# The effect of humic and compost extract on the growth characteristics of strawberry plant runners.

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**Abstract**
A greenhouse experiment was carried out at the Department of Horticulture and Landscape, College of Agriculture, Tikrit University, during the 2025–2026 growing season to investigate the effect of humic and compost extract on some growth characteristics of strawberry runners. Strawberry runners obtained from the Mohammed nursery were used and planted in plastic pots containing loamy soil mixture inside the greenhouse.

The study was arranged as a factorial experiment within a randomized complete block design (RCBD) involving two factors and three replicates, as the first factor included the application of humic in three concentrations: 0, 1, and 3 ml $L^{-1}$, while the second factor included the application of compost extract in three concentrations: 0, 15, and 25%. Several vegetative and chemical traits were evaluated including leaf number, leaf area, chlorophyll concentration and carbohydrate content, and NPK percentages. Humic acid and compost extract treatments significantly affected all studied characteristics, as the T9 treatment (humic 3 ml $L^{-1}$ + compost extract 25%) prevailed significantly and produced the highest values for leaf number, leaf area, chlorophyll content, carbohydrate percentage, and NPK concentrations, while the control treatment recorded the lowest values.

Keywords: humic acid, compost, strawberry

## 1.Introduction

Strawberry *(Fragaria × ananassa* Duch.) is considered one of the most important small fruit crops in the world because of its high nutritional and economic value, as its fruits are distinguished by containing vitamins, mineral salts and antioxidant compounds, in addition to the high demand for it for fresh consumption and the food industry. Strawberry plants are propagated vegetatively using runners, which are the primary means of producing seedlings, so improving the growth of runners and their vegetative characteristics is one of the important factors in the success of growing this crop. [19]. Recent studies have focused on the use of biostimulants and organic fertilizers to improve plant growth and reducing dependence on chemical fertilizers. Humic acid is widely used as an organic biostimulant because of its important role in enhancing nutrient uptake, improving soil properties, and stimulating plant metabolic activities, which leads to enhanced vegetative growth and increased leaf content of chlorophyll, carbohydrates, and nutrients. [6]. A study conducted by [21] showed that application of humic acid to strawberry plants led to increased leaf growth, improved fruit quality, increased nutrient absorption efficiency, in addition to improved the biological activity of the soil . [17] indicated that the use of humic acid in strawberry plants increased vegetative growth and improved plant physiological characteristics of the plant by increasing leaf number and leaf area and enhancing the photosynthesis process. Compost extracts can

provide plants with essential nutrients and beneficial microorganisms that improve soil fertility and plant performance, which positively impacts plant growth and the efficiency of mineral nutrient uptake. A study by [10 , 12] The use of compost in growing media improved the growth of strawberry plants and increased nutrient uptake efficiency and productivity under protected cultivation conditions. The study by [20] also showed that The application of vermiCompost improved the vegetative
growth characteristics and increased the physiological activity of strawberry plants as a result of enhanced soil biological properties and increasing microbial activity.

**Study objective**

This study aimed to investigate the effect of humic and compost extract on some growth characteristics of strawberry plant runners including, the number of leaves, the area of one leaf, and the content of chlorophyll, carbohydrates, and major nutrient elements (NPK).

**2.Material and method**

The experiment was conducted in the greenhouse belonging to the Department of Horticulture and landscape the College of Agriculture – Tikrit University during the 2025–2026 growing season to study the effect of humic acid and compost extract on the growth of strawberry plant runners. Strawberry runners of the Ruby Gem variety were obtained from the Muhammad Nursery located in Kirkuk Governorate, and then planted inside the plant greenhouse in plastic pots containing mixed soil. Humic acid and compost extract were foliar applied to the plants four times at 15-day intervals..

The study was arranged as a factorial experiment within a randomized complete block design (RCBD) with three replicates.

