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Foliar Spraying with Various Commercial Products: Their Impact of on Roomy Red Grape Cultivar's Nutritional Status and Growth

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Abstract: Grapes are widely recognized as a popular fruit crop that has witnessed significant growth in production and the introduction of new varieties over the past twenty years. Therefore, improving vegetative growth and chemical content are important. This study was conducted in a private vineyard located west of Bani Mazar Center; Minia Governorate was chosen for this investigation. Trials were carried out in 2019 and 2020 over the course of two seasons on 16-year-old Roomy Red grapevine cultivars grown on their own roots. To study the effect of two commercial products, namely; Stimulant and Acadian, with different levels (0, 0.25, 0.5, and 1 g/L) for each one in a randomized complete block design, on the vegetative growth aspects and leaves chemical content of Roomy Red grapevines. The result of the present work suggests that spraying Acadian was the best choice on Roomy Red grapevines at 1 g/L, followed by 0.5 g/L without statistical difference, and recorded the uttermost mean values of studied vegetative growth aspects and chemical content during both seasons of the experiments. It can be recommended that foliar application with 0.5 g/L recorded the best economical results.

Key words: Amino acids, Acadian, vegetative, chemical and Roomy Red grapevines.

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1. Introduction

Grapes are widely recognized as a popular fruit crop that has witnessed significant growth in production and the introduction of new varieties over the past twenty years. This is mainly because of the substantial financial advantages it provides to manufacturers. Egypt's third-most popular fruit crop, after citrus and mango, is grapes. According to **Kabsha *et al.* (2023**), Egypt's grape acreage has increased significantly, reaching 190486 fed. The productive area is 174715 fed., and the yield is 9.13 tons/fed. In spite of this, Egypt's grape production ranks 32nd worldwide in the **FAO's 2020** report, despite the country's substantial contribution. Annual exports of Egyptian grapes are at 131,000 metric ton, and the country plans to grow that number in the future (**M.A.L.R., 2019**). The top priorities for Egypt's pomologists include enhancing the Roomy Red grapevine's yield in both quantitative

and qualitative terms, as well as monitoring cluster looseness and shot berries.

The status of the world now clearly shows how implementing ecologically friendly farming practices is essential to achieving sustainable growth. Chemicals have detrimental impacts on the soil, the plants that are cultivated on it, as well as the beneficial microbial communities and soil microorganisms. Examining a wide range of workable possibilities would be necessary fulfill the growing need for organic inputs. Aside from fertilizers and insecticides, bio-stimulants are any material, microbe, or substance that might promote plant development (**Brown and Saa, 2015**). Over the previous ten years, their use has grown significantly (**Calvo *et al.*, 2014**). One such alternative is the use of Ascophyllum nodosum extract (an Acadian product) with amino acids (a stimulant product).

Amino acids are generally considered biological stimulants that enhance plant productivity and growth (**Kowalczyk *et al.*, 2008**). They function as components of particular plant hormone coenzymes and enhance photosynthesis, which in turn promotes plant development (**Amin *et al.*, 2011**). The valuable impacts of the amino acids on chlorophyll synthesis and vegetative development led to their selection. Additionally, by aiding in the uptake and transport of certain micronutrients by the plant, such as iron, zinc, manganese, and copper, it has a chelating impact on them (**Ghasemi *et al.*, 2013**).

Using only natural plant extracts offers a novel approach that may improve grape quality and productivity without harming people or the environment. Natural plant extracts from intertidal marines, contain a wide range of other compounds as well as several classes of plant-promoting compounds that are recognized to have a favorable impact on stress signaling and, as a result, on many crops' growth metrics and biomass (**Khan *et al.*, 2009; Minocha *et al.*, 2014**). In relation to this, it has been observed that by bolstering plant defenses, extracts from the brown seaweed Ascophyllum nodosum can improve plant development and lessen biotic and abiotic illnesses (**Shukla *et al.*, 2019**). Many companies produce A. nodosum extracts for use in horticulture and agriculture all over the world. Research has demonstrated that commercial extracts made from *A. nodosum* can improve the quality and growth of apples, grapes, and watermelons (**Abdel-Mawgoud *et al.*, 2010; Frioni *et al.*, 2018**).

