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Effect of foliar spraying with Seaweed Extract (*Chlorella vulgaris*) and Nano fertilizers on growth, yield and fruit quality of Flame Seedless grapevines

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Abstract

The present study was conducted during three successive seasons 2020, 2021, and 2022 on thirty-six uniform 6-year-old Flame seedless grapevines, in a Private vineyard in Gohaina region, Sohag, Egypt. This study examined how grapevines respond physiologically, in terms of growth, yield, and quality, to Hydrogen Cyanamide and seaweed extract (*Amphora coffeaeformis*) as dormancy breaking, as well as *Chlorella vulgaris*, Nano fertilizers (nano Fe+ Zn), and conventional fertilizers (EDTA Fe + Zn) applied three times at on the same vines at fruit set, berry size 6:8 mm and at veraison stage as single or combined.The highest value of growth and yield parameters and chemical characteristics were recorded to combined application of (Hydrogen Cyanamide) dormix 5% 1st week of Jan.× *Chlorella vulgaris* at 1ml/l and (nano Fe + Zn)1$_{ppm}$ (as an average of the three studied seasons) aspects than using each material alone. It is concluded that the foliar combined application Hydrogen Cyanamide 5% 1st week of Jan. once and *Chlorella vulgaris* at 1ml/l and (nano Fe + Zn) 1$_{ppm}$ applied three times on the same vines at fruit set, berry size 6:8 mm and at veraison stage led to clear enhancements in the majority of the tested vegetative and fruiting parameters of Flame seedless grapevines.

Keywords: Nano-fertilizers, nano-iron, nano-zinc, *Chlorella vulgaris*, Nano, seaweed extract.

INTRODUCTION

Grape (*Vitis vinifera* L.) belongs to the plant family Vitaceae. It is one of the most significant commercial fruit crops grown in temperate tropical regions (Gowda *et al., 2008*). The total world area of grapes reached 6.85 million hectares with a total production of 79.51 million tons of fruits per year (F.A.O, 2021). In Egypt, only citrus crops come before grapes as the second fruit crop. Because grape growers received a high net return, their cultivated area grew rapidly in the last two decades. The total cultivated area of grapes was about 190486 feddans (fed.) with a production of 1594782 tons and productivity is 9.13 tons/fedden. (Central Agency for Public Mobilization and Statistics, Egypt 2021). Prolonged dormancy is considered to be the major obstacle to economic production of temperate fruits in warm winter regions. In these regions, the need for artificial means to compensate for lack of natural chilling becomes a dominant factor for maintaining economic production (Erez, 1987 & 1995). Hydrogen cyanamide, an efficient rest breaking treatment for grapevines, has been used successfully to supplement chilling and improve bud brust and fertility percentage, growth and yield (Dokoozlian *et al*.,. 1995, Carreno *et al*., 1999, Lombard *et al*., 2006, Muhtaseb and Ghnaim, 2008 and Trejo-Martínez *et al*., 2009). Despite these attributes hydrogen cyanamide is not accepted by organic protocols for grape production, especially the European Union's the main export market for Egyptian grapes. Thus, it is necessary to find environmentally friendly and operator safer bud break promoters that are as effective as Dormex suitable for organic table grape production. In addition, bio-fertilization is very safe for human, animal and environment to get lower pollution and reduce soil salinity via decrease mineral usage fertilization as well as saving fertilization cost Recently, a great attention is paid to biologically active constituents of natural origin, including biomass in particular, defined as plant growth bio-regulators or bio-stimulant (Ronga *et al*., 2019). In addition, bio-fertilization is very safe for human, animal and environment to get lower pollution and reduce soil salinity via decrease mineral usage fertilization as well. Pervious investigators indicated that the constituents of such activities occur commonly in an alga which is the source of some bio-stimulant (La Torre *et al*., 2016; Mulbry *et al*., 2017; Ronga *et al*., 2019). Algae contain different components such as hormones, vitamins, amino acids and various elements which can modify and improve the productivity of agricultural crops. *Amphora coffeaeformis* Algal extracts caused highly significant changes in major and minor fractions of phenolic compounds, vanillic, chlorogenic and caffeic acids. That led to significant growth promoters that are as effective, as yield, carbohydrates, and various chemical constituents of plants in response to the algal extracts applications (Amer *et al*., 2019). The essential compounds such as tannins, antioxidants, amino acids, vitamins, alcohols, phenolic compounds, caffeine and minerals pan important functions in plant metabolism and are responsible for enhancing bud breaking, growth and fruiting of most fruit crops (Balbaa *et al*., 1976). Therefor, can use *Amphora coffeaeformis* instead of Hydrogen cyanamide as dormancy breaking. Seaweed extracts like *Chlorella vulgaris* used in agriculture for nutrient sup-plements and as biostimulants or biofertilizers to enhance plant growth and productivity. There is wide range of beneficial influences of seaweed extracts such as enhanced chlorophyll concentration in leaves, increased growth and yield and extended postharvest quality (Blunden *et al*., 1997) (Sabir and Sabir, 2009) , (Amer *et al*., 2019), (Prabakaran *et al*., 2019). Seaweed extract: (*Chlorella vulgaris* & *Halamphora coffeaeformis*) the both algae were chosen for evaluating their biostimulants activity in this study according to previous investigators (Bhosle *et al*., 1993; Faheed and Abd-El Fattah, 2008). Application of *Chlorella vulgaris* extract as foliar spray has gradually improve yield expressed in weight and number of clusters as well as berry weight d in response to increasing algal extract concentrations. Spraying algal extract was accompanied with hastening fruit quality compared to the untreated vines. Slight promotion was detected on fruit quality which increased TSS, TSS/Acid ratio and total sugars and decreasing total acidity rather than control (Abd El Moniem and Abd-Allah 2008). Nano-technology has been recognized as an efficient enhancement in the agricultural field because of its unique physicochemical properties; nanomaterials are increasingly used in agriculture to enhance the biomass of plants because of its small size with a large surface area. The ambition of nanomaterials in agriculture is to reduce the amount of spread chemicals, minimize nutrient losses in fertilization and increased yield through pest and nutrient management. (Sabir, *et al.,* 2014; Prasad *et al.,* 2017; He *et al.,* 2018). Nanostructured materials typically consist of particles less than 100 nm in diameter. Due to their size, these materials have properties that are different from micrometric or larger-sized materials. These include differences in physical strength, chemical reactivity, and electrical conductivity. The development of nanotechnology could play an important role in crop management (Nair *et al.,* 2010). Nano-fertilizers are the materials with reduced size and large surface area, absorbed rapidly and completely in the plant correcting the nutritional deficiencies (Khan and Rizvi, 2017). The uptake of nanoparticles (NPs) is estimated to be 15-20 times more than conventional bulk particles (Rajput *et al.,* 2018). Zinc Oxide Nanoparticles (ZnO NPs) are nano-scaled micro-nutrients which were used in low concentrations and play an important role in plant functions. ZnO NPs enhance the growth characteristics and fruit quality of many plants, (Prasad *et al.,* 2012; Tarafdar *et al.,* 2014; Venkatachalam *et al.,* 2017; Allam 2018; Rossi *et al.,* 2019; El-Said *et al.,* 2019; Abou-Zaid and Shaaban 2019 and Abou El-Nasr *et al.*, 2021). Zinc is required for the activity of different enzymes, including dehydrogenases, aldolases, isomerases, transphosphorylases, RNA and DNA polymerases, cell division, maintenance of membrane structure and photosynthesis, and also acts as a regulatory cofactor in protein synthesis (Marschner, 2012). Vegetative and fruiting characters were registered maximum through the application of ZnO NPs (1.2 ppm) as compared to conventional fertilizers ($ZnSO_4$ and Zn EDTA) in grapes cv. Flame Seedless (El-Said *et al.*, 2019). Iron is an essential element for plant metabolism; it acts as a cofactor for various enzymes which directly or indirectly involved in DNA synthesis and respiration. Further, It also work as a cofactor for various enzymes involved in redox reactions such as photosynthesis, respiration, and hormone synthesis (Barberon *et al.,* 2011). According to Álvarez *et al.*, (2013) iron deficiency reduced the efficacy of photosynthetic and carbon fixation in plants which ultimately leads to reduced vegetative growth and crop yield. Iron deficiency caused chlorosis in fruit trees (Nijjar, 1990). Mohamed (2020) showed that Using iron bulk or nano significantly increased yield, and improved the cluster and berry traits, and also improved leaf area, leaf total chlorophyll as well as leaf nutrient composition compared to control on "Thompson seedless" grapevine. Mostly, amounts of Fe nutrient in the soil are more than the plant needs but cannot readily be absorbed by plants.The best and alternative way is to use these micro-nutrients as foliar spray (Drostkar *et al.*, 2016). Fe nano-fertilizers foliar application was very effective in enhancing growth aspects, vine nutritional status and berry setting, yield, colouration and quality (Wassel *et al.*, 2017). This investigation was carried out to study the effect of seaweed extract the foliar application and nanosize fertilizer with mineral fertilization on vine growth and the feasibility of improving bud break, yield, cluster quality, and extended postharvest quality of grapevine to achieve higher economic returns under south Egypt.

