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Article

Competence of Compost and N Bio-Inoculates as Alternative Tools in Early Sweet Vineyards Fertilization Programs

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Abstract: The potential efficiency of different compost and N bio-inoculates combinations treatments to partial replacement of N mineral fertilizer in early sweet vineyard fertilization programs during three successive seasons (2019, 2020 and 2021) were conducted in this present investigation. According to the obtained data, it was generally found that mixing low doses (50 and 25%) of recommended dose of N mineral fertilizer with different compost and N bio-inoculates combinations increased significantly vegetative growth, yield and quality of early sweet vineyards during all studied seasons. The highest values of nitrate and nitrite contents in berries were found in vines treated with the recommended dose of N mineral fertilizer (100%NMF) alone, while the lowest and best values were gained from 100% compost combined with the three N bio-inoculates (AZO1, AZO2 and AZO3) treatments. The 50% N mineral fertilizer combined with 50% compost + AZO2 treatment gave the highest values of almost all studied traits during all tested seasons as compared with using recommended dose (100% NMF) alone. Finally, it could be concluded that to improve growth, yield and quality of early sweet vineyard and in the same time overcoming the actual hazards of N mineral fertilizers application, it might be recommended that to use a little dose of N mineral fertilizer combined with compost and N bio-fertilizers or using compost supplemented with N bio-fertilizers in grape fertilization programs.

Key words: Grape, N mineral fertilizer, Compost, bio-inoculates, yield and quality traits.

INTRODUCTION

Grape (*Vitis vinevera* L.), is considered as one of the common and favorable fruit crops around the world, due to its amazing flavor, excellent taste, highly nutritional value and pharmaceutical properties (**Kareem *et al.*, 2022**). It occupied the second rank in Egypt after citrus crops. According to the **statistics of the Ministry of Agriculture** in Egypt **(2020),** the grapes total cultivated area has increased rapidly and reached about 200,000 feddans with total production about 1,800,000 tons. Early sweet grapevine cultivar is a brilliance variety with a huge seedless berry and creamy white color with high sweet juice content (**Ali and Mohamed, 2016)** as well as, it grown and adapted well in almost all Egyptian areas. It matures early (in the last week of May) at this time it has a greater opportunity to export and easily marketing in numerous foreign countries.

Fertilization process is one of the important tools for increasing soil fertility and yield improving crop (**Moraru *et al.,* 2003**). Nitrogen is one of the major plant nutrient elements beside Phosphorous (P) and Potassium (K). Nitrogen is the most necessary element for plants. It is involved in biochemical compounds synthesis like, protein, enzymes, amino acids, polypeptides in the plant system (**Mengel and Kirkby, 1987**). Moreover, it effects on grapes quality and productivity as well as the development vegetative growth of grapevines (**Grechi *et al.,* 2007**).

The high and frequent uses of mineral fertilizers in agricultural production led to numerous hazards like, increment of environment pollution, negative effects on the human health and reduce the useful substances such as minerals and vitamins in the fruits contents but in the same time increase harmful residues in food (**Abd El- Rahman and Bakr, 2022)**. In this respect, the main goal of organic agriculture is producing healthy and safety foods without using any chemical fertilizers and pesticides as well as, keeping our environment from pollution. To achieve this target, it must have alternative tools like organic and bio-fertilizers (**Cataldo *et al.,* 2020**).

Compost is considered as one of the most necessary organic fertilizers that added to the agricultural soils. It contains a number of crucial nutritional sources which enhance fruit growth, yield and quality as well as its play a good role in soil fertility increment, reducing soil pH, soil structure by improving aeration, retaining moisture, and encouraging the growth and vitality of microorganisms in the soil (**Mostafa *et al.,* 2019 and Pawar *et al.,* 2020**). Bio-fertilizers are biological materials that have an important role in the sustainability of different agricultural crops, by reducing chemical fertilizers applications (**Rouphael and Colla, 2020**). It helps for reducing the costs of N and P chemical fertilizers and increasing soil fertility by preserving soil physical conditions. Different efficient bacterial strains were use a bio-fertilizers such as *(Azotobacter chroococcum*) for nitrogen-fixing, (*Bacillus Megatherium*) as phosphate dissolvers and (*Bacillus criculans*) as silicate dissolvers bacteria. Using bio-fertilizers leads to raise the number and vitality of soil microorganisms and therefore increase the availability of plant nutrients in rhizospheric region (**Hiwale, 2015**).

