CHAPTER

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Effects of fertilization with poultry litter on the cultivation of cherry tomatoes - *Solanum lycopersicum L.*

Crossref doi https://doi.org/10.56238/alookdevelopv1-181

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ABSTRACT

Among the vegetables of economic importance, the cherry tomato (Solanum lycopersicum L.) stands out, whose demand has increased over the years, which has caused its cultivation area to have grown. Generally, the cultivation of cherry tomatoes is done conventionally and the use of fertilizers and phytosanitary products during the crop cycle is common. On the other hand, the use of organic fertilization and biofertilizers is constituting a parallel route to reduce and/or replace the chemicals applied. The present study aimed to evaluate the effect of different doses of poultry litter fertilization on cherry tomato production. The experiment was carried out in a greenhouse with the cherry tomato cultivar Solanum lycopersicum cv. Sweet Heaven – Sakata@ and sixth batch poultry bed, with 120 days of fermentation, mixed with maravalha. The experimental design was completely randomized (IHD) with 4 treatments of 10 replications each. The fertilization occurred on two occasions: at planting and 20 days later, according to the treatments: T1 - Control; T2 - 35 g/pot; T3 - 70 g/pot; T4 - 105 g/pot; T5 - 140 g/pot. The data obtained were submitted to analysis of variance and Tukey's test. For the variables height of the 1st bunch and weight of the bunches, statistical differences were observed between the treatments, which did not occur for the variables number of bunches and fruits/plant and weight of the fruits. The T4 treatment was statistically different from the others in the variable height of the 1st bunch with an average of 57 cm. The same happened for the variable bunch weight, in which T1 presented heavier bunches than the others with an average of 89.1 g/bunch. It was concluded that the use of organic fertilization with poultry litter can be a complementary alternative for the fertilization of tomato crop.

Keywords: Organic Fertilization, Cultivation of the Tomato, Handling Sustainable, Organic cultivation techniques.

1 INTRODUCTION

The tomato (*Solanum lycopersicum* L.) belongs to the Solanaceae family and originates from the Andean countries, from northern Chile to Colombia (FAYAD *et al.*, 2016). Several types of tomatoes are found in the market, most notably the table tomato (S. lycopersicum*) and the cherry tomato (*S. lycopersicum *var. cerasiforme*) (BONNATO, 2014).

The cherry tomato stands out for having a smaller size, a sweeter and more delicate flavor to the palate, in this way it is used in the preparation of various dishes in modern gastronomy and also in the ornamentation of dishes, thus leading to greater popularity and growth in its production and consumption in *natura* (CARVALHO; PAGLIUCA, 2007).

A quality vegetable depends on several characteristics that directly influence consumer preference, such as physical, physico-chemical and chemical characteristics. In addition to these characteristics, there are others that also indicate organoleptic and nutritional quality of foods, in this case cherry tomatoes, such as total and/or soluble pectin; acidity, vitamins and reducing sugars (CARVALHO *et al*., 2005; CARDOSO *et al*., 2006).

The cherry tomato has small, rounded or grape-like fruits, weighing about 10 to 30 grams, bilocular, intense red or yellow in color for some hybrids, which draws a lot of attention for its strong coloration (FAYAD *et al*., 2016).

According to Madeira (2009) for the conduction of the crop, it is suggested the spacing between rows from 0.30 m to 0.50 m and spacing between plants to 0.50 m to 0.70 m, considering the planting of simple rows, being conducted with three to four stems. It is observed that the conventional tomato crop is still a major consumer of pesticides, due to the massive presence of pests and diseases, for the production of healthier foods and preservation of the environment the production of organic tomatoes (or under organic management) has been a business desired by several producers (LIBÂNIO, 2010).

As for organic agriculture, Côrrea, *et al*. (2012), highlights that in this type of cultivation the use of pesticides and genetically modified organisms is not allowed and the adoption of management practices that compromise the quality of the soil or that cause its loss by erosive processes is not tolerated, still seeking good management practices such as crop rotation, green manure and the use of plant extracts, homemade syrups, among others. According to Gonçalves (2022), the productivity of organic crops, so far, is very satisfactory, producing up to 3kg per plant more than the conventional.

