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Increasing Yield of "Early Sweet" Grapevine by Foliar Application with Seaweed Extract at Different Concentration During Growth Stages

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Abstract: The trial was executed during 2022 and 2023 seasons on 30 "Earl sweet" Seedless grapevines, seven-year-old vines grafted onto Paulsen rootstock grown in a private vineyard located at the West of Matay Center, Minia Governorate, Egypt. To investigate the effect of different concentration of seaweed extract (0.05, 0.1 and 0.2%) and number of sprayings (once, twice and thrice) during growth stages on yield and berries quality of "Earl sweet" Seedless grapevines. Results revealed that, with increasing concentration of seaweed and number of spraying the parameters under investigation was increased except total acidity was decreased. The best treatment was when vines treated with 0.2% seaweed extract thrice (at the beginning of growth, after berry setting and one month later) during both seasons. therefore, to promote yield and berry quality of "Earl sweet" grapevines, it is recommended to spray the grapevines three times with 0.2% of seaweed extract.

Key words: Grape, Earl sweet Seedless, Seaweed extract, Yield, Quality.

INTRODUCTION

Grapes is considered the third-most valuable horticultural crop in the world after citrus and mango (**Alston and Sambucci, 2019**). Grapes are a significant crop for the Egyptian economy; grapevines covered 11.0 million hectares worldwide, yielding 90 million tons of fruit annually (**FAO, 2019**). Its cultivated area reached 190486 fed., yielding approximately 1594781 ton of fruits. Furthermore, grapes are regarded as the most significant crop for export in the horticulture industry; their export value is approximately 10% of the entire horticultural export, despite their quantity being just 3% (**MALR, 2019**). However, according to the **FAO (2019**), Egypt is ranked 32nd globally. Over the last ten years, Egypt's grape output has expanded dramatically. In the recently reclaimed parts of the Egyptian Deserts, new kinds have gained

popularity, especially early ripening cultivars like 'Early Sweet,' which ripens in the third week of May. This cultivar produces seedless, greenish yellow fruits with a fragrant flavor. There is a lot of potential for exporting this cultivar to the Arabic and European markets (**Ali *et al.*, 2023**).

Under the situation of global climate change, viticulture faces new risks and problems. Geographical and climatic limitations on grapevine growing regions are indicative of high quality and optimal yield (**Magalhães, 2008**). Because of the milder winters, there will be more pests and illnesses in the vineyards, which will enhance the impact of climate change on grapevine phenology, production, and berry quality (**Jones, 2013 and Fraga *et al.*, 2017**). The foliar use of bio stimulants to avoid plant diseases and enhance fruit quality on grapevines has emerged as an intriguing method. By acting as plant bio stimulants, foliar applications of bio stimulants improve plant growth and nutrient uptake. An alternative to soil fertilization that reduces some of the environmental impacts caused by fertilizer loss into groundwater, bio stimulants applied topically to plants improve growth and nutrient uptake. The use of these organic substances influences the growth of pathogens, plant physiology, and the varied expression of genes in plants that initiate metabolic processes and defense mechanisms (**Cabo *et al.*, 2021**).

The natural compounds known as marine bioactive substances derived from seaweeds are an important class of bio stimulants (**Shukla *et al.*, 2019; Rouphael and Colla, 2020**). These substances have a favorable effect on plant health, growth, and yield due to their ability to boost metabolism, increase antioxidant content, and improve nutrient availability (**Zhang *et al.*, 2008**). According to **Khan *et al.* (2012**), seaweed (*Ascophyllum nodosum* L.) contains a wide variety of chemicals, including auxins, cytokinins, and other plant growth regulators. It is also rich in organic matter, vitamins, amino acids, sterols, and complex polysaccharides. Thus, seaweed extract is essential for plant metabolism, productivity, and improving plant development, harvest, and fruiting. It has emerged as a key tactic for achieving sustainable agriculture in recent years, particularly in semi-arid and dry locations with soils deficient in organic nutrients (**Cataldo *et al.*, 2022**). Research has shown that seaweed extract can affect the development, yield, and quality of fruit in various grape types, including Flame Seedless, Sangiovese, and Ruby Seedless (**Stino *et al.*, 2017; Salvi *et al.*, 2019 and Masoud *et al.*, 2023**).

