Effect of Brassinolide Levels on Some Growth of Sunflower

Helianthus annuus L.

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Abstract. Field experiment was carried out at Research Station, College of Agriculture, Anbar University, during 2019 spring season to study the effect of four level of brassinolide (0, 0.5, 1, 1.5 mg L-1) on some Morphological characters of three sunflower varieties (Ishaqi 1, Akmar and Sakha) The results of the statistical analysis showed the significant effect of the cultivars and brassinolide concentrations on the studied characters. The sprayed plants with 1.5 mg L-1 of brassinolide recorded the highest values of plant height (197.5 cm), leaf area (6179 cm². plant⁻¹), mean of dry weight (171.5 g. plant⁻¹), Crop Growth Rate (17.709 gm. m⁻². days⁻¹) and Net Assimilation Rate (1.47 gm⁻². day⁻¹). Whereas the cultivars differed significantly in all the studied traits, as Sakha variety recorded the highest values for plant height, leaf area, mean of the dry weight to plant, Crop Growth Rate and Net Assimilation Rate, (182.2 cm, 7738 cm².plant⁻¹, 212.6 g. plant⁻¹, and 13.317 gm .m⁻². days⁻¹, and 1.96 gm⁻².day⁻¹) respectively.

1.Introduction.

Sunflower is an important oil crop, as it ranks third oil production, after soybean and palm oil crops. The percentage of oil in its seeds reaches 55%, and it contributes about 14% of oil production in the world. Sunflower oil is included in the human diet and in some industries, such as soap. Its seed's meal used in the feeding of ruminants and poultry due to its high content of protein (40%) and carbohydrates (20%) [1]. The need for this crop is continuous and increasing year after year. Therefore, scientific research continues to improve its productivity. Growth regulators have a role in increasing yield and improving its quality, among these regulators is Brassinolide which is a steroidal compound with multiple hydroxyls that has physiological effects, as it regulates the photosynthesis process and increases its efficiency [2]. It also plays a major role in cell division and elongation and delaying aging [3] and in other field crops, [4] reported the use of Brassinolide on soybeans at a concentration of 0.5ppm led to a significant increase in plant height and foliar area. [5] showed that the use of Brassinolide on sesame crops at pod formation stage and flowering stage led to a significant increase in plant height that was attributed the reason for the increase to the effect of the regulator on the meristematic tissues of the plant by increasing the number and size of cells. In another study, it was found that spraying sunflower plants at a rate of 1 mg. L⁻¹ of Homobarassinolide regulator at the flowering stage was achieving highest mean plant height, leaf area, and seed yield per unit area [6]. Therefore, this investigation was carried out to study the effect of four Brassinolide level on some growth characters, of sunflower varieties.

2.Materials and Methods.

A field experiment was carried during spring growing season 2019 at the Research Station of the College of Agriculture - Anbar University, with the aim of studying the effect of spraying four concentrations of Brassinolide (0, 0.5, 1, 1.5) mg L⁻¹. At the tablet’s appearance stage to three varieties of sunflower (Ishaqi 1, Akmar, and Sakha). The experiment was carried out by arranging the split-plot according to a randomized complete block design (R.C.B.D.) with three replications, varieties arranged as main plot, and Brassinolide were the secondary plot. The experiment land was prepared with two perpendicular plowings, then it was graded and flattened, after which it was divided into experimental units of (3 x 3 m) dimensions so that the area of the experimental unit became 9 m². with 5 rows per plot, the distance between each line 60 cm and between the hole 25 cm, so the plant density was 66666 plants ha⁻¹, a distance of 2 m is left between experimental unit and another and between replications. The three sunflower varieties were sow 3 seeds in each hole on 3/15/2019, then watered, irrigation was depending on the soil moisture and plant need. When the plants reached the stage of emergence five leaves were reduced to one plant in the hole, and the weeds were removed twice to get rid of the harm growing weeds with the crop. Brassinolide
concentrations were sprayed in growing bud stage, each level was sprayed until the leaves of the plant were completely wet.

