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# Improving Some Vegetative Growth Characters, Yield and its Components by the Effect of Weed Control Treatments and Plant Densities in Sesame (*Sesamum indicum* L.)

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**Abstract.** A field experiment was carried out in the summer season in the field of a farmer in the Zankora / Ramadi / Anbar Governorate, located at longitude 43° E and latitude 38° N, in silty loam texture soil to study the effect of weed control treatments and different plant densities on growth characteristics, yield and its components of sesame crop. The complete randomized block design (R.C.B.D) was used in a Split Plot arrangement with three replications. The plant densities allocated to the main plot (100000, 80000, and 66666 plants ha<sup>-1</sup>), and the sub plot included several weed control treatments, which are the use of the mechanical method with three levels, which is the manual hoeing process once, twice and three times during the growing season, in addition to the two control treatments (the weed free and the weedy treatments). The results showed that there is a clear effect of different weed treatments on all the traits under study. The weedy treatment achieved the highest mean number and density of weeds after 60 and 90 days of planting, which amounted to 25, 17.8 plants m<sup>-2</sup>, while the three hoeing treatments achieved the highest percentage of inhibition in the dry weight of the weeds, which was 93.27%, the free weeds treatment gave the highest mean of stem diameter, plant dry weight and 500-seed weight, and the individual plant yield was 1.43 cm, 163 gm, 2.05 gm, and 265.20 gm, respectively. Whereas the effect of plant densities showed that there was no significant effect on most of the studied traits. As for the two-way interaction between weed control treatments and plant densities, it had a significant effect on yield characteristics, as treatment W<sub>4</sub>D<sub>1</sub> recorded the lowest mean of weeds after 60 days of planting (2.33 plants m<sup>2</sup>), Also, treatment W<sub>3</sub>D<sub>3</sub> recorded the highest inhibition rate of 94.61%, and treatment W<sub>4</sub>D<sub>2</sub> recorded the highest mean leaf area index of 5.04, while weed free treatment W<sub>1</sub> when interacted with plant density D<sub>3</sub> had the highest mean of stem diameter trait that was 1.54 cm. The treatment W<sub>1</sub>D<sub>1</sub> recorded the highest value of the dry weight of the plant, which was 196 gm. It also affected the yield of the individual plant when it was interacting with the highest mean of 291.70 gm, which was positively reflected in improving most of the vegetative growth characteristics and some yield traits.

## 1. Introduction

Sesame crop (*Sesamum indicum*) is one of the most important oilseed crops in most countries with hot and semi-hot climates and temperate regions. The crop is grown for the purpose of obtaining oil, because it is one of the finest table oils, with of 50-60%. It is also one of the best oils due to the high percentage of unsaturated fatty acids in it, such as Linoleic and Linoleic acid, which the body cannot form, and its seeds contain a good percentage of protein amounting



to 25.3%, in addition to containing a percentage of carbohydrates and flavonoid compounds that are anti-oxidant which is distinguished by preserving its natural properties [1].

The crop has multiple uses, including as basic raw materials such as making candy and pastries, and in some medical preparations and cosmetics, as well as using its seed a meal to feed animals because it contains a high percentage of protein and is used to make bread when mixed with maize flour. Its seeds contain a proportion of phosphorous, calcium and fiber, and the remains of its plants are sometimes used as fuel [2]. Despite the importance of this crop, its productivity rate is still low in Iraq, as the cultivated area of it reached 2,678 hectare in 2015 with a productivity of 2,344 tons compared to the global production of which the cultivated area amounted to 10.51 million hectare and its production was 6.1 million tons [3].

