Effect of Humic Acid, Gibberellin and Tryptophan on The Growth and Flowering Characteristics of Goldenrods Plant Solidago Canadensis

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Abstract

The experiment was conducted in high school of Al-Hilla agricultural for the summer and autumn season 2020 to study the effect of humic acid and foliar application of gibberellin and tryptophan acid on the growth of the goldenrods plant resulting from the cultivation of solidago candasis which took it from residues of plant seeds growing. However, the first factor was humic acid, plants treated with humic acid were (H0 control, H1 = 5 ml / L), the second factor was the foliar application of gibberellin acid with the two levels (G1 = 100 mg / liter, G2 = 200 mg / L) and third factor was tryptophan acid with two three levels (T0 = without treated, T1 = 100 mg / L, T2 = 150 mg / L). The experiment was conducted as a factorial experiment (2×3×3) with split-plot design according to the randomized complete blocks design (R.C.B.D) with three replicates. The results showed that humic acid fertilization improved the studied characteristics of the goldenrods plant. While treatment with gibberellin acid at concentration of 100 mg / liter due to improve the number of branches, leaf area and the number of inflorescences and the percentage of carbohydrates, whereas, treatment with concentration of 200 mg / liter leads to improve of plant height, length of inflorescence and vase life. As for the treatment with tryptophan acid, the concentration 150 mg / L improved all the studied parameters.

Keywords: Goldenrods, Humic, Gibberellin, Tryptophan acid, Growth.

1. Introduction

Goldenrods (Solidago canadensis L) belongs to Asteraceae family and grows as a wildflower in North America, Asia and Europe. It has other names: Tara, Northern mimosa, Golden feather, Goldenrod and it has widely planted in landscapes for flowering landscapes, and as an excellent cut flower used as a filler in bouquets for the durability of its high stems after harvest and also used as a dried flower [1]. It is considered one of the oldest ornamental plants transmitted from North America to Europe and in England, it has been known there [2]. It is an attractive and easy-to-grow species, thus, it has been widely used by gardeners [3]. Goldenrods can also be used to vegetate damaged areas and to restore and stabilize soils, its plant is well tolerated for grazing by caw, sheep and horses as feed [4]. In Iraq, it noticed a significant decline in the culture of the production of cutting flowers, due to several reasons, which may be the lack of researches that thrive in our harsh environmental conditions without the need for costs to provide an appropriate environment, the goldenrods plant was chosen for this study, it is a new crop among the top 25 from the most famous cutting flowers around the world, it has rarely been mentioned in Arab sources and references to ornamental plants, despite its benefits and great importance and suitability of productivity in the conditions of Iraq.

