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# Effect of ethephon levels and amino acids on the growth characteristics of oat crop

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## *SUMMARY*

*A field experiment was conducted during the 2021–2022 season in an agricultural field in Basra Governorate. The aim was to study the effect of spraying ethephon and amino acids on the growth characteristics of oats (Avena sativa L.) Shifa cultivar. The experiment involved three levels of ethephon (0, 0.240, and 0.600 kg ha$^{-1}$), represented by the symbols E0, E1, and E2 respectively, and two spray levels of amino acids (0 and 5 ml L$^{-1}$), represented by the symbols A0 and A1. A factorial experiment was applied using the R.C.B.D (randomized complete block design) in a split plots arrangement with three replications. The results revealed significant differences in the levels of ethephon for most of the studied characteristics. The level of 0.240 kg ha$^{-1}$ (E1) was superior in terms of chlorophyll content, crop growth rate, and the number of tillers, with increases of 39.07%, 39.26%, and 16.36%, respectively, compared to the control treatment (E0). Regarding the amino acids treatments, spraying at a concentration of 5 ml L$^{-1}$ (A1) demonstrated significant superiority, resulting in the highest plant height, flag leaf area, chlorophyll content, and crop growth rate. This study concludes that amino acids play a crucial role in plant growth, and the combination of 5 ml L$^{-1}$ amino acids with 0.240 kg ha$^{-1}$ of ethephon significantly increased chlorophyll content and crop growth rate.*

***Keywords:*** *oat; ethephon; amino acids; lodging index*

## *INTRODUCTION*

Oats (*Avena sativa* L.) is one of the winter grain crops, and its importance comes through its multiple uses. As oat grains are used in the human diet and are used in the manufacture of bread and pasta because they contain a high percentage of vitamins and unsaturated fatty acids, in addition to the grains containing a high percentage of antioxidants Oxidative stress (Duda et al., 2021).

Oats are also considered one of the important crops worldwide, but in Iraq, their cultivation is limited, and their production rate remains low in comparison to global production. One of the primary reasons for this substantial disparity in productivity between Iraq and the rest of the world is the limited adoption of modern technologies, such as fertilization programs and advanced irrigation systems, in the cultivation and management of this crop. Additionally, another contributing factor is the issue of lodging, which is considered a major problem causing yield losses that can reach up to 35%. High-yielding varieties can be prone to lodging due to stem fragility (Bainsla et al., 2020).

The addition of ethephon during the early stages reduces plant height by shortening the length of the internodes, resulting in a 6.54% reduction in lodging and, consequently, a decrease in yield loss (Misheck and Fanuel, 2014). Ethephon also enhances plants' salinity tolerance, reduces the toxicity of heavy elements, increases photosynthetic efficiency, boosts the activity of antioxidant enzymes, promotes proline production, and regulates the plant's water balance (Yang et al., 2021). Addaheri and Abood (2020) demonstrated that spraying oat plants with ethephon at a concentration of 500 mg L$^{-1}$ resulted in significant differences in various parameters, including the average number of days from sowing to 100% flowering, the number of days from 100% flowering to physiological maturity, plant height, number of tillers, and lodging index. Additionally, Zaibel and Mohsen (2022) found that spraying wheat plants with ethephon at a concentration of 0.900 kg ha$^{-1}$ led to significant differences in the lodging index and the number of tillers.

Many studies indicated that amino acids play a positive role in improving the quality of plant yields as they contribute to stimulating physiological processes. These acids also participate in building proteins, vitamins, enzymes, plant pigments and natural hormones such as IAA and GA3, and promote cell division and energy processing. Therefore, their importance and effectiveness are in all stages of plant growth, which encourages vegetative and root growth of the plant, and thus is reflected in the yield and its components (Mohsen and Jasim, 2020 and Al-Badrawi and Alabdulla, 2021). Hussein and Hashem (2021) in their study comparing the effect of spraying amino acids on two cultivars of oats, noted that there were significant differences in chlorophyll content and flag leaf area. Alshadiwi and Alrubaiee (2022) also indicated in their study that spraying amino acids with different concentrations gave a significant increase in flag leaf area, chlorophyll content and crop growth rate of oat crop.

Due to the lack of studies on the effect of ethephon and amino acids on oat productivity in the soils of southern Iraq, this study was conducted, which aimed to know the effect of spraying concentrations of ethephon and spraying levels of amino acids and the interaction between them on the growth characteristics of the oat crop.

