# Effect of planting dates and mulching with different types on some growth characteristics and yield of two okra cultivars

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**ABSTRACT**

The study was conducted in one of the plastic houses affiliated with the Horticultural Facilities Department, College of Agriculture, Tikrit University. During the agricultural season 2022-2023. To know the response of two okra cultivars to mulching and planting date and their effect on some vegetative growth and yield characteristics. The study was conducted as a factorial experiment according to a randomized complete block design with a split-plot system. The study included two okra cultivars (Betra) local and Climson) and different mulching (black plastic, wheat straw and with out mulching) and four planting dates (2/10, 2/11, 2/12 and 2/01) for three replicates. The data were analyzed according to the SAS program. Using Duncan Multiple Range Test to compare the means at 0.05 probability level, the results showed: Climson cultivar was significantly superior in pod diameter, weight and plant yield, reaching 2.03 cm, 5.46 g and 2142.78 g plant-1, respectively. As for the mulch treatments, mulching the soil with black plastic was superior in the leaf content of chlorophyll b 4.32 mg 100 g-1 fresh weight, as well as in the fresh weight of the vegetative group, as the treatment of mulching with wheat straw was superior 266.33 g plant-1 and did not differ significantly from mulching with black plastic. As for the number of pods and plant yield, the treatment of mulching with black plastic was superior, 480.23 pods/plant-1 and 2328.00 g/plant-1, respectively, compared to the two treatments of mulching the soil with wheat straw and without mulching, which gave the lowest values. It was also shown from the interaction treatment (Climson variety + mulching with black plastic + the second date) a significant effect on the two traits of the number of pods and plant yield, which reached 570.24 pods/plant-1 and 3210.45 g/plant-1, respectively. We conclude from this that applying the process of mulching the soil with black plastic and the appropriate time has a positive role on Climson okra plants.

**Keywords: Okra varieties, mulching, planting dates, yield characteristics.**

## :Introduction

Okra (Abelmoschus esculentus L. Moench) is a common summer vegetable belonging to the Malvaceae family. It consists of edible green pods, seeds, and fibers[2]. It is a fast-growing annual plant that reproduces by seeds. It is native to Africa but is found throughout the tropical and subtropical regions of the world. It is grown for its small fruits and eaten cooked. It has therapeutic effects for humans as it contains a high percentage of iodine. Its leaves also have anti-inflammatory properties and contain flavonoids and catechins [1], [17]. Okra cultivation occupies a large area in the production and marketing map in Iraq, so its

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cultivation is spread in all the different governorates of Iraq. The report issued by the Agricultural Statistics Directorate on the production of secondary crops indicates a decrease in the okra crop in Iraq, as the area planted with this crop amounted to about 56,054 dunums (2,500 m2) for the year 2022, and the total production recorded 88,800 tons, which is a low rate compared to 2021, as it was estimated at 93,400 tons, and the cultivated area was 50,008 dunums (2,500 m2) [4]. One of the most important ways to increase the yield of the plant is to use varieties that are suitable for the environmental conditions of the region. Hence, the varieties planted have varied in their growth nature and genetic compositions. There are a number of local varieties that have been planted and adapted in different regions of the country and have become known by the name of the common region in them, such as Al-Mawsiliyyah in Mosul, Al-Halawiyyah in reference to the city of Hillah, the center of Babylon Governorate, and Betra and Al- Betra in central and southern Iraq, Al-Hussainawiyyah, and many other varieties [12]. Mulching is a widely adopted agricultural practice and is often used as a water-saving strategy due to its effectiveness in reducing soil evaporation[3]. Its effects vary depending on the materials used and the extent of soil mulch, as the type of soil mulching depends on the prevailing environmental conditions and the planting dates, for example, which greatly affects the determination of the type of mulch[14]. Planting dates affect the germination rate, growth and yield of the plant. Therefore, determining the optimal planting dates is very important, especially with the current climate changes, for the success of okra cultivation, as this factor has a direct impact on vegetative growth, yield, its components and quality, and early production during the winter period has a high economic return due to its high price [6]. Therefore, this study aims to determine the best variety of okra and the most appropriate planting dates under plastic house and to use the most appropriate type of Mulching to obtain high early production and high quality.

