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# Response of Growth and Yield Traits of Safflower Varieties (*Carthamus tinctorius* L.) to Zinc Foliar Application.

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## ABSTRACT

Safflower (*Carthamus tinctorius* L.) is an internationally important oil crop. This experiment was carried out to evaluate the effects of Zinc foliar application rates (0, 200, 400 and 600ppm) on yield and yield components of safflower varieties (Gilla, G-2018, Rabeey500), a field experiment was conducted during growing season of 2023-2024 at Grdarasha experimental field research/Collage of Agricultural Engineering Science. A factorial experiment based on randomized complete block design (RCBD), with three replicates was used. Traits such as vegetative growth (plant height, leaf area, leaf area index, dry matter, crop growth rate), yield and yield components (No. of primary branches, no. of secondary branches, no. of head plant$^{-1}$, no. of seed head$^{-1}$, 1000 seed weight, seed yield, biological yield and Harvest index) and percentage of protein, protein yield, percentage of oil and oil yield in seeds. The highest rate of most of vegetative growth parameters were recorded by Gilla variety exception of plant height (148.34cm) and some of yield and yield components, like oil percentage (24.20%) and oil yield (4812.17kg ha$^{-1}$) recoded by Rabeey500 variety, while G-2018 recorded the maximum level (7.20) of primary branches, (29.62%) of protein percentage and (5061.06kg ha$^{-1}$) protein yield. Zn foliar application significantly increased all studied traits at 400ppm excepting of oil (23.48%) and protein percentage (29.11%) in seed were obtained with 600ppm Zn spray. Interaction between varieties and Zn spray also has significant differences for all characteristics measured, as well as, the maximum produce for these parameters were found with Gilla, Rabeey500 and 200, 400 and 600ppm of Zn spray.

***Keywords*:** safflower, cultivars, oil crop, yield component, zinc.



## INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is one of the most important oilseed crops with high-quality seed oil that belongs to the family Compositae or Asteraceae. It can be grown especially in the arid and semiarid regions of the world [20]. The primary reason for safflower cultivation of is for its seed, which is extracted to produce premium edible oil, also many chemical components (secondary metabolites) found in safflower have anticoagulant and antioxidant properties as well as other pharmacologically significant health benefits for humans, including the prevention of heart, reproductive, and gastrointestinal disorders [4]. Micronutrients are those elements which are essential for plant growth and development. They perform many physiological functions, including structural, enzymatic, regulatory, and ionic [18]. Zinc is required for chlorophyll production, pollen function, fertilization and germination, in addition to the activity of some enzymes that play a good role in carbohydrates metabolism, chloroplast and cytoplasm by Zn [10].

Cultivars have Significant differences of Safflower plant for seed yield, number of capitula plant$^{-1}$, 1000-seed weight, plant height and seed oil content, except days to flowering. Yield of Padideh cultivars 12.8% more than K.w.2 cultivars and 7.6% more than Goldasht cultivars [11]. [17] reported that an experiment was established to select the proper variety between different varieties of safflowers under the Jordanian condition, two local and two imported varieties (Sirothora and Sironaria), found that significant differences between varieties. [7] studied the influence of spraying of different zinc concentrations on yield and yield components of 10 safflower genotypes, they found that zinc is regarded as one of the most important micronutrients for safflower nutrition and has an obvious role in seed yield of this crop. [3] in their study about effect of foliar applications of Zn in different levels (4, 6, 8, 10, 12, and 14 g L$^{-1}$) on safflower plant resulted that Zn significantly increased the biomass yield, number of capitula plant$^{-1}$, number of seeds capitulum$^{-1}$ and grain yield of plants compared with control plants.

The aim of this study is to evaluate the appropriate varieties which respond to a better level of zinc with respect to growth and yield performance.

## Materials and Methods

The experiment was conducted during November 15th, 2023 to June 13th, 2024 at Grdarasha Research Field, Collage of Agricultural Engineering Sciences, Salahaddin University – Erbil to study the effect of foliar application of zinc on some growth and yield traits of safflower varieties (*Carthamus tinctorius* L.), Grdarasha Research Field is locating at 36. 40º N, 44.10º E and at an elevation 470m above sea level. Representative air – dried soil sample was taken for field at the depth (0-30cm), then sieved with 2mm mesh and analyzed for some physical and chemical properties as shown in Table (1). Climatic conditions of field during planting season are shown in Table (2).

