EFFECT OF VINE LOAD AND SEAWEED EXTRACT ON THE GROWTH AND YIELD OF GRAPE VINES (VITIS VINIFERA L.), SHATTER AL-ANZ CULTIVAR

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Article info	Abstract
  	The experiment was conducted in the grape orchard of the Department of Horticulture and Landscape at the College of Agriculture / Tikrit University during the 2023 growing season, to study the effect of vine load at three levels (30, 40 and 50) eyes vine^{-1} and spraying with seaweed extract at three levels (0, 20 and 40) mL L^{-1} at a rate of three sprays during the study period, with an interval of 10 says between one spray and next, on some characteristics of vegetative growth and yield of grape vines cultivar Shatter Al-Anz, 5 years old. Results obtained were summarized as follows: Level 50 eyes vine^{-1} led to a significant improvement in the studied traits (Leaves area, percentage of chlorophyll, number of clusters, total yield, Percentage of TSS and sugars and total acidity), reaching (9.29 m^2, 35.32 SPAD unit, 26.61 cluster vine^{-1}, 9.21 kg, 16.86%, 15.94% and 0.51%) respectively. While level 30 eyes vine^{-1} led to a significant improvement in the weight of cluster, reaching 412.67 g. Spraying with seaweed extract at two concentrations of 20 and 40 mL L^{-1} led to a significant increase in the leaves area, percentage of chlorophyll, number and weight of bunches, total yield, percentage of TSS and total sugar comparing to the control treatment, reaching (8.31, 8.56 m^2, 34.65, 35.11 SPAD unit, 21.17, 21.50 cluster vine^{-1},

380, 392 gm, 7.83, 8.29 kg, 16.48, 16.94% and 15.70, 15.93%) respectively. The bilateral interaction between the levels of factors included in the study had a significant effect on most of the studied characteristics.

تأثير مستوى التحميل والرش بمستخلص الطحالب البحرية في بعض صفات النمو وحاصل العنب صنف شطر العنز

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الخلاصة

اجريت التجربة في بستان العنب التابع لقسم البستنة وهندسة الحدائق في كلية الزراعة/ جامعة تكريت خلال موسم النمو 2023 لدراسة تأثير حمولة الكرمة بثلاث مستويات (30، 40، 50) عين كرمة$^{-1}$ والرش بمستخلص الطحالب البحرية بثلاث مستويات (0، 20، 40) مل لتر$^{-1}$ بمعدل ثلاث رشات خلال فترة الدراسة بفاصل 10 ايام بين الرشة والاخرى على بعض صفات النمو الخضري والحاصل لكرمات العنب صنف شطر العنز بعمر 5 سنوات.

ولخصت النتائج التي تم الحصول عليها بما يلي: ادى المستوى 50 عين كرمة$^{-1}$ الى تحسين من الصفات المدروسة بصورة معنوية (المساحة الورقية للكرمة ونسبة الكلوروفيل في الاوراق وعدد العناقيد والحاصل الكلي ونسبة المواد الصلبة الذائبة والسكريات والحموضة الكلية) اذ بلغ (9.29 م^2، SPAD unit 35.32، 26.61 عنقود كرمة$^{-1}$، 9.21 كغم، 16.86%، 15.94%، 0.51%) على التوالي، بينما ادى المستوى 30 عين كرمة$^{-1}$ الى تحسن معنوي في وزن العنقود اذ بلغ 412.67 غم. وادى الرش بمستخلص الاعشاب البحرية بتركيزين 20 و40 مل لتر$^{-1}$ الى زيادة معنوية في المساحة الورقية للكرمة ونسبة الكلوروفيل في الاوراق وعدد ووزن العناقيد والحاصل الكلي ونسبة المواد الصلبة الذائبة والسكريات الكلية مقارنة مع معاملة المقارنة اذ بلغ (8.31، 8.56 م^2 و34.65، SPAD unit 35.11، 21.17، 21.50 عنقود كرمة$^{-1}$، 380.67، 392.00 غم، 7.83، 8.29 كغم، 16.48، 16.94%، 15.70، 15.93%) على التوالي، وكان للتداخل الثنائي بين مستويات العوامل الداخلة في الدراسة تأثير معنوي في اغلب الصفات المدروسة.