It was shown by (**El-Naggar, 2004**), that treatment with bio-fertilizers such as: phosphorene (*Mycrohyza* and *Phosphobacterium*), microbein (*Rhizobium*) and biogein (*Azotobacter*) exhibited improvement in growth, yield, physical and chemical properties of grapevines. The ongoing application with organic and bio-fertilizer will be significantly improving grape yield and quality in future (**Kassem *et al.,* 2002, Petoumenou and Patris, 2021** and **Cataldo *et al.,* 2022**).

So the main object of this investigation, is to study the efficiency of different compost and N bio-inoculates combination doses for partial replacement of N mineral fertilizer to improve some vegetative, yield and fruit quality traits of early sweet grapevines.

MATERIALS AND METHODS

This research was done over the course of three following seasons (2019, 2020, and 2021) on seventy-two uniform 7 -years old early sweet grapevines grafted onto Paulsen grapevines rootstock grown in a private vineyard located at Matay district, Minia Governorate, Egypt. Vines were grown in clay soil under surface irrigation system using Nile water and at 2 x 3 meters apart space (700 vines / fed.). During three seasons at the first week of January, winter pruning was done. Vines were cane-pruned and trellises by Gable system. Vine load was 78 eyes (22 fruiting spurs x 3 eyes + six replacement spurs x two eyes). The soil physical and chemical characteristics during experiment are shown in Table (1).

The main target of this experiment is to reduce or partial replacement of N mineral fertilizers by combining compost (organic fertilizer) and N bio-inoculates, so we used ammonium sulfate (20.6 % N) as source of N mineral fertilizer. Use compost (El Nile compost) as a source of organic fertilizers. The chemical analysis of the tested compost is shown in Table (2). While bio-inoculates were used as liquid cultures of 5-days old from three different isolates of *Azotobacter chroococcum* bacteria (AZO1, AZO2 and AZO3) containing ($8x10^7$ cells/ml) which are kindly prepared at Microbial genetics Lab., faculty of agriculture, Minia University.

Table (1). Physical and chemical analysis of the experimental soil

Constituents	Values		
Distribution of particle sizes	**Seasons**		
	1st	**2nd**	**3rd**
Sand %	5.2	5.5	5.4
Silt %	23.8	22.5	22.7
Clay %	71.0	72.0	71.9
Texture	Clay	Clay	Clay
pH (1: 2.5 extract)	7.7	7.8	7.5
EC (1 : 2.5 extract) mmhos/ 1 cm 25ºcm	0.79	0.77	0.76
Total CaCO3 %	1.96	1.95	1.98
O.M. %	1.72	1.69	1.71
Total N %	0.07	0.09	0.09
P ppm (Oslen)	4.2	4.3	3.9
K ppm (ammonium acetate)	605.0	607.2	605.7
Mg (ppm)	6.0	5.3	5.7
Available micronutrients (EDTA, ppm):			
Fe	3.8	3.5	3.9
Zn	3.0	2.8	3.2
Mn	5.3	5.5	5.6
Cu	1.0	0.94	0.98

Table (2). Physical and chemical properties of the tested compost

Compost properties	Values
Moisture content (%)	21
Organic matter (%)	51.43
C/N ratio	1:14.6
pH (1: 2.5 extract)	7.1
EC (1 : 2.5 extract) DS/M	3.23
Conductivity mmhos/cm	4.2
Organic matter%	33.5
NH_4^+ (mg/kg)	298
NO_3^- (mg/kg)	27
N (%)	1.32
P (%)	0.86
K (%)	1.49

Three unequal batches of ammonium sulfate (20.6 % N) was added at 45% at growth start (1st week of Mar.), 35% just after berry setting (middle of April and 20% one month after harvesting and placed 10 cm under the soil surface on both sides of the vine rows (50 cm from the trunk). Organic fertilizer (compost) was applied at once in the first of February. Bio-inoculates strains were added twice (at first of February and middle of March). The compost and bio-inoculates were side dressed in a band of 50 cm wide on both sides of the vine rows and mixed with the soil surface. At the laboratory of Soil and Water Research Institute, Agricultural Research Centre, samples of soil and compost were physically and chemically analyzed using the method of **Jakson (1973)**.

Eight different treatments were used in the experiment as follow:

1. 100% (60 g/ vine) recommended dose of N mineral fertilizer by adding (291 g/vine) ammonium sulphate (20.6 % N).

