aim of studying the effect of bacterial and fungal Biofertilizer, vermicompost and spraying with the NPK and their interaction on some characteristics quality the grape trees of Helwani variety.

Treatments and experimental design

The research was carried out with three factors (4*3*2) within the split plot design with factorial design, where the first factor Biofertlizer distributed on main plots, second factor represents vermicompost (3 treatments), and third factor is spraying with nutrients, and three replicates with one tree for the experimental unit, thus the number of experimental trees became 72 trees, the data was analyzed using the program Genstst, least significant difference was tested (LSD) at a probability level of 0.05 to compare arithmetic averages.

Study factors.

First factor: Biofertilizer

M0: without inoculation
M1: *Mycorrhiza***,** inoculation with 400 g of fungi /vine^{-1}
M2: *Azotobacter***,** inoculation with 200 g of bacterial/vine^{-1}
M3: *Azotobacter + Mycorrhiza.*

Second factor: organic fertilizers

N0: Without adding
N1: Vermecompost**,** adding 5 kg/ vine^{-1}.
N2: Vermecompost, adding 7 kg/ vine^{-1}.

Third factor: Foliar spraying

F0: Without spraying (spraying with distilled water only).

F1: Spraying with 2.5 ml L^{-1} of fertilizer.

Study Characteristic:

Percentage of total soluble solids T.S.S

It was calculated using a manual refractometer (Hand Rerfractometer) when reaping. nanometers.

Total acidity

Total acidity was estimated according to the method (**A.O.A.C, 1975**).

Anthocyanin:

I thought by device Spectrophotometer at a wavelength (535 nm), as stated in the method of (**Ranganna, 1977**).

Carbohydrate percentage in canes

I used the method (**Joslyn, 1970**) in estimating the percentage of carbohydrates in branches.

Nitrogen percentage in canes

Using a Micro Kjeldahl device, estimated nitrogen percentage in canes.

Table (1): Some physical and chemical properties of orchard soil.

Adjective	pH	EC	OM	CEC	N	P	K	sand	Alluvial	Clay
2022 season	7.21	2.64	6.39	18.6	23.65	5.97	112.5	415.00	277.00	308.00
2023 season	7.32	2.73	7.01	19.8	24.18	6.13	116.7	417.00	273.00	310.00
Measuring unit	---	DC Siemens M^{-1}	g. kg $^{-1}$	Cmol+Kg-1	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	g. kg $^{-1}$	g. kg $^{-1}$	g. kg $^{-1}$

RESULTS AND DISCUSSION

Percentage of total soluble solids T.S.S:

Results of (Table, 2) show that M3 had a significant impact by giving 16.28%, 16.63%, while control treatment was recorded M0 which gave 14.74% and14.78% for both seasons sequentially. regarding vermicompost, the results showed a significant impact of treatment N2 and its value was 15.96% and 16.35% compared to N0 which gave 14.64% and 14.88% for both seasons sequentially, F1 had significant impact by spraying with mineral fertilizer (NPK) which had 15.78% and 16.15% compared to F0 which gave 14.88% and 15.09% for both seasons sequentially. Table (2) also show that the M3N2 treatment excelled on the rest of treatments in TSS by giving it highest values 17.33%, 18.20% compared to treatment M0N0 which produced the lowest 14.28%, 14.32% respectively, it was observed that the found in M3F1treatment 17.06%, 17.66% respectively, while the treatments M0F0 gave lowest 14.37%, 14.48 respectively, While the treatment N2F1 produced the highest rate 16.57%, 17.06%, while the treatments N0F0 gave lowest rate 14.46%, 14.56% respectively.

(Table, 3) the interaction treatments achieved a significant effect on these traits, and the M3N2F1 treatment was characterized by giving the highest values of 18.25%, 19.90 %

compared to the lowest rates of control M0N0F0 that gave 13.92%, 13.95% for two seasons respectively.