Phytohormones are considered the most important endogenous substances for modulating physiological and molecular responses, a critical requirement for plant survival as sessile organisms, Phytohormones act either at their site of synthesis or elsewhere in plants following their transport [5,6]. Plant growth and flowering depend on the balance of growth regulators and plants respond quickly to changing the hormonal balance [7]. Gibberellins, especially gibberellic acid (GA3) play an important role in plant growth and development. Gibberellins are classified as a various of plant hormones that enhance certain physiological or biochemical pathways in plants [8]. Gibberellic acid improves the yield and quality of ornamental plants by encouraging plant growth and stem elongation [9]. Some of authors studied the effect of GA3 on ornamental plants showed that it accelerates flowering and enhances plant height [10]. Authors are still looking a clean technique characteristics for sustainable and environmental systems in modern agriculture to increase the production, Organic fertilization is the most important way to develop and raising the agricultural production value and reduce the environmental pollution resulting from the excessive use of mineral fertilizers [11]. The nutrients balance in the soil and meet the basic requirements of plant nutrient elements throughout the growth stages. Humic acid
considered an important organic fertilizer, which used to improve the properties of soil and speed up growth. Generally, humate is considered the most common material that increases the nutrient elements, especially the micronutrient elements [12]. Humic acid has an effect on plant growth, where it works to transport nutrients inside the plant, raises the level of photosynthesis and increases the absorption of nutrients and dry matter in the plant. As well as stimulating the plant to resist stress conditions, where spraying it on the leaves increases the building and accumulation of active substances, including the alkaloids Vinblastine and Vincristine [13]. Amino acids are very important for stimulating cell growing, which act as a buffer in helping and maintain favorable pH value within the plant cell, due to it contains both acid and base groups. The regulatory role of amino acid is Illustrated on plant growth and development via its impact on gibberellins biosynthesis [14]. Studies have proven that the application of amino acids, including tryptophan, with different concentrations has led to vegetative improvement, flowering growth, and chemical traits [15]. The amino acid tryptophan, Indole-3-glycerol phosphate, is the primer of the biosynthesis of the hormone indole acetic acid (IAA), which leads to an increase in vegetative growth by providing plants with nutrients and increasing their absorption and entry into the building and production of organic compounds that help increase and improve plant growth [16]. Given the scarcity of applied studies in Iraq on improving the phenotypic and flowering traits of the goldenrods plant and its suitability for open cultivation in the conditions of Iraq, the study aims to improve the vegetative and floral growth by individual and interaction of Bio stimulants effect, GA, Humic acid and tryptophan, also the study aims to obtain clean agriculture and reducing pollution without relying on chemical fertilizers.

2. Materials and Methods

The experiment was conducted under lath house in high school of Al-Hilla agricultural for the summer and autumn season 2020, to study humic acid and foliar application of gibberellin and tryptophan acid on the growth of the goldenrods plant, which resulted from the cultivation of cultivar residues (Solidago candasis) was taken from seed plants. During March 2020, the seedlings were cultivated in pots with a diameter of 30 cm containing a soil medium consisting of 1:3 river pot and peat moss, respectively.

2.1. The first study factor: Humic acid

Plants were treated with humic acid produced by Al-Zohour Company for Investment and Agricultural Development (Humic acid 12%, N 1.5%, K2O 2%), by two concentrations, and the addition was ground up to 250 ml per pot, as follows: (H0 = without adding, H1 = added to the soil 5 ml / L) every 20 days throughout the growth period until flowering.

2.2. The second factor: Gibberellic acid (GA3)

The plants were sprayed until completely wet and according to the concentrations 100 = G1 mg / L, G2 = 200 mg / L, in addition to the control plants G0 = control, the first Foliar application after two months of transplanting and the second spraying one month from first spraying.

2.3. The third factor: Tryptophan

The plants were sprayed with tryptophan until completely wet and according to the concentrations as follows: (T0 = control, T1 = 100 mg / L, T2 = 150 mg / L). The first spray was a month after transplanting and the spraying process was repeated every 20 days until the flowering period.

2.4. Experimental design

The experiment was conducted based on factorial experiment (2×3×3) by arranging the split plot according to the Complete Randomized Blocks Design (R.C.B.D), with three replicates, where each replicate contains 18 treatments, five plants for each experimental unit. The concentrations of humic acid represented the main plot, and the concentrations of tryptophan and gibberellic acid and their interactions as a sub-plot. Means were compared using L.S.D test at 5% level [17].
3. Results and Discussion