With the increase of cultivated areas and dissemination of the organic model, it reduces the risks for producers, who do not need to come into contact with these agrochemical products, helps to avoid contamination of the environment and the main thing, offers the final consumer a quality product, healthy and without pesticide residues (GONÇALVES, 2022).

Alvarenga (2004) highlights the requirement of tomato plants in front of fertilization, because the efficiency of nutrient absorption by plants is considered low. The nutritional requirements vary throughout the development of the crop and depend on several other factors such as environmental conditions, soil and the choice of cultivar. Still, according to the author, the lack or excess of nutrients can be crucial for the development and final productivity.

The use of manure and other organic compounds according to Almeida *et al*. (1982) constitute a parallel way to reduce and/or replace the use of chemical fertilizers to be applied to agricultural crops, such as tomato. Leite *et al*. (2003) reiterates that the addition of organic compounds to the soil is an effective way of recycling nutrients and returning carbon to the soil gradually.

As a result of the increase in the production of poultry waste, the environmental impacts have also arrived, because its generation rate is much higher than its degradation rate, so it is necessary to recycle and reuse these residues from the agricultural activity, with the objective of recovering matter, energy, thus reducing its losses (OLIVEIRA *et al*., 2008). With this, the use of aviary bed has emerged as an effective and inexpensive alternative.

Wutke et al. in 2009, in their studies, observed after the application of the poultry litter, an increase in the concentration of macro nutrients, increase in the total carbon present in the soil, in addition to greater incorporation of organic matter in the soil, greater capacity of retention and infiltration of soil water, increase in soil pH, improvements in physical quality, chemical and biological soils, and increase in the productivity of various crops such as corn, soybeans, cotton and pastures.

The use of avian litter as organic fertilization allows at the same time a correct form of disposal of this waste as a form of fertilization capable of improving the physical, chemical and biological characteristics of the soil (OLIVEIRA *et al*., 2008).

Due to its relevance and information gap, the present study aims to evaluate the effect of different doses of poultry litter fertilization on cherry tomato production.

2 MATERIAL AND METHODS

2.1 STUDY LOCATION AND EXPERIMENTAL DESIGN

The experiment was conducted in a greenhouse of the Federal University of Paraná – UFPR in the municipality of Palotina, Paraná, at the following coordinates 24°17'35" S. and 53°50'27" W. The region has an altitude of 330 meters above sea level, warm and temperate climate, Red Latosol of clayey texture.

For planting, tomato seedlings with 20 days of the species Solanum *lycopersicum* L. variety Sweet Heaven – Sakata[@] (Solanaceae) were used. In turn, the poultry litter used originates from the sixth batch, with 120 days of fermentation, mixed with maravalha. Following the recommendation of organic fertilization, according to Morales (2019), the chemical analysis of the poultry litter used to verify whether the values are in accordance with the existing literature was performed (Tables 1 and 2).

Table 1. Average values for organic fertilizers commonly used in tomato fertilization.

Origin	Moisture (%)	Dry Mass (%)	Approve. N (%)	N content (%)	P2O5 content (%)	K2O content (%)
Poultry bed	15,0	85,0	0,3	2,4	2,5	2,0

Cast iron: Morales, 2019.

Table 2. Results of the chemical analysis of the poultry litter used as fertilization for cherry tomatoes.

Macronutrients	(g/kg)	%	Micronutrients	(mg/kg)	Other Features	
Nitrogen	24,33	2,43	Boro (B)	41,07	pH	7,85
Total Phosphorus (P)	20,53	2,05	Iron (Fe)	16650,00	Humidity (at 65ºC) (%)	18,07
Total phosphorus (P2O5)	47,01	4,70	Zinc (Zn)	1200,00	Organic Carbon (%)	4,97
Total Potassium (K)	7,58	0,76	Cobras (Cu)	159,75	Conductivity (mS/cm)	1,88
Total Potassium (K2O)	9,12	0,91	Manganese (Mn)	2225,00	Volatile Solids (%)	39,11
Sulphur (S)	3,05	0,30				
Calcium (Ca)	70,73	7,07				
Magnesium (Mg)	24,11	2,41				

Source: Own authorship (2023).