Total acidity:

Results of (table, 2) show superiority of Biofertilizer treatment M3 significantly decreased total acidity percentage by giving lowest value of 0.588% and 0.571% compared to M0 which give 0.645% and 0.698% respectively, also excelled to vermicompost treatment N2 by giving her lowest percentage 0.541% and 0.593% for N0 which give 0.658% and 0.676%, also the treatment of spraying with mineral fertilizer is superior to treatment F1by giving her a lower rate of 0.554% and 0.597% for F0 which gave a value of 0.654% and 0.672% for both seasons. Table 2 confirm superiority of M3N2 significantly decreased by giving it lowest percentage of acidity.0.509% and 0.525% for a treatment M0N0 which gave a higher percentage 0.719% and 0.739%, followed by a M0N1and without a significant difference for second season by giving it a percentage of 0.700%, and results indicate that there are significant differences for treatment M3F1by giving lowest percentage 0.503% and 0.518% compared to M0F0 which gave 0.693% and 0.728%, as for treatment N2F1Significantly, acidity percentage decreased by a rate of 0.498% and 0.566% compared to N0F0 which gave 0.710% and 0.722% respectively. Results of table 3 triple interference of the study factors in the table above indicated that there were significant differences for triple interference treatment M3N2F1 characteristic of total acidity is that it gives lowest percentage of acidity in berries 0.461% and 0.485% compared to the control treatment M0N0F0 which gave a higher percentage 0.760% and 0.779% for the first and second seasons, respectively.

Anthocyanin:

Results of (Table, 2) show that M3 had significant effect on anthocyanin, by giving 78.61, 74.51 (Mg100g-1) compared with M0, which gave 64.24 and 57.07 (Mg100g-1) for both seasons sequentially. The results also show that adding vermicompost led to significant differences, as the N2 treatment had significant effect by giving 76.37 and 72.03(Mg100g-1) compared with N0 which gave 64.43 and 59.04 (Mg100g-1) for both seasons sequentially. Treatment of Spraying with mineral fertilizer F1 had significant effect by giving 75.48 and 71.20 (Mg100g-1) compared to F0 which gave 65.14 and 59.24 (Mg100g-1) for both seasons sequentially. Table (2) also show that M3N2 treatment excelled on the rest of the treatments in anthocyanin by giving highest values 89.13 and 84.73 (Mg100g-1) compared to the treatment M0N0 which produced the lowest 59.35 and 51.88 (Mg100g-1) seasons respectively, it was observed that found in M3F1 treatment 86.61 and 82.21 (Mg100g-1) seasons respectively, while treatments M0F0 gave lowest 68.41 and 64.46.

respectively, while treatment N2F1 treatment produced the highest rate 80.36 and 76.19 (Mg100g-1) while treatments N0F0 gave lowest rate 59.82 and 53.77 (Mg100g-1) seasons respectively.

(Table, 3) results showed that there were significant differences in above characteristic between averages of treatments due to effect of triple intervention, as treatment M3N2F1 excelled gave highest rates of 98.41 and 92.24 (Mg100g-1) compared to control treatment that gave lowest rates of 53.36 and 24.26(Mg100g-1), for both seasons, respectively.

Carbohydrate percentage in canes

Results of (Table, 2) show that M3 had significant impact in the Biofertilizer by giving 14.24% and 16.98 %, compared to M0, which gave 10.97% and 12.65 %, vermicompost fertilizer N2 had significant effect which gave 13.76 and 15.97% compared to N0 which gave 10.96% and 13.24%, F1 treatment of spraying with mineral fertilizer significantly had significant effect by giving 13.64% and 15.82%, while F0 treatment gave 11.05% and 13.51% for both seasons sequentially. Table (2) also show that M3N2 treatment excelled on rest of treatment giving it 16.18% and 18.95% compared to the treatment M0N0 which produced 9.86% and 11.50% seasons respectively, it was observed that found in M3F1 treatment 16.55% and 19.17% seasons respectively, while treatments M0F0 gave 9.89% and 11.85% respectively, While treatment N2F1 treatment produced the rate 15.55% and 17.45%, while treatments N0F0 gave rate 10.38% and 12.39% seasons respectively.