2. 50 % N mineral fertilizer (145.50 g/ vine) ammonium sulphate (20.6 % N) combined with 50 % compost (1.32% N) (2.27 kg / vine) and AZO1 (50ml /vine)
3. 25 % N mineral fertilizer (72.75 g/ vine) ammonium sulphate (20.6 % N) +75 % compost (3.41 kg / vine) + AZO1 (50ml /vine)
4. 50 % N mineral fertilizer (145.50 g/ vine) ammonium sulphate (20.6 % N) + 50 % compost (2.27 kg / vine) + AZO2 (50ml /vine)
5. 25 % N mineral fertilizer (72.75 g/ vine) ammonium sulphate (20.6 % N) plus 75 % compost (3.41 kg / vine) + AZO2 (50ml /vine)
6. 50 % N mineral fertilizer (145.50 g/ vine) ammonium sulphate (20.6 % N) + 50 % compost (2.27 kg / vine) + AZO3 (50ml /vine)
7. 25 % N mineral fertilizer (72.75 g/ vine) ammonium sulphate (20.6 % N) plus 75 % compost (3.40 kg / vine) + AZO3 (50ml /vine)
8. 100% compost (4.55 kg / vine) + 150 ml /vine (AZO1, AZO2 and AZO3 mixture)

Three replicates of each treatment and three vines per replication were used in the experimental design, which was complete randomized block design. Except for N fertilization on all of the chosen vines, standard horticultural practices were used in the farm.

Studied parameters are as follow:

1- Vegetative growth parameters

Average shoots length (cm) was calculated by measuring the length of the ten main shoots per vine (cm) and then average was recorded and average numbers of leaves / shoot were measured.

The average leaf area (cm^2) was calculated by selecting twenty mature leaves from the main shoots opposing the basal clusters during the first week of May. The following equation, presented by **Ahmed and Morsy (1999),** was used to calculate the leaf area (measured in cm^2).

Leaf area = 0.56 (0.79 x w2) + 20.01, where, W = the maximum leaf width.

Weight of pruning wood per vine (kg) was calculated by weighing the one-year-old wood that was removed during pruning (first week of January).

Average cane thickness (cm): was measured with a vernier calliper just before winter pruning in the five basal internodes of the ten vegetative canes per vine.

2- Yield and berries quality

At harvest time, (middle of May during the three seasons) when the TSS/acid ratio in the berries of the check treatment reached at least 25:1 according to **Weaver (1976)** each vine's yield was calculated as weight (kg), number of clusters (counted per vine), and average cluster weight (g/cluster).

Berries quality: The following chemical characteristics of the berries from four clusters randomly selected from each examined vine were determined:

1- Average berry weight (g.).

2- The percentages of shoot berries

3- Total soluble solids (T.S.S.%) in the juice by hand refractometer.

4- Total sugars (%) in the juice by **Lane and Eynon (1965)** volumetric method as described in **A.O.A.C (2000).**

5- Total acidity (as g tartaric acid/ 100 ml juice) was determined according to A.O.A.C **(2000)** by titration against NaOH using phenolphthalein as an indicator.

6- The ratio between total soluble solids and acid was estimated by dividing SSC% by total acidity.

7- The content of nitrite and nitrate in berries juice (ppm) was measured due to the methods of Ridnour–**Lisa *et al.* (2000)**.

3- NPK content in leaves: According to **Summer 1985** and **Balo et al., 1988,** twenty leaves picked from those leaves opposite to the basal clusters for each vine were taken at (the first week of May) in the three seasons. Nitrogen (%) was determined by the modified microkejldahl method as described by **Chapman and Pratt, (1965)** Phosphorus (%) was determined by using Olsen method as reported by **Chapman and Pratt (1965)**. Potassium (%) was flamephotometrically determined using the method outlined by **(Wilde *et al.*, 1985)**.

4- Measurements of plant pigments: Leaves photosynthetic pigments chlorophylls a and b and carotenoids as (mg/ 100g F.W.) were determined according the methods of (**Von-Wettstein, 1957** and **Hiscox and Isralstam, 1979**).

Statistical Analysis

Data were statistically analysed using a randomized complete block design in accordance with **Snedecor and Cochran (1967).** The average means were compared using the revised L.S.D. values at the 5% level as part of the statistical analysis of the provided data (**Steel and Torrie, 1980**).

RESULTS AND DISCUSSION

1-Vegetative growth parameters

The possible effect of different doses of compost and N bio-inoculates combinations on some vegetative growth of early sweet vineyards during three successive seasons were shown in Table 3 and 4.

