



INFLUENCE OF SIX PLANTING DENSITIES ON THE PRODUCTION AND QUALITY OF MELON (*Cucumis melo* L.) GALIA CULTIVAR SAN LUIS ANCASH

Frangio Alain Guillen Mendoza¹
Ana Melva Contreras Contreras²
Adriana María Castillo Corzo³
Claudia Liliana Felles Isidro⁴
Fulgencio Villegas Silva⁵
Miguel Angel Castillo Corzo⁶

ABSTRACT

Objectives: The objective of this research was to study the influence of six different planting densities on the production and quality of melon (*Cucumis melo* L.) cultivar Galia, in the San Luis experimental field of the Universidad San Pedro, located in San Luis, Ancash.

Theoretical Framework: The study was based on agricultural theories related to crop management, especially planting techniques and their effects on yield and fruit quality. It focused on how variations in planting density affect crop physiology and fruit development.

Methodology: A completely randomized block design (CRBD) was used with three blocks and six treatments, each with three replications. The treatments included different planting densities, and various variables were evaluated, such as leaf cover, fruit diameter, weight, and melon yield.

Results and Discussion: The results showed no significant differences in leaf cover, polar diameter, or equatorial diameter of the fruit. However, treatments T5, T2, and T4 presented similar fruit weights, and T6, with the lowest planting density, showed the highest content of total soluble solids (10.20 °Brix).

Research Implications: The research demonstrates that planting density influences the total and commercial yield of melons as well as their quality.

Originality/Value: This study provides relevant information to improve the production of Galia melons, contributing data that can be applied in agricultural practices to optimize crop quality and yield.

Keywords: Galia Melon, Planting Density, Yield, Fruit Quality, Soluble Solids.

¹ Universidad Nacional de Barranca, Barranca, Peru. E-mail: mendoza@gmail.com
Orcid: <https://orcid.org/0000-0002-8936-4614>

² Universidad Nacional de Barranca, Barranca, Peru. E-mail: acontreras@unab.edu.pe
Orcid: <https://orcid.org/0000-0001-8425-8225>

³ Universidad Nacional José Faustino Sánchez Carrión, Huacho, Peru.
E-mail: acastillo@unjfsc.edu.pe Orcid: <https://orcid.org/0000-0002-7415-1501>

⁴ Universidad Nacional de Barranca, Barranca, Peru.
E-mail: cfelles@unab.edu.pe Orcid: <https://orcid.org/0000-0002-9739-6683>

⁵ Universidad Nacional Mayor de San Marcos, Lima, Peru.
E-mail: fvillegas@unmsm.edu.pe Orcid: <https://orcid.org/0000-0002-2560-9352>

⁶ Universidad Nacional Mayor de San Marcos, Lima, Peru.
E-mail: mcastilloc@unmsm.edu.pe Orcid: <https://orcid.org/0000-0002-2652-799X>



INFLUÊNCIA DE SEIS DENSIDADES DE PLANTIO NA PRODUÇÃO E QUALIDADE DO MELÃO (*Cucumis melo* L.) CULTIVAR GALIA SAN LUIS ANCASH

RESUMO

Objetivos: O objetivo desta pesquisa foi estudar a influência de seis diferentes densidades de plantio na produção e qualidade do melão (*Cucumis melo* L.) cultivar Galia, no campo experimental San Luis da Universidade San Pedro, localizado em San Luis, Ancash.

Marco Teórico: O estudo baseou-se em teorias agrícolas relacionadas ao manejo de culturas, especialmente ao plantio e seus efeitos no rendimento e na qualidade do fruto. O foco foi analisar como as variações na densidade de plantio impactam a fisiologia da cultura e a formação dos frutos.

Método: Foi utilizado um delineamento experimental de blocos completamente ao acaso (DBCA), com três blocos e seis tratamentos, cada um com três repetições. Os tratamentos incluíram diferentes densidades de plantio, e foram avaliadas diversas variáveis, como a cobertura foliar, o diâmetro dos frutos, o peso e o rendimento do melão.

Resultados e Discussão: Os resultados mostraram que não houve diferenças significativas na cobertura foliar e no diâmetro polar e equatorial dos frutos. No entanto, os tratamentos T5, T2 e T4 apresentaram peso de fruto semelhante, e o T6, com a menor densidade de plantio, apresentou maior conteúdo de sólidos solúveis totais (10,20 °Brix).