Results are shown in (table, 3) there were significant differences in above characteristic as a result of triple interactions, as treatment was excelled M3N2F1 gave 19.37% and 22.13% compared to M0N0F0 gave 9.05% and 10.25% for two seasons, respectively.

Nitrogen percentage in canes

Results of (Table, 2) indicates that study factors led to a significant increase in the nitrogen percentage, as it is noted that the M3 had a significant impact by giving 1.317% and 1.407% about a treatment M0 which gave 1.186% and 1.240%. Treatment of vermicompost N2 had a significant impact by giving 1.291% and 1.388% compared to N0 which gave 1.195% and 1.252%, as for spraying with NPK mineral fertilizer, treatment F1 had a significant impact by giving 1.276% and 1.371% compared to F0 treatment, which gave 1.201% and 1.264% for both seasons sequentially. Table (2) also show that M3N2 excelled on rest of treatments by giving highest values 1.418%, 1.513% compared to M0N0 which produced lowest 1.166%, 1.200% seasons respectively, it was observed found in M3F1 treatment 1.401%, 1.512% seasons respectively, while treatments M0F0 gave lowest 1.170%, 1.212% respectively, While N2F1 treatment produced the highest rate 1.358%, 1.462% while treatments N0F0 gave lowest rate 1.178%, 1.225% seasons respectively .

(Table, 3) as for triple interactions, results indicate that there are significant differences between averages of treatments, as the treatment excelled M3N2F1 gives highest value of nitrogen percentage 1.570%, 1.656% compared to control treatment that gave lowest of 1.153%, 1.160% for both seasons, respectively.

Table (2): Effect of bacterial and fungal Biofertilizers, vermicompost, and spraying with mineral fertilizers NPK and interaction between them in some characteristics quality for the. Helwani grape for the seasons 2022 and 2023.