The field was ploughed with two perpendicular lines and the soil was well softened with Rotavator plow to erosion control and conservation of soil moisture. land divided in to plots with dimensions (2m × 2m) area and 40cm distance between rows and 10cm between plants with three replications resulting, 36 plots.

Three safflower varieties (*Carthamus tinctorius* L.) (Gilla, G-2018, Rabeey 500) were chosen for this study. Different Zinc level (control, 200, 400, 600ppm) were used as a foliar application. Seeds were sown on 15th November, 2023 at depth of 3cm. Through the experimental period plants irrigated depending on rainfall and manual weed control repeated more than once. Zinc solution was prepared by dissolving 1 g of zinc in 1000 ml of distilled water, then diluted to required concentrations (0, 200, 400, and 600 ppm) for foliar application. A surfactant agent, Tween, was added at a concentration of 0.1% to the solutions. Spraying was carried out at two stages, the first spray was applied after one month from sowing date and the second spray was applied at the beginning of the flowering. The spray was carried out early in the morning till run-off.

Table 1. Some chemical and physical properties of the field soil of Grdarasha

| Soil properties | Soil component |
|---|---|
| Sand (g $kg^{-1}$) | 384.75 |
| Slit (g $kg^{-1}$) | 515.00 |
| Clay (g $kg^{-1}$) | 100.25 |
| Texture Class | Silty clay loam |
| pH | 7.53 |
| Electrical Conductivity (EC) ds $m^{-1}$ | 0.38 |
| Organic Matter (%) | 0.91 |
| Bulk density (Mg $m^{-3}$) | 1.45 |
| Total Nitrogen (N) ppm | 89.17 |
| Total Phosphor (P) ppm | 5.36 |
| Total Potassium (K) ppm | 64.10 |

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Table 2. Climatic conditions during the growing season

| Months (2023-2024) | Air Temp. C° | | Relative moisture % | Rainfall (mm) |
|---|---|---|---|---|
| | Minimum | Maximum | | |
| September | 26.1 | 38.4 | 16.0 | |
| October | 20.0 | 30.0 | 30.7 | 0.7 |
| November | 13.4 | 21.5 | 60.5 | 10.1 |
| December | 9.5 | 18 | 67.0 | 46.5 |
| January | 7.9 | 14.8 | 72.1 | 66 |
| February | 7.8 | 15.9 | 62.5 | 142 |
| March | 11 | 19.5 | 52.5 | 71 |
| April | 18.3 | 29.2 | 34.3 | 67 |
| May | 20.6 | 30.7 | 32.7 | 46 |
| June | 29.8 | 41 | 12.9 | |

*Data source: Meteorological Directory- Erbil province

Five plants were selected from middle lines of each experimental unit to study the plant height (cm), leaf area ($cm^2$), leaf area index, dry matter (gm), crop growth rate (CGR) (g $m^{-2}$ $day^{-1}$), no. of primary branch, no. of secondary branch, no. of head $plant^{-1}$, no. of seed $head^{-1}$, 1000 seed weight (g), seed yield (kg $ha^{-1}$), biological yield (kg $ha^{-1}$) and Harvest index. Seeds ground by electrical grinder for each experimental unit. A 0.3g of ground samples were digested by adding 10ml of concentrated $H_2SO_4$ and 10ml of $H_2O_2$ with heating for digestion as described by [14]. The percentage of protein and protein yield (kg $ha^{-1}$) in seeds were estimated from digested samples by kjeldahl method [13] and the percentage of oil and oil yield (kg $ha^{-1}$) in seeds by Soxhlet method [12].

Crop Growth Rate (CGR) = $\frac{1}{GA} \times \frac{W2-W1}{T2-T1}$ (Abdullah *et al*., 2022)

LAI = $\frac{\text{plant total leaf area per plan}}{\text{Average land area occupied by plant}}$ [1]

Harvest index= $\frac{\text{Seed yield (kg /ha)}}{\text{Biological yield (kg /ha)}} \times 100$ [6]

The experiment was designed according to factorial randomized complete block design (RCBD) with three replicates, comparisons between means were made using Duncan's Multiple Range Test at 5% level. The statistical analysis was carried out by using SPSS (Statistical Package for Social Sciences) Program, version (22.0) in 2019 [19].