This study was designed to investigate the effect of different commercial products that contain amino acids, namely Stimulant products and natural plant extracts that contain brown seaweed Ascophyllum nodosum and are called Acadian, on the growth and the state of leaves nutrition of Roomy Red grapevines.

2. Materials and Methods

2.1. Vineyard location

A private vineyard situated west Bani Mazar Center; Minia Governorate was selected for this study. Trials were carried out in 2019 and 2020 over the course of two seasons on 16 years old Roomy Red grapevines cultivar grown on their own roots. To study the effect of two commercial products namely; Stimulant and Acadian with varying concentration of Roomy Red grapevines.

Planting distances of 2 x 2 m separated the 21 vines that were chosen for standardized growth vigor. In both years, a head pruning method was used to trained the vines in the second week of January with 16 fruiting spurs x 4 eyes + 4 replacement spurs x 2 eyes; thus, the total eyes left on each vine were 72 eyes.

The soil is clayey; Table (A) shows the results of the preliminary tests conducted on the soil's physical and chemical properties in accordance with **Wilde *et al.* (1985).** Since the water table is at least 2 m deep, the soil has water that drains well. The vines were watered with using surface irrigation from the water Nile. The experimental vines were also subjected to the general agricultural practices, pest management and fertigation recommendations made by the Egyptian Ministry of Agriculture.

Table (A). Physio-chemical analysis of vineyard soil

Soil characters		2019/2020
Particle size distribution (%)	Sand	2.23
	Silt	35.91
	Clay	61.86
	Texture class	Clayey
EC ppm (1:2.5 extract)		296
pH (1:2.5 extract)		7.48
Organic matter %		2.08
$CaCO_3$ %		2.16
Soil nutrients	Total N (%)	0.13
	Available P (ppm)	5.35
	Available K (ppm)	493.5
	Zn (ppm)	2.86
	Fe (ppm)	3.25
	Mn (ppm)	4.13
	Cu (ppm)	0.89

2.2. Studied treatments and design

Every treatment was represented by three vines (replicas) in a completely randomized block pattern, and each vine served as a representative sample, sprayed using a handgun sprayer on the vine until well wetted. Spraying took place twice: once before blooming, during the first week of March, and again in mid-April after the berry set using the following treatments:

1. Control (spray with tap water)
2. Stimulate (0.25 g/L).
3. Stimulate (0.50 g/L).
4. Stimulate (1 g/L).
5. Acadian (0.25 g/L).
6. Acadian (0.50 g/L).
7. Acadian (1 g/L).

The commercial Acadian product is a pure marine natural plant extract that contains 100% Ascophyllum nodosum extract. It was used in this study and ordered from Acadian Co. Table (B) displays the chemical content of the Acadian extract powder as mentioned by (**Doss *et al.*, 2015).**

Table (B). The Chemical content of an extract from an Acadian marine plant

Physical data:	
NPK and mineral (ash)	45 % - 55 %
Moisture	Max 10%
Alganic acid	Min 10%
Mannitol	Min 4 %
Amino acid	Min 4 %
Other organic matter derived from seaweed	Min 20 %
Guaranteed minimum analyses:	
Total nitrogen (N)	0.8 – 1.5 %
Available phosphoric acid (P_2O_5)	1 - 2 %
Soluble potash (K_2O)	17 – 22 %

The commercial Stimulant product contains a special composition of amino acids that interferes in to the formation of growth hormones, flowering, and shoot setting in a natural way that does not stress the plant. In addition to the cytokines and natural auxins used in this study and brought from Bio-Nano Technology Co. Table (C) displays the chemical composition of the Stimulant powder product.

Table (C). Chemical Composition of Stimulant product

Compounds	Value
Amino acids	4.9%
Boron	1%
Magnesium	2%
Zinc	1.5%
Cytokines + auxin	2%
Vitamins	2%

2.3. Data collection

A. Vegetative development traits

At the end of the growth season, the following metrics were measured from four randomly selected fresh shoots per vine:

1. Main shoot length: by measured the fruiting shoots.
2. Leaves number.

   Leaf area (cm^2) = 0.45 (0.79 x $diameter^2$) + 17.77 according to **Ahmed and Morsy (1999**).
3. The weight of pruning wood/vine is measured in kg using a spring balance that is manually adjusted.
4. Cane thickness (mm).