Given the great importance of this crop, its cultivation in Iraq has faced many problems that cause it to decrease in productivity, such as the presence of weed plants in its fields, which accompany it throughout the growing season, which causes it heavy losses in growth, and the result is estimated at 50 - 90% due to its intense competition for nutrients, light, water and place. Also, some of these plants have the ability to secrete chemicals from all their parts that inhibit the growth of this crop or affect its growth and productivity [4]. The prevailing climatic conditions such as the high humidity of the air at night and the sensitivity of this plant to soil moisture and drought, all this led to a decrease in its cultivation when compared with the cultivation of other crops such as grain crops. In order to increase the cultivation of this crop and achieve its highest productivity, some techniques and treatments have been applied that will achieve this, including controlling the weed plants accompanying this crop and reducing its damage, such as competition for the main and necessary requirements for growth as it hosts some pathogens that it carries when present with it, which causes weakness in growth and a decrease in productivity in quantity and quality

In order to reduce the use of chemical pesticides due to the environmental problems that it causes if it is used excessively. So, some other methods were used to control weed plants, including the mechanical method that can be used in fields with a medium area, through which weed plants are disposed of or may eliminate 90% of them, especially if it is done at the right time and in the early stages of germination and for an appropriate and close period whenever the need arises. The process of controlling weed plants was not the only way to get rid of weed plants, but rather to increase the cultivation of the crop with different plant densities by increasing the dense vegetation cover that can intercept 95% of the light, which is reflected positively in improving the growth of the crop and increasing the economic yield, which results in the inhibition of growth of weed plants and reducing density [5].

Therefore, this study aims to determining the number of hoeing that can reduce the damage of weed plants accompanying the crop, which is reflected in the increase in the growth of the crop, the yield, its components and quality characteristics. Determining the appropriate plant density for the growth of the crop to reduce the damage of weed plants and improve growth characteristics of yield and crop, and to determine the best interaction between the number of hoeing that can be made and the plant density, which can achieve the best growth of plant and the highest productivity per unit area.

## 2. Materials and Methods

A field experiment was carried out in the summer season of 2013 in the field of a farmer in the Zangora area of Ramadi District / Anbar Governorate, which is located at latitude 38 N and longitude 43 E in silty clay to study the effect of control weed plant operations and plant densities on some vegetative growth characteristics and yield and its components of sesame. Samples were taken from the field soil randomly and from different directions of the field land at the depth of 0-30 cm before planting to demonstrate some of its physical and chemical properties in Table (1).

The complete randomized block design (R.C.B.D) was used in a Split Plot arrangement with three replications, where the main plot consists of three plant densities denoted by (D1, D2, D3), whereas the sub-plot consists of 5 weed control treatments (W0, W1, W2, W3, and W4). Then, soil servicing operations were performed, such as perpendicular plowing by the

Moldboard plows, and then the smoothing process was carried out using the flexible spike-tooth harrows, and it was leveled by the leveling machine. Then it was divided into experimental units with a length of 3 m and a width of 4 m, and the distance between one line and another according to the plant densities used (60, 50, 40) cm, and the distance between one hill and another was 25 cm, so the number of experimental units was 45 experimental units for three replications. Sesame seeds were planted on 28/4/2013 at a depth of 2-3 cm [6], and the local variety was used in cultivation. A number of seeds were placed in each hill, and after the planting process was completed, the field was irrigated with the first irrigation, then the irrigations were continued when needed. The replanting process for the failed hills was carried out 4-7 days after the plants appeared on the surface of the soil with seeds soaked for 24 hours. The thinning process was carried out in two stages and after a month of germination [6]. Nitrogenous fertilizer was added in the form of urea (N 46%) at a rate of 80 kg (N) ha<sup>-1</sup> in two batches, the first at planting and the second immediately after the hoeing process. Phosphate fertilizer was also added to the experiment in the form of super phosphate (46%) P<sub>2</sub>O<sub>5</sub> in one batch when at cultivation at a rate of 80 kg ha<sup>-1</sup> [6].

The harvesting process was carried out after the emergence of signs of maturity of the crop, such as yellowing of the leaves and falling of the lower ones, in addition to the discoloration of the main stem and basal branches.

After carrying out the experiment, the data on the studied traits were recorded:

First: The effect of different treatments on the number and density of weeds at 90 days from planting and the percentage of control in order to identify the degree of weed spread after 90 days of planting by using a square with dimensions ((100 x 100 cm) for an area of one square meter from each experimental unit [7].

