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EFFECT AZOTOBACTER, MYCORRHIZAE, VERMICOMPOST, AND NPK SPRAYING ON PRODUCTION OF CV HALAWANI GRAPES.

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ABSTRACT

This experiment was carried out in one of the orchards of Diyala on grape vines, during two seasons 2022 - 2023, to study the effect of adding bacterial and fungal biofertilizers , vermicompost fertilizer, and foliar applied mineral fertilizer NPK on growth and production traits on cv. Halawani grape trees. The experiment was carried out a randomized complete block design within a split plot and three factors with three replicates, using 72 trees. The 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). The 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 treatment, 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 production traits represented by number of clusters in vine, cluster weight, total vine yield, 100 berries weight, and total sugar, by producing highest (49.16, 63.00 vine cluster^{-1}, 761.3, 964.8 g, 37.41, 60.71 kg vine^{-1} , 568.20, 679.00 g, and19.24% ,17.72%), respectively for both seasons.

Key words: bacteria,biofertilizers, chemical fertilizer, fungi, organic.
***Part of Ph.D. dissertation of the 1st author.**

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INTRODUCTION

Commercial grapes *Vitis vinifera* L. belong to the genus *Vitis* it is one of 14 genera belonging to the grape family *vitaceae* (AL-Saidi, 2000),Grapes are one of the most important types of fruits for humans and the oldest and most widespread in various parts of the world due the ability to grow in various environmental conditions in addition to their high nutritional value.(Georgiev et al., 2014),The latest statistics from the Food and Agriculture Organization FAO(FAO, 2022), showed The global production of grapes was estimated at 73,524,196.23 tons, Grape fruits are considered to have high nutritional value in that they contain sugars, organic acids, vitamins, fats, proteins, mineral salts, etc.(Zhou et al., 2022). Biofertilizers are added to the soil near the root system of the plant for the increasing nutrients and enhancing soil fertility by fixing atmospheric nitrogen or dissolving phosphorus and some enzymes and phytohormones and their importance in biological control and considered environmentally friendly, Its enhances Plant growth and productivity (Daniel et al., 2022), Azotobacter, has the ability to fix nitrogen and product of the plant hormones. In addition, they stimulate beneficial rhizosphere microbes close to the roots of plants and protect the plant from pathogens .(Sumbul et al., 2020), Soil microorganisms, including Mycorrhiza,

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play a key role in soil fertility and biodiversity, forming a mutualistic bond with plants and enhancing the absorption of nutrients and thus enhancing plant growth, productivity and tolerance to biotic and abiotic stresses such as temperature, salinity and drought.(Fasusi et al., 2023),Organic matter is a source of food for beneficial soil organisms such as worms the earth In addition to its role in improving the physical characteristics of the soil(Havlin et al., 2005),Vermicompost helps improve soil structure, texture, porosity, water retention, drainage, and aeration, in addition to reducing soil erosion, enhances soil microbial activity, and reduces the occurrence of pests and diseases in plants (Makkar et al., 2023),It is considered foliar fertilization is a measure of increase in productivity and quality, foliar fertilizers provide an excess of fertilizing elements especially large items NPK, which allows plants to grow under the right conditions and resist stress factors(Murtaza et al., 2022),the study aims to improving yield characteristics in quantity and quality.

