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# Effect of Plant Densities on Some Growth Traits of Varieties of Sorghum (Sorghum Bicolor (L) Moench).

Sana Qasim Hussein[1], Ali Kareem Hussein[2]
[1,2]Department of Plant Production Techniques, AL-Musayyib College of Techniques Technology, Middle EL-ghrates Technical, University, Iraq.
*Email: [1]sanaqasim977@gmail.com*

**Abstract**

This study was applied in one of the farmers' fields located in the Abi gharaq area 10 km northwest of the Babylon Governorate district during the autumn season of the year 2019, with the aim of studying the effect of plant densities 83333, 71420 and 53333 plant $ha^{-1}$) and took the symbols (K3, K2 and K1), on some growth traits of three different varieties of sorghum (Enqathe, Rabeh and Kafir) its symbol was (V3, V2 and V1). As the variety outperformed V1 by giving it the highest average in characteristic of the number of days from planting up to 50% flowering and leaf area. $Cm^2$ reached (70.77 day and 4,050.66 $cm^2$) While variety V2 gave the highest average in character of the number of branches. $Plant^{-1}$. The number of leaves $plant^{-1}$ (2.2 and 11.82 leaf $plant^{-1}$). While the variety V3 gave the highest average in the characteristic of plant height. Cm reached (176.33 cm). The plant density had a significant effect on all the studied traits, so the plant density of K3 gave the highest average in the characteristic of the number of days of planting up to 50% flowering and plant height. Cm reached (70.77 day and 163.22 cm), While the plant density of k1, gave the highest average in the characteristic of the number of branches of a plant, the number of leaves $plant^{-1}$, and the leaf area. $Cm^2$ reached (2.11 branch $plant^{-1}$, 11.76 leaf $Plant^{-1}$ and 4095.89 $cm^2$).

**Key words:** Sorghum, plant densities, seeds and varieties

## INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) is an important crop, especially in semi-arid tropical regions, because it has a capacity to withstand many environmental stresses. Sorghum is grown in the world with an area of 38 million hectares and its annual production is 58 million tons, with a productivity rate of 1.5 tons. (FAO 2014) Although Sorghum endures many environmental stresses, it is affected by drought, especially in the pre-flowering stage (Tomar et al 2013). Its grains are used as a basic material in the concentrated diets for feeding animals, especially poultry, due to its high protein content of up to 12%. Sorghum is a crop tolerant of salinity, drought and relatively high temperatures (Ottman and Olson 2009). The decline in the yield of Sorghum is due to the lack of genotypes with high productivity and other reasons related to soil and crop service operations. Plant density is one of the most important agricultural processes that affect the yield of grains and increase it with the availability of other conditions suitable for growth leads to an increase in the grain yield until the optimum density is reached that gives the highest yield rate of grain yield (Al-Badrani et al 2012). (Ayub et al 2010) also found that the stem diameter differed between the cultivated varieties. As for the plant density, many researchers (Nahaba, 2004 and Al-

Dulaimi 2010) emphasized the difference in its response to growth characteristics such as plant height, leaf area, its evidence, and biological yield, as well as the difference in yield under the influence of Plant density. The results of the study conducted by (Mahmood 2012) in Germany showed that the two varieties (Goliath and Bovital) gave different values in the growth and yield of dry matter, percentage of protein and fiber, and total ash percentage. The research aims to study the effect of plant densities and varieties on some growth characteristics of sorghum for the autumn season, to diagnose the best plant density with the best variety to achieve the highest growth rate per unit area in the environment of the central region of Iraq.

## MATERIALS AND METHODS

This study was applied in one of the farmers' fields located in the Abi gharaq area 10 km northwest of the Babylon Governorate district during the autumn season of the year 2019 to study the effect of plant densities on some growth traits of three different varieties of sorghum. Using the design of factor experiments according to the arrangement of Randomized Complete Block Design (RCBD) and with three replications. The experiment included three plant densities (83333,71420 and 53333) plant $ha^{-1}$ and occupied the first factor, taking the symbols (K3, K2 and K1), while the varieties (Enqathe, Rabeh and Kafir) occupied the second factor and its symbol was (V3, V2 and V1). The test soil was plowed by two perpendicular plows, then it was refined with disc harrows and it was leveled and divided according to the above-mentioned design. The samples were examined in the soil and water laboratories of the Technical Institute / Al-Musaib, Table (1). The seeds were planted manually, at a rate of 4 seeds in each hole and on a 5m furrows, the distance between furrow and another is 75 cm, the distance between the holes is (10.15 and 20) cm (according to the plant density) and by 6 furrows for each treatment, then it was reduced to one plant after 15 days of germination. Nitrogen fertilizer was used at a rate of 320 kg N. $ha^{-1}$ in the form of urea (46% N), added in three batches, the first when planting, the second when the plant reached a height of 30 cm, and the third at the stage of 75% the beginning of the emergence of heads (Al-Shalji 2000), and superphosphate fertilizer was added. Triple superphosphate fertilizer ($P_2O_5$ 46%) was added at a rate of 200 kg $ha^{-1}$ at one time before planting (Hamdan 2011). The experiment land was irrigated and weed from the weeding, and the corn stalk borer insect was controlled by receiving the granulated diazinon pesticide (10%). At a rate of 6 kg $ha^{-1}$ and in two batches, the first after 20 days of emergence and the second 15 days after the first batch. Then, random samples were selected from ten plants from the two midlines from each experimental unit to study the required traits. After collecting and classifying the data for the studied characteristics, it was analyzed statistically according to the design followed, adopting the Genstat program, and the arithmetic averages of the parameters were compared using the lowest significant difference test at the level of 0.05.