3.1. Plant height (cm)

The results in Table (1) indicate to a significantly effect of humic acid when spraying on the goldenrods plant, where spraying at a concentration of 5 ml.L⁻¹ led to an increase in the plant height that reached 150.30 cm, it excelled on control treatment 135.36 cm. Spraying with gibberellic acid also led to a significant increase in plant height at a concentration of 200 mg.L⁻¹ it helped to increase the plant height to 151.01 cm, which it showed a significant difference from the control treatment 131.25 cm. Whereas, spraying with tryptophan acid, the concentration 150 mg.L⁻¹ was excelled and showed the highest value in plant height of 148.64 cm, with a significant difference from the control treatment 137.94 cm. The bi-interactions between humic acid and gibberellin acid led to significant differences between plants, where the H1G1 treatment was characterized by the highest plant height of 158.84 cm compared to the lowest plant height of 125.18 cm when treated H0G0, also, the interactions between gibberellin acid and tryptophan acid led to significant differences, where the treatment G1T3 exhibited the highest average of plant height of 158.22 cm compared to the control treatment G0T1 128.71 cm. While the interaction between humic acid and tryptophan acid showed significant differences in the height of the gold stick plant was 155.40 cm when treated with H1T3 compared to the lowest plant height of 130.36 cm when treated with control treatment H0T1. The triple interaction between the study factors achieved significant differences, where the treatment H1G1T3 gave the highest plant height of 165.44 cm, and most of the treatments of the triple interaction differed significantly from the control treatment H0G0T1 which gave the lowest height of the goldenrods plants and amounted to 123.10 cm.

| Humic acid | Gibberellin acid | Amino acid (Tryptophan) | Average (H x G) |
|------------|------------------|-------------------------|----------------|
| Control treatment (H0) | distilled water(G0) | 123.107 | 125.110 | 127.327 | 125.181 |
| 5 ml. L⁻¹ (H1) | 100 mg.L⁻¹ (G1) | 126.773 | 135.440 | 151.000 | 137.738 |
| | 200 mg.L⁻¹ (G2) | 141.220 | 140.997 | 147.330 | 143.182 |
| | distilled water(G0) | 134.330 | 137.330 | 140.330 | 137.330 |
| | 100 mg.L⁻¹ (G1) | 147.220 | 151.550 | 165.440 | 154.737 |
| | 200 mg.L⁻¹ (G2) | 154.993 | 161.107 | 160.440 | 158.847 |
| L.S.D 0.05 | | 0.9192 | 0.6231 |

| Interaction (G x T) | Distilled water(G0) | 128.718 | 131.220 | 133.828 | 131.256 |
| | 100 mg.L⁻¹ (G1) | 136.997 | 143.495 | 158.220 | 146.237 |
| | 200 mg.L⁻¹ (G2) | 148.107 | 151.052 | 153.885 | 151.014 |
| L.S.D 0.05 | | 0.6349 | 0.4117 |

| Interaction (H x T) | Control treatment (H0) | 130.367 | 133.849 | 141.886 | 135.367 |
| | 5 ml. L⁻¹ (H1) | 145.514 | 149.996 | 155.403 | 150.304 |
| L.S.D 0.05 | | 0.6011 | 0.7434 |

3.2. The number of branches per plant

Table (2) indicate the significantly effect of humic acid when sprayed on the goldenrods plant, where spraying at a concentration of 5 ml.L⁻¹ led to an increase in the number of branches amounted to 8.31, superiored on the control treatment 6.52. Spraying with gibberellic acid led to a significant increase in the number of branches via concentration of 100 mg.L⁻¹ which led to increasing the number of branches to 8.09, with a significant difference compared to control treatment 6.31. When spraying with tryptophan acid, the concentration 150 mg.L⁻¹ excelled and gave the highest number of branches reaching 8.00 and a significant difference from the control treatment 6.89. The bi-interactions between humic acid and gibberellin acid led to significant differences between plants, the treatment H1G1 was characterized by the highest number of branches reached 8.96 compared to the lowest value 5.37 for treatment H0G0. Also, the interactions between gibberellin acid and tryptophan acid led to significant differences, the treatment G1T3 showed the highest average number of branches that amounted to 9.33 compared to control treatment G0T1 which gave 6.11. While the interaction between humic acid and tryptophan acid gave significant differences in the number of branches of the goldenrods, the highest of which reached 8.92 in the treatment H1T3 compared to the lowest number of branches in the control treatment H0T1 5.92. The triple interaction...
between the factors of the study achieved significant differences, where the treatment H1G1T3 gave the highest number of branches reached 10.33, and most of the treatments of the binary interaction significantly differed from the control treatment H0G0T1 which gave the lowest number of branches 5.00.