## *MATERIALS AND METHODS*

A field experiment was conducted during the season of 2021–2022 in one of the agricultural fields in Basra Governorate_Iraq (longitude 47.43° west and latitude

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30.39º north). A factorial experiment was used in randomized complete block design (R.C.B.D.) in split plot arrangement with three replications. It included two factors, the first was spraying three concentrations of ethephon (zero, 0.240, and 0.600 kg $ha^{-1}$), which took the following symbols ($E_0$, $E_1$ and $E_2$). A commercial product (Coupon) of Belgian origin was used, and the second factor includes spraying two levels of amino acids: without spraying ($A_0$), spraying with a concentration of 5 ml $L^{-1}$ ($A_1$). The commercial product (Amino plus), which is a mixture of amino acids, was used as follows: aspartic (1.56), threonine (1.02), serine (2.21), glutamic (2.62), proline (2.55), glycine (1.78), alanine (1.41), valine (1.74), leucine (1.77), isoleucine (1.07), tyrosine (0.40), phenylalanine (0.94), histidine (0.14), arginine (1.66), cysteine (0.87) and methionine (0.08). Amino acids occupied the main plots, while the concentrations of ethephon occupied the sub-plot. Random soil samples were taken from the field before planting and some physical and chemical properties of the soil were estimated (*Table 1*).

*Table 1.* **Some chemical and physical properties of soil**

| Properties | | Value |
|---|---|---|
| pH | / | 7.40 |
| E.C | ds $m^{-1}$ | 5.16 |
| Available N | mg $kg^{-1}$ soil | 44 |
| Available P | mg $kg^{-1}$ soil | 16.25 |
| Available K | mg $kg^{-1}$ soil | 131.6 |
| Organic matter | g $kg^{-1}$ | 3.10 |
| Sand | | 268.70 |
| Silt | g $kg^{-1}$soil | 328.50 |
| Clay | | 402.80 |
| Soil texture | | clay loam |

Soil service operations were carried out from two orthogonal plowing, smoothing and leveling. After which the field was divided into three sectors, each sector containing 6 experimental units. The area of the experimental unit is 6 $m^2$ (3m x 2m) included 12 lines, and the distance between the lines is 15 cm. Phosphate fertilizer was given at the rate of 100 kg $P_2O_5$ $ha^{-1}$ and the Potassium fertilizer at a rate of 60 kg $ha^{-1}$. Oat seeds were plant at cv. Shifa on 15/11/2021, at a seeding rate of 100 kg $ha^{-1}$. The irrigation method was Surface Irrigation.

The ethephon was sprayed in three growth stages: ZGS18, ZGS25, and ZGS30 according to the scale of Zadoks et al. (1974), while the amino acids were sprayed on the shoots of plants in the elongation and flowering stages. Spraying was done using a 16 liter portable sprinkler, and the control treatment was sprayed with distilled water only. The following characteristics have been studied: plant height (cm), flag leaf area ($cm^2$), chlorophyll content (mg $gm^{-1}$), crop growth rate (g $m^{-2}$ $day^{-1}$), number of tillers (tiller $m^{-2}$) and lodging index. Recording the lodging index after the flowering stage based on the scale of Wiersma et al. (1986). Data were collected and analyzed using the SPSS statistical program, and the least significant difference test (L.S.D) was used to compare the means.

## *RESULTS AND DISCUSSION*

### Plant height (cm)

The results indicate that increasing the concentration of ethephon had a significant effect on gradually reducing plant height in oats, as the plants treated with concentration 0.600 kg $ha^{-1}$ ($E_2$) gave the lowest average plant height of 95.90 cm, while the control treatment ($E_0$) gave the highest average plant height of 101.56 cm (*Table 2*). The reason for the decrease in plant height may be due to the action of ethylene released from the ethephon in the plant tissues, which works to inhibit auxin transport in the stem tissues and thus reduce the ability to elongate the stem (Zaibel and Mohsen, 2022). The results also show that the spraying of amino acids gave a significant increase in plant height, and the highest mean was 100.04 cm, while the control treatment recorded the lowest mean, which was 96.06 cm. The reason can be attributed to the role of amino acids in increasing cell division and the formation of proteins, which encourages growth and thus increases plant height (Mohsen and Jasim, 2020).

*Table 2.* **Effect of spraying ethephon and amino acids on plant height (cm)**

| Ethephon / Amino acids | No spray of ethephon ($E_0$) | Spray of ethephon 0.240 Kg $ha^{-1}$ ($E_1$) | Spray of ethephon 0.600 Kg $ha^{-1}$ ($E_2$) | Average of Amino acids |
|---|---|---|---|---|
| No spray of amino acids ($A_0$) | 98.86 | 95.53 | 93.80 | 96.06 |
| Spray of amino acids 5 $mlL^{-1}$ ($A_1$) | 104.26 | 97.86 | 98.00 | 100.04 |
| Average of ethephon | 101.56 | 96.70 | 95.90 | |
| **L.S.D ($P \leq 0.05$)** | **Ethephon 3.65** | **Amino acids 3.45** | **Interaction N.S.** | |

