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EFFECT OF BIOFERTILIZERS, ORGANIC AND CHEMICAL FERTILIZATION ON VEGETATIVE GROWTH AND NPK CONCENTRATION IN LEAVES GRAPE CV HALAWANI

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ABSTRACT

This experiment was carried out at one orchards grapes in Diyala, during two seasons 2022-2023 on grape, to study the effect of adding bacterial and fungal biofertilizers, vermicompost fertilizer, and foliar applied mineral fertilizer NPK on growth and production characteristics on cv. Helwani, the experiment was carried out a randomized complete block design within split plot with three factors and three replicates, using of 72 trees. The first factor included the addition biofertilizers which included: without inoculation (M0), inoculation with 400 g of fungi (M1).Inoculation with 200 g of bacterial (M2) and inoculation with both fungi and bacteria (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 vegetative growth traits such as leaf area, chlorophyll, dry weight, mature canes length and immature canes length, by producing 92.48, 109.67cm^2, 279.26, 312.60 (mg.100g^{-1}f w), 48.12, 53.23% and 208.60cm, 214.53 cm, 28.81, 25.88 cm for two seasons Sequentially, the highest percentage of N, P and K in leaves in the mentioned treatment for both seasons.

Key words: azotobacter, macro nutrients, mycorrhiza, spray, worm manure.
***Part of Ph.D. dissertation of the 1st author.**

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INTRODUCTION

The grapes *Vitis vinifera* L. belongs to the Vitaceae 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 et al.,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 et al.,2021), Grape fruit has a high nutritional value and has many uses, as its grains 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) Important bacterial species that encourage root growth is Azotobacter, benefits the plant through it Production of indole acetic acid (IAA), gibberellins, and conversion nitrogen element in the atmosphere into a form that can be used by a vital process called nitrogen fixation, they are groups of bacteria present in the rhizosphere and on the surfaces of plant roots, most of which live freely in the rhizosphere. They are very beneficial for soil and plants alike, also working on Inhibit the growth of pathogens present in the soil (Al-Baldawy et al.,2023) Arbuscular mycorrhizae fungi (AMF) have a significant impact on better soil health, crop rotation, plant and soil biodiversity, sustainable agriculture

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development, plant species disease resistance, improved soil structure development, mineral nutrient and water uptake, and carbon sequestration. These collaborations affect soil structure and carbon sequestration as well, by increasing the root-absorbing surface area, mycorrhizal fungi efficiently absorb important immobile nutrients like phosphorus, and nitrogen, especially in nutrient-poor soils (Rodriguez et al.,2015) Scientific research indicates that vermicompost contains humic acids and nutrients from earthworm secretions, rich microbial groups, growth hormones and enzymes, thus enhances soil fertility, vegetative and productive growth of plants (Velasquez et al.,2020). Also, the nutrients NPK it is important for plant growth and productivity (Ortas, 2023), and spraying it on the plant leaves leads to modifying and regulating physiological processes, foliar spraying is a more practical method as it is quick to compensate for the lack of elements in the plant (Bons & Sharma, 2023) the study aims to increase vegetative growth and strengthen trees.

MATERIALS AND METHODS

The experiment was carried out a private grapes orchard located in Diyala during the 2022 - 2023 growing season on 15 years of age Halwani cultivars, a successfully cultivated table in these areas. 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 vegetative growth traits the vegetative grape trees of Helwani 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: leaf area (cm), Leaves content of chlorophyll (mg 100 g-1 f.w), Dry weight of leaves (%),length of the mature part of the canes (cm), Length of the immature part of the canes (cm), Leaves content of Nitrogen (%) was measured using a Kjeldahl distillation, Leaves content of phosphorous (%), Leaves content of potassium (%) using a flame photometer.

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

Leaf area (cm^2) : The results of Table (2) show that M3 had a significant impact by producing 79.76cm^2-plant and 87.29cm^2-plant, while the control treatment was recorded M0 which Produced 67.28 cm^2-plant and71.03cm^2-plant for both seasons sequentially. Regarding vermicompost, the results showed a significant impact of the treatment N2 and its value was 78.92cm^2 –plant and 84.20 cm^2 –plant compared to N0 which Produced 68.64cm^2-plant and72.83cm^2-plant for both seasons sequentially, F1 had significant impact by spraying with mineral fertilizer (NPK) which had 77.82cm^2 –plant and 82.90cm^2 –plant compared to F0 Which Produced 69.04cm^2 –plant and 73.51 cm^2-plant for both seasons sequentially,.Table (2) also show that the M3N2 treatment excelled on the rest of the treatments in leave area by producing it the highest values 85.44 cm^2-plant , 96.83cm^2-plant. compared to the treatment M0N0 which produced the lowest 62.27cm^2-plant, 66.66 cm^2-plant respectively, it was observed that the found in M3F1treatment 83.61cm^2-plant, 94.63cm^2-plant respectively, while the treatments M0F0 gave lowest62.25 cm^2-plant, 67.39 cm^2-plant respectively, While the treatment N2F1 treatment produced the highest rate 84.99 cm^2-plant, 90.24 cm^2-plant, while the treatments N0F0 gave lowest rate 65.76 cm^2-plant, 69.99cm^2 –plant respectively. Table (3) the interaction treatments achieved a significant effect on these traits, and the M3N2F1 treatment was characterized by producing the highest values of 92.48cm^2-plant, 109.67 cm^2-plant compared to the lowest rates of control M0N0F0 that Produced 57.51cm^2, 61.85 cm^2 for two seasons respectively.