2- Control ratio: It is calculated by the following equation:

$$\text{Control percent \%} = \frac{\text{No. of weeds in weedy treatment} - \text{No. of weeds in other treatment}}{\text{No. of weeds in weedy treatment}} \times 100 \text{ [8]}$$

Second: The effect of different treatments on the vegetative growth characteristics of a crop:

1- Leaf area index: - can be calculated according to the following formula;

$$\text{Leaf area index} = \frac{\text{total leaf area}}{\text{the area the plant occupies}}$$

2- Stem diameter (cm): It was calculated as an average of ten plants taken randomly from the two middle lines of each experimental unit using the Vernier machine.

3- Dry weight of the plant (gm): The dry weight of the plant was calculated as an average of the ten plants taken from the aforementioned, as ten whole stems were taken and cut into small pieces and placed in perforated paper bags and dried naturally, and until their weight was stable, they were weighed with a sensitive scale.

Third: The effect of different treatments on the characteristics of the yield and its components.

1. Weight of 500 seeds (gm).

2. The individual yield of the plant (gm).

Fourth: Statistical Analysis:

The data under study were analyzed according to the analysis of variance method for randomized complete blocks design and split plot arrangement. Least significant difference test L.S.D was used to compare the different arithmetic means at the level of probability of 0.05 using the statistical software Genstat v12.1 [9].

Table 1. Some physical and chemical properties of field soil before planting

physical and chemical properties	Units	Analysis result
pH	-	7.45

Ec	ds.m <sup>-1</sup>	2.03
Ava. K	ppm	140
Ava. P	ppm	10.5
Ava. N	ppm	53
الكلس	%	22
Organic mater	%	0.97
Bulk density	g.cm <sup>-3</sup>	1.38
% Sand	%	1.8
%Silt	%	32.5
%Clay	%	42.7
Soil texture		Silt Clay

### 3. Results and Discussion

#### 3.1. Weed types and density (plant m<sup>-2</sup>) after 60 days of planting

With the sesame crop, there are several types of weeds, both types of annual and perennial, due to the length of the growing season, the suitability of the environmental conditions and the appropriate time for planting the season that is planted in the month of April, so many weeds accompany it. This is what was shown by the weeds present with weedy treatment in which the weed plants were left to compete with the crop throughout its growing season, and these weeds that were observed in the field are Hairy-node beargrass, Johnson grass, Rough pigeed, and Field Bindweed plants. as for the plants of the Priekly alhagi, the Cocklebur and the Leaved, their presence in the field was a small percentage (Table 2).

Table 2. Types of weeds spread in the experiment

English name	Scientific name	Family	Life cycle
Johnson grass	<i>Sorghum halepense</i> L .	Poaceae	Perennial
Hairy-node beargrass	<i>Dichanthium annulatum</i>	Gramineae	Perennial
Nut grass	<i>Cyperus rotundus</i> L.	Cyperaceae	Perennial
Field Bindweed	<i>Convolvulus arivesis</i> L.	Convolvulaceae	Perennial
Rough pigeed	<i>Amaranthus retroflexus</i> L.	Amaranthaceae	Annual
Priekly alhagi	<i>Alhagi maurorum</i> Medic .	Papilionaceae	Perennial
Cocklebur	<i>Xanthium strumarium</i>	Compositae	Annual
Leaved	<i>Chrozphora tinctoria</i> L. Ref	Euphorbiaceae	Annual

The results of Table (3) indicated that the weed plant control treatments had a significant effect on the weed density and its presence in the field. The results showed a decrease in the number of weeds and their density per square meter. The weedy treatment recorded the highest average number of weeds of 25 plants m<sup>-2</sup> compared with the manual hoeing treatment that was conducted 3times (W4), which amounted to 3.56 plants m<sup>-2</sup>, which did not differ significantly from the hoeing treatment (W3) which recorded an average of 4.33 plants m<sup>-2</sup>, due to the lack giving the opportunity for the weed to grow and leaving it to compete with the crop for the necessary elements of the plant such as nutrients, water and light and to benefit from them.

The effect of plant densities was significant, as the results showed that the plant density D1 recorded the lowest density of weed plants (5.33 plants m<sup>-2</sup>) and it differed significantly from densities D2 and D3, noting that density D2 recorded a higher average for weed plants of 11.33

plants  $m^{-2}$  and the reason is due to the increase in the number of crop plants in unit area, which reduced the chances of weed plants emerging and their presence with crop plants compared to other densities, and this result agreed with [10], which indicated that increasing the number of crop plants reduces the chances of weed plants coexisting with the crop.

