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YIELD AND FRUIT QUALITY OF TWO INDUSTRIAL TOMATO HYBRIDS IN DIFFERENT PLANT POPULATIONS

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ABSTRACT

The spatial adjustment of tomato plant arrangement for industrial processing is a simple technology that allows better use of area, yield and product quality. Thus, the objective of this research was to evaluate the agronomic characteristics of industrial tomato hybrids in different plant populations. The experiment was conducted in a randomized block design and the treatments were arranged in a 2 x 6 factorial scheme, with 4 replications. The treatments were two tomato hybrids (H 1301 and HMX 7885) and six plant populations (18000, 22000, 26000, 30000, 34000 and 38000 plants per hectare). The plant population affected the yield and pulp yield in the industrial tomato independent of the hybrid.

Keywords: Density, ºBrix, Fruit quality, Pulp yield.

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INTRODUCTION

Tomatoes (*Solanum esculentum*) are cultivated and consumed practically everywhere in the world, ranging from vegetable gardens and greenhouses to large commercial farms, due to their great adaptability to various edaphoclimatic conditions and cropping systems (Souza et al., 2022).

This fruit stands out as one of the main vegetables grown in Brazil for industrial processing. Its production is basically concentrated in the Midwest region, and this activity generates employment, income and foreign exchange for the country (Moretti and Matos, 2009).

The genetic characteristics of cultivars and management practices, such as spacing and density, greatly influence tomato fruit production and quality for processing (Abdel-Mawgoud et al., 2007). Mehla et al. (2010) reported that plant population influences fruit production and quality parameters such as pulp yield.

It is notorious that the market is always looking for quality, because consumers are very demanding, so a better quality of fruit is sought to offer the final consumer a product with high quality. In addition, the agricultural sector is constantly improving its search for greater efficiency in production (Gonçalves Neto et al., 2015).

In view of the above, the objective of this study was to evaluate the yield and fruit quality of industrial tomato in two hybrids and different plant populations.

METHODOLOGY

The experiment was conducted in the area of the Larga Grande farm (16° 24' 10" south latitude and 47° 31' 2" west longitude), located in the municipality of Cristalina-GO, with an average altitude of 867 m, between January 2023 and August 2024. The rainfall index and temperatures during the experiment period were collected at a meteorological station 1.5 km away from the area (Figure 1).

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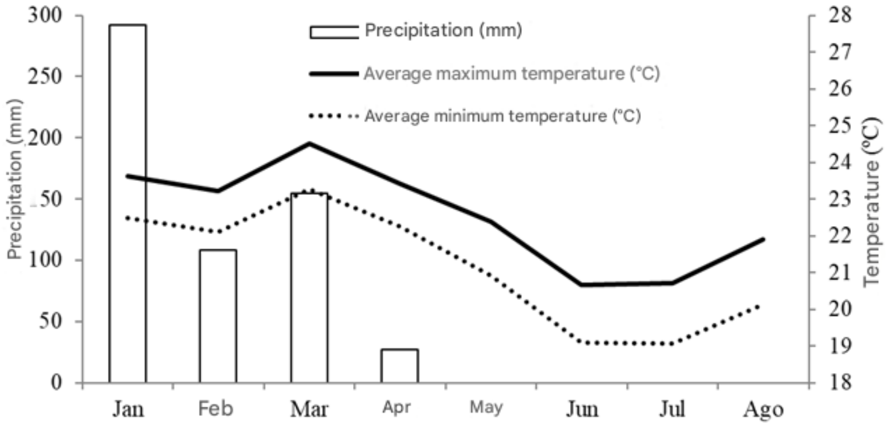
Figure 1. Rainfall and minimum and maximum average temperature in the municipality of Cristalina (GO) during the period of the experiment, January to August 2024.



Source: Irrigated Agriculture Situation Room – Amethyst Project - Orpheus Station (2024).

The soil classified as Red Yellow Latosol presented the following physicochemical characteristics at the depth of 0 to 0.20 m: pH in CaCl of 6.11; K, Ca, Mg, H+Al of 0.22; 4,9; 2,4; and 2.5 cmolc dm-3, respectively; P of 91.5 mg dm-3; organic matter of 3.09 dag $^{kg-1}$; and particle size of 34, 11 and 55 dag $^{kg-1}$ of clay, silt and sand, respectively.

The experimental design was adopted in randomized blocks and the treatments were arranged in a 2 x 6 factorial scheme, with 4 replications. Two tomato hybrids (H 1301 and HMX 7885) and five plant populations (18000, 22000, 26000, 30000, 34000 and 38000 plants per hectare).

Each experimental unit consisted of four double lines, ten meters long, and 0.5 m from each end was discarded for evaluations.

Soil preparation was carried out by means of plowing and two harrowings. Transplanting was carried out mechanically, on February 8, 2024, in double rows, with spacing of 0.7 m and 1.10 m between rows and varying the density in the row to reach the five populations studied.