كلمات مفتاحية: مستوى التحميل، مستخلص الطحالب البحرية، Vitis vinifera L.، شطر العنز.

Introduction

Grapes (*Vitis vinifera* L.) belong to the Vitaceae family. They are among the widely consumed fruits in the world and have great economic returns due to their high nutritional value, as they contain a high percentage of the sugars glucose, fructose, and organic acids such as malic, tartaric, citric, and a little protein, fats, some types of vitamins A, B1, B2, B6, and C and many mineral elements K, P, Ca, Fe, Mg, Si, Na and Mn (7 and 9). It is described medically as a stimulant for the brain cells and heart muscles and a tonic for the liver and kidneys. It is used in the treatment of cancer, as it inhibits the formation of swelling and stops DNA damage, it is used as an alcoholic drink and reduces the incidence of diseases of the stomach, intestines and urinary system (12). There are more than 100 varieties of grapes grown in Iraq, including the Shatter Al-Anz variety, which is a good table variety with conical clusters with prominent shoulders and is large in size and weight, the berry are cylindrical in shape and slightly tapered, white or amber yellow in color, the skin is thin and the pulp is firm in consistency, it is a late-maturing variety, its cultivation is widespread in the central region of Iraq, but its yield is low due to the fall of a high percentage of flowers, which leads to a lack of nodes (7).

Pruning is considered as one of the important operations performed on grapes annually in order to achieve a balance between the vegetative and fruiting systems to obtain a balanced production of high quality, prolong the life of the vine, and ensure the presence of the fruiting parts for the coming year, vine load is one of the basic processes that determine the level and quality of grape production in terms of the number of eyes left on the fruiting cane (7 and 27).

Al-Musawi, (6) Found that leaving 4 buds on cuttings of grape seedling cultivar Francy gave the highest rate of total leaf area and chlorophyll content in the leaves, with a significant superiority compared to 2 and 3 buds on cuttings. When Shalan (25) studied the effect of pruning on grape varieties Flame Seedless with leaves 2,3,4 and 5 (nodes cm^{-2} TCSA), the number of 2 nodes outperformed the rest of the levels in terms of leaf area, weight of clusters and percentage of total dissolved solids, for both years of the study, and significantly at the rest of the levels, while the level of 5 eyes was significantly higher in the number of clusters, cluster weight, and total acidity percentage for both years of the study. In the study Kumar *et al*., (19) on the effect of pruning severity on grapes the Muscat Hamburg variety, it was found that leaving 9 buds on the cane gave the highest rate of leaf area and total vine yield, with significant superiority over other levels. Farhan *et al*., (11) Showed in their study on grapes of the White Intensity variety that pruning the cane at the 2 eyes level significantly increased the average leaf area and number of clusters, reaching (117.26 m^2, 3.89 clusters vine^{-1}), respectively, compared to the other levels.

Seaweed extract are among the materials that are used after drying or extracting them as a mineral source for plants because they contain a large percentage of growth-promoting substances in addition to amino acids, nutrients, and vitamins, it also has significant physiological effects on the plant when sprayed or added to the soil, as it increases the plant ꞌs tolerance to salinity and drought and protects the plant from

disease, it is considered an organic source used in agricultural production at a rate of 15 million tons annually in various parts of the world (2 and 26).

