Effect of Foliar Application of Glutamic Acid and Nano Zinc Oxide on The Active Compounds and Phenols of Goldenrods (Solidag SP)

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Abstract

The experiment was conducted in the Department of Horticulture, College of Agriculture, Tikrit University for the agricultural season 2020. Two factors were studied: first; foliar application of glutamic acid at three levels (0.100,200) mg.L-1, and the second; nano zinc oxide at four levels (0,0.5,1,1050) mg.L-1 in Randomized Complete Block Design ( RCDB) with three replication. The interaction A2Z3 treatment (glutamic acid 200 mg. L-1 + nano zinc oxide 1.50 g.L-1) was achieved the highest values of a-Pinene, limonene, Linalool and Myrcene Terpinen which reached (31.4, 20.3, 22.4, 27.4 and 28.2 mg.L-1) respectively, compared to the control treatment. Whereas the interaction treatment A2Z2 (glutamic acid 200 mg.L-1 + nano zinc oxide 1 g.L-1) achieved the highest values of Camphene (35.6 mg. L-1). While the interaction of A2Z3 (glutamic acid 200 mg.L-1 + nano-zinc oxide 1.50 g.L-1) was recorded the highest concentration of Rutin and Caryophyllene, which reached (40.1 - 253.8 µg.ml-1 ) respectively. While the interaction treatment A1Z3 (glutamic acid 100 mg.L-1 + nano zinc oxide 1.50 g.L-1) was achieved the highest value of Quercetine (192.9 µg.ml1).

Keywords: Solidago, Nano-zinc, Glutamic acid, Foliar nutrition, Nanotechnology.

1.Introduction

Goldenrods plant belongs to the genus Solidago, which it contains 100-130 species of flowering plants, most of them are perennial herbaceous species (perennial) belonging to the Asteraceae family, found in meadows and pastures. It can be used as ornamental plants, and its flowers are an important source for bees in the production of honey. It is native to Mexico, South America, Europe, Asia and Australia. Solidago virgaurea is one of the most important species of the genus Solidago, which spreads in Europe and Asia [1]. It is a perennial herbaceous plant that multiplies by rhizomes, offshoots and seeds that grow after maturity and germinate easily, with upright stems reaching a meter or more in height [2]. The goldenrods plant is one of the medicinal plants that was used in ancient cultures by chewing the leaves and roots to relieve sore throats and teeth, and its essential oil is similar to the fragrance of star anise and it used to reduce protein deposition in the urine of patients with kidney failure. Furthermore, the oil produced from the leaves and flowers of the goldenrods is distinguished by its containing flavonoids that strengthen the arteries and it is a good anti-fungal [3]. Glutamic acid is also involved in the development of chlorophyll molecule, which gets affected by carbohydrate anabolism. It builds growth materials similar to plant hormones and release it from anabolism source so as to collect and create an imbalance in nutrient content so as to finally increase the metabolic activity. It also plays a positive role in meeting different environmental conditions when the plant exposed to it. Glutamic acid supports the growth of the plant [4,5], [6], mentioned that effect of foliar spraying of amino acids on the sweet basil plant achieved a positive effect in the leaves content of phenolic substances, flavonoids and total proteins, also [7] mentioned to the positive effect of foliar application of amino acid to increase the antioxidant compounds in arugula leaves and seeds. Nano-structured fertilizer exhibits novel physico-chemical properties, so that they can satisfy plant root demand more efficiently in comparison with conventional fertilizers (in the form of salts). The controlled release of the nutrient could be through the process of dissolution and ion exchange reactions [8-10].

Nano-materials are currently being used as nanotechnology provides new multidisciplinary windows in agricultural and food sciences and contributes to many agricultural research that can lead to new ways to solve many agricultural problems, where nanoparticles have other potential applications in the farming system, such as the detection of pollutants, plant diseases, pests, and pathogens, especially in foliar fertilization or soil fertilization [11].
Zinc has an importance in vegetative growth as it enters into the synthesis of the amino acid tryptophan, which is important in the synthesis of indole acetic acid and is important in cell divisions and cell elongation and thus increasing the characteristics of vegetative growth [12], [13], mentioned that chelated zinc and nano-chelated zinc with (1.5,1.0.5,0 g.L⁻¹), achieve a significant differences of menthol, menthone and menthofuran, which amounted to (237,%61%) 28%, respectively compared to the control treatment.