The experiment was implemented on 02/05/2022 with definitive transplantation of tomato seedlings in 8-liter plastic pots. The data on the chemical characteristics of the soil are shown in Table 3.

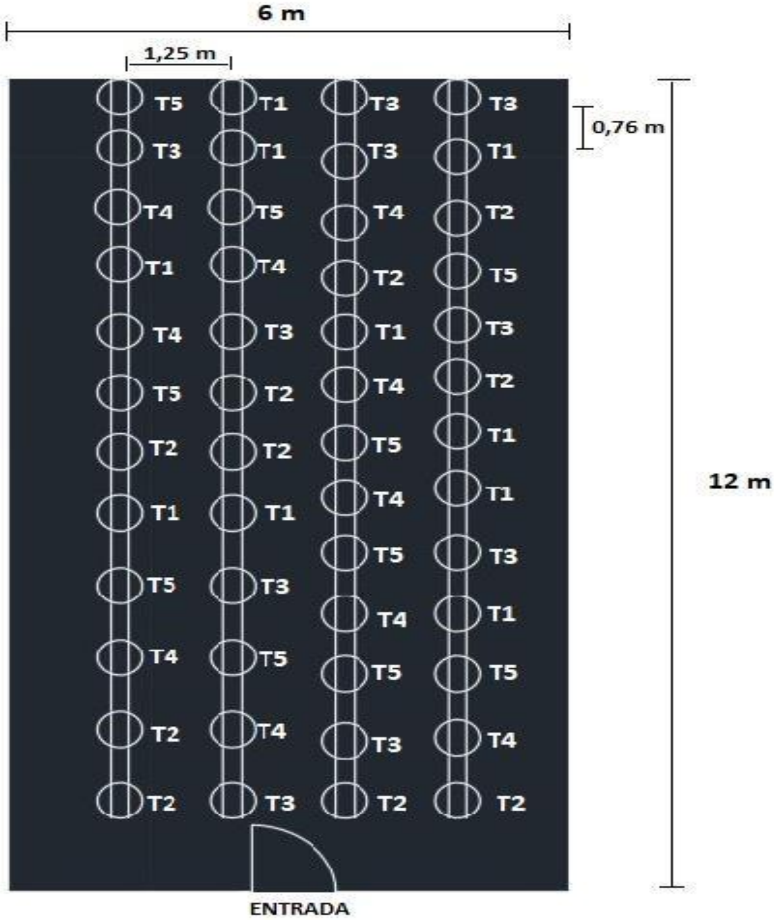
Table 3. Results of soil chemical analysis.

Macronutrients		
Elements	**Results (cmol /dm³)**	**Level of interpretation**
Calcium (Ca)	5,21	High
Magnesium (Mg)	1,26	High
Potassium	0,20	Medium
	(mg/ dm³)	**Level of interpretation**
Phosphorus (P)	19,90	-
	(Cmol /dm³)	**Level of interpretation**
Sum of bases (S)	**6,67**	-
CTC efetiva (t)	**6,67**	High
CTC pH 7,0	**10,07**	Medium
	(Cmol /dm³)	**Level of interpretation**
Carbon	5,84	Low
M. Organic (M.O)	10,08	Low
	pH	
SMP pH	6,51	
pH CaCl2	5,14	
	Acidity (Cmol /dm³)	
Potential acidity (H+Al)	3,40	

Source: Own authorship (2023).

The experiment was implemented using a completely randomized design (IHD) with four treatments and 10 replications each. The 50 seedlings were arranged in 4 lines, with the spacing between these pots of 0.76 m and 1.25 m between the rows (Figure 1).

Figure 1. Organization and spacing of pots for growing cherry tomatoes.



Source: Own authorship (2023).