Data in Table 3 showed that except the two treatments 25% NMF+75%compost+AZO3 and 100% compost + (AZO1, 2 and 3) mixture all the other treatments significantly increase the main shoot length, no. of leaves/ shoot and leaf area traits of early sweet vines during the three following seasons as compared with the recommended dose of N mineral fertilizer (100% NMF). The highest values of main shoot length were observed in vines treated with 50% NMF+50%compost+AZO2 (109.7, 110.9 and 111.0 cm) during the three successive seasons respectively. While, the lowest values of main shoot length were found in vines treated with 100% compost + (AZO1, 2 and 3) mixture (93.7, 94.0 and 95.3cm) at the three tested seasons, respectively as compared with recommended dose of N mineral fertilizer (100% NMF). In the same direction, results showed in Table 3 exhibited that vines treated with 50% NMF+50%compost+AZO2 had the highest values of no. of leaves/ shoot and leaf area traits as compared with the recommended dose of N mineral fertilizer (100% NMF) and all other treatments during the three studied seasons.

Results shown in Table 4 revealed that there was a considerable increase at pruning wood /vine trait in vines treated with all tested treatments except 100% compost + (AZO1, 2 and 3) mixture which gave the lowest values as compared with all other treatments during all studied seasons. Vines treated with 50% NMF+50%compost+AZO2 gave the highest values of pruning wood /vine trait **(**1.50, 2.13 and 2.22 kg) with a significant increase during the three studied seasons, respectively as compared with all other treatments.

Concerning cane thickness traits, data showed that all tested treatments increased significantly this trait except 100% compost + (AZO1, 2 and 3) mixture which gave the lowest values as compared with all other treatments. The two treatments 50% NMF+50%compost+AZO2 and 50% NMF+50%compost+AZO1 gave the highest values during the three studied seasons.

The previous results are in accordance with those of **Abd El- Rahman and Abeer (2022)** on Superior grapevines and **El-Shenawy and Fayed (2005)** on Crimson seedless grapevine that recorded that application of organic and bio-fertilizers improved different vegetative growth as compare to mineral fertilizer application. It was also reported by **Uwakiem (2006)** that using 50%N mineral fertilizer (100g/vine) + 50% organic and bio-fertilizers mixture affected positively on growth traits of Banaty grapevines rather than using N mineral fertilizer alone.

On the same direction, **Uwakiem, (2011)** found that using mineral N + bio-fertilizers combination as a partial substitute for chemical fertilizers was very effective for improving vegetative growth in Thompson seedless grapevines. The enhancement of vegetative growth by compost and bio-fertilizers could be due to encourage the uptake of the important nutrients, which led to increase protein and carbohydrate synthesis, improve cell division and tissues development and increase the production of phytohormones (Indole acetic acid, ghibellines and cytokinins), which in turn affects positively on plant vegetative growth parameters (**Kannaiyan, 2002**).

Table (3). Effect of different compost doses and N bio-inoculates combination treatments on the main shoot length, number of leaves/shoot and leaf area/ shoot of early sweet vineyards during three successive seasons (2019, 2020 and 2021)

Treatment	Main shoot length (cm)			No. of leaves/ Shoot			Leaf area $(cm)^2$		
	Seasons								
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
100% NMF	99.2	100.8	104.0	14.0	17.0	19.0	109.5	121.0	122.3
50% NMF+50%compost+AZO1	106.0	104.8	107.6	17.6	22.0	24.0	115.7	126.7	128.0
25%NMF+75%compost+AZO1	100.5	102.5	106.0	15.0	19.0	22.0	112.0	124.0	125.4
50% NMF+50%compost+AZO2	109.7	110.9	111.0	17.6	24.0	27.0	117.7	131.9	133.2
25% NMF+75%compost+AZO2	103.0	107.9	109.3	16.3	23.0	23.0	112.9	118.0	130.3
50% NMF+50%compost+AZO3	102.5	102.5	106.9	16.5	20.0	21.0	113.8	119.0	119.4
25% NMF+75%compost+AZO3	96.0	97.9	103.0	16.3	18.0	18.0	108.0	116.0	117.4
100% compost + (AZO1, 2 and 3) mixture	93.7	94.0	95.3	14.0	14.0	16.0	108.0	113.0	112.7
New L.S.D $_{0.5}$	**1.4**	**1.2**	**1.2**	**1.1**	**2.0**	**2.0**	**1.5**	**1.2**	**1.2**

Table (4). Effect of different compost doses and N bio-inoculates combination treatments on pruning wood /vine and cane thickness of early sweet vineyards during three successive seasons (2019, 2020 and 2021)

