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Enhancing Red Globe Grapevines Growth, Yield, and Quality with Various Bio - Stimulant Applications

Soltan H.A.H.[1], EL-Saman A.Y.[2] , Abdelaziz A. M. R.[1] and Refaai M.M.[1]

[1]Central Laboratory of Organic Agriculture, Agricultural Research Center, 12619, Giza, Egypt
[2]Viticulture Dept. Hort. Res. Instit., Agricultural Research Center, Giza, Egypt

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ABSTRACT

The present study was carried out during the course of two subsequent seasons (2023 and 2024) in a private vineyard located in Samalot district, Minia Governorate to evaluate the positive effect of various bio-stimulants (Seaweed extract, EM and Compost tea) and their combinations on growth, yield and quality of vigour twelve-year old own-rooted Red Globe grapevines. Regarding vegetative growth traits (Main shoot length, number of leaves/shoot and leaf area), results revealed that all combined treatments were better than single and control treatments and increased vegetative growth traits particularly that of (seaweed extract 25 ml/vine + EM 20ml /vine as soil amendment). The highest values of yield / feddan were recorded in vines treated with the combined treatments (seaweed extract 25 ml / vine + E.M 20 ml /vine and 50 ml compost tea at 10 % /vine + EM 20 ml l vine (18.7 and 1.88 ton) and (17.8 and 18.6 ton) as compared to all other treatments during the two seasons, respectively. Finally, under experiment conditions it could be concluded that to improve vegetative, yield and quality of Red globe grapevines this investigation recommended to use seaweed extract and compost tea as a foliar application and Effective Microorganisms (EM) as soil amendment whether if it in a single or combined treatments, the seaweed extract 25 ml / vine + EM 20 ml /vine as soil amendment combined treatment is the most effective among all treatments during both studied seasons.

Keywords: Red globe grapevine, seaweed extract, effective microorganisms, compost tea.

1. Introduction

Worldwide, grapes (*Vitis vinifera* L.) are among the most significant commercial fruit crops. Diverse range of grape varieties such as (Superior seedless, Early sweet, Crimson seedless, Flame seedless and Red globe) were imported and cultivated for evaluation under the Egyptian conditions.

Red globe variety was identified by the University of California, USA. Among all red grape types, it is thought to have the largest red grapes. Red Globe grapevines planted in Minia Governorate face severe problems such as inconsistent fruit colour, compact bunches, poor vine foliage, and berry sunburn damage. The primary cause of the yield decline that has been noticed is the inappropriate environmental conditions (Uwakiem, 2021).

Bio-stimulants are any materials or microbes used on plants to boost crop yield and quality traits, resilience to abiotic stress, improve soil fertility, decrease the need for mineral fertilizers, and making them crucial for the sustainable growth of horticultural crops (Du Jardin, 2015). Effective microorganisms (E.M.) consist of a variety of beneficial microbes such as photosynthesis and lactic acid bacteria, yeast and actinomycetes degrade fungus that can be introduced to soil through infection in order to increase the soil's microbial diversity (Safwat and Matta, 2021).

In agriculture, seaweed extract and its compounds employed as possible growth regulators. It generates amino acids, molecules that resemble isopentenyl adenine, vitamin B12, biotin, and GA3 to support crop development and fruiting (Arioli *et al.*, 2015 and Battacharyya *et al.*, 2015). Moreover,

Corresponding Author: Hassan Ahmed Hassan Soltan, Central Laboratory of Organic Agriculture, Agricultural Research Center, 12619, Giza, Egypt. E-mail: soloo2525@gmail.com

seaweed extract boosts plant resistance to diseases and pests and enhances plant development, productivity, and fruit quality (Ashmawi *et al.,* 2021).

Composting is essential to organic farming because it improves soil fertility overall (Scotti *et al*., 2016). It might be essential for managing plant diseases by regaining the soils suppressive qualities (Pane *et al*., 2014). Compost tea is a liquid extract that is abundant in beneficial microorganisms, organic and inorganic bio-molecules (Ingham, 1999), which can actively protect plants from bacteria and fungi that cause phytopathogenic diseases as well as promote plant development and yield.

So, the object of this present investigation is to evaluate the positive effect of different bio-stimulants (Seaweed extract, EM and Compost tea) and their combinations on growth, yield and quality of Red Globe grapevines.