MATERIALS AND METHODS

The present study was conducted during three successive seasons, 2020, 2021, and 2022 on thirty-six uniform 6-years old Flame seedless grapevines in a private vineyard in the Gohaina region, Sohag Governorate, Egypt. The texture of the vineyard soil is loamy, and well-drained water since the water table depth is not less than two meters.

Table 1. Analysis of the tested vineyard soil

Measured character		Values			
Particle size distribution		Sand %	Silt %	Clay %	Texture grade
		24	38.20	37.80	Clay loam
Soil moisture content	Depth (cm)	0-15	15-30	30-45	45-60
	Field capacity	32.21	31.79	29.75	29.20
	Wilting point	13.75	13.20	12.41	11.19
	Available water	18.44	18.61	17.35	17.40
	(Bulk density (g/cm3	1.16	1.20	1.22	1.29
Soil chemical characteristics	$HCO3^-$	0.26	EC (ds m^{-1})		0.9
	Cl^-	0.28	pH		7.9
	$So4^{--}$	0.65	Available N (mg/kg)		17.5
	Ca^{++}	0.55	Available P (mg/kg)		10
	Mg^{++}	0.36	Available K (mg/kg)		178
	Na^+	0.23	Organic matter (%)		1.22
	K^+	0.12			

The chosen vines trained on the Y-Trellis (Y.T.) system, planted at a distance of 2x3 m, having similar trunk diameter, and irrigated with a surface irrigation system and N.P.K. fertigation was added as recommended by the Ministry of Agricultural. Cane pruning was applied in all seasons on the second week of December, leaving 48 eyes per vine (based on six fruiting canes x 6 eyes + 6 renewal spurs x 2 eyes). In the experimental design in (Table 2), vines were set up in a completely randomized design by using a split-plot design; the dormancy breaking treatments (dormix 5% and *H. coffeaeformis* 2 ml/ l) were arranged as the main plot, whereas the others application was laid out as sub plots, with six treatments which included control and three replications of one vine each. Grapevines were sprayed for foliar application in the subplots three times on the same vines at the fruit set, berry size 6:8 mm, and the veraison stage.