The fertilization was carried out in two stages, half the amount at planting and the second 20 days after according to the types of treatment: Control (T1) – Only soil; Treatment 2 (T2) – 35 g/vessel; Treatment 3 (T3) – 70 g/vessel; Treatment 4 (T4) – 105 g/vessel; Treatment 5 (T5) – 140 g/vessel. The doses of the treatments were equivalent to 0 and 20 ton/ha-1, being: T1 – 0 ton/ha-1; T2 – 5 tons/$^{ha-1}$; T3 – 10 tons/$^{ha-1}$; T4- 15 ton/ha-1 and T5 – 20 ton/ha-1.

Regarding the cultural treatments, the conduction of the tomato crop was under the carousel system consisting of tutoring with wire wires horizontally, above the rows of tomatoes. The plants were conducted with ribbons that were tied to the wires. Phytosanitary management for weed control was carried out fortnightly through weeding and manual grubbing as needed. The application of 2% Neem oil and cow urine with a dilution of 200 ml for every 20 liters of water was used for repellency and pest control and with the same dosage. Disease control was not necessary. Irrigation was performed with the application of approximately 1 L of water/plant/day via drip.

2.2 DATA ANALYSIS

The mass of the bunches and fruits were measured using portable precision digital and the height of the 1st bunch with the use of a tape measure. All data obtained in the samples were submitted to analysis of variance and Tukey test, at a significance level of 5% by the SISVAR software (FERREIRA, 2011).

3 RESULTS

The analysis of variance indicated that for the variables height of the bunch and weight of the bunches, statistical differences were identified between the treatments evaluated. While the variables number of fruits per bunch and weight of each fruit in the bunch showed no statistical difference between the treatments (Table 4).

Table 4. Results of the Analysis of Variance for the variables Height of the Cluster, Number of Bunches/Plant, Amount of Fruits/Cluster, Weight of the Bunches and Weight of the Fruits of the tomato plants under the influence of fertilization with poultry litter.

Factor of Variation	GL	SQ QM F		P
Height Cacho (cm)				
Treatment	4	2708,00 677,00 3,203		0,0213
Error	45	9510,00 211,3333		
Total Fixed	49			
CV (%)	32,89			
Overall Average (unit)	40,20	Number of Observations		50
Number of Curls/Plant (unit)				
Treatment	4	23,32 5,83 1,185		0,3303
Error	45	221,40 4,92		
Total Fixed	49			
CV (%)	27,18			
Overall Average (unit)	8,16	Number of Observations		50
Amount of Fruits/Basket (unit)				
Treatment	4	130,920653	32,730163 0,843	0,4995
Error	195	7571,874347	38,830125	
Total Fixed	199			
CV (%)	52,39			
Overall Average (unit)	11,895		Number of Observations	200

Cacho Weight (g)					
Treatment	4	4771,13	1192,78	2,548	0,0407
Error	198	92704,41	468,20		
Total Fixed	202				
CV (%)	26,93				
Overall Average (unit)	80,33		Number of Observations		203
Fruit Weight (g)					
Treatment	4	27,264682	6,816171	2,263	0,0637
Error	198	596,311672	3,011675		
Total Fixed	202				
CV (%)	13,12				
Overall Average (unit)	13,22660		Number of Observations		203

GL = Degrees of freedom; SQ = Sum of squares; QM = Mean Square; F-value; P-value; CV (%) = Coefficient of variation; * = significant at 5% probability; ns = not significant. Source: Own authorship (2023).

The comparison of the means of the variables evaluated between the treatments with different doses of fertilization with poultry litter are in table 5.

Table 5. Results of Tukey's test (comparison of means) for the variables Height of the Cluster, Number of Fruits per Cluster, Weight of Fruits and Weight of the Basket on the influence of fertilization with poultry litter in the cultivation of cherry tomatoes. **(g)**

