Effect of Spraying With Benzyl Adenine and Licorice Root Extract on Some Vegetative Growth Characteristics and Chemical Content of Strawberry (Fragaria Ananassa Duch) CV. Rubygem

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Abstract

This study was conducted inside the plastic house of the Agricultural Research and Experiment Station of the Agriculture College - University of Kirkuk / Iraq, during the growing season 2020/2021. To study the effect of spraying the growth regulator of benzyl adenine in three concentrations (0, 30, 60) mg.L⁻¹ and licorice root extract in three concentrations (0, 3000, 6000) mg.L⁻¹ on some growth characteristics and chemical content of strawberry plants of Rubygem type. The obtained results were summarized that spraying with a concentration of 60 mg.L⁻¹ of the growth regulator benzyl adenine BA led to a significant superiority in most growth characteristics and chemical content of strawberry plants (leaf area, leaves number, leaves area, dry matter in plant, leaf content of chlorophyll and nitrogen total) where reached (95.81 cm², 15.78 leaf. plant⁻¹, 1513.93 cm², 38.68 %, 28.66 %, 3.24 %) respectively. While spraying with concentrations (30 and 60 mg.L⁻¹) of benzyl adenine was significantly superior to the control treatment in the phosphorous and carbohydrates content of leaves. Spraying with a concentration of 6000 mg.L⁻¹ of licorice extract significantly increased in most of the study traits (dry matter in plant, leaf content of chlorophyll, nitrogen, phosphorous and carbohydrates total) where reached (39.06 %, 25.69 mg.g⁻¹, 3.09 %, 0.334 %, 3.38 %) respectively. Spraying with a concentration of 3000 mg.L⁻¹ of licorice was significantly superior in the characteristics of leaf area and Leaves area, which reached (85.08, 1303.18) cm² respectively.

Keywords: Benzyl Adenine, Licorice, strawberry, Rubygem.

1. Introduction

Fragaria ananassa Duch. belongs to the Rosaceae family. It is a perennial herbaceous plant with a short life cycle that lives 5-6 years with a short and thick stem ranging between 5-8 cm extending above the surface of the soil and rising only slightly, reaching 25-30 cm [1]. Its cultivation spreads in the semi-tropical regions to the cold regions, Strawberry is a plant with a temperate climate where its vegetative growth begins early in the beginning of spring when the air temperature reaches 2-5 ºC and begins to flower when the temperature reaches 10-15 ºC regardless of the photoperiod. The optimum temperature for its growth and giving it the highest yield with high-quality properties ranges between 13-24 ºC [1,2].

Adding nutrients through foliar spraying is one of the modern and effective methods of fertilization in agriculture, as it is sprayed on the shoots in the form of a liquid solution and is not less of efficient than nutrient absorption through the roots in addition to it reduces environmental pollution resulting from adding fertilizers to the soil [3]. Benzyl adenine is one of the most important synthetic growth regulators, which belongs to the group of cytokinins. It stimulates cell division and dilation and causes the stimulation of cell dilation laterally, and plays a role in delaying leaf aging and stimulating the transport of nutrients in addition to its effect in activating the synthesis of RNA and protein in cells [4,5], and in this field clarified [6] that spraying local orange trees with (30 and 45) mg.L⁻¹ of benzyl adenine led to a significant increase in leaf area. Reach [7] when spraying two types of grape seedlings, (Hallawani and Kamali) with a concentration of 10 mg.L⁻¹ of cytokinin KT-30 significantly increased the leaves number, leaf area, chlorophyll index, plant dry weight and leaf content of macronutrients nitrogen, phosphorous and carbohydrates, reached (17.92 leaf.seeding⁻¹, 704.29 cm², 48.40 Spad unit, 2.71 g, 1,42%, 0.132%, 6.46%) respectively, compared with the comparative treatment. On the other hand revealed studying [8] the area of one leaf and leaf area of the grape vine cultivar Halawni and Black Balad were significantly increased when spraying with...
concentration (0.25 and 0.50) mL\(^{-1}\) of cytokinin KT-30, which reached (141.43 and 141.72 cm\(^2\), 20.41 and 20.49 m\(^3\)), respectively, compared with comparison treatment, and in a study [9] it was found that the percentage of nitrogen, phosphorous and carbohydrates in the leaves of Lemon Saplings was significantly increased when spraying with a concentration of 50 mg.L\(^{-1}\) of benzyl adenine compared to the control treatment. Recent studies have tended to use some plant extracts as an alternative to chemicals in agriculture and to preserve the environment and avoid the side effects that these chemicals cause on human health and environmental pollution. The licorice plant Glycyrrhiza glabra L. is a perennial herbaceous plant that belongs to the family Fabaceae and the genus Glycyrrhiza, which includes 20 species, which means in Greek the sweet veins or roots, its flowers cluster purple in color, the root group extends to a depth of 2 m, with sub-roots branching about 30 cm below the surface of the soil [10,11]. In the study of [12] when spraying fig seedlings variety Aswad Diyala with licorice extract at a concentration of 4 g.L\(^{-1}\), caused a significant increase in leaf area and leaf content of chlorophyll and total nitrogen for both study seasons compared with spraying at a concentration of 2 g.L\(^{-1}\) and the control treatment,[13] showed that leaf area and total chlorophyll content of grape vines were significantly increased when spraying with a concentration of 20 g.L\(^{-1}\) of licorice extract.[14] in her study of two cultivars of strawberry, (Rubygem and Festival) found that the average number of leaves, their content of total chlorophyll, the average dry weight of the shoot, the percentage of nitrogen were significantly increased when spraying with a concentration of 4 g.L\(^{-1}\) licorice extract reached (13.69 leaf.plant\(^{-1}\), 4.74 mg.g\(^{-1}\) F.W., 4.64 g, 4.37%) respectively, compared to the control treatment, while the percentage of phosphorous increased when spraying at a concentration of 2 g.L\(^{-1}\), which amounted to 2.28% compared to the control treatment. While [15] showed in their study on grapes cultivar Halaway that the leaf area of the vines and the leaves content of total chlorophyll were significantly increased when spraying with licorice root extract at 2.5 g.L\(^{-1}\). [16] found that spraying Salemy cultivar pomegranate trees with licorice root extract at a concentration of 20 g.L\(^{-1}\) resulted in a significant increase in the macronutrients percentage in the leaves of nitrogen and phosphorous. While [17] explained that spraying pomegranate trees, a Salimi cultivar, showed a significant increase in most of the vegetative growth characteristics.

