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Cherry tomato production with different doses of organic compost

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Cherry tomato cultivation in protected environments ensures production in the off-season, reaching yields up to 100 t ha^{-1} with 150 days of cultivation. Fertilization with organic composts can influence the production components of cherry tomato. From this perspective, this study aimed to evaluate different doses and organic composts, based on their nitrogen contents, on the production components of cherry tomato. The experiment was conducted in the municipality of Boa Vista - RR, at the Agrotechnical School (EAgro) of the Federal University of Roraima (UFRR), Campus Murupu. Cherry tomato cultivation was performed in a protected environment (greenhouse). The experimental design was in randomized blocks with a 4 × 5 factorial arrangement referring to four types of compost (pigeon pea and rice husk; pigeon pea and sawdust; poultry manure and rice husk; and poultry manure and sawdust) and five doses (50, 125, 200, 275, and 350 kg ha^{-1}) calculated based on the nitrogen content of the inputs, with four replications. The experiment evaluated the number of fruits per plant, the mean fruit mass, the mean fruit mass per plant and treatment, and the mean yield per hectare. There was no significant difference at 5% probability for the doses, composts, and the interaction between doses and composts for all studied variables. The mean yield was 14.31 t ha^{-1}. The type of compost did not influence the production components of cherry tomato. Cherry tomato yield was not increased by the organic composts in the protected environment.

Key words: *Solanum lycopersicum* var. *cerasiforme*, nitrogen, organic fertilizer.

INTRODUCTION

Tomato is a significant crop for rural producers. Depending on the purpose (industry or fresh consumption), its cultivation can be 100% mechanized, with a market value that may vary considerably but usually ensuring a steady income to the participants of its production chain. In 2018, tomato production in Brazil yielded 4 million tons in a harvested area of 71,940 ha, with the states of Goiás, São Paulo, and Minas Gerais ranking as the largest producers with the respective areas of 14,682, 11,075, and 7,320 ha (IBGE, 2018). In the North region, the major tomato-producing states are Pará, Rondônia, and Roraima, with 233, 201, and 118 ha, respectively (IBGE, 2018).

The tomato cultivars are divided into four broad groups:

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cherry, Italian, salad, and Santa Cruz (Filgueira, 2012). Cherry tomato cultivation is attractive due to its profitability, which, according to Negrisoli et al. (2015), may reach up to 80%, including production costs, except for infrastructure expenses. Cultivation in protected environments can ensure production in the off-season, especially in places with intense rainfall, as it mitigates losses and optimizes fertilization. Tomato yield in protected environments may reach up to 100 t ha^{-1} in 150 days of cultivation (Genuncio et al., 2010), and most commercial cherry tomato cultivars do not tolerate heat; moreover, warm and humid regions may be attacked by bacterial wilt (Marques, 2018).The mineral nutrition of tomato relates to its yield as nitrogen (N) influences its growth and production (Ferreira et al., 2010). Ferreira et al. (2010) observed that the weight and number of tomato fruits increased with increasing soil N levels. N is extremely important in terms of nutrient control in plants as it influences fruit weight, production, and yield, among other agronomical attributes. Therefore, high nitrogen uptake by plants should be compensated by fertilization (Ferreira et al., 2010). Organic matter supplementation in tomato cultivation intensifies the levels of the nitrogen fertilizer, indispensable to reach maximum total production (Ferreira et al., 2003). Fertilization can be performed using organic composts. However, the N supply for the crop depends on the nature and content of this nutrient in the soil, the carbon/nitrogen ratio (C/N) of plant remains, the degree of contact of the mulch with soil colloids, and the N demand by decomposers (Calvo, 2010). Organic materials improve the physical, chemical, and biological characteristics of the soil, resulting in high fertility and better conditions for water retention, porosity, and aggregation, favoring the cation exchange and microbial life (Mueller et al., 2013). The compost is an organic fertilizer that assists in solving environmental problems related to agro-industrial residues, such as rice husk and sawdust, carbon-rich materials that are readily available in the Industrial District of Boa Vista, RR. The composition of organic composts demands nitrogen sources (N), favoring regional poultry farmers who use broiler manure. However, this material that becomes available for use in organic or agroecological agriculture has its restrictions. From this perspective, using a nitrogen-rich plant source in the compost, such as pigeon pea, could constitute an alternative to decreasing the dependence on animal sources. The state of Roraima is characterized by settlement projects in which family farming is a predominant activity. The soils in Roraima are usually poor in OM and show low nutrient availability, especially nitrogen (N) and phosphorus (P) (Melo et al., 2003). An expressive number of family farmers work with olericulture, most of whom use low-quality organic materials. The search for the sustainability of production systems is an aspiration of producers, students, and defenders of organic and agroecological productive models as agrochemical-based systems tend not to respect the soil-plant system. Food production with compost fertilizers favors the financial aspect of producers and provides healthy food for consumers. Moreover, the cultivation approach based on ecological fertilization principles is usually well-received by small producers.