Chlorophyll concentration (mg.100g^{-1}f.w): The results of Table (2) indicates that the study factors led to a significant increase in the chlorophyll concentration in the leaves, as it is noted that the M3 had a significant impact by producing 237.00 and 254.43 (mg.100g^{-1}) About a transaction M0 which gave 202.25 and 214.39 (mg.100g^{-1}). The treatment of vermicompost N2 had a significant impact by producing 233.11 and 246.63(mg.100 g^{-1}) compared to N0 which gave 206.43 and 219.00(mg.100 gm^{-1}), as for spraying with NPK mineral fertilizer, the treatment F1 had a significant impact by producing 229.42 and 243.16 (mg.100 g^{-1}) compared to the F0 treatment, which Produced 208.06 and 221.06 (mg.100 g^{-1}) for both seasons sequentially. Table (2) also shows that the M3N2 treatment excelled on the rest of the treatments in chlorophyll by producing it the highest 256.72, 278.58 (mg .100g^{-1}) compared to the treatment M0N0 which produced the lowest 189.66, 202.61(mg.100g^{-})seasons respectively, it was observed that the found in M3F1 treatment 252.27, 274.53(mg .100g^{-1}) seasons respectively, while the treatments M0F0 Produced lowest 192.01, 204.65(mg .100g^{-1}) respectively, While the treatment N2F1 treatment produced the highest rate 247.51, 263.06(mg .100g^{-1}), while the treatments N0F0 Produced lowest rate 198.60, 212.16(mg .100g^{-1}) 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 gives the highest value of chlorophyll 279.26 ,312.60 (mg.100 g^{-1}) compared to the control treatment that Produced the lowest content of 183.88 , 197.40 (mg.100 g^{-1}) for two consecutive seasons.

Dry weight of leaves (%): The results of Table (2) show that M3 had significant effect by producing 38.91%, 40.93% compared with M0, which produced the lowest percentage 28.43%, 30.40%, the fertilization with vermicompost treatment N2 had significant effect by producing 37.45% and 39.92% while the treatment N0 had 30.11% and 32.06%, spraying with NPK treatment F1 had significant effect, by producing 36.73%, 38.82%, compared with F0 which had 30.91%, 32.66% for both seasons sequentially. Table (2) also show that the M3N2 treatment excelled on the rest of the treatments in dry weight by giving it the highest values 43.24%, 46.86% compared to the treatment M0N0 which produced the lowest 24.79%, 26.75% seasons respectively, it was observed that the found in M3F1 treatment 42.66%, 44.92% seasons respectively, while the treatments M0F0 gave lowest 26.17%, 27.54%

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respectively, While the treatment N2F1 treatment produced the highest rate 40.55%, 43.52%, while the treatments N0F0 gave lowest rate 27.08%, 29.49%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 produced the highest percentage (48.12%, 53.23%), followed by, without a significant difference, the M1N0F0 treatment which produced a percentage of 24.03% for the first season only compared to the control treatment M0N0F0 which produced the lowest percentage of 22.27%, 25.02% for the two seasons respectively. The mature part length of the canes (cm): The results of Table (2) show that M3 had significant effect on the length of mature stalks, by producing 172.28 cm, 182.99 cm compared with M0, which produced 146.36 cm, 155.37 cm for both seasons sequentially. The results also show that adding vermicompost led to significant differences, as the N2 treatment had significant effect by producing 165.49 cm, 173.51 cm compared with N0 which gave 146.21 cm, 154.47 cm for both seasons sequentially. The treatment of spraying with mineral fertilizer F1 had significant effect by producing 162.20 cm, 170.81 cm, compared to F0 which gave 150.92 cm, 160.36 cm for both seasons sequentially. Table (2) also show that the M3N2 treatment excelled on the rest of the treatments in length of the mature part of the canes by producing it the highest values 187.87 cm, 195.17 cm compared to the treatment M0N0 which produced the lowest 136.15cm , 140.15cm seasons respectively, it was observed that the found in M3F1 treatment 183.08cm, 194.20cm seasons respectively, while the treatments M0F0 produced lowest 142.27cm, 151.87cm respectively, While the N2F1 treatment produced the highest rate 173.68cm, 181.42, while the treatments N0F0 lowest rate 142.17cm, 152.23cm seasons respectively. Table (3) results showed that there were significant differences in the above characteristic between the averages of the treatments due to the effect of the triple intervention, as the treatment M3N2F1 excelled producing the highest rates of 208.60 cm and 214.53 cm, followed by the M3N1F1 treatment with rates of 178.07 cm and 196.47 cm compared to the control treatment lowest rates of 129.20 cm and 135.90, respectively for the two seasons.