2. Materials and Methods

This investigation was conducted over two consecutive seasons 2023 and 2024 in a private vineyard located in Samalot district, Minia Governorate to evaluate the positive effect of different bio-stimulants (seaweed, EM and compost tea) and their combinations on growth, production and quality of vigour twelve-year old own-rooted Red Globe grapevines (700 vines/Fed.).

The soil features a clay loam texture Table (1), is well-drained, and has a water table that is at least two meters deep. Vines were planted with a spacing of 2.0 m between vines and 3.0 m between rows.

Table 1: The physical and chemical characteristics of the soil utilized in the two seasons of 2023 and 2024 at a depth of 0 to 30 cm.

Constituents	Value	
	1st season	2nd season
Sand (%)	21.44	21.22
Silt (%)	30.14	30.17
Clay (%)	48.42	48.61
Soil type	Clay loam	Clay loam
Organic matter (%)	1.48	1.49
pH (1:2.5)	7.80	7.83
E.C. (m mhos/cm)	1.03	1.04
$CaCo_3$ (%)	2.00	1.99
Available Ca^{++} (mg/100g)	30.17	30.15
Total N (%)	0.09	0.08
Available P (%)	28.85	28.77
Available K^+ (mg/100g)	3.24	3.25
Available Na^+ (mg/100g)	1.99	2.01
Available micronutrients (EDTA, ppm):		
Fe	7.85	7.87
Cu	2.05	2.04
Zn	2.11	2.13
Mn	7.12	7.13

During the first week of January in both seasons, the chosen vines were pruned. Methods of spur pruning and Y-modified form support were used. Each vine should have 66 eyes in both seasons (based on 18 fruiting spurs x 3 eyes plus 6 replacement spurs x 2 eyes). A surface irrigation system was used throw water from the Nile. The identical vines were used for the experiment in both seasons. The suggested horticulture techniques that are frequently used in the vineyard were implemented to the selected vines (63 vines). The following seven treatments were used in this study:

T1: Control (just water-sprayed vines)
T2: Foliar applications with seaweed extract 25 ml / vine
T3: Foliar applications with 50 ml compost tea at 10 % / vine
T4: E.M. 20 ml / vine as soil amendment
T5: Seaweed extract 25ml / vine + 50 ml compost tea at 10 % / vine
T6: Seaweed extract 25 ml / vine + EM 20 ml /vine as soil amendment
T7: 50 ml compost tea at 10 % / vine + EM 20 ml / vine as soil amendment

Three vines were used for each of the three replications of each treatment. Seaweed (*Ascophyllum nodosum*) and Effective microorganisms (EM) were foliar sprayed as supplement at 3 doses, the 1st dose two weeks after bud burst, the 2nd dose one week after fruit set, the 3rd dose at veraison while, E.M was applied as soil amendment for one time two weeks after bud burst. Commercial Seaweed extract was used in this study as a modified *Ascophllum nodosum* marine plant extraction with chemical and physical properties as shown (Table 2).

Table 2: Physiochemical properties of Seaweed extract employed in this investigation.

Item	Value
O.M.%	50-59
Moisture%	6.2
Carbohydrates%	38-51
Aliginic acid%	12-19
Protein%	6.5-8
Inorganic matter%	47-61
Mannitol%	5-6
N%	1.2-1.3
P%	0.04-0.08
K%	1.3-1.5
S%	2-8
Mg%	0.5-0.8
Ca%	0.4-1.4
Cu (ppm)	1.0-5.0
Fe (ppm)	60-180
Zn (ppm)	20-100
Mn(ppm)	6-12
B	30-100
Mo	2-5
Cytokinins%	0.03
IAA%	0.04
IBA%	0.01

Concentrated solution of compost tea (Table 3) was made at the Agricultural Research Centre (ARC), Central Laboratory of Organic Agriculture (CLOA), Egypt, by soaking 10 L of compost in 50 L of chlorine-free water (at a ratio of 1:5) for three days while an air pump continuously pumped air during that time. The compost was then filtered through a plastic net.

Table 3: Chemical and microbiological characteristics of the compost tea employed in this investigation.