Table 2. Applied foliar treatments were as follows:

Treatments (A) Once implemented	Treatments (B) All treatment were appliaed three times on the same vines at fruit set, berry size 6:8 mm and at veraison stage.
Control	T1- control (Water).
Dormex 5% at 1st week of Jan.	T2- Conventional fertilizers (Fe EDTA 500ppm + Zn EDTA 500ppm).
	T3- Nano fertilizers (nano Fe 1ppm + nano Zn 1ppm)
	T4- C. vulgaris 1 ml/L.
	T5- C. vulgaris 1ml/L + (Fe EDTA 500ppm + Zn EDTA 500ppm).
	T6- C. vulgaris 1 ml/L + (nano Fe 1ppm + nano Zn 1ppm).
H. coffaeformis 2 ml/L at 1st week of Jan.	T1- control (Water).
	T2- Conventional fertilizers (Fe EDTA 500ppm + Zn EDTA 500ppm).
	T3- Nano fertilizers (nano Fe 1ppm + nano Zn 1ppm).
	T4- C. vulgaris 1ml/L.
	T5 - C. vulgaris 1ml/L + (Fe EDTA 500ppm + Zn EDTA 500ppm).
	T6- C. vulgaris 1 ml/L + (nano Fe 1ppm + nano Zn 1ppm).

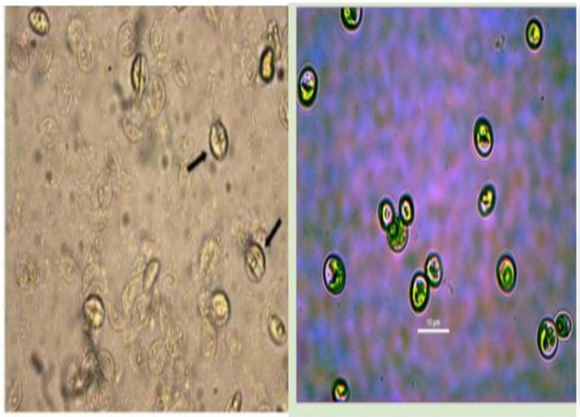
Seaweed extract: (*H. coffeaeformis*) in Table (3), the accepted name of the agla (*Amphora coffeaeformis*) according to the World Register of Marine Species (WoRMS), the algae was chosen for evaluating its biostimulants activity in this study according to previous investigators (Bhosle *et al.*, 1993& Faheed and Abd-El Fattah, 2008). The concentration of the algal solutions (2 g/L) was suggested by (Amer *et al.*, 2019). Microalga (*Chlorella vulgaris*) in Table (3) is effect on growth parameters and some physiological response of growth. In general, microalgal treatment significantly increased the growth compared with those of the control (Faheed and Abd-El Fattah 2008). The concentration of the algal solutions (1 g/L) was suggested by (Amer *et al.*, 2019). Both varieties of algae were prepared for this experiment by the Algae Production Unit, National Research Center, Egypt (NRC).

Table 3. Chemical composition of (*H. coffeaeformis*) used in study.

Algal composition (%)	Moisture	Carbohydrate	Protein	Ashes	Total Water soluble	Acid soluble
	89.5	33.60	15.74	30.43	13.11	16.24
Coubound			Concentration (μg −1)		Macro elements (%)	
Gallic acid			28.31		N	5.41
Protocatechuic acid			14.24		P	1.32
p-Hydroxybenzoic acid			7.69		K	0.63
Catechin			38.08		Ca	26.9
Chlorogenic acid			9.89		Mg	2.29
Caffeic acid			12.26		Na	1.51
p-Coumaric acid			39.69		Micro elements (ppm)	
Cinnamic acid			12.33		Fe	7.89
Total chlorophyll (T-Chl)			20.68		Mn	1.10
Total carotenoids (TCAR)			15.6		Zn	13.52
					Cu	0.46

Table 4. Chemical composition of (*C. vulgaris*)

Algal composition (%)	Carbohydrate	Protein	Fats	Macro elements (%)	
	12.80	44.60	7.30	N	7.10
Amino acid composition	(g/100 g protin)			P	0.66
Argniine		6.90		K	2.15
Histidine		2.00		Ca	0.18
Isoleucine		3.20		Mg	0.34
Lucien		9.50		Na	0.04
Lysine		6.40		Micro elements (ppm)	
Methionine		1.30		Fe	245.00
Phenylalanine		5.50		Mn	131.20
Threonine		5.30		Zn	111.50
Tryptohan		1.50		Cu	28.00
Valine		7.00			



Amphora coffeaeformis *Chlorella vulgaris*

Figer (1): Microscopic images of (*Amphora coffeaeformis & Chlorella vulgaris*) used in study.

Nanosize fertilizer: Iron oxide nanoparticles (Fe_3O_4 NPs) it is diameter is less than 50 nm; zinc Oxide Nanoparticles (ZnO N.P.s) with size ≤ 30 nm were confirmed by the transmission electron microscopy (HR-TEM) images for both. The two nanomaterials were purchased from Nano Gate Company, Nasr city, Cairo, Egypt. Nano-Fe and nano-Zn treatments were applied by foliar spraying at a concentration (1_{ppm}) in keeping with (El-Saber *et al.*, 2021; El-Said *et al.*, 2019) respectively.

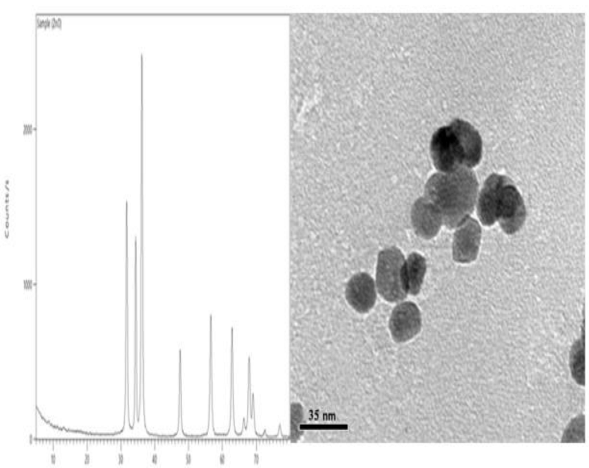


Figure (2): Shows the XRD pattern of the prepared sample & the TEM image of Nano Iron Fe3O4 (magnetite).