Treatment	TSS %		Total acidity %		Anthocyanin Mg100g^{-1}		Carbohydrate %		Nitrogen %	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
M0	14.74	14.78	0.645	0.698	64.24	57.07	10.97	12.65	1.186	1.240
M1	14.99	15.29	0.602	0.620	70.40	66.42	11.76	13.91	1.209	1.287
M2	15.32	15.69	0.610	0.649	67.99	62.88	12.42	15.13	1.243	1.335
M3	16.28	16.63	0.558	0.571	78.61	74.51	14.24	16.98	1.317	1.407
LSD5%	0.31	0.35	0.026	0.029	2.83	2.19	0.89	0.63	0.022	0.048
N0	14.64	14.88	0.658	0.676	64.43	59.04	10.96	13.24	1.195	1.252
N1	15.40	15.64	0.612	0.635	70.13	64.59	12.35	14.79	1.230	1.312
N2	15.96	16.35	0.541	0.593	76.37	72.03	13.76	15.97	1.291	1.388
LSD5%	0.16	0.19	0.018	0.024	1.35	1.45	0.37	0.39	0.018	0.023
F0	14.88	15.09	0.654	0.672	65.14	59.24	11.05	13.51	1.201	1.264
F1	15.78	16.15	0.554	0.597	75.48	71.20	13.64	15.82	1.276	1.371
LSD5%	0.12	0.15	0.014	0.019	0.94	0.74	0.33	0.21	0.014	0.015
M0N0	14.28	14.32	0.719	0.739	59.35	51.88	9.86	11.50	1.166	1.200
M0N1	14.74	14.99	0.646	0.700	63.73	54.49	10.96	12.78	1.183	1.245
M0N2	15.21	15.31	0.569	0.654	69.65	64.83	12.08	13.67	1.208	1.276
M1N0	14.61	14.96	0.643	0.648	66.08	61.55	11.01	13.00	1.185	1.251
M1N1	14.98	15.30	0.622	0.634	70.22	66.62	11.59	14.04	1.205	1.281
M1N2	15.38	15.62	0.540	0.578	74.90	71.10	12.67	14.69	1.238	1.328
M2N0	14.58	15.06	0.649	0.687	63.52	58.44	11.21	14.03	1.203	1.268
M2N1	15.47	15.76	0.635	0.647	68.62	62.74	12.03	14.77	1.225	1.303
M2N2	15.92	16.25	0.545	0.614	71.82	67.46	14.03	16.59	1.301	1.435
M3N0	15.10	15.19	0.621	0.630	68.78	64.29	11.74	14.42	1.225	1.291
M3N1	16.40	16.50	0.544	0.557	77.93	74.50	14.81	17.58	1.310	1.418
M3N2	17.33	18.20	0.509	0.525	89.13	84.73	16.18	18.95	1.418	1.513
LSD5%	0.37	0.43	0.037	0.046	3.30	2.99	0.98	0.83	0.035	0.056
M0F0	14.37	14.48	0.693	0.728	60.08	49.67	9.89	11.85	1.170	1.212
M0F1	15.11	15.26	0.597	0.668	68.41	64.46	12.05	13.45	1.202	1.268
M1F0	14.73	15.03	0.650	0.662	66.15	62.15	10.94	13.19	1.192	1.256
M1F1	15.26	15.55	0.554	0.578	74.64	70.70	12.58	14.63	1.226	1.317
M2F0	14.94	15.25	0.659	0.674	63.71	58.34	11.45	14.21	1.208	1.284
M2F1	15.70	16.13	0.561	0.624	72.27	67.42	13.40	16.05	1.277	1.386
M3F0	15.49	15.60	0.613	0.623	70.61	66.81	11.94	14.79	1.234	1.303
M3F1	17.06	17.66	0.503	0.518	86.61	82.21	16.55	19.17	1.401	1.512
LSD5%	0.33	0.38	0.030	0.037	2.95	2.29	0.92	0.66	0.027	0.050
N0F0	14.46	14.56	0.710	0.722	59.82	53.77	10.38	12.39	1.178	1.225
N0F1	14.83	15.21	0.606	0.631	69.04	64.31	11.53	14.08	1.211	1.280
N1F0	14.85	15.09	0.667	0.674	63.21	56.08	10.85	13.64	1.200	1.252
N1F1	15.95	16.18	0.557	0.595	77.04	73.09	13.85	15.94	1.260	1.371
N2F0	15.35	15.63	0.584	0.620	72.38	67.87	11.93	14.50	1.225	1.314
N2F1	16.57	17.06	0.498	0.566	80.36	76.19	15.55	17.45	1.358	1.462
LSD5%	0.21	0.25	0.024	0.033	1.72	1.67	0.53	0.45	0.024	0.028

Note that: M1= *Mycorrhiza* M2=*Azotobacter* M3= (*Mycorrhiza* + *Azotobacter)*, N1= Vermicompost 5 kg/tree-1 N2=Vermicompost 7 kg/tree-1, F1= Spraying with fertilizer NPK (2.5 ml/L-1).

Table (3): Effect of bacterial and fungal biofertilizers, vermicompost, and spraying with mineral fertilizers NPK and interaction between them in some characteristics quality for the cv. Helwani grape for the seasons 2022 and 2023.