MATERIALS AND METHODS

The experiment was carried out in a private grapes orchard located in Diyala district during the (2022 - 2023) growing season on 15 of years age Halawani cultivars, growing distance between vines was (1.5) m and between line (5) m, vines ware trended 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, in order to study the effect of bacterial and fungal biofertilizer and compost, organic vermicompost and foliar of NPK and their interactions on characteristics of the production yield grape trees of Halawani cultivars. The research was carried out with three factors and three replications, with one tree for every experimental unit, total number of experimental trees was 72 trees. The first factor was biofertilizer and its symbol (M). With four levels (M0 without addition and M1 400 g/tree-1mycorrhiza M2 adding 200 g/tree^{-1} Azotobacter bacteria and M3 interaction between bacteria and fungi), the second factor was adding of application organic vermicompost and was given the symbol (N) and three levels (0, 5 kg/tree^{-1} and 7 kg/tree^{-1}) and the third factor was foliar applied NPK it was given letter (F) at two concentrations (0 and 2.5 g/L^{-1}). The experiment was carried out with a completely randomized block design (RCBD) according to the arrangement of split plots, the main plots included biofertilizers and the secondary plots included the interaction between vermicompost and mineral fertilizer. The data was analyzed using the program Genstst, the least significant differences (LSD) were tested at a probability level of 0.05 to compare arithmetic averages. The following parameters were measured: Number of clusters (cluster vine^{-1}), Cluster weight (g), Total yield (kg vine^{-1}), 100 Berries weight (g), and Total sugar (%).

Table 1. Some physical and chemical properties of field 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
measruing 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 $^{-1}$

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RESULTS AND DISCUSSION

Number of clusters: The results of Table (2) show that M3 treatment has a significant impact by producing the highest rate 42.88 and 53.17 cluster vine^{-1}, while treatment M0, produced gave 26.41 and 40.42 cluster vine^{-1} for both seasons sequentially. Regarding vermicompost, the results showed a significant impact of the treatment N2, which produced the highest rate of 35.29 and 50.62 cluster vine^{-1}, compared to N0, which produced 29.50 and 41.04 cluster vine^{-1}for both seasons sequentially. F1 had significant impact by spraying with mineral fertilizer (NPK) which had highest rate of 34.18 and 49.49cluster vine^{-1} compared to the F0 treatment which reached 30.72 and 43.46 cluster vine^{-1}for the two seasons. Table (2) also show that the M3N2 treatment excelled on the rest of the treatments by producing the highest (44.41and 58.75 cluster vine^{-1}) compared to the treatment M0N0 which produced the lowest 23.75 and 35.00 cluster vine^{-1}respectively it was observed that M3F1 treatment produced 42.88 and 57.33 cluster vine^{-1} respectively, while the treatments M0F0 produced lowest 25.00, 38.17 cluster vine^{-1} respectively, while the treatment N2F1 treatment produced the highest rate 37.79 and 53.38 cluster vine^{-1} while the treatments N0F0 produced lowest rate 28.25 and 37.25 cluster vine^{-1}respectively. Table (3) reveals the interaction treatments achieved a significant effect on these traits, and the M3N2F1 treatment was characterized by producing the highest (49.16 and 63.00 cluster vine^{-1}), compared to the comparison treatment M0N0F0, which control the lowest rate 22.00 and 31.50 cluster vine^{-1} for both seasons, respectively.

Cluster weight (g): The results of Table (2) show that M3 had significant effect by producing 658.4 g and 813.8 g than the M0 treatment, which was 591.8 g and 654.2 g respectively. The fertilization with vermicompost treatment N2 had significant effect by producing 651.5 g and 773.8 g, while the treatment N0 had 587.7 g and 657.5 g, spraying with NPK treatment F1 had significant effect, by producing 643.9 g and 752.3 g, compared with F0 which had 595.0 g and 681.0 g for both seasons. Table (2) also show that the M3N2 treatment excelled on the rest of the treatments in Cluster weight by giving it the highest values 704.9 g, 883.3g compared to the treatment M0N0 which produced the lowest 551.5 g, 600.8g seasons respectively, it was observed that the found in M3F1 treatment 689.8 g, 876.3 g, seasons respectively, while the treatments M0F0 gave lowest 565.6 g, 626.1g, respectively, While the treatment N2F1 treatment produced the highest rate 682.6g, 807.7g, while the treatments N0F0 gave lowest rate 563.3g, 631.1g seasons respectively. Table (3) as for the triple interactions of the treatments, the results showed that there were significant differences in the percentage of dry weight for the treatment M3N2F1 gave the highest values 761.3g, 964.8g, followed by, compared to the control treatment M0N0F0 which gave the lowest values 514.9 g and 567.6 respectively.

