



(RESEARCH ARTICLE)



Application of sheep manure at different doses incorporated into a Latosol in lettuce production

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Abstract

The growing demand for more sustainable agricultural practices has encouraged the adoption of organic fertilization as a viable alternative to mineral fertilizers. This experiment was conducted from August to November 2024 at the Rafael Fernandes Experimental Farm of the Department of Plant Sciences at the Federal Rural University of the Semi-Arid Region (UFERSA), in the district of Alagoinha (5°03'37"S, 37°23'50"W), with the objective of evaluating the application of sheep manure at different doses incorporated into a latosol in lettuce production. The experiment was conducted in pots under a randomized block design, with four treatments and five replications. The treatments consisted of four periods of sheep manure incorporation, varying the incorporation times (0, 21, 35, and 49 days before transplanting). The following agronomic characteristics were evaluated: plant height, number of leaves, head diameter, fresh mass, and dry mass. The best agronomic performance was observed in the 49-day period following the application of sheep manure before lettuce transplanting, with a value of 170.30 g plant⁻¹ of green mass. The use of sheep manure is of paramount importance as an organic fertilizer in lettuce production.

Keywords: Organic Farming; Leafy Vegetables; Soil Fertility; Family-based production system; Semi-arid region

1. Introduction

Horticulture is one of the main activities in the Brazilian agricultural sector, with great socio-economic relevance, especially for family farming. Vegetable crops, in general, have a growing cycle that varies from one vegetable to another in terms of days, being produced throughout the year in small areas, presenting high market demand, in addition to contributing significantly to food security, income generation and strengthening the local economy [1].

Within this context of family-based agriculture, lettuce (*Lactuca sativa* L.) stands out. It is a leafy vegetable belonging to the Asteraceae family, originating in the Asian region. It is a crop produced in all regions of Brazil and occupies a prominent place in the population's diet, being a favorite salad, appreciated both for its flavor and nutritional value as well as for its financial accessibility for consumers [2].

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Plant nutritional management is an essential step in agricultural production systems. In the case of leafy vegetables, which are generally intensively cultivated, regular fertilization becomes necessary to maintain productivity [3]. Nitrogen is the most important nutrient for most agricultural crops, and it is also considered essential for lettuce cultivation, contributing significantly to plant growth, especially in the initial stages of development [4].

Despite the agronomic benefits provided by mineral fertilization, its indiscriminate use can trigger several negative environmental impacts, such as soil salinization, gradual reduction of its fertility, and the accumulation of chemical compounds, which compromise the sustainability of the production system [5]. In this context, organic fertilization emerges as a viable and ecologically more suitable alternative, standing out for reducing the costs of mineral fertilizers and for providing a wider range of essential nutrients, such as nitrogen, phosphorus, sulfur, and micronutrients.

In the study region, there is a predominance of large quantities of goat manure available on the farms where they work in family farming producing vegetables in the semi-arid region, which is of great importance for increasing production.

Objective of the study

Given the importance of seeking alternatives that aim to nutritionally supplement the soil in areas where vegetables are produced, the objective was to evaluate the application of goat manure at different doses incorporated into a latosol in lettuce production.

2. Materials and methods

2.1. Characterization of the experimental area

The experiment was conducted between August and November 2024 at the Rafael Fernandes experimental farm, located in the Lagoinha district, rural area of Mossoró-RN, Brazil, in 0.35 x 0.32 m pots, in soil classified as a sandy loam Red-Yellow Latosol [6]. The Lagoinha district is located at the following coordinates: latitude 5°03'37" S and longitude 37°23'50" W, with an altitude of 72 m. The experimental farm has an area of 400 hectares.

According to Back et al. [7] and the Köppen classification, the local climate is BSw^h, dry and very hot, with the dry season normally from June to January and the rainy season from February to May. The average annual rainfall is 673.9 mm and the average relative humidity is 68.9%.

2.2. Soil chemical analysis

Before the experiment was set up, soil samples were taken at a depth of 0-20 cm, air-dried, and sieved through a 2 mm mesh. They were then analyzed at the Soil Chemistry and Fertility Laboratory of UFERSA, with the following results: pH (water 1:2.5) = 6.8; Ca (calcium) = 2.3 cmolc dm⁻³; Mg (magnesium) = 0.5 cmolc dm⁻³; K (potassium) = 0.15 cmolc dm⁻³; Na (sodium) = 0.08 cmolc dm⁻³; P (phosphorus) = 28.9 mg dm⁻³ and O.M. (organic matter) = 11 g kg⁻¹.