2.1. The studied characters:

Ten plants were taken randomly for each treatment to estimate the following characters:

1. Plant height (cm): The height of the plant was measured from the base of the plant at ground level to the base of the disc [7].
2. Leaf Area (cm\(^2\)): It was calculated by measuring the maximum width of the plant leaves, then multiplying the sum of the squares of width by the coefficient (0.65) to obtain the foliar area of the plant according to the following equation [8].
   \[ L.A = 0.65 \sum L^2 \]
   \[ \text{AS: } L.A = \text{leaf area, } L = \text{width of leaf, } 0.65 = \text{constant} \]
3. The dry weight of the Vegetative total (gm. plant\(^{-1}\)): dry the Vegetative total of the five plants in air and then Dried them in electric oven at a temperature of 65 ° C for 48 hours [9], and then record the mean dry weight of per plant.
4. Crop Growth Rate (CGR): It was measured using the following equation:
   \[ \text{CGR} = \frac{W_2-W_1}{T_2-T_1} \]
5. Net Assimilation Rate (NAR): It was calculated using the following equation:
   \[ \text{NAR} = \frac{W_2-W_1}{\ln \frac{L_2}{L_1}} \]
6. Relative Growth Rate (RGR): It was calculated using the following equation
   \[ \text{RGR} = \frac{\ln \frac{W_2}{W_1}}{T_2-T_1} \]

2.2. Statistical analysis

The data were statistically analyzed according to the technique of analysis of variance (ANOVA) using the GStat program. The least significant difference test (L.S.D) was used to distinguish the statistically different averages at a probability level of 0.05 [10].

3. Results and Discussion

3.1. Plant height (cm)

The results of Table (1) indicate the significant effect of varieties and Brassinolide concentrations on plant height. Akmar variety superior with the highest mean plant height, 186.7 cm, and There are no significant differences with Sakha variety (182.2 cm). However, both varieties were significantly superior to the variety Ishaqi 1, which gave the lowest average for this trait of 153.3 cm. The superiority of Akmar variety in this trait may be due to its genetic nature by responding to environmental conditions better than other varieties, and this is reflected in the increase in division and elongation of its cells, and then the increase in plant height, these results are consistent with the findings of [11,12]; they indicated that there were significant differences between sunflower cultivars in a trait of plant height. The results also showed that the increase in spraying with Brassinolide was accompanied by a significant increase in mean plant height. As the higher concentration (1.5 mg liter\(^{-1}\)) gave the highest mean of the trait 197.5 cm, with an increase of (31.49, 14.29 and 12.41) %, compared with the concentrations 0, 0.5 and 1 mg L\(^{-1}\) respectively, increasing in plant height may be due to the effectiveness of Brassinolide in increasing cell division and elongation, these results are in agreement with those reported [6] found. The results of the same table also indicate that the Akmar varieties with the effect of spraying with a concentration of 1.5 mg L\(^{-1}\) gave the highest mean for this trait (212.7 cm) and did not differ significantly from the cultivar Sakha sprayed with the same concentration (205 cm), Ishaqi 1, with the comparison treatment, the lowest average for this trait was 130 cm.

Table1. The effect of Brassinolide concentrations on mean plant height (cm) for sunflower varieties
3.2. Leaf area (cm² plant⁻¹)