Total yield (kg tree^{-1}): The results of Table (2) show that M3 had significant effect on total yield by producing 26.65 kg tree^{-1} and 43.77 kg tree^{-1}compared with M0, which produced 15.72 kg tree^{-1}and 26.65 kg tree^{-1} respectively. The results also show that adding vermicompost led to significant differences, as the N2 treatment had significant effect by producing 23.26 kg tree^{-1} and 39.66 kg tree^{-1}, compared with N0 which produced 17.49 kg tree^{-1} and 27.32 kg tree^{-1}. As for spraying with the mineral fertilizer F1, had significant effect by producing 22.25 kg tree^{-1} and 37.78 kg tree^{-1}, compared to the F0 treatment, which produced 18.43 kg tree^{-1} and 29.96 kg tree^{-1}for both seasons. Table (2) also show that the M3N2 treatment excelled on the rest of the

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treatments in total yield by producing highest 31.55kg tree^{-1}, 52.23 kg tree^{-1} compared to the treatment M0N0 which produced the lowest 13.16 kg tree^{-1}, 21.14 kg tree^{-1}seasons respectively, it was observed that the found in M3F1 treatment 29.83 kg tree^{-1}, 50.48 kg tree^{-1}, seasons respectively, while the treatments M0F0 produced lowest 14.21 kg tree^{-1}, 24.10 kg tree^{-1}, respectively, While the treatment N2F1 treatment produced the highest rate 26.10 kg tree^{-1}, 43.70 kg tree^{-1}, while the treatments N0F0 produced lowest rate 16.08 kg tree^{-1}, 23.68 kg tree^{-1}, seasons respectively. The triple interaction between the study factors significantly affected the total yield of one vine, as the results showed the superiority of the treatment M3N2F1 was significantly higher by producing highest average weight of 37.41 kg tree^{-1} and 60.77 kg tree^{-1} compared to the control treatment M0N0F0, which gave the lowest average of 11.32 kg tree^{-1} and 17.88 kg tree^{-1}for the first and second seasons.

100 berries Weight (g): The results of Table (2) indicate that the study factors led to a significant increase in the 100 berries weight, as it is noted that the M3 had a significant impact by producing 517.01 g and 610.44 g compared treatment M0 which produced a rate of 492.12 g and 529.39 g, , the treatment of vermicompost N2 had a significant impact by giving 514.26 g, and 588.67 g compared to N0 treatment, which produced a lower average of 489.09 g and 527.46 g, as for spraying with NPK mineral fertilizer, the treatment F1 had a significant impact by producing 510.27 g and 577.69 g compared to the F0 treatment, which produced 492.51 g and 540.11 g for the first and second seasons, respectively. Table (2) also show that the M3N2 treatment excelled on the rest of the treatments by producing it the highest (539.15 g, 645.83g), while the M1N0 treatment did not produced a significant difference for the first seasons ,compared to the treatment M0N0 which produced the lowest (480.28 g, 504.33 g) for both seasons respectively, it was observed that the found in M3F1 treatment 530.06g, 645.11g seasons respectively, while the treatments M0F0 produced lowest 485.00 g, 517.22 g respectively, while the treatment N2F1 treatment produced the highest rate 525.77 g, 572.75 g, while the treatments N0F0 produced lowest rate 479.36 g, 512.33 g seasons respectively. Table (3) As for the triple interactions, the results indicate that there are significant differences between the averages of the treatments, as the treatment excelled M3N2F1 produced the highest (568.20g and 679.00 g), compared to the control treatment M0N0F0, which produced a lower average of 468.97g and 489.00 for both seasons, respectively.