B. Leaves chemical content

1. The pigments measured in leaves (mg/100g) were total carotenoid, chlorophyll a, and b, as per **Von Wettstein (1957**).
2. In the first week of July, levels of N, P, K, S and Mg (%) as well as Zn, Fe, and Mn (ppm), were measured in the leaf petioles that correspond to the basal clusters, using the protocols laid out by (**Cottenie *et al.*, 1982 and Balo *et al.*, 1988**).

2.4. Statistical analysis

The new L.S.D. approach was applied at 0.05 to compare the means that represented the effects of the tested treatments, according to **Mead *et al.*, (1993).**

3. Results and Discussion

Effect of two commercial products—Stimulant and Acadia—at different concentrations on Roomy Red grapevines vegetative traits i.e., main shoot length, number of leaves/plant, leaf area, pruning wood weight and cane thickness during 2019 and 2020 growing seasons are presented in Table (1 & 2).

3.1. Average main shoot length (cm)

It is evident from the collected data in Table (1) that using commercial products as Stimulant and Acadian at different concentration greatly heightened the main shoot length, leaves number, leaf area, pruning wood weight and cane thickness related to the control vines during both seasons. Increasing concentration from the two commercial products, the main shoot length was increased, without significant difference between the level of 0.5 and 1 g/L for both products. Acadian recorded the highest significant mean value for main shoot length more than Stimulant product. The uppermost values of main shoot length recorded at 1 g/L Acadian (113.2 & 113.8 cm) for main shoot length, (23.0 & 24.0) for leaves number and (95.6 cm^3) for leaf area, (2.19 & 2.26 kg) for pruning wood weight and (1.24 & 1.28 mm) for cane thickness, respectively in the two seasons followed by 0.5 g/L Acadian (112.4 & 112.8 cm) for main shoot length, (22.0 & 23.0) for leaves number and (94.5 & 94.6 cm^3) for leaf area, (2.14 & 2.21 kg) for pruning wood weight and (1.21 & 1.24 mm) for cane thickness respectively in the two seasons without significant difference between them, while the lowest mean value recorded with the untreated vines (106.5 & 107.2 cm) for main shoot length, (17.0 & 16.0) for leaves number and (87.6 & 88.7 cm^3) for leaf area, (1.92 & 1.97 kg) for pruning wood weight and (1.00 & 1.04 mm) for cane thickness, respectively in the two seasons. The same pattern held true for both seasons, with the other treatments recording middling values.

Acadian and Stimulant chemicals, when applied topically, significantly improved several aspects of vegetative growth. The enhancement of plant tolerance to biotic and abiotic challenges can be related to the crucial role of amino acids and Ascophyllum nodosum extract, which has been demonstrated to boost growth.

Amino acids are organic nitrogenous chemicals that are essential for protein synthesis and a number of metabolic processes that support plant growth according to **Coruzzi and Last (2000) and Davies (1982).** In addition, it is widely known that amino acids play important roles in preventing senescence, scavenging free radicals, and reversing oxidative alterations to lipids and components of plasma membranes, all of which help plants resist pathogenic conditions (**Orth *et al.*, 1993**). This study showed that treating the vines with amino acid in form of Stimulant product sprays enhanced the vegetative growth parameters.

Table (1). Effect of Stimulant and Acadian fertilizers on main shoot length, number of eaves/plant and leaf area of Roomy Red grapevines during 2019 and 2020 seasons

Characteristics / Treatments	Main shoots length (cm)		Number of leaves/shoot		Leaf area (cm^3)		Pruning wood weight (kg)/vine		Cane thickness (mm)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	106.5	107.2	17.0	16.0	87.6	88.7	1.92	1.97	1.00	1.04
Stimulant (0.25 g/L)	108.2	108.7	18.0	17.0	89.3	90.0	2.00	2.05	1.06	1.10
Stimulant (0. 50 g/L)	109.8	110.8	20.0	20.0	91.1	91.5	2.07	2.13	1.14	1.17
Stimulant (1 g/L)	110.4	111.5	21.0	21.0	91.8	92.2	2.11	2.17	1.16	1.21
Acadian (0.25 g/L)	110.0	111.0	19.0	20.0	92.8	93.1	2.07	2.14	1.15	1.18
Acadian (0. 50 g/L)	112.4	112.8	22.0	23.0	94.5	94.6	2.14	2.21	1.21	1.24
Acadian (1 g/L)	113.2	113.8	23.0	24.0	95.6	95.6	2.19	2.26	1.24	1.28
New LSD at 0.5	**1.0**	**0.9**	**1.1**	**1.2**	**1.3**	**1.2**	**0.06**	**0.07**	**0.04**	**0.05**