In this field, Kok *et al*., (18) explained that spraying grape vine Trakya Ilkeren cultivar with seaweed extract at a concentration of 1000 mg L^{-1} led to a significant increase in the yield of the vine and the total acidity of the fruits, while spraying at a concentration of 5000 mg L^{-1} led to significant increase in the cluster weight, and percentage of total dissolved solids at a concentration of 3000 mg L^{-1} increased significantly compared to the rest of the concentrations. Hussein *et al*., (14) Found that when spraying Salimi pomegranate trees with a concentration of 10 mg L^{-1} of seaweed extract Alga 300, it led to a significant increase in leaf area, average number, size and weight of fruits. Percentage of total dissolved solids, and total yield compared to spraying with concentrations of 0 and 5 mg L^{-1}. Abd El Moniem, and Abd-Allah (1) Showed that spraying 5-year-old grapes with 75% seaweed extract led to a significant increase in leaf area, number and weight of clusters, total yield, and percentage of total sugars for both study seasons. It was found from the study of El-Senosy (10) that spraying seedless grapes with seaweed extract at a concentration of 0.2% significantly increased the leaf area, percentage of chlorophyll, cluster weight, vine yield, and percentage of total dissolved solids for two study seasons, while the 0.2% concentration of the extract reduced the total acidity level significantly for both seasons of the study compared to the remaining concentrations of 0.1% and 0.05% and the comparison treatment.

Materials and Methods

The study was conducted in the grape orchard of the Department of Horticulture and Landscape Engineering at Tikrit University/College of Agriculture, Iraq, during the 2023 growing season. To study the effect of vine load at three levels 30, 40 and 50 eyes vine^{-1} at a rate of (3 cane × 10 eyes), (4 cane × 10 eyes) and (5 cane × 10 eyes), respectively. Spraying with seaweed extract (Algaforce), it is a natural compound and plant stimulant extracted from marine algae Ascophyllum nodosum. Which contains 32% naturally extracted marine algae, 0.35% total nitrogen, 0.35% organic nitrogen, 6.5% potassium oxide, and 8% organic carbon. The extract was applied to the plants at three levels 0, 20 and 40 ml L^{-1}. This was to evaluate the influence of the used extract on some vegetative parameters and yield of Shatter Al-Anz variety. The 5-year-old grapes were trained on wire with the heigt of 70 cm above soil surface and the distance between two trees were 2 × 3 m. Samples of field soil were taken at a depth of 0-40 cm to analyze some physical and chemical characteristics, as shown in Table 1.

Table 1: Some physical and chemical characteristics of field soil.

Characteristics	N (mg L^{-1})	P (mg L^{-1})	K (mg L^{-1})	Organic matter %	Sand %	Silt %	Clay %	Texture
Result	49	6.8	123	1.10	25.8	48.2	26.0	Silty loom

All the necessary cultural operations were carried out on the vines during the trial period in terms of weeding, control of diseases and insects, in addition to chemical

fertilization of the field with neutral NPK compound fertilizer at a rate of 200 grams per vine. Winter pruning of the vines was carried out the beginning of February for the study year, by leaving 3-5 fruiting canes for each vine, with 10 eyes, and leaving 4 renewal spurs for each vine, with tow eyes for each spur.

The canes were distributed radially to benefit from the light to a greater extent. Starting on April 20, 2023, when the length of the new growth reached 30 cm, the vines were sprayed in the early morning until they were completely wet. There was a 10-day gap between the second and third sprayings. To reduce surface tension, bright material was used as a dispersing agent at a concentration of 0.1%. The experiment was carried out according to a randomized complete block design (R.C.B.D.), with three replications and three vines per experimental unit. Thus, the total number of vines included in the experiment was 81 grape vines. The data were analyzed statistically according to the analysis of variance table using the computer software SAS (23), and the means were compared according to the Duncan multinomial test at the probability level of 0.05.

Studied characteristics: The following characteristics were studied at the end of the experiment on September 1, 2023.
1- Leaves area of the vine (m^2): It was calculated according to the following equation:
    Leaves area of the vine= leaf area × number of leaves
2- Total chlorophyll in the leaves (SPAD unit): Calculated using the field device (Chlorophyll Meter SPAD-502).
3- Number of clusters (cluster $vine^{-1}$):
4- Cluster weight (g):
5- Total vine yield (kg): calculated according to the following equation: Total vine yield= cluster weight × number of clusters
6- Total soluble solids (%): This percentage was calculated using a Hand Refractometer.
7- Total sugar (%): Measured according to (16)
8- Total acidity (%): Measured according to (22).