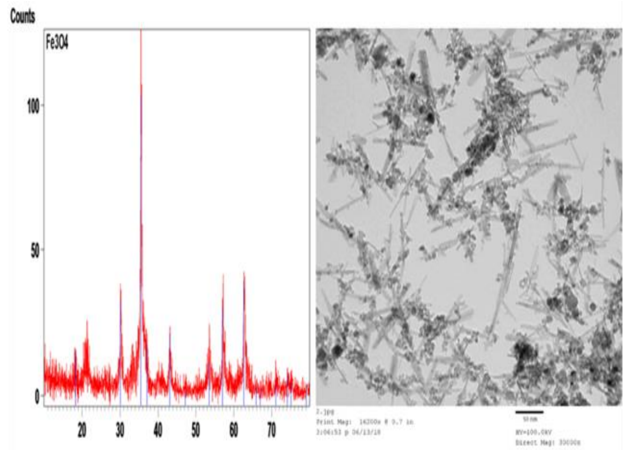


Figure (3): Shows the XRD pattern of the prepared sample & the TEM image of ZnO nanoparticles at (30 ±5 nm).

Conventional fertilizers: Iron EDTA (Fe EDTA) and Zinc EDTA (Zn EDTA), the two micronutrients, were bought from Agrico International Company, Giza, Egypt. The manufacturer's suggested concentration for foliar application (500 $_{ppm}$) for both iron and zinc EDTA. The following parameters were assessed for this study:

1. Vegetative growth determinations:

Four new shoots were randomly chosen per vine to measure the following parameters e at the end of the growing season:

a. Budburst (%)

b. Shoot Length (cm)

c. the number of leaves per shoot.

d. Leaf area (cm^2): Calculating using the following equation outlined by Ahmed and Morsy (1999).

Leaf area (cm^2) = 0.45 (0.79 x diameter2) + 17.77.

2. Leaf chemical analysis:

a. To determine the mineral content of each vine's 20 leaves, including the blade and petiole (the sixth leaf from the shoot tip), a sample was taken in mid-July. First, the leaves were cleaned in distilled water and then baked at 60 to 70 °C until their weight remained constant. The dried samples were ground in a stainless steel knife mill, and 0.2 grams of each sample's ground material were then digested with a solution of perchloric: sulphuric acid1:10(v/v) according to Jackson (1967). Nitrogen was determined as the method described by Pregl (1945), while phosphorus was colourimetrically determined as the method of Truog and Meyer (1929), potassium was determined using a flame photometer according to the method of Mason (1963), and iron and zinc were measured using the atomic absorption apparatus according to the method of Cottenie *et al.* (1982).

b. Chlorophyll: Ten leaves were opposite to the first basal clusters on the recent shoots (according to Balo *et al.* (1988) and were taken in the first week of May for determining chlorophylls a and b (mg/ 1.0 g F.W.). Accurately weighted 0.5g of fresh plant leaf sample was taken and homogenized in tissue homogenizer with 10 ml of extractant solvent Ethanol 95%. The homogenized sample mixture was centrifuged at 10,000 rpm for 15min. The supernatant was separated, and 0.5 ml was mixed with 4.5 ml of the respective solvent. The solution mixture was analyzed for Chlorophyll-a and Chlorophyll-b content in a spectrophotometer (Parkin). The methods described by (Sumanta *et al.,* 2014). The optical densities of pigments (chlorophylls a and b) were measured colourimetrically at 664 and 649 nm wavelengths, respectively. These pigments were calculated using the following equations (mg/L.) Chlorophyll

a = (13.36 x E664) – (5.19 x E649).
Chlorophyll b = (27.43 x E649) – (8.12 x E664).
Total chlorophylls = chlorophyll a+ chlorophyll b.
Where E = optical density at a given wavelength.

3. Yield parameters:

Four clusters per vine were harvested at the ripening stage when juice TSS% reached 16% in 50% of treatments to determine the average of No. of clusters/vine, yield/vine (kg.), the weight of 100 berries (g), and the shot berries number/cluster.

4. Berry chemical analysis:

A hand refractometer determined the total soluble solids (T.S.S. %) in the juice. Then T.S.S./acidity ratio was measured.

5. Chemical analysis:

a. Berries skin content of total anthocyanin. Berry skin anthocyanins (mg/100g fresh weight) were determined according to Husia *et al.* (1965).

b. Total carbohydrate percentage in the canes. Total carbohydrates were determined colourimetrically at a wavelength of 490 nm using the phenol-sulphuric acid method (Smith et al., 1956).

6. Statistical analysis:

Obtained data were subjected to analysis of variances (ANOVA) according to 40 using the M.S.T.A.T. program. Duncan Multiple Range test 41 was used to compare between means at the probability of 5 %.

RESULTS AND DISCUSSIONS

1. Vegetative growth:

1.1 Bud burst (%):

The data presented in Tables (5) revealed that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly enhanced the percentages of bud burst (%) compared with control. However, the statistical analysis pointed to non-significant differences for the bud burst (%) interaction between the treatments; the highest data was recorded in the first season by Dormex × Nano (Fe + Zn) were (97.23%), the highest values in the second and third seasons recorded by Dormex × *C. vulgaris* (97.92, and 98.61%).

1.2 Main shoot length (cm):

The data shown in Tables (6) demonstrated that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly improved the main shoot length (cm) compared with control. Moreover, the statistical analysis stated significant differences for the the main shoot length (cm) due to the interaction between the check treatments, the maximum values in the main shoot length (145.4, 156.9 and 153.0 cm were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Arioli *et al., (*2020) and Hussain *et al., (*2021).

