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Response of Some Growth Traits and Yield of Two Eggplant Cultivars Grown at Different Spacing

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I. Abstract

The research was carried out at the Horticultural Research Station of the Department of Horticulture and Landscape Architecture at Tikrit University/College of Agriculture during the 2024 crop season. The objective was to examine the impact of two planting spacing, 35 cm and 45 cm, on the growth and yield of two eggplant cultivars, Chintu and AS-16. The research was conducted using a randomized complete block design (RCBD) with three replications. The means were analyzed using Duncan's multiple range test at a significance level of P≤0.05 with SAS software. The findings indicated that the AS-16 cultivar surpassed the other cultivars on leaf count, stem diameter, fruit quantity, and overall yield. The Chintu cultivar surpassed the other variety in leaf area and fruit diameter. The planting distance did not significantly influence the majority of the examined features. The interaction between cultivar and distance exhibited variable effects. Production escalated when the AS-16 cultivar was sown at a spacing of 45 cm, whereas the Chintu cultivar had the lowest yield at that same distance.

Keywords: Eggplant, planting distances, varieties, vegetative growth, yield.

*The research is taken from the master's thesis of the first researcher.

II. Introduction

Eggplant (Solanum melongena L.) belongs to the Solanaceae family and is a self-pollinating vegetable indigenous to India. [1] Eggplant is a fundamental component in various cuisines, especially Iraqi cuisine, owing to its substantial nutritional content. It comprises 12.55–12.77% protein, 45 mg of vitamin C per 100 g, 62–68% carbs, and 344.6 mg of phenolic acid per kg of eggplant, hence augmenting its health advantages. [2] Notwithstanding its significance, statistics reveal that eggplant production in Iraq is inferior relative to other Arab nations. Total production attained 102,452 thousand tons across 8,356 thousand hectares, yielding a production rate of 12,261 tons per hectare, but the average production across Arab nations was 21,264 tons per hectare [3].

Eggplant cultivars exhibit a range of shapes and hues, including oval and elongated forms, with colors such as white, yellow, green, and deep purple [1].

The spacing of plants among various species poses a significant challenge for farmers cultivating them in diverse soil types. Implementing proper spacing in crop production is crucial, as it diminishes competition between plants and weeds. Optimal spacing enhances crop development and boosts production. Elevated plant density can result in heightened competition for water and nutrients, adversely affecting plant growth and productivity. Ensuring adequate spacing diminishes competition for sunshine, water, and nutrients, while also mitigating the transmission of pests and diseases among plants [4].

A multitude of studies has been undertaken with eggplant, including cultivars and spacing. The research conducted by [1] demonstrated that the Kashi Taro cultivar excelled in growth characteristics, including plant height, branch count, leaf count, and leaf area.

[5] demonstrated that the Barcelona hybrid exhibited the highest leaf count (103.60 leaves per plant) with no significant difference compared to the Super Barcelona hybrid (103.02 leaves per plant). Nonetheless, it substantially

