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Impact of mulching with sawdust, charcoal and spraying with growth regulator salicylic on some vegetative growth characteristics of two cultivars of grape vines (Halwani and Kamali)

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Abstract

This study was conducted at the Agricultural Research and Experiments Station of the Faculty of Agriculture/ Department of Horticulture and Garden Engineering-University of Kirkuk/Iraq, during the growing season of 2023. The study aims to study the effect of mulching with three types (Non-mulching, Sawdust and Charcoal) where the mulching was done once with a thickness of 5 cm and on a circular area with a radius of 30 cm. The vegetative total was sprayed with three concentrations of salicylic acid (0, 100 and 150) mg litre and on five sprays with an interval of 15 days between each spray starting from 20/4 to 20/6 for two varieties of young vines (Halwani and Kamali). The experiment was carried out according to the design of the complete random sectors (R.C.B.D) as a factor experiment and with three replicates. The results showed that the mulching levels were affected significantly, as the mulching with charcoal led to a significant superiority in all the studied characteristics (Stem length, Stem diameter, area of one leaf and the percentage of total chlorophyll in the leaves). The mulching reached 114.89 cm, 6.66 mm, 88.51 cm², and 7.316% respectively compared to the comparison treatment, while the number of leaves was significantly affected when covered with sawdust. It rose to 134.556 vine leaves. The effect of spraying treatment with a salicylic growth regulator is significant in all characteristics when spraying 150 mg L⁻¹. In terms of the varieties, the Kamli variety outperformed the Halwani (stem length, number of leaves and area of one leaf), while the Halwani outperformed the percentage of total chlorophyll. Also, the varieties did not differ among themselves in the characteristics of the diameter of the main stem. Bilateral and triple overlaps between factor levels included in the study had significant effects on most of the characteristics examined.

Keywords: Mulching, salicylic acid, Halwani, Kamali

Introduction

The grapes *Vitis vinifera* L. belong to the genus *Vitis*, which is one of the 14 genera spread in cultivation in the world and belongs to the family Vitaceae, has attracted the interest of humans for more than six thousand years to cultivate grapes and production and manufacture of fruits and juice. Grapes ranked first among fruit trees in terms of production, and it is believed that the original homeland of grapes is Central Asia, especially in the area between the southern Black Sea and the Caspian Sea and northern Persia. All varieties were produced before the North American continent was discovered and then cultivation spread east and west and throughout the region, between latitudes (20-50) north of the equator and (20-40) south of the equator is one of the best places to grow it (Saidi, 2000 and Hussein *et al.*, 2000) [23, 11].

The mulching process is one of the important processes that increase the moisture content of the soil by 57% compared to plants not covered due to the lack of evaporation from the soil surface and increase the ability of the soil to conserve water (Al-Rawi *et al.*, 1995) [4]. Also, Land cover contributes to horizontal and vertical salinity reduction (Janabi, 2005) [12]. The covering materials may be organic or inorganic (industrial in nature) they change the temperature and moisture balance at the soil surface, creating more favorable conditions for plant growth, in addition to their role in maintaining soil moisture, reducing weed growth and increasing soil productivity, soil heating systems can be improved with various types of mulch materials (Pramanik *et al.*, 2015) [20].

Coal is a heterogeneous Material that contains organic material consisting of carbon, hydrogen, oxygen, sulfur and nitrogen in addition to inorganic components (metals) with a quantity of water, and carbon constitutes 60-95% of its total volume, while hydrogen constitutes 5% and may decrease to about 2% (Rees, 1966) [22]. Van Donk *et al.* (2012) [25] have shown that sawdust is used to reduce soil water evaporation, weed competition and cooling, the degree of effect required on the quality, quantity, durability of the mulching material, soil type and climate conditions (Pramanik *et al.*, 2015) [20]. Némethy *et al.* (2006) [15] noted that soil coverage affects organic plant residues. On the growth of grapes during the two growing seasons, the results showed that it was the most effective in terms of nutrient distribution in grapes and yield and had a positive effect on soil structure and moisture.