Implicações da Pesquisa: A pesquisa evidencia que a densidade de plantio influencia o rendimento total e comercial do melão, bem como sua qualidade.

Originalidade/Valor: Este estudo oferece informações relevantes para a melhoria da produção do melão Galia, contribuindo com dados que podem ser aplicados em práticas agrícolas para otimizar a qualidade e o rendimento da cultura.

Palavras-chave: Melão Galia, Densidade de Plantio, Rendimento, Qualidade do Fruto, Sólidos Solúveis.

INFLUENCIA DE SEIS DENSIDADES DE SIEMBRA EN PRODUCCIÓN Y CALIDAD DE MELÓN (*Cucumis melo* L.) CULTIVAR GALIA SAN LUIS ANCASH

RESUMEN

Objetivos: El objetivo de esta investigación fue estudiar la influencia de seis diferentes densidades de siembra en la producción y calidad del melón (*Cucumis melo* L.) cultivar Galia, en el campo experimental San Luis de la Universidad San Pedro, ubicado en San Luis Ancash.

Marco Teórico: El estudio se basó en teorías agrícolas relacionadas con el manejo de cultivos, especialmente en la siembra y sus efectos sobre el rendimiento y la calidad del fruto. Se enfocó en cómo las variaciones en la densidad de siembra impactan en la fisiología del cultivo y la formación de frutos.

Método: Se utilizó un diseño experimental de bloques completamente al azar (DBCA) con tres bloques y seis tratamientos, cada uno con tres repeticiones. Los tratamientos incluyeron diferentes densidades de siembra, y se evaluaron diversas variables como la cobertura foliar, el diámetro de los frutos, el peso y el rendimiento del melón.

Resultados y Discusión: Los resultados mostraron que no hubo diferencias significativas en la cobertura foliar y en el diámetro polar y ecuatorial del fruto. Sin embargo, los tratamientos T5, T2 y T4 presentaron un peso de fruto similar, y T6, con la menor densidad de siembra, mostró un mayor contenido de sólidos solubles totales (10,20 °Brix).

Implicaciones de la Investigación: La investigación evidencia que la densidad de siembra influye en el rendimiento total y comercial del melón, así como en su calidad.

Originalidad/Valor: Este estudio ofrece información relevante para la mejora de la producción del melón Galia, contribuyendo con datos que pueden ser aplicados en prácticas agrícolas para optimizar la calidad y el rendimiento del cultivo.



Palabras clave: Melón Galia, Densidad de Siembra, Rendimiento, Calidad del Fruto, Sólidos Solubles.

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1 INTRODUCTION

Melon (*Cucumis melo* L.) cultivation is of great economic and social importance due to its high demand in national and international markets. Among its varieties, the Galia melon stands out for its sweetness, aroma, and fruit quality. Agronomic management techniques, such as planting density, have a significant impact on the yield and quality of the harvested product. Previous studies have shown that planting density affects factors such as fruit weight, size, and organoleptic quality. However, there is variability in the results due to climatic conditions, soil characteristics, and the varieties cultivated. In the context of cultivation in the San Luis region of Ancash, there is a need to evaluate these techniques to optimize production and ensure high-quality fruits that meet market demands.

1.1 RESEARCH QUESTION

What will be the influence of six planting densities on the production and quality of the melon (*Cucumis melo* L.) cultivar Galia in San Luis, Ancash?

1.2 JUSTIFICATION

Methodologically, this research will allow farmers to implement evidence-based results, providing technical guidance to improve the yield and quality of melon crops. From an economic perspective, the findings will contribute to increased productivity, improving farmers' incomes and enabling greater competitiveness in national and international markets. Furthermore, melon is considered a nutraceutical food due to its health-promoting properties, which encourages its consumption and expansion in demanding markets. This research will also address environmental aspects by optimizing resources such as water and agricultural inputs through appropriate planting densities.



1.3 RESEARCH OBJECTIVES

1.3.1 General objective

To evaluate the influence of six planting densities on the production and quality of melon (*Cucumis melo* L.) cultivar Galia in San Luis, Ancash.

1.3.2 Specific objectives

1. Determine the influence of the six densities on the yield of the melon crop (*Cucumis melo* L.) cultivar Galia in San Luis, Ancash.
2. To analyze the effect of six planting densities on the quality parameters of the melon crop (*Cucumis melo* L.) cultivar Galia in San Luis, Ancash.