2. Material and Methods

This study was conducted inside the plastic house at the Agricultural Research and Experiment Station of the Agriculture College - Kirkuk University / Al-Sayada during the growing season 2020/2021, to study the effect of spraying the growth regulator with benzyl adenine at three concentrations (0, 30, 60) mg.L\(^{-1}\), symbolized by (BA\(_0\), BA\(_3\), BA\(_6\)), respectively, and spraying licorice root extract at three concentrations (0, 3000, 6000) mg.L\(^{-1}\) and is symbolized by (C\(_0\), C\(_3\), C\(_6\)) respectively. The seedlings were brought from Sulaimani Governorate, stored in cold stores of suitable and homogeneous sizes, ready for planting. The soil was prepared, smoothed and prepared for planting, and seedlings were planted on 2020/11/1 on ridge with a width of 60 cm and a height of 25 cm, and the distance between one plant and another is 30 cm. The seedlings were sprayed with 6-benzyl amino purine after dissolving it with a little ethyl alcohol and sprayed with licorice extract after soaking them in warm distilled water for 24 hours and filtering the solution with two layers of tampon [18]. At the rate of three sprays and a difference of one month between the second spray during the growing season, when the first spray was on 2020/12/1, the second spray was on 2021/1/2, and the third was on 2021/2/1. The experiment was carried out according to the RCBD design, with three replications (8 seedlings per experimental unit). The number of seedlings in one replicator was 72 seedlings, and the total number of seedlings of the experiment was 216 seedlings. 5 random plants were selected from each experimental unit to taking readings on them. The analysis was carried out statistically according to the analysis of variance using the SAS system for the analysis of statistical experiments (2001 SAS, V 9.0) and compared using the Duncan’s polynomial test under the probability of 0.05 [19].

3. Study Characteristics

First : Vegetative growth characteristics:
1. Leaf area (cm\(^2\)) : according to [20].
2. Leaves number (leaf. plant\(^{-1}\)) :
3. Leaves area (cm\(^2\)) :
4. Dry matter in plant (%) :

Second : Chemical content characteristics:
1. Leaf content of chlorophyll (mg.g\(^{-1}\) fresh weight) : It was estimated according to the method [21].
2. Leaf content of nitrogen (%) : Using the Micro-Kjeldahl device and according to the method reported by it [22].
3. Leaf content of phosphorous (%) : As described [23].
4. Leaf content of carbohydrates (%) : According to the [24].
4. Results and Discussion

4.1 Vegetative growth characteristics

The results shown in Table (1) indicate that the vegetative growth characteristics of strawberry plants were significantly affected when spraying with the growth regulator benzyl adenine at a concentration of 60 mg.L\(^{-1}\) treatment (BA\(_0\)), which gave the highest rates in characteristics (leaf area, leaves number, leaves area and dry matter in plant) as reached (95.81 cm\(^2\), 15.78 leaf, plant\(^{-1}\), 1513.93 cm\(^2\), 38.68 %), respectively, compared with the treatment BA\(_0\), which gave lower values, reached (68.28 cm\(^2\), 14.33 leaf, plant\(^{-1}\), 981.71 cm\(^2\), 38.12%) respectively for all characteristics.