Treatment	Pruning wood /vine (kg.)			Cane thickness (cm)		
	Seasons					
	1st	2nd	3rd	1st	2nd	3rd
100% NMF	1.36	1.73	1.82	1.12	1.18	1.22
50% NMF+50%compost+AZO1	1.41	1.94	2.03	1.20	1.47	1.51
25%NMF+75%compost+AZO1	1.32	1.83	1.92	1.16	1.38	1.42
50% NMF+50%compost+AZO2	1.50	2.13	2.22	1.23	1.62	1.66
25% NMF+75%compost+AZO2	1.40	2.02	2.11	1.15	1.57	1.61
50% NMF+50%compost+AZO3	1.40	1.64	1.73	1.16	1.38	1.47
25% NMF+75%compost+AZO3	1.40	1.54	1.62	1.15	1.05	1.11
100% compost + (AZO1, 2 and 3) mixture	1.29	1.41	1.40	1.06	1.02	1.06
New L.S.D $_{0.5}$	**0.06**	**0.07**	**0.07**	**0.03**	**0.05**	**0.05**

2- Berries quality parameters

The effect of different compost doses and N bio-inoculates combination treatment on some berries quality traits (berry weight, shot berries, total acidity%, T.S.S.% and T.S.S. / acid) of early sweet vineyards during three followed seasons were shown in Table (5) and (6).

Data in Table (5) revealed that almost all of the tested treatments exhibited a significant increase in berry weight traits during the three studied seasons as compared to recommended dose of N mineral fertilizer **(**100% NMF). Only the two treatments 25% NMF+75%compost+AZO3 and 100% compost + (AZO1, 2 and 3) mixture gave a low value (4.79 and 4.72 kg, respectively) at the first season. The highest values of berries weight were found in the vine treated with 50% NMF+50%compost+AZO2 during all studied seasons (5.17, 5.73 and 6.12kg, respectively). The highest values of shot berries% were recorded in vines treated with the recommended dose of N mineral fertilizer (100% NMF) during all studied seasons (10.0, 10.0 and 10.7%, respectively). The presented data in **Table 5** showed that all tested treatments decrease significantly the shot berries% as compared with to 100% NMF treatment except 25%NMF+75%compost+AZO1 treatment which gave results near to these of 100% NMF treatments. The best result of shot berries% were obtained by 100% compost + (AZO1, 2 and 3) mixture treatment (6.3, 4.3 and 3.6%, respectively) followed by these of 25% NMF+75%compost+AZO3 treatment.

These results were emphasized by the results of **Abd El-Monem *et al.* (2008) Abd El-Aziz (2012)** and **Omar (2013)** who reported that the using organic and bio fertilizers led to considerable increment in berry weight of Flame Seedless grapevines.

Regarding total acidity% in berries, data revealed that all tested treatment decrease significantly total acidity% in berries as compared with 100% NMF treatment. Vines treated with 100% compost + (AZO1, 2 and 3) mixture showed the lowest and the best values of total acidity% during all studied seasons with the same value (0.552%) as compared with all other treatments and the recommended dose of N mineral fertilizer (**Table 5**). According to data in **Table 6**, it was clearly observed that all tested treatments induced significantly T.S.S. % and T.S.S./acid values in early sweet berries as compared with the recommended dose of N mineral fertilizer. The best values of T.S.S. % and T.S.S./acid were obtained after treated vine with 100% compost + (AZO1, 2 and 3) mixture and 50% NMF+50%compost+AZO3, respectively during studied seasons. Similar results were obtained by **Abd El-Wahab (2011)** on Red Globe grapes. These effects could be attributed to increments of macro and microelements in organic fertilizers, which encourage plant photosynthesis and led to high available sugars that can be used for growth and fruit ripening (**Belal, 2006)**. Also, it was found by **Masoud (2012)** that using organic manure or bio-fertilizers, or even a combination of both, significantly increased the total soluble solids (TSS) and anthocyanin content of 'Flame' and 'Ruby' seedless grapes compared to using mineral N fertilization alone.

Concerning nitrate ad nitrite content in berries, it was clearly observed that all tested treatments reduced significantly nitrate ad nitrite content in berries of early sweet cultivar as compared with the recommended dose of N mineral fertilize (Table 7). The 100% NMF treatment gave the highest values of nitrate ad nitrite content while, the lowest and the best values were found in vines treated with 100% compost +(AZO1, 2 and 3) mixture as compared with all other treatments during all studied seasons. Our results are in the same line with those of **Abd El-Aziz (2012)** on both Superior and Crimson seedless and **Omar (2013)** on Ruby seedless grape cultivar. Similar results were also obtained by **Belal (2006**) who found that the combinations treatment of organic and mineral nitrogen doses gave a significant reduction in nitrate and nitrite content in the juice of berries of Thompson Seedless grapevines as compared with mineral nitrogen fertilizer alone. Also, **Farag (2006**) who concluded that 100% N mineral fertilization lead to accumulation high levels of NO_3^- and NO_2^- in the berries while organic fertilization caused a clear reduction in nitrate and nitrite content of berries of Flame Seedless grapes grapevines.