Salicylic acid is an internal plant hormone made from amino acids and was first isolated from tree bark in 1828, it plays an important role in improving plant tolerance to biotic stress conditions. It enters into many physiological processes including floral induction, regulation of ion absorption, hormonal balance, stomata movement, photosynthesis, cellular metabolism, protein synthesis, stomata closure and gas exchange (Popova *et al.*, 1997; Raskin, 1992) [19, 21]. Al-Hamidawi (2012) [3] the effect of spraying four concentrations (0, 50, 75 and 100) mg L⁻¹ of the Halawani variety was studied, which exceeded the concentration (100 mg L⁻¹) of salicylic 185.00 mg 100 g⁻¹ compared to the control treatment. It exceeds the leaf area allocated to each cluster of vines sprayed with concentration (100 mg L⁻¹) salicylic acid, as it gave the largest paper area to the cluster reaching (3943.00 cm²) during the study season. When Al-Atrushy (2021) [1] studied the effect of salicylic acid spraying on the vegetative growth of grapes, the Halawani variety affected the leaf area, when the spray concentration was 150 mg L⁻¹, its performance was significantly better than that of salicylic acid, and the highest leaf area rate 164.43 cm² was obtained in the first season. The overall chlorophyll properties of leaves sprayed with salicylic acid at a concentration of 150 mg L⁻¹ were also significantly superior to 188.48 mg g⁻¹ soft weight compared to the comparative treatments.

Among the local varieties spread for grapes is Halwani and Kamali, which are good edible varieties and are characterized by the pastry variety with its regular hermaphrodite flowers. They are one of the good pollinated varieties of the Kamali, and the variety Kamali is characterized by hermaphrodite flowers, but functionally

feminine (stamens short hanging down) and thus need a pollinator because pollen is fertilized (Saidi, 2000) [23]. In a study conducted by Othman *et al.* (2018) [16] explored the effect of spraying with ascorbic acid on some vegetative growth characteristics of the two grape varieties, where the Kamali variety excelled in leaf area and number of leaves, stem diameter, the highest moral value amounted to 90.78 cm, 1395 leaves per vine, 17.29 mm, respectively. Yet, the Halwani variety excelled in stem length, reaching 1.87 cm. The Kamali variety outperformed the Halwani variety significantly in the leaf area of the vine, as the Kamali variety achieved the highest rate in the paper area of the vine reaching 20.83 and 21.55 m² compared to the Halwani variety, which became 19.31 m² and 20.72 m² respectively for both seasons of study. Because there are no studies in this area, especially on vines inside Iraq, this study was conducted with the aim of promoting the vegetative growth of young vines of Halwani and Kamali varieties by covering the soil and spraying with salicylic acid. This was to show the impact of these factors in building a strong structure for vines in the early years of breeding.

Materials and Methods

This study was carried out at the Agricultural Research and Experiments Station of the College of Agriculture / Department of Horticulture and Garden Engineering / University of Kirkuk / Iraq, during the growing season of 2023, to study the mulching of the soil of grape vines with three types (NON-mulching, Sawdust and Charcoal). At the beginning of the experiment, a circular area with a radius of 30 cm was covered once with a thickness of 5 cm and sprayed with three concentrations (0, 100 and 150) mg L⁻¹ of the growth regulator salicylic acid. Additionally, add Tween 0.1 m L⁻¹ as a dispersion to reduce the surface tension of water molecules, for two varieties of young vines (Halawani and Kamali) at the age of 5 years and planted with dimensions of 2 m between one vine and another and 2.5 m between one line and another and bred by wire breeding. The vines were pruned at the end of February for the study season. When clearing brush from the field, all necessary service work (such as irrigation and fertilization) is carried out equally in all operations. Pools of water were then built around the trees. Install a drip irrigation system and take samples at different locations in the trial plot, for the purpose of conducting some chemical and physical analyzes in addition to the coal and mulch used in the experiment.

Table 1: Some chemical and physical properties of field soil, sawdust and charcoal used in mulching

Properties	EC mmho cm ⁻¹	PH	TDS mg kg ⁻¹	N mg kg ⁻¹	P mg kg ⁻¹	K mg kg ⁻¹	Organic Carbon %	Tissue	Clay %	Silt %	Sand %
Soil	1.294	7.3	730	420.300	25.930	132.447	0.276	Sandy mixture	2	46	52
Charcoal	-	-	-	4763.4	79.644	3973.410	4.137	-	-	-	-
Sawdust	0.11	6.18	20	39	43	60	0.44	-	-	-	-

Studied characteristics

All measurements were taken on 1/9/2023.

