ENVIRONMENTAL SCIENCE ARCHIVES
ISSN: 2583-5092
Volume II Issue 2, 2023
www.envsciarch.com

RESEARCH PAPER OPEN ACCESS

# Response of Sweet Corn Growth to Soil Fertilization with Sulfur, NPK Levels and Spraying of Ascorbic Acid

**Ali Hussein Jasim and Mohammad Raheem Hariz**
Field Crops Department, Agriculture College, Al-Qasim Green University, Iraq
Correspondence and requests for materials should be addressed to AHJ (email: ajasim11@gmail.com)

Received: 2023/03/07
Accepted: 2023/04/20
Published: 2023/07/03

## Abstract
The experiment was carried out in Abu Gharaq area, 10 km west of Hilla city, Iraq during the autumn season of 2018 in silt clay soil to study the effect of foam sulfur addition (0 and 20 Kg.ha$^{-1}$), NPK fertilizer (20:20:20) at levels of 0, 75 and 150 Kg.ha$^{-1}$, ascorbic acid spraying at concentrations of (0, 25 and 50 mg.L$^{-1}$) and their interactions on growth of sweet corn. A randomized complete block design with three replications was used. The results showed that the addition of (20 Kg.ha$^{-1}$) foam sulfur caused a significant increase in plant height (125.9 cm), plant leaf number (12.19), plant leaf area (4206 cm$^2$), chlorophyll (60.4 SPAD), leaf content of N, P and K (15.49, 2.854 and 19.66 mg.g$^{-1}$) respectively. Increasing the level of NPK up to (150 Kg.ha$^{-1}$) significantly caused an increase in plant height (126.8 cm), plant leaf number (12.06), plant leaf area (4258 cm$^2$), chlorophyll (61.7 SPAD), leaf content of nitrogen, phosphorus and potassium (15.63, 2.88 and 19.96 mg.g$^{-1}$) respectively. Spraying ascorbic acid up to (50 mg.L$^{-1}$) significantly increased plant leaf area (4208), and chlorophyll leaf content (59.2). The interactions between the factors caused a significant effect on most traits.

**Keywords:** Ascorbic acid; Foam sulfur; NPK fertilizer; Sweet corn

## Introduction
Sweet corn (*Zea mays. Saccharata* Sturt) is one of the maize groups, but it is a newly introduced crop to be cultivated in Iraq (Jasim and Arat, 2021). Sulfur is used as a reformer for alkaline calcareous soil due to its oxidization to sulfuric acid which then increases the solubility of soil lime and reduces the soil pH which positively affects the availability of many nutrients in the soil (Al-Ezzawi, 2006). Sulfur is an essential nutrient for the formation of protein and amino acids as well as it plays a vital role in the composition of chlorophyll without entering the chlorophyll structure (Ali et al., 2014). It had a positive effect on increasing maize growth and nutrient uptake (Mahal et al., 2022). Adding essential mineral fertilizers, especially NPK is necessary to increase the growth and yield of plants, and its availability is important to supply the nutrient needs of maize plants (Sudding et al., 2021; Al-Gym and Al-Asady, 2020; Sebetha and Mashele, 2019; and Jasim et al., 2016). Ascorbic acid is an antioxidant compound and plays various roles in many physiological processes in plant growth (Pignocchi and Foyer, 2003; Smirnoff and Wheeler, 2000), enhances plant growth and improves sweet corn tolerance (Kotb et al., 2021; Ghassemi et al., 2020). This study aimed to determine the effect of foam sulfur, NPK (20-20-20), ascorbic acid and their interactions on the growth of sweet corn.

## Materials and Methods
A factorial experiment was conducted in Babylon, Iraq at 32.52 North latitude and 44.37 East longitudes, in the autumn season of 2018 to study the influence of foam sulfur (0 and 20 kg.ha$^{-1}$), NPK (0, 75, and 150 Kg.ha$^{-1}$) and ascorbic acid levels (0, 25 and 50 mg.L$^{-1}$) on the growth of sweet corn in silt clay loam soil (Table 1).