The study aimed to know the possibility of cultivating the goldenrods plant under the conditions of Salah El-Din province due to its environmental and medical importance by knowing its response to spraying with glutamic acid and nano-zinc oxide and their interactions in the traits of vegetative growth, mineral content and active substance.

2. Materials and Methods

The study was conducted in the Department of Horticulture and Landscape, College of Agriculture, Tikrit University for the agricultural season 2020, the experiment was studying the effect of spraying with glutamic acid and nano-zinc oxide on some vegetative growth traits, mineral content and the active substance of Solidag SP plant. The seedlings were transferred on 01/02/2020 in plastic pots with a diameter of (22 cm) containing peat moss and loam soil in a ratio of 1:1. A two-factor field experiment with their interactions was conducted based on a randomized complete block design (RCBD).

2.1. Determination of the active compounds in the volatile oil of goldenrods plant leaves using GC-MS

2.1.1. Oil extraction

Twenty grams of the fresh sample has been taken and put in a beaker. 100 ml of distilled water has been adding to the beaker and set in the Calfanger device for 3 hours. The extract was collected and add 20 ml of hexane to separate the oil from the water.

2.1.2. Analysis method

The analysis methods were conducted in the laboratories of the Ministry of Science and Technology / Department of Environment and Water using a gas chromatograph device, Shimadzu 2010 model, Japanese origin, using the Flame Ionized Detector (FID) and column type DM-5Ms (30m * 0.25 um * 0.25 mm), the temperature was The temperature of the injection area and the detector, respectively: 280, 340 Celsius, the temperature of the separation column starting from 100 - 300 Celsius, at a rate of 10 degrees/min. Use of inert nitrogen gas as a carrier gas at an average of 100 KPa [14].

2.2. Determination of some phenolic compounds in the volatile oil of gold stick plant leaves using HPLC

Solid-liquid extraction to analyze polyphenols and phenols plants, Commonly used extraction solvents are alcohols (methanol, ethanol, acetone, ether, and ethyl acetate), the first steps of the preparation procedure are grinding and homogenization, take 15 g of sample and homogeneous and add 15 ml of chloroform and 10 ml of hexane to sample for withdrawing chlorophyll, terpenoids, and fats for 10 hours with stirring. Then the extract is placed in a crushing device for 20 minutes at a 45 C, then add 25 ml of methanol and transferred to the separating funnel. Then the polar organic layer (methanol) is collected and transferred to the rotary evaporator to obtain a dry extract. The process was repeated 3 times to obtain a sufficient quantity based on the method [15] a high-performance liquid chromatography device has been used. The carrier phase was used: methanol: distilled water: formic acid, (70: 25: 5) The separation column was: C18 - ODS (25cm * 4.6 mm) to separate the phenols and an ultraviolet detector was used: UV - 280 nm, where the flow rate of the conveying phase was: 1.3 ml/min

3. Results and Discussion

3.1. Determination of Active Compounds in Volatile Oil of Gold Stick Plant Using GC-MS

Table 14 shows that the overlap interaction A2Z3 (glutamic acid 200 mg.L⁻¹ + nano zinc oxide 1.50 g.L⁻¹).It achieved the highest values of the active substances (α-Pinene - limonene - Linalool - Myrcene - Terpinen) reached (31.4 - 20.3 - 22.4 - 27.4 - 28.2), respectively. Whereas, the interaction treatment A2Z2 (glutamic acid 200 mg.L⁻¹ + nano zinc oxide 1g.L⁻¹) recorded the highest values of Camphene compound 35.6 g.L⁻¹ compared to the lowest concentration of the compound mentioned at the control treatment.
Table 1. Effect of glutamic acid and nano zinc oxide on some active substances of goldenrods plant.