Spraying with licorice extract at a concentration of 3000 mg.L\(^{-1}\) (treatment C\(_2\)) was significantly superior to the other treatments for leaf area and leaves area of the plant with an increase of (6.29 and 8.04) %, respectively, compared with the control treatment. The superiority of the two treatments C\(_1\) and C\(_2\) on the comparison treatment (C\(_0\)) for leaves number with an increase amounted to (0.79 and 0.93) %, respectively, for both the two treatments. While the percentage of dry matter in plant increased significantly when spraying with a concentration of 6000 mg.L\(^{-1}\) of licorice extract (C\(_2\)), reaching 39.06% compared with the other treatments.

As for the bilateral interaction between the levels of benzyl adenine and licorice extract, the interaction treatment BA\(_2\)C\(_1\) was significantly superior to the other treatments for the two characteristics of leaf area and leaves area of the plant, reached (101.43, 1583.69) cm\(^2\) respectively, and the number of leaves and dry matter in plant significantly increased when the interaction BA\(_2\)C\(_2\) was treated, reaching (16.05 leaf, plant\(^{-1}\) and 39.84%), respectively, compared with the other treatments.

Table 1. Effect of spraying with benzyl adenine and licorice root extract on some vegetative growth characteristics of strawberry (Frangaria ananassa Duch.) CV. Rubygem.

| BA (mg.L\(^{-1}\)) | C (mg.L\(^{-1}\)) | Studied Characteristics | Leaf area (cm\(^2\)) | Leaves number (leaf. plant\(^{-1}\)) | Leaves area (cm\(^2\)) | Dry matter in plant (%) |
|-------------------|------------------|-------------------------|----------------------|-------------------------------|---------------------|------------------------|
| BA\(_0\)          | C\(_0\)           | Leaf area 67.27 f       | Leaves number 14.19 g | Leaf area 952.72 h           | Dry matter 37.63 e  |
| C\(_1\)           |                  |                         |                      |                               |                     |
| C\(_2\)           |                  |                         |                      |                               |                     |
| BA\(_1\)          | C\(_1\)           | Leaf area 69.93 e       | Leaves number 14.49 e | Leaf area 1021.06 f           | Dry matter 38.37 d  |
| C\(_2\)           |                  |                         |                      |                               |                     |
| C\(_0\)           |                  |                         |                      |                               |                     |
| BA\(_2\)          | C\(_1\)           | Leaf area 80.08 d       | Leaves number 15.34 d | Leaf area 1208.59 e           | Dry matter 37.40 f  |
| C\(_2\)           |                  |                         |                      |                               |                     |
| C\(_0\)           |                  |                         |                      |                               |                     |
| Average BA        | BA\(_1\)          | Leaf area 82.50 b       | Leaves number 15.37 b | Leaf area 1270.10 b           | Dry matter 38.33 b  |
| BA\(_2\)          |                  |                         |                      |                               |                     |
| C\(_0\)           |                  |                         |                      |                               |                     |
| Average C         | BA\(_1\)          | Leaf area 95.81 a       | Leaves number 15.78 a | Leaf area 1513.93 a           | Dry matter 38.68 a  |
| C\(_0\)           |                  |                         |                      |                               |                     |
| Average C         | C\(_1\)           | Leaf area 90.04 c       | Leaves number 15.07 b | Leaf area 1206.17 c           | Dry matter 37.89 c  |
| C\(_2\)           |                  |                         |                      |                               |                     |
| Average C         | C\(_2\)           | Leaf area 85.08 a       | Leaves number 15.19 a | Leaf area 1303.18 a           | Dry matter 38.18 b  |
|                  |                  |                         |                      |                               |                     |
|                  |                  |                         |                      |                               |                     |

Means not sharing the same letter (s) within each column for each are significantly different at 0.05 level of probability.

4.2 Chemical content characteristics

The results of Table (2) indicate a significant increase in most of the chemical content characteristics of strawberry plants when increasing the concentrations of spraying with the growth regulator Benzyl adenine, where the treatment BA\(_2\) was superior to the two characteristics of the Leaf content of chlorophyll and nitrogen with an increase of (35.12 and 10.96) %, respectively, compared with the control treatment. Whereas, the two treatments BA\(_1\) and BA\(_2\) were superior to the leaves content of phosphorous and total carbohydrates, as it reached (0.331, 0.331, 3.24 and 3.28) %, respectively for both treatments. However, when spraying with licorice root extract at a concentration of 6000 mg.L\(^{-1}\), the treatment (C\(_2\)) had a significant effect on an increase in all chemical content characteristics (Leaf content of chlorophyll, nitrogen, phosphorous and total carbohydrates) with an increase rate over the control treatment that reached (8.95, 3.00, 4.05, 19.01) % respectively.