2.3. Experimental design and treatments

The experimental design used was a randomized complete block design with four treatments and five replications. The treatments consisted of four periods of sheep manure incorporation (0, 21, 35, and 49 days before transplanting the lettuce crop). The work was carried out in a greenhouse with pots arranged in blocks within the physical space. The plots consisted of pots measuring 0.35 x 0.32 m, where three lettuce seedlings were planted, with two pots constituting one plot, with a total area of 0.22 m². The incorporation of organic fertilizer (goat manure) was carried out according to each treatment, with transplanting performed in all experimental plots on the same day. A dose of 4.0 kg m⁻² of sheep manure was used in all experimental plots.

Irrigation was carried out in two shifts (morning and afternoon) to maintain the soil at the field capacity necessary for the full development of the crop. Cultural practices consisted of removing weeds, preventing competition for water and nutrients with the lettuce crop.

2.4. Chemical composition of sheep manure

Sheep manure was acquired from a producer in the Mossoró-RN region. Chemical analyses were performed in the soil, water, and plant laboratory of the Department of Agricultural and Forestry Sciences of the Center for Agricultural Sciences, with the following chemical concentrations: pH = 7.40; Nitrogen (N) = 9.42 g kg⁻¹; Organic matter (OM) = 110.5

g kg⁻¹; Phosphorus = 320.5 mg dm⁻³; Potassium (K) = 1,063 mg dm⁻³; Sodium (Na⁺) = 180 mg dm⁻³; Calcium (Ca⁺) = 6.10; Magnesium (Mg²⁺) = 0.20 mg dm⁻³ and Aluminum (Al³⁺) = 00 mg dm⁻³.

2.5. Agronomic characteristics of lettuce cultivation

Twenty-two days after transplanting, the experiment was harvested, and the plants were transported to the Post-Harvest Vegetable Laboratory of the Department of Agronomic and Forestry Sciences at UFERSA, Brazil, where the following characteristics were analyzed: Plant height (measured from six plants per plot in the experimental area, from the base to the apex of the plant with a millimeter ruler and expressed in cm plant⁻¹); number of leaves (obtained by counting all the leaves of a sample of six plants, expressed in units plant⁻¹); plant diameter (measurement was performed with six plants per plot, with values expressed in cm), yield (measured by the weight of all plants in the plot, on a precision scale of 1.0 g, expressed in g plant⁻¹) and dry matter mass (obtained by weighing all plants on an electronic scale with a precision of 1.0 g, followed by drying in a forced-air oven at 65 °C, until constant mass, expressed in g plant⁻¹).

2.6. Statistical analysis

Statistical analysis was performed according to conventional analysis of variance methods [8], using the statistical software ESTAT [9]. The response curve fitting procedure was performed using the ESTAT software [9], applying regression analysis and conducting hypothesis tests that help the researcher to accept or reject a statistical hypothesis based on experimental results [10]; [11].

3. Results and discussion

The different periods of sheep manure incorporation contributed significantly to the increase in the evaluated characteristics of the lettuce crop, with a statistically significant difference at the p<0.01 probability level in all characteristics (Table 1). Sheep manure constitutes a highly relevant organic material for farmers who organically cultivate vegetables in the semi-arid region of Brazil.

The coefficients of variation in the experiment showed high reliability for plant height, number of leaves, diameter, and dry mass, with values of 9.68%, 9.30%, 8.86%, and 4.39%, respectively. For lettuce yield, the coefficient of variation was 15.30%. According to [12], in field experiments, coefficients of variation (CV) below 10% are considered low, meaning they have high precision and reliability. Between 10% and 20%, the CV is medium, possessing average reliability in the studied values.

Table 1 Fisher F-test values for plant height, expressed in cm plant⁻¹ (AP), number of leaves, expressed in plant⁻¹ units (NH), diameter, expressed in cm (DA), lettuce yield, expressed in g (RA) and dry mass, expressed in g (MS) of lettuce as a function of different periods of sheep manure incorporation in an Oxisol.

