Effect of foliar application of different concentrations of yeast solution on the production factors of Helwani and Zeni grape cultivars (*Vitis vinifera* L.)

Abdulmunem AL-HOMSI and Dr. Rida DRAIE
Faculty of Agricultural Engineering, Idlib University

Abstract:

The research was conducted aiming to study the effect of two concentrations of foliar spray with yeast solution (5,15 g/L.) and control (0 g/L) on the production factors of the Helwani and Zeni grape cultivars in Sejer village in Idlib governorate during the 2022 agricultural season.

The results showed a significant superiority of Helwani cultivar in shoot length (134.4 cm), number of internodes (28.04), bunch weight (462.6 g), bunch volume (459.4 cm^3), number of berries per bunch (67.4), percentage of total dissolved solids (15.47%), and pH (4.36) on Zeni cultivar. While Zeni cultivar was superior in the number of bunches (77.8), thousand-seed weight (55.41 g), and total productivity (24.4 kg/shrub) over Helwani cultivar. Foliar spray at a concentration of 5 g/L of yeast solution significantly increased leaf area (86.4 cm^2), phalanx length (4.85 cm), bunch weight (411.7 g), bunch volume (406.9 cm^3), number of berries (68.5), berry weight (6.13 g), berry volume (5.99 cm^3) and titratable acid percentage (0.28%), Compared to the concentration of 15 g/L and the control. While the concentration of 0 g/L (control) was significantly superior in pH (4.28) over 5 g/L and 15 g/L concentrations, and a concentration of 15 g/L was significantly superior in total sugars (14.78%) over the concentrations of 0 and 5 g/L.

Concerning the interaction of experimental factors, foliar spray of the Helwani cultivar with a concentration of 5 g/L of yeast solution gave the highest result in the leaf area (86.5 cm^2), shoot length (145.1 cm), internodes length (5.17 cm), number of internodes per shoot (28.81), bunch weight (494.8 g), bunch volume (490.8 cm^3), and number of berries per bunch (80). In contrast, the treatment of Zeni cultivar with a concentration of 5 g/L of yeast solution gave the highest result in the number of bunches (91.8), berry weight (6.44 g), berry volume (6.44 cm^3) and total productivity (30 kg/shrub).

Finally, the statistical analysis showed that there was a high positive correlation between shoot length and each of the number of internodes and volume and weight of the bunch, and between the fruit volume and weight on the one hand and the weight and volume of the bunch on the other hand. There was also a high negative correlation between acidity and the number of bunches, on the one hand, and total productivity, on the other hand.

Keywords: Zeni grape, Helwani grape, Foliar Spray, Yeast, Productivity

تأثير الرش الورقي بعدة تراكيز من الخميرة في عوامل الإنتاج لصنفي العنب الحلواني والزيني (*Vitis vinifera* L.)

عبد المنعم الحمصي، د. رضا دريعي

كلية الهندسة الزراعية، جامعة إدلب

الملخص:

أجري البحث بهدف دراسة تأثير الرش الورقي بتركيزين من محلول الخميرة (5، 15 غ/لتر) والشاهد (0 غ/لتر) في عوامل الإنتاج لصنفي العنب الحلواني والزيني في قرية سيجر التابعة لمحافظة إدلب خلال الموسم الزراعي 2022.

أظهرت النتائج تفوقاً معنوياً للصنف الحلواني في طول الفرع (134.4 سم)، وعدد السلاميات (28.04)، ووزن العنقود (462.6 غ)، وحجم العنقود (459.4 سم³)، وعدد الحبات في العنقود (67.4)، ونسبة المواد الصلبة الذائبة الكلية (15.47%)، ودرجة الحموضة (4.36) على الصنف زيني. بينما تفوق الصنف الزيني في عدد العناقيد (77.8) ووزن الألف بذرة (55.41 غ) والإنتاجية الكلية (24.4 كغ/شجيرة) على الصنف الحلواني. كما حقق الرش الورقي بتركيز 5 غ/لتر من مستخلص الخميرة تفوقاً معنوياً في مساحة الورقة (86.4 سم²)، وطول السلامية (4.85 سم)، ووزن العنقود (411.7 غ)، وحجم العنقود (406.9 سم³)، وعدد الحبات (68.5)، ووزن الحبة (6.13 غ) وحجم الحبة (5.99 سم³) ونسبة الحموضة القابلة للمعايرة (0.28%) مقارنة بالتركيز 15 غ/ل والشاهد. بينما تفوق التركيز 0 غ/لتر (الشاهد) معنوياً في قيمة الـ pH (4.28) على التركيزين 5 غ/لتر و15 غ/لتر، كما تفوق التركيز 15 غ/لتر معنوياً في نسبة السكريات الكلية (14.78%) على التركيزين 0 و5 غ/لتر.