Table 3. The effect of different treatments and the interaction between them on the number of weeds (plant  $m^{-2}$ ) after 60 days of planting

Plant density (Plant $ha^{-1}$ )	Weed control treatments					Plant density mean
	W Weedy	W <sub>1</sub> Weed free	W <sub>2</sub> One hoein g	W <sub>3</sub> Two hoein g	W <sub>4</sub> Three hoeing	
100 000 =D <sub>1</sub>	15.00	0.00	5.33	4.00	2.33	5.33
80000 =D <sub>2</sub>	39.67	0.00	11.6 7	2.33	3.00	11.33
66666 =D <sub>3</sub>	20.33	0.00	8.00	6.67	5.33	8.07
Weed treatments mean	25.00	0.00	8.33	4.33	3.56	
L.S.D <sub>0.05</sub>			D=0.92 , W= 1.04 , D.W=1.74			

The two-way interaction between the two factors of the study was significant, as the manual hoeing treatment for three times (w4) when it was performed and interacted with the plant density D1, as well as the hoeing treatment two times (D3) when it was interacted with the plant density D2 recorded the lowest average and the same value amounted 2.33 plants  $m^{-2}$ , While the weedy treatment (W) when interacted with density D2 which recorded the highest value for the number of weeds accompanying the crop (39.67 plants  $m^{-2}$ ).

### 3.2. Weed density (plant $m^{-2}$ ) after 90 days of planting

The results showed that the control operations (manual hoeing) after 90 days of planting behaved the same as they did after 60 days of planting, as the treatment of hoeing was superior to three times (W4) and recorded a lower average for weed plants of 3.1 plants  $m^{-2}$ . It did not differ significantly from the (W2) which recorded an average of 4.00 plants  $m^{-2}$ . Whereas, the weedy treatment recorded the highest average for this trait of 17.89 plants  $m^{-2}$ . The decrease in weed number and density came as a result of the efficiency of the hoeing process in reducing the number of weed plants accompanying the crop.

The results indicated that plant densities did not differ significantly among them, but they differed numerically among them, as the plant density D2 recorded the highest average for the presence of weed plants in it (7.53 plants  $m^{-2}$ ). Perhaps the reason for this is due to the slow growth of the crop plants in the first stage, which made the distance between the crop plants have the greatest role in increasing the vegetative area that shades the plants of the accompanying weed and which prevents the light from reaching them, and this was confirmed by Table (3) when studying the density of weed plants at 60 days from planting, and after the crop plants reach an advanced stage of growth and develop in their vegetative and root system that the plant needs to compete with weed plants.

The results indicated a significant two-way interaction between the two factors of the study, as the weedy treatment (W) when it was interacting with the plant density D2 gave the highest mean for the presence of weed plants (20.67 plants  $m^{-2}$ ), which in turn differed significantly from the interaction of other treatments in which the hoeing treatment (W4) when interacted with plant density D2, gave the lowest mean of the trait was 2.67 plants  $m^{-2}$ . The reason may be attributed to the fact that the effect of the hoeing process and its continuous procedure made significant differences in reducing the number of weeds, while the seeding rates varied among

them, and this explained that the hoeing process has the ability to eliminate the high percentage of weed plants in the lowest and highest average seeding rates.

Table 4. The effect of different treatments and the interaction between them on the number of weeds (plant m<sup>-2</sup>) after 90 days of planting

Plant density (Plant ha <sup>-1</sup> )	Weed control treatments					Plant density mean
	W Weedy	W <sub>1</sub> Weed free	W <sub>2</sub> One hoeing	W <sub>3</sub> Two hoeing	W <sub>4</sub> Three hoeing	
100 000 =D <sub>1</sub>	15.67	0.00	8.67	5.33	3.67	6.67
80000 =D <sub>2</sub>	20.67	0.00	10.67	3.33	3.00	7.53
66666 =D <sub>3</sub>	17.33	0.00	13.00	3.33	2.67	7.27
Weed treatments mean	17.87	0.00	10.78	4.00	3.11	
L.S.D <sub>0.05</sub>	D= N.S , W=1.11 , D.W= 1.86					

### 3.3. The percentage of inhibition in the dry weight of the weed (%)

It was noticed from the results of Table (5) that there were significant differences between the treatments in the percentage of inhibition. The treatment (W4) achieved the highest inhibition rate of 93.27%, while the hoeing treatment (W1) gave the lowest inhibition rate of 50.96%.