Item	Value
pH	8.55
Ec (ds/m)	5.11
N (mg/l)	40.48
P (mg/l)	17.06
K (mg/l)	12.46
Fe (mg/l)	1.36
Mn (mg/l)	0.92
Zn (mg/l)	0.14
Total count (cfu ml^{-1})	
Bacteria	1.9×10^7
Fungi	3.6×10^3
Actinomycetes	1.3×10^5

A variety of beneficial microorganisms, primarily lactic acid and photosynthetic bacteria, yeast, and streptomycetes, were donated by the Central of Bio-fertilizer, Faculty of Agriculture, Minia University, to create Effective Microorganisms (EM). For the current experiment, a randomized complete block design (RCBD) was used. The following parameters were noted during both seasons:

2.1. Vegetative growth parameters

Main shoot length (cm), number of leaves /shoot and leaf area (cm^2)

Leaf area (cm^2) = 0.45 (0.79× d^2) +17.77. According to Ahmed and Morsy (1999), the average leaf area was calculated using d as the maximum leaf diameter.

2.2. Physical and yield parameters

Clusters length (cm.), cluster shoulder (cm), Berry weight (g), No. of clusters / vine, Bunche weight (g), and Yield/vine (kg) as number of clusters/vine X average cluster weight (g) were determined

2.3. Chemical Properties of Berries:

Using a hand Refractometer, the juice content of total soluble solids was ascertained, proportion of reducing sugars (Lane and Eynon, 1965), The amount of tartaric acid in 100 millilitres of juice was used to represent the percentage of total acidity. (AOAC, 2000), total nitrate was calculated using the APHA (2005) and, in accordance with Yildiz and Dikmen (1991), the total anthocyanin of the berry skin (mg/100g fresh weight).

2.4. Leaf N, P and K contents

Oven-dried petiole samples of the 5^{th} and 6^{th} apical leaves were used to measure the amounts of N, P, and K. The modified micro-Kejldahl technique, as outlined by Wild *et al.* (1985), was used to determine nitrogen. A flame photometer was used to measure potassium, and the Olsen photometric technique was used to estimate phosphorus (Chapman and Pratt, 1962).

2.5. Leaf photosynthesis pigments

Chlorophylls a & b and total chlorophyll (mg/ 1g F.W) were determined due to Moran and Porath (1980).

The current data was statistically analysed, and treatment means were compared at the 5% level using the New L.S.D. test in accordance with (Mead *et al.,* 1993).

3. Results and Discussion

3.1. Some vegetative growth aspects

The potential effects of different bio-stimulants (Seaweed extract, Compost tea and E.M.) concentration treatments and their combinations on performance of Red globe grapevines are shown as following.

Data in Table 4 showed that all tested treatments effect significantly on main shoot length trait of Red globe grapevine as compared to control during both seasons. It have been observed that the two single treatments (seaweed extract 25 ml / vine and E.M 20 ml / vine) were superior more than the other single and control treatments. All combined treatments were better than single and control treatments and increased the main shoot length trait particularly that of (seaweed extract 25 ml / vine + EM 20ml /vine) which gave the highest values of main shoot length (111.9 and 113.6 cm) during the two seasons, respectively.

Regarding No. of leaves /Main Shoot trait, the results revealed that all tested treatments were better than control, the highest values of No. of leaves /Main Shoot were found in grapevines treated with seaweed extract 25 ml / vine + EM 20ml /vine (24.3 and 26.0) as compared to other treatments throughout the course of two seasons, respectively (Table 4). Among all single treatments, soil applications with EM 20 ml / vine were the greatest and provided the biggest values (22.2 and 26.0) as compared to other single during the two seasons, respectively.

Concerning leaf area trait, it have been observed also that all combined treatments were better than single treatments as well as, treated with seaweed extract 25 ml / vine + EM 20ml /vine was the most effective treatment and produced the greatest leaf area values (137.0 and 137.5 cm^2) during the two seasons, respectively (Table 4).

Table 4: Effect of different bio-stimulants applications on some vegetative growth characters of Red globe grapevines during 2023 and 2024 seasons.

Treatments	Main shoot length (cm)		No. of leaves /Main Shoot		leaf area (cm^2)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
T1	97.4	98.1	18.9	21.0	129.3	131.3
T2	105.4	106.1	21.0	22.7	131.6	134.0
T3	104.0	104.7	20.6	22.6	130.5	132.5
T4	105.8	106.6	22.2	24.3	132.9	134.9
T5	111.0	112.4	22.7	24.3	133.5	135.0
T6	**111.9**	**113.6**	**24.3**	**26.0**	**137.0**	**137.5**
T7	111.4	112.9	24.0	25.9	136.0	136.5
New L.S.D$_{0.5\%}$	**1.1**	**1.1**	**1.5**	**1.4**	**1.1**	**1.5**

T1: Control (just water-sprayed vines), T2: Foliar applications with seaweed extract 25 ml / vine, T3: Foliar applications with 50 ml compost tea at 10 % / vine, T4: EM 20 ml / vine as soil amendment, T5: Seaweed extract 25ml / vine + 50 ml compost tea at 10 % / vine, T6: Seaweed extract 25 ml / vine + EM 20ml /vine as soil amendment, T7: Foliar application with 50 ml compost tea at 10 %/ vine + EM 20 ml / vine as soil amendment.