وفيما يخص تفاعل العوامل التجريبية، أعطى الرش الورقي للصنف الحلواني بتركيز 5 غ/لتر من محلول الخميرة أعلى نتيجة في مساحة الورقة (86.5 سم²)، وطول الفرع (145.1 سم)، وطول السلامية (5.17 سم) وعدد السلاميات في الفرع (28.81)، ووزن العنقود (494.8 غ)، وحجم العنقود (490.8 سم³)، وعدد الحبات في العنقود (80). في المقابل أعطت معاملة شجيرات الصنف الزيني بتركيز 5 غ/لتر من مستخلص الخميرة أعلى نتيجة في عدد العناقيد (91.8) ووزن الحبة (6.44 غ) وحجم الحبة (6.44 سم³) والإنتاجية الكلية (30 كغ/شجيرة).

أخيراً أظهر التحليل الإحصائي وجود علاقة ارتباط إيجابي عالٍ بين طول الفرع وكلٍ من عدد السلاميات وحجم ووزن العنقود، وبين حجم الثمرة ووزنها من جهة ووزن العنقود وحجمه من جهة ثانية. كما كانت هناك علاقة ارتباط سلبي عالٍ بين درجة الحموضة وكل من عدد العناقيد والإنتاجية الكلية. كما كان هناك ارتباط سلبي كبير بين الحموضة وعدد العناقيد من ناحية والإنتاجية الكلية من ناحية أخرى.

الكلمات المفتاحية: العنب الحلواني، العنب الزيني، الرش الورقي، الخميرة، الإنتاجية.

Introduction:

Grapes are perennial climbing shrubs with tendrils that originate opposite to the leaves. The floral bunches are rarely axillary and the plants can be hermaphroditic or unisexual, either male or female. Wild and cultivated grapes are members of the Vitaceae family, which comprises around a thousand species distributed into fourteen genera. The genus *Vitis*, one of the most significant genera within the Vitaceae family, stands out due to its notable agricultural importance. Within the family, they have two consecutive nodes carrying internodes, followed by a node without internodes, and then two nodes carrying internodes again. European grapes are divided into wild European grapes (*Vitis vinifera* ssp.*Silvestris*) and cultivated European grapes (*Vitis vinifera* ssp. *Sativa*). The cultivated grape varieties include all globally known or local varieties in any production region, and these varieties have their direct origin from wild grapes in different regions or are the result of hybridization between agricultural varieties, or they may be the result of mutations (Gabriel, 2004).

Grapes require irrigation, fertilization, and various maintenance operations to achieve optimal yields. Currently, there is a growing trend to enhance productivity per unit area by utilizing organic fertilizers and stimulants as an alternative to mineral fertilizers, which can have negative impacts on human health. One of the significant materials employed in providing safe plant nutrition without harming the environment is bread yeast. Bread yeast is a protein-rich substance that contains high levels of sugars, vitamins and mineral elements. It also contains growth regulators and essential amino acids that contribute to plant growth (Nagodawithana, 1991; Mahmoud, 2001). The chemical composition of dry yeast is outlined in Table (1).

Baker's yeast, *Saccharomyces cerevisiae* L., belongs to the Saccharomycetaceae fungal family. It is a single-celled, true-nucleus, a usually multiply-chromosomal organism that reproduces asexually by budding and sexually through the formation of ascospores (Barnett *et al.*, 2000). It is characterized as being inexpensive and can be produced in large quantities by factories for use in baking. It is available in various commercial forms, primarily as fresh or compressed yeast, which represents the traditional form of baker's yeast, and as dry yeast, which can be stored for a relatively long time in addition, it has a fast action, absorbs moisture and produces carbon dioxide gas (AL-Hafiz and Al-Sawi, 1990).

Table (1): Chemical composition of dry yeast (Nagodawithana, 1991)

Component	Content	Component	Content
Main Components (%)		Minerals (mg/kg)	
		Na	0.12
Protein	47	Mg	1.65
Carbohydrates	33	S	3.90
Nucleic Acids	8	Cu	8.00
Minerals	8	Cr	2.20
Fats	4	Mo	0.04
Vitamins	1.1	Ca	0.75
Vitamins (mg/100g)		K	21.00
		Zn	0.17
Thiamine	6-100	Se	0.10
Choline	400	Ni	3.00
Pyridoxine	28	Sn	3.00
Biotin	1.3	Fe	0.02
Niacin	300-500	P	13.5
B12	0.001	Si	0.03
Riboflavin	35-50	Mn	0.02
Folic Acid	5-13	Va	0.04
Pantothenic Acid	70	Li	0.17

1- Justification and objectives of the research:

1) Justification:

The cultivars of Helwani and Zeni grapes are among the most widespread cultivars in Syria, particularly in Idlib Governorate. However, due to the continuous increase in population density in this region, the cultivated grape area has decreased, as it has been replaced by the cultivation of other tree or plant species instead of grape shrubs. Therefore, the current focus is on vertical expansion and increasing production per unit area. One of the important methods, currently adopted globally to achieve this expansion, is the use of safe organic biostimulants that leave no residual effects and do not harm the environment or the plants and ultimately do not pose a risk to human health. Based on this idea, this research has been conducted to study the effect of foliar application of yeast solution on the growth and productivity of Helwani and Zeni grape cultivars.