It appears from Table 2 the Sakha variety achieved the highest mean leaf area, reaching 6179 cm² plant⁻¹, and significantly outperforming Akmar (5751 cm² plant⁻¹) and Ishaqi-1 variety, which scored the lowest mean (4644 cm² plant⁻¹). The outperformance rate was 7.44 and 33.05%, respectively, the last two varieties significantly differed from each other this result was compatible with the results of [13] who found a discrepancy between sunflower varieties in the leaves area. It is clear from table 2 the increase in the concentrations of spraying Brassinolide led to a significant increase in the mean leaf area, as the concentration 1.5 mg. L⁻¹ gave the highest mean of it 7738 cm² plant⁻¹, the percentage of increase for this concentration was 143.33, 53.84, and 25.80% compared to the concentrations. 0, 0.5, and 1 mg. L⁻¹, respectively. Interaction showed Sakha variety sprayed with a concentration 1.5 mg L⁻¹ gave the highest mean for this trait of 8721 cm² plant⁻¹ and it did not significantly differ from the Akmar variety sprayed with the same concentration (8490 cm² plant⁻¹), but both of them were significantly superior other interaction treatments which the Ishaqi-1 variety was given with the comparison treatment the lowest mean to this trait 3184 cm² plant⁻¹.

Table 2. The effect of Brassinolide concentrations on leaf area (cm² plant⁻¹) for sunflower varieties

| Brassinolide concentration (Mg L⁻¹) | Varieties (V) | Mean |
|-------------------------------------|--------------|------|
|                                     | Sakha | Akmar. | Ishaqi 1 |      |
| 0                                  | 161.7 | 159.0  | 130.0    | 150.2|
| 0.5                                | 184.0 | 185.0  | 149.3    | 172.8|
| 1                                  | 178.0 | 190.0  | 159.0    | 175.7|
| 1.5                                | 205.0 | 212.7  | 174.9    | 197.5|
| Mean                               | 182.2 | 186.7  | 153.3    |      |
| LSD 0.05                           | 13.32 | 7.69   | 8.34     |      |

3.3. Dry weight for total vegetative part of the plant (g plant⁻¹)

Results of Table 3 showed the Sakha variety achieved highest mean for this trait reaching 171.5 g plant⁻¹ and it was significantly superior to Akmar and Ishaqi-1 varieties which gave the lowest mean for the trait 122.6 gm. plant⁻¹, the last two varieties significantly differed in this trait. The superiority of the Sakha variety in this trait due to its superiority in a foliar area table 2 and thus its increased efficiency in intercepting and absorbing light, thus increasing the efficiency of photosynthesis and increasing its products that were deposited in the form of dry matter in the plant.
Similar result was also reported by [11] who indicated that there are differences between varieties in mean dry weight of a vegetative growth.

According to the presented data in Table 3, dry weight of the plant was significantly affected by spraying (1.5 mg L\(^{-1}\)) Brassinolide, and recorded a highest value of 212.6 g plant\(^{-1}\) with a significant increase reached (126.17, 75.12, and 44.82) \%, comparing with 0, 0.5 and 1 mg. L\(^{-1}\), respectively. The superiority of higher concentration attributed to superiority in plant height and foliar area Tables 1, and 2 which reflected with the increase dry weight. The results of interaction, Table 3 showed the Sakha variety plants by effect of concentration spraying 1.5 mg. L\(^{-1}\) Brassinolide had achieved the highest mean of plant weight 251.1 gm. plant\(^{-1}\) that superior on all other interaction treatments in which comparative plants to Ishaqi 1 variety gave the lowest mean for this trait 88.2 gm. plant\(^{-1}\).

Table 3. The effect of Brassinolide concentrations on mean dry weight (g plant\(^{-1}\)) of sunflower varieties.

| Brassinolide concentration (Mg. L\(^{-1}\)) | Varieties (V) | Mean |
|-------------------------------------------|--------------|------|
|                                           | Sakha        | Akmar, | Ishaqi 1 |     |
| 0                                         | 99.4         | 94.5   | 88.2     | 94.0 |
| 0.5                                       | 151.3        | 110.3  | 102.7    | 121.4 |
| 1                                         | 184.3        | 144.6  | 111.4    | 146.8 |
| 1.5                                       | 251.1        | 198.6  | 188.2    | 212.6 |
| Mean                                      | 171.5        | 137.0  | 122.6    |      |
| LSD 0.05                                  | V×T          | T      | V        |      |