## Results and Dissuasion

### Growth parameters

According to the results presented in Table 3, the Gilla variety recorded the highest values for all growth parameters and the lowest values found by the Rabeey500 variety, except that plant height significantly increased to 148.07cm with the Rabeey500 variety. Zn foliar application significantly raised the rates of all parameters and registered the maximum values with 400ppm as compared with control and other concentrations. The interaction between varieties and Zn spray shows in the same table, Rabeey500 variety recorded the highest plant (158.44cm) with 400ppm Zn spray when compare with other treatments while, for other growth parameters Gilla with 400ppm Zn foliar application recorded the height values and lowest rates found with Rabeey500 and control. The variation may be related to the difference of the genetic formation between cultivars. These differences in genotypes are due to their toleration behaviour at both low and high temperature condition [9]. The activity of some enzymes that play a good role in carbohydrates metabolism, chloroplast and cytoplasm by Zn [10]. Zinc addition has a beneficial influence on assimilation transfer, photosynthetic enzyme activity, chlorophyll generation, and improved plant growth [8].

Table 3. Response of growth parameters in different varieties of safflower to foliar application of zinc

| Varieties | Plant height (cm) | Leaf Area ($cm^2$) | LAI | Dry matter g $m^{-2}$ | C.G.R (g $m^{-2}$ $day^{-1}$) |
|---|---|---|---|---|---|
| Gilla | 147.79 a | 1087.80 a | 2.71 a | 1162.26 a | 7.04 a |
| G-2018 | 142.07 b | 985.30 b | 2.46 b | 1005.64 b | 6.28 b |
| Rabeey500 | 148.34 a | 900.53 c | 2.25 c | 950.84 c | 6.13 c |
| Zn concentration (ppm) | Plant height (cm) | Leaf Area ($cm^2$) | LAI | Dry matter g $m^{-2}$ | C.G.R (g $m^{-2}$ $day^{-1}$) |
| Control | 139.30 d | 822.38 d | 2.05 d | 750.77 d | 4.68 d |
| 200 | 144.98 c | 911.08 c | 2.27 c | 976.62 c | 6.09 c |
| 400 | 153.82 a | 1202.74 a | 3.00 a | 1299.27 a | 8.11 a |
| 600 | 146.15 b | 1028.64 b | 2.57 b | 1131.66 b | 7.06 b |
| Varieties× Zn concentration | Plant height (cm) | Leaf Area ($cm^2$) | LAI | Dry matter g $m^{-2}$ | C.G.R (g $m^{-2}$ $day^{-1}$) |
| Gilla, control | 143.10 f | 890.88 h | 2.22 h | 812.70 j | 4.92 g |
| Gilla, 200 | 148.32 d | 988.34 f | 2.47 f | 1126.71 e | 6.83 d |
| Gilla, 400 | 154.55 b | 1346.22 a | 3.66 a | 1445.99 a | 8.76a |
| Gilla, 600 | 145.17 e | 1125.77 c | 2.81 c | 1263.66 b | 7.66 c |
| Gilla, control | 135.96 i | 821.46 j | 2.05 j | 759.34 k | 4.74 h |
| G-2018, 200 | 141.03 g | 885.77 h | 2.21 h | 921.81 h | 5.76 f |
| G-2018, 400 | 148.47 d | 1200.22 b | 3.00 b | 1238.18 c | 7.73 c |
| G-2018, 600 | 142.81 f | 1033.78 e | 2.58 e | 1103.22 f | 6.89 d |
| Rabeey500, control | 138.84 h | 754.82 k | 1.88 k | 680.29 l | 4.39 i |
| Rabeey500, 200 | 145.59 e | 859.15 i | 2.14 i | 881.33 i | 5.68 f |
| Rabeey500, 400 | 158.44 a | 1061.77 d | 2.65 d | 1213.62 d | 7.83 b |
| Rabeey500, 600 | 150.48 c | 926.37 g | 2.31 g | 1028.11 g | 6.63 e |

*The similar letters between treatments means there are no significant differences between them using Duncan's Multiple Test at 5% level.