2) Research objectives:

This research aims to achieve the following objectives:

1. Compare the response of Zeni and Helwani grape cultivars to yeast treatment.
2. Study the effect of optimal concentration of yeast spray on the growth and productivity of Helwani and Zeni grape cultivars.

2- Literature review:

Foliar nutrition is an important factor in the development of modern agriculture. Research and experiments have confirmed the possibility of supplying plants and fruit trees with various nutrients by spraying them with solutions containing these elements, which can be absorbed by the plant leaves and other aerial parts of plants, such as stems and fruits. Studies have shown that nutrient absorption through leaves is usually faster and more efficient than absorption through roots (Oosterhuis, 2007), and it is commonly done through foliar spray or soil application (El-Ghamring *et al.*, 1999).

Bread yeast is a natural source of cytokinins, which promote cell division and differentiation, and stimulate protein and nucleic acid synthesis, as well as chlorophyll production (Amer, 2004; Fathy and Farid, 1996). It also plays an important role in increasing enzyme activity, improving nutrient uptake and other processes that stimulate overall plant growth (Abbas, 2013). Additionally, yeast releases CO2, which positively affects overall photosynthetic production (Khalil and Ismael, 2010). Currently, there is a significant interest in the potential use of yeast as a natural and safe agent to stimulate plant growth. It has become a successful alternative to chemical fertilizers and is safe for humans, animals and the environment (Omran, 2000). Studies and research conducted on dry yeast solutions have shown a clear positive impact on vegetative growth and internal nutritional content due to their content of tryptophan, which is a precursor for the synthesis of the auxin indole acetic acid (IAA) (Moor, 1979).

Ferguson *et al.* (1995) mentioned that the multiple positive effects of using active bread yeast as a foliar spray on plants can be attributed to its various vital components such as proteins, vitamin B and some plant growth regulators, especially cytokinins. Subba-Rao (1984) and Nijjar (1985) suggested the possibility of using active bread yeast to improve vegetative growth and fruit production for both vegetables and fruit trees. Recent studies have shown that bread yeast serves as a natural source of cytokinins and stimulates the growth of treated plants (Amer, 2004). Barnett *et al.* (1990) demonstrated that bread yeast improves vegetative growth in treated plants due to its high content of growth regulators (auxins and cytokinins) and its role in increasing the accumulation of carbohydrates within the plant through the activation of photosynthesis. El-Desouky *et al.* (1998) and Wanas (2006) also mentioned that bread yeast stimulates cell division, increases cell volume, stimulates protein and nucleic acid synthesis, and enhances chlorophyll formation in treated plants.

The use of yeast in fertilization leads to improved plant growth in its early stages, attributed to the yeast's content of amino acids and vitamins (Fathy and Farid, 1996). Yeast solution helps activate cell division and the formation of nucleic acids and proteins (Fathy and Farid, 1996).

Ahmed *et al.* (1997) demonstrated that the use of active bread yeast at a concentration of 1.0% as a foliar spray on red Romi grapevines led to improved vegetative growth of the treated plants.

The treatment with yeast strains showed positive results on the productivity of seedless grapevines and the quality of the fruits. The percentage of green buds and floral buds, the plant length and the number of leaves were significantly improved because of applying different yeast strains. The weight of the bunch and the number of berries increased significantly, and the total soluble solids (TSS%) increased with the application of all yeast strains. Moreover, the treatment with the Enzymacor strain yielded the highest acidity and anthocyanin content in the fruit skin (Hashem *et al.*, 2008).

According to a study conducted by Al-Hasan (2013), the treatment with a mixture of yeast, iron and seaweed solution (Se + Fe + Ye) increased the average percentage of fruit set to (71.4%) compared to the control (34.6%), and an increase in the average yield to (8.5 kg/shrub) compared to the control (6.31 kg/shrub). Foliar fertilization with seaweed solution, yeast and iron also led to a significant increase in leaf area compared to the control.

A study was conducted using a seedless grape cultivar by Thompson, aged 11 years, on a grape farm in the Agriculture Research Directorate in Erbil, Kurdistan Region, Iraq during the 2015 growing season to investigate the potential effects of foliar application of natural yeast (biofertilizer) and liquid organic fertilizer (B&S Pot-min) on the quantity and quality of the crop. The results indicated that a concentration of 12 g/L of yeast and 4 mL/L of liquid organic fertilizer significantly affected the crop and physical characteristics of bunches and berries. The treatment with yeast led to an increase in the number of bunches, bunch weight and yield, with significant differences compared to the control. Additionally, the addition of yeast resulted in a significant increase in total soluble solids (TSS) and a decrease in titratable acidity (TA), with the highest TSS/TA ratio compared to the control (Al-Hawezy and Ibrahim, 2018).