1.3 Number of leaves per shoot:

The data provided in Tables (7) suggested that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly optimized the number of leaves/shoot compared with control. Besides, the statistical analysis declared significant differences for the number of leaves/shoot due to the interaction between the check treatments, the maximum values in the number of leaves/shoot (37.33, 40.74 and 39.99) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Omran *et al.* (2005); Hussain *et al., (*2021).

1.4 Leaf area (cm^2):

The data presented in Tables (8) revealed that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly enhanced the Leaf area (cm^2) compared with control. The statistical analysis showed significant differences for the Leaf area (cm^2) interaction between the treatments; the highest data (145.3, 150.7 and 149.2 cm^2) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Omran *et al.* (2005); Abo El-Ez *et al.* (2018); Arioli *et al., (*2020) and Hussain *et al., (*2021).

1.5 Weight of pruning wood (kg/vine):

The data presented in Tables (9) indicated that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly enhanced the weight of pruning wood (kg/vine) compared with control. furthermore, the statistical analysis declared significant differences for the weight of pruning wood (kg/vine) due to the interaction between the check treatments, the maximum values in the weight of pruning wood (2.94, 3.51 and 3.34 kg/vine) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Omran *et al.* (2005); Faheed and Abd-El Fattah (2008); Abd El Moniem and Abd-Allah (2008); Arora *et al.* (2011); Abo El-Ez *et al.* (2018); Arioli *et al., (*2020) and Hussain *et al., (*2021).

Table 5. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the percentages of bud burst % of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorme	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	74.30^b	74.30^b	79.17^d	79.17^d	74.31^e	74.31^e
T2	97.22^a	93.06^a	96.5^{ab}	92.97^c	97.22^a	90.97^{cd}
T3	97.22^a	93.75^a	97.22^a	93.06^{bc}	97.92^a	93.06^{cd}
T4	95.83^a	93.75^a	96.53^{ab}	95.83^{ab}	96.53^{ab}	92.28^{cd}
T5	96.53^a	93.75^a	95.83^{ab}	95.83^{ab}	97.92^a	92.36^{cd}
T6	96.53^a	94.44^a	97.92^a	95.83^{ab}	98.61^a	93.75^{bc}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 6. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the main shoot length (cm) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorme	*A. coffeaeform*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	110.3^h	110.3^h	112.2^g	112.2^g	113.6^i	113.6^i
T2	128.1^f	122.8^g	128.4^e	122.5^f	127.9^g	121.5^h
T3	130.7^{ef}	128.6^f	136.2^d	128.2^e	134.9^f	129.1^g
T4	139.9^{bc}	133.9^{de}	147.7^c	138.1^d	142.3^{cd}	137.0^{ef}
T5	143.3^{ab}	137.0^{cd}	151.6^b	146.6^c	147.4^b	139.6^{de}
T6	145.4^a	141.5^{abc}	156.9^a	149.0^{bc}	153.0^a	145.6^{bc}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 7. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the number of leaves per shoot of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorme	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	17.00^{i}	17.00^{i}	19.58^{g}	19.58^{g}	18.43^{f}	18.43^{f}
T2	21.93^{g}	19.54^{h}	24.80^{f}	21.43^{g}	22.89^{e}	19.99^{f}
T3	24.77^{f}	22.70^{fg}	29.23^{e}	26.00^{f}	25.00^{e}	23.43^{e}
T4	31.30^{cd}	27.32^{e}	37.31^{bc}	29.00^{e}	32.99^{c}	28.43^{d}
T5	34.83^{b}	30.33^{d}	39.22^{ab}	33.22^{d}	36.91^{b}	32.89^{c}
T6	37.33^{a}	33.57^{bc}	40.74^{a}	35.73^{c}	39.99^{a}	34.78^{bc}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 8. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the leaf area (cm^2) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorme	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	97.5^{g}	97.5^{g}	117.7^{g}	117.7^{g}	106.9^{g}	106.9^{g}
T2	118.1^{ef}	115.8^{f}	124.0^{ef}	122.8^{f}	120.0^{f}	117.2^{f}
T3	123.2^{d}	119.9^{de}	127.8^{de}	125.4^{ef}	125.1^{e}	120.4^{f}
T4	128.5^{c}	126.9^{c}	131.9^{cd}	130.9^{d}	130.7^{cd}	128.7^{d}
T5	137.9^{b}	129.7^{c}	141.7^{b}	136.1^{c}	139.9^{b}	134.0^{c}
T6	145.3^{a}	139.3^{b}	150.7^{a}	144.2^{b}	149.2^{a}	139.9^{b}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 9. Effect of foliar spray with Seaweed extract, Nano size fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the weight of pruning wood (kg/vine) of Flame seedless grapevines during 2020, 2021, and 2022 seasons.

Treatments	2020		2021		2022	
	Dorm	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	1.37^{i}	1.37^{i}	1.56^{h}	1.56^{h}	1.40^{h}	1.40^{h}
T2	1.53^{h}	1.45^{hi}	1.88^{fg}	1.74^{g}	1.80^{fg}	1.70^{g}
T3	1.72^{g}	1.53^{h}	2.11^{e}	1.99^{ef}	2.03^{e}	1.86^{f}
T4	2.13^{e}	1.96^{f}	2.80^{c}	2.56^{d}	2.59^{d}	2.45^{d}
T5	2.56^{c}	2.33^{d}	3.01^{b}	2.83^{c}	2.93^{b}	2.76^{c}
T6	2.94^{a}	2.74^{b}	3.51^{a}	3.13^{b}	3.34^{a}	3.06^{b}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

2. Leaf and canes chemical composition:

2.1 Leaf content of Fe:

The data presented in Tables (10) revealed that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly enhanced the leaf content of Fe compared with control. However, the statistical analysis declared significant differences for the leaf content of Fe due to the interaction between the treatments; the highest data (141.6, 151.6 and 147.5 mg/100g) was recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These results are consistent with those reported by Zhang and Ervin (2004); Alalaf *et al.*, (2020), Ali *et al.*,(2021); Hussain *et al. (*2021) and Mohebbi *et al.* (2022).