METARIALS AND METHODS:

This study was conducted in one of the plastic houses affiliated with the Horticultural Facilities Division - College of Agriculture - University of Tikrit during the 2022-2023 season to determine the response of two okra varieties (local Batira and Climson) to soil mulching and planting dates and their effect on growth characteristics and yield. A plastic house was prepared with a length of 45 m, a width of 9 m and a height of 3.5 m with an area of the house of 405 m2, and Mulching with yellow polyethylene with a thickness of 200 mm microns. The soil was ploughed using a rotary plough, and a sample of the field soil was taken to determine its physical and chemical properties (Table 1). Decomposed organic fertilizer (sheep waste) was added in an amount of 1 m3/h-1, and then the soil was leveled and smoothed using a hoe to prepare a good bed for the seeds. The cultivation was done in terraces using a drip irrigation system. The planting was done on 10/02/2022, and three planting terraces were designated inside the house, 60 cm wide, with a distance of 1 m between each terrace, leaving a distance of 2.5 m on each side of the house for ease of movement. Irrigation pipes were installed, with two pipes per terrace, with 10 plants per experimental unit, and the environmental conditions inside the greenhouse were measured, as in Table 2:

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

| Soil separators | | | | CEC $ds.m^{-1}$ | pH - | EC mm | Organic matter $g\ kg^{-1}$ | N P K $mg\ kg^{-1}$ |
|---|---|---|---|---|---|---|---|---|
| Texture | sand | clay | silt | | | | | |
| Sandy clay | 776 | 149 | 75 | 2.54 | 7.36 | 2.80 | 1.3 | 32 5.82 20.2 |

**Table 2. Monthly average temperature and relative humidity for the study period**

| months | (10) | (11) | (12) | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|---|---|---|
| Average temperature (C°) | 32.25 | 23.90 | 18.50 | 16.10 | 65.17 | 25.75 | 31 | 34.5 | 38.5 |
| Relative humidity (%) | 35 | 41 | 66 | 48 | 54 | 60 | 45 | 40 | 31 |

Experiment design:

The experiment included three study factors, namely two okra cultivars (local and Climson) with three different mulching (black plastic, wheat straw and with out mulching) at four planting dates (2/10, 2/11, 2/12 and 2/01), The experiment was carried out using a Randomized Complete Block Design (R.C.B.D.) according to the Split Split Plot system, where the planting dates were considered the main plot, the mulching was considered the secondary plot, and the varieties were considered the sub-sub plot. Then, okra seeds were planted on the terrace with a distance of 30 cm between holes and a length of 1.5 m for the experimental unit, which had 24 experimental units for each replicate and a total of 72 units for three replicates. The data were analyzed according to the SAS program [15]. Duncan's Multiple Range Test was used to compare means at the 0.05 probability level.

STUDIED CHARACTERISTICS:

Plant height (cm), total number of branches (plant-1 branch), chlorophyll b (mg 100g-1 fresh weight), fresh weight of plant shoots (g plant-1.(

Pod diameter (cm), pod weight (g), number of pods (plant-1 pod), plant yield (g .(

RESULT AND DISCUSSION:

.1Effect of variety on growth and yield of okra

Data analysis in Table (3) shows that there were no significant differences in vegetative growth traits, while the Climson variety was significantly superior in most yield traits, including pod diameter, pod weight and plant yield. The reason is attributed to the existence of genetic differences between the two varieties under study, and that these genetic differences between the two varieties result in a final difference in the characteristics of the crop, as well as the existence of differences in the efficiency and adaptation of the varieties to the prevailing environmental conditions and the occurrence of an overlap between genetic and environmental factors in their effect on these characteristics [10]. The reason may also be attributed to the existence of dormant genes (silent genes) that are affected by the environmental conditions of the soil and are called environmental genes. These results are

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consistent with what was stated [8] when studying 14 genetic hybrids, as the genetic strain Green Glory recorded the highest pod length, pod weight, number of pods, and plant yield.