A research study was conducted during the 2021 season in the Deir Hafar region, east of Aleppo, to investigate the effect of foliar fertilization with a combination of some micronutrients (Fe-B-Zn-Mn-Cu-Mo) at concentrations of 0.5, 1 and 1.5 grams per litre, and dry yeast extract at concentrations of 10, 15 and 20 grams per litre, on the productivity of grapevines (Helwani cultivar) and fruit quality. The results showed the superiority of the dry yeast extract at a concentration of 20 g/L and the micronutrient mixture at a concentration of 1.5 g/L with significant differences in terms of fruit diameter, total soluble solids (T.S.S) and flavour index. The respective values were (2.7 cm - 14.9% - 69.6) and (2.65 cm - 15.0% - 67.7), compared to the control (2.17 cm - 12.2% - 46.7). Treatment with yeast at a concentration of 20 g/L also outperformed all other treatments in terms of bunch weight, volume and yield, with values of (1.34 kg - 1191.7 cm^3 - 74.2 kg) compared to the control (0.5 kg - 259.8 cm^3 - 25.9 kg). Additionally, on the one hand, the treatment with yeast at a concentration of 20 g/L exhibited higher levels of reducing sugars and pH in the fruit juice, with values of (14.6 - 5.0%) respectively, compared to the control (12.2 - 3.9%). On the other hand, the total acidity (T.A) decreased in the yeast treatment at a concentration of 20 g/L, reaching 0.21% compared to the control (0.26%) (Shuaib *et al.*, 2022).

A study was conducted to investigate the effect of foliar spray with three levels of yeast (4, 6, 8 g/L) and potassium humate at three levels (2, 4, 6 mL/L) on the growth and development of grapevines, specifically the Sabe'i cultivar, and the mutual interaction between them. The results indicated the significant superiority of foliar spray with yeast at a concentration of 8 g/L in terms of the percentage increase in shoot length (171.1%), the percentage increase in leaf number (230%), and the average dry weight of roots (55.22 g) compared to the control (50.90%, 77.33%, 11.60 g) respectively. Additionally, foliar spray with yeast at a concentration of 6 g/L significantly outperformed the control in terms of the percentage increase in shoot number (251.6%), average leaf surface area (253.16 cm^2), and average root length (69.34 cm) compared to the control (119.8%, 39.44 cm, 27.12 cm) respectively (Al-Mastao, 2018).

3- Research materials and methods:

4-1- Study Location: This research was conducted in a field of Sijar town, located approximately 10 km west of Idlib city in the Al-Rouj Plain region, with an annual rainfall of 450 mm.

4-2- Plant material: The study was carried out on non-grafted grapevines, specifically on two grape cultivars:

- **Zeni**: It belongs to late-maturing table grape varieties with good taste. It can withstand long-distance shipping.
- **Helwani**: The vine is characterized by heavy fruiting, and its fruits have a reddish-green color. The fruits are firm with thick skin, making them more transportable and storable without damage.

4-3- Experimental procedures:

The grapevines were pruned on February 20, 2022, using a 2/5 pruning method. They were then sprayed with winter oil on March 1, 2022. The vines were irrigated using irrigation canals, and the nitrogen fertilizer was added on April 14, 2022. Fungicides were applied alternately in the fifth month to control powdery and downy mildew. Boron and micronutrients were sprayed in the fifth and seventh months, and fungicides for grey mould were sprayed in the seventh and eighth months.

4-4- Experimental treatments:

Factor 1 (Cultivars): The study was conducted on two grape cultivars, Zeni and Helwani.

Factor 2 (Treatment Concentration): Three concentrations of yeast were used (0, 5, and 15 g/L).

4-5- Methodology:

The spray solution was prepared by adding water to the yeast according to the desired concentration. Then 5 g of sugar was added to the solution, which was left for two hours to activate and enhance the effectiveness of yeast. A spreading agent was added to facilitate the dispersion and adhesion of the spray treatments. The spray was done using a backpack sprayer, continuing until the complete wetting of the treated vines, at a rate of 5 litres per vine. The foliar spray was conducted in three stages:

1. The first spray: before flowering (May 1, 2022).
2. The second spray: after the berries set (June 1, 2022).
3. The third spray: before maturity (July 23, 2022).