Total sugar (%): Show the results of the table (2) show that treatment M3 is significant in the total sugars by producing the highest 16.06 % and 15.45%, comparing with control M0, which produced 13.88% and 13.27%.There are also significant differences for the N2 vermicompost treatment, which produced 15.55% and 14.92%, compared to the N0, which produced 14.25% and 13.75%. It is also noted that the F1 treatment with mineral fertilizer spraying was significantly excelled, producing the highest (15.30% and 14.75%), compared to F0 treatment, which produced a lower 14.43% and 13.90% two both seasons, respectively. Table (2) also show that the M3N2 treatment excelled on the rest of the treatments in total sugars by producing the highest values 17.50%, 16.43%, compared to the treatment M0N0 which produced the lowest 13.50%, 12.90% seasons respectively, it was observed that the found in M3F1 treatment 16.86%, 16.05% respectively, while the treatments M0F0 produced lowest 13.64%, 12.93% respectively, while the treatment N2F1 produced the highest rate 16.24%, 15.48%, while the treatments N0F0 produced

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lowest rate 14.06%, 13.57% seasons respectively. The results of the triple interference of the study factors in the Table (3) above indicated that there were significant differences for the triple interference treatment M3N2F1 for produced the highest rate 19.24% and 17.72%, compared to the control treatment M0N0F0, which produced a lower rate 13.09% and 12.39% for both seasons.

Table 2. Effect of Azotobacter, Mycorrhiza, vermicompost, and foliar NPK and their interaction productive traits for the cv. Halawani grape for the seasons 2022 and 2023

Treatment	clusters Number (Vine cluster $^{-1}$)		cluster weight (g)		total yield (kg/vine)		100 berries weight (g)		Total Sugars	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
M0	26.41	40.42	591.8	654.2	15.72	26.65	492.12	529.39	13.88	13.27
M1	30.16	44.17	604.2	685.3	18.32	30.46	492.88	542.61	14.93	14.59
M2	33.08	48.14	623.4	713.2	20.68	34.60	503.55	553.17	14.58	14.15
M3	40.13	53.17	658.4	813.8	26.65	43.77	517.01	610.44	16.06	15.29
LSD5%	0.72	1.49	12.88	16.94	0.50	1.25	4.65	11.36	0.38	0.22
N0	29.50	41.04	587.7	657.5	17.49	27.32	489.09	527.46	14.25	13.78
N1	32.56	47.75	619.2	718.6	20.28	34.63	500.82	560.58	14.78	14.28
N2	35.29	50.62	651.5	773.8	23.26	39.66	514.26	588.67	15.55	14.92
LSD5%	0.53	0.54	6.49	6.42	0.30	0.55	3.34	4.01	0.25	0.18
F0	30.72	43.46	595.06	681.0	18.43	29.96	492.51	540.11	14.43	13.90
F1	34.18	49.49	643.90	752.3	22.25	37.78	510.27	577.69	15.30	14.75
LSD5%	0.32	0.52	4.10	6.12	0.27	0.46	2.29	4.12	0.19	0.14
M0N0	23.75	35.00	551.5	600.8	13.16	21.14	480.28	504.33	13.50	12.90
M0N1	27.00	42.00	601.1	662.5	16.24	27.86	493.85	533.67	13.95	13.28
M0N2	28.50	44.25	622.8	699.4	17.76	30.96	502.23	550.17	14.19	13.64
M1N0	27.25	39.00	571.8	634.1	15.61	24.76	475.68	517.33	14.40	14.16
M1N1	30.50	46.25	605.8	689.8	18.51	31.99	496.23	543.67	14.89	14.55
M1N2	32.75	47.25	634.9	732.0	20.83	34.63	506.72	566.83	15.50	15.06
M2N0	31.25	42.67	605.8	655.5	18.93	27.97	498.02	519.50	14.11	13.73
M2N1	32.50	49.50	621.1	703.6	20.22	35.01	503.68	548.17	14.65	14.16
M2N2	35.50	52.25	643.4	780.4	22.90	40.83	508.95	591.83	14.99	14.57
M3N0	35.75	47.50	621.5	739.7	22.26	35.41	502.37	568.67	15.02	14.32
M3N1	40.25	53.25	648.7	818.3	26.15	43.65	509.50	616.83	15.65	15.12
M3N2	44.41	58.75	704.9	883.3	31.55	52.23	539.15	645.83	17.50	16.43
LSD5%	1.05	1.61	15.34	18.46	0.64	1.42	6.65	12.20	0.52	0.35
M0F0	25.00	38.17	565.6	626.1	14.21	24.10	485.00	517.22	13.64	12.93
M0F1	27.83	42.67	618.0	682.3	17.23	29.21	499.24	541.56	14.12	13.61
M1F0	28.83	41.33	580.7	658.0	16.80	27.31	482.27	528.67	14.55	14.27
M1F1	31.50	47.00	627.6	712.6	19.83	33.62	503.49	556.56	15.31	14.92
M2F0	31.66	45.33	606.9	688.4	19.23	31.38	498.80	538.78	14.29	13.89
M2F1	34.50	50.94	640.0	738.0	22.13	37.83	508.30	567.56	14.87	14.41
M3F0	37.38	49.00	626.9	751.3	23.48	37.05	503.96	575.78	15.22	14.53
M3F1	42.88	57.33	689.8	876.3	29.83	50.48	530.06	645.11	16.89	16.05
LSD5%	0.79	1.57	13.35	17.84	0.58	1.32	5.24	11.98	0.43	0.27
N0F0	28.25	37.25	563.3	631.1	16.08	23.68	479.36	512.33	14.06	13.57
N0F1	30.75	44.83	612.0	683.9	18.90	30.96	498.82	542.58	14.44	13.99
N1F0	31.12	45.25	601.4	671.9	18.80	30.57	495.40	535.25	14.36	13.79
N1F1	34.00	50.25	637.0	765.2	21.76	38.68	506.23	585.92	15.20	14.77
N2F0	32.79	47.88	620.3	739.8	20.42	35.62	502.76	572.75	14.86	14.36
N2F1	37.79	53.38	682.6	807.7	26.10	43.70	525.77	604.58	16.24	15.48
LSD5%	0.64	0.81	7.95	9.55	0.43	0.76	4.22	6.25	0.33	0.24