Table (1) Some physical and chemical properties of the soil of the experiment

| **The traits** | **The value** |
|---|---|
| **The degree of reaction pH** | **ml7.14** |

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| | |
|---|---|
| **The degree of electrical conductivity EC Racy Siemens $M^{-1}$** | **2.72** |
| **Ready nitrogen(mg / kg $^{-1}$ soil)** | **38** |
| **Ready phosphorus (mg $kg^{-1}$soil)** | **14.28** |
| **Ready Potassium(mg / kg $^{-1}$ soil)** | **281** |
| **Volumetric distribution of soil separators** | |
| **Clay g . $Kg^{-1}$** | **340** |
| **Sand g . $Kg^{-1}$** | **179** |
| **Silt g . $Kg^{-1}$** | **481** |
| **Soil Texture** | **A silty clay loam** |

**Study traits:**

1-The number of days from planting to 50% flowering: by calculating the number of days from planting until the emergence of male inflorescences in 50% of plants.

2- Plant height, cm: was measured after flowering was complete and measured from the soil surface to the base of the head holder node.

3-Number of leaves $plant^{-1}$: calculated the number of leaves for ten plants, and then took their average.

**4-** The leaf area, $cm^2$: Five plants were selected randomly from the two middle lines at the stage of full flowering by measuring the length and width of the leaf for all the leaves of the plant and the area was calculated from the following equation: $A = LxW \times 0.75$, since A = leaf area (cm) and L = leaf length (Cm) and W = width of a portion of the leaf (cm) and constant = 0.75 (Liang et al 1973).

**5-**Number of branches $Plant^{-1}$: the number of branches after their emergence was calculated for ten plants randomly.

## RESULTS AND DISCUSSION:

### The number of days from planting up to 50% flowering

The response of the varieties depends on the response of the functional processes within the plant, and when the required amount of dry matter is available, flowering occurs, and when the flowering signal is formed in the plant, RNA synthesis increases from the terminal vegetative meristem that helps the response to flowering (Sharma et al 2006). The results of Table (2) indicate the superiority of the genotype V3 over the rest of the genotypes by giving it the lowest average number of days to flowering, which was 63.22 day. The reason for this is due to the different genetic nature of these varieties and their different response to the prevailing environmental conditions during the growth period, and this is consistent with (Al-Salmani 2009). The plant density surpassed the low density K1 by giving it the lowest average number of days to flowering, reaching 63.33 day, while the plant density K3 gave the highest average number of flowering days, which reached 70.77 day. And it may return to flowering, the stage in which the active vegetative growth of the plant stops, and it is among the growth factors most affected by the intensity of light and temperature and their interference with the genotype of the plant. As for the averages of compatibility between

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varieties and densities, it is clear that all the varieties had their behavior towards an increase in the average number of days to flowering, as the plant density increased and in different proportions, the interaction was significant as the genotype V1 with density K3 gave the highest rate of 72.00 day. While the genotype V3 with the density of K2 gave the lowest rate of 63.33 day, this result agreed with what was found (Mallinath et al 2010).

Table (2) The effect of plant varieties and densities and their overlapping in the characteristic of the number of days from planting to 50% flowering

| **Varieties (V)** | **Plant densities (K)** | | | **Mean (V)** |
|---|---|---|---|---|
| | **K 1** | **K 2** | **K 3** | |
| **V1** | **70.00** | **70.33** | **72.00** | **70.77** |
| **V2** | **65.00** | **65.33** | **69.00** | **66.44** |
| **V3** | **55.00** | **63.33** | **71.33** | **63.22** |
| **Mean (K)** | **63.33** | **66.33** | **70.7 7** | |
| **LSD 0.05** | | **K = 2.77** | **V = 2.77** | **V * K = 5.54** |