4-6- Parameters and characteristics measured:

The study relied on the characterization of the International Plant Genetic Resources Institute (IPGRI, 1983) and the method developed by Galet, a researcher at the Faculty of Agriculture, University of Montpellier in France (Galet, P,1983), as well as the characterization by Manzo and Tamponi (1987). The morphological traits of the grape cultivars were studied by selecting three closely-aged vines from each treatment. Thirty leaves were taken between the eighth and eleventh nodes when the shoot growth ceased. Regarding the bunches, ten bunches were taken from each cultivar. As for the berries, 100 mature berries were taken from the central region of each bunch, and the same was done for the seeds, where 1000 fully formed seeds were collected. Initially, the grapes (berries) were crushed using a fruit blender, and the crushed sample (20 g) was diluted with distilled water up to 250 ml. Based on this treatment, the following measurements and traits were taken:

4-6-1- Measurements of vegetative growth:

1. **Leaf Area (LA):** Image-J software was used on a computer device (Schneider *et al.*, 2012).
2. **Length of vegetative shoots (LS):** The length of the shoot at the end of the growing season was measured using a metric scale.
3. **Number of internodes per shoot (NI):** Ten measurements were taken for each treatment.
4. **Length of internode per shoot (LI):** Ten measurements were taken for each treatment.

4-6-2- Measurements of productivity:

1. **Number of bunches per shrub (NB)**.

2. **Weight of a single bunch** [g] **(WB):** The weight of 10 bunches was measured using a sensitive balance (5g/kg) for each replication, and then the average weight of a single bunch was calculated.
3. **Volume of a single bunch** [cm^3] **(VB):** It was measured using the water displacement method.
4. **Number of berries per bunch (NBe):** Three bunches were counted for each treatment, and then the average number of berries per bunch was calculated.
5. **Weight of a single berry** [g] **(WBe):** Based on 100 berries taken from the middle part of the bunch taken from 10 bunches, the weight of the berries was calculated.
6. **Volume of a single berry** [cm^3] **(VBe)**: It was measured using the water displacement method.
7. **Weight of 1000 Seeds** [g] **(WS).**
8. **Total yield per shrub [**kg] **(TY):** It was calculated by multiplying the average number of fruit bunches per vine by the weight of a single bunch.

4-6-3-The qualitative measurements of the fruits:

1. **Total soluble solids (TSS%):** They were measured using a refractometer. 1-2 drops of the clarified grape juice were added to the refractometer for measurement.
2. **Total acidity (TA%):** The total acidity was calculated using the following equation:

Total Acidity % = [(0.1 × base titer value) × malic acid constant (0.075) × titration volume in the consumer] / (sample volume) × 100

Previous studies such as Watkins *et al.* (1995) and Graham *et al.* (1995) were considered for estimating total acidity.

3. **Total Sugars (TS%):** They were estimated by titrating 25 ml of the prepared filtrate in a 100 ml volumetric flask and then completing the volume to the mark with distilled water. Precise 10 ml of 3.3% potassium ferricyanide ($K_3Fe(CN)6$) solution and 5 ml of 10% sodium hydroxide (NaOH) solution were added to another flask. The mixture was heated to boiling and a 1%

methylene blue indicator was added. The resulting mixture was titrated with a known 2% glucose solution until the colour of the solution disappeared. Total sugars (reference sugar + sugar resulting from sucrose hydrolysis) were calculated according to the method described by Cantarelli *et al.* (2008), Al *et al.* (2009) and Al-Kheyrat (2015).

$$\text{Reducing sugar \%} = (3.3 \times V \times C) / (Q \times W)$$

Where:

Reducing sugar %: Percentage of reducing sugar.
V: Volume of the flask used in the calibration process.
C: Concentration of the glucose sugar solution used for calibration.
Q: Quantity of the consumed glucose sugar solution.
W: Weight of the sample.

4. **pH**: The acidity degree was measured using a pH meter. Grape juice was obtained and placed in a cup for measurement after calibrating the device.

4-7 -Experimental design and statistical analysis:

The experiment was conducted on 18 grapevines (Helwani, Zeni), with 9 vines of each cultivar. Three treatments were applied based on spray concentration (0, 5, 15 g/L). Each treatment had three replicates. Therefore, the total number of grapevines used in the experiment was 2×3×3=18.

A completely randomized design (CRD) was used in this study. The data were analyzed using the statistical software GenStat V-12. Means were compared using the least significant difference (L.S.D.) test at a significance level of 5% for field readings and 1% for laboratory experiments. The correlation coefficient (r) was calculated using SPSS software.

4- 5- Results and Discussion:

5-1- Effect of foliar application of yeast on the vegetative growth traits:

Table (2): effect of foliar spray of yeast on the vegetative growth traits of Helwani and Zeni grape cultivars

Treatment \ Trait		LA* (cm^2)	LS (cm)	LI (cm)	NI
Helwani		81.2	134.4	4.7	28.04
Zeni		79.7	79.2	4.21	18.47
LSD 5% (Cultivars)		5.15	19.61	0.66	3.46
0 (Ctrl)		77.6	109	4.03	24.65
5 g/L		86.4	126.5	4.85	22.32
15 g/L		77.4	102.8	4.47	22.79
LSD 5% (Levels)		6.31	24.02	0.81	4.24
Helwani	**0 (Ctrl)**	78.7	131.8	4.31	27.21
	5 g/L	86.5	145.1	5.17	28.81
	15 g/L	78.5	126.4	4.61	28.11
Zeni	**0 (Ctrl)**	76.5	86.1	3.75	22.1
	5 g/L	86.3	75	4.54	15.83
	15 g/L	76.3	76.6	4.33	17.47
LSD 5% (V x L)		8.92	33.96	1.14	6
C.V. (%)		5.9	17.2	13.6	14.5