### Yield and yield components

Table (4) clarifies the Response of yield and yield components in different varieties of safflower to foliar application of zinc. Findings show that significantly variation was recorded for number of primary branches and harvest index between varieties, the greater number (7.20) of primary branches was obtained by G-2018 and (18.48) by Rabeey500 for harvest index. In contrast, no significant effect was recorded between varieties for other yield characteristics. Zn foliar application has significant effect of yield and yield component, the highest values (8.15, 6.63, 14.78, and 38.88) of number of primary branches, secondary branches, number of head plant$^{-1}$ and number of seed head$^{-1}$ respectively was recorded by 400ppm Zn spray and lowest rate for these parameters were (5.83, 3.72, 9.55 and 29.25) respectively recorded by control. In addition, Zn foliar application has no significant differences found for 1000 seed weight, seed yield, biological yield, and harvest index. In interaction between varieties and Zn spray significantly affected on yield characteristics and the maximum values (8.76, 6.73 and 15.50) was observed for number of primary branches, secondary branches and number of head plant$^{-1}$ respectively by Rabeey500 and 400ppm whereas, the maximum produce (39.44) for number of seed head$^{-1}$ was recorded with Gilla and 400ppm and (20.31) for harvest index by Rabeey500 and 600ppm. On the other hand, the decline in these parameters was observed for all varieties for those plant that were not spraying by Zn.

The variation in yield characteristics of varieties may be related to the genetic formations and their response to environmental conditions [15]. Zinc is a necessary nutrient that plants absorb and transfer in the form of Zn2+. It has specific physiological functions in all living systems, including the preservation of biological membranes, structural and functional integrity, the facilitation of protein synthesis and gene expression, the structure of enzymes, the production of energy, and the Krebs cycle, Zinc also positively affects crop yield, meaning that both the quantitative and qualitative yield of crops is heavily dependent on it (Zn) [5].

**Seed oil and protein content**

The data presented in Table (5) indicated that the ratio of oil significantly progressed in Rabeey500 variety of safflower by (24.20%) and percentage of protein significantly increased by (29.62%) for G-2018, while the lowest ration of theses parameters was obtained by Gilla cultivar. No significant differences were found between all varieties for oil and protein yield (kg ha$^{-1}$). Zn foliar application at 600ppm recorded the greater produce of oil and protein when compared with other treatments and no significant effect of Zn spray was observed for oil and protein yield (kg ha$^{-1}$). The results in the same table show the interaction between varieties and Zn foliar application, from the results the maximum rate (25.11% and 5759.88 kg ha$^{-1}$) of oil and oil yield were recorded by Rabeey500 and 200ppm whereas, the protein ration significantly progressed by (35.65%) for Gilla and control and no significant effect was found for protein yield. This variation among genotypes might be due to differences in physiological traits responsible for production potential [16]. Numerous researchers have noted that an increase in the percentage of seed oil might result from providing plants with the micronutrient components they require. Microelements effectively improved photosynthesis and assimilate translocation to the seed due to the augmentation of enzymatic activity [2]

Table 4. Response of yield and yield components in different varieties of safflower to foliar application of zinc