2 THEORETICAL FRAMEWORK

Montes (2020), in his study on the effect of planting density on Super Torreón F1 melon, concluded that the best combination was 0.60 m (24.27 t/ha), surpassing 0.50 m (22.39 t/ha) and 0.40 m (22.61 t/ha). Distances less than 0.30 m reduced yield to less than 19.04 t/ha. Furthermore, at greater spacing, the fruits were heavier (more than 1.50 kg).

Gutiérrez (2018) analyzed density in Black Fire watermelon in Cañete, finding a higher yield with 2083 plants/ha. Although density did not affect quality, larger fruits were observed with 2500 plants/ha. Ulloa *et al* . (2016) studied Mickey Lee watermelon and concluded that there were no significant differences, although T1 had the highest yield.

Jiménez and Acosta (2013) reported that optimizing density could increase the yield of pinto beans from 1,700 kg/ha to 2,500 kg/ha. García *et al* . (2006) noted that mathematical models have attempted to predict the effect of density on yield, but factors such as seed quality and cultivar choice influence the results.

Díaz and Monge (2017) concluded that 3.9 plants/m² maximize yield and Brix degrees. Sosa (2014) and Moreno *et al* . (2014) demonstrated that growth regulators and vermicompost affect fruit quality. Rebougas *et al* . (2017) noted that fruit weight and soluble solids depend on macronutrient concentrations.



Other studies (Laínez & Krarup, 2008; Bazán, 2015; Sarmiento, 2016) have analyzed the agronomic management of melon. Bazán (2015) concluded that a fertilization of 150-100-150 kg/ha of NPK optimizes yield (47.49 t/ha).

This study seeks to improve the yield and quality of melons, benefiting their commercial and export potential.

3 METHODOLOGY

This applied and experimental research project was developed in Nuevo Chimbote, San Luis, Santa Fe Province, in a temperate, desert, and oceanic climate. A completely randomized block design (CRBD) with six treatments and three replicates was used to analyze the cultivation of Galia melon.

On December 12, 2019, Hawita professional substrate was prepared, and seeds were sown in germination trays, achieving 85% germination. The seedlings were transplanted into seed bags with a substrate of sand, humus, agricultural soil, and rice straw. The experimental field was then prepared and a technical irrigation system was installed.

On January 7, 2020, the seedlings were transplanted to the final field with organic matter and furadan for nematode control. Irrigation was carried out three times a week, and weed control was carried out manually. Molasses traps were installed for lepidopterans, and fertilization was carried out in January and February with NPK and ammonium nitrate. Chemical and organic products against nematodes were also applied.

Crop management included pest monitoring, weed control, and evaluation of leaf cover, vine length, and fruit quality.

On January 27, the main vines were pruned to expose roots and promote flowering. The first fruits were observed on March 10, 35 days after planting.

Fifty-four plants were selected to evaluate parameters with basic tools, ensuring quality fruit and optimizing Galia melon production.

4 RESULTS AND DISCUSSIONS

The first specific objective is to determine the influence of the six densities on the yield of the melon crop (*Cucumis melo* L.) cultivar Galia San Luis Ancash

For this, the assumptions of normality and homogeneity were made.



Table 1

Multiple comparisons to determine the best treatment for percentage leaf cover in Galia melon.

Treatments	N	1	2	3
T3	3	57,333		
T1	3	60,200		
T6	3	61,400		
T2	3		70,733	
T4	3		71,567	
T5	3			84,100
P-value		0.349	0.837	1,000

With this analysis, treatments T3, T1 and T6 have statistically the same percentage of leaf cover in Galia Melon. The same occurs with T2 and T4, which statistically have the same percentage of leaf cover, and treatment T5 is the one that statistically has the different percentage of leaf cover than the other treatments.

Table 2

ANOVA for completely randomized block designs on the averages of main runner length in Galia Melon in the San Luis field

Origin	Sum of Squares	Gl.	Mean Square	F	P-value.
Model	63,940a	8	7,992	204,819	0.000
Treatments	0.179	5	0.036	0.917	0.508
Blocks	0.067	2	0.033	0.855	0.454
Mistake	0.390	10	0.039		
Total	64,330	18			

a. R squared = 0.994 (Adjusted R squared 0.989)

As the p-value $0.454 > 0.05$ the null hypothesis is accepted which tells us that statistically there are no differences between the block averages, and for the treatments the p-value $0.508 > 0.05$, therefore we accept the null hypothesis in which we can say that statistically there are no differences in the treatments for main guide length averages . in Melon Galia in the San Luis field.