Stimulant products containing amino acids and Acadian products including extracts from Ascophyllum nodosum increase the body's natural synthesis of hormones and growth-promoting substances like ethylene, IAA, GA3 and cytokinins. Plant cell division and the creation of organic macromolecules, enzymes, DNA, and RNA depend on these growth factors. As a result, applying amino

acids and Ascophyllum nodosum extract to Roomy Red vines promotes overall health as well as yield. The current study's conclusions are corroborated by earlier research by **Ahmed (2022)** on Ruby Seedless grapevines and **Abada *et al.*, (2023)** on Prime seedless grapevines**.** All of these studies showed that the vegetative growth parameters increased as the concentration of Ascophyllum nodosum extract increased. In addition to **Ibrahiem and Radwan (2019)** on Red Globe grapevines, **Farouk *et al.* (2021)** on Superior grapevines, **Sayed, (2022)** on some grape cultivars and **Zagzog and Qaoud (2023)** on Roomy Red Grapevines, they all found an increase in vegetative growth traits by foliar application by amino acids.

3.2. Chemical composition of leaves

The chemical composition values of the leaves of Roomy Red grapevines as leaves pigments (chlorophyll a, b, total chlorophyll, total carotenoid) and leaves nutrient status (N, P, K, Zn, Mg, S, Fe, and Mn) as influenced by foliar spraying with different concentrations of commercial stimulant and Acadian products during the winter seasons of 2019 and 2020 are expressed in Tables 2 to 4.

3.3. Leaves pigments content mg/g F.W

Treating Roomy Red grapevines with two commercial products at different concentration namely: Stimulant and Acadian significantly improved the chlorophyll, a-, b-and total chlorophyll as well as total carotenoid content compared with the untreated vines (Table 2). In this respect, the best product was Acadian than the Stimulant during both seasons, additionally, with increasing the concentration of both products, the pigments content was increased without discernible statistical change between the level of 0.5 and 1 g/L for both products. The chlorophyll content (a, b and total) and total carotenoid upper limit values were noted on the vines that got the highest concentration 1 g/L followed by 0.5 g/L from Acadian product without significant difference between them more than the Stimulant product. The increase over control at 1 g/L Acadian was (23.42 & 21.18%), (27.78 & 21.05&), (25.37 & 21.13%) and (24.00 & 22.78%), respectively during both seasons for chlorophyll A, chlorophyll B, total chlorophyll, and total carotenoid while the lowest mean values indicated with control. The other treatments recorded middle values during two seasons.

When amino acids are applied foliarly, they can boost the rates of photosynthetic and chlorophyll production, which improves plant development, especially in climate-unfavorable situations (**Ertani *et al.*, 2009; Garcia *et al.*, 2011**). Amino acid-supplied plants typically have higher protein, sugar, and other nutrient levels, demonstrating their higher nutritional quality. Additionally, plants with this trait are better able to withstand challenges from temperature, salinity, and drought (**Tantawy *et al.*, 2009; Cerdán *et al.*, 2013**). Applying amino acids can also improve gene expression and stomata regulation for improved plant growth (**Svennerstam *et al.*, 2008; Souri, 2016). El-Kenawy (2022)** found that using amino acids three times as foliar application led to a raise in leaves chlorophyll content. These findings about the influence of amino acids on pigment content promotion are consistent with those found by **Ibrahiem and Radwan (2019), Ahmed (2022) and Zagzog and Qaoud (2023).**

Higher concentrations of Ascophyllum nodosum extract may have contributed to the raise in chlorophyll content because they reduced the breakdown of chlorophyll, which in turn raised the levels of chlorophyll (**Whapham *et al.*, 1993 and Blunden *et al.*, 1997**). This reduction in chlorophyll degradation may have played a role in this increase in chlorophyll content. In a similar vein, plants given Ascophyllum nodosum extract demonstrated increased pigment levels through improved photosynthesis and stomatal conductance, as documented by **Salvi *et al.*, (2019).** Previous research has demonstrated that spraying seaweed extract at high concentrations produces the highest pigment values. The present positive effects of Ascophyllum nodosum extract in form of Acadian product are compatible with the results achieved by **El-Senosy (2022**), **Belal *et al.*, (2023)**, and **Abada *et al.* (2023)**.

