Effect of Biofertilizer and Humic Acid on Growth and Flowering of Solidago spp

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Abstract A pot experiment was carried out in lath house of Horticulture and Landscape Dep / College of Agriculture - Tikrit University for the period from February to December 2020. The experiment included two factors, Humic Acid add (control) and the addition at a concentration of 3 g. L⁻¹, Biofertilizers without addition, Glomus mosseae at rate 50 gm.pot⁻¹ and Bacillus sabtilus . results showed the superiority of the treatment of Mycorrhizae in most of the studied traits, and it gave a plant height 111.52 cm and the number of spores 258.74 .10gm⁻¹. The addition of was superior and gave 5.84 inflorence stems and 13.95 day vase life. interaction treatment between Mycorrhiza and Humic interaction treatment gave the highest concentration of nitrogen, phosphorus and potassium where 2.08%, 0.323% and 1.70%, respectively.

1. Introduction

Solidago sp is a perennial flowering herbaceous plant native to North America, and some species originated in Europe and South America which belongs to the family Asteraceae . The plant reproduces with rhizomes, rhizome and seeds that grow after their maturity and germinate quickly. It is considered a medicinal plant par excellence . Due to the aesthetic of its yellow flowers, it is used in the field of decoration, such as cut flowers, flowerpots, and flower beds and circles, resistant to salinity and soil cloudiness, so it is planted near the water holes in the flower beds and is planted with plant hedges to give a colour gradient in the flowering stage and is grown as a single plant in the corners of the garden or between rocks. It is used in the phytoremediation of soils contaminated with heavy elements and can absorb and accumulate these elements in the root, stem and leaves [1], [2].

Biofertilizers are defined as a microbe or a microbes group that provide one or more nutrients necessary for plant growth in a soft form for it by transforming it from the elements from their unprepared forms to their ready-to-absorb forms. Bacteria Fungi and green algae Blue are among the most important sources of biological fertilizers, as these organisms important role by providing nutrients or resisting diseases and resisting conditions surrounding plant growth such as environmental stress. Mycorrhizae fungi are added in several ways in the form of (pad) under the seeds or placed next to (Band dressing) It is also added by mixing the pollen with the soil when a large quantity of pollen is needed, as in the nurseries, or by using speed pelleting, as the pollen (soil, spores, infected roots) is mixed with the seeds using Arabic glue [3]. Bacillus bacteria are one of the genera that dissolve phosphates by secreting organic acids such as formic, acetic, lactic, furmic and others that lower the soil pH and dissolve phosphates in their various forms, as well as some Hydroxy acid may bind with calcium and iron, thus preventing its association with phosphates, which increases the effectiveness of solubility and use of phosphates [4]. Humic compounds have interest in plant nutrition, release nutrients and raise available elements and their role in increasing the capacity of the ketogenic exchange and therefore play an important and
positive role in plant growth and improve the properties of the soil physically, chemically and biologically as they contain nutrients [5]. They have the ability to facilitate the absorption of calcium, potassium, phosphorous, magnesium and nitrogen. Through this, it improves plant growth and affects the growth of buds and roots without risks to the environment [6], [7] showed that the addition of humic acid at a concentration of (2%) to the gerbera plant increases the number of flowers, the number of days required for the emergence of the first flower, the number of leaves and the leaf area measured by the comparison treatment.

The study aimed to know the behaviour, growth and flowering of Solidago sp under Salah El-Din Governorate's conditions, through knowing its response to organic fertilization with humic acid and bio fertilization with Mycorrhizae and Bacillus bacteria.