Causes of Variation	GL	PH	NL	DA	YL	DM
Treatments	3	13.61**	16.20**	6.44**	9.56**	51.4**
Blocks	4	0.33 ^{ns}	0.20 ^{ns}	2.98 ^{ns}	0.55 ^{ns}	1.19 ^{ns}
Residue	12	----	----	----	----	----
Average	----	11.0	16.33	19.57	139.8	13.45
Coefficient of variation (%)	----	9.68	9.30	8.86	15.30	4.39

** = significant at 1% * = significant at 5% ns = not significant.

3.1. Lettuce plant height

Regarding plant height, there was no maximum point, as it depended on the different periods of sheep manure incorporation, with a value of 12.80 cm plant⁻¹ at the 49-day incorporation period (Figure 1). Plant height in lettuce cultivation is influenced by the availability of nitrogen in the soil, which is absorbed by the plants according to their nutritional needs. [13], studying the growth and productivity of lettuce with the application of organic and mineral fertilizers, found a maximum height of 22.2 cm plant⁻¹ with the use of bovine manure, in the amount of 80 Mg ha⁻¹, value higher than the present research.

[14], studying the agroeconomic viability of lettuce (*Lactuca sativa* L.) fertilized with mung bean (*Vigna radiata* L.) and bovine manure, found a lettuce plant height of 12.1 cm plant⁻¹ in the presence and absence of mung bean with bovine manure, value lower than the present. Fertilization with organic waste contributes to the full development of vegetable crops [15]. Similar behavior was observed by [16] studying lettuce productivity with different amounts of a mixture of hairy woodrose (*Merremia aegyptia* L.) with rooster tree (*Calotropis procera*) applied as topdressing, with a value of 15.43 cm plant⁻¹ at a quantity of 3.5 kg m⁻². This superiority is related to the nitrogen concentration of hairy woodrose (*Merremia aegyptia* L.) and rooster tree (*Calotropis procera*), with values exceeding 20.0 g kg⁻¹.

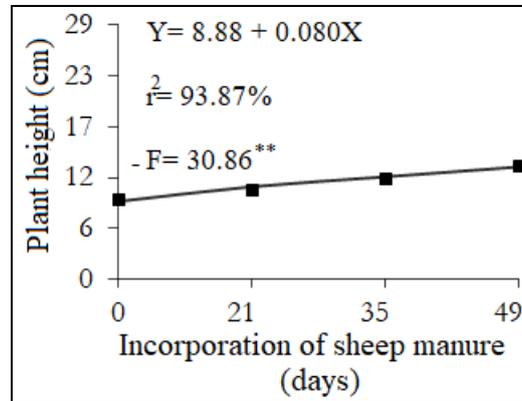


Figure 1 Lettuce plant height under periods of sheep manure incorporation in a soil classified as Oxisol.

3.2. Number of leaves

For the characteristic number of leaves, there was an increase with the increase in the periods of incorporation of sheep manure, with a maximum value of 19.60 plant⁻¹ units 49 days before transplanting (Figure 2). Lower performance compared to the aforementioned research was observed by [17], who studied the agronomic efficiency of lettuce fertilized with different organic compounds and found 11.34 leaf units/plant. However, [13], studying the growth and productivity of lettuce with the application of organic and mineral fertilizers, found a leaf count of 28.3 units plant⁻¹ with the use of bovine manure in the amount of 80 Mg ha⁻¹, higher than the aforementioned research.

[14], studying the agroeconomic viability of lettuce (*Lactuca sativa* L.) fertilized with mung bean (*Vigna radiata* L.) and bovine manure, found 14.0 units of leaves/plant in the presence and absence of mung bean with bovine manure, a value lower than the present research. As observed by [16], studying the productivity of lettuce with different amounts of the mixture of hairy woodrose (*Merremia aegyptia* L.) with rooster tree (*Calotropis procera*) applied as topdressing, with a value of 18.5 units plant⁻¹ at a quantity of 3.1 kg m⁻².