Table (5). Effect of different compost doses and N bio-inoculates combination treatments on berry weight, shot berries% and total acidity% of early sweet vineyards during three successive seasons (2019, 2020 and 2021)

Treatment	Berry weight (g)			Shot berries %			Total acidity %		
	Seasons								
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
100% NMF	4.81	5.00	5.04	10.0	10.0	10.7	0.721	0.720	0.720
50% NMF+50%compost+AZO1	5.10	5.28	5.38	8.7	9.0	8.6	0.672	0.673	0.679
25%NMF+75%compost+AZO1	4.86	5.14	5.25	10.0	10.0	9.8	0.678	0.694	0.572
50% NMF+50%compost+AZO2	5.17	5.73	6.12	7.0	6.0	6.5	0.652	0.624	0.652
25% NMF+75%compost+AZO2	4.95	5.57	5.52	9.6	8.7	7.6	0.622	0.552	0.550
50% NMF+50%compost+AZO3	5.02	6.11	5.71	9.0	8.0	3.6	0.699	0.581	0.699
25% NMF+75%compost+AZO3	4.79	5.94	5.59	8.0	5.0	4.6	0.594	0.602	0.594
100% compost + (AZO1, 2 and 3) mixture	4.72	5.28	5.25	6.3	4.3	3.6	0.552	0.552	0.522
New L.S.D $_{0.5}$	**0.8**	**0.11**	**0.12**	**0.9**	**0.9**	**1.0**	**0.020**	**0.022**	**0.220**

Table (6). Effect of different compost doses and N bio-inoculates combination treatments on TSS percentages and T.S.S./ acid of early sweet vineyards during three successive seasons (2019, 2020 and 2021)

Treatment	TSS%			TSS / acid		
	Seasons					
	1st	2nd	3rd	1st	2nd	3rd
100% NMF	18.1	18.0	18.3	25.1	25.0	25.4
50% NMF+50%compost+AZO1	18.8	18.6	18.6	28.0	27.6	27.4
25%NMF+75%compost+AZO1	18.5	18.3	19.1	27.3	26.4	33.4
50% NMF+50%compost+AZO2	19.4	19.5	19.4	29.8	31.3	29.7
25% NMF+75%compost+AZO2	19.1	19.0	19.8	30.7	34.4	36.0
50% NMF+50%compost+AZO3	20.1	20.3	20.2	32.3	34.9	28.9
25% NMF+75%compost+AZO3	19.7	19.9	20.6	28.1	33.1	34.7
100% compost + (AZO1, 2 and 3) mixture	20.5	20.6	20.6	34.5	37.3	39.5
New L.S.D $_{0.5}$	**0.3**	**0.2**	**0.2**	**0.9**	**0.9**	**0.8**

3- Yield parameters

The effect of different compost and N bio-inoculates combinations treatments on different yield traits (no. of clusters / vine, cluster weight and yield/vine) of early sweet vineyards were presented in Table (8).

Results showed that there were no significant differences between all tested treatment and the recommended dose of N mineral fertilizer at no. of clusters / vine trait except 50% NMF+50%compost+AZO2 and 50% NMF+50%compost+AZO3 which increased significantly this trait during the two last (2nd and 3rd) seasons as compared with the recommended dose on N Mineral fertilizer (100%NMF).

It was found in (Table 8) that almost all of the tested treatments make a significant increase in cluster weight trait during all studied seasons except 100% compost + (AZO1, 2 and 3) mixture treatment which gave values less than these of the recommended dose on N Mineral fertilizer. Regarding yield/ vine trait, Data in Table 8 revealed that there was a clear increase in this trait in vines treated with all tested treatments during studied seasons except 100% compost + (AZO1, 2 and 3) mixture treatment which gave the lowest values with a significant decrease as compared with 100%NMF treatment. The highest values of yield/vine were recorded in vines treated with 50% NMF+50%compost+AZO2 (16.6, 15.8 and 15.5kg) during all studied seasons, respectively.

These results are in accordance with those of **Masoud (2012) and Ahmed *et al.* (2015**) that exhibited a clear improvement in the cluster traits and yield of Superior seedless grapes after treatments with 50% N mineral fertilizer+ 50% manures + 30 mL of a EM bio-fertilizer. Similar results were obtained by **Abd El-Aziz (2012)** and **Omar (2013)** on Crimson seedless on Ruby seedless grape cultivar, respectively. The enhancing effect of partial replacement of mineral NPK by compost and bio-fertilizers could due to their abilities to provide important nutrients, fixing atmospheric nitrogen, increasing uptake of various elements and phytohormones which reflected on improving yield per vine and finally appear in total yield per feddan (**Abdelaal *et al.*, 2013; Hegazi *et al.*, 2014 and Shaaban, 2014**).