The plant densities did not have any significant effect in this trait, but they differed numerically among them, as D2 recorded the highest inhibition rate of 67.38%, while D1 recorded the lowest inhibition rate of 63.74%. Thus, their dry weights were not affected, which was reflected in the inhibition rate.

The results showed a significant effect of the two-way interaction, the (W3) when it was interacted with the plant density (D3) gave the highest percentage of inhibition was 94.61% and it did not differ significantly from the three-time hoeing treatment when it was interacted with the two plant densities D1 and D2, which recorded an average of (92.846%, 92.38%) respectively, while the one-time hoeing treatment (W2) when interacted with D1 had a lower rate of inhibition rate of 41.08%.

Table 5. The effect of different treatments and the interaction between them on the inhibition percentage (%)

Plant density (Plant ha <sup>-1</sup> )	Weed control treatments					Plant density mean
	W Weedy	W <sub>1</sub> Weed free	W <sub>2</sub> One hoeing	W <sub>3</sub> Two hoeing	W <sub>4</sub> Three hoeing	
100 000 =D <sub>1</sub>	0.00	100	41.08	85.22	92.38	63.74
80000 =D <sub>2</sub>	0.00	100	58.93	85.13	92.84	67.38
66666 =D <sub>3</sub>	0.00	100	52.86	78.86	94.61	65.27
Weed treatments mean	0.00	100	50.96	85.48	93.27	





### 3.4.2. Stem Diameter (cm)

The results indicated that weed treatments had a significant effect on this trait (Table 7). The Weed free treatment (W1) recorded a higher average of stem diameter of 1.43 cm, which did not differ significantly from the stem diameter in the Weed hoeing treatment (W4), which achieved an average of 1.40, but both differed significantly from the other treatments in which the weedy treatment (W) achieved less average for this trait was 0.64 cm, the superiority of the treatment of the free weeds is due to the weed not competing with the crop plants, which allowed the crop plants to make the maximum use of the necessary requirements of the plant, which was positively reflected on the increase in the efficiency of the carbon metabolism process, which resulted in an increase in the division of stem cells longitudinally and its thickness increased, which increased the diameter of the stem [11].

There was no significant effect of the plant densities, but they differed numerically among them. The results of the study also showed that the interaction between the two factors of the study was significant for the effect on this trait, as the treatment of the free weeds (W1) when it was interacted with the plant density D3 gave the highest mean of stem diameter (1.54 cm), which did not differ significantly from the interaction of the treatment W1 with the plant density D1, which recorded an average of 1.48 cm. With treatment (W3) when it interacted with the plant density, which recorded an average of 1.38 cm. Also with the hoeing treatment W4 when it interacted with the densities D1 and D2 (1.44 and 1.49) cm respectively compared with the lowest average recorded by the Weedy treatment when it interacted with D1 was 0.59 cm, which did not differ significantly from the interaction of the Weedy treatment W0 with the densities D2 and D3, which recorded an average of 0.62 and 0.77 cm respectively.

Table 7. Effect of different treatments and the overlap between them on average stem diameter (cm)

Plant density (Plant ha <sup>-1</sup> )	Weed control treatments					Plant density mean
	W Weedy	W <sub>1</sub> Weed free	W <sub>2</sub> One hoeing	W <sub>3</sub> Two hoeing	W <sub>4</sub> Three hoeing	
100 000 =D <sub>1</sub>	0.59	1.48	1.01	1.38	1.49	1.19
80000 =D <sub>2</sub>	0.62	1.27	1.05	1.19	1.44	1.11
66666 =D <sub>3</sub>	0.72	1.54	0.96	1.11	1.28	1.12
Weed treatments mean	0.64	1.43	1.00	1.23	1.40	
L.S.D <sub>0.05</sub>		D= N.S	W= 0.15	D.W= 0.24		