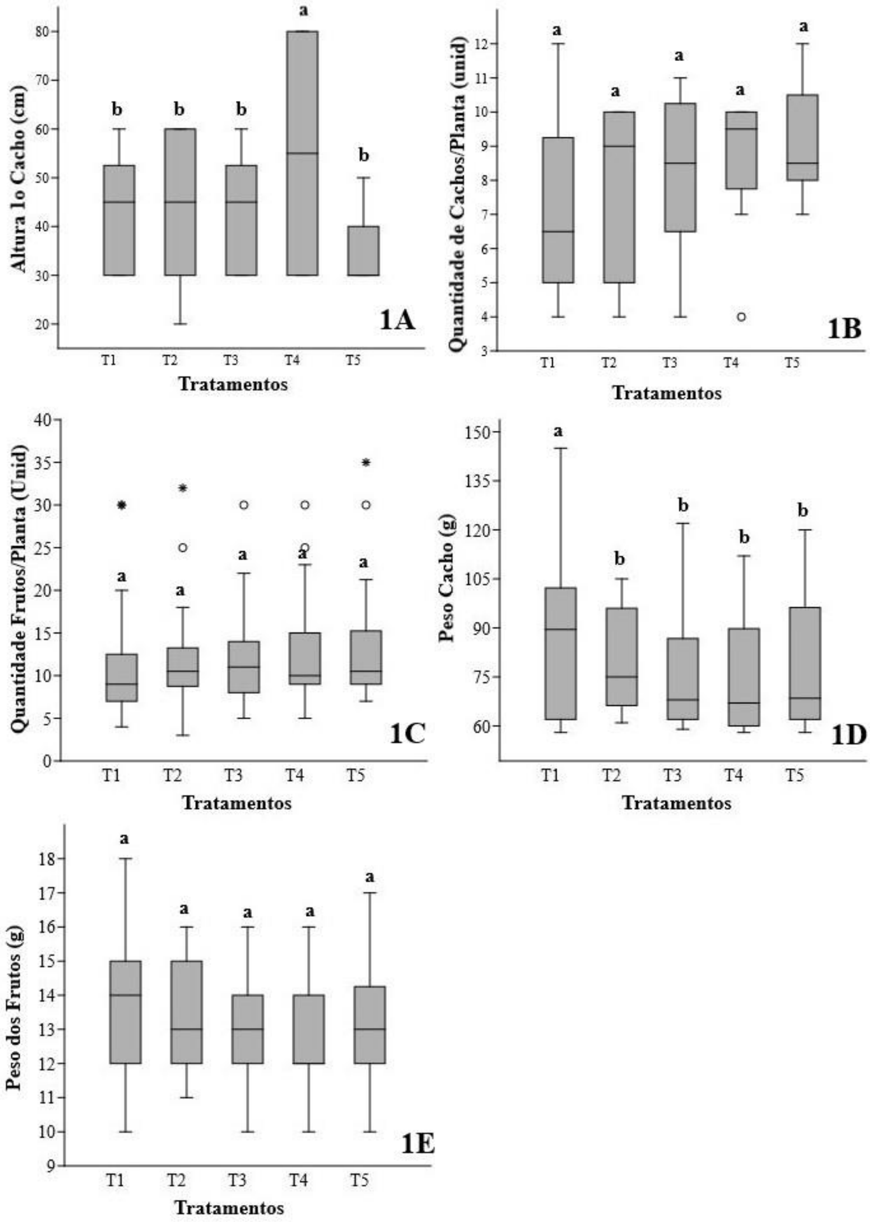
Treatments	**Height 1st Basket (cm)**	**Quantity Curls (unit)**	**Quantity Fruits (unit)**	**Fruit Weight (g)**	**Weight Cacho (g)**
Treatment 1	43,00 b	7,10 a	10,78 a	13,78 a	89,19 a
Treatment 2	44,00 b	7,80 a	11,74 a	13,47 a	79,75 b
Treatment 3	43,00 b	8,20 a	11,67 a	12,95 a	79,37 b
Treatment 4	57,00 a	8,60 a	12,02 a	12,77 a	78,24 b
Treatment 5	34,00 b	9,10 a	13,23 a	13.12 to	74.75 b

*Means with different letters in the column, differ statistically by Tukey's test (p<0.05). Source: Own authorship (2023).

For the variable height of the 1st bunch, the T4 treatment differed statistically from the others, with an average of 57 cm. For the variable weight/bunch, T1 differed from the others, with an average of 89.1 g/bunch. For the other variables, no differences were recorded between the treatments. In a complementary way, in T1 were measured lower amount of fruits/bunch (X = 10.78 fruits/bunch), but with heavier bunches. In T4 and T5, the inverse was identified with more fruits/bunch (12.02 and 13.23 fruits/bunch, respectively) and lighter bunches (74.7 and 78.2 g/bunch).