4- Photosynthetic pigments in leaves

As shown in Table (9) data revealed that all tested treatments increased significantly the content of all studied pigments in leaves particularly, 100% compost + (AZO1, 2 and 3) mixture followed by 25%NMF+75%compost+AZO1 treatments which have the highest values of chlorophyll a, b and carotenoids content in leaves as compared with the recommended dose on N Mineral fertilizer (100%NMF) treatment.

Table (7). Effect of different compost doses and N bio-inoculates combination treatments on reducing sugars %, nitrogen dioxide (NO_2) content of juice and nitrate (NO_3) of early sweet vineyards during three successive seasons (2019, 2020 and 2021)

Treatment	Reducing sugars %			Nitrate content (NO_2) ppm			Nitrite (NO_3) ppm		
	Seasons								
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
100% NMF	13.8	13.8	13.8	8.8	9.2	8.8	36.2	35.9	38.1
50% NMF+50%compost+AZO1	14.8	15.1	15.6	7.7	4.2	2.3	26.0	13.5	9.2
25%NMF+75%compost+AZO1	14.2	14.3	14.4	5.6	5.8	5.3	22.5	20.7	20.2
50% NMF+50%compost+AZO2	15.5	15.8	16.2	7.2	5.6	4.3	34.1	22.6	19.8
25% NMF+75%compost+AZO2	14.0	14.5	14.5	6.2	3.7	2.3	27.0	14.4	9.5
50% NMF+50%compost+AZO3	14.4	15.0	15.0	7.5	5.8	5.3	36.7	30.9	10.2
25% NMF+75%compost+AZO3	14.0	14.1	14.4	5.7	5.7	2.0	25.6	15.8	18.3
100% compost + (AZO1, 2 and 3) mixture	13.5	13.0	13.3	3.4	3.2	2.3	21.5	15.7	9.8
New L.S.D $_{0.5}$	**0.4**	**0.5**	**0.5**	**0.8**	**0.5**	**0.4**	**6.2**	**3.8**	**4.1**

Table (8). Effect of different compost doses and N bio-inoculates combination treatments on number of clusters / vine, cluster weight and yield/vine of early sweet vineyards during three successive seasons (2019, 2020 and 2021)

Treatment	No. of clusters / vine			Cluster weight (g)			Yield / vine (kg)		
	Seasons								
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
100% NMF	24.0	26.6	27.4	434.3	475.0	478.0	10.4	12.6	13.1
50% NMF+50%compost+AZO1	25.4	27.2	27.9	478.0	539.0	542.0	12.1	14.8	15.1
25%NMF+75%compost+AZO1	24.8	27.1	29.0	435.0	500.0	503.0	10.8	13.5	14.6
50% NMF+50%compost+AZO2	25.6	28.6	27.9	532.0	552.0	555.0	13.6	15.8	15.5
25% NMF+75%compost+AZO2	24.9	27.2	26.9	455.0	513.0	516.0	11.3	13.9	13.9
50% NMF+50%compost+AZO3	25.1	27.4	27.0	455.0	525.0	528.0	11.4	14.4	14.2
25% NMF+75%compost+AZO3	24.8	26.8	28.2	452.0	487.0	490.0	11.2	13.0	13.8
100% compost + (AZO1, 2 and 3) mixture	24.0	26.6	27.0	434.0	462.0	465.0	10.4	12.3	12.5
New L.S.D $_{0.5}$	**N.S**	**0.7**	**0.7**	**16.0**	**12.0**	**12.0**	**0.4**	**0.3**	**0.3**

The previous data are in agreement with those reported by (**Hosam El-Dein,** and **Boshra, 2008; Shaheen *et al.*, 2013** and **Hegazi *et al.*, 2014)** on grapevines cultivars. The improving effects of organic and bio-fertilizers on increasing photosynthetic pigments may be due to increase the availability of macro and micro nutrients which participate directly in pigment formation which in turn increase the activity of photosynthesis process and therefore increase yield and quality of vines (**El Haggar *et al.*, 2004** and **Mohamed, 2008**).