### Flag leaf area ($cm^2$)

The results show that the levels of ethephon differ in their effect on the area of the flag leaf area, as it the level ($E_2$) gave the highest average of 52.54 $cm^2$ without a significant difference from the level ($E_1$), while the level ($E_0$) gave the lowest average of the flag leaf area of 39.00 $cm^2$. It is also noted from *Table 3* that there are significant differences when spraying amino acids, as the spraying treatment with a concentration of 5 ml $L^{-1}$ ($A_1$) recorded the highest mean leaf area of 49.65 $cm^2$, while the control treatment ($A_0$) gave the lowest average of 43.49 $cm^2$. The reason for this may be attributed to the role of amino acids in increasing the level of internal auxin, and then increasing the synthesis and formation of proteins. As auxins work on the

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distribution of processed foodstuffs, which leads to an increase in the vital activities of the plant and thus an increase in its leafy area (Hussein and Hashem, 2021).

*Table 3.* **Effect of spraying ethephon and amino acids on flag leaf area ($cm^2$)**

| Ethephon / Amino acids | No spray of ethephon ($E_0$) | Spray of ethephon 0.240 Kg $ha^{-1}$ ($E_1$) | Spray of ethephon 0.600 Kg $ha^{-1}$ ($E_2$) | Average of Amino acids |
|---|---|---|---|---|
| No spray of amino acids ($A_0$) | 36.70 | 42.83 | 50.94 | 43.49 |
| Spray of amino acids 5 $mlL^{-1}$ ($A_1$) | 41.30 | 53.51 | 54.15 | 49.65 |
| Average of ethephon | 39.00 | 48.17 | 52.54 | |
| **L.S.D ($P \leq 0.05$)** | **Ethephon 5.74** | **Amino acids 3.04** | **Interaction N.S.** | |

## Chlorophyll content (mg $gm^{-1}$)

The results show a significant difference in the concentrations of ethephon in the content of chlorophyll in the flag leaf, as it the level ($E_1$) gave the highest average of 5.41 mg $gm^{-1}$, while the level ($E_2$) gave the lowest average of 3.89 mg $gm^{-1}$. It is also noted from *Table 4* that there are significant differences when spraying amino acids, as the treatment ($A_1$) excelled and gave the highest average chlorophyll content of 5.00 mg $gm^{-1}$, while the comparison treatment ($A_0$) gave the lowest average of 3.96 mg $gm^{-1}$. The reason for the increase in chlorophyll content is due to the role of amino acids in increasing the amount of internal auxin, and thus it will prevent plant leaves from falling and aging and delay the process of chlorophyll degradation (Al-Badrawi and Alabdulla, 2021). The results of *Table 4* also indicate that there is a significant effect of the interaction between the two factors in the content of chlorophyll, as the combination excelled ($A_1 \times E_1$) and recorded the highest average of 6.56 mg $gm^{-1}$, while the combination ($A_0 \times E_0$) recorded the lowest average of 3.57 mg $gm^{-1}$.

## Crop growth rate (g $m^{-2}$ $day^{-1}$)

The results show that the concentrations of ethephon differ in the crop growth rate, as the level 0.240 kg $ha^{-1}$ ($E_1$) gave the highest average of 14.40 g $m^{-2}$ $day^{-1}$, while the control treatment gave the lowest average of crop growth rate of 10.34 g $m^{-2}$ $day^{-1}$. It is also noted from *Table 5* that there are significant differences when spraying amino acids, as the spraying treatment with a concentration of 5 ml $L^{-1}$ ($A_1$) gave the highest average crop growth rate of 13.51 g $m^{-2}$ $day^{-1}$, while the control treatment ($A_0$) gave the lowest average was 12.20 g $m^{-2}$ $day^{-1}$. The reason for this may be due to the fact that amino acids are one of the main cellular components of the plant. Which participate in the metabolic pathways and regulate the osmotic effort; and increase the number of branches in the plant and improve the components of the yield and the quality of protein and increase its quantity (Mohamad et al., 2016). The results of *Table 5* also indicate that there is a significant effect of the interaction between the two factors on the crop growth rate, as the combination excelled ($A_1 \times E_1$) and recorded the highest average of 15.30 g $m^{-2}$ $day^{-1}$, while the combination ($A_0 \times E_0$) recorded the lowest average 10.23 g $m^{-2}$ $day^{-1}$.