2.2 Leaf content of Zn (mg/100g):

The data shown in Tables (11) demonstrated that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly improved the leaf content of Zn (mg/100g) compared with control. Additionally, the statistical analysis declared significant differences for leaf content of Zn (mg/100g) due to the interaction between the check treatments, the maximum values in the leaf content of Zn (28.21, 32.32 and 31.18 mg/100g) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Arioli *et al.*, *(*2020) and Rouphael and Colla (2020); Mohamed (2020); Alalaf *et al.*, (2020), Ali *et al.*(2021); Hussain *et al. (*2021) and Mohebbi *et al.* (2022).

2.3 Total Chlorophyll (mg/g F.W.):

The data provided in Tables (12) suggested that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly optimized the total Chlorophyll (mg/g F.W.) compared with control. Besides, the statistical analysis pointed to significant differences for the total Chlorophyll (mg/g F.W.) due to the interaction between the check treatments, the maximum values (5.51, 6.45 and 6.07 mg/g F.W.) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Stino *et al.(*2017); Mattner *et al. (*2018); Amer *et al.*, (2019); Arioli *et al.* (2020); Rouphael and Colla (2020); Mohamed (2020); Alalaf *et al.*, (2020), Ali *et al.*(2021); Hussain *et al. (*2021) and Mohebbi *et al.* (2022).

2.4 Total carbohydrate (%) in cans:

The data presented in Tables (13) revealed that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly enhanced the total carbohydrate (%) compared with control. The statistical analysis showed significant differences for the total carbohydrate (%) due to interaction between the treatments; the highest data (37.00, 39.33 and 38.50 %) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Zhang and Ervin (2004); Abd El Moniem and Abd-Allah (2008); Mahmood-ul-Hassan (2008); Papenfus *et al*. (2013); Ahmed *et al.* (2014), Arioli *et al. (*2015), Battacharyya *et al. (*2015); Kamiab and Zamanibahramabadi (2016); Stino *et al.(*2017); Mattner *et al. (*2018); Amer *et al.*, (2019); Arioli *et al.* (2020); Rouphael and Colla (2020); Mohamed (2020); Alalaf *et al.*, (2020), Ali *et al.*(2021); Hussain *et al. (*2021) and Mohebbi *et al.* (2022).

Table 10. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the leaf content of Fe (mg/100g) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dormex	*A. coffeaeformi*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	61.7^{h}	61.7^{h}	74.3^{i}	74.3^{i}	69.2^{k}	69.2^{k}
T2	115.8^{f}	111.8^{g}	121.8^{g}	115.8^{h}	116.8^{i}	112.1^{j}
T3	125.1^{e}	117.9^{f}	127.1^{f}	120.2^{g}	125.9^{g}	119.7^{h}
T4	129.5^{d}	126.6^{de}	146.3^{c}	133.6^{e}	133.7^{e}	129.5^{f}
T5	141.6^{b}	138.9^{bc}	151.6^{b}	140.9^{d}	147.5^{b}	140.2^{d}
T6	146.7^{a}	137.5^{c}	160.6^{a}	146.7^{c}	151.5^{a}	143.5^{c}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 11. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the leaf content of Zn (mg/100g) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorme	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	14.56^{h}	14.56^{h}	15.03^{i}	15.03^{i}	14.68^{j}	14.68^{j}
T2	18.82^{ef}	17.30^{g}	18.99^{g}	17.88^{h}	18.79^{h}	17.45^{i}
T3	19.62^{e}	18.04^{fg}	20.74^{f}	19.24^{g}	19.98^{g}	18.81^{h}
T4	25.27^{c}	22.54^{d}	27.02^{d}	24.61^{e}	26.51^{e}	24.37^{f}
T5	27.33^{b}	25.44^{c}	30.60^{b}	29.03^{c}	28.88^{c}	27.60^{d}
T6	28.21^{a}	26.50^{b}	32.32^{a}	30.87^{b}	31.18^{a}	30.27^{b}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 12. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the total Chlorophyll (mg/g F.W.) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorm	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	1.79^{j}	1.79^{j}	2.24^{k}	2.24^{k}	2.10^{j}	2.10^{j}
T2	2.16^{i}	2.49^{h}	3.36^{i}	2.94^{j}	3.20^{h}	2.94^{i}
T3	2.97^{f}	2.63^{g}	3.62^{g}	3.55^{h}	3.46^{g}	3.19^{h}
T4	4.74^{d}	4.53^{e}	5.35^{e}	5.26^{f}	5.15^{e}	4.89^{f}
T5	4.88^{c}	4.76^{d}	5.94^{c}	5.53^{d}	5.57^{c}	5.23^{d}
T6	5.51^{a}	5.13^{b}	6.45^{a}	6.02^{b}	6.07^{a}	5.63^{b}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 13. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the total carbohydrate (%) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorm	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	18.90^{j}	18.90^{j}	21.33^{j}	21.33^{j}	20.33^{i}	20.33^{i}
T2	24.00^{h}	22.97^{i}	26.33^{h}	24.30^{i}	25.50^{fg}	23.77^{h}
T3	25.13^{g}	23.90^{hi}	27.17^{g}	26.00^{h}	26.33^{f}	25.13^{g}
T4	30.00^{e}	28.67f	34.67^{d}	31.20^{f}	33.00^{d}	30.40^{e}
T5	35.00^{b}	31.33^{d}	38.57^{b}	33.50^{e}	37.47^{b}	32.50^{d}
T6	37.00^{a}	33.90^{c}	39.33^{a}	36.40^{c}	38.50^{a}	35.80^{c}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