Table (2). Effect of Stimulant and Acadian fertilizers on chlorophyll a, b, total chlorophyll and total carotenoid of Roomy Red grapevines during 2019 and 2020 seasons

Characteristics / Treatments	Chlorophyll a mg/100 g FW		Chlorophyll b mg/100 g FW		Total chlorophyll mg/100 g FW		Total carotenoid mg/100 g FW	
	2019	2020	2019	2020	2019	2020	2019	2020
Control	1.11	1.18	0.90	0.95	2.01	2.13	1.00	1.01
Stimulant (0.25 g/L)	1.2	1.29	0.97	1.01	2.17	2.30	1.06	1.08
Stimulant (0. 50 g/L)	1.26	1.34	1.02	1.06	2.28	2.40	1.13	1.15
Stimulant (1 g/L)	1.30	1.36	1.05	1.09	2.35	2.45	1.15	1.18
Acadian (0.25 g/L)	1.27	1.35	1.04	1.08	2.31	2.43	1.14	1.16
Acadian (0. 50 g/L)	1.34	1.40	1.11	1.13	2.45	2.53	1.21	1.22
Acadian (1 g/L)	1.37	1.43	1.15	1.15	2.52	2.58	1.24	1.24
New LSD at 0.5	**0.05**	**0.04**	**0.05**	**0.04**	**0.08**	**0.07**	**0.04**	**0.05**

3.4. Leaves N, P, K, Mg and S% status

It can be concluded from data in Table (4) that foliar application with some commercial products namely Stimulant and Acadian significantly increased leave nitrogen, phosphorus, potassium, magnesium and sulfur% related to the untreated vines. Increasing levels of both commercial products led to an increase in leaves nutrient percentage without significant difference between 0.5 and 1% concentrations. From the data in could found that the commercial product Acadian was effective than Stimulant. The other treatments recorded middle values. The highest mean values over the control vines detected in the case of 1 g/L Acadian by (14.81 & 18.06%), (93.75 & 88.24 %), (14.04 & 15.04), (43.14 & 46.94%) and (40.04 & 42.59%) for N, P, K, Mg and S%, respectively followed by spray with 0.5 g/L Acadian by (13.58 & 16.13%), (75.09 & 76.47%), (11.40 & 13.27%), (37.25 & 42.86%) and (34.55 & 38.89%) N, P, K, Mg and S%, respectively during both seasons without appreciable statistical variations.

Table (3). Effect of Stimulant and Acadian fertilizers on leaf N, P, K, Mg and S% of Roomy Red grapevines during 2019 and 2020 seasons

Characteristics / Treatments	Leaf N%		Leaf P%		Leaf K%		Leaf Mg %		Leaf S %	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	1.62	1.55	0.16	0.17	1.14	1.13	0.51	0.49	0.55	0.54
Stimulant (0.25 g/L)	1.68	1.62	0.19	020	1.21	1.17	0.55	0.54	0.62	0.59
Stimulant (0. 50 g/L)	1.76	1.70	0.23	0.25	1.27	1.25	0.61	0.61	0.67	0.65
Stimulant (1 g/L)	1.79	1.74	0.25	0.28	1.29	1.26	0.63	0.63	0.69	0.68
Acadian (0.25 g/L)	1.78	1.73	0.23	0.26	1.22	1.21	0.64	0.64	0.67	0.68
Acadian (0. 50 g/L)	1.84	1.80	0.28	0.30	1.27	1.28	0.70	0.70	0.74	0.75
Acadian (1 g/L)	1.86	1.83	0.31	0.32	1.30	1.30	0.73	0.72	0.77	0.77
New LSD at 0.5	**0.04**	**0.05**	**0.04**	**0.04**	**0.04**	**0.03**	**0.04**	**0.03**	**0.04**	**0.03**

3.5. Leaves content of Zinc, iron and manganese (ppm)

The results presented in Table (4) explained that the zinc, iron and manganese content of Roomy Red grapevine leaves rose significantly ($P \leq 0.05$) when Stimulant and Acadian were applied in foliar way, in comparison to the untreated vines that received a tap water spray. A gradual increase explained that the zinc, iron and manganese value was observed with increased levels of both commercial products during both seasons. The rate of 0.5 and 1 g/L for Stimulant or Acadian had no significant difference between them. Despite this, the foliar application with 1 g/L Acadian scored the highest mean values of

Zn, Fe and Mn ppm over the other treatments compared to the control, followed by 0.5 g/L from Acadian with no significant difference between two treatments. The other treatments recorded middle values in 2019 and 2020 seasons.