**Table 1 Chemical and physical properties of the soil used in the experiment.**

| Result | unit | characteristic |
|---|---|---|
| Clay loam | - | Soil texture |
| 25 | % | sand |
| 40 | | silt |
| 35 | | Clay |
| 6.7 | - | pH |
| 4.3 | Ds $m^{-1}$ | Electrical conductivity |
| | | cations |
| 9 | Mmol $L^{-1}$ | Calcium ion |
| 6.8 | | Magnesium ion |
| 11 | | Sodium ion |
| 0.7 | | Potassium ion |
| | | anions |
| 23 | Mmol $L^{-1}$ | $SO_4^{--}$ |
| 16.3 | | $Cl^-$ |
| 2.3 | | $HCO_3^-$ |
| 24.2 | ppm | Available nitrogen |
| 3.11 | | Available phosphorus |
| 3.51 | | Total iron |
| 229.6 | G $kgm^{-1}$ | lime |
| 1.58 | | Organic matter |

**2-1 Experiment factors**

The experiment included two factors at different concentrations, as follows:

The first factor: humic acid ( H )

Humic was applied in three concentrations:

H0=zero ml $L^{-1}$.

H1=1 ml $L^{-1}$.

H2=3 ml $L^{-1}$.

The second factor: Compost extract ( C )

Compost extract was applied in three concentrations:

C0=zero %.

C1=15%

C2=25%

The experiment consisted of 9 treatment randomly distributed into three replicates, as follows:

H0C0=T1
H0C1=T2
H0C2=T3
H1C0=T4
H1C1=T5
H1C2=T6
H2C0=T7
H2C1=T8
H2C2=T9

Therefore, the total number of experimental units was 27.

**2-2.Preparing compost extract**

The compost extract was prepared by mixing 10 liters of compost and adding it to 10 liters of water. The mixture was then mixed well and filtered to obtain the final extract, which was considered to have a concentration of 50%. From it, the required concentrations for the experiment were prepared.

**2-3. Characteristics studied**

The characteristics studied included the following:

**2-3-1. Number of leaves for the plant (leaf. Plant$^{-1}$).**

The number of leaves was determined by counting the number of leaves of 5 plants in the experimental unit and extracting the average number of leaves.

**2-3-2. leaf Area (cm²).**

The leaf area was calculated according to [15] at the end of the experimental season.

**2-3-3. Chlorophyll content of leaves. ( mg.L$^{-1}$).**

Fresh leaf samples were used for chlorophyll extraction using 80% acetone according to [1].

**2-3-4. Total carbohydrate content (%).**

[9] method was used to estimate the total carbohydrates in leaves using phenol and sulfuric acid, and then the absorbance was measured using a spectrophotometer at a wavelength of 490 nm.

**2-3-5. Mineral content of leaves:**

The matured leaves were taken with their petioles [14], while they were in a stage of relative nutrient stability (Ibrahim, 2010). Then the collected leaves were washed with water to remove dust and dried in an air oven at 70°C until constant weight. The dried samples were then ground and passed through a sieve with holes of 0.2 mm in diameter, and were subjected to a wet digestion process using sulfuric and perchloric acid, as described by [4]Then the elements were determined as follows:

**2-3-5-1. Nitrogen N% in leaves:**

Nitrogen was determined with the Micro-kjeldahl apparatus as described by [8].

**2-3-5-2. Phosphorus P (%) in leaves**

Phosphorus was determined according to the method described by [16].

**2-3-5-3. Potassium K% in leaves:**

Potassium was determined using a Flame Photometer as described by [4].

**2-4. Statistical analysis**

The data were statistically analyzed according to the Randomized Complete block design (RCBD) , means were compared using the Least Significant Difference (LSD) test at a probability level of 0.05.

**3.Results and discussion**

**3-1. The effect of humic acid and compost extract on the number of leaves of the strawberry plant**

leaves number was significantly influenced by humic acid application, H2 treatment significantly increased the number of leaves and recorded the highest mean value 18.3 plant leaves$^{-1}$ compared to treatments H1 and H0, which recorded 14.0 and 10.7 plant leaves$^{-1}$, respectively. The results also showed a significant effect of the compost extract on the number of leaves, as treatment C2 gave the highest significant average of 15.7 plant leaves$^{-1}$, when compared to control treatment C0, which recorded the lowest value of 13.0 plant leaves$^{-1}$. As for the overlap values between humic and compost extract in the number of leaves, the T8 and T9 coefficients significantly prevailed the rest of the overlap values, recording the highest average of 19

plant leaves$^{-1}$, without any significant difference between them, while the control treatment T1 gave the lowest average of 9 plant leaves$^{-1}$.