**Table 2.** Effect of humic acid, gibberellin and tryptophan and their interactions on the number of branches of goldenrods plant (branch.plant\(^{-1}\)).

| Humic acid | Gibberellin acid | Amino acid (Tryptophan) | Average (H x G) |
|------------|-----------------|------------------------|-----------------|
| Control treatment (H0) | Distilled water (G0) | 5.00 | 5.44 | 5.66 | 5.37 |
| | 100 mg.L\(^{-1}\) (G1) | 6.11 | 7.22 | 8.33 | 7.22 |
| | 200 mg.L\(^{-1}\) (G2) | 6.66 | 7.00 | 7.22 | 6.96 |
| | Distilled water (G0) | 7.22 | 7.00 | 7.55 | 7.26 |
| | 100 mg.L\(^{-1}\) (G1) | 8.00 | 8.55 | 10.33 | 8.96 |
| | 200 mg.L\(^{-1}\) (G2) | 8.33 | 8.88 | 8.88 | 8.70 |
| 5 ml. L\(^{-1}\) (H1) | | | L.S.D 0.05 | 0.574 |
| Interaction (G x T) | Distilled water (G0) | 6.11 | 6.22 | 6.61 | 6.31 |
| | 100 mg.L\(^{-1}\) (G1) | 7.05 | 7.89 | 9.33 | 8.09 |
| | 200 mg.L\(^{-1}\) (G2) | 7.50 | 7.94 | 8.05 | 7.83 |
| | | | L.S.D 0.05 | 0.709 |
| Interaction (H x T) | Control treatment (H0) | 5.92 | 6.55 | 7.07 | 6.52 |
| | 5 ml. L\(^{-1}\) (H1) | 7.85 | 8.14 | 8.92 | 8.31 |
| | | | L.S.D 0.05 | 0.623 |
| | Amino acid (Tryptophan) average | 6.89 | 7.35 | 8.00 | 0.675 |
| | | | L.S.D 0.05 | 0.445 |

3.3. Leaf area (leaf.plant\(^{-1}\))

From the results of Table (3) showed to a significant effects of humic acid when spray on the goldenrods plant, spraying at a concentration of 5 ml.L\(^{-1}\) led to an increase in leaf area 2379.29, surpassed on the control treatment, which amounted to 1847.25. Spraying with gibberellic acid led to a significant increase in leaf area. Spraying at a concentration of 100 mg.L\(^{-1}\) gave increase of leaf area 2361.88, with a significant difference from the control treatment of 1676.61. When spraying with tryptophan acid, the concentration 150 mg.L\(^{-1}\) excelled in the highest leaf area amounting to 2346.94, with a significant difference from the control treatment of 1867.27. The bi-interactions between humic acid and gibberellic acid led to significant differences between plants, where the treatment 2H1G was characterized by the highest leaf area of 2786.00 compared to the lowest number of leaves 3410.33, and most of the treatments of the triple interaction significantly differed from the control treatment H0G0T1 which gave the least goldenrods plant leaf area 1576.00.

3.4. Inflorescence length (cm)

The results in Table (4) point to a significant effect of humic acid when spray on the goldenrods plant, where spraying at a concentration of 5 ml.L\(^{-1}\) led to an increase in the length of the inflorescence amounted to 23.11, excelled on the control treatment, which amounted to 18.81, and spraying with gibberellic acid led to a significant increase in the length of the inflorescence. Spraying by concentration of 200 mg.L\(^{-1}\) assisted to increase the length of the inflorescence to 22.48, with a significant difference from the control treatment of 17.98. While, spraying with tryptophan acid, the concentration of 150 mg.L\(^{-1}\) showed the highest length of inflorescence was 22.39, with a significant difference from the control treatment 19.44. The bi-interactions between humic acid and gibberellic acid led to significant differences between plants, where the treatment H1G2 was characterized by the highest inflorescence length of 25.26 compared to the lowest length of inflorescence reached 16.57 for H0G0. Furthermore, interactions between gibberellic acid and tryptophan acid to the presence of significant
differences, treatment G1T3 gave the highest mean inflorescence length of 25.33 compared to control treatment G0T1 which gave 17.05, while the interaction between humic acid and tryptophan acid gave significant differences in the length of the inflorescence of the goldenrods reached 24.92 in the treatment H1T3 compared to the lowest length of the inflorescence when the control H0T0 by 17.86. The triple interaction between the factors of the study achieved significant differences, where the treatment H1G1T3 gave the highest length of inflorescence, which amounted to 29.11, and most of the treatments of the triple interaction differed significantly from the control treatment H0G0T1 which gave the lowest length of the inflorescence and reached 15.55.