**Table 3. Effect of variety on growth and yield of okra**

| Treatments | studied characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variety | Plant height (cm) | Total number of branches (branch plant$^{-1}$) | Chlorophyll b content of the leaves (mg 100g$^{-1}$ fresh weight) | Fresh weight of the vegetative mass (g plant$^{-1}$) | Pod diameter (cm) | Pod weight (g plant$^{-1}$) | Number of pods (pod plant$^{-1}$) | Plant yield (g plant$^{-1}$) |
| Betra | 105.81 a | 9.36 a | 4.25 a | 256.67 a | 1.94 b | 4.16 b | 401.29 a | 1668.09 b |
| Climson | 103.44 a | 10.33 a | 4.15 a | 239.64 a | 2.03 a | 5.46 a | 394.58 a | 2142.78a |

*The averages that carry the same alphabetical letters for the individual factors and their interactions do not differ significantly from each othe according to Duncan's multiple range test at the probability level of 0.05.

.2Effect of mulching on the growth and yield of okra

The results of Table (4) show that there was no significant difference between the mulching treatments in plant height, total number of branches, and pod diameter and weight. While the treatment of mulching the soil with black plastic gave a significant superiority in the rest of the studied characteristics and did not differ significantly with the treatment of mulching the soil with straw in the characteristics of the chlorophyll content of the leaves and the fresh weight of the green group, as soil moisture plays an important role in influencing the physical properties of the soil such as apparent density, porosity and permeability, as well as raising the temperature of the soil [11], which affects the ability of the soil to retain water and exchange air, which leads to moisturizing the root zone and facilitating the absorption of elements and nutrients, and thus increasing plant growth, which leads to increasing the fresh weight of the green group of the plant [20], and these results are consistent with previous studies conducted by [16] ,The reason for improving the vegetative growth characteristics when mulching with black plastic and wheat straw may be attributed to the fact that the moisture content in the soil plays an important role in determining its chemical properties, which affects the availability of nutrients and pH levels, which are two important factors for plant growth[5]. The appropriate moisture content enhances microbial activity and the availability of easily absorbed minerals, thus enhancing the accessibility of nutrients by the roots. The soil pH also decreases with increasing moisture content, thus leaching basic cations and releasing organic acids [18], as okra thrives in soil with a pH ranging from 5.5 to 6.5 [19.[

**Table 4. Effect of mulching on growth and yield of okra**

| Treatments | studied characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mulching | Plant height (cm) | Total number of branches (branch plant$^{-1}$) | Chlorophyll b content of the leaves (mg 100g$^{-1}$ fresh weight) | Fresh weight of the vegetative mass (g plant$^{-1}$) | Pod diameter (cm) | Pod weight (g plant$^{-1}$) | Number of pods (pod plant$^{-1}$) | Plant yield (g plant$^{-1}$) |
| With out mulch | 98.75a | 9.75 a | 3.95 b | 222.46 b | 1.98 a | 4.86 a | 286.92 c | 1386.43 c |
| Wheat straw mulch | 107.65 a | 10.29 a | 4.32 a | 266.33 a | 1.96 a | 4.72 a | 426.65 b | 2001.87 b |
| Mulch with black plastic | 107.48 a | 9.50 a | 4.32 a | 255.67 a | 2.02 a | 4.85 a | 480.23 a | 2328.00 a |

*The averages that carry the same alphabetical letters for the individual factors and their interactions do not differ significantly from each other according to Duncan's multiple range test at the probability level of 0.05.

.3Effect of planting dates on growth and yield of okra

The statistical analysis data in Table (5) indicate that planting dates did not differ significantly among themselves in each of the characteristics of plant height, pod diameter, and pod weight. But, the second planting date gave a significant superiority in the total number of branches of the plant, and on the other hand, the third date gave a significant superiority in the chlorophyll content of the leaves, while the first date obtained the highest plant height, number of pods, and plant yield of 341.61 g and 459.7 pods/plant-1 and 2182.39 g, respectively. The reason for the significant increase in some of the characteristics of the crop may be attributed to the availability of suitable environmental conditions for growth, which is then reflected positively on the characteristics of the crop. Perhaps the reason for this superiority in the number of pods is that the larger the okra plant grows, the more pods it has, in order to increase the efficiency of intercepting sunlight and converting it into chemical energy, which leads to an increase in the number of pods and thus an increase in the plant's yield. These results are consistent with what was reached by [7] when studying different planting dates, as they found significant differences in the number of pods and the yield of the okra plant. The reason for the increase in yield may also be due to the fact that the planting date was an ideal planting date in terms of the availability of suitable temperature and light, which are the most important factors that determine the growth, productivity and quality of the okra plant yield. These results are consistent with what was reached by [6] when studying different planting dates, as they found significant differences in the number of pods and pod length.