Treatment	TSS %		Total acidity %		Anthocyanin Mg100g^{-1}		Carbohydrate %		Nitrogen %	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
M0N0F0	13.92	13.95	0.760	0.779	53.36	42.26	9.05	10.25	1.153	1.160
M0N0F1	14.64	14.69	0.679	0.700	65.33	61.50	10.67	12.76	1.180	1.240
M0N1F0	14.50	14.62	0.701	0.709	57.84	44.27	9.93	12.36	1.170	1.230
M0N1F1	14.97	15.36	0.591	0.692	69.62	64.71	11.99	13.20	1.196	1.260
M0N2F0	14.70	14.89	0.617	0.696	69.03	62.49	10.69	12.95	1.186	1.246
M0N2F1	15.72	15.73	0.520	0.613	70.27	67.17	13.48	14.38	1.230	1.306
M1N0F0	14.44	14.60	0.699	0.704	62.90	57.75	10.42	12.42	1.170	1.236
M1N0F1	14.79	15.33	0.588	0.592	69.25	65.35	11.61	13.57	1.200	1.266
M1N1F0	14.77	15.11	0.673	0.684	64.49	60.53	10.49	13.13	1.193	1.233
M1N1F1	15.20	15.49	0.572	0.585	75.96	72.71	12.70	14.94	1.216	1.330
M1N2F0	14.97	15.40	0.577	0.597	71.07	68.17	11.91	14.01	1.213	1.300
M1N2F1	15.80	15.84	0.504	0.558	78.72	74.03	13.42	15.37	1.263	1.356
M2N0F0	14.56	14.74	0.709	0.712	59.34	55.21	10.84	13.35	1.183	1.250
M2N0F1	14.59	15.38	0.590	0.663	67.70	61.68	11.58	14.71	1.223	1.286
M2N1F0	14.94	15.30	0.687	0.691	62.18	56.22	11.03	14.02	1.210	1.263
M2N1F1	16.01	16.23	0.584	0.603	75.06	69.25	13.02	15.52	1.240	1.343
M2N2F0	15.32	15.71	0.583	0.621	69.60	63.60	12.47	15.26	1.233	1.340
M2N2F1	16.52	16.78	0.508	0.607	74.04	71.33	15.59	17.92	1.370	1.530
M3N0F0	14.90	14.94	0.675	0.692	63.67	59.87	11.23	13.55	1.206	1.256
M3N0F1	15.30	15.44	0.567	0.568	73.90	68.71	12.25	15.29	1.243	1.326
M3N1F0	15.17	15.36	0.608	0.612	68.33	63.32	11.95	15.06	1.230	1.283
M3N1F1	17.63	17.65	0.480	0.502	87.53	85.68	17.68	20.10	1.390	1.553
M3N2F0	16.40	16.51	0.558	0.565	79.84	77.23	12.64	15.77	1.266	1.370
M3N2F1	18.25	19.90	0.461	0.485	98.41	92.24	19.37	22.13	1.570	1.656
LSD5%	0.47	0.55	0.049	0.064	3.91	3.42	1.23	0.95	0.048	0.066

Note that: M1= *Mycorrhiza* M2=*Azotobacter* M3= (*Mycorrhiza* + *Azotobacter*), N1= Vermicompost 5 kg/tree^{-1} N2=Vermicompost 7 kg/tree$^{-1,}$ F1= Spraying with fertilizer NPK (2.5 ml/L^{-1}).

Reason for the increase in the quality characteristics of grapes inoculated with *Azotobacter* bacteria may be attributed to its role in decomposing organic matter in the soil into its simple components that are beneficial to plants, microorganisms, and soil. The catalytic effect of the bacteria used is not only an indication of the demonstrated ability to fix nitrogen leading to increase the process of carbon metabolism, it has the ability to secrete auxins and gibberellins **(Bahadur, 2016)** which works to increase the surface area of the roots Which leads to increasing the availability and availability of essential nutrients in soil (**Al-Salmawy & abdul- Reda., 2023**)thus increasing paper space(**Altotanje & Joody, 2019**) and increased accumulation Nutrient elements in plant tissues this increases the concentration of chlorophyll, improves vegetative growth, increases productivity, and the quality of grapes (**Pesakovic *et al.*, 2017**). This is consistent with the results (**Reddy *et al.*, 2023**).