A randomized complete block design with three replications was used. The seeds were planted on August 16, 2018 (Jasim and Alsaeedi, 2018) on both sides of the ridges (100 cm) at 25 cm between plants. The experiment contained 54 experimental units (3x3 m for each one). Loam sulfur was added to the soil preparation according to treatments. NPK fertilizer was added in lines below plant line 10 cm (separated in two parts at the 8 and 12 leaf stages and the ascorbic acid was sprayed at the 8 and 12 leaf stages. At maturity (November 20), 10 plants from inner lines were assessed to calculate plant height, plant leaves number, plant leaf area, and leaf chlorophyll (SPAD). At flowering, 5 leaves from each experimental unit were taken to determine N, P and K content. Genstat-12 was used to analyze the data and the means were compared by LSD 0.05.

**Table 1.** Some soil physical and chemical characteristics before planting

| The character | | Value | The character | | Value |
|---|---|---|---|---|---|
| pH | | 7.5 | Soil mixture | sand | 186 mg $kg^{-1}$ |
| ECe | | 2.91 dSc $m^{-1}$ | | silt | 339 mg $kg^{-1}$ |
| Available | N | 8.41 mg $kg^{-1}$ | | clay | 475 mg $kg^{-1}$ |
| | P | 10.02 mg $kg^{-1}$ | Soil texture | | Silt clay soil |
| | K | 191.0 mg $kg^{-1}$ | | | |

## Results and discussion

Table (2) shows that the addition of sulfur caused a significant effect on increasing the plant height to 125.9 cm compared to the control treatment (117.3 cm). This increase may be due to the role of sulfur in plant nutrition and its entry into many vital processes within the plant, causing an increase in cell division and elongation, and this result is consistent with Tiweri et al. (2022); Elfahdawi and Ali (2020). NPK fertilizers caused a significant effect on plant height and the level of 150 Kg.$ha^{-1}$ gave the highest average of 126.8 cm, compared to the control treatment (116.6 cm). This increase may be due to the availability and absorption of these nutrients, as nitrogen has a positive effect on the activity of meristem tissues, cell division, and the biosynthesis of amino acids, including tryptophan, the source of IAA, which plays a role in cell division (Alasady and Jasim, 2019). Also, phosphorus plays a role in activating the process of cell division due to its entry into the formation of many energy-rich compounds, increasing cell division and elongation. These results are in line with Chakraborty et al. (2020), and Al-Gym and Al-Asady (2020). All the interactions between the factors caused a significant effect on this trait, and adding 20 kg $ha^{-1}$ foamy sulfur + 150 Kg.$ha^{-1}$ NPK + 50 mg.$L^{-1}$ ascorbic acid gave the highest plant height (130.6 cm), compared to the control treatment (109.3 cm).

**Table 2.** Effect of sulfur, NPK fertilizer levels and ascorbic acid levels on plant height (cm)

| Sulfur | NPK (Kg $ha^{-1}$) | Ascorbic acid (mg $L^{-1}$) | | | Sulfur X NPK | Mean of NPK | Mean of sulfur |
|---|---|---|---|---|---|---|---|
| | | 0 | 25 | 50 | | | |
| 0 | 0 | 109.3 | 110.0 | 114.0 | 111.1 | 116.6 | 117.3 |
| | 75 | 111.7 | 117.5 | 121.1 | 116.8 | 121.3 | |
| | 50 | 120.0 | 125.9 | 126.0 | 123.9 | 126.8 | |
| 20 | 0 | 119.0 | 123.5 | 124.0 | 122.2 | | 125.9 |
| | 75 | 120.4 | 127.7 | 129.5 | 125.8 | | |
| | 150 | 128.4 | 129.9 | 130.6 | 129.6 | | |
| **$LSD_{0.05}$** | | **17.84** | | | **10.30** | **7.28** | **5.95** |
| Sulfur | 0 | 113.7 | 117.8 | 120.4 | | | |
| | 20 | 122.6 | 127.0 | 128.0 | | | |
| **$LSD_{0.05}$** | | **10.30** | | | | | |
| NPK | 0 | 114.1 | 116.7 | 119.0 | | | |
| | 75 | 116.1 | 122.6 | 125.3 | | | |
| | 150 | 124.1 | 127.9 | 128.3 | | | |
| **$LSD_{0.05}$** | | **12.62** | | | | | |
| Mean of ascorbic | | 118.1 | 122.4 | 124.2 | | | |
| **$LSD_{0.05}$** | | **n.s.** | | | | | |