Table 3. Effect of humic acid, gibberellin and tryptophan and their interactions on leaf area of goldenrods plant.

| Humic acid   | Gibberellin acid | Amino acid (Tryptophan) | Average (H x G) |
|--------------|-----------------|-------------------------|-----------------|
|              | Distilled water | 100 mg.L⁻¹ (T1) | 150 mg.L⁻¹ (T3) | Fixed effect |
| Control treatment (H0) | 100 mg.L⁻¹ (G1) | 1776.000 | 2065.000 | 2319.333 | 2053.556 |
| 5 ml. L⁻¹ (H1) | 200 mg.L⁻¹ (G2) | 1770.333 | 1832.333 | 1847.333 | 1816.667 |
| Distilled water (G0) | 1634.333 | 1677.667 | 1733.000 | 1681.667 |
| 100 mg.L⁻¹ (G1) | 1859.333 | 2741.000 | 3410.333 | 2670.222 |
| 200 mg.L⁻¹ (G2) | 2587.333 | 2722.667 | 3048.000 | 2786.000 |
| L.S.D 0.05 | 313.5096 | 293.2498 | 159.1755 | 376.5821 |
| Interaction (G x T) | distilled water (G0) | 1605.167 | 1696.333 | 1728.333 | 1676.611 |
| 100 mg.L⁻¹ (G1) | 1817.833 | 2403.000 | 2864.833 | 2361.889 |
| 200 mg.L⁻¹ (G2) | 2178.833 | 2277.500 | 2447.667 | 2301.333 |
| L.S.D 0.05 | 300.8641 | 159.1755 | 300.8641 | 159.1755 |
| Interaction (H x T) | Control treatment (H0) | 1707.556 | 1870.778 | 1963.444 | 1847.259 |
| 5 ml. L⁻¹ (H1) | 1681.667 | 2670.222 | 2786.000 | 2379.296 |
| L.S.D 0.05 | 300.8641 | 376.5821 | 300.8641 | 376.5821 |
| Amino acid (Tryptophan) average | 1867.278 | 2125.611 | 2346.944 | 2346.944 |

Table 4. Effect of humic acid, gibberellin and tryptophan and their interactions on The inflorescence length of goldenrods plant.

| Humic acid   | Gibberellin acid | Amino acid (Tryptophan) | Average (H x G) |
|--------------|-----------------|-------------------------|-----------------|
|              | Distilled water | 100 mg.L⁻¹ (T1) | 150 mg.L⁻¹ (T3) | Fixed effect |
| Control treatment (H0) | 100 mg.L⁻¹ (G1) | 18.887 | 20.110 | 21.553 | 20.183 |
| 5 ml. L⁻¹ (H1) | 200 mg.L⁻¹ (G2) | 19.160 | 19.717 | 20.220 | 19.699 |
| Distilled water (G0) | 18.550 | 19.443 | 20.220 | 19.404 |
| 100 mg.L⁻¹ (G1) | 21.690 | 22.923 | 22.830 | 22.481 |
| 200 mg.L⁻¹ (G2) | 24.220 | 26.130 | 25.440 | 25.263 |
| L.S.D 0.05 | 0.8594 | 0.5905 | 0.5252 | 0.6303 |
| Interaction (G x T) | distilled water (G0) | 17.050 | 17.887 | 19.025 | 17.987 |
| 100 mg.L⁻¹ (G1) | 19.608 | 22.353 | 25.332 | 22.431 |
| 200 mg.L⁻¹ (G2) | 21.690 | 22.923 | 22.830 | 22.481 |
| L.S.D 0.05 | 0.6137 | 0.4343 | 0.5252 | 0.6303 |
| Interaction (H x T) | Control treatment (H0) | 17.866 | 18.719 | 19.868 | 18.817 |
| 5 ml. L⁻¹ (H1) | 21.033 | 23.390 | 24.923 | 23.116 |
| L.S.D 0.05 | 0.5252 | 0.6303 | 0.5252 | 0.6303 |
| Amino acid (Tryptophan) average | 19.449 | 21.054 | 22.396 | 22.396 |
3.5. The number of inflorescences on plant