Results and Discussion

Vegetative characteristics: We note from the results of Tables 2 and 3 that the vine load has a significant effect on the leaves area of the vine and the percentage of chlorophyll in the leaves, as the level of 50 eyes $vine^{-1}$ was significantly higher and reached (9.29 m^2 and 35.32 SPAD unit), respectively. Spraying with a concentration of 40 mL L^{-1} of seaweed extract was significantly superior to the remnant of the levels, with an increase rate of 7.81% over the comparison treatment in the leaves area of the vine. While spraying with 20 and 40 mL L^{-1} of seaweed extract significantly increased the percentage of chlorophyll in the leaves over the control treatment and reached 34.65 and 35.11 SPAD unit, respectively. As for the interaction between the two factors, the interaction treatment at the level of 50 eyes $vine^{-1}$ interfere with spraying at a concentration of 40 mL L^{-1} of seaweed extract gave the highest rate in the leaf area of the vine, which amounted to 9.41 m^2 Table 2. While the level of 30 eyes $vine^{-1}$, interfere with the control treatment of seaweed extract, gave the lowest rate and amounted to 6.20 m^2. As for the character of percentage of chlorophyll in the leaves, table 3, the

level of 50 eyes vine^{-1} interfere with spraying with a concentration of 40 mL L^{-1} of seaweed extract was significantly superior to the remnant of the interaction parameters and reached 36.84 SPAD unit.

Table 2: Effect of vine load and seaweed extract on vine leaves area (m^2).

Vine Load (eyes vine^{-1})	Seaweed Extract (mL L^{-1})			Average Vine Load
	0	20	40	
30	6.20 d	6.97 cd	7.57 bc	**6.92 c**
40	8.45 ab	8.68 a	8.71 a	**8.61 b**
50	9.16 a	9.29 a	9.41 a	**9.29 a**
Average Seaweed Extract	7.94 b	8.31 ab	8.56 a	

Numbers with the same letters are not significantly different based on the Duncan multiple range test at p=0.05.

Table 3: Effect of vine load and seaweed extract on percentage of chlorophyll in the leaves (SPAD unit).

Vine Load (eyes vine^{-1})	Seaweed Extract (mL L^{-1})			Average Vine Load
	0	20	40	
30	33.64 de	34.78 bc	34.56 bc	**34.33 b**
40	33.30 e	34.22 bcd	33.95 cde	**33.82 c**
50	34.17 bcd	34.96 b	36.84 a	**35.32 a**
Average Seaweed Extract	33.71 b	34.65 a	35.11 a	

Numbers with the same letters are not significantly different based on the Duncan multiple range test at p=0.05.

Yield characteristics: The results from tables 4,5 and 6 demonstrate that the level of 50 eyes vine^{-1} was significantly superior to the remnant of the levels in the number of clusters and the total yield of the vine, reaching (26.61 cluster vine^{-1} and 9.21 kg), respectively, while level 30 eyes vine^{-1} was significantly superior to the remnant of the levels in cluster weight, reaching 412.67 g. Spraying with seaweed extract at two concentrations of 20 and 40 mL L^{-1} had a significant effect on the control treatment in all yield characteristics, number and weight of clusters and total vine yield, which reached (21.17, 21.50 cluster vine^{-1}, 380.67, 392.00 g, 7.83, 8.29 kg) respectively.

As for the interaction between the levels of two factors, the level of 50 eyes vine^{-1} interfere with spraying at a concentration of 40 mL L^{-1} of seaweed extract, and gave the highest rate in the number of clusters and the total yield of the vine reaching (26.83 cluster vine^{-1} and 9.56 kg) respectively. While the intervention treatment at the level of 30 eyes vine^{-1} interfere with spraying at a concentration of 40 mL L^{-1} of seaweed extract gave the highest rate in cluster weight, reaching 432.00 g.

Table 4: Effect of vine load and seaweed extract in number of clusters (cluster vine^{-1}).

Vine Load (eyes vine^{-1})	Seaweed Extract (mL L^{-1})			Average Vine Load
	0	20	40	
30	15.17 d	15.50 cd	16.00 c	**15.56 c**
40	21.33 b	21.33 b	21.67 b	**21.44 b**
50	26.33 a	26.67 a	26.83 a	**26.61 a**
Average Seaweed Extract	**20.94 b**	**21.17 ab**	**21.50 a**	

Numbers with the same letters are not significantly different based on the Duncan multiple range test at p=0.05.