Our results are consistent with those documented by Abdelaziz *et al.* (2017) on Superior Grapevines, Mekawy and Galal (2021) on Red Globe and Superior Seedless Grapevines, Ahmed (2022) on Ruby Seedless and Ali *et al.* (2024) on Superior grapevines. Seaweed extract has advantages for vegetative development because it includes oligosaccharides that improve cell division, photosynthesis, and metabolic pathways for improved nitrogen absorption and assimilation (Gonzalez *et al.,* 2013). According to Hetherington and Woodward (2003), seaweed extract also improved stomata, which regulate gas exchange between a leaf's interior, stomata densities, and the atmosphere. This improved vegetative growth by enabling plants to better regulate their water relations and increase their capacity for photosynthesis. Conversely, the beneficial impact of effective microorganisms (EM) on vegetative growth may result from their capacity to generate beneficial compounds that regulate plant growth or increase soil nutrient availability and absorption, including Mg, K, N, and Fe that support vegetative growth (Martin et al., 1989 and Sabry et al., 2009). The

existence of plant nutrients including calcium, magnesium, and potassium, and phytohormones like gibberellins, indoleacetic acid, and cytokinins, may be the reason why compost tea promotes vegetative development (Ertani *et al*., 2013 and Zhang *et al*., 2014).

3.2. Yield and clusters characters

The effect of different bio-stimulates treatments on yield and clusters characters of Red globe grapevines are shown in Table 5. Data indicated that none of the treatments differed significantly throughout the first season in No. of clusters / vine while, in the second season all studied treatments increased significantly no. of clusters / vine particularly the two treatments (25 ml seaweed extract / vine + EM 20 ml / vine as soil amendment) and (50 ml compost tea at 10 %/ vine + EM 20 ml l vine as soil amendment) that gave the highest value of No. of clusters / vine (32.0) as compared to other treatments.

Results presented at Table 5 exhibited that all tested treatments increased significantly the weight of clusters during both seasons as compared to control.
The highest values of cluster weight were obtained after treatment with seaweed extract 25 ml / vine + E.M 20ml / vine as soil amendment (832.0 and 840.0 g) during the two seasons, respectively. Soil addition of E.M 20 ml / vine treatment was superior more than all other single treatments and control during the two seasons.

Concerning cluster length trait, the recorded data showed that all tested treatments effect significantly on cluster length during both seasons as compared to control. The highest values of cluster length were found by the two treatments seaweed extract 25 ml / vine + Soil addition of EM 20ml /vine and 50 ml compost tea at 10 %/ vine + EM 20 ml l vine as soil amendment (21.8 and 21.8 cm) and (21.0 and 20.9 cm) during the two seasons, respectively (Table 5).

Regarding cluster shoulder trait, results showed that all tested treatments improved this trait as compared to control during both seasons. The best results of Bunche shoulder were obtained by the combined treatments as compared with single treatments. The highest values of Bunche shoulder were found in grapevine treated with Seaweed extract 25 ml alga / vine + Soil addition of EM 20ml / vine (13.7 and 13.8 cm) during the two seasons, respectively.

Concerning yield per vine trait, the presented results showed that all tested treatments increased significantly the yield of vine except the single treatment (Foliar applications with 50 ml compost tea / vine) which made a little increment in this trait as compared with control. All combined treatments were superior to that of single and control treatments during both seasons. The highest values of yield per vine were recorded in vines treated with the two combined treatments (seaweed extract 25 ml / vine + Soil addition of EM 20ml /vine and foliar application of 50 ml compost tea at 10 %/ vine + Soil addition of EM 20 ml l vine (25.8 and 26.9 kg) and (25.5 and 26.6 kg) during the two seasons, respectively (Table 5).