For the supply of Ca and Mg, 2000 kg $^{ha-1}$ of dolomitic limestone was applied and to correct the S, 1100 kg $^{ha-1}$ of agricultural gypsum was used. In the base fertilization carried out, the haul applied 160 kg $^{ha-1}$ of K2O. In the planting furrow, 1500 kg $^{ha-1}$ of fertilizer formulated 06-29-00 (N, P2O5, K2O) was deposited in the planting furrow. Irrigation was carried out by central pivot and irrigation management was carried out through the replacement of crop evapotranspiration, using agrometeorological indicators of the region, soil type and plant development stage. Phytosanitary treatments, aiming at controlling

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weeds, pest insects and pathogens were carried out according to the need and following the recommendations for the crop.

At harvest, yield, pulp yield, total soluble solids (TSS), pH, color and consistency were evaluated. The fruit mass was obtained on a semi-analytical scale with a resolution of 0.01 g. The total soluble solids were determined by the method of modification of the refractive index of the solution, with the aid of a portable digital refractometer (model PAL-1, Atago), and the results were expressed in degrees Brix (ºBrix). The pH was determined directly on the crushed pulp using a digital benchtop pH meter (Model pH510 Series, OAKTON), calibrated with buffer solutions of pH 4.00, 7.00 and 10.00. All analyses were performed in duplicate. For consistency, a consistometer, the Bostwick®, was used. To determine the color, he used the Hunterlab® equipment. The pulp yield was estimated using the formula: $P_{(t/ha\ of\ pulp)}$= [(production$_{(t/ha)}$ x 0.95) x ºBrix of juice] / 28.

The data were submitted to analysis of variance (p <0.05) and, in case of significance, the means were submitted to regression analysis, using Sisvar software version 5.8.

RESULTS AND DISCUSSION

There was a significant effect only of the plant population on the variables. The plant population significantly affected the yield and pulp yield of the tomato plant (Table 1). Other variables, such as soluble solids content, hydrogen potential, color, and consistency were not influenced by the treatments.

Table 1. Mean squares and significance levels for the variables evaluated in the industrial tomato according to the source of variation.

FV	GL	Medium Square					
		Prod	Rp	º Brix	ph	Colour	Consistency
Hybrid (H)	1	5.79ns	0.55ns	0.11ns	0.01ns	0,000ns	0.63ns
Population (PP)	5	250,47**	3.75**	0.35ns	0.006ns	0.011ns	0,87
HxPP	5	31.98ns	0.25ns	0.31ns	0.005ns	0.008ns	3,24
Block	3	36.63ns	0.09ns	0.16ns	0.036ns	0.031ns	10.38ns
Error	33	27,02	0,70	0,12	0,004	0,008	1,48
CV		19,20	25,92	8,61	1,43	3,89	21,90
Average		122,77	16,43	4,13	4,38	2,30	5,55

[1/] FV = source of variation, GL = degree of freedom, Prod = yield, Rp = pulp yield, º Brix = soluble solids content, pH = hydrogen potential, Color = fruit color, CV = coefficient of variation. ns, *, ** = not significant, significant at 5 and 1%, respectively by the F test.
Source: Authors (2024).

The average tomato fruit yield for hybrids H 1301 and HMX 7885 was 118.96 and 126.57 t $^{ha-1}$, respectively. This result indicates that the evaluated materials showed

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adaptability to the environmental conditions of the cultivation site. According to Souza et al. (2022), the genotype x environment interaction is the main factor that influences fruit yield.

Mean values of 4.12 for Brix, 4.38 for pH, staining of 2.30 and consistency of 5.55 were observed (Table 1 and Table 2). The contents of total soluble solids (TSS) are the main responsible for the flavor of the fruit and tend to increase as maturation evolves, due to the degradation of polysaccharides (Ramos et al., 2013). According to Silva and Giordano (2000) the average desirable value for tomato fruits for processing is 4.50 ºBrix. Thus, higher values in this chemical attribute add flavor to the sauce produced, and promote better pulp yield (Soares and Rangel, 2012). According to Luz et al. (2016), climate conditions and irrigation and fertilization management can interfere with the content of soluble solids. Souza et al. (2022) evaluating materials 8328, U2006, BOSS, ADVANCE, and N901 found total soluble solids averages of 3.91 to 4.19 ºBrix of industrial tomatoes produced in the Mato Grosso region.

According to Silva and Giordano (2000), the pH values should vary between 3.7 and 4.5, and all the averages found in the different hybrids and spacings are within or close to this range. In addition, a pH lower than 4.5 inhibits the growth and proliferation of bacteria, contributes to the more acidic flavor of the tomato and helps in the conservation of the fruit after harvest. However, values higher than 4.5 require an increase in the temperature for sterilization and the processing time (Ferreira et al., 2017).

Table 2. Yield (Prod), pulp yield (Rp), soluble solids content (º Brix), hydrogen potential (pH), fruit color (color) and consistency of industrial tomato pulp as a function of hybrids and plant population.