Producers should seek to improve the physical and biological soil conditions by incorporating organic materials that are good soil conditioners, making it more favorable to agriculture, improving water penetration and retention, and favoring the structure, aeration, and porosity of the soil. This increases microbial life and even eliminates pathogens, favoring nutrient availability, making clayey and compact soils more favorable, as well as sandy and poorly structured soils (Filgueira, 2012). In Roraima, studies are still incipient with regard to agricultural production based on ecological fertilization, justifying the search for alternatives to guide the adoption of organic production systems, especially for producing horticultural species using organic inputs only.

From this perspective, this study aimed to evaluate the effect of different doses and organic composts on the production components of cherry tomato.

MATERIALS AND METHODS

Location of the experiment

The experiment was conducted in the municipality of Boa Vista, Roraima, Brazil, at the Agrotechnical School (EAgro) of the Federal University of Roraima, Campus Murupu, 03°04'13.2'' N and 060°48'57.5'' W (Datum WGS 84), distant approximately 35 km from the capital, Boa Vista, heading toward Pacaraima, north of Highway BR 174. The soil of the experimental area was classified as a Dystrophic Yellow Argisol (Embrapa, 2013).

Area preparation and planting

Cherry tomato cultivation was performed in a bow-shaped protected environment (greenhouse) built with a north-south orientation and covered with transparent polyethylene. The structure was 50 m long, 7 m wide, 4 m high, and had its laterals protected from the base to the maximum height with a 50% shading screen.

The area was first weeded with a hoe, after which a tractor (75 hp) was used to pull a ridger with 1.2 m wide rotary discs, removing crop remains and weeds, which were incorporated into the soil. Considering the width of the greenhouse, the usable space was divided into four planting ridges (blocks) 1.2 m wide, with a 0.44 m space between ridges.

The cherry tomato seedlings were produced in polystyrene trays with 162 cells, each with 33 mL. Transplantation was performed when the seedlings had four definitive leaves, around 25 days after emergence, in the second week of August 2019. The space between plants was 0.40 m.

Experimental design

The experimental design was in randomized blocks, with a 4 × 5 factorial arrangement referring to four types of compost (pigeon pea and rice husk; pigeon pea and sawdust; poultry manure and rice

Table 1. Soil chemical attributes at the 0-10 cm and 10-20 cm soil layers before the experiment began.

Depth (cm)	pH (H_2O)	O.M.	P	K	Ca	Mg	H+Al
		g dm^{-3}	mg dm^{-3}		mmolc dm^{-3}		
0-10	6.1	9	35	58.5	16	3	15
10-20	5.4	7	93	39	9	2	20
	Al	S	Cu	Fe	Zn	Mn	B
	mmolc dm^{-3}	mg dm^{-3}	mg dm^{-3}				
0-10	0	14	1.6	21	7.8	49	0.61
10-20	0	11	1.5	24	4.7	45	0.2

Source: Pirasolo Agrotechnical Laboratory.