3. Yield characteristics:

3.1 Number of clusters/vine:

A perusal of data depicted in Tables (14) show the impact of treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly improved the number of clusters/vine compared with control. However, the statistical analysis declared significant differences for number of clusters/vine due to the interaction between the treatments; the highest data (28.67, 36.00, and 31.67) was recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in the three seasons, respectively. These findings are in harmony with those reported by Abd El Moniem and Abd-Allah (2008); Stino *et al. (*2017); Mattner *et al. (*2018); Amer *et al. (*2019), Ghadakchi *et al.* (2019), Arioli *et al., (*2020); Hussain *et al., (*2021) and Abo El-Ezz *et al.*, (2022).

3.2 Cluster weight (g.):

The data shown in Tables (15) demonstrated that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly improved the cluster weight (g.) compared with control. Additionally, the statistical analysis declared significant differences for cluster weight (g.) due to the interaction between the check treatments, the maximum values in cluster weight (394.0, 461.2 and 428.8 g.) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Hussain *et al., (*2021) and Abo El-Ezz *et al.*, (2022).

3.3 yield/vine (kg.):

The data provided in Tables (16) suggested that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly optimized the yield/vine (kg.) compared with control. Besides, the statistical analysis pointed significant differences for the yield/vine (kg.) due to the interaction between the check treatments, the maximum values (11.30, 16.59, and 13.58 kg) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in the three seasons, respectively. These findings are in harmony with those reported by Abd El Moniem and Abd-Allah (2008); Stino *et al. (*2017) and Abo El-Ezz *et al.*, (2022).

Table 14. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the number of clusters/vine of Flame seedless grapevines during 2020, 2021, and 2022 seasons.

Treatments	2020		2021		2022	
	Dorme	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	14.6^{f}	14.6^{f}	16.6^{g}	16.6^{g}	16.0^{g}	16.0^{g}
T2	19.3^{e}	17.3^{ef}	22.3^{ef}	20.6^{f}	20.6^{ef}	19.6^{f}
T3	20.3^{de}	18.6^{e}	24.0^{e}	21.6^{f}	23.0^{de}	20.3^{ef}
T4	24.33^{bc}	22.67^{cd}	29.33^{c}	26.67^{d}	26.67^{bc}	23.00^{de}
T5	26.00^{ab}	24.00^{bc}	32.33^{b}	29.00^{c}	29.67^{a}	25.33^{cd}
T6	28.67^{a}	26.33^{ab}	36.00^{a}	30.67^{bc}	31.67^{a}	29.00^{ab}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 15. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the cluster weight (g.) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorme	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	159.6^{i}	159.6^{i}	183.4^{h}	183.4^{h}	166.8^{e}	166.8^{e}
T2	207.1^{gh}	202.1^{h}	214.3^{fg}	198.8^{gh}	210.7^{d}	192.5^{de}
T3	214.4^{g}	207.4^{gh}	226.4^{f}	205.0^{g}	215.8^{d}	208.6^{d}
T4	297.7^{e}	284.0^{f}	379.7^{c}	308.1^{e}	345.6^{b}	304.6^{c}
T5	344.6^{c}	323.8^{d}	414.1^{b}	361.4^{d}	399.0^{a}	331.7^{bc}
T6	394.0^{a}	363.4^{b}	461.2^{a}	415.1^{b}	428.8^{a}	402.4^{a}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 16. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the yield/vine (kg.) of Flame seedless grapevines during 2020, 2021, and 2022 seasons.

Treatments	2020		2021		2022	
	Dormex	*A. coffeaeformis*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	2.33g	2.33g	3.05j	3.05j	2.67g	2.67g
T2	4.00ef	3.50f	4.79h	4.10i	4.35ef	3.79f
T3	4.36e	3.87ef	5.43g	4.44hi	4.96e	4.24ef
T4	7.247cd	6.440d	11.14d	8.217f	9.203c	7.000d
T5	8.950b	7.770c	13.37b	10.49e	11.84b	8.407c
T6	11.30a	9.557b	16.59a	12.73c	13.58a	11.67b

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

4. Berry quality characteristics:

4.1 T.S.S (%):

The data depicted in Table (17) show the impact of treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly improved the T.S.S (%) compared with control. However, the statistical analysis declared significant differences for the T.S.S (%) due to the interaction between the treatments; the highest data in the T.S.S (18.53, 18.07 and 18.13 %) was recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in the three seasons, respectively. These findings are in harmony with those reported by Abd El Moniem and Abd-Allah (2008); Stino *et al. (*2017); Hussain *et al., (*2021) and Abo El-Ezz *et al.,* (2022).

4.2 Total acidity (%):

The data shown in Tables (18) demonstrated that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly decreased the total acidity (%) compared with control. Additionally, the statistical analysis declared significant differences for total acidity (%)due to the interaction between the check treatments, the lowest values in total acidity (0.51, 0.52 and 0.51 %) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in 2020, 2021 and 2022 seasons, respectively. These data are in harmony with those reported by Stino *et al. (*2017); Mattner *et al. (*2018); Amer *et al. (*2019), Ghadakchi *et al.* (2019), Arioli *et al., (*2020); Hussain *et al., (*2021) and Abo El-Ezz *et al.*, (2022).