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**Table 5. Effect of planting dates on growth and yield of okra**

| Treatments | studied characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Planting dates | Plant height (cm) | Total number of branches (branch plant$^{-1}$) | Chlorophyll b content of the leaves (mg 100g$^{-1}$ fresh weight) | Fresh weight of the vegetative mass (g plant$^{-1}$) | Pod diameter (cm) | Pod weight (g plant$^{-1}$) | Number of pods (pod plant$^{-1}$) | Plant yield (g plant$^{-1}$) |
| 02/10 | 110.55 a | 10.28 a | 3.74 c | 341.61 a | 2.05 a | 4.83 a | 459.77a | 2182.39a |
| 02/11 | 102.52 a | 10.55 a | 4.30 b | 206.44 b | 1.99 a | 4.86 a | 434.60a b | 2121.18 a |
| 02/12 | 101.35 a | 8.33 b | 4.73 a | 193.61 b | 1.94 a | 4.72 a | 391.14 b | 1856.57a b |
| 02/01 | 104.08 a | 10.22 a | 4.02 bc | 250.94ab | 1.97 a | 4.84 a | 306.21 c | 1461.61 b |

*The averages that carry the same alphabetical letters for the individual factors and their interactions do not differ significantly from each other according to Duncan's multiple range test at the probability level of 0.05.

Effect of variety and mulch interaction on growth and yield of okra

It is noted from the data in Table (6) that there are no significant differences between the factors of variety and soil mulching in growth characteristics. While a significant effect was found on the yield characteristics of okra plants, the interaction of the Climson variety with black plastic mulching had a significant effect, which gave the highest values in each of the pod diameter, number of pods, and plant yield of 2.06 cm and 484.76 pods plant-1 and 2664.65 g plant-1. In contrast, the interaction treatment of the variety and the comparison treatment (without mulching) gave a significant superiority in the pod weight characteristic of 5.57 g.

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**Table 6. Effect of variety and mulch on growth and yield of okra**

| Treatments | | studied characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variety | Mulching | Plant height (cm) | Total number of branches (branch plant$^{-1}$) | Chlorophyll b content of the leaves (mg 100g$^{-1}$ fresh weight) | Fresh weight of the vegetative mass (g plant$^{-1}$) | Pod diameter (cm) | Pod weight (g plant$^{-1}$) | Number of pods (pod plant$^{-1}$) | Plant yield (g plant$^{-1}$) |
| Betra | With out mulch | 99.67 a | 8.75 a | 3.83 a | 233.00 a | 1.93 ab | 4.15 b | 299.94 b | 1255.73e |
| | Wheat straw mulch | 108.88a | 10.00 a | 4.58 a | 255.75 a | 1.91 b | 4.15 b | 428.23 a | 1757.19 cd |
| | Mulch with black plastic | 108.88a | 9.33 a | 4.32 a | 281.25 a | 1.98 ab | 4.18 b | 475.69 a | 1991.36 bc |
| Climson | With out mulch | 97.83 a | 10.75 a | 4.07 a | 211.92 a | 2.02 ab | 5.57 a | 273.90 b | 1517.14 de |
| | Wheat straw mulch | 106.42a | 10.58 a | 4.07 a | 276.92 a | 2.01 ab | 5.29 a | 425.07 a | 2246.56 b |
| | Mulch with black plastic | 106.08 a | 9.67 a | 4.32 a | 230.08 a | 2.06 a | 5.51 a | 484.76 a | 2664.65 a |

*The averages that carry the same alphabetical letters for the individual factors and their interactions do not differ significantly from each other according to Duncan's multiple range test at the probability level of 0.05.