As for the role of biofertilizers (*Mycorrhiza*), it may be attributed to improving the physical, chemical and biological characteristics of the soil, secreting organic acids, enzymes

and antibiotics, producing some plant growth regulators, increasing the readiness and availability of nutrients, increasing the surface area of the roots, and increasing the plant's resistance to stresses (**Santander *et al.*, 2017**)All of this prompted the plant to produce a strong shoot, an increase in the efficiency and outcomes of the carbon metabolism process, better accumulation of nutrients and complex compounds such as carbohydrates , proteins, amino acids, and organic acids in the plant, and an increase in the efficiency of the shoot in manufacturing carbohydrates and nitrogen in canes . (**Ali &Abdul Latif, 2024**), it also has the ability to secrete some organic acids, enzymes and chelators elements like a compound siderophores that work to chelate especially minor elements iron element thus improving vegetative growth, production, and quality of the crop (**Winkelmann**, **2017)** the availability of these nutrients in the shoot has an important role in the functioning of vital processes within plant tissues for their role in building proteins, nucleic acids, and amino acids, building chlorophyll, and decomposing carbohydrates to release the energy needed for vital processes, leading to an increase in the percentage of sugars and their transfer to the grains, thus reducing the acidity in the juice and increasing the percentage of TSS in bean juice is consistent with(**Karoglan *et al.*, 2021**).

As for the increase in the quality characteristics of grape berries when vermicompost is added, the reason may be attributed to its abundant content of organic matter and nutrients (**Fernandez-Bayo *et al.*, 2015; Al-Khafaji &Al-Jubouri, 2023**)in addition to its role in increasing the readiness of these elements in the soil solution and protecting them from washing and stabilization, thus making it easier for the plant to obtain them(**Al-Obaidi & Abdul-Ratha, 2021; Al-Halfi & Al-Azzawi,2022**) through it, the plant can build a strong root system that enables it to absorb the largest amount of elements in the soil to build a dense vegetative system that results in an increase in the level of manufactured carbohydrates and chlorophyll concentration(**Al-Khafaji *et al.*, 2022**) this leads to an increase Proteins, amino acids, and nucleic acids (RNA and DNA) and growth regulators that the plant needs in its growth and development, and the surplus of them is stored in parts of the vine, including grape seeds. The reason may be attributed to its retention of humic and fulvic acids in more active forms, which act as growth stimulants similar to hormones and lead to the conversion of plant nutrients into more readily available forms. It reflects positively on the quality indicators of the yield and improves the qualitative characteristics of the fruits (**Levinsh, 2020**), and these results are consistent with (**Al-Hlfie & Hussin, 2023**).

Increase in the qualitative characteristics of grape berries may be due to the plants being sprayed with mineral fertilizer NPK and the major nutrients it contains: nitrogen, phosphorus, and potassium, which are important for plant growth and their impact on improving vegetative growth indicators.(**Saaseea & Al-A'amry, 2023**) Especially increasing leaf area and total chlorophyll levels than stimulating the plant to absorb the largest amount of light, and then increasing the rates of carbon metabolism, which led to an increase in the amount of manufactured carbohydrates. The percentage of sugars increased, which led to a reduction in the acidity of the juice the surplus of which is transferred to storage places, including grapes (**Al-Sahhaf, 1989**; **Dong *et. al.*, 2005**) and agrees with the findings of (**Calzarano *et. al.*, 2023**).

CONCLUSION

Effect of the study factors (Biofertilization, vermicompost, and spraying with NPK mineral fertilizer) was reflected positively in improving the vegetative growth indicators of grape plants, which led to an improvement in the productive qualities and quality of the crop. This is due to the role of biofertilizers in improving the physical and chemical characteristics of the soil in addition to vermicompost, which contains many nutritious elements, increases the soil's moisture retention and increases its aeration, as it provides ideal conditions for the growth of the root system and increases the activity of microorganisms and their numbers in the soil, which increases the readiness and availability of nutrients and increases their absorption from the plant, as well as foliar nutrition and the synergistic and positive role of interfering treatments in Improving the physical, chemical and biological characteristics of the soil and increasing the readiness and availability of the elements necessary for growth, which improved the nutritional status of the plant, which reflected positively on the qualitative characteristics of the crop.

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