** See paragraph 4-6*

According to Table 2, the treatment of the Helwani grape cultivar with yeast showed a significant superiority over the Zeni cultivar in both shoot length and number of internodes per shoot. The values for Helwani were 134.4 cm and 28.04 internodes respectively. However, there were no significant differences between the two cultivars in terms of leaf area (cm^2) and internode length (cm).

In addition, the grapevine spray treatment with a concentration of 5 g/L yeast demonstrated a significant advantage over the other concentrations in terms of leaf area (86.4 cm^2). It also showed a significant improvement over the control treatment (0 g/L) in internode length (4.85 cm). However, there were no significant differences between the three spray concentrations in shoot length (cm) and number of internodes per shoot.

Regarding the interaction between the experimental factors (Table 2), the Helwani cultivar treated with a concentration of 5 g/L yeast extract yielded the highest results in terms of leaf area, shoot length, internode length, and the number of internodes per shoot. The values were 86.5 cm^2, 145.1 cm, 5.17 cm, and 28.81 internodes respectively.

This is consistent with the results of Al-Mastou (2018) on Sabi'ee grapevines and the findings of Mansour (1998) and Ahmed *et al.* (1997) on Red Roomy grapevines, where foliar application of yeast improved the vegetative growth of treated grapevines. This effect can be attributed to the high content of yeast in auxins and Cytokinins, as well as its role in increasing the accumulated carbohydrate content inside the plant by activating the photosynthetic process (Barnett *et al.*, 1990), and its role in enhancing enzyme activity and improving mineral nutrient uptake among other functions (Abbas, 2013). Additionally, yeast contains tryptophan, which serves as a source for the synthesis of indole acetic acid (IAA) (Moor, 1979).

5-2- Effect of foliar application of yeast on yield traits:

Table (3): Effect of foliar spray of yeast on yield traits of Helwani and Zeni grape cultivars

Treatment / Trait		NB*	WB (g)	VB (cm^3)	NBE	WBe (g)	VBe (cm^3)	WS (g)	TY (kg)
Helwani		24	462.6	459.4	66.4	5.66	5.42	47.71	11.1
Zeni		77.8	309.8	304.5	50.9	5.88	5.79	64.13	24.4
LSD 5% (Cultivars)		26.16	29.29	28.37	12.71	0.61	0.49	2.07	8.23
0 (Ctrl)		39.4	346.7	345.1	45.2	5.31	5.09	51.82	12.9
5 g/L		56.9	411.7	406.9	68.5	6.13	5.99	52.43	20.4
15 g/L		56.3	400.2	393.8	62.3	5.87	5.73	51.56	20
LSD 5% (Levels)		32.04	35.87	34.74	15.56	0.74	0.6	2.07	10.07
Helwani	**0 (Ctrl)**	24.8	413.9	414	41	5.25	5.07	47.63	10.6
	5 g/L	22	494.8	490.8	80	5.83	5.54	51.65	10.9
	15 g/L	25.1	479.1	473.2	78.3	5.92	5.64	46.13	11.8
Zeni	**0 (Ctrl)**	54.1	279.5	276.2	49.4	5.37	5.12	56.02	15.2
	5 g/L	91.8	328.7	323.1	57	6.44	6.44	53.21	30
	15 g/L	87.5	321.2	314.3	46.3	5.83	5.82	56.99	28.2
LSD 5% (V x L)		45.32	50.73	49.13	22.01	0.65	0.85	3.59	14.25
C.V. (%)		49.6	7.4	7.20	20.6	10.2	8.60%	3.90	45

** See paragraph 4-6*

Table (3) demonstrates the significant superiority of the Helwani cultivar shrubs over the Zeni cultivar shrubs in terms of bunch weight, bunch volume and the number of berries. The respective values were 462.6 g, 459.4 cm^3, and 66.4 berries. Conversely, the Zeni cultivar shrubs showed significant superiority over the Helwani cultivar shrubs in terms of the number of bunches, thousand-seed weight and total productivity, with the values of 77.8 bunches, 55.41 g and 24.4 kg, respectively. There were no significant differences between the two cultivars in terms of berry weight and berry volume.

Table 3 also illustrates the superiority of the 5 g/L grapevine foliar spray level over the control group in terms of bunch weight, bunch volume, the number of berries, berry weight, and berry volume, with the values of 411.7 g, 406.9 cm^3, 68.5 berries, 6.13 g, and 5.99 cm^3 respectively. However, there were no significant differences between the different spray levels in terms of the number of bunches, thousand-seed weight, and total productivity.