The dual interaction between the study factors levels had a significant effect on increasing the chemical content of strawberry plants, where the treatment BA\(_2\)C\(_1\) was significantly superior to the leaf content of total chlorophyll over the other treatments, reached 32.46 mg.g\(^{-1}\) F.W. The interference treatment, BA\(_2\)C\(_2\), was significantly superior to the rest of the coefficients to the leaf content of nitrogen, as it reached 3.29%. As for the phosphorous content of the leaves, the BA\(_2\)C\(_2\) interaction treatment had a significant superiority over the rest of the treatments and amounted to 0.347%, while the leaf content of carbohydrates.
increased when the treatment BA₂C₂ reached 3.62%, which did not differ significantly with the interaction treatment BA₄C₂, which reached 3.52%.

**Table 2.** Effect of spraying with benzyl adenine and licorice root extract on chemical content characteristics of strawberry 
*(Fragaria ananassa* Duch.) CV. Rubygem.

| BA (mg.L⁻¹) | C (mg.L⁻¹) | Leaf content of chlorophyll (mg g⁻¹ F.W.) | N (%) | P (%) | carbohydrates(%) |
|------------|------------|----------------------------------------|-------|-------|------------------|
| BA₀       | C₀         | 20.87 f                                | 3.01 f | 0.304 i | 2.57 e           |
| BA₁       | C₁         | 20.99 f                                | 2.89 g | 0.305 h | 3.21 b           |
| BA₂       | C₀         | 21.76 e                                | 2.84 h | 0.311 g | 2.99 cd          |
| BA₂       | C₂         | 23.13 d                                | 2.84 h | 0.331 c | 2.91 d           |
| BA₀       | C₁         | 27.57 b                                | 3.04 e | 0.314 f | 3.28 b           |
| BA₁       | C₂         | 22.85 d                                | 3.02 b | 0.314 c | 3.28 b           |
| BA₂       | C₀         | 32.46 a                                | 3.27 b | 0.343 b | 3.62 a           |
| BA₂       | C₂         | 20.79 c                                | 3.29 a | 0.323 e | 3.19 b           |
| Average BA | BA₁        | 21.21 c                                | 2.92 c | 0.307 b | 2.93 b           |
| Average BA | BA₂        | 22.52 b                                | 3.02 b | 0.331 a | 3.24 a           |
| Average C | C₀         | 28.66 a                                | 3.24 a | 0.331 a | 3.28 a           |
| Average C | C₁         | 23.58 c                                | 3.00 c | 0.321 b | 2.84 c           |
| Average C | C₂         | 25.12 b                                | 3.07 b | 0.314 c | 3.23 b           |
| Average C | C₉         | 25.69 a                                | 3.09 a | 0.334 a | 3.38 a           |

Means not sharing the same letter (s) within each column for each are significantly different at 0.05 level of probability.

The study findings can be interpreted the Tables (1 and 2) that an increase in the studied traits when spraying with benzyl adenine to its role in increasing cell division and elongation and then increasing growth, which is reflected in an increase in the average number of leaves and leaf area, in addition to its physiological role by canceling the apical dominance and also has an important role in delaying the decomposition of proteins and chlorophyll and thus delaying the aging of leaves Which leads to prolonging the life of the leaf by encouraging the movement of nutrients and the continuity of protein synthesis [25]. And increase the effectiveness of the installation process of photosynthesis in the manufacture of food in the leaves and transition within the plant, which encourages plant growth [26] Thus, it affects the increase in its chemical content of nutrients, these results are in consistent with [6, 7, 8, 9].

The increase that occurs when spraying with licorice root extract is due to its containment of Mevalonic acid, which is the biological precursor of gibberellin as it leads to the expansion of leaf cells, which increases their area as well as their containment of nutrients (N, Fe, Zn, Mg, Ca) But because of its great role in building chlorophyll, where nitrogen contributes to the formation of chlorophyll and the increase in the number and sizes of chloroplasts, as well as an increase in the carna [27] these results are in consistent with [12-17].

**Conclusion**

It was concluded from this study that spraying Rubygem strawberry plants with the growth regulator BA at a concentration of 30 and 60 mg.L⁻¹ and licorice root extract at a concentration of 3000 and 6000 mg.L⁻¹ led to an increase and improvement of the vegetative growth characteristics and the chemical content of the plants individually or overlapping with each other significantly.

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