Therefore, the current study aims to highlights the effect of foliar application by different concentration of seaweed extract and number of applications on some yield and quality of "Early Sweet" grapes grown under Minia region conditions.

MATERIALS AND METHODS

1- Experimental site

The trial was executed during 2022 and 2023 seasons on 30 "Earl sweet" Seedless grapevines grafted onto Paulsen rootstock grown in a private vineyard located at the West of Matay Center, Minia Governorate, Egypt. The vines were 7 years-old, cultivated at 2 x 3 m apart (700 vines/fed), the selected vines were all about the same level of vigorousness. The soil was clay well drained as indicated in Table (A), the soil analysis with done according to **Wilde *et al*. (1985**), with a water table depth not less than 2m. Surface irrigation system was followed using Nile water.

The vines were pruned during Winter in the two seasons at the first week of Jan. Vine load was 60 eyes/vines. Different treatments resulted in different lengths of fruiting spurs. The gable supporting system was utilized, and all of the chosen vines got standard vineyard horticulture treatments.

2- Treatments description

The experiment was arranged in a randomized complete block design (RCB) during 2022 and 2023 with three replicates and the vines included 10 treatments from different concentration of seaweed extract (0.05, 0.1 and 0.2%) during different time (once (at the beginning of growth), twice (at the beginning of growth and after berry setting), while the thrice (at the beginning of growth, after berry

setting and one month later) comparing to the control treatment (sprayed with tap water). Analysis of used seaweed extract according to (**James, 1994**) indicated in Table (B).

Table (A). Chemical and physical analysis of vineyard soil

Soil characters		2022/2023
Particle size distribution (%)	Sand	2.11
	Silt	37.67
	Clay	60.22
	Texture class	Clay
EC ppm (1:2.5 extract)		300
pH (1:2.5 extract)		7.50
Organic matter %		2.19
$CaCO_3$ %		2.25
Soil nutrients	Total N (%)	0.10
	Available P (ppm)	5.31
	Available K (ppm)	500.9
	Zn (ppm)	2.9
	Fe (ppm)	3.3
	Mn (ppm)	4.0
	Cu (ppm)	0.9

Table (B). Analysis of the seaweed extract

Characters	Value
Moisture%	6.0
O.M%	45-60
Inorganic matter%	45-60
Protein%	6-8
Carbohydrates %	35-50
Aliginic acid%	10-20
Mannitol%	4-7
Total N%	1.0-1.5
P%	0.02-0.09
K%	1.0-1.2
Ca%	0.2-1.5
S%	3-9
Mg%	0.5-0.9
Cu (ppm)	1.0-6.0
Fe (ppm)	50-200
Mn (ppm)	5-12
Zn (ppm)	10-100
B (ppm)	20-100
Mo (ppm)	1-5
Cytokinin %	0.02
IAA %	0.03
ABA%	0.01

3. Data collection

The following parameters were measured to evaluate the effects of different concentration seaweed extract spraying on yield and berry quality.

3.1. Yield and cluster characteristic

Berry setting (%): was calculated as follow: After the initial spraying, two clusters per vine were placed in perforated white cheese bags. These bags were opening, blossoming, and closing. The berry set was calculated as follow:

$$\text{Berry Setting\%} = \frac{\text{Number of berries/cluster}}{\text{total number of flower/cluster}}$$

Number of cluster/vine, average cluster weight (g), Average cluster length, width (cm) and Yield/vine (kg).

3.3. Physical characteristic of the berry

Shoot berry%, average berry weight (g), length and diameter (cm).