Regarding the interaction of experimental factors, Table 3 shows that, on the one hand, spray Zeni cultivar shrubs with a concentration of 5 g/L of yeast extract yielded the highest results in terms of the number of bunches, berry weight, berry volume, and total productivity, with the values of 91.8 bunches, 6.44 g, 6.44 cm^3, and 30 kg respectively. On the other hand, spraying Helwani cultivar shrubs with a concentration of 5 g/L gave the highest results in terms of bunch weight, bunch volume and the number of berries in the bunch, with the values 494.8 g, 490.8 cm^3 and 80 berries respectively. Treatment of Zeni cultivar shrubs with a concentration of 15 g/L of yeast extract resulted in the highest value in thousand-seed weight, which amounted to 56.99 g.

Our results align with the findings of Shuaib *et al.* (2022) in their study on Helwani grapevine shrubs. This effect can be attributed to yeast being an important source of folic acid, melatonin, certain antibiotics like glucan, and cytokinin hormone, which activates cell division in plant cells, leading to increased vegetative growth and fruit development (Neklyudov *et al.*, 1993). The increase in fruit weight, length, diameter and volume can be attributed to the significant role of yeast in enhancing the accumulation of dry matter in leaves by improving the efficiency of photosynthesis, thereby promoting fruit growth. Additionally, yeast contains a high amount of the amino acid tryptophan, which contributes to the production of auxins (IAA), directly responsible for cell division and increased cell volume, thus improving the quality characteristics of the fruits (Fathy and Farid, 1996).

5-3- Effect of foliar application of yeast on the studied fruit traits:

Table (4): Effect of foliar spray of yeast on the characteristics of the studied fruits

Treatment \ Trait		TSS* (%)	TA (%)	TS (%)	pH
Helwani		15.47	0.26	13.88	4.36
Zeni		13.05	0.27	14.02	3.92
LSD 5% (Cultivars)		1.97	0.02	0.56	0.12
0 (Ctrl)		15.12	0.24	13.89	4.28
5 g/L		13.29	0.28	13.17	4.1
15 g/L		14.97	0.28	14.78	4.04
LSD 5% (Levels)		2.41	0.03	0.69	0.15
Helwani	**0 (Ctrl)**	16.17	0.25	13.57	4.46
	5 g/L	14.66	0.27	13.97	4.39
	15 g/L	15.59	0.29	14.1	4.22
Zeni	**0 (Ctrl)**	14.06	0.24	14.21	4.09
	5 g/L	12.75	0.29	12.38	3.81
	15 g/L	14.34	0.27	15.46	3.87
LSD 5% (V x L)		3.41	0.04	0.98	0.21
C.V. (%)		9.4%	5.7%	2.8%	0.2%

** See paragraph 4-6*

Table 4 shows the superiority of the Helwani cultivar over the Zeni cultivar in terms of total soluble solids content and acidity when sprayed with yeast. The values in the Helwani cultivar were 15.47% and 4.358 respectively, while there were no significant differences between the two cultivars in terms of total acidity and total sugars.

Similarly, Table 3 demonstrates no significant differences between the yeast spray levels (0, 5, 15 g/L) in terms of total soluble solids content. The highest value was recorded in the control (15.12%). However, the levels (5, 15 g/L) outperformed the control (0 g/L) in terms of total acidity, and the values were 0.28, 0.28 and 0.24 respectively. Additionally, the 15 g/L yeast spray level outperformed the control in the total soluble solids content with a value of 14.78%. Finally, the control treatment (0 g/L) showed superiority in pH compared to other spray levels, with a value of 4.28.

Regarding the interaction between experimental factors, Table 4 indicates that the highest content of total soluble solids and pH was observed in the interaction of the control treatment (0 g/L) with Helwani cultivar, with values of 16.17% and 4.46 respectively. The highest content of the total sugars was found in the interaction of the third yeast spray level (15 g/L) with the Zeni cultivar, with a value of 15.46%. Moreover, the interaction of the second yeast spray level (5 g/L) with the Zeni cultivar and the interaction of the third yeast spray level (15 g/L) with the Helwani cultivar showed the highest content of total acidity, with a value of 0.29.

Our findings are consistent with the previous studies by Al-Hawezy and Ibrahim (2018) on Thompson grapes and Shuaib *et al.* (2022) on Helwani grapes. This effect can be explained by the important role of bread yeast in releasing CO_2 gas as one of the byproducts of the fermentation process of monosaccharides, which creates a supportive environment for the photosynthesis process. Additionally, the increase in fruit yield upon yeast spray can be attributed to its high content of minerals, carbohydrates and amino acids, which contribute to flower formation. Furthermore, yeast enhances the resistance of plants to pathogens, thereby it increases the fruit set and reduces the incidence of abortion due to diseases (Attyia *et al.*, 2001).

