

## RESPONSE OF YIELD AND QUALITY OF THREE CULTIVARS OF MAIZE TO FOLIAR SPRAYING WITH AGRIKERTOP NUTRIENT SOLUTION

Anas I. Hasan<sup>1</sup>, Hamid A. Ajaj<sup>1</sup>, Nihad M. Abood<sup>2\*</sup>, S S Shahatha<sup>2</sup> and M O Mousa<sup>2</sup>

<sup>1</sup>Department of Field Crops, College of Agriculture, University of Anbar, Iraq

<sup>2</sup>Center of Desert Studies, University of Anbar, Iraq

\*Email: [Ag.nihad.mohammed@uoanbar.edu.iq](mailto:Ag.nihad.mohammed@uoanbar.edu.iq)

### ABSTRACT

A field experiment was conducted during the fall season of 2019 in the College of Agriculture - University of Anbar at the Hamidiyah area / Ramadi District / Anbar Governorate, in order to study the response of growth, grain yield and its components and quality of three cultivars of maize (Fajir 1, Baghdad 3 and Sarah) to foliar spraying at four concentrations of AGRIKERTOP nutrient solution (0, 50, 100 and 150 mg L<sup>-1</sup>). A randomized complete block design (R.C.B.D) according to split-plots arranging was used at three replicates. The nutrient solution concentrations occupied the main plots and the cultivars occupied the sub-plots. The results of the statistical analysis showed that the Sarah cultivar was superiority in the leaf area, grains number per ear, grains weight per ear, grain yield (7.45 ton ha<sup>-1</sup>) and percentage of oil in the grains (4.63%). The higher concentration of the nutrient solution (150 mg L<sup>-1</sup>) was also superiority in the traits under study. The interaction between studied factors also had a significant effect on most studied traits, as the Sarah cultivar x 150 mg L<sup>-1</sup> recorded the highest values for the most traits, outperforming all other combinations except for the plant height trait in which the combination (Baghdad 3 x 150 mg L<sup>-1</sup>) outperformed.

---

**Keywords:** Foliar nutrition, Maize, grain yield, Oil percentage.

### INTRODUCTION

Maize crop (*Zea mays* L.), is one of the most important cereal crops in the world. It is believed that its original homeland is North America because there are types of it there (El-Sahooki, 1990). The importance of maize emerges from its versatility as food for humans and animal feed, as well as its use in many industries in extracting oil and starch from its seeds. Its leaves are a basic material for the manufacture of paper, and its seeds are also used in the manufacture of concentrated feed because they contain 81% carbohydrates, 10% protein, 6.4% oil, 2% ash, and some vitamins (Sachin and Misra, 2009). The United States of America ranks first in the cultivation of this crop in terms of cultivated area and production, followed by China and India (FAO, 2016). Despite the fact that the maize is one of the major old crops in Iraq, the production rate per unit area is still low, as the cultivated area for the year 2017 amounted to about 55,7 thousand hectares, with a total production of 185,3 thousand tons (Directorate of Agricultural Statistics, 2018). This decline in crop production per unit area may be due to many stresses to which the plant is exposed, including soil salinization, lack of irrigation water, environmental

fluctuations such as high temperatures and hot high winds, as well as improper use of soil and crop management, which negatively affected the performance of the plant, its vital processes, and then its productivity. Therefore, it is necessary to study these obstacles and develop appropriate solutions to them through the use of modern technologies in agriculture. And the cultivation of high-productivity cultivars that are adapted to the environmental conditions in Iraq, as well as the search for other sources, including the use of nutrient solutions to reduce the use of chemical fertilizers in order to preserve the environment (Saleh, 2017). Therefore, the current study was conducted in order to study the response of growth, grain yield and its components and quality of some cultivars of maize to foliar spraying of AGRIKERTOP nutrient solution.