1. Rate of increase in leg length (cm).
2. Rate of increase in stem diameter (mm).
3. The rate of increase in the number of leaves (vine leaf¹).
4. Area of one leaf (cm²) is calculated according to the method mentioned by Saieed (1990) [24] and 10 full-

grown leaves were taken from each young vine and painted on egg leaves known weight and area. Then the drawn papers were cut and weighed with a sensitive electric balance. This weight was compared with the weight and area of the white leaves that were painted on it to extract its area, which represents the area of plant leaves according to the following equation: Area leaf = large sheet area × weight of the cut part / weight of a

- large leaf.
- The percentage of total chlorophyll in the leaves. It was estimated by cutting the leaves into small pieces with sterile scissors and weighing 0.25 g of the cut leaves, placing them in an opaque container and adding 15 ml of 95% concentrated ethanol (Knudson *et al.*, 1977) [14]. In a dark place 24 hours. The process was repeated three times and the solution was measured using a spectrophotometer (100 v⁻¹ Laboratory EMC) at wavelengths of 665 and 649 nm.

Results and Discussion

1. Rate of increase in leg length (cm): The results of the statistical analysis showed that the length of the main leg has been significantly affected by the levels of coverage. It gave the highest rate when covered with charcoal and became 114.89 cm compared to the lowest rate, which rose to 95.74 cm when treated without coverage. Also, spraying with a salicylic growth regulator has affected significantly if the concentration exceeds 150 mg litres on the rest of the

concentrations and amounted to 126.92 cm compared to the comparison treatment, which rose to 86.75 cm. In addition, the varieties differed between them in the characteristic of the length of the main stem, where the Kamali variety significantly outperformed the Halwani variety to reach 129.14 cm. The overlap between the levels of coverage and varieties had a significant effect in this capacity if the coverage of the Kamali variety significantly exceeded the rest of the interventions and amounted to 141.54 cm. As for the bilateral overlap between the levels of spraying with the salicylic growth regulator and the varieties, the spraying at a concentration of 150 mg L⁻¹ of salicylic variety significantly outperformed the rest of the interventions and amounted to 138.19 cm. As for the triple overlap, we note that the treatment of charcoal coverage overlapped with spraying at a concentration of 150 mg L⁻¹ of salicylic for the Kamali variety which gave the highest value in the main stem length characteristic of 158.22 cm, while the comparative treatment of the Halwani variety had the lowest value of 23.95 cm.

Table 2: Effect of mulching and spraying with salicylic growth regulator on the rate of increase in main stem length (cm) for two young grapevine varieties

Levels Mulching	Levels Salicylic mg L ⁻¹	Cultivars		Salicylic × Mulching
		Halwani	Kamali	
Non-mulching	0	23.95 j	144.67 b	84.31 f
	100	52.67 i	94.06 g	73.36 g
	150	141.08 b	118.00 e	129.54 b
Sawdust	0	107.08 f	108.72 f	107.90 d
	100	125.94 d	133.89 c	129.92 b
	150	52.91 i	138.33 bc	95.62 e
Coal	0	25.78 j	110.28 f	68.03 h
	100	86.00 h	156.11 a	121.06 c
	150	152.94 a	158.22 a	155.58 a
	Levels Mulching			Average mulching
Mulching × Cultivars	Non-mulching	72.57 f	118.91 c	95.74 c
	Sawdust	95.31 d	126.98 b	111.15 d
	Coal	88.24 e	141.54 a	114.89 a
	Salicylic mg L ⁻¹			Average Salicylic
Salicylic × Cultivars	0	52.27 f	121.22 c	86.75 c
	100	88.20 e	128.02 b	108.11 b
	150	115.65 d	138.19 a	126.92a
Average Cultivars	85.37 b	129.14 a		

“The values with similar letters for each factor or its interactions individually do not differ significantly according to the Dunkin' polynomial test below the probability level 0.05%”

2. Rate of increase in stem diameter (mm): The results shown in Table (3) showed that the diameter of the main leg was significantly affected by the levels of coverage. The highest rate of stem diameter was when the covering with charcoal reached 6.66 mm compared to the rest of the coefficients. The spraying with a salicylic growth regulator has been affected significantly. The spraying exceeds the concentration of 150 mg L⁻¹. On the rest of the concentrations, it amounted to 7.20 mm compared to the comparison treatment of 5.75 mm, and the varieties did not differ among themselves in the characteristic of the diameter

of the main stem. The bilateral overlap between the levels of coverage and salicylic was significantly affected in the characteristic of the diameter of the main stem if the coverage with charcoal overlapped with spraying at a concentration of 150 mg L⁻¹ of salicylic significantly at 7.64 mm compared to the rest of the interactions of salicylic of the Kamali variety significantly over the rest of the overlaps and reached 7.40 mm. As for the triple overlap, the charcoal treatment overlapped with spraying at a concentration of 150 mg L⁻¹ of salicylic for the Kamali variety producing the highest value in the main stem diameter of 8.11 mm.