Table 5: Effect of vine load and seaweed extract on cluster weight (g).

Vine Load (eyes vine^{-1})	Seaweed Extract (mL L^{-1})			Average Vine Load
	0	20	40	
30	386.00 b	420.00 a	432.00 a	**412.67 a**
40	345.00 d	373.00 bc	387.00 b	**368.33 b**
50	332.00 d	349.00 cd	357.00 cd	**346.00 c**
Average Seaweed Extract	**354.33 b**	**380.67 a**	**392.00 a**	

Numbers with the same letters are not significantly different based on the Duncan multiple range test at p=0.05.

Table 6: Effect of vine load and seaweed extract on total vine yield (kg).

Vine Load (eyes vine^{-1})	Seaweed Extract (mL L^{-1})			Average Vine Load
	0	20	40	
30	5.85 h	6.51 g	6.91 fg	**6.43 c**
40	7.36 ef	7.96 de	8.38 cd	**7.89 b**
50	8.74 bc	9.31 ab	9.59 a	**9.21 a**
Average Seaweed Extract	**7.32 b**	**7.83 a**	**8.29 a**	

Numbers with the same letters are not significantly different based on the Duncan multiple range test at p=0.05.

Quality characteristics: We note from the results of the statistical analysis in tables 7 and 8 that the level 50 eyes vine^{-1} was significantly superior to the remnant of the levels in the percentage of dissolved solids and total sugars, with a percentage increase the control treatment of 3.88 and 4.52%, respectively for two characteristics. While the level 50 eyes vine^{-1} had the lowest percentage in the total acidity of grape berries (table 9), which reaching 0.51%. Spraying with a concentration of 20 and 40 mL L^{-1} of seaweed extract led to a significant improvement in the quality characteristics, as it was significantly superior to the control treatment and reached 16.48, 16.94 and 15.70, 15.93%, respectively, for soluble solids and total sugars, while two levels led to a significant reduction in the total acidity in the berries, reaching 0.52 and 0.53%. Respectively, compared to the control treatment.

As for the interaction between the levels of the two factors, level 50 eyes vine^{-1} interfere with spraying at a concentration of 20 mL L^{-1} of seaweed extract, gave the highest rate in the percentage of total soluble solids, reaching 17.09%. While the level of 50 eyes vine^{-1} interfere with a concentration of 40 mL L^{-1} of seaweed extract gave the highest percentage of total sugars, reaching 16.47%. The level of 50 eyes vine^{-1} interfere with a concentration of 40 mL L^{-1} and 20 ml L^{-1} of seaweed extract gave the lowest rate of total acidity, reaching 0.49%.

Table 7: Effect of vine load and seaweed extract in total soluble solids (%).

Vine Load (eyes vine^{-1})	Seaweed Extract (mL L^{-1})			Average Vine Load
	0	20	40	
30	15.23 c	16.38 ab	17.07 a	**16.23 b**
40	15.07 c	15.98 bc	17.02 ab	**16.02 b**
50	16.78 ab	17.09 a	16.72 ab	**16.86 a**
Average Seaweed Extract	**15.69 b**	**16.48 a**	**16.94 a**	

Numbers with the same letters are not significantly different based on the Duncan multiple range test at p=0.05.

Table 8: Effect of vine load and seaweed extract in total sugars (%).

Vine Load (eyes vine^{-1})	Seaweed Extract (mL L^{-1})			Average Vine Load
	0	20	40	
30	14.05 d	15.51 abc	16.21 a	**15.25 b**
40	14.64 cd	15.80 ab	15.13 bc	**15.19 b**
50	15.56 abc	15.80 ab	16.47 a	**15.94 a**
Average Seaweed Extract	**14.75 b**	**15.70 a**	**15.93 a**	

Numbers with the same letters are not significantly different based on the Duncan multiple range test at p=0.05.

Table 9: Effect of vine load and seaweed extract in total acidity (%).