## MATERIALS AND METHODS

A field experiment was conducted during the fall season of 2019 in the College of Agriculture - University of Anbar at the Hamidiyah area / Ramadi District / Anbar Governorate, in order to study the response of growth, grain yield and its components and quality of three cultivars of maize (Fajir 1, Baghdad 3 and Sarah) to foliar spraying at four concentrations of AGRIKERTOP nutrient solution (0, 50, 100 and 150 mg L<sup>-1</sup>). A randomized complete block design (R.C.B.D) according to split-plots arranging was used at three replicates. The nutrient solution concentrations occupied the main plots while the cultivars occupied the sub-plots. The seeds of the maize cultivars were sown in 20 July 2019 by placing 3 seeds per hill and thinned to one plant per hill after two weeks of emergence. The planting was done in plots with an area of 3 x 3 m, with a distance between the lines of 60 cm, and between one plant and another 25 cm. The main plots were separated with a distance of 2 m and 1 m between the sub-plots, leaving 2 m between one replicate and another. Crop irrigation was carried out whenever needed. Phosphorous fertilizer P<sub>2</sub>O<sub>5</sub> was applied at a 200 kg ha<sup>-1</sup>, during land preparation.

Nitrogen fertilizer was applied as a urea (46% N) at a 200 kg ha<sup>-1</sup> at two doses, the first was applied after 20 days of seeds emergence whereas the second was applied at the emergence of silking (Jalow, 2006). Then the weeding was carried out as needed. The process of the AGRIKERTOP spraying was conducted in the early morning by sprinkler at a twice, the first was spraying at the vegetative growth stage, while the second was spraying when emergence of the female flowering. The experimental units were harvested at full maturity stage of the plants to study the following characteristics.

- 1- Days number from sowing to 75% female flowering:** It was calculated from planting to 75% of female flowering stage.
- 2- Plant height (cm):** It was measured using a tape measure from the area of contact of the plant with the soil until the last node below the male inflorescence (Al-Baldawi *et al.*, 2014).
- 3- Leaf area (cm<sup>2</sup>):** The leaf area of the plant was calculated by measuring the area of the leaf that lies under the main earbone leaf using the following equation:  
Leaf area per plant = (leaf length)<sup>2</sup> x 0.75 (Elsahookie, 1985)
- 4- Number of grains in the ear:** The number of grains in the main ear was calculated for a sample taken from five plants from the midlines of each experimental unit at harvest.

- 5- Weighing of 500 grains (g):** 500 grains from each harvested sample were manually calculated and weighed by a sensitive electronic scale.
- 6- Grain yield (ton ha<sup>-1</sup>):** It was calculated by multiplying the yield of one plant per experimental unit by the plant density and then converting it to ton per hectare.
- 7- The percentage of oil in the grains (%):** The grains content of oil was estimated using the Soxhlet device, according to the method A.A.C.C, 1976.

## RESULTS AND DISCUSSION

### Days number from sowing to 75% female flowering

The results in Table 1 show that the maize cultivars didn't significant difference in the days number from sowing to 75% female flowering. However, the Sara cultivar needed a shorter period of 85.1 days, while the Baghdad 3 cultivar needed a longer period of 87.5 days to reach this stage. Also, the results reveal that there was a significant effect of spraying concentrations with AGRIKERTOP nutrient solution in the characteristic of the days number from sowing to 75% female flowering. The spraying AGRIKERTOP at a 150 mg L<sup>-1</sup> gave a shortest time to reach this stage of 83.8 days with non-significant difference with spraying AGRIKERTOP at a 100 mg L<sup>-1</sup> compared with spraying AGRIKERTOP at a 0 and 50 mg L<sup>-1</sup> which it took a longer duration 88.4 and 88.8 days, respectively. The reason of superiority of the higher concentration in reducing the number of days could be attributed to the role of the nutrient solution in accelerating vegetative growth and prolonging the reproductive growth period. In order to benefit from the transfer of processed materials to seeds without using them in vegetative growth, because maize is a determinate growth habit, so flowering is required in a limited time in order to transfer manufactured materials from the source to the sink. These results are in agreement with Abdullah (2020). The interaction between studied factors hadn't significant effect on this trait.