To determine the number of leaves per Galia melon guide in the San Luis field, assumptions such as the normality and homogeneity tests were made.



Table 3

Duncan's multiple comparisons to determine the best treatment for the number of leaves per vine in Galia melon

Treatments	N	1	2	3
T5	3	28,3267		
T1	3	28,3800		
T3	3	30,6833	30,6833	
T2	3	33,9600	33,9600	33,9600
T4	3		35,1433	35,1433
T6	3			37,2333
P-value		0.069	0.131	0.258

By analyzing it is determined that treatments T₅, T₁, T₃ and T₂ have statistically the same effect on the number of leaves per guide In Galia melon the same occurs with T₃, T₂, and T₄ statistically have the same number of leaves per guide and Treatments T₂, T₄ and T₆ statistically have the same number of leaves per guide. To determine the number of female flowers in Galia melon in the San Luis field, assumptions such as the normality and homogeneity tests were made.

Table 4

Duncan's multiple comparisons to determine the best treatment for the number of female flowers in Galia melon

Treatments	N	1	2	3
T1	3	14.33		
T3	3	16.33		
T6	3		24.33	
T2	3		28.33	
T4	3		29.33	29.33
T5	3			35.00
P-value		0.467	0.098	0.055

With this analysis we determined that treatments T₁ and T₃ have statistically the same effect on the number of female flowers of Galia melon, the same occurs with T₆, T₂, and T₄ statistically have the number of female flowers equal and Treatments T₄ and T₅ have equal number of female flowers in Galia melon.

Regarding the specific objective for To determine the influence of the six densities on the quality of the melon crop (*Cucumis melo* L.) cultivar Galia San Luis Ancash, the assumptions such as the normality and homogeneity tests were made.



Table 5

ANOVA for completely randomized block designs on the means for the polar diameter of fruit in Galia melon in the San Luis field

Origin	Sum of Squares	Gl.	Mean Square	F	P-value.
Model	1671,050 ^a	8	208,881	446,198	0.000
Treatments	16,689	5	3,338	7,130	0.004
Blocks	3,918	2	1,959	4,185	0.048
Mistake	4,681	10	0.468		
Total	1675,731	18			

a. R squared = 0.995(Adjusted R squared 0.992)

As the p-value $0.048 > 0.05$ the null hypothesis is accepted which tells us that there are no differences between the block averages, but for the treatments the p-value $0.004 < 0.05$ so we accept the alternative hypothesis in which we can say that there are differences in at least one of the treatments for the polar diameter of the Galia Melon fruit in the San Luis field

Table 6

Duncan's multiple comparisons to determine the best treatment for fruit polar diameter in Galia melon

Treatments	N	1	2	3
T5	3	7,7400		
T2	3		9,0300	
T4	3		9,6033	9,6033
T3	3		10,1833	10,1833
T6	3			10,4133
T1	3			10,4833
P-value		1,000	0.77	0.172

It is determined that treatments T_2 , T_4 and T_3 have statistically the same effect on the polar diameter of the fruit in Galia melon. The same occurs with T_4 , T_3 , T_6 and T_1 , statistically they have equal polar diameters of the fruit and Treatment T_5 is the one that has a different polar diameter of the fruit compared to the other treatments.

To determine the equatorial diameter of the fruit in Galia melon in the San Luis field, the assumptions of the normality and homogeneity test were made, for which the ANOVA test was performed.



Table 7

ANOVA test for completely randomized block designs on the means for the equatorial diameter of fruit in Galia melon in the San Luis field

Origin	Sum of Squares	Gl.	Mean Square	F	P-value.
Model	1810,518 ^a	8	226,315	541,265	0.000
Treatments	16,488	5	3,298	7,887	0.003
Blocks	1,442	2	0.711	1,701	0.231
Mistake	4,181	10	0.418		
Total	1814,699	18			

a. R squared = 0.998(Adjusted R squared 0.996)

Since the p-value $0.231 > 0.05$, the null hypothesis is accepted, which tells us that there are no differences between the block averages, but for the treatments the p-value $0.003 < 0.05$, so we accept the alternative hypothesis in which we can say that there are differences in at least one of the treatments for the Equatorial Diameter of the fruit in Galia Melon in the San Luis field.