3.3. Chemical characteristic of the berry according to (**A.O.A.C., 2000**)

TSS% in the juice hand refractometer, total acidity as a tartaric acid/100 ml juice), TSS/acidity ratio and total sugar%

4. Statistical analysis

Randomized Complete Block Design was used to do statistical analysis (RCBD). New L.S.D. at 5% was used to compare treatment means (**Mead *et al.*, 1993**).

RESULTS AND DISCUSSION

The following results demonstrated the effect of various concentration of seaweed extract at different times on physical and chemical status of berries as well as yield and its components on "Early Sweet" grapevines during 2022 and 2023 seasons.

1. Berry setting%, Yield and cluster characteristic

Data illustrated in Table 1 indicate the effect of foliar application with seaweed extract at different concentrations during different time on "Early Sweet" grapevines yield expressed in berry setting%, number of cluster/vine, average cluster weight, yield/vine, average cluster length and width in comparing with the control treatment.

Statistical analysis of the data presented in the following Table indicated that treatments of seaweed extract (0.05, 0.1 and 0.2%) affected on the berry setting, yield and cluster characteristic of earl sweet grapevine. It is evident that the highest values of mentioned parameters are associated with vines sprayed with 0.2%. The increase in concentrations of seaweed extracts significantly increased the traits during both seasons. In addition, the increase in sprayed time during growth stages also increased berry setting%, number of cluster/vine, average cluster weight, yield/vine, average cluster length and width and the best time with vines spayed three time at the beginning of growth, after berry setting and one month later during both seasons.

Table (1). Effect of spraying seaweed extract at different concentration and frequencies on berry setting, yield and cluster characteristic during 2022 and 2023 seasons

Characteristics / Treatments	Berry setting %		No. of clusters/vine		Average cluster weight (g)		Yield/vine (kg)		Average cluster length (cm)		Average cluster width (cm)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	023
Control	10.3	10.5	30.0	32.0	455.0	459.0	13.6	14.7	17.0	17.2	13.2	13.6
Seaweed extract at 0.05% once	14.0	14.5	30.0	35.0	476.0	475.2	14.3	16.6	20.0	20.3	14.8	14.9
Seaweed extract at 0.05% twice	15.5	16.1	30.0	39.0	486.1	484.3	14.6	18.9	20.6	21.0	15.2	15.3
Seaweed extract at 0.05% thrice	16.6	17.5	30.0	41.0	492.4	492.0	14.8	20.2	21.0	21.4	15.4	15.5
Seaweed extract at 0.1 % once	15.7	16.2	30.0	38.0	487.2	485.2	14.6	18.4	20.7	21.0	15.3	15.2
Seaweed extract at 0.1% twice	17.1	17.8	30.0	42.0	497.3	494.3	14.9	20.8	21.3	21.8	15.8	15.6
Seaweed extract at 0.1% thrice	18.3	19.1	30.0	43.0	504.4	502.4	15.1	21.6	21.6	22.2	16.0	15.8
Seaweed extract at 0.2% once	16.8	17.5	30.0	40.0	493.3	493.2	14.8	19.7	21.0	21.5	15.5	15.4
Seaweed extract at 0.2% twice	18.3	19.2	30.0	44.0	504.3	502.3	15.1	22.1	21.7	22.2	15.9	15.8
Seaweed extract at 0.2% thrice	19.4	20.4	30.0	45.0	510.4	510.5	15.3	23.0	22.0	22.7	16.0	16.0
New LSD at 0.5	**1.0**	**1.2**	**N.S.**	**2.0**	**6.0**	**7.5**	**0.2**	**0.9**	**0.3**	**0.4**	**0.1**	**0.2**