Immature part Length of the canes (cm):

The results of Table (2) show that M3 had significant impact in the biofertilizer by the minimum length of the immature part 41.02 cm and 34.34 cm, followed by treatment M1 Mycorrhiza at a rate of 44.24 cm and 36.37 cm compared to M0, which produced 56.33 cm and 44.14 cm. The vermicompost fertilizer N2 had significant effect which reached 39.32 cm and 33.71 cm compared to N0 which reached 53.73 cm and 42.28 cm. The F1 treatment of spraying with mineral fertilizer significantly had significant effect by producing 43.94 cm and 35.87 cm, while the F0 treatment produced 50.63 cm and 40.86 cm for both seasons sequentially. Table (2) also show that the M3N2 treatment excelled on the rest of the treatments in length of the immature part of the canes by producing it the lowest length 32.76cm, 29.16cm compared to the treatment M0N0 which produced 66.01cm , 51.36cm seasons respectively, it was observed that the found in M3F1 treatment 38.62cm, 32.37cm seasons respectively, while the treatments M0F0 produced 61.82cm, 48.38cm respectively, while the treatment N2F1 treatment produced the rate 37.13cm, 32.06, while the treatments N0F0 produced rate 58.66 cm, 45.90cm seasons respectively. The results are shown in the table (3) there were significant differences in the above characteristic as a result of the triple interactions, as the treatment was excelled M3N2F1 produced a shorter immature part length of 28.81 cm , 25.88 cm than the comparison treatment, which produced an average of 74.88 cm , 60.17 cm for the two seasons, respectively.

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Table 2. Effect of Azotobacter, Mycorrhiza, vermicompost, and foliar applied NPK and their interaction in vegetative growth traits of c.v Helwani grapes for the seasons 2022 and 2023.

Treatment	leave area cm^2		Total Chlorophyll mg.100 g-1 fresh weight		Dry weight %		length of the mature part of the canes(cm)		Length of the immature part of the canes(cm)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
M0	67.28	71.03	202.25	214.39	28.43	30.40	146.36	155.37	56.33	44.14
M1	71.05	75.57	212.86	227.38	32.64	34.08	151.60	158.91	44.24	36.37
M2	75.63	78.94	222.83	232.26	35.31	37.55	156.01	165.08	47.54	38.62
M3	79.76	87.29	237.00	254.43	38.91	40.93	172.28	182.99	41.02	34.34
LSD5%	1.20	3.68	3.68	5.19	1.41	1.89	3.70	3.11	2.83	2.66
N0	68.64	72.83	206.43	219.00	30.11	32.06	146.21	154.47	53.73	42.28
N1	72.73	77.59	216.67	230.71	33.90	35.24	157.98	168.77	48.80	39.11
N2	78.92	84.20	233.11	246.63	37.45	39.92	165.49	173.51	39.32	33.71
LSD5%	0.60	1.18	2.16	2.94	0.60	0.53	2.30	2.03	1.29	1.10
F0	69.04	73.51	208.06	221.06	30.91	32.66	150.92	160.36	50.63	40.86
F1	77.82	82.90	229.42	243.16	36.73	38.82	162.20	170.81	43.94	35.87
LSD5%	0.38	1.16	1.93	2.16	0.49	0.41	1.47	1.18	0.99	0.79
M0N0	62.27	66.66	189.66	202.61	24.79	26.75	136.15	140.15	66.01	51.36
M0N1	67.09	71.23	200.92	213.14	27.82	30.19	150.13	161.52	57.10	43.16
M0N2	72.49	75.19	216.18	227.41	32.68	34.26	152.80	164.45	45.88	37.90
M1N0	65.61	71.08	203.58	218.61	28.56	30.46	143.32	153.58	49.99	38.90
M1N1	70.86	75.28	209.18	225.22	32.95	33.58	152.85	160.42	45.60	37.66
M1N2	76.67	80.36	225.82	238.32	36.42	38.20	158.63	162.73	37.12	32.54
M2N0	70.96	73.45	213.01	223.94	32.87	34.58	147.75	155.92	53.18	41.29
M2N1	74.86	78.92	221.78	230.61	35.58	37.73	157.60	167.62	47.93	39.33
M2N2	81.07	84.44	233.71	242.23	37.48	40.35	162.67	171.70	41.53	35.24
M3N0	75.73	80.11	219.48	230.85	34.23	36.46	157.63	168.25	45.73	37.55
M3N1	78.11	84.95	234.81	253.86	39.25	39.47	171.33	185.55	44.58	36.29
M3N2	85.44	96.83	256.72	278.58	43.24	46.86	187.87	195.17	32.76	29.16
LSD5%	1.43	3.89	4.70	6.51	1.59	1.96	4.87	4.19	3.25	2.97
M0F0	62.25	67.39	192.01	204.65	26.17	27.54	142.27	151.87	61.82	48.38
M0F1	72.32	74.67	212.50	224.12	30.68	33.26	150.46	158.88	50.85	39.91
M1F0	66.34	71.78	203.73	219.37	29.33	31.01	147.69	155.83	46.56	38.30
M1F1	75.76	79.36	222.00	235.40	35.96	37.15	155.51	161.99	41.91	34.43
M2F0	71.69	74.91	214.77	225.92	33.00	35.16	152.24	161.98	50.71	40.46
M2F1	79.57	82.96	230.90	238.59	37.62	39.94	159.77	168.18	44.38	36.78
M3F0	75.91	79.96	221.74	234.33	35.16	36.95	161.48	171.78	43.43	36.30
M3F1	83.61	94.63	252.27	274.53	42.66	44.92	183.08	194.20	38.62	32.37
LSD5%	1.25	3.81	4.24	5.61	1.48	1.91	3.96	3.30	2.97	2.73
N0F0	65.76	69.99	198.60	212.16	27.08	29.49	142.17	152.23	58.66	45.90
N0F1	71.53	75.67	214.27	225.84	33.15	34.63	150.25	156.72	48.80	38.66
N1F0	68.53	72.38	206.87	220.82	31.31	32.19	153.28	163.26	51.71	41.32
N1F1	76.93	82.81	226.47	240.59	36.49	38.30	162.67	174.29	45.89	36.90
N2F0	72.84	78.17	218.71	230.21	34.36	36.31	157.30	165.60	41.52	35.36
N2F1	84.99	90.24	247.51	263.06	40.55	43.52	173.68	181.42	37.13	32.06
LSD5%	0.74	1.79	3.10	3.83	0.82	0.71	2.83	2.42	1.72	1.42