Table 2**.** Nutrient contents of the four types of compost used in the study.

Compost	g of nutrients kg^{-1} compost							
	N	P	K	Ca	Mg	S	% C	C/N ratio
GA	6.07	0.56	1.6	2.83	0.57	0.7	15.89	26.19
GS	13.77	0.84	1.46	4.17	1.01	1.1	24.88	18.07
PA	10.5	19.47	7.3	52	5.12	2.2	12.23	11.6
PS	27.07	63.00	22.00	182.00	33.87	5.27	17.60	14.04

GA: Pigeon pea and rice husk; GS: pigeon pea and sawdust; PA: poultry manure and rice husk; PS: poultry manure and sawdust.

husk; and poultry manure and sawdust) and five doses (50, 125, 200, 275, and 350 kg ha^{-1}) calculated based on the nitrogen content of the inputs, with four replications. Each planting ridge (block) was 48 m long, and the experimental plot was 2.4 m long and 1.20 m wide. Each plot was formed by six plants, and the three central plants formed the useful plot.

Fertilization

Before the experiment began, soil samples were collected (10 individual samples forming a composite sample) in the protected environment area at the 0-10 and 10-20 cm depths. After collection, the samples were air-dried and sieved through a 2 mm mesh sieve, thus obtaining the air-dried fine earth (TFSA). The TFSA samples were stored in plastic bags and sent to the Pirasolo Agrotechnical Laboratory in the state of São Paulo, Brazil, where the contents of macro and micronutrients were determined (Table 1).

The organic composts used in this study, acquired from EMBRAPA Roraima, were the subject of a study on the production and characterization of organic composts based on by-products from the agro-industrial complex of Boa Vista/RR.

The four types of compost, pigeon pea and rice husk (GA), pigeon pea and sawdust (GS), poultry manure and rice husk (PA), and poultry manure and sawdust (PS), were analyzed with regard to their chemical composition (Table 2). The contents supplied to each plot, consisting of the doses of 50, 125, 200, 275, and 350 kg ha^{-1}, were calculated as a function of their N contents (Table 3).

Natural phosphate was applied homogeneously throughout the experiment at the dose of 120 kg ha^{-1} of P_2O_5 (20% P_2O_5). The organic composts were applied to the planting holes. The content of compost, in kg ha^{-1}, was calculated as a function of the N content to estimate how many kilograms should be applied per plot, thus determining the content per planting hole. A 30% fraction of the compost was supplied via basal fertilization, while the remainder was applied as topdressing, split into three applications: 30% in the first and second applications and 10% in the last application, totaling 100% of each dose (Table 3).

Crop management practices

The plants were not trained. Irrigation was performed by dripping using micro-perforated hoses with a 20 cm distance between holes. The experimental area was hoed at 20 and 40 days after planting. The area was attacked by bacterial wilt in the flowering period, and all plants fertilized with the composts containing poultry manure (Table 3) were affected. To prevent the infestation of the entire production area, the plants fertilized with composts based on poultry manure and rice husk and poultry manure and sawdust were uprooted and burned. Therefore, the results mentioned here refer to the composts in which the N source was of vegetal origin: pigeon pea and rice husk compost, and pigeon pea and sawdust compost (Table 3).

Harvest

Fruit harvest began 53 days after transplantation. The fruits were collected in 1 L paper bags, counted, and weighed, thus determining the number of fruits per plant (fruits plant^{-1}), the mean fruit mass (g fruit^{-1}), the fruit mass per plant (g plant^{-1}), and the yield (t ha^{-1}).

The data were subjected to analysis of variance (ANOVA) using the statistical software Sisvar (Ferreira, 2014). The means referring to the types of compost were compared by the Scott-Knott test at 5% of probability, while those referring to the doses were compared by polynomial regression.

Table 3. Compost doses used for fertilization in the experimental plots.