Table 2: The effect of humic acid and compost extract on the number of leaves of the strawberry plant.

| H / C | H0 | H1 | H2 | Average |
|---|---|---|---|---|
| C0 | 9 | 13 | 17 | 13 |
| C1 | 11 | 13 | 19 | 14.3 |
| C2 | 12 | 16 | 19 | 15.7 |
| Average | 10.7 | 14 | 18.3 | |
| | 1.8 H | 1.5 C | 2.6 HXC | LSD |

**3-2.The effect of humic acid and compost extract on the area of one leaf (cm2) of the strawberry plant**

The results showed a significant effect of humic acid on the area of one leaf, H2 treatment significantly increased leaf area and recorded the highest average value of 49.7 cm² compared to treatments H1 and H0, which recorded 39.7 and 31.0 cm², respectively. The results also showed a significant effect of the compost extract on the area of one leaf, as treatment C2 gave the highest average of 43.3 cm² compared to treatments C1 and C0, which recorded 40.3 and 36.7 cm², respectively. As for the interaction between humic and compost extract, it gave a significant effect on the area of one leaf, as the T9 treatment prevailed significantly and achieved the highest average of 53 cm², while the T1 control treatment gave the lowest average of 28 cm².

Table 3: The effect of humic acid and compost extract on the area of one leaf (cm2) of the strawberry plant.

| H / C | H0 | H1 | H2 | Average |
|---|---|---|---|---|
| C0 | 28 | 36 | 46 | 36.7 |
| C1 | 31 | 40 | 50 | 40.3 |
| C2 | 34 | 43 | 53 | 43.3 |
| Average | 31 | 39.7 | 49.7 | |
| | H 4.1 | C 3.5 | HXC5.8 | LSD |

**3-3.The effect of humic acid and compost extract on the chlorophyll content of the leaves (mg.L-1) for strawberry plant.**

The results showed a significant effect of humic acid on the chlorophyll content of the leaves, with treatment H2 being significantly prevailed and recording the highest average of 52.7 mg L$^{-1}$ compared to treatments H1 and H0, which recorded 44.7 and 36.7 mg L$^{-1}$, respectively. The results also showed a significant effect of the compost extract on the chlorophyll content, as treatment C2 gave the highest average of 48.0 mg L$^{-1}$ compared to treatments C1 and C0, which recorded 45.0 and 41.0 mg L$^{-1}$, respectively. As for the interaction between humic and compost extract, it showed a significant effect on the chlorophyll content, as the T9 treatment prevailed significantly and achieved the highest average of 57 mg L$^{-1}$, while the T1 control treatment gave the lowest average of 34 mg L$^{-1}$.

Table 4: Effect of humic acid and compost extract on the chlorophyll content of leaves (mg.L-1) for strawberry plant.

| H / C | H0 | H1 | H2 | Average |
|---|---|---|---|---|
| C0 | 34 | 41 | 48 | 41.0 |
| C1 | 37 | 45 | 53 | 45 |
| C2 | 39 | 48 | 57 | 48 |
| Average | 36.8 | 44.7 | 52.7 | |
| | H 3.2 | C 2.8 | HXC4.5 | LSD |

### 3-4. The effect of humic acid and compost extract on the carbohydrate content (%) of strawberry leaves

The results showed a significant effect of humic acid on the carbohydrate content of the leaves, with treatment H2 showing the highest significant effect and recording the highest average of 13.6% compared to treatments H1 and H0, which recorded 11.2% and 9.0%, respectively. The results showed a significant effect of compost extract on carbohydrate content, with treatment C2 recording the highest average of 12.2% compared to treatments C1 and C0, which recorded 11.4% and 10.2%, respectively. The interaction between humic and compost extract showed a significant effect on the percentage of carbohydrates, as the T9 treatment prevailed significantly and achieved the highest percentage of 14.7%, while the control treatment T1 gave the lowest percentage of 8.2%.