Note that:M1= Mycorrhiza ,M2=Azotobacter ,M3= (Mycorrhiza + Azotobacter) andN1= Vermicompost 5 kg/tree-1 ,N2=Vermicompost 7 kg/tree-1 ,F1= Spraying with fertilizerNPK(2.5 ml/L^{-1}).

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Table 3. Effect of Azotobacter, Mycorrhiza, vermicompost, and foliar applied NPK and their interaction in vegetative growth traits of c.v Helwani grapes for the seasons 2022 and 2023.

Treatment	leave area cm2		Total Chlorophyll mg.100 g-1 fresh weight		Dry weight %		The length of the mature part of the canes		Length of the immature part of the canes	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
M0N0F0	57.51	61.85	183.88	197.40	22.27	25.02	129.20	135.90	74.88	60.17
M0N0F1	67.03	71.48	195.44	207.82	27.31	28.48	143.10	144.40	57.15	42.55
M0N1F0	62.09	67.80	192.54	205.57	26.66	27.20	146.87	157.73	62.43	46.18
M0N1F1	72.10	74.67	209.31	220.70	28.97	33.19	153.40	165.30	51.78	40.15
M0N2F0	67.14	72.52	199.61	210.97	29.58	30.40	150.73	161.97	48.15	38.78
M0N2F1	77.84	77.86	232.75	243.85	35.77	38.12	154.87	166.93	43.62	37.02
M1N0F0	63.17	68.91	195.12	210.02	24.03	27.57	140.37	153.10	53.87	40.77
M1N0F1	68.05	73.24	212.05	227.20	33.09	33.36	146.27	154.07	46.10	37.03
M1N1F0	65.30	70.28	201.34	217.32	29.82	29.74	148.20	156.67	47.12	39.86
M1N1F1	76.43	80.28	217.03	233.12	36.07	37.42	157.50	164.17	44.08	35.45
M1N2F0	70.54	76.16	214.72	230.75	34.13	35.74	154.50	157.73	38.69	34.28
M1N2F1	82.80	84.55	236.92	245.89	38.71	40.67	162.77	167.73	35.55	30.80
M2N0F0	68.61	71.29	203.09	219.09	30.45	31.83	146.43	155.03	59.05	43.89
M2N0F1	73.31	75.62	222.93	228.78	35.28	37.32	149.07	156.80	47.31	38.69
M2N1F0	71.17	73.44	214.91	224.11	33.18	35.03	153.47	164.00	50.55	41.56
M2N1F1	78.56	84.40	228.66	237.11	37.97	40.43	161.73	171.23	45.30	37.10
M2N2F0	75.29	80.01	226.32	234.55	35.35	38.61	156.83	166.90	42.52	35.93
M2N2F1	86.85	88.87	241.10	249.90	39.60	42.08	168.50	176.50	40.53	34.55
M3N0F0	73.74	77.91	212.32	222.13	31.55	33.56	152.70	164.90	46.82	38.76
M3N0F1	77.72	82.32	226.64	239.56	36.91	39.37	162.57	171.60	44.63	36.35
M3N1F0	75.59	78.00	218.71	236.28	35.56	36.79	164.60	174.63	46.74	37.68
M3N1F1	80.64	91.89	250.90	271.44	42.94	42.15	178.07	196.47	42.42	34.89
M3N2F0	78.40	83.98	234.18	244.57	38.36	40.50	167.13	175.80	36.71	32.45
M3N2F1	92.48	109.67	279.26	312.60	48.12	53.23	208.60	214.53	28.81	25.88
LSD5%	1.66	4.62	6.48	8.16	1.93	2.12	5.90	4.97	3.93	3.43