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).

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Table 3. Effect of Azotobacter, Mycorrhiza, vermicompost, and foliar NPK and their interaction between them on productive traits for the cv. Halawani grape for the seasons 2022 and 2023

Treatment	clusters Number (Vine cluster $^{-1}$)		cluster weight (g)		total yield (kg/vine)		100 berries weight (g)		Total sugars	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
M0N0F0	22.00	31.50	514.9	567.6	11.32	17.88	468.97	489.00	13.09	12.39
M0N0F1	25.50	38.50	588.1	634.1	15.00	24.41	491.60	519.67	13.90	13.41
M0N1F0	26.00	41.00	584.0	621.5	15.19	25.47	489.93	517.00	13.88	12.97
M0N1F1	28.00	43.00	618.1	703.4	17.29	30.24	497.77	550.33	14.02	13.59
M0N2F0	27.00	42.00	597.8	689.4	16.12	28.94	496.10	545.67	13.96	13.44
M0N2F1	30.00	46.50	647.8	709.4	19.40	32.98	508.37	554.67	14.43	13.84
M1N0F0	26.50	34.50	538.2	624.8	14.26	21.55	455.47	514.67	14.33	14.09
M1N0F1	28.00	43.50	605.4	643.3	16.95	27.98	495.90	520.00	14.47	14.24
M1N1F0	29.00	44.50	587.2	638.7	17.03	28.41	488.47	518.00	14.38	14.12
M1N1F1	32.00	48.00	624.4	740.9	20.00	35.57	504.00	569.33	15.39	14.98
M1N2F0	31.00	45.00	616.7	710.4	19.12	31.96	502.87	553.33	14.94	14.59
M1N2F1	34.50	49.50	653.2	753.5	22.54	37.30	510.57	580.33	16.06	15.53
M2N0F0	30.50	40.50	596.2	648.1	18.18	26.24	495.47	517.67	13.96	13.64
M2N0F1	32.00	44.83	615.4	662.9	19.69	29.70	500.57	521.33	14.26	13.82
M2N1F0	31.00	45.50	606.0	659.5	18.78	30.01	498.97	519.33	14.17	13.75
M2N1F1	34.00	53.50	636.3	747.8	21.66	40.01	508.40	577.00	15.13	14.57
M2N2F0	33.50	50.00	618.6	757.7	20.74	37.89	501.97	579.33	14.76	14.29
M2N2F1	37.50	54.50	668.2	803.2	25.06	43.77	515.93	604.33	15.22	14.85
M3N0F0	34.00	42.50	604.1	684.1	20.55	29.07	497.53	528.00	14.88	14.16
M3N0F1	37.50	52.50	639.0	795.4	23.96	41.76	507.20	609.33	15.16	14.49
M3N1F0	38.50	50.00	628.3	767.9	24.19	38.38	504.23	586.67	15.02	14.31
M3N1F1	42.00	56.50	669.1	868.8	28.10	48.92	514.77	647.00	16.28	15.93
M3N2F0	39.66	54.50	648.4	801.9	25.70	43.70	510.10	612.67	15.77	15.14
M3N2F1	49.16	63.00	761.3	964.8	37.41	60.77	568.20	679.00	19.24	17.72
LSD5%	1.28	1.98	17.83	22.87	0.90	1.75	8.47	15.20	0.68	0.48