Effect of variety and dates interaction on okra growth and yield

Statistical analysis of the data in Table (7) showed that the two-way interaction of the factors of variety and planting dates had a significant effect on the growth characteristics and yield of okra plants. It was found that there was a significant difference when the two varieties and the first date were combined for each of the total number of branches, fresh weight of the vegetative group, pod diameter and number of pods: 11.77 branches plant-1, 360.44 g plant-1, 2.12 cm and 494.37 pods plant-1, respectively. On the other hand, the interaction of Climson variety and the fourth and second dates had a significant effect on both traits, pod weight and plant yield, 5.61 g and 2515.08 g plant-1, respectively.

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**Table 7. Effect of variety and planting dates on growth and yield of okra**

| Treatments | | studied characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| variety | Planting dates | Plant height (cm) | Total number of branches (branch plant$^{-1}$) | Chlorophyll b content of the leaves (mg 100g$^{-1}$ fresh weight) | Fresh weight of the vegetative mass (g plant$^{-1}$) | Pod diameter (cm) | Pod weight (g plant$^{-1}$) | Number of pods (pod plant$^{-1}$) | Plant yield (g plant$^{-1}$) |
| Betra | 02/10 | 116.74 a | 8.78 bc | 3.85 cd | 360.44 a | 1.97 ab | 4.20 b | 494.37 a | 2051.66 b |
| | 02/11 | 100.11 a | 11.22 ab | 4.49 ab | 233.11 c | 1.99 ab | 4.22 b | 409.64 bc | 1727.28 c |
| | 02/12 | 104.60 a | 7.66 c | 4.70 ab | 190.44 c | 1.89 b | 4.16 b | 378.37 cd | 1585.71 c |
| | 02/01 | 101.78 a | 9.78 abc | 3.95 cd | 242.67 bc | 1.91 b | 4.06 b | 322.76 ed | 1307.72 d |
| Climson | 02/10 | 104.37 a | 11.77 a | 3.64 d | 322.78 ab | 2.12 a | 5.46 a | 425.17 abc | 2313.13 ab |
| | 02/11 | 104.93 a | 9.89 abc | 4.11abc | 179.78 c | 1.98 ab | 5.49 a | 459.56 ab | 2515.08 a |
| | 02/12 | 98.09 a | 9.00 abc | 4.76 a | 196.78 c | 1.99 ab | 5.27 a | 403.91 bc | 2127.43 b |
| | 02/01 | 106.38 a | 10.67 ab | 4.10 bc | 259.22 bc | 2.03 ab | 5.61 a | 289.67 e | 1615.51 c |

*The averages that carry the same alphabetical letters for the individual factors and their interactions do not differ significantly from each other according to Duncan's multiple range test at the probability level of 0.05.

Effect of overlapping mulching and planting dates on growth and yield of okra

Data from Table (8) show that the interaction between soil mulching and planting dates has a significant effect. The interaction treatment of straw mulching and the first planting date gave a significant superiority for each of the plant height, fresh weight of the vegetative group and the number of pods 126.09 cm and 411.33 g plant-1 and 508.61 pods plant-1 respectively. While the dual interaction treatment between black plastic mulching and the second date gave the highest plant yield of 2656.60 g plant-1.

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**Table 8. Effect of mulch and planting dates on growth and yield of okra**