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surpassed the Hauser hybrid, which registered the lowest count of 95.00 leaves per plant. The Barcelona hybrid surpassed the Barcelona hybrid in terms of plant height, branch quantity, and leaf area. [6] demonstrated that the local variation greatly surpassed the eggplant variety in terms of plant height, stem diameter, branch count, leaf count, and leaf area. [7] demonstrated in their study that the eggplant variety did not significantly influence several of the examined features. The green variety demonstrated superiority in plant height, leaf count, flower quantity, and leaf area three weeks post-planting. In a study conducted by [8] on the impact of hybrids "Paris," "Achillea," and "Barcelona" on eggplant plants in Diyala Governorate, it was found that the hybrid "Paris" significantly surpassed the other two hybrids in all measured vegetative growth parameters, including plant height, leaf count, leaf area, stem diameter, and leaf chlorophyll content. A study conducted by [4] demonstrated substantial impacts of plant spacing at 30, 45, and 60 cm on plant height, branch count, leaf quantity per plant, leaf area, and leaf dry weight at the conclusion of the growing season across both seasons. The 30 cm spacing resulted in the highest plant height in all seasons, although the 60 cm separation enhanced the number of branches, leaves per plant, and leaf dry weight. The 45 cm spacing exhibited the highest leaf area per plant. [9] found that planting distances did not significantly influence yield attributes and their components, including fruit weight and yield per plant, although the impact was considerable for the other traits examined. The 20 cm plant spacing yielded the highest averages for yield, early yield, and total yield per plant at significant levels ($p<0.05$ and $p<0.01$), achieving 1.537 kg/plant, 3.378 kg/plant, and 1.348 kg/m², respectively. The 40 cm plant spacing had the lowest values for the same attributes, measuring 0.973 kg/plant, 2.200 kg/plant, and 0.716 kg/m². They established that planting density significantly influenced vegetative growth characteristics, including plant height and total leaf count. The 20 cm and 30 cm plant spacings exhibited the highest averages for these characteristics, attaining 55.185 cm per plant and 78.815 leaves per plant, respectively. The 40 cm plant spacing exhibited the lowest averages for vegetative growth characteristics, measuring 48.469 cm per plant and 66.259 leaves per plant, respectively. The changes in the remaining attributes were not significant. In their 2018 study, [10] examined the impact of seaweed extract and planting distance on the development and production of two eggplant hybrids, revealing that plant spacing greatly influenced plant height, with a maximum measurement of 76.87 cm seen at a spacing of 30 cm. The distance between plants considerably influenced leaf area. [11] discovered that both the quantity and mass of fruits per plant considerably increased with greater spacing between and within rows. The broader spacing (120 cm × 70 cm) produced the maximum yield per plant and per hectare in both seasons, in contrast to the smaller spacing (80 cm x 30 cm), which yielded the lowest values. Notable increases were detected at a 120 cm planting interval in characteristics such as the quantity of fruits per plant, fruit weight, and overall yield per dunum.

This study seeks to evaluate the performance of two eggplant varieties to identify the superior variety based on growth and productivity. Ascertain the ideal planting distance for the kinds, considering the absence of study on these two criteria, particularly in Salah al-Din Governorate.

III. Materials and Methods

Experimental Implementation Site:

The experiment was conducted in the Department of Horticulture and Landscape Engineering, College of Agriculture, Tikrit University, at the Horticultural Research Station for the 2023 agricultural season. After determining the appropriate area of land, it was plowed and thoroughly smoothed. The experiment was then analyzed in the laboratory by taking soil samples from various locations in the field, from the surface to a depth of (30) cm. The samples were then thoroughly mixed together for homogeneity [12].

Table (1) shows the physical and chemical properties of the field soil before planting**.**

Characteristics	Unit	Concentration
Sand	%	34
Silt	%	29

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Clay	%	37
Texture	clayey sandy mixture	
pH		7.19
Electrical Conductivity	mS/m	3.46
Organic Matter	milligram.kg	1.27
Nitrate	milligram.kg	12.3
Ammonium	milligram.kg	13.11
Available Phosphorus	milligram.kg	15.7
Potassium	milligram.kg	3.28

Field preparation:

The experimental land was cultivated with a rotary plow, then smoothed and leveled. The experimental area was partitioned into three duplicates, each comprising four experimental units. The area of each experimental unit was 180 cm^2. Plants were arranged within the experimental unit at two intervals: the initial spacing was 35 cm, accommodating nine plants, alternating on either side of the line. The second measured 45 cm and housed seven plants, arranged alternately on either side of the line. The width of the line was 50 cm. A drip irrigation system was subsequently constructed, and the experimental unit was enveloped in a black plastic cover to inhibit the growth of weeds and plants, as well as to preserve soil moisture. The cover was secured on both sides by fastening its edges to the dirt. [13]

Seedling production and cultivation:

The seeds were sourced from Karbala Governorate, Iraq, and were cultivated in plastic trays, each comprising 50 cavities. Peat moss was utilized to fill the cavity, after which the seeds were sown in the center. Irrigation commenced immediately post-planting and persisted bi-daily. The trays were positioned in the greenhouse of the Horticulture and Landscape Engineering Department and covered with clear nylon to elevate the temperature and expedite seedling production until they attained the right age, characterized by the emergence of four true leaves. The seedlings were relocated to the field at the emergence of four true leaves per plant. Humic acid was incorporated into the irrigation water at a concentration of 10 ml per liter on each planting date to enhance the plant's acclimatization to the soil and supply a nitrogen fertilizer source [14] Balanced fertilizer (NPK) was applied every 10 days, while crop maintenance operations, including irrigation, weed removal, disease management, and other activities, were conducted as necessary [15]. Apamec 36 EC was utilized to manage spider infestations.