Table 3: Effect of mulching and spraying with salicylic growth regulator on the rate of increase in main stem diameter (mm) for two young grape vineyard varieties

Levels Mulching	Levels Salicylic mg L ⁻¹	Cultivars		Salicylic × Mulching
		Halwani	Kamali	
Non Mulching	0	4.78 g	6.72 bcd	5.75 de
	100	5.39 efg	5.53 efg	5.46 ef
	150	6.33 cde	8.05 a	7.19 ab
Sawdust	0	7.28 abc	5.56 efg	6.42 dc
	100	4.84 g	5.00 g	4.92 f
	150	7.50 ab	6.06 efd	6.78 bc
Coal	0	5.33 efg	4.83 g	5.08 ef
	100	7.00 abcd	7.50 ab	7.25 ab
	150	7.17 abcd	8.11 a	7.64 a
	Levels Mulching			Average Mulching
Mulching × Cultivars	Non Mulching	5.50 b	6.77 a	6.13 b
	Sawdust	6.54 a	5.54 b	6.04 b
	Coal	6.50 a	6.82 a	6.66 a
	Salicylic mg L ⁻¹			Average Salicylic
Salicylic × Cultivars	0	5.80 b	5.70 b	5.75 b
	100	5.74 b	6.01 b	5.88 b
	150	1.00 a	7.40 a	7.20 a
Average Cultivars	6.18 a	6.37 a		

“The values with similar letters for each factor or its interactions individually do not differ significantly according to the Dunkin' polynomial test below the probability level 0.05. %”

3. The rate of increase in the number of leaves (vine leaf¹): The results in Table (4) showed that the number of leaves has been significantly affected by the levels of coverage, as the coverage with sawdust produced the highest rate of 134.556 leaves per vine compared to the lowest rate, which was to 110.778 cm. The spraying with a salicylic growth regulator was affected significantly if the concentration of 150 mg liter⁻¹ exceeded the rest of the concentrations at 152.944 leaf per vine compared with the comparison treatment at 101.333 leaves per vine. In terms of the effect of varieties, the Kamali variety significantly outperformed the Halwani variety, as it rose to 151.482 leaves per vine. The bilateral overlap between the levels of coverage and

salicylic had a significant effect on the diameter of the main stem if it exceeded the coverage with charcoal overlapping with spraying at a concentration of 150 mg L⁻¹ of salicylic significantly at 180.83 leaves per vine compared with the rest of the treatments. The coverage with sawdust for the Kamali variety significantly exceeded the rest of the overlaps peaked to 170.00 leaves per vine. As for the triple overlap, the charcoal treatment overlapping with spraying at a concentration of 150 mg L⁻¹ of salicylic for the Halwani variety had the highest value in the characteristic of increasing the number of leaves and amounted to 181.00 leaves per vine.

Table 4: Effect of mulching and spraying with salicylic growth regulator on the rate of increase in total leaf number (Leaf Vine⁻¹) for two young grapevine varieties

Levels Mulching	Levels Salicylic mg L ⁻¹	Cultivars		Salicylic × Mulching
		Halwani	Kamali	
Non Mulching	0	70.33 l	97.67 gh	84.00 g
	100	78.67 kj	143.00 e	110.83 e
	150	120.67 f	154.33 d	137.50 bc
Sawdust	0	84.33 i	171.00 b	127.67 d
	100	95.67 h	175.33 b	135.50 c
	150	117.33 f	163.67 c	140.50 b
Coal	0	82.67 ij	102.00 g	92.33 f
	100	76.33 k	175.67 b	126.00 d
	150	181.00 a	180.67 a	180.83 a
	Levels Mulching			Average mulching
Mulching × Cultivars	Non mulching	89.89 f	131.67 c	110.778 b
	Sawdust	99.11 e	170.00 a	134.556 a
	Coal	113.33 d	152.78 b	133.056 a
	Salicylic mg L ⁻¹			Average salicylic
Salicylic × Cultivars	0	79.11 e	123.56 c	101.333 c
	100	83.56 d	164.67 a	124.111 b
	150	139.67 b	166.22 a	152.944 a
Average Cultivars	100.778 b	151.482 a		