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).

The effect of the study factors (biofertilization, vermicompost, spraying with mineral fertilizer NPK) was reflected positively on improving the productive qualities, Table (2) and (3). This may be attributed to the role of biofertilizers in improving the physical, chemical and biological characteristics of the soil and its production of plant growth regulators, antibiotics and increasing the absorption of essential nutrients for plant growth, which achieves an increase in the growth of the root and shoot system. By increasing the efficiency of the Photosynthesis and increasing the outputs of this process, which has a positive impact on increasing production and its components, Azotobacter bacteria play a major role in Improving soil fertility and decomposition of organic materials. These beneficial effects can be attributed to the biosynthesis of biologically active substances, stimulating microorganisms in the root zone, producing inhibitors of plant pathogens, improving the availability of nutrients and increasing their availability to plants, and producing growth stimulating hormones, in addition to fixing nitrogen, which has an important role in bio processes in plant, which is reflected in increasing the efficiency of the carbon metabolism and increasing the synthesis of nutrients that are used to build a strong vegetative system, thus improving the efficiency of the roots by absorbing nutrients through the growth of root system as a result of the production of plant hormones, especially auxin, and this is due to the availability of the necessary elements for

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the plant. This leads to increasing and improving the quality of production (Kaleji et al., 2023) , (Arora et al., 2018), and agrees with (Hassan & Salem,2020) , (Jangid et al., 2023), as for the Mycorrhiza fungus, it has the ability to excreted growth hormones (auxin, cytokinin, gibberellin), and this in turn leads to increased root and vegetative growth as a result of increased division and expansion of plant cells and tissues, which increases production and its components. (Nicoals et al., 2014). it can also excreted a substance glomalin which hold soil particles and increase its ability to retain water, thus improving water consumption and improving soil construction. It also has the ability to excreted some organic acids, enzymes, and chelates elements such as the compound Siderophores Which works to chelate the elements (AL- Rubaye et al., 2019) and (Wang et al., 2023), as a result of the increased availability and absorption of water and nutrients, the carbon metabolism activities in the plant and the accumulation of its products increased (Kalayu, 2019). the effect of interaction of inoculation treatment between Azotobacter bacteria and Mycorrhiza fungi compared to the single inoculation treatments may be attributed to the synergistic and positive role of both the in improving the physical, chemical and biological characteristics of the soil and increasing the availability of the elements necessary for growth, which improved the nutritional status of the plant, which was reflected positively in improving the production and its components of the plant, (Kaleji et al., 2023), (Winkelmann, 2017). There is a clear response of grape plant yields to vermicompost fertilization, as its growth and development improved with increasing levels of added fertilizer. Recent studies have found that levels of organic matter in the soil work to enhance the microbial biomass of the soil and activities using organic fertilizers such as vermicompost. good plant growth can be attributed to biological effects such as increasing beneficial enzymatic activities and numbers of beneficial organisms, as well as the presence of effective biologically active substances on plant growth, such as plant hormones and humic acids in vermicompost, the reason may be due to the role of this fertilizer in improving the physical, chemical and biological characteristics of the soil by increasing the soil's moisture retention and increasing 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 availability of nutrients and increases their absorption from the plant, leading to increasing growth. vegetative growth is good and this is reflected in increased production and its components (Alarcon-Zayas et al., 2024), (Atiyeh et al., 2002) and (Dominguez et al., 2017). Regarding the reason for the increase in yield and its components when spraying plants Grapes with mineral fertilizer NPK, the reason may be attributed to what this contains Fertilizer of nutrients the task of the plant Nitrogen, phosphorus, and potassium, and their effect on vegetative growth .it has an effect on the products of carbon metabolism and increasing the accumulation of processed foodstuffs and their transport to storage places to provide their growth requirements, leading to an increase in their weight, numbers and volume (Barker & Pilbeam, 2007). the interaction between the studied factors had a positive effect in improving yield indicators and its components, through the effective role in increasing the accumulation of nutrients and carbohydrates and their transfer from leaves to grapes, this led to increase weight and number Clusters, grapes weight and volume which was reflected in an increase in the yield per plant and the total yield for the vine(Jasim & Hamid, 2023). The effect of biofertilizer, vermicompost, and foliar with NPK in