Table 8

Duncan's multiple comparisons to determine the best treatment for the equatorial diameter of the Galia melon fruit

Treatments	N	1	2	3
T5	3	8,1900		
T2	3		9.5233	
T3	3		9.9667	9.9667
T4	3		10.2433	10.2433
T1	3			10,8600
T6	3			11,0933
P-value		1,000	0.222	0.075

It is determined that treatments T2, T3 and T4 have statistically the same effect on the equatorial diameter of the Galia melon fruit. The same occurs with T3, T4, T1 and T6, which statistically have the same equatorial diameter of the fruit, and Treatment T5 is the one with a different equatorial diameter of the Galia melon fruit compared to the other treatments. To determine the weight of the Galia melon fruit in the San Luis field, we proceed to make assumptions such as the normality and homogeneity tests.



Table 9

ANOVA for completely randomized block designs for the average fruit weight of Galia melon in the San Luis field

Origin	Sum of Squares	Gl.	Mean Square	F	P-value.
Model	18,665 ¹⁰	8	2,333		
Treatments	1,287	5	0.257	66,915	0.000
Blocks	0.150	2	0.075	7,380	0.004
Mistake	0.349	10	0.035	2,147	0.168
Total	19,014	18			

a. R squared = 0.982 (Adjusted R squared 0.967)

Since the p-value $0.168 > 0.05$, the null hypothesis is accepted, which tells us that there are no differences between the block averages, but for the treatments the p-value $0.004 < 0.05$, so we accept the alternative hypothesis in which we can say that there are differences in at least one of the treatments for average fruit weight of Galia Melon in the San Luis field. Now we will use multiple comparisons to determine the different.

Table 10

Duncan's multiple comparisons to determine the best treatment for average fruit weight of Galia melon.

Treatments	N	1	2	3
T5	3	0.5133		
T2	3	0.8467	0.8467	
T4	3	0.8633	0.8633	
T1	3		1,1267	1,1267
T3	3			1.2333
T6	3			1,2867
P-value		0.053	0.110	0.340

With this analysis we determined that treatments T5, T2 and T4 statistically have the same weight of Galia Melon fruit. The same occurs with T2, T4 and T1 statistically have equal yields and treatments T1, T3 and T6 these also statistically have the same average fruit weight.



Table 11

ANOVA test for completely randomized block designs on Brix degree averages in Galia melons in the San Luis field

Origin	Sum of Squares	Gl.	Mean Square	F	P-value.
Model	1238,401 ^a	8	154,800		
Treatments	45,436	5	9,087	188,118	0.000
Blocks	0.618	2	0.309	11,043	0.001
Mistake	8,229	10	0.823	0.375	0.696
Total	1246,630	18			

a. R squared = 0.993 (Adjusted R squared 0.988)

Since the p-value $0.696 > 0.05$, the null hypothesis is accepted, which tells us that there are no differences between the block averages, but for the treatments the p-value $0.001 < 0.05$, so we accept the alternative hypothesis in which we can say that there are differences in at least one of the treatments for the Brix degrees of Galia Melon in the San Luis field.

Table 12

Duncan's multiple comparisons to determine the optimal Brix level for Galia melon cultivation

Treatments	N	1	2	3	4
T5	3	5,8000			
T2	3	6,4333	6,4333		
T1	3		7,933	7.9333	
T3	3			9.0333	9.0333
T4	3			9,4333	9,4333
T6	3				10,2000
P-value		0.413	0.70	0.082	0.163

It is determined that treatments T5 and T2 have statistically equal Brix degree of Galia Melon, the same occurs with T2 and T1 statistically have equal Brix degree, Treatment T1, T3 and T4 have statistically equal Brix degree and T3, T4 and T6 have statistically equal Brix degree and it is the one that has a better yield of Galia melon compared to the other treatments

Regarding the specific objective to determine the influence of the six densities on the yield of the melon crop (*Cucumis melo* L.) cultivar Galia San Luis Ancash, in all cases, the assumptions such as the normality and homogeneity test were made.



Table 13

Duncan's multiple comparisons to determine the best treatment for fruit set in Galia melon cultivation

Treatments	N	1	2	3
T3	3	10.67		
T1	3	12.00		
T6	3		21.67	
T2	3		22.67	
T4	3		26.00	
T5	3			32.00
P-value	3	0.574	0.099	1,000

By analyzing it is determined that treatments T1, T3 have statistically the same effect on the number of Galia melon fruits, the same occurs with T6, T2 and T4 statistically they have the same number of fruits and Treatment T5 is the one that has a better number of Galia melon fruits compared to the other treatments.