Table 5: The effect of humic acid and compost extract on the carbohydrate content (%) of strawberry leaves.

| H / C | H0 | H1 | H2 | Average |
|---|---|---|---|---|
| C0 | 8.2 | 10.1 | 12.4 | 10.2 |
| C1 | 9 | 11.3 | 13.8 | 11.4 |
| C2 | 9.8 | 12.1 | 14.7 | 12.2 |
| Average | 9 | 11.2 | 13.6 | LSD |
| | H 1.1 | C 0.9 | HXC1.6 | |

### 3-5 .The effect of humic acid and compost extract on the nitrogen content of the leaves (%) of the strawberry plant

The results showed a significant effect of humic acid on the nitrogen content of the leaves, with treatment H2 showing the highest significant effect and recording a mean of 2.30% compared to treatments H1 and H0, which recorded 1.93% and 1.55%, respectively. The results showed a significant effect of compost extract on nitrogen content, with treatment C2 yielding the highest average of 2.08% compared to treatments C1 and C0, which recorded 1.94% and 1.77%, respectively. The interaction between humic and compost extract showed a significant effect on the nitrogen percentage, as the T9 treatment prevailed significantly and achieved the highest percentage of 2.48%, while the T1 control treatment gave the lowest percentage of 1.42%.

Table 6: Effect of humic acid and compost extract on the nitrogen content (%) of strawberry leaves.

| H / C | H0 | H1 | H2 | Average |
|---|---|---|---|---|
| C0 | 1.42 | 1.78 | 2.11 | 1.77 |
| C1 | 1.56 | 1.94 | 2.32 | 1.94 |
| C2 | 1.67 | 2.08 | 2.48 | 2.08 |
| Average | 1.55 | 1.93 | 2.30 | LSD |
| | H 0.18 | C 0.15 | HXC0.26 | |

### 3-6. The effect of humic acid and compost extract on the phosphorus content of the leaves (%) of the strawberry plant.

The results showed a significant effect of humic acid on the phosphorus content of the leaves, with treatment H2 showing the highest significant effect and recording a mean of 0.41% compared to treatments H1 and H0, which recorded 0.33% and 0.24%, respectively. The results also showed a significant effect of the compost extract on the phosphorus content, with treatment C2 yielding the highest average of 0.36% compared to treatments C1 and C0, which recorded 0.33% and 0.29%, respectively. The interaction between humic and compost extract also showed a significant effect on the phosphorus percentage, as the T9 treatment prevailed significantly and achieved the highest percentage of 0.45%, while the T1 control treatment gave the lowest percentage of 0.21%.

Table 6: The effect of humic acid and compost extract on the phosphorus (%) content of strawberry leaves.

| H / C | H0 | H1 | H2 | Average |
|---|---|---|---|---|
| C0 | 0.21 | 0.29 | 0.37 | 0.29 |
| C1 | 0.24 | 0.33 | 0.41 | 0.33 |
| C2 | 0.27 | 0.36 | 0.45 | 0.36 |
| Average | 0.24 | 0.33 | 0.41 | LSD |
| | H 0.04 | C 0.03 | HXC0.06 | |

**3-7 The effect of humic acid and compost extract on the potassium content of the leaves (%) of the strawberry plant.**

The results showed a significant effect of humic acid on the potassium content of the leaves, with treatment H2 showing the highest significant effect and recording a mean of 2.20% compared to treatments H1 and H0, which recorded 1.83% and 1.45%, respectively. The results also showed a significant effect of the compost extract on the potassium content, with treatment C2 giving the highest average of 1.98% compared to treatments C1 and C0, which recorded 1.83% and 1.67%, respectively. In addition, the interaction between humic and compost extract showed a significant effect on the potassium content, with treatment T9 showing the highest content at 2.38%, while control treatment T1 had the lowest content at 1.31%.