Vine Load (eyes vine^{-1})	Seaweed Extract (mL L^{-1})			Average Vine Load
	0	20	40	
30	0.57 a	0.54 a	0.55 a	**0.55 a**
40	0.56 a	0.53 a	0.55 a	**0.55 a**
50	0.56 a	0.49 b	0.49 b	**0.51 b**
Average Seaweed Extract	**0.56 a**	**0.52 b**	**0.53 b**	

Numbers with the same letters are not significantly different based on the Duncan multiple range test at p=0.05.

From the results shown in the tables 2 and 3, the level of 50 eyes vine^{-1} increased the leaves area of the vine and chlorophyll content of the leaves, the reason for the increase in leaf area is due to the increase in the number of eyes left behind, which leads to an increase in the number of leaves, which is reflected positively in this characteristic. Also, the reason for the increase in the chlorophyll content of the leaves may be due to the role of pruning in increasing the activity of the roots and thus absorbing the nutrients that enter into the formation of chlorophyll (17 and 23).

As for the increase in yield characteristics when leaving 50 eyes vine^{-1}, which is represented by the increase in the number of clusters, Table 4, as a result of the existence of a common relationship between the quantity of yield and the number of clusters, as production increases with the increase in the number of eyes left on the vine (3) which is reflected positively in increasing the total yield, Table 6. As for the decrease in cluster weight. That as the number of clusters increases, the weight of the cluster decreases as a result of competition between them for the nutrients manufactured in the leaves, so the share of each cluster of these materials decreases (8).

As for the quality characteristics of the fruits, the increase in the percentage of sugars and total dissolved solids (Table 7 and 8) is due to the increase in the chlorophyll

content of the leaves, which leads to an increase in the products of the photosynthesis process and thus an increase in the share of each cluster of nutrients and carbohydrates manufactured in the leaves, as the clusters are the strongest polarizer for the products of photosynthesis (4). Also, increasing the percentage of sugars adversely affected the decrease in the total acidity. These results are in agreement with (6, 13, 15, 19 and 25).

As significant effect of seaweed extract on the vegetative characteristics of grape vines, as this is due to the Algaforce extract containing many elements, as it contains 0.35% nitrogen, which is involved in the synthesis of chlorophyll, amino and nuclear acids, proteins and enzymes in the plant. It also contains potassium in the form of potassium oxide at a contains 8%, which has a role in opening and closing stomata and the water state of the plant and helps in causing cellular expansion and growth of apical meristematic tissue (20) these factors affect the increase in the permeability of cell membranes and the transfer of elements, which leads to an increase in cell division and elongation, which is reflected in an improvement in the characteristics of vegetative growth (20). The significant effect of seaweed extract on quantitative and qualitative yield characteristics may be due to an increase in the leaf area of the vine, which results in an increase in photosynthesis and thus an increase in the amount of carbohydrates manufactured in the leaves and their transfer to the clusters. In addition, the Algaforce extract contains a percentage of nitrogen, which works to form amino acids, including the amino acid Tryptophane, which is the initiating compound in the construction of auxin, which stimulates cell division in the cells of the fruit and increases their numbers and size (21) which increases the size and weight of the fruits, the quantity of yield, and improves their qualitative characteristics. These results are in agreement with (5, 10, 13 and 18).

Conclusions

It is concluded from this study that leaving 50 eyes at rate of (5 cane $\times$ 10 eyes) per vine, on grape vines, Shatter Al-Anz variety. It led to a significant increase in total chlorophyll in the leaves, Number of clusters, total vine yield and total sugar, while the small number of eyes left on the vine had a significant effect on the characteristics of cluster weight, total soluble solids and total acidity. Spraying the vines with concentrations of 20 and 40 mL Liter^{-1} of Algaforce seaweed extract, led to a significant increase in all vegetative and qualitative traits and yield traits compared to the non-spraying treatment. The bilateral interaction between both factors (Vine load and Seaweed extract) had a significant effect in improving the studied characteristics.

Supplementary Materials:
No Supplementary Materials.

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Author M. F. Al-Doori and S. A. Hussein; methodology, writing—original draft preparation, Author M. F. Al-Doori and S. A. Hussein writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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