3.4. Crop Growth Rate (g.m\(^{-2}\) day\(^{-1}\))

Results of Table (4) indicated the significant effect of varieties and Brassinolide concentrations and their interaction on crop growth mean. As Sakha variety was a significantly highest crop growth rate 13.317 g.m\(^{-2}\) days\(^{-1}\) compared to other varieties where Ishaqi 1 variety gave the lowest average for this trait 8.794 g.m\(^{-2}\) day\(^{-1}\). The superiority of the Sakha variety in this trait may be attributed to the different varieties ability in photosynthesis, which reflected in an increase in plant height, leaf area, and dry weight Table 1, 2, 3 and these results are compatible with what found by [14]. The results also showed an increase in the spraying concentrations Brassinolide accompanied by a significant increase in the crop growth rate, as the higher concentration (1.5 mg L\(^{-1}\)) gave the highest mean for this trait (17.709 gm. m\(^{-2}\) day\(^{-1}\)) with an increase 220.35, 115.41 and 59.94 \%, comparing with 0, 0.5, and 1 mg L\(^{-1}\), respectively. The superiority of Brassinolide in growth means attributed to its positive role in increasing plant height, foliar area, and dry weight of the plant Table 1, 2, and 3. This result compatible with the finding of [15,16]. The results of interaction between the two studying factors indicate that Sakha variety with the spraying of 1.5 mg L\(^{-1}\) gave the highest crop growth rate 21.47 g.m\(^{-2}\)day\(^{-1}\) and it was significantly superior to the other interaction factors where Ishaqi 1 variety gave with comparison treatment the lowest mean for this trait reached 5.083 g.m\(^{-2}\)day\(^{-1}\).

Table 4. The effect of Brassinolide concentrations on the crop growth rate (g.m\(^{-2}\) day\(^{-1}\)) for sunflower varieties.

| Brassinolide concentration (Mg. L\(^{-1}\)) | Varieties (V) | Mean |
|-------------------------------------------|--------------|------|
|                                           | Sakha        | Akmar, | Ishaqi 1 |     |
| 0                                         | 6.033        | 5.468  | 5.083    | 5.528 |
| 0.5                                       | 11.100       | 7.040  | 6.523    | 8.221 |
| 1                                         | 14.660       | 10.062 | 7.937    | 11.072 |
| 1.5                                       | 21.470       | 16.200 | 15.633   | 17.709 |
| Mean                                      | 13.317       | 9.787  | 8.794    |      |
| LSD 0.05                                  | V×T          | T      | V        |      |
3.5. Relative Growth Rate (g.g\(^{-1}\)day\(^{-1}\))

Presented in table (5) indicated a significant effect of varieties and Brassinolide concentrations on relative growth rate. As the Sakha variety was significantly superior with highest relative growth rate 0.0204 g.g\(^{-1}\)day\(^{-1}\) compared to other varieties as Ishaqi 1 variety gave the lowest value 0.0166 g.g\(^{-1}\)day\(^{-1}\). The results also showed an increase in spraying concentrations with Brassinolide accompanied by a significant increase in relative growth rate, as the higher concentration (1.5 mg L\(^{-1}\)) gave the highest mean for this trait 0.0250 g.m\(^{-2}\)day\(^{-1}\) with an increase 96.86, 59.24, and 30.21% compared to concentrations 0, 0.5, and 1 mg. L\(^{-1}\), respectively. Results of the same table also indicate Sakha variety with the effect of spraying concentration 1.5 mg. L\(^{-1}\) gave the highest mean for this trait 0.0270 g.g\(^{-1}\)day\(^{-1}\) and it significantly superior on the other interference factor, as Ishaqi 1 variety with the comparison treatment gave the lowest average for this trait reached 0.0120 g.g\(^{-1}\)day\(^{-1}\).