2. Materials and Methods:
The study was carried out in lath house, Department of Horticulture and Landscape/ College of Agriculture - Tikrit University, from February to December 2020. It was planted on 3/15/2020 in pots 24 cm in a mixture of 3:1 loam soil: peat moss, experiment included two factors: the first addition of Humic Acid, at two levels without adding (control), and the addition at a concentration of 3g. liter was added with irrigation water by adding 100 ml/pot with two additives, the first when planting and the second one month after the first addition. The second factor is Biofertilizers and has three levels without addition, Glomus mosseae at a rate 50 (g/pot) in the form of a pillow under the seedlings. In addition to Bacillus sabtilus, Arabic glue was used as an adhesive for bacteria with a concentration of 10%. Roots of seedlings are soaked with a solution of Arabic glue for a quarter of an hour, after which they are soaked for a quarter of an hour with a solution of basil bacteria and planted in pots. A factorial experiment was carried out with Randomized Complete Block Design (R.C.B.D) with three replications. Experimental unit consisted of three pots. The following characteristics were taken (plant height, total chlorophyll, dry matter in leaves, the concentration of nitrogen, phosphorous and potassium in leaves, number of flower stems, flower stem length, flower stem weight, vase life, number of fungal spores according to [8]. The results were analysed statistically using the SAS program and the averages were compared according to the Duncan test at a probability level of 0.05.

3. Results and Discussion:
From the data of Table (1), we find that there is a significant superiority of the two biological fertilization treatments over the control treatment and the Mycorrhizae treatment outperformed all the studied characteristics. It gave a plant height of 111.52 cm, chlorophyll content of 3.68 mg., A dry substance 14.10%, and a concentration of nutrients (1.95, 0.299 and 1.63%) for nitrogen, phosphorous, and potassium. The treatment of inoculation with Mycorrhizae gave the highest number of spores in the medium of cultivation, which reached 258.74 spores. 100 gm. The addition of humic at a concentration of 3 g/l exceeded the comparison treatment and gave a plant height of 113.32 cm, and a concentration of nutrients 1.98% nitrogen, 0.297% phosphorus and 1.63% potassium. From the double overlap coefficients, we find the superiority of the interaction treatment between fertilization with mycorrhiza and the addition of humic in all the vegetative growth characteristics 3.97 mg. Chlorophyll and 15.12% dry substance, and the highest number of spores was 287.80 g/100g.
Table (1) Effect of bio fertilizer and humic acid on vegetative growth of *Solidago*

| Bio fertilizer | Height plant cm | Chlorophyl mg.ml⁻¹ | Dry mater % | N % | P % | K % | No. spore Spore.100 gm |
|----------------|-----------------|--------------------|-------------|-----|-----|-----|------------------------|
| Control        | 98.22 c         | 3.27 c             | 13.41 c     | 1.75 c | 0.216 c | 1.52 c | 12.30 c               |
| Bacillus       | 104.03 b        | 3.42 b             | 13.74 b     | 1.82 b | 0.280 b | 1.58 b | 181.84 b              |
| Mycorhiza      | 111.52 a        | 3.68 a             | 14.10 a     | 1.95 a | 0.299 a | 1.63 a | 258.74 a              |
| Humic acid gm.L⁻¹ |                |                    |             |      |       |       |                        |
| 0              | 95.86 b         | 3.15 b             | 12.91 b     | 1.71 b | 0.263 b | 1.52 b | 118.67 b              |
| 3              | 113.32 a        | 3.76 a             | 14.59 a     | 1.98 a | 0.297 a | 1.63 a | 183.25 a              |
| Interaction    |                 |                    |             |      |       |       |                        |
| Control        | 90.28 f         | 2.97 f             | 12.62 f     | 1.63 f | 0.253 f | 1.47 e | 10.45 f               |
| Bacillus       | 102.95 d        | 3.40 d             | 13.09 d     | 1.82 d | 0.275 c | 1.55 c | 229.68 b              |
| Mycorhiza      | 106.17 c        | 3.57 c             | 14.19 c     | 1.88 c | 0.269 d | 1.56 c | 14.15 e               |
| Humic acid gm.L⁻¹ |                |                    |             |      |       |       |                        |
| 0              | 113.70 b        | 3.75 b             | 14.45 b     | 1.98 b | 0.299 b | 1.64 b | 190.89 c              |
| 3              | 120.09 a        | 3.97 a             | 15.12 a     | 2.08 a | 0.323 a | 1.70 a | 287.80 a              |

The means per column with similar letters are not significant at 5% (Duncan’s multiple range tests).