Table (3) showed that sulfur caused a significant effect on increasing plant leaves number, to 12.19 compared to the control treatment (11.56 leaves). This increase may be due to S in increasing many plant vital processes as well as increasing the soil acidity, which facilitates the solubility and readiness of other nutrients and their absorption by the plant, which is positively reflected in this characteristic. This result is consistent with Tiweri et al. (2022), and Jasim and Ghani (2015). Plant leaf number was significantly affected by adding NPK and the level of 150 Kg.ha$^{-1}$ gave the highest number (12.06), compared to the control treatment (11.33). This result may be attributed to an increase in the readiness of N, P and K elements in the soil solution and their absorption by plant roots, which leads to an increase in cell division and growth. This result is in line with Chakraborty et al. (2020), Al-Gym and Al-Asady (2020); Sebetha and Mashele (2019). The interaction between S and NPK caused a significant effect, and the treatment of 20 Kg.ha$^{-1}$ sulfur + 75 Kg.ha$^{-1}$ NPK gave the highest number (12.30), compared to the control treatment (11.28). The interaction between S and ascorbic acid caused a significant effect and adding 20 Kg.ha$^{-1}$ sulfur + 50 mg.L$^{-1}$ ascorbic acid gave the highest number (12.30) compared to the control treatment (11.22).

**Table 3.** Effect of sulfur, NPK fertilizer levels and ascorbic acid levels on plant leaf number

| Sulfur | NPK (Kg ha$^{-1}$) | Ascorbic acid (mg L$^{-1}$) | | | Sulfur X NPK | Mean of NPK | Mean of sulfur |
|---|---|---|---|---|---|---|---|
| | | 0 | 25 | 50 | | | |
| 0 | 0 | 11.03 | 11.27 | 11.44 | 11.28 | 11.33 | 11.56 |
| | 75 | 11.47 | 11.23 | 11.50 | 11.40 | 11.85 | |
| | 50 | 11.17 | 12.03 | 12.10 | 11.86 | 12.06 | |
| 20 | 0 | 11.93 | 12.05 | 12.16 | 12.04 | | 12.19 |
| | 75 | 12.17 | 12.31 | 12.35 | 12.30 | | |
| | 150 | 12.09 | 12.36 | 12.39 | 12.21 | | |
| **$LSD_{0.05}$** | | **n.s.** | | | **0.971** | **0.687** | **0.561** |
| sulfur | 0 | 11.22 | 11.51 | 11.79 | | | |
| | 20 | 12.16 | 12.10 | 12.30 | | | |
| **$LSD_{0.05}$** | | **0.971** | | | | | |
| NPK | 0 | 11.48 | 11.65 | 11.83 | | | |
| | 75 | 11.92 | 11.70 | 11.93 | | | |
| | 150 | 11.67 | 12.07 | 12.38 | | | |
| **$LSD_{0.05}$** | | **n.s.** | | | | | |
| **Mean of ascorbic** | | 11.34 | 11.81 | 12.02 | | | |
| **$LSD_{0.05}$** | | **n.s.** | | | | | |