Table (5) indicate to a significant effect of humic acid when spray on the goldenrods plant, where spraying at a concentration of 5 ml.L$^{-1}$ led to an increase in the number of inflorescences that amounted to 8.48, superior to the control treatment, which amounted to 6.72. Spraying with gibberellic acid led to a significant increase in the number of inflorescences. Spraying at a concentration of 100 mg.L$^{-1}$ assisted to increase the number of inflorescences to 8.31, with a significant difference from the control treatment of 6.64, but when spraying with tryptophan acid, the concentration of 150 mg.L$^{-1}$ surpassed on the highest number of inflorescences reached 8.21, with a significant difference from the control treatment, which amounted to 7.06. The bi-interactions between humic acid and gibberellin acid led to significant differences between plants, where the treatment H1G1 was characterized by the highest inflorescence diameter of 9.27 compared to the lowest inflorescence diameter of 5.70 when treated H0G0. Also, the interactions between gibberellin acid and tryptophan acid led to a significant differences, where treatment G1T3 gave the highest average number of inflorescences which amounted to 9.44 compared to control treatment G0T1 by 6.22, while the interaction between humic acid and tryptophan showed a significant differences in the number of inflorescences, the highest of which was 9.11 when treatment H1T3 compared to the minimum 6.05 diameter of the inflorescence in the treatment of control treatment H0T1. The triple interaction between the study factors achieved significant differences, where the treatment H1G1T3 gave the highest diameter of inflorescence amounted to 10.44, and most of the treatments of the triple interaction differed significantly from the measurement treatment H0G0T1 which gave the lowest diameter of the inflorescence and reached 5.33.

Table 5. Effect of humic acid, gibberellin and tryptophan and their interactions on number of inflorescences of goldenrods plant .

| Humic acid          | Gibberellin acid | Amino acid (Tryptophan) | Average (H x G) |
|---------------------|------------------|-------------------------|-----------------|
|                     | Distilled water  | 100 mg.L$^{-1}$         | 150 mg.L$^{-1}$ |
| Control treatment (H0) | Distilled water(G0) | 5.33 | 5.82 | 5.94 | 5.70 |
| 5 ml. L$^{-1}$ (H1) | 100 mg.L$^{-1}$(G1) | 6.28 | 7.33 | 8.44 | 7.35 |
|                     | 200 mg.L$^{-1}$(G2) | 6.55 | 7.22 | 7.55 | 7.11 |
|                     | Distilled water(G0) | 7.11 | 7.55 | 8.11 | 7.59 |
|                     | 100 mg.L$^{-1}$(G1) | 8.44 | 8.94 | 10.44 | 9.27 |
|                     | 200 mg.L$^{-1}$(G2) | 8.66 | 8.33 | 8.77 | 8.59 |
| L.S.D 0.05 | 0.664 | 0.455 | 0.408 | 0.250 |
| Interaction (G x T) | distilled water(G0) | 6.22 | 6.69 | 7.02 | 6.64 |
|                     | 100 mg.L$^{-1}$(G1) | 7.36 | 8.14 | 9.44 | 8.31 |
|                     | 200 mg.L$^{-1}$(G2) | 7.61 | 7.78 | 8.16 | 7.85 |
| L.S.D 0.05 | 0.455 | 0.400 | 0.320 | 0.250 |
| Interaction (H x T) | Control treatment (H0) | 6.05 | 6.79 | 7.31 | 6.72 |
|                     | 5 ml. L$^{-1}$ (H1) | 8.07 | 8.27 | 9.11 | 8.48 |
| L.S.D 0.05 | 0.430 | 0.210 | 0.180 | 0.080 |
| Amino acid (Tryptophan) average | 7.06 | 7.53 | 8.21 | 0.508 |
| L.S.D 0.05 | 0.285 | 0.150 | 0.100 | 0.050 |