| Treatments | | studied characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mulching | Planting dates | Plant height (cm) | Total number of branches (branch plant$^{-1}$) | Chlorophyll b content of the leaves (mg 100g$^{-1}$ fresh weight) | Fresh weight of the vegetative mass (g plant$^{-1}$) | Pod diameter (cm) | Pod weight (g plant$^{-1}$) | Number of pods (pod plant$^{-1}$) | Plant yield (g plant$^{-1}$) |
| With out mulch | 02/10 | 91.53 b | 11.33 a | 3.65 c | 250.00 c | 1.99 a | 5.01 a | 359.96 bcd | 1789.63 cd |
| | 02/11 | 91.60 b | 10.67 ab | 4.00 bc | 176.17 c | 2.05 a | 4.91 a | 292.56 edf | 1427.79 de |
| | 02/12 | 105.17 ab | 8.00 bc | 4.31 ab | 242.67 c | 1.93 a | 4.63 a | 282.33 ef | 1313.60 de |
| | 02/01 | 106.70 ab | 9.00 abc | 3.84 c | 221.00 c | 1.93 a | 4.91 a | 212.83 f | 1014.73 e |
| Wheat straw mulch | 02/10 | 126.09 a | 9.83 abc | 4.02 bc | 411.33 a | 2.06 a | 4.70 a | 508.61 a | 2318.46 ab |
| | 02/11 | 107.00 ab | 11.67 a | 4.21 b | 218.50 c | 1.96 a | 4.76 a | 473.99 ab | 2279.15 ab |
| | 02/12 | 99.87 b | 8.00 c | 5.04 a | 175.33 c | 1.91 a | 4.66 a | 408.35 bc | 1906.11 bc |
| | 02/01 | 97.63 b | 11.67 a | 4.02 bc | 260.17 bc | 1.92 a | 4.76 a | 315.65 bcd | 1503.79 cd |
| With black plastic | 02/10 | 114.05 b | 9.67 abc | 3.56 c | 363.50 ab | 2.10 a | 4.78 a | 510.75 a | 2439.10 a |
| | 02/11 | 108.97 ab | 9.33 abc | 4.69 ab | 224.67 c | 1.96 a | 4.91 a | 537.25 a | 2656.60 a |
| | 02/12 | 99.00 b | 9.00 abc | 4.84 a | 162.83 c | 1.97 a | 4.86 a | 482.74 ab | 2350.00 a |
| | 02/01 | 107.90 ab | 10.00 abc | 4.20 b | 271.67 bc | 2.05 a | 4.84 a | 390.16 bcd | 1866.32 bc |

*The averages that carry the same alphabetical letters for the individual factors and their interactions do not differ significantly from each other according to Duncan's multiple range test at the probability level of 0.05.

Effect of interaction of cultivar, mulch and planting dates on growth and yield of okra

Table (9) indicates that there are significant differences in the triple interactions between the experimental factors in growth and yield characteristics. It was shown that the interaction treatment of the variety, frequency, mulching with wheat straw, and the third date gave the highest leaf content of chlorophyll. The triple interaction treatment of Betira variety, wheat straw mulching and the first date was significantly superior with the highest number of pods, 587.67 pods plant-1. In the same context, the treatment of the interaction of the variety Betra, mulching with black plastic and the first date outperformed the trait of plant height. On the other hand, the

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treatments of the interaction of the variety Climson and without mulching (comparison) and the first and fourth dates outperformed significantly for the traits of the total number of branches and the weight of the pod. While the interaction treatment of Climson variety, wheat straw mulching and the first date gave the highest fresh plant weight of the vegetative group, which amounted to 461.67 g plant-1. While the two treatments of Climson variety interaction and black plastic mulching for the first and second dates recorded the highest pod diameter and plant yield .

## CONCLUSION

From these results we can conclude that the Climson variety is characterized by good yield and productivity, The second date 11/02 showed the best results compared to the other agricultural dates, The use of black plastic soil mulch improved most growth characteristics and gave the best results, While the interaction between these factors was significant in most of the studied traits .

## RECOMMENDATIONS

Adopting the Climson variety in okra production due to its superiority in most growth characteristics and yield, Use black plastic mulching the soil at the second planting date to give the best results .