Study factors

The following factors were selected for the experiment

Varieties: AS-16 / Chintu

Planting distances: The first distance was 35 cm, the second distance was 45 cm.

Experimental design

The experiment was designed according to a Randomized Complete Block Design (RCBD) with three replicates, each replicate containing 4 experimental units resulting from the interaction of the two study factors. The number of experimental units was 12 experimental units.

Traits studied:

During the research, the following traits were studied on five plants randomly selected from each experimental unit:

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Vegetative growth traits:

Plant height (cm/plant-1): Measured from the point of contact of the stem with the soil to the growing tip using a tape measure at the end of the season**.**

Number of leaves (leaf-plant-1): This trait was measured by counting the leaves present on the plant at the end of the experiment**.**

Leaf area (cm/plant-1): Leaf area was measured according to the method of [16]. Five leaves were weighed after the petioles were removed, and discs of known area were then cut from them to calculate the average weight. Leaf area was calculated using the following equation:

Leaf area= Average leaf weight * Area of the disc cut from the leaf/ Average weight of the disc cut from the leaf

The total leaf area of the plant was then calculated using the following equation:

Leaf area of the plant cm^2/plant-1 = area of one leaf × number of leaves

Main stem diameter (mm/plant-1): Stem diameter was measured using a Vernier caliper at the end of the experimental season.

Quantitative yield characteristics:

Fruit number (fruit/plant): The number of fruits per experimental unit was determined from the beginning of the harvest season until the end of the harvest season using the following equation [17]:

Total number of fruits = Total number of fruits in the experimental unit / Number of plants in the experimental unit

Total yield (tons per hectare): This trait was measured after calculating the total yield of all 10 plants grown in the experimental unit. The yield per hectare was then calculated using the following equation:

Total yield (tons per hectare-1) = yield of experimental unit / experimental unit * 100

Fruit diameter (cm/fruit-1): Fruit diameter was measured from the largest diameter area using a Vernier caliper for the same fruits whose length was measured in each experimental unit. The average of these measurements was taken.

Fruit weight (g/fruit-1): The total weight of the plants' fruits in each experimental unit was calculated and then divided by the total number of fruits to obtain the average, as shown below:

Fruit weight = Total fruit weight in the experimental unit / Total number of fruits in the experimental unit

IV. Results and discussion

Table (2) illustrates the impact of cultivar, plant spacing, and their interaction on vegetative development characteristics. The AS-16 cultivar shown notable advantage in leaf count and main stem diameter, with values of 87.553 leaves per plant and 10.993 mm, respectively. The Chintu cultivar exhibited superior performance in plant height and leaf area, measuring 41.167 cm^2/plant^1 and 2776.167 cm^2/plant^1, respectively. No substantial variation was observed in plant height between it and the AS-16 cultivar. The 35 cm spacing greatly surpassed the 45 cm spacing in terms of plant height and leaf area, achieving measurements of 41.945 cm/plant^1 and 2458.367 cm^2/plant^1, respectively. The 45 cm spacing exhibited no significant difference in leaf number and main stem diameter compared to the 45 cm spacing, as both recorded analogous values without substantial variation. The interaction between the

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Chintu cultivar and a spacing of 35 cm resulted in considerably elevated values for plant height and leaf area, measuring 43.333 cm/plant and 2847.5 cm^2/plant, respectively. The AS-16 cultivar at a 45 cm spacing exhibited a superior leaf count of 88.728 leaves per plant, while the combination of AS-16 and 35 cm spacing achieved the highest significant measurement for main stem diameter at 11.149 mm. The interaction coefficients for the Chintu cultivar at 45 cm spacing and the AS-16 cultivar at 45 cm spacing yielded the lowest values for certain traits, indicating a significant interaction effect on vegetative growth, contingent upon the compatibility between the cultivar and the spacing.