3.6. Vase life (day)

Table (6) the results point to a significant effect of humic acid when spray on the goldenrods plant, where spraying at a concentration of 5 ml.L$^{-1}$ led to an increase in the vase life of 12.38, surpassed on the control treatment 10.54. Spraying with gibberellin acid led to a significant increase in the vase life, spraying at a concentration of 200 mg.L$^{-1}$ helped increase the vase life 12.07, with a significant difference from the control treatment of 10.46. When spraying with tryptophan acid, the concentration 150 mg.L$^{-1}$ excelled on the highest Vase life 12.08 with a significant difference from the control treatment 10.88. The bi-interactions between humic acid and gibberellin acid led to significant differences between plants, where treatment H1G2 was characterized by the highest vase life of 12.92 compared to the
lowest vase life of 9.44 when treated H0G0, as well as interactions between gibberellic acid and tryptophan acid to the presence of significant differences where treatment G1T3 gave the highest.

The average vase life was 13.19 compared to the control treatment G0T1 by 10.27. Whereas, the interaction between humic acid and tryptophan acid gave a significant differences in the vase life of the goldenrods 13.03 in the treatment H1T3 compared to the minimum vase life in the treatment of the control treatment H0T1 by 9.99. The triple interaction between the study factors made significant differences, as the treatment H1G1T3 gave the highest vase life of 14.22 and most of the treatments of the triple interaction significantly differed from the control treatment H0G0T1 which gave a lowest vase life of the goldenrods 9.33.

Table 6. Effect of humic acid, gibberellin and tryptophan and their interactions on vase life of goldenrods plant.

| Humic acid   | Gibberellin acid | Amino acid (Tryptophan) | Average (H x G) |
|--------------|------------------|-------------------------|-----------------|
| Control      | Distilled water  | 9.330                   | 9.333           | 9.442           |
| treatment (H0)| 100 mg.L⁻¹(G1)  | 9.443                   | 10.720          | 12.167          | 10.777          |
|              | 150 mg.L⁻¹(G2)  | 11.217                  | 11.440          | 11.553          | 11.403          |
| 5 ml. L⁻¹(H1)| Distilled water  | 11.220                  | 11.663          | 11.550          | 11.478          |
|              | 100 mg.L⁻¹(G1)  | 11.553                  | 12.997          | 14.220          | 12.923          |
|              | 200 mg.L⁻¹(G2)  | 12.553                  | 13.333          | 13.327          | 12.738          |
| L.S.D 0.05  | 0.9648           |                         | 0.4447          |                 |
| Interaction | Distilled water  | 10.275                  | 10.498          | 10.607          | 10.460          |
| (G x T)     | 100 mg.L⁻¹(G1)  | 10.498                  | 11.858          | 13.193          | 11.850          |
|              | 150 mg.L⁻¹(G2)  | 11.885                  | 11.887          | 12.440          | 12.071          |
| L.S.D 0.05  | 0.6852           |                         | 0.3296          |                 |
| Interaction | Control treatment | 9.997                   | 10.498          | 11.128          | 10.541          |
| (H x T)     | 5 ml. L⁻¹(H1)   | 11.776                  | 12.331          | 13.032          | 12.380          |
| L.S.D 0.05  | 0.5602           |                         | 0.4688          |                 |
| Amino acid (Tryptophan) average | 10.886 | 11.414 | 12.080 | 10.886 | 11.414 | 12.080 | 0.4439 |