### 3.4.3. Plant dry weight (gm)

The results showed that the hoeing treatments had a significant effect on plant dry weight (Table 8). The treatment of free weed W1 was distinguished, and it achieved the highest average for this trait (163 gm Plant<sup>-1</sup>) and did not differ from (W4), which recorded an average of 158 gm Plant<sup>-1</sup>, but it differed significantly from the other treatments in which the weedy treatment recorded the lowest mean for the trait that reached 23 gm plant<sup>-1</sup>. The absence of the weeds and the lack of competition with the crop in the weed free treatment or its decrease in the

treatment of hoeing for three times (W4) helped the crop to make the most of the necessary growth requirements and this was reflected positively on the increase in vegetative growth in the plant such as the increase in the leaf area index and stem diameter (Tables 6 and 7) and thus increase the dry weight of the plant. Khan *et al.* [15] indicated that the decrease in the dry matter weight in the weedy treatment is due to the lack of light and the lack of nutrient transfer, which led to the lack of carbonic metabolism products, which is the reason for the decrease in the total dry matter weight of the plant. The plant densities do not have a significant effect on this trait, but they differed numerically among them. The two-way interaction between weed control treatments and densities had a significant effect on the dry weight of the plant. The free weeds treatment (W1) when interacted with plant density D1 was characterized by the highest value of dry weight of the plant ( $196 \text{ gm plant}^{-1}$ ) when compared with the lowest average for the trait recorded by the Weedy treatment when it was interacted with plant density D1 ( $16 \text{ gm plant}^{-1}$ ), which did not differ significantly from the same treatment interacted with densities D2 and D3, which recorded averages of 25 and  $26 \text{ gm plant}^{-1}$  respectively.

Table 8. The effect of different treatments and the interaction between them on the average dry weight of the plant (gm)

Plant density (Plant ha <sup>-1</sup> )	Weed control treatments					Plant density mean
	W Weedy	W <sub>1</sub> Weed free	W <sub>2</sub> One hoeing	W <sub>3</sub> Two hoeing	W <sub>4</sub> Three hoeing	
100 000 =D <sub>1</sub>	16.0	196.0	55.0	144.0	165.0	115.0
80000 =D <sub>2</sub>	25.0	142.0	67.0	111.0	144.0	104.0
66666 =D <sub>3</sub>	26.0	151.0	66.0	146.0	165.0	111.0
Weed treatments mean	23.0	163.0	73.0	133.0	158.0	
L.S.D <sub>0.05</sub>		D= N.S , W= 18 ,			D.W= 28	

### 3.5. Yield and yield component characters

#### 3.5.1. Weight of 500 seeds (gm)

The weight of the seeds is one of the main components of the total seed yield in the crop. The seeds are the final and main sink of processed nutrients. In addition, the weight of the seeds of any plant is a function of the rate of carbon metabolism and the transfer of its products [11]. The results indicated that there is a significant effect of different weed treatments on this trait (Table 9). The weed free treatment (W1) was characterized by the highest mean of (2.05 gm), as it was significantly superior to the weedy treatment W, which gave a lower mean of the seed weight (1.55 gm), while the other treatments of the Weed (W2, W3, W4) did not differ significantly from W1 and achieved an average of (1.93, 1.94, 1.94 gm) respectively. The reason for the increase in seed weight in the weed free treatment (continuous hoeing) may be due to the absence or lack of Weed plants in this treatment, which was reflected in the lack of competition for the crop for the main growth requirements such as nutrient, water, light and mineral elements, which in turn was reflected on increasing the growth of the plant in general, which led to an increase in the efficiency of the photosynthesis process in it and the production of the substance that is transferred from the source to the sink in the plant, which leads to an increase in its accumulation in the seeds and this reflected positively on the increase in the

weights of its seeds. Mohammed *et al.* [16] indicated that the presence of the weed plant with the crop plants leads to a decrease in the weight of 500 seeds, and the absence of the competition factor between the weed plants and the crop plants has an important effect in increasing the weight of 500 seeds.

The hoeing treatments used in this experiment did not have any significant effect on this trait, but they differed numerically among them. Also, there is no significant effect of the study factors interacting in this trait, but they differed numerically among them.