**Table 1:** Effect of spraying of nutrient solution (AGRIKERTOP) on the number of days from sowing to 75% female flowering of maize cultivars.

concentration of nutrient solution mg L <sup>-1</sup>	Cultivars			Mean concentration
	Fajir 1	Baghdad 3	Sarah	
0	88.0	88.7	88.7	88.4
50	90.7	91.0	84.7	88.8
100	83.3	86.0	83.3	84.2
150	83.3	84.3	83.7	83.8
Mean cultivars	86.3	87.5	85.1	
LSD <sub>0.05</sub>		N.S	N. S	2.5

### Plant height (cm)

The results show that the cultivars was significantly differed in this character, the Baghdad 3 plants had the highest mean 174.9 cm with non-significant difference with plants of Fajir 1 (167.1 cm), while it significantly differed with plants of Sarah cultivar which recorded 166.6 cm (Table

2). The reason of difference among cultivars could be attributed to difference in their genetic structure and their responses to environmental conditions surrounding growth. These results agreed with Ajaj *et al.*, (2021). Regarding of AGRIKERTOP concentrations, The results indicate that the spraying the bio stimulant (AGRIKERTOP) at a concentration of 150 mg L<sup>-1</sup> was significantly superior and achieved the highest mean of 180.6 cm which it didn't significantly differ with 100 mg L<sup>-1</sup>, while it significantly differed with other concentrations especially control treatment (0 mg L<sup>-1</sup>) which achieved the lowest mean of 158.5 cm. The reason of superiority could be attributed to the role of the nutrient solution in increasing the plant contains of macro and micro nutrients and amino acids, which led to an increase in the efficiency of the photosynthesis process and thus an increase the division of meristematic cells and internodes elongation, which led to an increasing the height of the plant (Ajaj *et al.*, 2020). The interaction between two factors hadn't significant effect on this trait (Table 2).

**Table 2:** Effect of spraying of nutrient solution (AGRIKERTOP) on the plant height (cm) of maize cultivars.

concentration of nutrient solution mg L <sup>-1</sup>	Cultivars			Mean concentration
	Fajir 1	Baghdad 3	Sarah	
0	158.6	161.8	155.0	158.5
50	159.8	175.4	165.1	166.7
100	170.3	176.3	170.4	172.3
150	179.6	186.2	176.0	180.6
Mean cultivars	167.1	174.9	166.6	
LSD <sub>0.05</sub>		7.13	N. S	5.78

### Leaf area (cm<sup>2</sup>)

The results indicate a significant effect of the cultivars in the leaf area. The cultivar of Sarah outperformed with the highest mean of 4892.7 cm<sup>2</sup>, which significantly differed from the Baghdad 3 cultivar which gave 4500.5 cm<sup>2</sup>, (Table 3). This difference may be due to differences of maize cultivars in the growth rate, which was reflected on the leaf area. These results are agreed with Ajaj *et al.*, (2021) and Al-Janabi *et al.*, (2021). According to research data, the spraying of AGRIKERTOP at a 150 mg L<sup>-1</sup> was significantly superior and gave the highest mean for the leaf area of 4882.0 cm<sup>2</sup>, compared with non-spraying of AGRIKERTOP (0 mg L<sup>-1</sup>) which gave the lowest mean of 4439.3 cm<sup>2</sup> with non-significant with concentration of 50 mg L<sup>-1</sup>. The superiority of spraying with nutrient solution in the leaf area could be attributed to the positive effect of the nutrient solution on the large number of biochemical and physiological processes which occur into plant tissues that led to an increasing the cells division, cells expansion and differentiation which was positively reflected on the increasing the photosynthesis efficiency and then increasing the leaf area. This result is in line with Abdullah (2020). The interaction between studied factors hadn't significant effect on this trait.

**Table 3:** Effect of spraying of nutrient solution (AGRIKERTOP) on the leaf area (cm<sup>2</sup>) of maize cultivars.

concentration of nutrient solution mg L <sup>-1</sup>	Cultivars			Mean concentration
	Fajir 1	Baghdad 3	Sarah	
0	4405	4312	4601	4439.3
50	4530	4496	4756	4594.0
100	4673	4577	4983	4744.3
150	4798	4617	5231	4882.0
Mean cultivars	4601.5	4500.5	4892.7	
LSD <sub>0.05</sub>		323.0		234.3
			N. S	