Table 14

ANOVA for completely randomized block designs on the means for yield per hectare in Galia melon in the San Luis field

Origin	Sum of Squares	Gl.	Mean Square	F	P-value.
Model	1129,504 ^a	8	141,188		
Treatments	81,689	5	16,338	266,114	0.000
Blocks	0.521	2	0.261	30,794	0.000
Mistake	5,306	10	0.531	0.491	0.626
Total	1134,810	18			

a. R squared = 0.995 (Adjusted R squared 0.99)

As the p-value $0.626 > 0.05$ the null hypothesis is accepted which tells us that there are no differences between the block averages, but for the treatments the p-value $0.000 < 0.05$, therefore we accept the alternative hypothesis in which we can say that there are differences in at least one of the treatments for the yield per hectare in Galia Melon in the San Luis field



Table 15

Duncan's multiple comparisons to determine the best treatment for yield per hectare in Galia melon cultivation

Treatments	N	1	2	3
T3	3	4,933		
T1	3	5,833		
T6	3		7,500	
T2	3		7,867	
T4	3		7,933	
T5	3			11,700
P-value		0.161	0.503	1,000

It is determined that treatments T₁ and T₃ have statistically the same effect on the yield of Galia melon, the same occurs with T₆, T₂ and T₄ statistically have equal yields and Treatment T₅ is the one that has a better yield of Galia melon compared to the other treatments.

Table 16

Duncan's multiple comparisons to determine the best treatment for commercial yield per hectare in Galia melon

Treatments	N	1	2
T5	3	4,5667	
T1	3	4,7000	
T2	3	4,8000	
T3	3	4.9333	
T4	3		6,1667
T6	3		7.0333
P-value		0.494	0.98

With this analysis we determined that treatments T₅, T₁, T₂ and T₃ have statistically the same effect on the commercial yield per hectare of Galia melon. The same occurs with T₄ and T₆, which statistically have the same commercial yield per hectare.

To determine the influence of six densities on the quality of melon (*Cucumis melo* L.) cultivar Galia in San Luis, Áncash, it was found that T6 (1.5 m apart) obtained the best average in fruit weight, polar and equatorial diameter, and percentage of total soluble solids. In contrast, T5 presented the lowest quality in all indicators. These results differ from Montes (2020), who obtained better quality with 0.60 m apart, but agree with Gracia *et al.* (2009) and Díaz and Monge (2017) regarding Brix degrees, indicating that greater apart increases its concentration. Gutiérrez (2018) and García *et al.* (2009) did not observe an influence of density on harvest yield and quality.

Regarding yield, considering the number of fruits per plant, yield per hectare, and market value, T5 (11.7 t/ha) and T6 were the most productive. However, statistically, these



treatments were equal, which differs from Sarmiento (2016), Díaz and Monge (2017), and Montes (2020), who reported higher yields with 0.60 m spacing (24.2 t/ha). These findings suggest that planting density influences the quality and yield of Galia melon.

5 CONCLUSION

The results obtained in the variable quality of the different planting densities of the melon (*Cucumis melo* L.) cultivar Galia allow us to conclude the following:

In terms of leaf cover, all treatments were statistically equal, except for T5, which had a different percentage of cover. There were no significant differences in the length of the vine, the number of leaves, and the number of female flowers.

The polar and equatorial diameters of the fruit were similar in all treatments, with values of 10.4883 cm (T1) and 11.0933 cm (T6). Regarding fruit weight, T5, T2, and T4 showed the same weight, as did T2, T4, and T1. Treatments T1, T3, and T6 had the highest average weight, at 1.2867 g.

Regarding the percentage of total soluble solids, T6 obtained the best average with 10.20 °Brix, indicating that a lower planting density results in better quality of the Galia melon.

In terms of yield, T5 had the highest number of fruits per plant (32 fruits) and the best yield per hectare (11.70 t/ha). However, the highest commercial yield was T6, at 7.033 t/ha. It is concluded that planting density affects both total and commercial yield, with better results achieved at lower densities.

It is recommended to investigate different planting densities in different melon varieties and hybrids to optimize production.

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