According to **Mohammadipour and Souri (2019a and 2019b)**, foliar feeding with amino acids can increase nutrient absorption and concentrations in the leaves. For micronutrients, specifically zinc and iron, such effects have been well documented (**Zhou *et al.*, 2007; Souri *et al.*, 2018**). Many nutrients have particular affinity for certain amino acids, and some of these acids can even form chelates with other nutrients. **Souri and Hatamian (2019**) note that this trait has recently seen extensive application in enhancing plant uptake and delivery of micronutrients, particularly iron. The advantages of nutrients that are bound to amino acids are amplified in plants (**Sadak *et al.*, 2015; Pranckietiene *et al.*, 2015**). Moreover, as previously indicated, improved photosynthesis can lead to increased assimilate production, improved plant development, and increased yield due to higher leaf nutritional status (**Galili and Amir, 2013; Souri *et al.*, 2017; Ma *et al.*, 2017**). A study was carried out by **Belal *et al.*, (2016),** it was discovered that amino acid foliar sprays boosted the levels of nitrogen, potassium, phosphorus, and magnesium in the petioles of Flame Seedless grapevine leaves. Changes in the amounts of specific proteins and amino acids, which encouraged cell elongation and division, are the reason these are increasing. These outcomes concur with those attained by **Ibrahiem and Radwan (2019), El-Kenawy (2022), and Zagzog and Qaoud (2023).**

Hormones included in the marine natural plant Ascophyllum nodosum extract may increase plant vitality and growth by encouraging root formation and better nutrient absorption. Various research has demonstrated that plant extract from *Ascophyllum nodosum* has unique growth-stimulating capabilities. These features may influence not only the structure of plant roots but also the physical, chemical, and biological properties of the soil (**Taskos *et al.*, 2019**). The inclusion of macro and micronutrients in the marine plant extract may also account for its ability to improve nutritional status (**Cabrera *et al.*, 2003**). The beneficial impacts of *Ascophyllum nodosum* marine plant extract on leaves nutritional status of the Roomy Red vines are consistent with those resulted by **El-Senosy (2022), Belal *et al.* (2023**) and **Abada *et al.* (2023),** discovered that increases in N, K, P, Mg, S%, Fe, Zn, and Mn ppm in grapevine leaves were correlated with increased Ascophyllum nodosum extract concentrations.

Table (4). Effect of Stimulant and Acadian fertilizers on leaf Zn, Fe and Mn ppm of Roomy Red grapevines during 2019 and 2020 seasons

Characteristics / Treatments	Leaf Zn ppm		Leaf Fe ppm		Leaf Mn ppm	
	2019	2020	2019	2020	2019	2020
Control	48.3	49.0	51.3	52.2	50.5	51.0
Stimulant (0.25 g/L)	52.3	52.4	54.4	55.2	53.6	54.2
Stimulant (0. 50 g/L)	55.2	55.4	57.5	58.0	57.0	57.3
Stimulant (1 g/L)	56.7	57.0	59.7	60.1	59.1	59.5
Acadian (0.25 g/L)	56.1	56.5	58.0	58.3	57.2	57.4
Acadian (0. 50 g/L)	59.2	59.7	61.6	62.0	61.1	61.0
Acadian (1 g/L)	60.6	61.2	63.9	64.2	62.9	62.9
New LSD at 0.5	**1.6**	**1.7**	**2.4**	**2.3**	**2.2**	**2.3**

Conclusion

According to the research under the same condition of the study from the economical way, it could be conducted that foliar application with 0.5 g/L from both stimulant or Acadian and preferred Acadian twice once before blooming, during the first week of March, and again in mid-April after the berry set under Roomy Red vineyard yielded the greatest outcomes of vegetative growth and the best of Roomy Red berries quality.

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