Note that: M1= Mycorrhiza, M2=Azotobacter, M3= (Mycorrhiza + Azotobacter) andN1= Vermicompost 5 kg/tree^{-1}, N2=Vermicompost 7 kg/tree^{-1}, F1= Spraying with fertilizer NPK (2.5 ml/L^{-1}).

Nitrogen percentage in leaves (%):

The results of Table (4) show that biofertilizer treatment Azotobacter and Mycorrhizae M3 had significant impact in percentage of nitrogen in the leaves, by while the treatments N0F0 produced rate 2.035%, 2.127% compared to M0, which gave the lowest percentage of nitrogen 1.407%, 1.556%, and the vermicompost treatment N2, had significant impact which produced 1.855%, 1.966%, compared to N0, which averaged 1.593%, 1.723%. The treatment of spraying with mineral fertilizer NPK (F1) had significant effect by producing 1.799%, 1.923, compared to F0 which averaged 1.638%, 1.756 for the two seasons. Table (4) also show that the M3N2 treatment excelled on the rest of the treatments in percentage of nitrogen in the leaves by producing it the highest 2.278%, 2.318% compared to the treatment M0N0 which produced the lowest 1.333%, 1.480% seasons respectively, it was observed that the

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found in M3F1 treatment 2.137%, 2.228% seasons respectively, while the treatments M0F0 lowest 1.350%, 1.497% respectively, While the treatment N2F1 treatment produced the highest rate 1.956%, 2.055%, while the treatments N0F0 produced lowest rate 1.565%, 1.670% seasons respectively. Table (5) the results of the triple interactions showed that there were significant differences in the percentage of nitrogen in the leaves, as the treatment was excelled to M3N2F1 by producing it the highest percentage 2.370%, 2.413% compared to the control treatment M0N0F0, which produced the lowest percentages of 1.273%, 1.396% seasons respectively.

Phosphorus percentage in leaves (%):

The results of Table (4) show that M3 had significant effect in the percentage of phosphorus in the leaves, which rate 0.317%, 0.341% followed by a transaction M1 which gave 0.263%, 0.297% compared to M0 which rate 0.199%, 0.229%. The results also show that fertilization with vermicompost led to significant differences, as the N2 treatment produced 0.280%, 0. 314% compared to N0 which rate 0.226%, 0.245%. As for the effect of spraying with NPK mineral fertilizer, the results show that F1 had significant effect which rate 0.272%, 0.305% compared to F0 which gave 0.232%, 0. 255 for both seasons, Table (4) also show that the M3N2 treatment excelled on the rest of the treatments in percentage of Phosphorus in the leaves by producing it the highest values 0.348%, 0.382% compared to the treatment MONO which produced the lowest 0.174%, 0.199% seasons respectively, it was observed that the found in M3F1 treatment 0.348%, 0.375% seasons respectively, while the treatments M0F0 lowest 0.185%, 0.209% respectively, While the treatment N2F1 treatment produced the highest rate 0.304%, 0.345%, while the treatments N0F0 lowest rate 0.211%, 0.225% seasons respectively. Table (5) results showed the positive effect of the triple interactions, as significant differences were found between the phosphorus recorded in the leaves of the treated plants, where it was noted that the excelled treatmentM3N2F1 by producing it the highest percentage of phosphorus reached 0.385% and 0.422% compared to the measurement treatment M0N0F0, which a lower percentage 0.150%, 0.170% seasons respectively.