4.3 Anthocyanin (mg/100 g F.Wt.):

The data provided in Tables (19) suggested that treating the vines with Seaweed extract, nanosize fertilizers (Fe, Zn N.P.s), and conventional fertilizers (Fe, Zn EDTA) significantly optimized the anthocyanin (mg/100 g F.Wt.) compared with control. Besides, the statistical analysis expressed significant differences for the anthocyanin (mg/100 g F.Wt.) due to the interaction between the check treatments, the maximum values (31.60, 28.43 and 29.83 mg/100 g F.Wt.) were recorded by Dormex × *C. vulgaris* + Nano (Fe + Zn) in the three seasons, respectively. These findings are in harmony with those reported by Stino *et al. (*2017).

Table 17. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the T.S.S (%) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorme	*A. coffeaefo*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	11.40bc	11.40bc	12.07g	12.07g	12.47g	12.47g
T2	15.93a	15.33ab	15.07f	14.87f	15.20ef	15.07f
T3	16.27a	15.85ab	15.40ef	15.20f	15.53e	15.20ef
T4	17.27a	16.33a	16.53bc	15.93de	16.93c	16.47d
T5	18.20a	16.60a	16.93b	16.27cd	17.73b	16.93c
T6	18.53a	17.07a	18.07a	16.47bcd	18.13a	17.00c

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 18. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the total acidity (%) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorm	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	0.79^{a}	0.79^{a}	0.75^{a}	0.75^{a}	0.76^{a}	0.76^{a}
T2	0.69^{c}	0.71^{b}	0.70^{bc}	0.71^{b}	0.71^{bc}	0.73^{b}
T3	0.66^{d}	0.70^{b}	0.69^{c}	0.70^{bc}	0.69^{d}	0.70^{cd}
T4	0.57^{f}	0.62^{e}	0.58^{e}	0.61^{d}	0.55^{gh}	0.59^{e}
T5	0.53^{g}	0.57^{f}	0.53^{f}	0.57^{e}	0.53^{h}	0.57^{f}
T6	0.51^{h}	0.54^{g}	0.52^{g}	0.56^{e}	0.51^{i}	0.55^{fg}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

Table 19. Effect of foliar spray with Seaweed extract, nanosize fertilizers (Fe, Zn NPs), and conventional fertilizers (Fe, Zn EDTA) single or mixture on the anthocyanin (mg/100 g F.Wt.) of Flame seedless grapevines during 2020, 2021 and 2022 seasons.

Treatments	2020		2021		2022	
	Dorm	*A. coffeaefor*	Dormex	A.coffeaeformis	Dormex	A.coffeaeformis
T1	16.27^{k}	16.27^{k}	16.17^{g}	16.17^{g}	17.40^{j}	17.40^{j}
T2	23.07^{h}	21.33^{j}	19.90^{f}	19.63^{f}	20.60^{h}	19.77^{i}
T3	24.77^{f}	22.70^{i}	21.43^{e}	21.23^{e}	21.79^{f}	21.30^{g}
T4	26.60^{d}	24.37^{g}	25.33^{c}	23.67^{d}	26.70^{d}	25.57^{e}
T5	29.50^{b}	25.77^{e}	26.77^{b}	25.50^{c}	28.67^{b}	26.63^{d}
T6	31.60^{a}	27.43^{c}	28.43^{a}	26.73^{b}	29.83^{a}	27.57^{c}

Mean separation within each column by Duncan multiple ranges (0.05); Means with similar letters are insignificantly different.

CONCLUSION

So, it is concluded that the combined foliar application dormix 5% first week of Jan. once and *C. vulgaris* at 1ml/l and (Nano Fe + Zn) 1_{ppm} applied three times on the same vines at fruit set, berry size 6:8 mm and at veraison stage led to clear enhancements in the majority of the tested vegetative and fruiting parameters of Flame seedless grapevines.

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تأثير الرش الورقي بمستخلص الاعشاب البحرية (*Chlorella vulgaris*) واسمدة النانو على نمو الكرمة والمحصول وجودة العنقود فى صنف العنب فليم سيدلس.

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الملخص العربي

اجريت هذه الدراسة خلال ثلاثة مواسم متتالية فى الاعوام 2020 ،2021 و 2022 على 36 كرمة عنب صنف فليم سيدلس. تمت التجربة فى مزرعة خاصة بمركز جهينة بمحافظ سوهاج. تهدف الدراسة الى تقييم استجابة صفات العنب الخضرية و الثمرية للمعاملة ب كاسرات السكون (هيدروجين السيناميد ومستخلص طحلب الامفورا خلال طور السكون ، بالاضافة الى الرش ورقياً ب اسمدة النانو (حديد + زنك) و مستخلص طحلب الكلوريلا و اسمده تقليدية فى صورة مخلبية (حديد +زنك) ، تم رش هذه المركبات منفرده او مخلوطة بعضها ثلاثة مرات متتالة على نفس الكرمات فى المواعيد الاتية: عند مرحلة العقد ، قطر حبات 6:8 مللى و عند مرحلة الطراوة . سجلت اعلى القيم للصفات الخضرية والثمرية لمعاملة (دورمكس 5% + طحلب الكلوريلا 1 مللى / لتر + اسمدة النانو (حديد+زنك) خلال الثلاثة مواسم مسجلةً نتائج اعلى من اى معاملة اخرى منفردة . تبين من هذه الدراسة ان تطبيق المعاملة بهديروجين السيناميد (درومكس) 5% خلال الاسبوع الاول من يناير مرة واحده، بالاضافة الى تطبيق الرش ورقياً بمخلوط (1مللى/ لتر من مستخلص طحلب الكلوريلا + 1 جزء فى المليون من اسمدة النانو (حديد + زنك) ثلاثة مرات خلال: مرحلة العقد و قطر حبات 6:8 مللى وعند بداية مرحلة الطراوة، ادى الي تحسين بشكل ملحوظ الغالبية العظمى للصفات الخضرية والثمرية لصنف العنب الفليم سيدلس.

الكلمات المفتاحية : اسمدة النانو ، نانو حديد ، نانو زنك ،طحلب الكلوريلا ، طحلب الامفورا.