#### Number of grains in the ear (grain ear<sup>-1</sup>)

The results indicate that the Sarah cultivar was significantly superior and gave the highest average number of grains per ear of 520.2 grains ear<sup>-1</sup>, with non-significant difference with Baghdad 3 cultivar (508.0 grains ear<sup>-1</sup>), while it significantly differed from the Fajir 1 cultivar which gave 486.6 grains ear<sup>-1</sup> (Table 4). The reason of superiority of the Sarah cultivar could be due to superiority in leaf area (Table 3) and increase the nutrients manufacture that transferred to the of new growth sites in the reproductive parts, so their abortion was reduced and thus increased their number. These results agreed with Al-Janabi *et al.*, (2021) and Al-Nassery *et al.*, (2016). According to research data, the spraying of AGRIKERTOP at a 100 and 150 mg L<sup>-1</sup> were significantly superior and recorded the highest averages of 515.4 and 535.0 grains ear<sup>-1</sup> respectively with non-significant differences between them compared with control treatment (0 mg L<sup>-1</sup>) which recorded a lowest average of 465.7 grains ear<sup>-1</sup>. The positive effect of increasing the concentrations of spraying with the nutrient solution in increasing the height of plant (Table 2) and leaf area (Table 3) provided a greater amount of processed food to go to the growing grains to increase their sets and reduce their abortion and then increase their number in the ear. This result is in agreement with of Al-Jobouri *et al.*, (2018). The interaction between studied factors had significant effect on the grains number per ear, as the Sarah cultivar that was spraying with AGRIKERTOP at a 150 mg L<sup>-1</sup> gave a best average of 572.1 grains ear<sup>-1</sup>, while the Fajir 1 cultivar that was spraying with 0 mg L<sup>-1</sup> of AGRIKERTOP gave a lowest average of 439.0 grains ear<sup>-1</sup>.

**Table 4:** Effect of spraying of nutrient solution (AGRIKERTOP) on the number of grains per ear of maize cultivars.

concentration of nutrient solution mg L <sup>-1</sup>	Cultivars			Mean concentration
	Fajir 1	Baghdad 3	Sarah	
0	439.0	469.3	488.7	465.7
50	491.4	513.1	506.2	503.6
100	506.3	526.2	513.7	515.4
150	509.7	523.3	572.1	535.0
Mean cultivars	486.6	508.0	520.2	
LSD <sub>0.05</sub>		29.5		30.6
			57.6	

### Weighing of 500 grains (g)

The maize cultivars were significantly differed in the Weighing of 500 grains, Fajir 1 recorded a best average of 84.2 g, followed by Sarah and Baghdad which recorded 72.1 g. The reason of increase the grain weight of Fajir 1 cultivar may be due to recording fewer grains per ear (Table 4), which led to an increase the transfer of metabolic products to the grain, and then increase the grain weight. These results are in line with Al-Jobouri *et al.*, (2018). The results reveal that the spraying of AGRIKERTOP at a 150 mg L<sup>-1</sup> was significantly outperformed and gave a best average of 500 grain weight (82.1 g), which was significantly differed with other sprayed concentrations and control treatment (0 mg L<sup>-1</sup>) which recorded a lowest average of 75.0 g. The reason of superior in the 500 grains weight when increasing the spraying concentrations of AGRIKERTOP could be due to the positive effect of AGRIKERTOP in increasing the photosynthesis efficiency and transferring their metabolic products from the source to storage sites (sink), in addition to an increasing the energy production, ATP biosynthesis and the construction of sugars, starch and protein and building the lipids that are stored in the grains, which eventually leads to their weight gain. This is in line with Abdullah (2020). The results indicate that the Fajir 1 cultivar which spraying with AGRIKERTOP at a 150 mg L<sup>-1</sup> was significantly superior and achieved a highest average of 500 grains weight of 86.7 g with non-significant difference with same cultivar which spraying with AGRIKERTOP at a 100 mg L<sup>-1</sup> and Sarah cultivar which spraying with AGRIKERTOP at a 150 mg L<sup>-1</sup>. All of these interactions were significantly differed from the other interactions in which Baghdad 3 which spraying with AGRIKERTOP at a 50 mg L<sup>-1</sup> recorded a lowest average of 68.8 g.