| Varieties | No. of Primary Branch | No. of Secondary Branch | No. of Head plant$^{-1}$ | No. of seed head$^{-1}$ | 1000 seed weight (g) | Seed yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) | Harvest index |
|---|---|---|---|---|---|---|---|---|
| Gilla | 6.85 ab | 4.98 a | 11.83 a | 33.55 a | 47.33 a | 19590.34 a | 110270.04 a | 18.00 a |
| G-2018 | 7.20 a | 5.10 a | 12.30 a | 30.16 a | 43.78 a | 16928.12 a | 111080.00 a | 15.34 b |
| Rabeey500 | 6.64 b | 5.36 a | 12.00 a | 36.63 a | 44.43 a | 19827.78 a | 108418.70 a | 18.48 a |
| Zn concentration (ppm) | No. of Primary Branch | No. of Secondary Branch | No. of Head plant$^{-1}$ | No. of seed head$^{-1}$ | 1000 seed weight (g) | Seed yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) | Harvest index |
| Control | 5.83 c | 3.72 d | 9.55 d | 29.25 b | 45.57 a | 18992.82 a | 101669.05 a | 18.60 a |
| 200 | 6.98 b | 5.45 b | 12.44 b | 31.07 ab | 46.08 a | 18618.24 a | 110000.05 a | 16.95 a |
| 400 | 8.15 a | 6.63 a | 14.78 a | 38.88 a | 44.75 a | 18007.30 a | 108611.55 a | 16.68 a |
| 600 | 6.62 b | 4.788 c | 11.41 c | 34.58 ab | 44.31 a | 19509.96 a | 119411.00 a | 16.86 a |
| Varieties× Zn concentration | No. of Primary Branch | No. of Secondary Branch | No. of Head plant$^{-1}$ | No. of seed head$^{-1}$ | 1000 seed weight (g) | Seed yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) | Harvest index |
| Gilla, control | 5.86 f | 3.86 cd | 9.73 ef | 29.66 ab | 46.53 a | 21553.22 a | 110154.33 a | 19.33 ab |
| Gilla, 200 | 6.83 c-f | 5.13 bc | 11.96 cd | 31.88 ab | 49.33 a | 17809.82 a | 105526.00 | 17.06 ab |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | a | |
| Gilla, 400 | 8.06 ab | 6.16 ab | 14.23 ab | 39.44 a | 48.00 a | 20049.94 a | 109691.50 a | 18.79 ab |
| Gilla, 600 | 6.63 c-f | 4.76 cd | 11.40 cde | 33.21 ab | 45.46 a | 18948.39 a | 115708.33 a | 16.84 ab |
| Gilla, control | 5.73 f | 3.73 d | 9.46 f | 21.66 b | 48.20 a | 17680.23 a | 100434.83 a | 17.81 ab |
| G-2018, 200 | 7.26 bcd | 5.10 bc | 12.36 cd | 27.99 ab | 43.20 a | 15106.88 a | 97657.83 a | 15.38 ab |
| G-2018, 400 | 8.76 a | 6.73 a | 15.50 a | 36.44 ab | 41.06 a | 17606.18 a | 130519.00 a | 14.75 ab |
| G-2018, 600 | 7.08 b-e | 4.83 cd | 11.90 cd | 34.55 ab | 42.20 a | 17319.22 a | 115708.33 a | 13.44 b |
| Rabeey500,Control | 5.90 f | 3.56 d | 9.46 f | 36.44 ab | 42.00 a | 17745.03 a | 94418.00 a | 18.67 ab |
| Rabeey500, 200 | 6.86 c-f | 6.13 ab | 13.00 bc | 33.33 ab | 45.73 a | 22938.02 a | 12681.33 a | 18.43 ab |
| Rabeey500, 400 | 7.63 bc | 7.00 a | 14.63 ab | 40.77 a | 45.20 a | 16365.22 a | 100434.83 a | 16.49 ab |
| Rabeey500, 600 | 6.16 def | 4.76 cd | 10.93 def | 35.99 ab | 44.80 a | 22262.28 a | 112005.66 a | 20.31 a |

*The similar letters between treatments means there are no significant differences between them using Duncan's Multiple Test at 5% level.

Table 5. Response of oil and protein content in seed of different varieties of safflower to foliar application of zinc