Table (4) shows that adding sulfur caused a significant increase in plant leaves area to 4206 cm$^2$ compared to the control treatment (3896 cm$^2$). This may be due to the role of sulfur in the formation of many compounds, especially protein compounds, as well as reducing soil pH, which leads to an increase in the readiness of nutrients, thus improving plant growth and development which is reflected in the leaf area. This result is consistent with Elfahdawi et al. (2020) and Padma et al. (2018). NPK fertilizer levels affected plant leaf area and adding 150 Kg.ha$^{-1}$ NPK gave the highest average of 4258 cm$^2$, compared to the control treatment (3848 cm$^2$). This may be due to increasing their uptake by the plant, and their effect on cell division and expansion. This result is in line with Chakraborty et al. (2020); Hasan et al. (2020), Sebetha and Mashele (2019). Ascorbic acid caused a significant increase in plant leaf area, and the concentration of 50 mg.L$^{-1}$ gave the highest average leaf area (4208 cm$^2$) compared to the control treatment (3989 cm$^2$). This may be due to the role of ascorbic as a catalyst and companion for many enzymes, as well as its role in the biosynthesis of several hormones, including gibberellins, which leads to cell expansion, elongation, and division, which is reflected in plant leaf area. This result agrees with Al-Freeh et al. (2020) and Mohammed et al. (2019). The interaction between the factors caused a significant effect and adding 20 Kg.ha$^{-1}$ sulfur + 150 Kg.ha$^{-1}$ NPK + 50 mg.L$^{-1}$ ascorbic acid gave the highest leaf area (4371 cm$^2$), compared to the control treatment (3369 cm$^2$).

Table (5) showed that adding sulfur caused a significant increase in leaf chlorophyll content to 60.4 compared to the control treatment (53.0). This may be attributed to the role of sulfur in decreasing the soil pH, which leads to an increase in elements solubility and readiness, and their absorption,

which reflected positively on plant growth and leaf chlorophyll content. This result agreed with Al-Salami et al. (2021). The chlorophyll was significantly increased by adding NPK, and the level of 150 kg/ha gave the highest average of 61.7 compared to the control treatment (52.1). This may be attributed to the availability and absorption of NPK and their effect, as nitrogen has a positive effect on the formation of the chlorophyll molecule. This result was agreed with Al-Gym and Al-Asady (2020), Hasan et al. (2020), and Jasim and Kateb (2017). The ascorbic acid caused a significant effect on increasing the chlorophyll, and spraying 50 $mg.L^{-1}$, gave the highest chlorophyll content of 59.2 compared to the control treatment, (53.7). his is consistent with Dogru and Yprlak (2020); Sebetha and Mashele (2019). The interactions between the factors caused a significant effect and adding 20 $Kg.ha^{-1}$ sulfur + 150 $Kg.ha^{-1}$ NPK + 50 $mg.L^{-1}$ ascorbic acid gave the highest of 66.0, compared to the control treatment (48.0).

**Table 4.** Effect of sulfur, NPK fertilizer levels and ascorbic acid levels on plant leaf area ($cm^2$)

| Sulfur | NPK (Kg $ha^{-1}$) | Ascorbic acid (mg $L^{-1}$) | | | Sulfur X NPK | Mean of NPK | Mean of sulfur |
|---|---|---|---|---|---|---|---|
| | | 0 | 25 | 50 | | | |
| 0 | 0 | 3369 | 3818 | 3597 | 3595 | 3848 | 3896 |
| | 75 | 3928 | 3632 | 4080 | 3880 | 4047 | |
| | 50 | 4262 | 4186 | 4187 | 4212 | 4258 | |
| 20 | 0 | 4000 | 4150 | 4151 | 4101 | | 4206 |
| | 75 | 4152 | 4226 | 4264 | 4214 | | |
| | 150 | 4227 | 4313 | 4371 | 4304 | | |
| **$LSD_{0.05}$** | | **484.5** | | | **279.7** | **197.8** | **161.5** |
| **Sulfur** | 0 | 3853 | 3879 | 3955 | | | |
| | 20 | 4126 | 4230 | 4262 | | | |
| **$LSD_{0.05}$** | | **279.7** | | | | | |
| **NPK** | 0 | 3685 | 3984 | 3874 | | | |
| | 75 | 4039 | 3929 | 4172 | | | |
| | 150 | 4244 | 4250 | 4279 | | | |
| **$LSD_{0.05}$** | | **342.6** | | | | | |
| **Mean of ascorbic** | | 3989 | 4054 | 4208 | | | |
| **$LSD_{0.05}$** | | **197.8** | | | | | |