Iraqi Journal of Agricultural Sciences –2026:57(1):284-294
P-ISSN: 0075- 0530/ E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/25k2jn95

Percentage increase the total sugars are due to the role of these fertilizers in influencing the physical and chemical properties of the soil, decomposing the organic materials in it into their simple components useful to the plant, and the stimulating effect of biofertilizers in the production of plant hormones that work to increase the surface area of the roots, which increases the absorption of nutrients and increases the process of photosynthesis and its products and storage. Excess of it in plant parts, which led to an increase in total sugars in the grapes berries (EL-Sayed, 2024) and (Pesakovic et al., 2017).

CONCLUSION

The above findings clearly indicate that combining biofertilizers with organic manures enhanced soil nutrient availability plant grapes which resulted in higher yield and improved quality, Azotobacter + mycorrhiza + vermecombost + NPK folir was found to be the best with respect to the Qualitative and productive characteristics for the transaction M3N2F1, there was a clear difference in the productivity between the two years.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

AUTHOR/S DECLARATION

We confirm that all Figures and Tables in the manuscript are original to us. Additionally, any Figures and images that do not belong to us have been incorporated with the required permissions for re-publication, which are included with the manuscript.

Author/s signature on Ethical Approval Statement.

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تأثير الازوتوباكتر والمايكورايزا والفيرميكمبوست والرش بالـ NPK في انتاجية العنب صنف حلواني

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المستخلص

نفذت التجربة في احدى بساتين العنب الخاصة في محافظة ديالى خلال الموسمين 2022 – 2023 على كرمات العنب لدراسة تأثير اضافة السماد الحيوي البكتيري والفطري والسماد العضوي والرش بالسماد المعدني NPK على بعض الصفات الانتاجية للعنب صنف حلواني ، بتصميم القطاعات العشوائية الكاملة 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 وبلغ عدد الأشجار 72 شجرة وتضمن العامل الاول اضافة 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 و N1 اضافة 5 كغم / شجرة و N2 اضافة 7 كغم /شجرة والعامل الثالث الرش بالـ NPK بمعاملتين هي F0 بدون رش و F1 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 المتمثلة بعدد العناقيد في الكرمة ووزن العنقود وحاصل الكرمة الكلي ووزن مئة حبة والسكريات الكلية ،باعطائها أعلى القيم بلغت (49.16 و63.00 عنقود كرمة$^{-1}$ و 761.3و 964.8غم و37.41 و60.77 كغم كرمة$^{-1}$ و568.20 و 679.00غم و 19.24% و17.72% بالتتابع للموسمين.

الكلمات المفتاحية: بكتريا ، سماد حيوي ، سماد معدني ، فطر، عضوي .

*** البحث مستل من اطروحة الدكتوراه للباحث الاول.**