Table (5): Pearson's simple linear coefficient (r) and its significance among the studied traits

	Leaf Area	Length of Shoots	Internode length	Number of internodes per shoot	Bunch weight	Bunch volume	Number of bunches	Number of berries	Berry weight	Berry volume	Thousand-seed weight	Total productivity	Total soluble solids	Total acidity	Total sugars	PH
Leaf Area	1															
Length of Shoots	0.391	1														
Internode length	0.326	.481*	1													
Number of internodes per shoot	0.306	.826**	0.072	1												
Bunch weight	0.293	.820**	0.406	.682**	1											
Bunch volume	0.307	.827**	0.412	.692**	.999**	1										
Number of bunches	-0.304	-.757**	-0.163	-.766**	-.617**	-.633**	1									
Number of berries	-0.079	0.285	0.236	0.203	.589*	.581*	-0.315	1								
Berry weight	-0.299	-0.036	0.465	-0.361	0.025	0.02	0.177	0.282	1							
Berry volume	-0.271	-0.167	0.418	-.520*	-0.093	-0.101	0.402	0.2	.940**	1						
Thousand-seed weight	-0.415	-.616**	-0.276	-.557*	-.683**	-.692**	.548*	-0.394	0.053	0.1	1					
Total productivity	-0.25	-.635**	-0.096	-.689**	-0.453	-.472*	.974**	-0.259	0.183	0.411	0.461	1				
Total soluble solids content	0.062	0.381	-0.038	.479*	0.428	0.44	-.502*	0.12	-0.425	-.473*	-.554*	-.506*	1			
Total acidity	-0.105	0.228	.499*	-0.058	0.289	0.274	0.186	0.291	.538*	.582*	-0.159	0.3	-0.292	1		
Total sugars	-.491*	-0.145	-0.447	0.022	-0.081	-0.09	0.041	0.007	-0.313	-0.337	0.311	0.02	0.329	-0.283	1	
PH	0.46	.741**	0.193	.831**	.679**	.697**	-.827**	0.157	-0.383	-.586*	-.533*	-.769**	.607**	-0.293	-0.018	1

*. Correlation is significant at the 0.05 level **. Correlation is significant at the 0.01 level

4-5- Correlation analysis:

Table (5) reveals the following relationships between the studied traits:

- **Highly significant positive linear correlation:** between the length of shoots and each of the number of internodes per shoot, bunch volume, bunch weight and pH; between the number of internodes per shoot and each of the total bunch weight, bunch and pH; between bunch weight and each of bunch volume and pH; between bunch volume and pH; between the number of bunches and thousand-seed weight; and between berry weight and berry volume.

- **High significant negative linear correlation:** between the length of shoots and each of thousand-seed weight and total productivity; between the number of internodes per shoot and each of the number of bunches and total productivity; between bunch weight and each number of bunches and thousand-seed weight; between bunch volume and each of the number of bunches and thousand-seed weight; between the number of bunches and pH; and between total productivity and pH.

- **Significant positive linear correlation**: between shoot length and internode length; between the number of internodes and total soluble solids content; between bunch weight and the number of berries per bunch; between bunch volume and each of the number of berries per bunch; between the number of bunches and thousand-seed weight; between berry weight and total acidity; and between berry volume and total acidity.
- **Significant negative linear correlation**: between leaf area and percentage of total sugars; between the number of internodes and berry volume; between bunch volume and thousand-seed weight; between the number of bunches and total productivity; between the berry volume and each of total soluble solid content and pH; between thousand-seed weight and each of total soluble solid content and pH; and between total productivity and total soluble solid content.

5- Conclusions:

1) The Helwani cultivar outperforms the Zeni cultivar in terms of shoot length, the number of bunches, weight, the volume of bunches, the number of berries, the percentage of soluble solids, and pH.
2) The Zeni cultivar outperforms the Helwani cultivar in terms of the number of bunches, thousand-seed weight and total productivity.

3) Foliar application with yeast concentration of 5 g/L shows superiority in terms of leaf area, shoot length, bunch weight and volume, the number of berries, the weight and volume of berries, and total acidity.
4) The control group (0 g/L) shows superiority in terms of acidity level. Spray with a yeast concentration of 15 g/L shows superiority in terms of sugar percentage.
5) Treating Helwani shrubs with a yeast solution concentration of 5 g/L gives the highest results in terms of leaf area, shoot length, internodes length, the number of internodes per shoot, bunch weight, bunch volume, and the number of berries per bunch.
6) Treating Zeni shrubs with a yeast solution concentration of 5 g/L gives the highest results in terms of the number of bunches, berry weight, berry volume, and total productivity.
7) There is a strong positive correlation between shoot length and the number of bunches, as well as the weight and volume of bunches.
8) There is a strong positive correlation between fruit volume and weight, as well as between bunch weight and volume.
9) There is a strong negative correlation between pH and both the number of bunches and total productivity.

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