Table 7: Effect of humic acid and compost extract on the potassium content (%) of strawberry leaves.

| H / C | H0 | H1 | H2 | Average |
|---|---|---|---|---|
| C0 | 1.31 | 1.68 | 2.02 | 1.67 |
| C1 | 1.45 | 1.84 | 2.21 | 1.83 |
| C2 | 1.58 | 1.97 | 2.38 | 1.98 |
| Average | 1.45 | 1.83 | 2.20 | LSD |
| | H 0.17 | C 0.14 | HXC 0.25 | |

The results of the study showed the superiority of humic coefficients and compost extract and the overlap between them in most of the characteristics studied, represented by the number of leaves, the area of one leaf, and the content of leaves of chlorophyll, carbohydrates, and macronutrients (NPK). This is attributed to the vital role of humic in improving the physical and chemical properties of the soil, increasing nutrient availability, and stimulating physiological processes within the plant. The beneficial effect of humic acid may be related to its ability to enhance membrane permeability and improve nutrient uptake efficiency, particularly nitrogen, phosphorus, and potassium. This leads to increased chlorophyll formation and improved photosynthesis, which results in increased vegetative growth, leaf number, and leaf area. It also stimulates cell division and elongation and increases root growth, which increases the efficiency of water and nutrient absorption. These results are consistent with [6 , 7] who indicated that humic acid acts as a biostimulant for the plant and contributes to improving vegetative growth, photosynthesis efficiency and increasing nutrient absorption, as consistent with [11 , 17] stated, as we showed that adding humic acid to the strawberry plant led to increasing vegetative growth and improving the physiological characteristics of the plant It is also consistent with the results of [21] who showed that the use of humic acid led to improved vegetative growth and increased nutrient absorption in the strawberry plant.

The results also showed that the application of compost extract resulted in a significant improvement in the studied characteristics compared to the control treatment. This is attributed to the compost extract containing nutrients, organic matter, and beneficial microorganisms, which play an important role in improving soil fertility and increasing plant nutrien availability. It also increases microbial activity in the root zone and improves nutrient

absorption efficiency, leading to increased chlorophyll and carbohydrate content and improved plant vegetative growth. The organic matter produced from compost also helps improve soil moisture retention and improve aeration, which has a positive impact on plant growth. These results are consistent with [2] and [12] Who indicated that the use of organic matter and compost improved the growth of strawberry plants and increased nutrient absorption under protected growing conditions, as consistent with [3] and [5] which showed that the use of vermiCompost improved the growth of strawberry plants and increased their vegetative characteristics as a result of improved soil bioactivity. As for the effect of the interaction between humic and compost extract, the results showed that the interaction between them achieved the best results in most of the characteristics studied, as the H2C2 treatment was significantly superior in the number of leaves, leaf area, chlorophyll and carbohydrate content, and macronutrient ratios, and this is due to the complementary effect between humic and compost extract, as humic works to increase the availability of elements and stimulate their absorption, while compost extract provides nutrients, organic matter, and beneficial microorganisms. This leads to improved physiological activity, photosynthesis, and increased carbohydrate formation within the plant. It also improves root growth and increases leaf surface area, which leads to increased photosynthetic efficiency and increased accumulation of carbohydrates and nutrients in the leaves. These results are consistent with [13, 18] They explained that the combination of organic fertilization and humic acid led to improved vegetative growth and mineral content of strawberry plants.

## 4-Conclusions

The results showed that the application of humic acid and compost extract significantly improved vegetative growth and nutrient content in strawberry plants, including leaf number, leaf area, chlorophyll, carbohydrates and NPK levels. The interaction between humic acid at 3 ml $L^{-1}$ and 25% compost extract at 25% produceded the best overall performance, indicating a synergistic effect in enhancing growth, nutrient uptake and photosynthetic efficiency.

## 5. Recommendations

it is recommended to apply Humic acid at a concentration of 3 ml $L^{-1}$ in combination with 25% compost extract due to its positive effects on improving the vegetative growth and chemical composition of strawberry runners. The use of organic fertilizers and biostimulants in strawberry seedling production is also encouraged, as they enhance the efficiency of nutrient uptake and reduce dependence on chemical fertilizers. Furthermore, future studies are recommended to evaluate higher concentrations and different types of organic extracts and to investigate their effects on strawberry growth and yield under various environmental conditions.

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