**Table 5:** Effect of spraying of nutrient solution (AGRIKERTOP) on the weighting of 500 grains of maize cultivars.

concentration of nutrient solution mg L <sup>-1</sup>	Cultivars			Mean concentration
	Fajir 1	Baghdad 3	Sarah	
0	79.4	72.1	73.6	75.0
50	85.1	68.8	75.2	76.4
100	85.8	72.2	78.9	79.0
150	86.7	75.3	84.2	82.1
Mean cultivars	84.2	72.1	77.9	
LSD <sub>0.05</sub>		2.3	4.5	3.1

### Grain yield (ton ha<sup>-1</sup>)

The results in Table 6 reveal that the Sarah cultivar was significantly superior and achieved a highest mean of grain yield (7.45 ton ha<sup>-1</sup>) compared with a Baghdad 3 cultivar which achieved a lowest mean (6.00 ton ha<sup>-1</sup>). The reason of superiority of Sarah cultivar could be attributed to its superiority in the number of grains per ear (Table 4). In this context, (Ajaj *et al.*, 2021) noted that

the maize cultivars was significantly differed in grain yield. Regarding of AGRIKERTOP concentrations, the results in Table 6 indicate that the spraying of AGRIKERTOP at a concentration of 150 mg L<sup>-1</sup> was significantly outperformed by giving the highest mean of grain yield (7.81 t ha<sup>-1</sup>) compared with rest treatments especially the control treatment which gave a lowest mean (5.86 ton ha<sup>-1</sup>). The outperforming of plants that were sprayed with AGRIKERTOP at a concentration of 150 mg L<sup>-1</sup> in the two yield components (Tables 4 and 5) led to its outperforming in the grain yield per unit area. These results reinforced with Ajaj *et al.*, (2020) who indicated that the grain yield of maize was significantly increased when adding the nutrient solution. The interaction between two factors had significant effect on the grain yield (Table 6). The plants of Sarah cultivar that were sprayed with AGRIKERTOP at a 150 mg L<sup>-1</sup> achieved a highest value (9.63 ton ha<sup>-1</sup>) and significantly differed from all other combinations especially the plants of Baghdad 3 cultivar with control treatment which achieved a lowest value 5.45 ton ha<sup>-1</sup>).

**Table 6:** Effect of spraying of nutrient solution (AGRIKERTOP) on the grain yield of maize cultivars.

concentration of nutrient solution mg L <sup>-1</sup>	Cultivars			Mean concentration
	Fajir 1	Baghdad 3	Sarah	
0	6.01	5.45	6.13	5.86
50	7.03	5.78	6.57	6.46
100	7.18	6.18	7.47	6.94
150	7.19	6.60	9.63	7.81
Mean cultivars	6.85	6.00	7.45	
LSD <sub>0.05</sub>		0.54		0.67
			1.01	

### The percentage of oil in the grains (%)

The results in Table 7 show that the plants of the Sarah cultivar was significantly outperformed and achieved a best percentage of oil in the grains (4.63%) compared with plants of the Fajir 1 cultivar (4.35%) and the plants of the cultivar Baghdad 3 which recorded a lowest mean (4.06%). The reason for this difference may be due to the genetic variation between varieties and the extent of the interaction of those factors with the prevailing environmental conditions, which was reflected in the different oil content of their seeds. This result is in line with the results of Al-Nassery *et al.*, (2016). The results also indicate that there is a significant effect between the concentrations of spraying with the nutrient solution AGRIKERTOP in this trait (Table 7), the spraying of AGRIKERTOP at a 150 mg L<sup>-1</sup> achieved a highest percentage (5.06%) and significantly differed with all other studied treatments in which the plant that were sprayed with distilled water only achieved a lowest percentage (3.43%). The reason for the increase the percentage of oil when increasing the sprayed concentrations of AGRIKERTOP could be

attributed to the positive effect of the solution in increasing the leaf area (Table 3), which increased the efficiency of its interception of light and then increased the process of photosynthesis and the transfer of its products to grains, in addition to an increase the energy production, ATP formation and the construction of sugars, starch and protein and the construction of lipids. This result agreed with the results of Al-Jobouri *et al.*, (2018). The interaction between two factors had significant effect on this trait, as the plants of the Sarah cultivar that were sprayed with AGRIKERTOP at a concentration 150 mg L<sup>-1</sup> had a highest value (5.28%) whereas the plants of Fajir 1 cultivar that sprayed with distilled water only had a lowest value (3.01%).