| Varieties | Oil % | Oil yield (kg ha$^{-1}$) | Protein % | Protein (kg ha$^{-1}$) |
|---|---|---|---|---|
| Gilla | 20.97 c | 4099.24 a | 25.58 c | 4999.54 a |
| G-2018 | 22.04 b | 3736.07 a | 29.62 a | 5061.06 a |
| Rabeey500 | 24.20 a | 4812.17 a | 26.30 b | 5167.42 a |
| Zn concentration (ppm) | Oil % | Oil yield (kg ha$^{-1}$) | Protein % | Protein (kg ha$^{-1}$) |
| Control | 21.43 d | 4031.60 a | 28.13 b | 5275.87 a |
| 200 | 22.04 c | 4163.34 a | 24.90 d | 4664.58 a |
| 400 | 22.66 b | 4068.43 a | 26.53 c | 4742.16 a |
| 600 | 23.48 a | 4599.95 a | 29.11 a | 5621.43 a |
| Varieties× Zn concentration | Oil % | Oil yield (kg ha$^{-1}$) | Protein % | Protein (kg ha$^{-1}$) |
| Gilla, control | 18.37 i | 3959.04 ab | 23.75 e | 5119.29 a |
| Gilla, 200 | 19.60 h | 3492.24 ab | 24.85 de | 4425.89 a |
| Gilla, 400 | 22.05 f | 4420.88 ab | 23.75 e | 4761.73 a |
| Gilla, 600 | 23.88 c | 4524.80 ab | 30.00 c | 5691.27 a |
| Gilla, control | 23.27 d | 4114.56 ab | 35.65 a | 6303.08 a |
| G-2018, 200 | 21.43 g | 3237.89 b | 24.00 e | 3638.24 a |
| G-2018, 400 | 21.44 g | 3774.99 ab | 25.85 d | 4550.57 a |
| G-2018, 600 | 22.04 f | 3816.86 ab | 33.00 b | 5752.36 a |
| Rabeey500,Control | 22.66 e | 4021.20 ab | 25.00 de | 4405.25 a |
| Rabeey500, 200 | 25.11 a | 5759.88 a | 25.85 d | 5929.62 a |
| Rabeey500, 400 | 24.50 b | 4009.44 ab | 30.00 c | 4914.18 a |
| Rabeey500, 600 | 24.53 b | 5458.18 ab | 24.35 e | 5420.66 a |

*The similar letters between treatments means there are no significant differences between them using Duncan's Multiple Test at 5% level.

## Conclusions

It is concluded that Gilla and Rabeey500 varieties record significant values compared to G-2018 in most of studied parameters, except the percentage of protein and protein yield were produced the maximum rate by G-2018 variety. Also, with the increase in the level of zinc, foliar application increased the production of all characteristics. From interactions between treatments for all characteristics selected, the highest amount was by Gilla and Rabeey500 varieties with all levels of zinc spray.

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# أستجابة بعض صفات النمو والحاصل لأصناف العصفر (.*Carthamus tinctorius* L) للرش الورقي بالزنك.

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الخلاصة

العصفر (.Carthamus tinctorius L)هو محصول زيتي ذو أهمية دولية. لذا أجريت هذه التجربة لتقييم تأثيرالرش بمستويات مختلفة من عنصرالزنك بمستويات (0، 200، 400 و 600 جزء في المليون) على المحصول ومكونات المحصول لأصناف من العصفر (Gilla, G–2018, Rabeey500) أجريت هذه التجربة الحقلية خلال الموسم الزراعي 2023–2024 في مركز البحوث الميدانية التجريبية كردرشة/كلية علوم الهندسة الزراعية. تم استخدام التجربة العاملية المعتمدة على تصميم القطاعات العشوائية الكاملة (RCBD) بثلاثة مكررات. تمت دراسة صفات مثل صفات النمو الخضري (ارتفاع النبات، مساحة الورقة، دليل مساحة الورقة، المادة الجافة، معدل نمو المحصول)، صفات المحصول ومكونات المحصول (عدد االافرع الأساسي، عدد الافرع الثانوي، عدد الكبسولات للنبات ، عدد البذرور للكبسولة ، وزن 1000 بذرة، حاصل البذور، المحصول البيولوجي ودليل الحصاد) ونسبة البروتين، حاصل البروتين، نسبة الزيت وحاصل الزيت في البذور. سجل أعلى معدل لمعظم مؤشرات النمو الخضري للصنف Gilla باستثناء ارتفاع النبات وبعض مكونات المحصول ونسبة الزيت وحاصل الزيت المسجل للصنف Rabeey500، بينما سجل G–2018 أعلى مستوى للأفرع الأولية ونسبة البروتين وإنتاجية البروتين. أدى الرش الورقي بالزنك إلى زيادة معنوية في جميع الصفات المدروسة عند التركيز 400 جزء بالمليون باستثناء نسبة الزيت والبروتين في البذور التي تم الحصول عليها عند رش الزنك بالتركيز 600 جزء بالمليون. كما أن التداخل بين الأصناف ورش الزنك كان له اختلافات معنوية لجميع الصفات المقاسة، كما وجد أقصى إنتاج لهذه المعايير مع Gilla و 200Rabeey500 و 400 و600 جزء في المليون من الرش بالزنك.

الكلمات المفتاحية : العصفر ، الأصناف، محصول زيتى،مكونات الحاصل، الزنك.