Table 9. Effect of different treatments and the interaction between them on the average weight of 500 seeds (g)

Plant density (Plant ha <sup>-1</sup> )	Weed control treatments					Plant density mean
	W Weedy	W <sub>1</sub> Weed free	W <sub>2</sub> One hoeing	W <sub>3</sub> Two hoeing	W <sub>4</sub> Three hoeing	
100 000 =D <sub>1</sub>	1.75	1.93	1.92	2.03	1.92	1.91
80000 =D <sub>2</sub>	1.46	2.05	2.04	2.00	1.82	1.88
66666 =D <sub>3</sub>	1.43	2.04	1.83	1.78	2,06	1.83
Weed treatments mean	1.55	2.05	1.93	1.94	1.94	
L.S.D <sub>0.05</sub>			D= N.S	W= 0.18	D.W= N.S	

### 3.5.2. Individual plant yield (gm)

The results indicated that there was a significant difference between the weed control treatments in the individual plant yield. The weed free treatment W1 outperformed and it gave the highest rate of 265.20 gm, followed by the three-time hoeing treatment (W4), which achieved an average of 248.20 gm, which differed significantly from W1. While the weedy treatment W0 recorded the lowest average for the trait (30.3 gm). The reason for the decrease in the yield of the individual plant in the weedy treatment resulted from the competition caused by the weed plants for the crop plants for the necessary requirements for vegetative growth such as water, nutrients and light, which negatively affected the growth and yield traits and this in turn was negatively reflected in the lack of growth and yield, and this was reflected in the increase in yield of the individual plant in the free weed treatment due to the absence of competition of the weed plants with the crop plants, which allowed the plants to make the maximum use of the necessary growth requirements, thus improving the growth of the crop, which was reflected in the efficiency of the carbon metabolism and food processing process, so the yield and its components increased, and this is consistent with [16]; [17] who showed that the absence of weed plants and their lack of competition for the crop led to an increase in the yield of sesame. The results also showed that there were significant differences between the densities to influence this trait. The plant density D2 achieved the highest average of 193.10 gm and did not differ significantly from the density D1 which gave an average of 188.00, but both differed significantly from density D3 which recorded a lower average of 175.60 gm, the reason for the superiority of density D1 in this trait is due to its superiority in one or more traits of the total yield, which led to an increase in the yield of the individual plant.

Table 10. The effect of different treatments and the interaction between them on the average yield of the individual plant (gm)

Plant density (Plant ha <sup>-1</sup> )	Weed control treatments					Plant density mean
	W Weedy	W <sub>1</sub> Weed free	W <sub>2</sub> One hoeing	W <sub>3</sub> Two hoeing	W <sub>4</sub> Three hoeing	
100 000 =D <sub>1</sub>	31.30	291.70	130.00	225.00	256.80	188.00
80000 =D <sub>2</sub>	26.10	282.70	233.30	201.90	221.50	193.10
66666 =D <sub>3</sub>	33.40	221.20	82.30	224.70	266.20	175.60
Weed treatments mean	30.30	265.20	150.20	217.20	248.20	
<b>L.S.D</b> <sub>0.05</sub>		D= 15.0	W= 13.30	D.W= 23.30		

The interaction between the two factors was significant in this trait. The treatment of the weed free W<sub>1</sub> was distinguished when it was interacted with the density D<sub>1</sub> which resulted in the highest mean of 291.70 gm, which did not differ significantly from the interaction of the same treatment with the density D<sub>2</sub>, which was (282.70 gm), while the difference was significant with the other treatments in which the weedy treatment W<sub>0</sub> when interacted with D<sub>3</sub> which was recorded lowest average of 1.43 gm.

#### 4. Conclusions

Applying hoeing (W<sub>4</sub>) for three times resulted in a reduction in the density of the weed accompanying the crop after 60 and 90 days of cultivation, whereby the control rate has increased. The absence of weed treatment did not differ significantly from applying triple hoeing in most of the growth features and crop components. The varying density had no significant effect on most of the studied growth and crop characteristics. Dual intervention had a significant effect on most of the studied features due to the efficacy of hoeing to control weed density, whereas the effect of plant density on the crop accompanying weeds was differential.

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