The application of higher doses of fertilization with poultry litter did not show differences in the production of Cherry Tomatoes, but allowed the plants to produce greater amounts of bunches and fruits (Figure 2).

Figure 2. Influence of fertilization with poultry litter on the productive characteristics of cherry tomato cultivation. 1A - Height of the 1st Cluster, 1B - Amount of Cluster / Plant, 1C - Amount of Fruits / Plant, 1D - Weight of the Bunches and 1E Weight of the Fruits.



Source: Own authorship (2023).

4 DISCUSSION

The differences found between the variables analyzed may have occurred due to the imbalance in the amounts of N, P and K available in the poultry litter, since these nutrients are not in the proportion that the tomato crop requires, according to the recommendations of the Manual of Fertilization and Liming (SBCS, 2004).

Another conditioning factor is the lack of synchronism between the mineralization of the nutrients of the organic fertilizer and the times of greater accumulation of nutrients by the crop. According to Fayad *et al*. (2002), the time of greatest absorption of nutrients coincides with the beginning of fruiting. Citing as an example the case of nitrogen this period corresponds to 46 days after planting. In turn, Azeez and Van Averbeke (2010), evaluated the rate of N mineralization of manure of animal origin, being observed that the N is mineralized rapidly in the first 30 days of application, leading to losses of N by leaching if the period of greater absorption of the nutrient by the crops does not coincide with this time.

The organic fertilization with poultry litter did not allow the occurrence of higher commercial yields of tomatoes compared to its non-application. Mueller *et al.* (2008) corroborate this information, demonstrating that the increase in production occurred when together with organic fertilization was performed with supplementation with mineral fertilization.

The efficiency of fertilizers of organic origin is directly related to the quality and quantity of the material applied, since its chemical composition can vary significantly (Fernandes et al., 2009). Therefore, it is essential to previously analyze the physicochemical characteristics of the soil and properly calculate the fertilization according to the requirements of the crop. This procedure was performed by Algeri (2018) when analyzing the use of pig and poultry manure in vegetables, and it was observed that the liquid swine waste had a higher concentration of nitrogen (N) compared to phosphorus (P) and potassium (K), while the poultry litter had more K and P than N. These differences resulted in deficiencies of some nutrients in the crop, adversely affecting production. On the other hand, when the two types of fertilizers were combined, the results were better. The combination of these two residues provided the crop with more balanced values of N, P and K, necessary for a good production. However, in this specific work, the results were not satisfactory, which can be attributed to the imbalance of nutrients in the crop. This indicates the need for additional supplementation both through mineral fertilization and other types of organic fertilizers.

Isolated organic fertilization can be an alternative when the soil expresses some type of limitation such as low N concentration or water deficit, for example, or the producer has both financial and logistical limitations to acquire mineral fertilization (PASCALE *et al*., 2016).

Muller et al. (2008), when analyzing the effect of organic fertilization complemented with different doses of mineral fertilization, found that there was higher productivity in plants that received fertilization with aviary litter. The authors highlighted that this effect may have been a result of supplementing the recommended amounts of macronutrients (N, P, K) for the crop.

The application of poultry litter increases the organic residues in the soil, stimulating the microbial population and demanding a greater supply of nutrients, which results in a better development of plants, in this case, increasing their size (SIQUEIRA AND FRANCO, 1988)

The application of poultry litter increases the amount of organic waste in the soil, stimulating the microbial population and increasing the demand for nutrients. This results in better plant development, especially in terms of size, which has repercussions on the final production (SIQUEIRA AND FRANCO, 1988).

5 FINAL CONSIDERATIONS

The organic fertilization with poultry litter in different doses for the cultivation of cherry tomatoes did not result in significant changes between the variables evaluated. However, its application can be an alternative fertilization to replace mineral fertilization. It is noteworthy that in certain regions the supply of this type of product is greater, and this provides farmers with greater ease in its acquisition and also more competitive prices compared to other sources of fertilization.

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