Table (2) Effect of variety, distance and interaction between them on vegetative growth characteristics

	Plant height cm plant-1	**Number of leaves leaf plant-1**	**Main stem diameter cm plant-1**	**Leaf area cm2 plant-1**
Chintu	41.167 a	71.161 b	10.413 B	2776.167 A
AS-16	39.722 a	87.553 a	10.993 A	2017.05 b
35cm	41.945 a	77.944 a	10.701 A	2458.367 a
45cm	38.944 b	80.769 a	10.705 A	2334.85 a
Chintu X35	43.333 a	69.511 b	10.253 B	2847.5 a
Chintu X 45	39.000 b	72.811 b	10.573 Ab	2704.833 a
AS-16 X35	40.556 ab	86.377 a	11.149 A	2069.233 b
AS-16 X45	38.889 b	88.728 a	10.837 Ab	1964.867 b

Similar alphabetical letters are not significantly different according to Duncan's multiple range test at a significance level of ≤ 0.05.

Table (3) demonstrates the impact of cultivar, spacing, and their interaction on yield characteristics. The AS-16 cultivar demonstrated remarkable advantage in fruit quantity and overall production per plant, achieving 2,600 fruits per plant and 6.495 tons per hectare, respectively. Simultaneously, the Chintu cultivar exhibited superior performance in fruit weight and diameter, achieving values of 67.73 g per fruit and 6.301 mm, respectively. Nonetheless, it did not markedly differ from AS-16 in terms of fruit diameter.

No significant variations were noticed in fruit number, weight, and diameter between the two spacings (35 cm and 45 cm), since the values were similar and did not substantially impact yield. The interaction effect between cultivar and spacing revealed that AS-16 at 45 cm spacing yielded the highest values for fruit number and total yield, achieving 2.733 fruits per $plant^{-1}$ and 6.777 tons per ha^{-1}, respectively. The interaction between Chintu and 45 cm spacing markedly surpassed the fruit diameter, achieving 6.363 mm, while the maximum fruit weight was noted in the same treatment, at 68.69 g/fruit. This interaction produced the lowest significant total output, at 1.318 tons per hectare. In contrast, the interaction between AS-16 and 35 cm spacing yielded much higher results for overall output, at 6.212 tons per hectare.

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Table (3) The effect of the variety, distance and interaction between them on the characteristics of the yield

Total yield per plant (tons/ha)	Diameter of one fruit (mm)	Weight of one fruit (g)	Number of fruits (fruit per plant)	
2.681 b	6.301 A	67.73 a	1.483 B	Chintu
6.495 a	5.518 B	63.58 a	2.600 A	AS-16
5.128 a	5.893 A	62.96 a	2.128 A	35cm
4.048 A	5.926 A	68.35 a	1.956 A	45cm
4.043 Ab	6.238 A	66.76 ab	1.789 Ab	Chintu X35
1.318 B	6.363 A	68.69 a	1.178 B	Chintu X 45
6.212 A	5.547 B	59.16 b	2.467 A	AS-16 X35
6.777 A	5.489 B	67.99 a	2.733 A	AS-16 X 45

Similar alphabetical letters are not significantly different according to Duncan's multiple range test at a significance level of ≤ 0.05.

The study's results indicated a distinct impact of both cultivar and inter-plant distance on the vegetative growth characteristics and yield components of eggplant. The AS-16 cultivar markedly surpassed the metrics of leaf count and main stem diameter, in addition to yield characteristics including fruit quantity per plant and overall yield. Conversely, the Chintu cultivar exhibited superior performance solely in the weight and diameter of individual fruits, without a corresponding increase in fruit quantity or overall yield. This suggests genetic variation among cultivars, linked to differences in genetic structure influenced by a set of genes that regulate the efficiency of element absorption and the allocation of photosynthetic products. This aligns with the research conducted by [6;18] In terms of plant spacing, a distance of 35 cm surpassed 45 cm in several vegetative characteristics, including plant height and leaf area, as well as total plant production, with the maximum yield attained at 35 cm spacing. This suggests that heightened plant density enhances the utilization of natural resources, including light, water, and nutrients, hence augmenting productivity. Spacing did not demonstrate a substantial impact on attributes such as leaf count or main stem diameter, suggesting that these characteristics are predominantly influenced by the variety rather than by spacing. This aligns with the research conducted by [10; 7; 19].

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