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4. Area of one leaf (cm²): The results in Table (5) showed that the area of one leaf has been significantly affected by the levels of coverage increasing the average area of the leaf when covering with charcoal, which increased 88.51 cm² compared to the lowest rate of 81.15 cm² when treated without coverage. the spraying with a salicylic growth regulator has been affected significantly if the concentration of 150 mg liter⁻¹ exceeds the rest of the concentrations and amounted to 95.03 cm² compared with the comparison treatment, which rose to 73.91 cm², and as for the effect of the varieties, the Kamali variety significantly outperformed the Halwani variety because of its values at 99.42 cm². The interaction between the levels of coverage and the varieties had a significant effect on this trait, as the coverage with

charcoal for the Kamali variety was significantly superior to the rest of the interactions and amounted to 102.66 cm². As for the bilateral interaction between the levels of spraying with the salicylic growth regulator and the varieties, spraying with a concentration of 150 mg L⁻¹ of salicylic for the Kamali variety was significantly superior to the rest of the interactions at 109.59 cm². The triple interaction between the treatments was covering with sawdust mixed with spraying at a concentration of 150 mg L⁻¹ of salicylic for the Kamali variety, which was the highest in terms of increasing leaf area and amounted to 111.95 cm². Yet, the treatment with charcoal mixed with a concentration of 0 mg L⁻¹ of salicylic acid for the Halwani variety had the lowest value and amounted to 46.69 cm².

Table 5: Effect of mulching and spraying with salicylic growth regulator on per leaf area (cm²) for two young grape vineyard varieties

Levels Mulching	Levels Salicylic mg L ⁻¹	Cultivars		Salicylic × Mulching
		Halwani	Kamali	
Non-mulching	0	57.12 f	103.68 ab	80.40d
	100	58.43 f	73.08 e	65.76 e
	150	84.85 d	109.74 ab	97.30 b
Sawdust	0	56.54 f	83.77 d	70.15 e
	100	107.49 ab	104.58 ab	106.03 a
	150	53.84 f g	111.95 a	82.90 d
Coal	0	46.69 g	95.70 c	71.19 e
	100	73.67 e	105.22 ab	89.44 c
	150	102.74 b c	107.08 ab	104.91 a
	Levels Mulching			Average mulching
Mulching × Cultivars	Non mulching	66.80 d	95.50 b	81.15 b
	Sawdust	72.62 c	100.10 a	86.36 a
	Coal	74.37 c	102.66 a	88.51 a
	Salicylic mg L ⁻¹			Average salicylic
Salicylic × Cultivars	0	53.45 d	94.38 b	73.91 c
	100	79.87 c	94.29 b	87.08 b
	150	80.48 c	109.59 a	95.03 a
Average Cultivars	71.26 b	99.42 a		

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5. The percentage of total chlorophyll in the leaves (mg g⁻¹ soft weight): The results of the statistical analysis showed that the percentage of total chlorophyll was significantly affected by the levels of coverage increasing the percentage of total chlorophyll when covering with charcoal of 7.316 mg g⁻¹ soft weight compared to the lowest rate of 4.830 mg g⁻¹ soft weight when treated without coverage, Spraying with a salicylic growth regulator had a significant effect if the concentration was 150 mg L⁻¹ exceeded the rest of the concentrations and amounted to 6.639 mg g⁻¹ soft weight compared to the comparison treatment at 4.912 mg g⁻¹ soft weight, as for the varieties, as the Halwani variety significantly outperformed the Kamali variety because it reached 6.014 mg g⁻¹ soft weight. The bilateral interaction between the levels of coverage and salicylic was significantly affected in the percentage of chlorophyll if the coverage with charcoal overlapped with spraying at a concentration of 100 mg litres⁻¹ of salicylic significantly and amounted to 7.708 mg g⁻¹ soft weight compared to the rest of the treatments. As for the triple overlap, we note that the treatment of charcoal coverage