**Table 5.** Effect of sulfur, NPK fertilizer levels and ascorbic acid levels on chlorophyll (SPAD)

| Sulfur | NPK (Kg $ha^{-1}$) | Ascorbic acid (mg $L^{-1}$) | | | Sulfur X NPK | Mean of NPK | Mean of sulfur |
|---|---|---|---|---|---|---|---|
| | | 0 | 25 | 50 | | | |
| 0 | 0 | 48.0 | 49.9 | 49.9 | 49.3 | 52.1 | 53.0 |
| | 75 | 50.3 | 50.6 | 54.7 | 51.9 | 56.5 | |
| | 50 | 52.6 | 59.3 | 62.0 | 58.0 | 61.7 | |
| 20 | 0 | 50.9 | 56.3 | 57.4 | 54.9 | | 60.4 |
| | 75 | 55.5 | 62.3 | 65.3 | 61.1 | | |
| | 150 | 64.8 | 65.4 | 66.0 | 65.4 | | |
| **$LSD_{0.05}$** | | **13.14** | | | **7.59** | **5.36** | **4.36** |
| **Sulfur** | 0 | 50.3 | 53.3 | 55.7 | | | |
| | 20 | 57.1 | 61.3 | 62.9 | | | |
| **$LSD_{0.05}$** | | **7.59** | | | | | |
| **NPK** | 0 | 49.5 | 52.9 | 53.1 | | | |
| | 75 | 53.7 | 56.5 | 60.0 | | | |
| | 150 | 58.7 | 62.6 | 64.0 | | | |
| **$LSD_{0.05}$** | | **9.29** | | | | | |
| **Mean of ascorbic** | | 53.7 | 57.3 | 59.2 | | | |
| **$LSD_{0.05}$** | | **5.36** | | | | | |

Table (6) showed that adding sulfur caused a significant increase of N content to 15.49 mg/g, compared to the control treatment (14.42 mg/g). This result may be attributed to the fact that sulfur improved plant growth and also led to increasing N available (Elfahdawi et al., 2020), and its absorption, which reflected positively in Increasing leaf N content. This result agrees with Jaliya

et al. (2012). Adding NPK fertilizer caused a significant increase in N content and the level of 150 Kg.ha$^{-1}$ achieved the highest average of 15.63 mg/g, compared to the control treatment (14.26 mg/g). This result was attributed to the increase in N availability and absorption by the plant. This result is consistent with Sofyan et al. (2021); Canatoy and Daquiado (2021). The interaction between the factors caused a significant increase in N content and the highest average (16.08 mg/g) was achieved by adding 20 Kg.ha$^{-1}$ foam sulfur + 150 Kg.ha$^{-1}$ NPK + 50 mg.L$^{-1}$ ascorbic acid compared to 12.31 mg/g at control treatment.