Regarding total yield per feddan, the obtained data showed that all combined treatments increased significantly yield per feddan as compared to control during both seasons as well as, single treatments increased slightly total yield per feddan as compared to control. The highest values of yield per feddan were recorded in vines treated with the combined treatments (seaweed extract 25 ml / vine + Soil addition of EM 20ml /vine and foliar application of 50 ml compost tea at 10 %/ vine + Soil addition of EM 20 ml l vine (18.7 and 18.8 ton) and (17.8 and 18.6 ton) as compared to all other treatments during the two seasons, respectively (Table 5).

Our results are in line with that observed in experiments conducted on different grapevine kinds by Allam *et al.* (2012), Khan *et al.* (2012), Ahmed *et al.* (2017), Abo-Zaid *et al.* (2019) and Qaoud and Zagzog (2023) and Ali *et al.* (2024).

Applying seaweed extract increases nutrient and water intake, which raises and activates the metabolism of carbohydrates, as seen by the higher yield (Nabti et al., 2016 and Osman et al., 2010). The majority of the more than 80 forms of useful microorganisms are found in effective microorganisms (EM) bio-stimulants, which are microorganisms that have the ability to decompose organic matter and improve berries and yield production (Olle, and Williams, 2013). In addition, these results might be explained by compost tea capacity to enhance NPK absorption and translocation by leaf tissues in addition to their macronutrient concentrations which reflect on increment of yield (Tarashkar *et al.,* 2023).

Table 5: Effect of different bio-stimulants applications on berries and yield characters of Red globe grapevines during 2023 and 2024 seasons.

Treatments	No. of clusters / vine		Cluster weight (g.)		Cluster length (cm.)		Cluster shoulder (cm.)		Yield/ vine (kg.)		Yield / feddan (ton)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
T1	30.0	30.0	780.0	788.0	18.5	19.3	12.0	12.0	23.4	23.6	16.4	16.5
T2	31.0	31.0	799.0	808.0	19.7	20.0	12.5	12.5	24.8	25.0	17.4	17.5
T3	30.0	31.0	789.0	797.0	19.1	19.8	12.5	12.5	23.7	24.7	16.6	17.3
T4	31.0	31.0	810.0	815.0	20.1	20.5	12.5	13.0	25.1	25.3	17.6	17.7
T5	31.0	31.0	819.0	823.0	20.5	20.5	13.1	13.2	25.4	25.5	17.8	17.9
T6	31.0	32.0	832.0	840.0	21.8	21.8	13.7	13.8	25.8	26.9	18.7	18.8
T7	31.0	32.0	820.0	830.0	21.0	20.9	13.2	13.5	25.5	26.6	17.8	18.6
New L.S.D$_{0.5\%}$	**N.S**	**1.0**	**0.8**	**0.7**	**0.4**	**0.4**	**0.6**	**0.5**	1.3	1.4	1.3	1.3

T1: Control (just water-sprayed vines), T2: Foliar applications with seaweed extract 25 ml / vine, T3: Foliar applications with 50 ml compost tea at 10 % / vine, T4: EM 20 ml / vine as soil amendment, T5: Seaweed extract 25ml / vine + 50 ml compost tea at 10 % / vine, T6: Seaweed extract 25 ml / vine + EM 20ml /vine as soil amendment, T7: Foliar application with 50 ml compost tea at 10 %/ vine + EM 20 ml / vine as soil amendment.

3.3. Some physical and chemical properties of berries

Due to data in Table 6, there were significant increments in Berry weight trait after application with all tested treatments during both seasons as compared to control. The highest values of berry weight were recorded in grapevines treated with combinations of seaweed extract 25 ml alga / vine + Soil addition of E.M 20ml / vine (12.75 and 12.76 g) followed by that of Foliar application of 50 ml compost tea at 10% / vine + Soil addition of EM 20 ml l vine (12.65 and 12.67 g) as compared to other treatments during the two seasons, respectively.

The effect of different bio-stimulants applications on chemical properties of Red globe berries is shown in Table 6. Data showed that almost of tested treatments increased significantly the anthocyanin content in berries during both seasons as compared to control. The highest values of berries anthocyanin were found after treatment with the combined treatment seaweed extract 25ml / vine + 50 ml compost tea at 10 %/ vine (6.0 and 6.5 mg/100g) followed by Foliar application of 50 ml compost tea at 10 %/ vine + Soil addition of E.M 20 ml l vine (6.0 and 6.4 mg/100g) during the two seasons, respectively as compared to all other treatments.