overlapping with spraying at a concentration of 150 mg liters of salicylic variety has given the highest value in this trait and amounted to 9.203 mg g⁻¹ soft weight. The increase in vegetative growth characteristics in tables (5, 3, 2 and 6) is attributed to the high nitrogen content of coal as shown in Table (1). Keller and Nussbaumer (1993) [13] pointed to the volatilization of oxides gas when burning wood, which indicates the presence of nitrogen within the chemical content of wood, where part of the nitrogen in wood is converted through burning to HCN, NH₃ and nitrogen oxide and remains 20% in charcoal. Nitrogen plays an important role in many of the vital processes that occur in the plant, such as the formation of amino acids, proteins and enzymes, which encourage cell divisions and cell elongation, which is reflected in an increase in the rate of plant height, leaf area and number of leaves (Emongor and Emongor, 2023) [6]. Its role increases the number and size of leaf cells and the formation of chlorophyll, which leads to an increase in the effectiveness of the leaves in photosynthesis and thus increase vegetative growth (Popov, 1978 and Al-Doori and Hussein, 2023) [18, 2].

Table 6: Effect of mulching and spraying with salicylic growth regulator on total chlorophyll percentage in leaves for two young grape vineyard varieties

Levels Mulching	Levels Salicylic mg L ⁻¹	Cultivars		Salicylic × mulching
		Halwani	Kamali	
Non mulching	0	3.161 h	3.428 gh	3.295 f
	100	3.841 fgh	4.125 fg	3.983 e
	150	7.692 c	6.733 d	7.212 ab
Sawdust	0	3.856 fgh	4.494 ef	4.175 e
	100	8.437 abc	4.527 ef	6.482 c
	150	5.160 e	6.298 d	5.729 d
Coal	0	8.225 c	6.306 d	7.265ab
	100	9.005 ab	6.410 d	7.708 a
	150	4.747 ef	9.203 a	6.975 c
	Levels Mulching			Average Mulching
Mulching × Cultivars	Non mulching	4.898 c	4.762 c	4.830 c
	Sawdust	5.818 b	5.106 c	5.462 b
	Coal	7.326 a	7.306 a	7.316 a
	Salicylic mg L ⁻¹			Average Salicylic
Salicylic × Cultivars	0	5.080 c	4.743 c	4.912 c
	100	7.094 a	5.021 c	6.058 b
	150	5.866 b	7.411 a	6.639 a
Average Cultivars	6.014 a	5.725 b		

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Spraying the growth regulator salicylic acid 150 mg L⁻¹ has a significant effect on significantly improving the growth quality of vegetative bodies because salicylic acid accelerates the photosynthesis process and improves the activity of important enzymes, which has been positively reflected. Thesis area (Hayat *et al.*, 2007) [81]. It plays an important role in regulating ion absorption, hormonal balance, and stomatal movement. It also accelerates the formation of chlorophyll and carotene pigments, accelerates the photosynthesis process and increases the activity of some important enzymes that have a positive impact on certain physiological processes of plants, and salicylic acid is one of the phenolic compounds (Popova *et al.*, 1997) [19]. All of this is reflected in an increase in the content of leaves of chlorophyll and other growth traits. These results are consistent with Hussein *et al.*, (2019) [9] Hadidi and Shahwani (2020) [7] and Hussein and Al-Doori (2021) [10]. The increase in vegetative growth traits between varieties is due to genetic differences between the two varieties resulting from differences genetic factors controlling the size and shape of the leaf for each variety and its breadth. Also, good nutrition of the leaves and increased bio metabolism of chlorophyll increases the leaf area of the vine (Carbonneau, 1976) [5]. These results are consistent with Othman *et al.*, (2018) [16], Saidi (2000) [23] and Othman and Hawezly (2022) [17].

Conclusion

This study demonstrated that mulching with charcoal significantly enhances the vegetative growth characteristics of grapevines, including stem length, stem diameter, leaf area, and chlorophyll content. The use of sawdust also significantly increased the number of leaves. Additionally, the application of salicylic acid at a concentration of 150 mg L⁻¹ significantly improved all measured growth parameters. Between the two varieties studied, Kamali generally outperformed Halwani in terms of stem length, number of leaves, and leaf area, while Halwani had a higher chlorophyll content. These findings suggest that combining specific mulching practices with salicylic acid application

can effectively promote the growth of young grapevines, potentially leading to better yields and quality in grape production.

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