5- N, P and K contents in leaves

The presented results in Table (10) showed that almost all tested treatments increased significantly the N content in leaves during all studied seasons as compared to 100% NMF treatment. The highest values of N content were recorded by 50% NMF+50%compost+AZO2 treatment during all studies seasons (1.46, 2.00 and 1.95%, respectively) as compared with 100% NMF and all other treatments. One the other side, there was a considerable increase in P content values after treatment with all tested treatments as compared with the recommended dose of N mineral fertilizer (100%NMF). The two treatments 50% NMF+50%compost+AZO2 and 50% NMF+50%compost+AZO1 gave the best values of P content in leaves during all studied seasons.

Data in Table (10) showed the superiority of the two treatments 50% NMF+50%compost+AZO2 and 50% NMF+50%compost+AZO1 in increasing of K content in leaves during all seasons as compared to all other treatments. It was also observed that 100% compost + (AZO1, 2 and 3) mixture treatment made a significant increment at K content values as compared with the recommended dose of N mineral fertilizer (100%NMF). Similar result obtained by **El-Shenawy and Fayed (2005)** who found that N content in leaf was increased after treatment with organic and bio-fertilizers containing nitrogen fixation bacteria *Azotobacter chrooccum*. These results are in accordance with those of **Nijjar (1985), Kassem and Marzouk (2002)** and **El-Karamany *et al*. (2000) and El-Seginy (2006)** who reported that the potential enhancement of organic fertilizers and bio-fertilizer on N, P and K content in leaves could be attributed to increment of the organic matter in the soil and the active of microorganisms that increase the availability nutrients in the soil.

Table (9). Effect of different compost doses and N bio-inoculates combination treatments on chlorophylls a and b (mg/100 g F.W) and total carotenoids (mg/100 g F.W) of early sweet vineyards during three successive seasons (2019, 2020 and 2021)

Treatment	Chlorophyll a (mg/ 100 g F.W.)			Chlorophyll b (mg/ 100 g F.W.)			Total carotenoids (mg/ 100 g F.W.)		
	Seasons								
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
100% NMF	4.4	4.6	4.7	2.2	2.4	2.6	2.3	2.1	2.0
50% NMF+50%compost+AZO1	4.8	5.0	5.4	3.1	2.8	3.0	2.7	2.5	2.4
25%NMF+75%compost+AZO1	6.1	6.3	6.4	3.9	3.2	3.4	3.1	2.9	2.8
50% NMF+50%compost+AZO2	5.6	5.0	5.5	3.4	3.5	3.7	3.4	3.2	3.1
25% NMF+75%compost+AZO2	6.1	5.8	6.9	4.2	3.8	4.0	3.7	3.5	3.4
50% NMF+50%compost+AZO3	5.2	6.6	6.2	3.6	4.1	4.0	4.0	3.8	3.4
25% NMF+75%compost+AZO3	6.4	5.0	5.5	3.6	4.4	4.4	4.3	4.2	3.7
100% compost + (AZO1, 2 and 3) mixture	7.5	7.2	7.6	4.6	4.7	4.9	4.6	4.5	4.5
New L.S.D $_{0.5}$	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.2**

Table (10). Effect of different compost doses and N bio-inoculates combination treatments on percentages of N, P and K in the leaves of early sweet vineyards during three successive seasons (2019, 2020 and 2021)

Treatment	N %			P %			K %		
	Seasons								
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
100% NMF	1.21	1.53	1.51	0.19	0.19	0.19	1.35	1.56	1.56
50% NMF+50%compost+AZO1	1.41	1.70	1.65	0.28	0.36	0.39	1.45	1.62	1.71
25%NMF+75%compost+AZO1	1.28	1.63	1.58	0.24	0.26	0.26	1.32	1.27	1.63
50% NMF+50%compost+AZO2	1.46	2.00	1.95	0.29	0.39	0.42	1.49	1.70	1.88
25% NMF+75%compost+AZO2	1.34	1.77	1.72	0.25	0.29	0.30	1.38	1.33	1.49
50% NMF+50%compost+AZO3	1.29	1.85	1.87	0.25	0.33	0.36	1.38	1.35	1.67
25% NMF+75%compost+AZO3	1.23	1.92	1.88	0.23	0.23	0.33	1.42	1.26	1.48
100% compost + (AZO1, 2 and 3) mixture	1.20	1.54	1.55	0.20	0.23	0.23	1.46	1.58	1.57
New L.S.D $_{0.5}$	**0.05**	**0.05**	**0.05**	**0.02**	**0.03**	**0.03**	**0.04**	**0.03**	**0.02**

Finally, it could be concluded that to improve growth, yield and quality of early sweet vineyard and in the same time overcoming the actual hazards of N mineral fertilizers application, it might be recommended that to use a little dose of N mineral fertilizer combined with compost and N bio-fertilizers or using compost supplemented with N bio-fertilizers in grape fertilization programs.

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