According to **Khan *et al.* (2012**), seaweed extract may have improved cell division, raised endogenous levels of growth promoters, macro- and micronutrients, carbohydrates, and hormones, particularly cytokinins, which result in larger fruits and weights. It may also have raised the natural peak of polyamine concentration in fruits. Our findings corroborate those of previous field trials that found that seaweed extract increased yield and its component. **Abo-Zaid *et al.* (2019**) reported that compared to the control group, and the recommended was spraying seaweed four times: once at the beginning of growth after flowering (first. of April), once just after berry setting (mid. of April), once a month later (mid. of May), and two weeks later (last of May). This would improve cluster characteristics, increase fruit yield. **Omar *et al.*, (2020**) on Flame Seedless; **Mohamed *et al.* (2021**) on Early Sweet; **El-Senosy (2022**) on Flame Seedless and **Al-Sagheer *et al.*, (2023)** on Thompson seedless, increasing concentration of seaweed extract from 0.05 to 0.2% improved yield (cluster number, yield/vine, cluster weight, length and width).

2. Berry physical characteristic

Morph-physical parameters of grapevine "Earl Sweet" as shoot berry, average berry weight, length and diameter are a crucial factor for good marketing either locally, regionally or globally as affected by foliar application with seaweed extract in different times during growth stages at different concentrations 0.05, 0.1 and 0.2% in comparing to the control treatments during seasons of 2022 and 2023 are presented in Table 2.

With regard to the effect of seaweed extract, data in Table 2 exert a significant effect on berry physical characteristic of the grapevine. Generally foliar application of vines during growth stages at different concentrations of seaweed extract decreased the shoot berry% and caused a significant increase in the average berry weight, length and diameter. The highest mean value of the shoot berry% was realized with the untreated plants (foliar with tap water), while the lowest mean values scored with the highest concentration of seaweed extract (0.2%) sprayed at the beginning of growth, after berry setting and one month later. On the contrary, the highest mean values of other physical parameters were recorded with increasing the concentration of seaweed extract up to 0.2% at the beginning of growth, after berry setting and one month later (three times) was the best for recording the highest mean values of average berry weight during 2022 and 2023 seasons.

The high mean values of physical traits of berries due to increasing seaweed extract are in agreement with those obtained by **Omar *et al.*, (2020**) on Flame Seedless; **Mohamed *et al.* (2021**) on Early Sweet; **El-Senosy (2022**) on Flame Seedless and **Al-Sagheer *et al.*, (2023)** on Thompson seedless, they all indicated that vines treated with the higher levels of seaweed led to an increase in physical parameters of berries as (berry weight, length, diameter and shape index).

Table (2). Effect of spraying seaweed extract at different concentration and frequencies on shoot berry %, average berry weight (g), berry length and berry diameter of early sweet grapevines during 2022 and 2023 seasons

Characteristics / Treatments	Shoot berry %		Average berry weight (g)		Berry length (cm)		Berry diameter (cm)	
	2022	2023	2022	2023	2022	2023	2022	2023
Control	7.9	8.0	4.20	4.25	2.00	1.95	1.90	1.93
Seaweed extract at 0.05% once	6.9	7.1	4.53	4.55	2.10	2.05	2.02	2.05
Seaweed extract at 0.05% twice	6.3	6.5	4.62	4.65	2.16	2.09	2.07	2.10
Seaweed extract at 0.05% thrice	5.9	6.2	4.69	4.73	2.18	2.11	2.09	2.13
Seaweed extract at 0.1 % once	6.2	6.6	4.63	4.66	2.15	2.10	2.06	2.11
Seaweed extract at 0.1% twice	5.7	6.1	4.71	4.75	2.22	2.14	2.11	2.16
Seaweed extract at 0.1% thrice	5.3	5.9	4.77	4.82	2.24	2.16	2.13	2.19
Seaweed extract at 0.2% once	5.9	6.3	4.70	4.74	2.18	2.12	2.08	2.14
Seaweed extract at 0.2% twice	5.3	5.9	4.78	4.82	2.25	2.15	2.12	2.19
Seaweed extract at 0.2% thrice	4.9	5.6	4.84	4.90	2.27	2.17	2.14	2.21
New LSD at 0.5	**0.4**	**0.3**	**0.06**	**0.07**	**0.02**	**0.01**	**0.01**	**0.02**