**Plant height. Cm**

The results in Table (3) showed that the varieties had a significant effect on the average plant height, as the variety V3, which scored the highest value for the average plant height, was 176.33 cm, while the V1 variety gave the lowest average for this characteristic, which reached 145.33 cm. The difference of these varieties in the characteristic of plant height is due only to their variation in the length of the internodes, which are one of the genetic characteristics in which each variety is distinguished from the other, this result is consistent with the findings of (Shihab 2011 and Al-Zubaidi 2013) who indicated that the varieties differ in the average plant height. The data of the same table indicate that the plant density K3 was superior in giving the highest average plant height compared to the rest of the densities. The plant height reached 163.22 cm. There was no significant difference between plant density K2, while plant density K1 gave the lowest average plant height of 158.11 cm. The reason may be attributed to the shading that encourages the action of auxins and gibberellins and contributes to the elongation of internodes, which was reflected in the height of the plant. This result is in agreement with the findings of both Bahrani and Deghani (2004) and Miko and Manga (2008) who indicated that the increase in plant densities led to an increase in plant height.

Table (3) Effect of plant varieties and densities and their overlap on plant height characteristic. Cm

| **Varieties (V)** | **Plant densities (K)** | | | **Mean (V)** |
|---|---|---|---|---|
| | **K 1** | **K 2** | **K 3** | |
| **V1** | 143.33 | 145.67 | 147.00 | **145. 33** |
| **V2** | 161.00 | 162.00 | 160.33 | **161. 11** |
| **V3** | 170.00 | 176.67 | 182.33 | **176. 33** |
| **Mean (K)** | **158.11** | **161.44** | **163.22** | |
| **LSD 0.05** | | **K = 2.14** | **V = 2.14** | **V * K = 4.18** |

The results of Table (3) showed that there is a significant overlap between K and V in the average plant height, as variety V3 with plant density K3 gave the highest average plant

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height of 182.33 cm, while variety V1 with plant density K1 gave the lowest average of 143.33 cm. Perhaps the reason is due to the nature of the variety and the spatial distribution of plants in the unit area that was reflected in the plant growth.

**leaf area. Cm$^2$**

The varieties differed significantly in the average leaf area, Table (4), as the variety V1 gave the highest average leaf area, which reached 4050.66 cm$^2$, while the variety V3 gave the lowest leaf area of 3087.22 cm$^2$. The reason may be due to the variation in the number of days required for the stages of growth between the varieties in which the length of expansion of the leaves differs, as well as in the number of leaves that differ according to the maturity of these varieties, as the medium-ripening varieties have the highest number of leaves. These results agree with what they have reached (Ayub et al 2010). The results also showed that there are significant differences between the arithmetic averages of this trait with different plant densities. A significant decrease in the average leaf area occurred when the plant density increased, as the plants planted with plant density K1 gave the highest average leaf area of 4095.89 cm$^2$. While K3 plant density gave the lowest average leaf area of 2967.77 cm$^2$. The reason for the decrease in the leaf area with the increase in plant density is due to the increase in competition between plants for the different growth requirements, which leads to a decrease in the amount of these requirements available for one plant and thus affects the size of the total leaf area and the plant (Ais 1990) This result agreed with (Gitz et al 2015) who observed that low plant density increases the proportion of leaf area.

Table (4) The effect of plant varieties and densities and their overlap on the characteristic of leaf area. Cm$^2$

| **Varieties (V)** | **Plant densities (K)** | | | **Mean (V)** |
|---|---|---|---|---|
| | **K 1** | **K 2** | **K 3** | |
| **V1** | 4299.67 | 3892.00 | 3960.33 | **4050.66** |
| **V2** | 4229.33 | 3416.00 | 3058.33 | **356.88** |
| **V3** | 3758.67 | 3618.33 | 1884.67 | **3087.22** |
| **Mean (K)** | **4095.89** | **3642.11** | **2967.7 7** | |
| **LSD 0.05** | | **K = 317.17** | **V = 317.17** | **V * K = 634.34** |

As for the bilateral overlap, it was significant, as the variety V1 exceeded the plant density K1 by giving the highest average of 4299.67 cm$^2$, while the lowest average for the leaf area was at the type V3 with the plant density K3, which reached 1884.67 cm$^2$.