**Table 6.** Effect of sulfur, NPK fertilizer levels and ascorbic acid levels on N content (mg.g$^{-1}$)

| Sulfur | NPK (Kg ha$^{-1}$) | Ascorbic acid (mg L$^{-1}$) | | | Sulfur X NPK | Mean of NPK | Mean of sulfur |
|---|---|---|---|---|---|---|---|
| | | 0 | 25 | 50 | | | |
| 0 | 0 | 12.31 | 14.21 | 13.97 | 13.49 | 14.26 | 14.42 |
| | 75 | 14.17 | 14.59 | 14.79 | 14.52 | 14.97 | |
| | 50 | 14.74 | 15.41 | 15.56 | 15.23 | 15.63 | |
| 20 | 0 | 14.76 | 15.14 | 15.20 | 15.03 | | 15.49 |
| | 75 | 14.75 | 15.59 | 15.93 | 15.42 | | |
| | 150 | 15.98 | 16.02 | 16.08 | 16.03 | | |
| **LSD$_{0.05}$** | | **3.678** | | | **1.461** | **1.043** | **1.035** |
| **Sulfur** | 0 | 13.74 | 14.75 | 14.77 | | | |
| | 20 | 15.16 | 15.58 | 15.74 | | | |
| **LSD$_{0.05}$** | | **1.461** | | | | | |
| **NPK** | 0 | 13.53 | 14.67 | 14.58 | | | |
| | 75 | 14.46 | 15.09 | 15.35 | | | |
| | 150 | 15.36 | 15.71 | 15.82 | | | |
| **LSD$_{0.05}$** | | **2.287** | | | | | |
| **Mean of ascorbic** | | 14.45 | 15.16 | 15.26 | | | |
| **LSD$_{0.05}$** | | **n.s.** | | | | | |

Table (7) showed that the addition of sulfur achieved a significant increase in P content to 2.854 mg/g, compared to the control treatment (2.514 mg/g). This result may be attributed to the decrease in the soil pH, thus dissolving phosphorus, increasing its availability (Elfahdawi et al., 2020), and its absorption by the plant. This result agreed with Rahman et al. (2011). Adding NPK caused a significant increase, and the level of 150 and 75 Kg.ha$^{-1}$ achieved the highest content of 2.880 and 2.707 mg/g, respectively, compared to 2.466 mg/g at the control treatment. This result may be due to the increase in the readiness of phosphorus in the soil solution, and its absorption by the plant.

**Table 7.** Effect of sulfur, NPK fertilizer levels and ascorbic acid levels on P content (mg.g$^{-1}$)

| Sulfur | NPK (Kg ha$^{-1}$) | Ascorbic acid (mg L$^{-1}$) | | | Sulfur X NPK | Mean of NPK | Mean of sulfur |
|---|---|---|---|---|---|---|---|
| | | 0 | 25 | 50 | | | |
| 0 | 0 | 2.253 | 2.393 | 2.413 | 2.377 | 2.466 | 2.514 |
| | 75 | 2.377 | 2.570 | 2.650 | 2.577 | 2.707 | |
| | 50 | 2.620 | 2.630 | 2.653 | 2.634 | 2.880 | |
| 20 | 0 | 2.463 | 2.447 | 2.600 | 2.556 | | 2.854 |
| | 75 | 2.673 | 3.077 | 3.120 | 2.881 | | |
| | 150 | 3.080 | 3.147 | 3.150 | 3.126 | | |
| **LSD$_{0.05}$** | | **0.677** | | | **0.3646** | **0.2578** | **0.2105** |
| **Sulfur** | 0 | 2.417 | 2.554 | 2.572 | | | |
| | 20 | 2.640 | 2.941 | 2.981 | | | |
| **LSD$_{0.05}$** | | **0.3646** | | | | | |
| **NPK** | 0 | 2.323 | 2.412 | 2.532 | | | |
| | 75 | 2.543 | 2.823 | 2.885 | | | |
| | 150 | 2.850 | 2.888 | 2.902 | | | |
| **LSD$_{0.05}$** | | **0.4465** | | | | | |
| **Mean of ascorbic** | | 2.528 | 2.748 | 2.777 | | | |
| **LSD$_{0.05}$** | | **n.s.** | | | | | |

This result agreed with Sofyan et al. (2021); Canatoy and Daquiado (2021), Al-Gym and Al-Asady (2020). The interaction between the factors caused a significant increase in P content and adding 20 Kg.ha$^{-1}$ sulfur + 150 Kg.ha$^{-1}$ NPK + 50 mg/L ascorbic acid achieved the highest leaf content (3.150 mg/g) compared to 2.253 mg/g at control treatment.