3. Berry chemical quality characteristics

Results depicted in Table 3 express the average values of chemical quality characters (TSS%, total acidity, TSS/acidity ratio and total sugar) of grapevine cv. 'Earl Sweet' as affected by foliar application with seaweed extract and number of foliar times during seasons of 2022 and 2023.

The effect of foliar application on grapevine with seaweed extract concentrations for one, two- and three-times during growth stages showed in Table 3. All concentration of seaweed extract was significantly affected in TSS%, total acidity, TSS/acidity ratio and total sugar content of grapevine berries comparing to the untreated plants. The highest mean values were recorded with 0.2% thrice as (20.8-21.1%) for TSS%, (31.0-31.4) for TSS/acidity and (19.8-20.8%) for total sugar, respectively during 2022 and 2023. While the total acidity content was decreased with increasing both of seaweed concentration and number of sprayings. This means that, the highest values of total acidity scored with untreated plants as (0.750 and 0.738 %), while the best reduction recorded with the vines treated with 0.2% seaweed extract as (0.72 and 0.673%) in the two seasons, respectively.

Some enzymes in seaweed extract boost the production of several phytohormones, proteins, sugars, and amino acids; as noted by **Khan *et al.* (2012) and Petoumenou and Patris (2021),** this is linked to an increase in TSS%, total sugar% and a decrease in total acidity % in grape juice. The obtained data also are in accordance with those of **Mohamed *et al.* (2021**) on Early Sweet; **El-Senosy (2022**) on Flame seedless; **Al-Sagheer *et al.* (2023)** on Thompson seedless, they found that compared to the control,

TSS%, TSS/acid, sugar percentage, and total acidity percentage all increased with increasing concentration of seaweed extract.

Table (3). Effect of spraying seaweed extract at different concentration and frequencies on TSS%, total acidity, TSS/acidity and total sugar% of early sweet grapevines during 2022 and 2023 seasons

Characteristics / Treatments	TSS%		Total acidity%		TSS/acidity ratio		Total sugar%	
	2022	2023	2022	2023	2022	2023	2022	2023
Control	18.6	19.3	0.750	0.738	24.8	26.2	17.0	18.0
Seaweed extract at 0.05% once	19.3	19.9	0.725	0.716	26.6	27.8	18.0	19.2
Seaweed extract at 0.05% twice	19.9	20.4	0.710	0.703	28.0	29.0	18.6	19.8
Seaweed extract at 0.05% thrice	20.2	20.6	0.700	0.693	28.8	29.7	19.0	20.1
Seaweed extract at 0.1 % once	19.8	20.4	0.711	0.702	27.8	29.1	18.7	19.7
Seaweed extract at 0.1% twice	20.4	20.7	0.694	0.690	29.4	30.0	19.3	20.3
Seaweed extract at 0.1% thrice	20.6	20.9	0.683	0.681	30.2	30.7	19.6	20.5
Seaweed extract at 0.2% once	20.2	20.6	0.700	0.691	28.6	29.8	19.1	20.0
Seaweed extract at 0.2% twice	20.7	20.9	0.684	0.681	30.2	30.7	19.6	20.6
Seaweed extract at 0.2% thrice	20.8	21.1	0.672	0.673	31.0	31.4	19.8	20.8
New LSD at 0.5	**0.1**	**0.02**	**0.01**	**0.08**	**0.8**	**0.7**	**0.2**	**0.2**

Conclusion

Therefore, under the same condition, it is recommended to apply seaweed extract three times at a 0.2% concentration to increase the quantitative production of "Early Sweet" grapevines and the best results in terms of berry quality.

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