Data presented in Table (6) showed that there were a considerable increments in TSS percentage in berries after treatment with all studied bio-stimulants particularly that of the two combined treatments seaweed extract 25 ml / vine + E.M 20ml /vine as soil amendment and foliar application of 50 ml compost tea at 10 %/ vine + E.M 20 ml l vine as soil amendment (18.6 and 18.5 %) and (18.3 and 18.2 %) with a significant increment as compared to control during both seasons, respectively.

It has been observed that all tested treatments reduced significantly the percentage of total acidity in berries of Red globe during both seasons as compared to control. The best total acidity values found in berries treated with both of seaweed extract 25 ml alga / vine + Soil addition of E.M 20ml / vine (0.595 and 0.591 %) and seaweed extract 25ml / vine + 50 ml compost tea at 10 %/ vine (0.595 and 0.600 %) during the two seasons respectively as compared to all other treatments (Table 6).

On the other side, increments were found at reducing sugar in the grapevines treated with all tested bio-stimulants. The highest values of reducing sugar were recorded by the combined treatment seaweed extract 25 ml alga / vine + E.M 20ml / vine as soil amendment (14.5 and 14.8%) followed by that of Foliar application of 50 ml compost tea at 10 %/ vine + EM 20 ml l vine as soil amendment (14.2 and 14.6%) during both seasons, respectively as compared to all other tested treatments.

It has been observed that all tested bio-stimulants treatments made a considerable reduction at the percentages of nitrite in berries as compared to control during the tested seasons (Table 6). The results revealed also that the combined treatments were more effective more that single treatment and reduced the nitrate percentages significantly as compared to control. . The lowest percentages of nitrate were found in grapevines treated with seaweed extract 25 ml alga / vine + Soil addition of E.M 20 ml / vine (0.74 and 0.81%) followed by that of Foliar application of 100 ml compost tea at 10 %/ vine + EM 20 ml l vine as soil amendment (0.84 and 0.90%) during the two seasons, respectively as compared to all other tested treatments.

Applying seaweed extract improves berry chemical properties by increasing nutrient and water intake, which in turn stimulates and activates the metabolism of carbohydrates (Nabti *et al.,* 2016 and Osman *et al.,* 2010). Similarly, applying seaweed extract topically to apples has been shown to improve their total sugar content (Spinelli et al., 2009). According to Calvo *et al.* (2014), seaweed extract has been found to contain significant amounts of organic acids, polysaccharides, amino acids, enzymes, and abscisic acid. These substances may be responsible for the rise in T.S.S%, T.S.S/acidity ratio, and lowering of acidity in the berries of Superior Seedless and Red Globe. It is consistent with a study that found that applying seaweed extract topically to Flame Seedless increased the content of anthocyanins (Strydom, 2013). Applications of seaweed extract slowed down fruit ripening, increasing the amount of anthocyanins in the treated berry skins (Salvi *et al.,* 2019). Additionally, seaweed extract contains polyphenols and abscisic acid (Ali *et al.,* 2021), which may be connected to the rise in anthocyanin in Red Globe cultivar berry skin.

Our findings concur with those of Mostafa *et al.* (2009), who found that applying compost tea as a foliar spray to Washington navel orange trees and Thompson seedless grapevines greatly improved the fruit quality (Abd El-Maksood, 2006, El-Mansi, 2007, Ezz, 1999 and Omar, 2005). According to Ahmed et al. (2017), utilising N in conjunction with EM and as a substantial alternative to inorganic N fertilizers greatly improved the berries' quality in terms of T.S.S., T.S.S./acid ratio, and overall acidity in comparison to utilizing N only. Furthermore, the microbial diversity in EM is increased by

Table 6: Effect of different bio-stimulants applications on some physical and chemical properties of Red globe berries during 2023 and 2024 seasons.

Treatments	Berry weight (g.)		Anthocyanin Cont. (mg/100g)		T.S.S %		Total acidity %		Reducing sugars %		Nitrite(NO_2) ppm	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
T1	11.75	11.74	5.5	5.8	15.9	15.7	0.655	0.652	13.2	13.5	1.35	1.31
T2	12.15	12.35	5.7	5.8	16.9	17.9	0.635	0.630	13.8	14.3	1.15	1.10
T3	12.04	12.14	5.8	6.0	16.6	17.8	0.651	0.645	13.7	14.1	1.25	1.25
T4	12.45	12.50	5.8	6.3	17.3	18.1	0.625	0.610	13.9	14.4	1.05	1.09
T5	12.36	12.36	6.0	6.5	17.6	17.8	0.595	0.600	14.0	14.4	0.95	1.00
T6	12.75	12.76	5.6	6.2	18.6	18.5	0.595	0.591	14.5	14.8	0.74	0.81
T7	12.65	12.67	6.0	6.4	18.3	18.2	0.620	0.615	14.2	14.6	0.84	0.90
New L.S.D$_{0.5\%}$	**0.12**	**0.11**	**0.3**	**0.3**	**1.8**	**1.6**	**0.002**	**0.022**	**1.7**	**1.3**	**0.11**	**0.12**