Compost	Dose of N (kg/ha)	kg/ha compost	Dose of compost plot^{-1} kg (2.4 m^2)	Basal fertilization	Top-dressing fertilization	
				kg/hole (30%)	1st and 2nd kg/hole (30%)	3rd kg/hole (10%)
GA	50	8237.23	1.968	0.0984	0.0984	0.0328
	125	20593.08	4.944	0.2472	0.2472	0.0824
	200	32948.93	7.896	0.3948	0.3948	0.1316
	275	45304.78	10.872	0.5436	0.5436	0.1812
	350	57660.63	13.848	0.6924	0.6924	0.2308
GS	50	3631.08	0.864	0.0432	0.0432	0.0144
	125	9077.71	2.184	0.1092	0.1092	0.0364
	200	14524.33	3.48	0.174	0.174	0.058
	275	19970.95	4.8	0.24	0.24	0.08
	350	25417.57	6.096	0.3048	0.3048	0.1016
PA	50	4761.9	1.152	0.0576	0.0576	0.0192
	125	11904.76	2.856	0.1428	0.1428	0.0476
	200	19047.62	4.56	0.228	0.228	0.076
	275	26190.48	6.288	0.3144	0.3144	0.1048
	350	33333.33	7.992	0.3996	0.3996	0.1332
PS	50	1847.74	0.4434	0.1330	0.1330	0.04434
	125	4619.36	1.1086	0.3325	0.3325	0.1108
	200	7390.98	1.7738	0.5321	0.5321	0.1773
	275	10162.60	2.4390	0.7317	0.7317	0.2439
	350	12934.22	3.1042	0.9312	0.9312	0.3104

GA: Pigeon pea and rice husk; GS: pigeon pea and sawdust; PA: poultry manure and rice husk; PS: poultry manure and sawdust.

Table 4. Mean values of the number of fruits per plant (NFP), mean fruit mass (MMF), fruit mass per plant (MFP), and yield of cherry tomato fertilized with pigeon pea and rice husk compost (GA) and with pigeon pea and sawdust compost (GS).

Compost	NFP (fruits plant^{-1})	MMF (g fruit^{-1})	MFP (g plant^{-1})	Yield (t ha^{-1})
GA	84.40^a	7.86^a	677.40^a	13.50^a
GS	97.20^a	7.80^a	756.00^a	15.12^a

Means followed by the same letter do not differ statistically by the Scott-Knott test at 5% probability.

RESULTS AND DISCUSSION

The cherry tomato production components were not influenced by the isolated effects of the composts, doses, or the interaction between these factors. Table 4 shows the mean values of the number of fruits per plant, mean fruit mass, production per plant, and yield of cherry tomato fertilized with pigeon pea and rice husk compost and with pigeon pea and sawdust compost.

The doses were established as a function of the N content. The amounts of the composts in kg ha^{-1} may have been insufficient to meet the demand of the other nutrients, even at the highest N dose of 350 kg ha^{-1}. For example, at the highest N dose in the GS compost, a total of 21.35 kg of P, 37.10 kg of K, 105.99 kg of Ca, 25.67 kg of Mg, and 27.95 kg of S is applied. According to Table 1 (soil chemical attributes in the 0-10 cm and 10-20 layers), the interpretation of soil analysis reveals that the levels of P and K should be 450 and 100 kg ha^{-1}, respectively (Costa, 2008). According to Filgueira (2012), P is the fifth nutrient in order of extraction but the first in response to fertilization, while K is the most required nutrient by the tomato crop, followed by N, Ca, S, P, and Mg. Moreover, P and Ca are two macronutrients that favor the widening of the root system (Filgueira, 2012).

Nutrients do not act in isolation. They are parts of a whole, factors explained by the law of interaction, in which “each production factor is all the more effective when the others are closer to their optimum”, that is, if they interact, with one or more elements exercising

Table 5. Number of fruits per plant (NFP), mean fruit mass (MMF), fruit mass per plant (MFP), and yield of cherry tomato fertilized with different doses of pigeon pea and rice husk compost (GA) and with pigeon pea and sawdust compost (GS).