Hybrid	Prod (t.ha-1)[1/]	Rp (t.ha-1)	º Brix	ph	Colour	Consistency
H 1301	118,96	16,05	4,07	4,40	2,31	5,44
HMX 7885	126,57	16,81	4,19	4,37	2,30	5,66
Plant Population						
18000	95,77	12,89	4,21	4,36	2,26	6,00
22000	113,80	14,54	3,95	4,41	2,34	5,06
26000	135,22	18,13	4,24	4,39	2,34	5,50
30000	143,43	21,41	4,45	4,34	2,33	5,37
34000	128,62	16,34	3,95	4,40	2,27	5,81
38000	119,75	15,28	3,95	4,37	2,29	5,56

Source: Authors (2024).

In general, the hybrids showed a color closer to red, as they were at the point of adequate maturation, meeting the requirement established by the industries for the production of sauce. The consistency is also within the average values, and the production of firm fruits considerably improves the conditions of post-harvest, transport and

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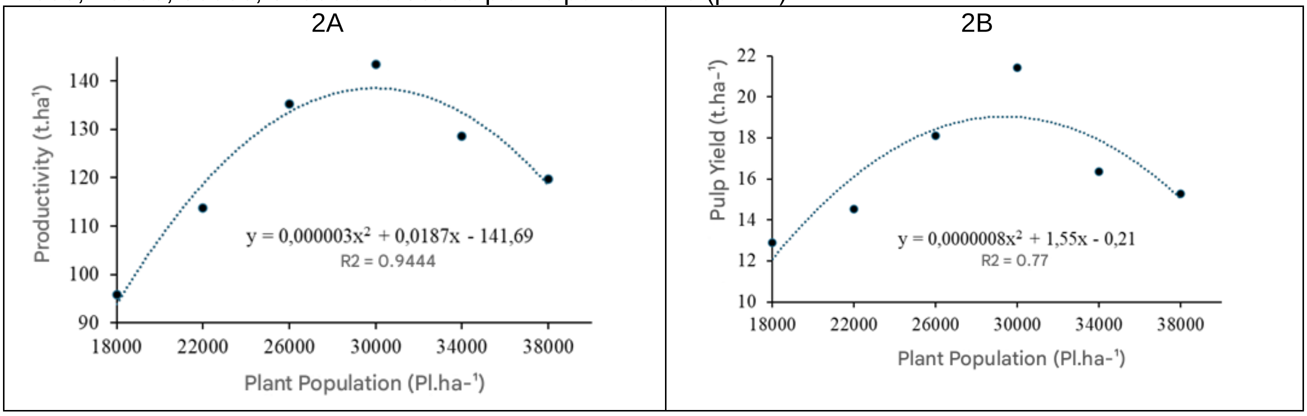
commercialization, reducing the susceptibility to mechanical damage and deterioration by the action of microorganisms (Aragão et al., 2004).

Yield (Figure 2A) and pulp yield (Figure 2B) were influenced by plant population. The hybrids H 1301 and HMX 7885 showed similar responses with a quadratic behavior in relation to the increase in the number of plants per hectare. Plant populations with 18000 and 38000 plants per hectare have similar values for these variables, and values of higher productivity and pulp yield are observed in populations close to 30000 plants. That is, both low and high densities harm the development of tomato plants.

Figure 2. Productivity (2A) and pulp yield (2B) of industrial tomato as a function of plant population (18000, 22000, 26000, 30000, 34000 and 38000 plants per hectare (pl $^{ha-1}$).



Source: Authors (2024)

These results differ from the study conducted by Wamser et al. (2012), which report that tomato densification can promote an increase in productivity, without compromising fruit quality and phytosanitary control. On the other hand, Maboko and Du Plooy (2013) and Maboko et al. (2017) report that tomato productivity is dependent on the plant population, however, a high population can result in smaller fruits, with lower soluble solids content, in addition to causing unnecessary stress on the plants, due to greater competition and incidence of pests and diseases (Wegayehu et al., 2015).

Additionally, due to the price of tomato hybrid seeds, the increase in plant population can burden the production system, which can hinder the return on invested capital, especially when there are losses in production quality (Cardoso et al., 2018). When testing plant populations in the creeping tomato plant, ranging from 25,974 to 35,714 plants $^{ha-1}$, Tuan and Mao (2015) reported higher yield, fruit size and higher fruit set in the smaller population, while Warner et al. (2002), testing densities between 33,300 and

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40,400 plants ha-1, reported the highest productivity at the density of 32,000 plants ha-1 and no influence of density on tomato fruit size.

However, Amundson et al. (2012) observed a linear increase in productivity and average size of tomatoes with increasing plant spacing (lower planting density). Thus, the hybrid's response to spacing is directly related to the genetic characteristic of the cultivar, edaphoclimatic and management conditions.

CONCLUSION

The study showed that there are no differences in the behavior between the two industrial tomato hybrids (HMX 7885 H1301), and both can be used in the edaphoclimatic conditions tested. On the other hand, plant population is a factor that influences pulp yield and productivity of tomato plants, and plant population around 30000 plants per hectare showed better results. This information is used as a parameter to be validated in other hybrids and under different soil conditions, climate, fertilization and water management.

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