*Table 4.* **Effect of spraying ethephon and amino acids on chlorophyll content (mg $gm^{-1}$)**

| Ethephon / Amino acids | No spray of ethephon ($E_0$) | Spray of ethephon 0.240 Kg $ha^{-1}$ ($E_1$) | Spray of ethephon 0.600 Kg $ha^{-1}$ ($E_2$) | Average of Amino acids |
|---|---|---|---|---|
| No spray of amino acids ($A_0$) | 3.57 | 4.26 | 4.06 | 3.96 |
| Spray of amino acids 5 $mlL^{-1}$ ($A_1$) | 4.22 | 6.56 | 4.23 | 5.00 |
| Average of ethephon | 3.89 | 5.41 | 4.15 | |
| **L.S.D ($P \leq 0.05$)** | **Ethephon 0.42** | **Amino acids 0.49** | **Interaction 0.60** | |

*Table 5.* **Effect of spraying ethephon and amino acids on crop growth rate (g $m^{-2}$ $day^{-1}$)**

| Ethephon / Amino acids | No spray of ethephon ($E_0$) | Spray of ethephon 0.240 Kg $ha^{-1}$ ($E_1$) | Spray of ethephon 0.600 Kg $ha^{-1}$ ($E_2$) | Average of Amino acids |
|---|---|---|---|---|
| No spray of amino acids ($A_0$) | 10.23 | 13.50 | 12.87 | 12.20 |
| Spray of amino acids 5 $mlL^{-1}$ ($A_1$) | 10.45 | 15.30 | 14.79 | 13.51 |
| Average of ethephon | 10.34 | 14.40 | 13.83 | |
| **L.S.D ($P \leq 0.05$)** | **Ethephon 0.52** | **Amino acids 0.55** | **Interaction 0.74** | |

## Number of tillers (tiller $m^{-2}$)

The results showed that the levels of ethephon were significantly different in the number of tillers, as the level ($E_1$) gave the highest average of 370.83 tiller $m^{-2}$, while the level ($E_0$) gave the lowest average number of tillers amounted to 323.00 tiller $m^{-2}$. It is noted from the results of *Table 6* that spraying with amino acids had a significant effect on this characteristic, as spraying with a concentration of 5 ml $L^{-1}$ ($A_1$) was superior and gave the highest mean number of tillers amounting to 376.44 tiller $m^{-2}$, while the control treatment ($A_0$) gave the lowest average of 313.66 tiller $m^{-2}$. The reason for the

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increase may be attributed to the important role of amino acids in increasing the formation and manufacture of endogenous auxin (IAA) and then increasing the synthesis and formation of proteins (Mustafa et al., 2018), which is reflected in the increase in vegetative growth and thus the increase in the number of tillers. The results of *Table 6* also indicate that there is a significant effect of the interaction between the two factors in the number of tillers, as the combination excelled ($A_1 \times E_1$) and recorded the highest average of 419.00 tiller $m^{-2}$, while the combination ($A_0 \times E_0$) recorded the lowest average of 302.00 tiller $m^{-2}$.

*Table 6.* **Effect of spraying ethephon and amino acids on number of tillers (tiller $m^{-2}$)**

| Ethephon / Amino acids | No spray of ethephon ($E_0$) | Spray of ethephon 0.240 Kg $ha^{-1}$ ($E_1$) | Spray of ethephon 0.600 Kg $ha^{-1}$ ($E_2$) | Average of Amino acids |
|---|---|---|---|---|
| No spray of amino acids ($A_0$) | 302.00 | 322.66 | 316.33 | 313.66 |
| Spray of amino acids 5 $mlL^{-1}$ ($A_1$) | 344.00 | 419.00 | 366.33 | 376.44 |
| Average of ethephon | 323.00 | 370.83 | 341.33 | |
| **L.S.D ($P \leq 0.05$)** | **Ethephon 16.20** | **Amino acids 23.56** | **Interaction 22.92** | |

**Lodging index**

The results show that the concentrations of ethephon were significantly different in the lodging index, as the level ($E_1$) was superior and gave the lowest average of 2.03, while the level ($E_0$) gave the highest average for the lodging index of 3.46. The reason for this may be due to the role of ethephon in stimulating the enzymes Tyrosine ammonialyase (TAL), Cinnamyl alcohol dehydrogenase (CAD) and Peroxidase (POD) responsible for the production of lignin, as the content of lignin in wheat stems increases by up to 11.8% (Zaibel and Mohsen, 2022). Which it results in an increase in leg strength and thus a decrease in the lodging index. It is also noted from *Table 6* that there were no significant differences when spraying amino acids and the effect of the interaction between the two factors was not significant in this characteristic.

## *CONCLUSIONS*

Based on the results obtained, it can be concluded that ethephon plays an important role in plant growth, as spraying with ethephon gave the best results in terms of leaf area, crop growth rate, and lodging index. The spraying of amino acids plays an important role in plant growth as it gave the best results in terms of plant height, leaf area, crop growth rate and number of tillers.

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