Compost	Kg/N /ha	NFP (fruits plant^{-1})	MMF (g fruit^{-1})	MFP (g plant^{-1})	Yield (t ha^{-1})
GA	50	80.9^{a}	7.8^{a}	641.2^{a}	12.82^{a}
GS		103.7^{a}	7.6^{a}	796.5^{a}	15.9^{a}
GA	125	77.7^{a}	7.9^{a}	629^{a}	12.6^{a}
GS		100^{a}	8.2^{a}	817^{a}	16.3^{a}
GA	200	78.5^{a}	7.4^{a}	603.3^{a}	12^{a}
GS		88.5^{a}	8.5^{a}	753.8^{a}	15^{a}
GA	275	96.5^{a}	8.2^{a}	811.5^{a}	16.2^{a}
GS		79.8^{a}	7.2^{a}	575.7^{a}	11.51^{a}
GA	350	88.4^{a}	7.9^{a}	701.9^{a}	14^{a}
GS		114^{a}	7.3^{a}	837^{a}	16.7^{a}

Means followed by the same letter do not differ statistically by the Scott-Knott test at 5% probability.

mutual or reciprocal influence, this interaction may be either synergistic or antagonistic (Camargos, 2005). There may be a lack of synchronicity in organic fertilization with respect to the time of highest nutrient accumulation by the plant, with the mineralization of nutrients present in the organic fertilizer (Mueller et al., 2013). Lisboa et al. (2018), when evaluating the nitrogen mineralization rate of organic residues, concluded that the organic compost should be applied approximately 15 days before planting. This management technique does not affect the N supply to plants due to the variability in the mineralization rates of this nutrient.

The mean yield of 14.31 t ha^{-1} was below the values obtained by other authors (Table 4). When studying the yield of cherry tomato grown in a protected environment and in the open as a function of irrigation levels and frequencies, da Fonte Franca (2017) obtained 1,756 and 2,149 g/plant for the protected and open environments, respectively, considering a population of 16,500 plants/ha (0.40 m × 1.50 m), with yield values of 28.974 and 35.458 t. It was mentioned that flower abortion in the protected environment is higher than in the open. Likewise, when studying the effect of irrigation levels and frequencies on grape tomato using 100 kg N/ha, Marques (2013) obtained values ranging from 1,090 to 1,520 g/plant for plants grown in the open, considering 20,083 plants/ha (0.40 m × 1.20 m), with the respective yields/ha of 21.89 and 30.526 t.

The mean values of the production components of cherry tomato as a function of the composts and doses used in the study are shown in Table 5.

Rossi (2011), evaluating the yield and quality of cherry tomato intercropped with green manures and mulch and without supplementary irrigation, obtained mean values of 44 fruits plant^{-1}, 479 g of fruits plant^{-1}, and a mean fruit mass of 15.41 g fruit^{-1}, concluding that the treatments had no significant effect at 5%. Although the author did not provide the yield data, the estimated fruit mass per plant reveals that the mean yield was below the value obtained in the present study.

When studying the production of tomato cultivars under hydroponic and fertigation conditions with nitrogen and potassium doses of 150 kg ha^{-1} N and 50 kg ha^{-1} P combined with 300 and 450 kg ha^{-1} K, Genuncio et al. (2010) obtained, in the hydroponic and fertigated environments, 1,680 and 1,500 g/plant, 34 and 33 g of mean fruit mass, and 4,900 and 4,200 g of fruits/ m^2, respectively, for the cherry tomato cultivar 261. On the other hand, the values obtained for the cherry tomato cultivar Chipano were 1,750 and 1,580 g/plant, 16 and 18 g of mean fruit mass, and 4,600 and 4,400 g of fruits/m^2. Therefore, the yield of cherry tomato cultivars is similar when they are grown under hydroponic conditions and using fertigation.

Conclusion

The type of compost did not influence the production components of cherry tomato. The doses of organic compost did not increase the yield of cherry tomato grown in the protected environment. The focus on N probably overlooked the contents of other nutrients as they all interact with each other.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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