**Table 7:** Effect of spraying of nutrient solution (AGRIKERTOP) on the percentage of oil in the grains of maize cultivars.

concentration of nutrient solution mg L <sup>-1</sup>	Cultivars			Mean concentration
	Fajir 1	Baghdad 3	Sarah	
0	3.01	3.22	4.05	3.43
50	4.34	3.58	4.30	4.07
100	4.94	4.66	4.87	4.82
150	5.11	4.78	5.28	5.06
Mean cultivars	4.35	4.06	4.63	
LSD <sub>0.05</sub>		0.43	1.78	

## REFERENCES

- A.A.C.C. 1976. American Association of chemists. Crude Fat in grain and stock feeds. A.A.C.C. Methods 30-20, Page 10.
- Abdullah, Bushra Fetikhan Najm. 2020. Effect of A Biostimulant on Growth, Yield and Quality Characteristics of Several Cultivars of Maize. Master's thesis. College of Agriculture - University of Anbar. p. 59. (Arabic)
- Ajaj, H A. Y A Mohammed, A. AM Alrubaya and A MS Addaheri.2021. Growth, Yield and Quality of three Cultivars of Sorghum (*Sorghum bicolor* L. Moench). *IOP Conf. Ser.: Earth Environ. Sci.* 904:1-9.
- Ajaj, H. A., Yas Ameen Mohammed and A.H. Noaman (2020). Improvement of Breach Wheat Performance by Foliar Application IQ Combi. *Int. J. Agricult. Stat. Sci.* Vol. 16, Supplement 1, pp. 1737-1741.
- Al-Jobouri, Ali Hamza,. Shaker Mahdi Salih and Akeel Nagem Abood.2018. Effect of Organic Stimulators on Some Yield Characters of maize (*Zea mays* L.). *Tikrit Journal for Agricultural Sciences.* 18 (1):28-48.
- Al-Baldawi, Muhammad Hathal Kadhum, Muwaffaq Abdul-Razzaq Suhail Al-Naqib, Jalal Hameed Hamza Al-Jubouri, Khalil Ibrahim Muhammad Ali, Khaleda Ibrahim Hashem Al-Tai, Hadi Muhammad Karim Al-Aboudi. 2014. Regulations and Standards for Cultivation



- and Study of Field Crops. Ministry of Higher Education and Scientific Research. University of Baghdad. College of Agriculture. 309. (Arabic)
- Al-Janabi. Y A, N M Abood, M I Hamdan. 2021. The effect of amino acids and the date of planting on some growth characteristics of the three varieties of maize *IOP Conf. Ser.: Earth Environ. Sci.* 904:1-12.
- Al-Nassery, Atheer Saber Mustafa,. Muhsin Ali Ahmed Al-Janabi and Fakhradeen A. Q. Sedeeq.2016. Effect of cultivars , fertilization and seed moisture at harvest on yield and quality of corn (*zea mays* L.). Tikrit Journal for Agricultural Sciences.16(4):208-220.
- Directorate of Agricultural Statistics - Central Bureau of Statistics / Iraq. 2018. (Arabic)
- Elsahooki, M. M. 1985. A shortcut method for estimating plant leaf area in maize. *Zeitschriftfur. Acker and pflanzenbau. Ct. Journal. Agron and crop Sciences.* 154: 157-160.
- Elsahooki, Medhat Majid, 1990. Maize Produced and Improvement. Ministry of Higher Education and Scientific Research. University of Baghdad - Iraq. AS: 488. (Arabic)
- FAO. 2016.Conservation and expansion from scientific side corn, rice and wheat. Guide to Sustainable Grain Production:1-124.
- Sachin, D. and P. Misra (2009). Effect of *Azotobacter chroococcum* (PGPR) on growth of bamboo (*Bambusa bamboo*) and maize (*Zea mays* L.) plants. *Biofir. Org.* 1(1): 24-31.
- Saleh, Baraa Hamid. 2017. Effect of Genetic Makeup and Spraying with Humiforte Biostimulator on Some Anatomical Indicators, Yield and Components of Sorghum (*Sorghum Bicolor* L. Moench). Master's thesis. College of Agriculture - University of Anbar. p.: 108. (Arabic)