3.7. Carbohydrate

From results in Table (7) showed the significant effect of humic acid when spray on the goldenrods plant, where spraying at a concentration of 5 ml.L⁻¹ led to an increase in the estimation of carbohydrates amounting to 10.09, excelled on the control treatment 8.57. Spraying with gibberellin acid also led to a significant increase in carbohydrates, spraying at a concentration of 100 mg.L⁻¹ helped to increase carbohydrates to 10.28, with a significant difference from the control treatment of 8.02. When spraying with tryptophan acid, the concentration of 150 mg.L⁻¹ surpassed on the highest carbohydrate amounting to 9.87 with a significant difference from the control treatment 8.81. The bi-interactions between humic acid and gibberellin acid led to significant differences between plants, where the treatment H1G1 was characterized by the highest carbohydrate estimating of 11.07 compared to the lowest carbohydrate estimation of 7.06 when treatment H0G0. Also, the interactions between gibberellin acid and tryptophan acid led to significant differences, as the treatment G1T3 gave the highest rate of carbohydrate estimation amounted to 11.32 compared to the control treatment G0T1 by 7.48. Whereas, the interaction between humic acid and tryptophan gave a significant differences in the estimation of carbohydrates, the highest amounted to 10.53 when H1T3 was compared to the lowest estimation of carbohydrates when measured H0T1 by 7.96. The triple interaction between the study factors achieved significant differences, as the treatment H1G1T3 gave the highest carbohydrate estimation of 12.57, and most of the triple interaction treatments significantly differed from the control treatment H0G0T1 which gave the lowest carbohydrate of 6.31.
Table 7. Effect of humic acid, gibberellin, and tryptophan and their interactions on carbohydrates of goldenrods plant.

| Humic acid | Gibberellin acid | Amino acid (Tryptophan) | Average (H x G) |
|------------|------------------|-------------------------|----------------|
| Control treatment (H0) | Distilled water (G0) | 6.31 | 6.98 | 7.89 | 7.06 |
| | 100 mg.L⁻¹ (G1) | 8.70 | 9.68 | 10.07 | 9.48 |
| | 200 mg.L⁻¹ (G2) | 8.86 | 8.91 | 9.69 | 9.15 |
| | Distilled water (G0) | 8.65 | 8.99 | 9.27 | 8.97 |
| | 100 mg.L⁻¹ (G1) | 10.03 | 10.61 | 12.57 | 11.07 |
| | 200 mg.L⁻¹ (G2) | 10.32 | 10.64 | 9.74 | 10.23 |
| | L.S.D 0.05 | 1.318 | | | 0.705 |
| Interaction (G x T) | Distilled water (G0) | 7.48 | 7.99 | 8.58 | 8.02 |
| | 100 mg.L⁻¹ (G1) | 9.36 | 10.15 | 11.32 | 10.28 |
| | 200 mg.L⁻¹ (G2) | 9.59 | 9.78 | 9.72 | 9.69 |
| | L.S.D 0.05 | 0.931 | | | 0.501 |
| Interaction (H x T) | Control treatment (H0) | 7.96 | 8.53 | 9.22 | 8.57 |
| | 5 ml. L⁻¹ (H1) | 9.67 | 10.08 | 10.53 | 10.09 |
| | L.S.D 0.05 | 0.786 | | | 0.787 |
| | Amino acid (Tryptophan) average | 8.81 | 9.30 | 9.87 | 8.58 |

Conclusion

It is evident from the previous results that treatment with humic acid (5 ml/L), gibberellin acid (100, 200 mg/L) and tryptophan acid (150 mg/L) improved in all the studied vegetative and flowering traits of the plant with a significant differences from the control treatment.

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