Table (8) showed that the addition of sulfur caused a significant increase of K content to 19.66 mg/g, compared to the control treatment (18.54 mg/g). This may be attributed to the role of sulfur in decreasing soil pH value which is reflected in increasing the availability of K (Elfahdawi et al., 2020) and its absorption. This result agreed with Jeet et al. (2012). NPK adding caused a significant increase, and the level of 150 Kg.ha$^{-1}$ achieved the highest average of 19.96 mg/g, compared to 18.47 mg/g at the control treatment. This result may be attributed to the role of NPK in increasing root spread and expansion and increasing K availability and its absorption by the plant. This result agreed with Sofyan et al. (2021); Canatoy and Daquiado (2021); Al-Gym and Al-Asady (2020). The interaction between foamy sulfur and NPK caused a significant increase and adding 20 Kg.ha$^{-1}$ sulfur + 150 Kg.ha$^{-1}$ NPK achieved the highest K content (20.44 mg/g) compared to 17.79 mg/g at the control treatment.

**Table 8.** Effect of sulfur, NPK fertilizer levels, and ascorbic acid levels on K content (mg.g$^{-1}$)

| sulfur | NPK (Kg ha$^{-1}$) | Ascorbic acid (mg L$^{-1}$) | | | Sulfur X NPK | Mean of NPK | Mean of sulfur |
|---|---|---|---|---|---|---|---|
| | | 0 | 25 | 50 | | | |
| 0 | 0 | 17.69 | 17.77 | 17.92 | 17.79 | 18.47 | 18.54 |
| | 75 | 17.91 | 18.21 | 18.94 | 18.35 | 18.87 | |
| | 50 | 18.90 | 19.64 | 19.90 | 19.48 | 19.96 | |
| 20 | 0 | 18.89 | 19.16 | 18.28 | 19.14 | | 19.66 |
| | 75 | 18.23 | 19.61 | 19.38 | 19.39 | | |
| | 150 | 20.34 | 20.46 | 20.51 | 20.44 | | |
| **$LSD_{0.05}$** | | **n.s.** | | | **2.458** | **1.154** | **1.044** |
| **Sulfur** | 0 | 18.17 | 18.54 | 18.92 | | | |
| | 20 | 19.17 | 19.74 | 20.06 | | | |
| **$LSD_{0.05}$** | | **n.s.** | | | | | |
| **NPK** | 0 | 18.09 | 18.46 | 18.65 | | | |
| | 75 | 18.29 | 18.91 | 19.61 | | | |
| | 150 | 19.62 | 20.05 | 20.21 | | | |
| **$LSD_{0.05}$** | | **n.s.** | | | | | |
| **Mean of ascorbic** | | 18.67 | 19.14 | 19.49 | | | |
| **$LSD_{0.05}$** | | **n.s.** | | | | | |

## Conclusion

From this experiment, it is clear that adding sulfur as an essential element to improve soil pH was active in enhancing the growth of sweet corn plants grown in soil tending to alkaline and increasing leaf content of N, P, and K by increasing the readiness of nutrients. Also, compound chemical fertilizer NPK (20-20-20) caused an increase in all plant growth indicators and leaf NPK content by increasing the availability of these elements. Ascorbic acid was sprayed as an antioxidant compound to increase the plant's resistance to reactive oxygen species and improve growth. Spraying ascorbic acid increased plant leaf area and leaf chlorophyll content.

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**Author Contributions**

AHJ and MRH conceived the concept, wrote and approved the manuscript.

**Acknowledgements**

Not applicable.

**Funding**

There is no funding source for the present study.

**Availability of data and materials**

Not applicable.

**Competing interest**

The authors declare no competing interests.

**Ethics approval**

Not applicable.



**Citation**: Jasim AH and Hariz MR (2023) Response of Sweet Corn Growth to Soil Fertilization with Sulfur, NPK Levels and Spraying of Ascorbic Acid. Environ Sci Arch 2(2):114-121.