Potassium percentage in leaves (%):

The results of Table (4) show that M3 significant impact in the percentage of potassium in the leaves at a rate 1.771%, 1.931% compared to the M0, which at a rate 1.487%, 1.618%, the vermicompost treatment N2 produced 1.728%, 1.850% compared to N0 which produced 1.555%, 1.683%, The spraying treatment with mineral fertilizer F1 had significant impact by producing 1.724% and 1.847% compared to F0 which gave 1.541%, 1.681% for two seasons. Table (4) also show that the M3N2 treatment excelled on the rest of the treatments in percentage of Potassium in the leaves by it the highest values 1.900%, 2.055% compared to the treatment M0N0 which produced the lowest 1.423%, 1.573% seasons respectively, it was observed that the found in M3F1 treatment 1.890%, 2.047% seasons respectively, while the treatments M0F0 rate lowest 1.385%, 1.548% respectively, While the treatment N2F1 treatment produced the highest rate 1.809%, 1.915%, while the treatments N0F0 gave lowest rate 1.473%, 1.595% seasons respectively. Table (5) the results show that there are significant differences in the percentage of potassium in the leaves of the treated plants as a result of the triple interactions, as the treatment outperformed M3N2F1 produced the highest percentage of 2.053% , 2.103% compared to the control treatment M0N0F0 which rate lowest percentage 1.303% , 1.476% respectively for both season.

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Table 4. Effect of Azotobacter, Mycorrhiza, vermicompost, and foliar applied NPK and their interaction in Concentration of Nitrogen, Phosphorus and Potassium in leaves (%) of C.V Helwani grape for the seasons 2022 and 2023.

Treatment	N%		P%		K%	
	2022	2023	2022	2023	2022	2023
M0	1.407	1.556	0.199	0.229	1.487	1.618
M1	1.531	1.645	0.263	0.297	1.603	1.710
M2	1.900	2.028	0.230	0.252	1.670	1.797
M3	2.035	2.127	0.317	0.341	1.771	1.931
LSD5%	0.053	0.046	0.019	0.027	0.018	0.013
N0	1.593	1.723	0.226	0.245	1.555	1.683
N1	1.706	1.828	0.251	0.280	1.614	1.759
N2	1.855	1.966	0.280	0.314	1.728	1.850
LSD5%	0.033	0.018	0.015	0.020	0.014	0.012
F0	1.638	1.756	0.232	0.255	1.541	1.681
F1	1.799	1.923	0.272	0.305	1.724	1.847
LSD5%	0.025	0.017	0.013	0.015	0.013	0.011
M0N0	1.333	1.480	0.174	0.199	1.423	1.573
M0N1	1.405	1.566	0.205	0.235	1.461	1.621
M0N2	1.485	1.623	0.217	0.252	1.576	1.661
M1N0	1.476	1.576	0.238	0.258	1.546	1.628
M1N1	1.500	1.610	0.254	0.292	1.580	1.708
M1N2	1.616	1.750	0.298	0.340	1.683	1.793
M2N0	1.748	1.876	0.216	0.229	1.605	1.706
M2N1	1.910	2.035	0.219	0.245	1.650	1.795
M2N2	2.043	2.175	0.256	0.282	1.755	1.890
M3N0	1.816	1.961	0.275	0.295	1.646	1.826
M3N1	2.011	2.103	0.328	0.347	1.766	1.913
M3N2	2.278	2.318	0.348	0.382	1.900	2.055
LSD5%	0.070	0.051	0.029	0.040	0.027	0.023
M0F0	1.350	1.497	0.185	0.209	1.385	1.548
M0F1	1.465	1.615	0.212	0.249	1.588	1.688
M1F0	1.485	1.578	0.245	0.272	1.523	1.645
M1F1	1.576	1.712	0.282	0.322	1.683	1.774
M2F0	1.783	1.921	0.213	0.231	1.605	1.716
M2F1	2.017	2.136	0.248	0.273	1.734	1.877
M3F0	1.933	2.026	0.286	0.307	1.652	1.815
M3F1	2.137	2.228	0.348	0.375	1.890	2.047
LSD5%	0.060	0.048	0.024	0.032	0.024	0.019
N0F0	1.565	1.670	0.211	0.225	1.473	1.595
N0F1	1.622	1.776	0.241	0.266	1.637	1.771
N1F0	1.594	1.720	0.230	0.256	1.503	1.664
N1F1	1.819	1.937	0.273	0.303	1.725	1.855
N2F0	1.755	1.877	0.256	0.283	1.648	1.785
N2F1	1.956	2.055	0.304	0.345	1.809	1.915
LSD5%	0.044	0.027	0.021	0.026	0.020	0.017

Note that: M1= Mycorrhiza M2=Azotobacter M3= (Mycorrhiza + Azotobacter) and 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 5. Effect of Azotobacter, Mycorrhiza, vermicompost, and foliar applied NPK and their interaction in Concentration of Nitrogen, Phosphorus and Potassium in leaves (%) of C.V Helwani grape for the seasons 2022 and 2023.