From Table (2) we find that the Mycorrhiza treatment exceeded the two bacillus and the comparison treatments, and it gave the highest number of rosette stems, which amounted to 5.71. In contrast, the comparison treatment showed 4.96 rosy stems. The treatment of Mycorrhizae gave the most extended pink branch of 33.45 cm. The addition of humic treatment outperformed the comparison treatment, and it gave the highest number of flower stems with 5.84 rosy stems, the longest pink stem weight of 6.54 g, and the longest flowering life of 13.95 days. Among the interaction coefficients between biological fertilization and humic fertilization, we find the superiority of the interaction between fertilization with Mycorrhiza and the addition of humic. The highest number of flower stems was 6.05, and the length of the pink stem was 34.99 cm, and the highest flowering age was 14.44 days.

Table (2) Effect of Bio-fertilizer and humic acid on flower development of *Solidago spp.*

| Bio fertilizer | No. flowers stalk | Length flowers stalk Cm | Weight flowers stalk gm | Vase life (days) |
|----------------|-------------------|-------------------------|-------------------------|-----------------|
| Control        | 4.96 c            | 30.77 c                 | 6.26 c                  | 12.96 c         |
| Bacillus       | 5.24 b            | 32.45 b                 | 6.43 b                  | 13.24 b         |
| Mycorhiza      | 5.71 a            | 33.45 a                 | 6.72 a                  | 13.49 a         |
| Humic acid gm.L⁻¹ |                 |                         |                         |                 |
| 0              | 4.77 b            | 30.20 b                 | 6.19 b                  | 12.51 b         |
| 3              | 5.84 a            | 34.24 a                 | 6.74 a                  | 13.95 a         |
| Interaction    |                   |                         |                         |                 |
| Control        | 4.44 c            | 28.22 f                 | 5.99 f                  | 12.49 dd        |
| Bacillus       | 4.49 cc           | 30.49 e                 | 6.18 e                  | 12.49 d         |
| Mycorhiza      | 5.38 b            | 31.90 d                 | 6.42 d                  | 12.55 dd        |
| Humic acid gm.L⁻¹ |                 |                         |                         |                 |
| 0              | 5.49 bb           | 33.33 c                 | 6.53 c                  | 13.44 c         |
| 3              | 5.99 a            | 34.41 b                 | 6.67 b                  | 13.99 b         |

The means per column with similar letters are not significant at 0.05 (Duncan’s multiple range tests).

The significant effect of vaccination with mycorrhiza is due to its giving the highest number of leaves compared to non-inoculated ones, and this is due to the role of the fungus in improving plant growth and increasing the effectiveness of photosynthesis, as the pathogen encourages the absorption of the phosphorus component that participates in the formation of
energy molecules ATP. At the same time, the host prepares it with carbon compounds [9], thereby increasing photosynthesis activity. The reason for the increase in the leaves' nutrients content when treated with the fungus is due to the role of Mycorrhizae in increasing the readiness of the phosphorus component in the soil by reducing the pH and increasing the absorption process of the element through external fungal spinning, and then it led to an increase of the phosphorus component in the plants inoculated with the mycorrhiza fungus. The results showed that humic acid has a positive role in improving the vegetative characteristics of the plant, and this may be attributed to the positive effect of humic acid because it contains micro and macro nutrients that have an essential role in plant nutrition and growth as well as its potassium content that regulates the process of opening and closing stomata and its role in the building process. Photosynthesis, which is one of the essential functions that it performs [10], and that humic acid has an apparent positive effect in its ability to reduce the pH, and it works to release essential nutrients (NPK) by increasing the capacity of microorganism activity and conversion in a way that the plant benefits, and this in turn encourages the absorption of nutrients, increases the number of leaves and vegetative growth, and that the available potassium element with the increase in the vegetative system promotes the formation of the carboxylase enzyme and its role in raising the efficiency of product rates and the movement of complete sap in the plant, and the important role of phosphorus in the formation of organic compounds resulted from the photosynthesis process and promotes the formation of carbohydrates, energy compounds ATP and ADP that are used upon active absorption and its positive role in plant growth and enhance the efficiency of photosynthesis [11], [12], [13].

4. Conclusion
In conclusion, it can be significant response to the addition of humic acid and Biofertilization treatment, especially Mycorhiza fungus gave the highest values to vegetative and flowering characteristics of Solidago plant.

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