T1: Control (just water-sprayed vines), T2: Foliar applications with seaweed extract 25 ml / vine, T3: Foliar applications with 50 ml compost tea at 10 % / vine, T4: EM 20 ml / vine as soil amendment, T5: Seaweed extract 25ml / vine + 50 ml compost tea at 10 % / vine, T6: Seaweed extract 25 ml / vine + EM 20ml /vine as soil amendment, T7: Foliar application with 50 ml compost tea at 10 %/ vine + EM 20 ml / vine as soil amendment.

the presence of lactic acid and photosynthetic bacteria, yeast, and actinomycetes fermenting fungus, all of which improve the quality of crops (Higa and Kinjo, 1991). Compost tea applied topically together with citric and ascorbic acids significantly increased the amount of total sugars in the fruits throughout both study seasons, according to research done by Fayed (2010) on Manfalouty pomegranate trees. The reduction of Nitrite in berries after treatment with different bio-stimulants might be related to increase NaR enzyme activity by increasing exogenous cytokinins which in turn can increase endogenous cytokinins, and cytokinins can increase NaR activity (Wang *et al.,* 2011 and Zhang, *et al.*, 2022).

3.4. NPK content in leaves

The effect of different bio-stimulants treatments on N, P and K contents in leaves of Red globe grapevines are shown in Table 7. As general, the obtained results showed that all tested treatments increased significantly NPK contents in leaves during both seasons as compared to control. The best results of NPK contents were found in grapevines treated with the combined treatments as compared to single and control treatments. The highest values of N (2. 38 and 2.41%), P (0.36 and 0.39%) and K (1.85 and 1.87%) were obtained after treatment with seaweed extract 25 ml alga / vine + EM 20ml / vine as soil amendment as compared to all other treatments during the two studied seasons, respectively.

Table 7: Effect of various bio-stimulants applications on N, P and K content in leaves of Red globe grapevines during 2023 and 2024 seasons.

Treatments	Leaf N %		Leaf P %		Leaf K %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
T1	1.98	1.98	0.22	0.25	1.58	1.59
T2	2.12	2.15	0.27	0.29	1.71	1.73
T3	2.06	2.11	0.25	0.27	1.64	1.66
T4	2.10	2.24	0.29	0.32	1.72	1.78
T5	2.17	2.25	0.31	0.32	1.79	1.80
T6	2. 38	2.41	0.36	0.39	1.85	1.87
T7	2.24	2.36	0.34	0.34	1.81	1.80
New L.S.D$_{0.5\%}$	**0.06**	**0.05**	**0.03**	**0.02**	**0.06**	**0.06**

T1: Control (just water-sprayed vines), T2: Foliar applications with seaweed extract 25 ml / vine, T3: Foliar applications with 50 ml compost tea at 10 % / vine, T4: EM 20 ml / vine as soil amendment, T5: Seaweed extract 25ml / vine + 50 ml compost tea at 10 % / vine, T6: Seaweed extract 25 ml / vine + EM 20ml /vine as soil amendment, T7: Foliar application with 50 ml compost tea at 10 %/ vine + EM 20 ml / vine as soil amendment.

The findings are consistent with those of Mohammed *et al.* (2010) on pears, Mostafa *et al.* (2009) on oranges, and Carvalho *et al.* (2019) on grapevines. By encouraging the accumulation of minerals, antioxidants, and essential amino acids, seaweed extracts have been demonstrated to increase the nutritional value of fruits (Frioni *et al.,* 2018; Stasio *et al.,* 2018; Carvalho *et al.,* 2019). Compost tea has the capacity to enhance NPK absorption and translocation by leaf tissues in addition to their macronutrient contents. EM treatment has been shown to have an influence on soil pH lowering, soil organic matter growth, soil nutrient and water absorption, and soil fertility improvement (El-Nwehy *et al.,* 2023).