Treatment	N%		P%		K%	
	2022	2023	2022	2023	2022	2023
M0N0F0	1.273	1.396	0.150	0.170	1.303	1.476
M0N0F1	1.393	1.563	0.197	0.229	1.543	1.670
M0N1F0	1.373	1.506	0.195	0.225	1.353	1.556
M0N1F1	1.436	1.626	0.214	0.246	1.570	1.686
M0N2F0	1.403	1.590	0.210	0.231	1.500	1.613
M0N2F1	1.566	1.656	0.225	0.274	1.653	1.710
M1N0F0	1.470	1.543	0.233	0.249	1.456	1.570
M1N0F1	1.483	1.610	0.243	0.267	1.636	1.686
M1N1F0	1.450	1.540	0.232	0.259	1.493	1.636
M1N1F1	1.550	1.680	0.276	0.326	1.666	1.780
M1N2F0	1.536	1.653	0.269	0.308	1.620	1.730
M1N2F1	1.696	1.846	0.327	0.373	1.746	1.856
M2N0F0	1.713	1.826	0.205	0.215	1.540	1.646
M2N0F1	1.783	1.926	0.227	0.243	1.670	1.766
M2N1F0	1.743	1.893	0.201	0.226	1.550	1.713
M2N1F1	2.076	2.176	0.237	0.264	1.750	1.876
M2N2F0	1.893	2.043	0.233	0.252	1.726	1.790
M2N2F1	2.193	2.306	0.280	0.312	1.783	1.990
M3N0F0	1.803	1.916	0.255	0.266	1.593	1.690
M3N0F1	1.830	2.006	0.296	0.324	1.700	1.963
M3N1F0	1.810	1.940	0.292	0.314	1.616	1.750
M3N1F1	2.213	2.266	0.364	0.379	1.916	2.076
M3N2F0	2.186	2.223	0.312	0.342	1.746	2.006
M3N2F1	2.370	2.413	0.385	0.422	2.053	2.103
LSD5%	0.091	0.063	0.042	0.052	0.041	0.034

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

The results refer to that vegetative growth and chemical characteristics for plant response to single factors or the interaction between biofertilization treatments and had a clear impact on improving plant growth, and this may be due to their production of many plant growth regulators such as auxins, gibberellins, and cytokinins, as well as increasing the readiness and absorption of some essential plant nutrients, such as nitrogen. Which Azotobacter bacteria fix in the soil, which is one of the basic elements that the plant needs greatly, as it constitutes an essential part in the formation of chlorophyll, in addition to its role in the formation of proteins, amino acids and enzymes. Therefore, adding Azotobacter bacteria to the soil contributed in one way or another to increasing the efficiency of the photosynthesis process and its products, thus increasing cell division and activation. Plant growth and Growth of growing increased elongation this had a positive impact on the characteristics of vegetative growth and increased concentration of nutrients in the leaves (Thakur et al.,2021) and (Aasfar et al.,2021) it agrees with the results (Al-Hadithi et al.,2017) and (Hoda et al.,2021), Mycorrhiza fungi also play a positive role in increased vegetative growth and macronutrients N , P and K As a result of the positive symbiotic relationship with the roots, which led to an increase the surface area of the roots leads to an increase absorption and accumulation of nutrients also, Mycorrhiza has the ability to take nutritional elements from the soil and transported To the roots of the plant and it has a role in improving the plant's growth environment and creating suitable conditions for its growth and the growth of microorganisms as well by improving the structure of the soil, increasing the stability of soil fine aggregates, and increasing its ability to retain water and aeration, as well. That hives increase the ability of the root system to absorb essential nutrients increasing its concentration in plant leaves by extending to