| Treatments | a-Pinene mg.L⁻¹ | Camphene mg.L⁻¹ | Limonene mg.L⁻¹ | Linalool mg.L⁻¹ | Myrcene mg.L⁻¹ | Terpinen mg.L⁻¹ |
|------------|----------------|----------------|----------------|----------------|----------------|----------------|
| A0Z0       | 10.2           | 14.5           | 1.4            | 2.3            | 5.8            | 6.4            |
| A0Z1       | 10.8           | 15.3           | 2.1            | 2.9            | 6.7            | 7.8            |
| A0Z2       | 17.4           | 23.1           | 8.5            | 9.8            | 13.6           | 15.1           |
| A0Z3       | 25.4           | 32.6           | 14.2           | 15.8           | 19.2           | 22.5           |
| A1Z0       | 12.2           | 17.1           | 3.2            | 4.2            | 8.1            | 9.1            |
| A1Z1       | 13.4           | 18.0           | 4.1            | 5.8            | 9.3            | 10.4           |
| A1Z2       | 20.1           | 26.7           | 10.3           | 11.4           | 15.8           | 17.6           |
| A1Z3       | 30.1           | 32.8           | 18.1           | 19.2           | 25.1           | 26.3           |
| A2Z0       | 15.1           | 20.6           | 6.4            | 7.2            | 11.3           | 12.4           |
| A2Z1       | 23.1           | 30.2           | 12.4           | 13.2           | 17.3           | 19.1           |
| A2Z2       | 27.9           | 35.6           | 16.2           | 17.6           | 22.5           | 24.9           |
| A2Z3       | 31.4           | 33.5           | 20.3           | 22.4           | 27.4           | 28.2           |

3.2. Determination of Phenolic Compounds in the Volatile Oil of goldenrods plant Leaves Using HPLC

Table (5) confirm that the interaction treatment A2Z3 (glutamic acid 200 mg.L⁻¹ + nano zinc oxide 1.50 g.L⁻¹) achieved the highest values of the active substances in the leaves of goldenrods (Rutin and Caryophyllene, which reached (40.1 - 253.8) respectively, Whereas the interaction treatment A1Z3 (glutamic acid 100 mg.L⁻¹ + nano zinc oxide 1.50 g.L⁻¹ record the highest values of the compound (Quercetine) which reached 192.9 g.L⁻¹.

Table 2. The effect of glutamic acid and nano zinc oxide on the active substances of the goldenrods.

| Treatments | Rutin µg.ml⁻¹ | Caryophyllene µg.ml⁻¹ | Quercetine µg.ml⁻¹ |
|------------|---------------|------------------------|-------------------|
| A 0 Z 0    | 2.1           | 21.0                   | 16.2              |
| A 0 Z 1    | 5.8           | 34.5                   | 34.5              |
| A 0 Z 2    | 21.4          | 143.5                  | 95.7              |
| A 0 Z 3    | 31.8          | 224.0                  | 155.4             |
| A 1 Z 0    | 7.6           | 59.0                   | 42.6              |
| A 1 Z 1    | 12.2          | 96.0                   | 66.6              |
| A 1 Z 2    | 23.2          | 151.0                  | 124.8             |
| A 1 Z 3    | 39.1          | 243.5                  | 192.9             |
| A 2 Z 0    | 19.0          | 105.0                  | 78.3              |
| A 2 Z 1    | 25.1          | 218.5                  | 137.6             |
| A 2 Z 2    | 36.0          | 234.5                  | 184.5             |
| A 2 Z 3    | 40.1          | 253.8                  | 190.5             |

The increase of the active substance in the leaves with foliar application of the amino acid may be due to role of the amino acid in regulating ions and modifying the movement of nutrients within the plant [16,17]. As for the increase in the concentration of phosphorus in the leaves, it may be due to the significant effect of the zinc oxide nanoparticles on growth regulators, and then motivating the plant to perform its vital and constructive activities, which it requires withdrawing more quantities of phosphorus to meet the plant’s need for it because it is an important element in the formation of nucleic acids and proteins, cellular membranes and energy compounds [18]. It is reflected positively in the increase in the active substances in the plant. The addition of amino acids to the plant leads to an increase in the number and expansion of cell divisions and contributes to the production and formation of secondary metabolic compounds in medicinal plants and its important role in the formation of plant tissues [19]. The increase in the content of nutrients and total phenols in the leaves is due to the fact that the nano-fertilizers provide the various metabolic reactions in the plant with a larger surface area, which leads to an increase in the average of photosynthesis, thus preserving the plant from various vital stresses. While the increase of active compounds and phenols as a result of spraying with nano-zinc oxide may be due to its active role in the synthesis of tryptophan and amino acids [7]. Hence, it is reflected positively in the increase of most of the active compounds.
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