3.5. Effect on photosynthetic pigments and sunburned berries %

According to data presented in Table 8, significant increments at photosynthetic pigments (Chlorophyll a, b and total chlorophyll) were recorded after treatments with all tested bio-stimulants as compared to control during both seasons. The highest values of chlorophyll a (6.8 and 6.8 mg/100 F.W.), chlorophyll b (3.9 and 4.1 mg/g. F.W.) and total chlorophyll (10.7 and 10.9 mg/g. F.W.) were recorded after treatment with seaweed extract 25 ml alga / vine + EM 20 ml / vine as soil amendment compared to all other treatments during both studied seasons, respectively. These obtained results align with the research of Xu *et al.* (2012), Abdelaziz, *et al.* (2017), El-Nwehy *et al.* (2023) and Abd El-Moatamed (2024). Shehata *et al.* (2011) attributed this rise to the betains in liquid fertilizers

derived from seaweed extracts, which reduce the breakdown of chlorophyll as well as, the availability of greater amounts of amino acids to the treated plants may be the cause of this rise in chlorophyll concentrations (El-Shabasi *et al*., 2005). Additionally, magnesium, a component of seaweed extract, is essential for the synthesis of chlorophyll, which may raise the amount of chlorophyll in leaves and subsequently affect the buildup of glucose reserves in canes of both cultivars (Tian *et al.,* 2017).

It's possible that the substantial influence of compounds that control plant development and are generated by helpful microorganisms (fungi, yeast, and bacteria) is the reason why EM bio-stimulants increase the amounts of chlorophyll or by enhancing the absorption and availability of soil nutrients, including N, Mg, and Fe, which are necessary for the production of chlorophyll (Martin *et al.,* 1989).

Table 8: Effect of various bio-stimulants treatments on photosynthetic pigments in leaves and sunburned berries of Red globe grapevines during 2023 and 2024 seasons.

Treatments	Chl. a (mg/g. F.W.)		Chl. b (mg/g F.W.)		T. chl. (mg/g F.W.)		Sunburned berries %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
T1	4.1	4.3	2.1	2.0	6.2	6.3	8.0	7. 7
T2	4.9	5.1	2.7	2.9	7.6	8.0	7.6	7. 7
T3	4.5	4.7	2.3	2.5	6.8	7.2	7.1	6. 8
T4	5.3	5.5	3.0	3.2	8.3	8.7	7.0	6. 6
T5	5.8	6.0	3.3	3.5	9.1	9.5	5. 8	5.4
T6	6.8	6.8	3.9	4.1	10.7	10.9	5.0	4.8
T7	6.1	6.5	3.6	3.8	9.7	10.3	5.5	5.1
New L.S.D$_{0.5\%}$	**0.3**	**0.3**	**0.3**	**0.3**	**0.4**	**0.4**	**1.0**	**1.1**

T1: Control (just water-sprayed vines), T2: Foliar applications with seaweed extract 25 ml / vine, T3: Foliar applications with 50 ml compost tea at 10 % / vine, T4: EM 20 ml / vine as soil amendment, T5: Seaweed extract 25ml / vine + 50 ml compost tea at 10 % / vine, T6: Seaweed extract 25 ml / vine + EM 20ml /vine as soil amendment, T7: Foliar application with 50 ml compost tea at 10 %/ vine + EM 20 ml / vine as soil amendment.

Concerning the percentages of sunburned berries trait, it had been observed that almost of tested treatments reduced sunburned berries % as compared to control during the seasons under study. The lowest percentages of sunburned berries were found in grapevines treated with seaweed extract 25 ml alga / vine + Soil addition of EM 20 ml / vine (5.0 and 4.8%) followed by that of Foliar application of 50 ml compost tea at 10 %/ vine + Soil addition of EM 20 ml l vine (5.5 and 5.1%) during the two seasons, respectively as compared to all other tested treatments (Table 8). The reduction in sunburned berries% might be attributed to the positive effect of all tested bio-stimulates on vegetative growth particularly that of No. of leaves /Main Shoot and leaf area which help to protect and cover red globe berries from high temperatures and sun light.

Finally, under the experiment conditions it could be concluded that to improve vegetative, yield and quality of red globe grapevines this investigation recommended to use seaweed extract and compost tea as a foliar application and Effective Microorganisms (EM) as soil amendment whether if it in a single or combined treatments, the seaweed extract 25 ml / vine + EM 20 ml /vine as soil amendment combined treatment is the most effective among all treatments during both studied seasons.

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