**Table 9. Effect of variety, mulch and planting dates on growth and yield of okra**

| Treatments | | | studied characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| variety | Mulching | Planting dates | Plant height (cm) | Total number of branches (branch plant$^{-1}$) | Chlorophyll b content of the leaves (mg 100g$^{-1}$ fresh weight) | Fresh weight of the vegetative mass (g plant$^{-1}$) | Pod diameter (cm) | Pod weight (g plant$^{-1}$) | Number of pods (pod plant$^{-1}$) | Plant yield (g plant$^{-1}$) |
| Betra | without mulch | 02/10 | 86.00 d | 8.33 b | 3.73 e | 306.67 bcd | 1.95 abc | 4.49 a-f | 379.88 e-j | 1705.66 e-i |
| | | 02/11 | 91.67 cd | 11.33 ab | 3.76 e | 194.00 def | 2.01 abc | 4.22 c-f | 303.01 h-l | 1278.70 hij |
| | | 02/12 | 109.67 a-d | 7.33 b | 4.23 b-e | 266.33 b-f | 1.89 abc | 3.93 ef | 273.16 jkl | 1073.51 ij |
| | | 02/01 | 111.33 a-d | 8.00 b | 3.60 e | 165.00 def | 1.87 abc | 3.96 def | 243.69 kl | 965.01 j |
| | Wheat straw mulch | 02/10 | 132.10 a | 9.00 b | 4.24 b-e | 361.00 abc | 1.95 abc | 3.79 f | 587.67 a | 2227.26 b-f |
| | | 02/11 | 104.33 bcd | 12.00 ab | 4.75 abc | 252.00 c-f | 1.98 abc | 4.27 c-f | 421.64 b-h | 1800.40 e-i |
| | | 02/12 | 102.07 bcd | 7.33 b | 5.17 a | 122.00 f | 1.85 bc | 4.23 c-f | 390.86 c-j | 1653.33 f-i |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 02/01 | 97.00 bcd | 11.67 ab | 4.16 b-e | 288.00 b-e | 1.85 c | 4.31 b-f | 312.71 h-k | 1347.78 hij |
| | With black plastic | 02/10 | 132.13 a | 9.00 b | 3.59 e | 413.67 ab | 2.01 abc | 4.31 b-f | 515.55 abc | 2222.02 b-f |
| | | 02/11 | 104.33 bcd | 10.33 ab | 4.95 ab | 253.33 c-f | 1.99 abc | 4.17 c-f | 504.26 a-d | 2102.76 c-g |
| | | 02/12 | 102.07 bcd | 8.33 b | 4.69 a-d | 183.00 def | 1.91 abc | 4.31 b-f | 471.07 a-f | 2030.31 d-g |
| | | 02/01 | 97.00 bcd | 9.67 ab | 4.06 b-e | 275.00 b-f | 2.00 abc | 3.91 ef | 411.86 b-i | 1610.37 f-i |
| Clim son | With out mulch | 02/10 | 97.07 bcd | 14.33 a | 3.57 e | 193.33 def | 2.02 abc | 5.51 abc | 340.03 f-k | 1873.56 e-h |
| | | 02/11 | 91.53 cd | 10.00 ab | 4.23 b-e | 158.33 def | 2.09 abc | 5.59 abc | 282.09 i-l | 1576.88 g-j |
| | | 02/12 | 100.67 bcd | 8.67 b | 4.39 a-e | 219.00 c-f | 1.98 abc | 5.33 a-e | 291.50 h-l | 1553.69 g-j |
| | | 02/01 | 102.07 bcd | 10.00 ab | 4.08 b-e | 277.00 b-f | 1.99 abc | 5.85 a | 181.96 l | 1064.46 ij |
| | Wheat straw mulch | 02/10 | 120.07 ab | 10.67 ab | 3.81 de | 461.67 a | 2.17 ab | 5.61 abc | 429.53 b-g | 2409.66 b-e |
| | | 02/11 | 109.67 a-d | 11.33 ab | 3.67 e | 185.00 def | 1.92 abc | 5.24 a-f | 526.32 ab | 2757.91 ab |
| | | 02/12 | 97.67 bcd | 8.67 b | 4.90 ab | 228.67 c-f | 1.95 abc | 5.07 a-f | 425.82 b-g | 2158.90 c-g |
| | | 02/01 | 98.27 bcd | 11.67 ab | 3.88 cde | 232.33 c-f | 1.99 abc | 5.21 a-f | 318.58 h-k | 1659.80 f-i |
| | With black plastic | 02/10 | 95.97 bcd | 10.33 ab | 3.53 e | 313.33 bcd | 2.18 a | 5.25 a-f | 505.94 a-d | 2656.18 bcd |
| | | 02/11 | 113.60 abc | 8.33 b | 4.43 a-e | 196.00 def | 1.93 abc | 5.63 abc | 570.24 a | 3210.45 a |
| | | 02/12 | 95.93 bcd | 9.67 ab | 4.98 ab | 142.67 ef | 2.04 abc | 5.40 a-d | 494.39 a-e | 2669.70 abc |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | 02/01 | 118.80 ab | 10.33 ab | 4.33 a-e | 268.33 b-f | 2.11 abc | 5.76 ab | 368.45 f-k | 212 2.27 c-g |

*The averages t

hat carry the same alphabetical letters for the individual factors and their interactions do not differ significantly from each other according to Duncan's multiple range test at the probability level of 0.05

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