**Number of branches. Plant$^{-1}$**

The results of Table (5) showed the significant effect of plant varieties and densities and the overlap between them on the characteristic of the number of branches plant $^{-1}$. Variety V2 gave the highest average number of branches for a plant with 2.2 branch plant$^{-1}$, while variety V3 gave the highest average of 1.57 branch plant$^{-1}$. The reason may be due to the difference in the environmental conditions of the temperature and the amount of radiation received, as well as the ability of a certain variety to express itself under certain environmental conditions at a time when the other variety is not able to do so. These results agreed with what was stated (Al-Shehab 2011). The plant density surpassed the low density K1 by giving it the highest rate of the number of branches in the plant which reached 2.11, compared to the high density K3, which gave the lowest rate of the number of branches in the plant, which amounted to 1.66. Perhaps the reason for the decrease in the number of productive branches with the increase in plant density is due to the decrease in the ratio between red light: distant red light (R: FR) by increasing plant density through reducing the distance between cultivated plants (Srirama et al 2006). (Lafarage et al 2002) stated that The quality of the light is a fundamental key to the emergence of branches in the sorghum, and this is in agreement with researchers who found that branching can be controlled by the quality of the light through the ratio between red light: far red light (Evers et al 2006), The reason for the decrease in branch production may also be attributed to an increase in plant density. It was associated with hormonal effects in response to changes in the quality of the light, i.e. the ratio of red light: the far red light. These results agreed with what was stated by (Kim et al 2010b) and also agreed with the results (Lafarage et al 2002 and Sriramaet al 2010) when studying doubling the plant density 8 times from 2 to 16 plants $m^2$ and 6 times from 1 to 6 plant $m^2$, as this corresponds to reducing the total number of branches by about 1 to two times. The double interference between V and K showed a significant effect on this characteristic, as the variety V2 with the density K1 gave the highest rate of 2.37 branch. $Plant^{-1}$, while the variety V3 with the density K3 gave the lowest rate of 1.07 branch $plant^{-1}$.

Table (5) The effect of plant varieties and densities and their overlap on the characteristic of the number of branch. $Plant^{-1}$

| **Varieties (V)** | **Plant densities (K)** | | | **Mean (V)** |
|---|---|---|---|---|
| | **K 1** | **K 2** | **K 3** | |
| **V1** | **1.80** | **1.67** | **1.90** | **1. 79** |
| **V2** | **2.37** | **2.20** | **2.03** | **2.20** |
| **V3** | **2.17** | **1.47** | **1.07** | **1. 57** |
| **Mean (K)** | **2.11** | **1.78** | **1.6 6** | |
| **LSD 0.05** | | **K = 0.25** | **V = 0.25** | **V * K = 0.50** |

**Number of leaves. $Plant^{-1}$**

The results of Table (6) showed that there are significant differences between genotypes and between plant densities and the overlap between them, as it is noticed that the genotype V2 is missed by giving it the highest rate of 11.82 leaf $plant^{-1}$, while the genotype V3 gave the lowest rate for this trait, which was 10.95 leaf $plant^{-1}$. The reason for this may be attributed to the genetic nature of them as well as their difference in plant height and dry matter yield, which have a positive and significant correlation with the number of plant leaves. This result is in agreement with the findings of (Dhaif et al 2002 and Faqira 2001) who found a significant difference in the number of leaves plant among the genotypes of sorghum. Plant densities showed a significant effect on this trait, as plant density K1 gave the highest average number of leaves in the plant, reaching 11.76 leaf $plant^{-1}$ It did not differ significantly from plant density K2, while plant density K3 gave the lowest average number of leaves in the plant with 10.94 leaf. $Plant^{-1}$. The reason may be due to the positive effect of

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the number of leaves with the lack of plant density to the lack of competition between plants for light, nutrients, water and carbon dioxide, which gives plants a great opportunity to grow into a good vegetative total. This was reflected in the number of plant leaves. These results are in line with the findings of each of Al-Hassan and Al-Douri (2011) and Enujeke (2013) stated that plant leaves were affected by the difference in plant density, while it did not agree with Faqira and Al-Sha'bi (2015) and Mandic et al (2016).

As for the overlap between genotypes and plant densities, genotype V2 outperformed by giving it the highest rate with plant density K1 of 12.57 leaf plant$^{-1}$, while the genotype V3 with density K3 gave the lowest rate of 9.77 leaf plant $^{-1}$.

Table (6) the effect of plant varieties and densities and their overlap on the characteristic (number of leaves. Plant $^{-1}$)

| **Varieties (V)** | **Plant densities (K)** | | | **Mean (V)** |
|---|---|---|---|---|
| | **K 1** | **K 2** | **K 3** | |
| **V1** | 10.40 | 11.30 | 11.77 | 11.1 5 |
| **V2** | **12.57** | 11.60 | 11.30 | **11.82** |
| **V3** | 12.33 | 10.77 | **9.77** | **10.9 5** |
| **Mean (K)** | **11.7 6** | 11.22 | **10.94** | |
| **LSD 0.05** | | **K = 0.65** | **V = 0.65** | **V * K = 1.30** |

## CONCLUSIONS

The sorghum varieties showed variation in response due to the difference in the genotype of each variety, and the difference in plant density levels showed clear variation in the studied traits individually and when they overlapped with the sorghum varieties, which confirms the difference of each genetic structure in a different way for plant density.

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