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areas beyond the reach of the roots, it also works to improve water relations consequently, the process of photosynthesis increases, and this is reflected in vegetative growth and an increase in nutrients (Bassam et al., 2016) and (Aslanpour et al., 2019). This may be due to organic fertilization treatments (vermicompost) over the comparison treatment without fertilization in all vegetative growth characteristics and metallic treatment, especially adding 7 kg/tree because of the macro- and micro-nutrients it contains. It also causes an increase in enzymatic activity, especially the phosphatase enzyme, in the soil, leading to an increase in the proportion of nutrients in the soil by increasing microbial biomass and its activity (Vambe et al.,2023), as well as enriching the soil with acids. Humic humus and improving the root growth environment, which creates suitable conditions for providing the plant with nutrients and efficient metabolism, leading to Improve plant growth and nutrients that's what he got (Yasmin & El-Shewaikh, 2023). The reason for this may be attributed to vermicompost content of essential nutrients that are important for growth Increasing the readiness and absorption of these elements and increasing their concentration in the leaves, which leads to an increase in the vegetative growth indicators of the plant (Ceritoglu & Erman,2018), (Al-Hadethi & Abboud,2020) and this is what he found (Abd El- Rahman & Abeer,2022) ,(Maha et al.,2022), an increase in vegetative growth and nutrients when use organic fertilizer at the level of 24 ton h^{-1}(Sharma et al.,2016).The reason for the superiority of mineral fertilizer spraying treatments NPK on the leaves in vegetative traits compared to the measurement treatment (spraying with water only) as a result of the direct addition of these elements to the leaves, which led to an increase in the leaves' content of the major elements that work to create a nutritional balance in the plant. It led to an increase in cell division and elongation and their presence in the plant in quantities. Which it needs helps the plant carry out its various vital activities with high efficiency, thus achieving good vegetative growth of the plant and increase its concentration (Abd El-Hady & Abd-Elhamied, 2018) this is consistent with (Emilian, et al,2013),. That Triple interference treatment had significantly impact vegetative growth indicators, and the reason is attributed to the complementary mechanism of action between biofertilizers and Vermicompost and spraying with mineral fertilizer NPK, as microorganisms contributed to increasing the decomposition of organic matter already present in the soil and added to it, improving the physical and chemical properties of the soil, and increasing the readiness and absorption of nutrients, and at the same time job vermicompost it increases the numbers and activity of microorganisms in the soil, as it is a source of energy and nutrients that organisms need to build their bodies, as well as providing It is not a suitable environment for its growth Vermicompost Maintain proper humidity for growth and that spray Mineral fertilizer NPK contributes to supplying the plant with the required nutrients in a balanced manner, which achieved good vegetative growth, offset by the building of a dense root system, which increased the rate of infection by fungi present in the rhizosphere region. Thus, the process of absorption of water and necessary nutrients and participation in most of the vital processes within the plant increased, which worked to improve Plant growth and development and an increase in the major elements in the plant leaves, and this is what I got (Shaker & Abdul rasool,2023) an improvement in vegetative growth standards and an increase in the percentage of nitrogen, phosphorus and potassium in the leaves.

CONCLUSION

Consequently from the previously mentioned results, it was clear biofertilizers, vermicompost fertilizer, and foliar applied mineral fertilizer NPK on growth and production characteristics on cv. Helwani, which indispensable for improvement of growth and the nutritional status of the graps trees and The M3N2F1 treatment gave the best results for leave area, dry weight, chlorophyll, The length of the mature part of the canes, and NPK nutrients for greps.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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.

Ethical Clearance and Animal welfare

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تأثير التسميد الحيوي والعضوي والكيميائي في النمو الخضري وتركيز NPK في اوراق العنب صنف حلواني

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قسم البستنة وهندسة الحدائق/كلية علوم الهندسة الزراعية/جامعة بغداد– العراق

المستخلص

نفذت التجربة في احد بساتين العنب في محافظة ديالى للموسمين 2022 – 2023 على العنب لدراسة تأثير اضافة السماد الحيوي والفيرميكمبوست والرش بالـ NPK في بعض صفات النمو الخضري والكيميائي للعنب صنف حلواني ،بتصميم القطاعات الكاملة المعشاة حسب ترتيب الالواح المنشقة وبثلاث عوامل وثلاث مكررات تضمن اللوح الرئيس السماد الحيوي واللوح الثانوي التداخل بين الفيرميكمبوست وNPK وبلغ عدد الأشجار72 شجرة وتضمن العامل الاول اضافة السماد الحيوي ورمز له (M) باربعة معاملات هي (M0 من دون تلقيح ،M1 الفطرا 400 غم /شجرة،M2 البكتريا 200غم /شجرة ،M3 التداخل بينهما والعامل الثاني اضافة الفيرميكمبوست ورمز له (N) بثلاث معاملات N0 بدون اضافة وN1 اضافة 5 كغم / شجرة وN2 اضافة 7 كغم /شجرة والعامل الثالث الرش بالـ NPK بمعاملتين هي F0 بدون رش وF1 رش الاشجار حتى البلل بتركيز 2.5 غم /لتر بأربعة رشات بين رشة واخرى ثلاثين يوما ابتداء من وصول الاوراق مرحلة الاتساع الكامل، تفوقت معاملة التداخل M3N2F1 في صفات النمو الخضري المتمثلة بمساحة الورقة وتركيز الكلوروفيل في الاوراق والوزن الجاف للاوراق وطول القصبات الناضجة وغير الناضجة مقارنة مع معاملة القياس للموسمين ،باعطائها أعلى القيم لهذه الصفات وقد بلغت92.48 و 109.67سم^2 و 279.26 و 312.60 ملغم.100غم−1 وزن طري و48.12 و53.23 % وكذلك سجلت اعلى القيم في نسبة N وP و K .

الكلمات المفتاحية: مايكورايزا ، ازوتوباكتر ، رش ، دمان دودة الارض ، العناصر الكبرى

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