Table 5. The effect of Brassinolide concentrations on the Relative Growth Rate (g.g\(^{-1}\)day\(^{-1}\)) for sunflower varieties.

| Brassinolide concentration (Mg. L\(^{-1}\)) | Varieties (V) | Mean |
|------------------------------------------|---------------|------|
|                                          | Sakha         | 0.0126 | 0.0120 | 5.528 |
|                                          | Akmar,        | 0.0143 | 0.0143 | 8.221 |
|                                          | Ishaqi 1      | 0.0163 | 0.0163 | 11.072 |
| 0                                        | 0.0136        | 0.0136 | 0.0136 | 17.709 |
| 0.5                                      | 0.0186        | 0.0190 | 0.0190 | 22.482 |
| 1                                        | 0.0223        | 0.0240 | 0.0240 | 27.244 |
| 1.5                                      | 0.0270        | 0.0270 | 0.0270 | 32.006 |
| Mean                                     | 0.0204        | 0.0175 | 0.0166 | 17.709 |
| LSD 0.05                                  | 0.0019        | 0.0011 | 0.0007 | 17.709 |

3.6. Net Assimilation Rate (g.m\(^{-2}\) day\(^{-1}\))

It appears from Table 6 Sakha variety attained the highest net assimilation rate 1.964 g.m\(^{-2}\)day\(^{-1}\) and significantly outperformed the Akmar variety 1.237 g.m\(^{-2}\)day\(^{-1}\), and Ishaqi-1 variety which scored the lowest average 0.966 g.m\(^{-2}\)day\(^{-1}\) the percentage of differentiation reached 58.77 and 103.31%, respectively, and the last two varieties significantly differed from each other.

It notices from the table that spraying with Brassinolide at a concentration 1.5 mg L\(^{-1}\) has achieved the highest net assimilation rate 1.479 gm\(^{-2}\) days\(^{-1}\), and it did not significantly differ from the concentration 0.5 mg L\(^{-1}\) (1.457 g.m\(^{-2}\) day\(^{-1}\)), but it significantly superior on the concentration 1.5 mg L\(^{-1}\) (1.281 g.m\(^{-2}\) day\(^{-1}\)), and the comparison treatment (1.339 g.m\(^{-2}\) day\(^{-1}\)). The results of the interaction in Table 6 showed that Sakha variety sprayed with a concentration 1.5 mg L\(^{-1}\) gave the highest net assimilation rate 2.217 g.m\(^{-2}\)day\(^{-1}\) and it significantly outperformed all the other interference treatments, as Ishaqi 1 variety which sprayed with a concentration 0.5 mg. L\(^{-1}\) gave the lowest mean for this trait 0.890 g.m\(^{-2}\)day\(^{-1}\).

Table 6. The effect of Brassinolide concentrations on Net Assimilation Rate (g.m\(^{-2}\)days\(^{-1}\)) of sunflower varieties.

| Brassinolide concentration (Mg. L\(^{-1}\)) | Varieties (V) | Mean |
|------------------------------------------|---------------|------|
|                                          | Sakha         | 1.535 | 0.993 | 1.339 |
|                                          | Akmar,        | 1.433 | 0.890 | 1.457 |
|                                          | Ishaqi 1      | 0.926 | 0.926 | 1.281 |
| 0                                        | 1.67          | 1.353 | 0.993 | 1.339 |
| 0.5                                      | 2.047         | 1.433 | 0.890 | 1.457 |
| 1                                        | 1.923         | 0.993 | 0.926 | 1.281 |
| 1.5                                      | 2.217         | 1.167 | 1.053 | 1.479 |
4. Conclusion

The main conclusions were summarized from the results of the research that the increase in the concentrations of Brassinolide was accompanied by a clear improvement in the growth of the crop, and this gives an evident indication to a positive effect of Brassinolide on the physiological activities of the plant, as noticed that a difference in genotype had a variation effect on the growth trait and showed the Sakha variety was best in terms of the studied growth indicators. It may appear superior in the yield traits later.

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