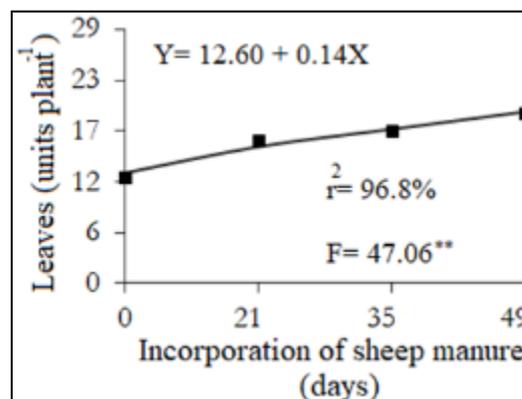


Figure 2 Number of lettuce leaves under periods of sheep manure incorporation in a soil classified as Oxisol.

3.3. Diameter of lettuce

For lettuce diameter, there was an increase of 4.56 cm plant⁻¹ with the increase in the incorporation periods of sheep manure, with a maximum value of 21.68 cm, in the incorporation period of 49 days before transplanting the lettuce crop (Figure 3). Research carried out on organic fertilization in lettuce also found that plants fertilized with manure showed

superior results [18]. [16], evaluating lettuce productivity with different amounts of a mixture of hairy woodrose (*Merremia aegyptia* L.) with rooster tree (*Calotropis procera*) applied as topdressing, found a lettuce diameter of 210.77 mm, equivalent to 21.77 cm per plant, a value similar to that of the aforementioned research.

[13], studying the growth and productivity of lettuce with the application of organic and mineral fertilizers, found a head diameter of 30.6 cm plant⁻¹ with the use of bovine manure, in the amount of 80 Mg ha⁻¹, higher than the aforementioned research. Similarly, [19], evaluating lettuce production as a function of doses of goat manure, found a diameter of 28.76 cm, with the application of 7.5 liters of manure, higher than the aforementioned research. [14], studying the agroeconomic viability of lettuce (*Lactuca sativa* L.) fertilized with mung bean (*Vigna radiata* L.) and bovine manure, diameter of 20.9 cm plant⁻¹ was found in the presence and absence of mung bean with bovine manure, a value lower than the present research.

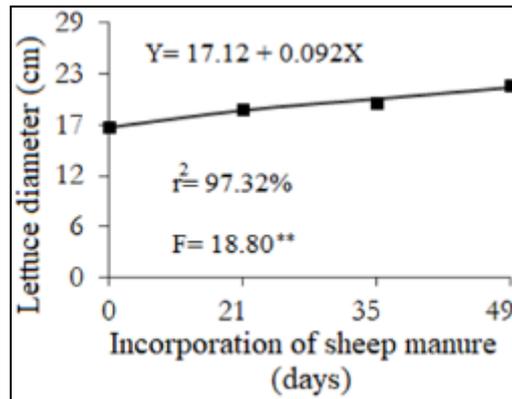


Figure 3 Diameter of lettuce under periods of sheep manure incorporation in a soil classified as Oxisol.

In terms of lettuce yield and dry mass, there was an increase with increasing incorporation periods, with a maximum value of 170.30 g plant⁻¹ and 16.83 g plant⁻¹ for yield and dry mass, respectively, at 49 days of sheep manure incorporation before lettuce transplantation (Figure 4A e 4B). The longer incorporation period likely contributed to greater nutrient availability in the soil, allowing the crop to absorb the nutrients at the time of greatest nutritional demand. According to [20], the use of organic fertilizers enables greater plant growth, especially in tropical soils of low fertility, due to the increased capacity for nutrient retention. [16], evaluating lettuce productivity with different amounts of a mixture of hairy woodrose (*Merremia aegyptia* L.) with rooster tree (*Calotropis procera*) applied as topdressing, found a green mass of 148.29 g plant⁻¹ with the application of 3.5 kg m⁻² of fertilizer, a value lower than the research. Lower values in terms of lettuce yield were observed by [13] studying the growth and productivity of lettuce with the application of organic and mineral fertilizers; they found a green mass of 112.5 g plant⁻¹, studying soybean hulls, which was lower than the aforementioned research.

[14], when studying the agroeconomic viability of lettuce (*Lactuca sativa* L.) fertilized with mung bean (*Vigna radiata* L.) and bovine manure, found a lettuce yield of 121 g plant⁻¹, at a spacing of 0.35 x 0.20 m, which was lower than the aforementioned research in the presence and absence of mung bean with bovine manure, a value lower than that of the present research.

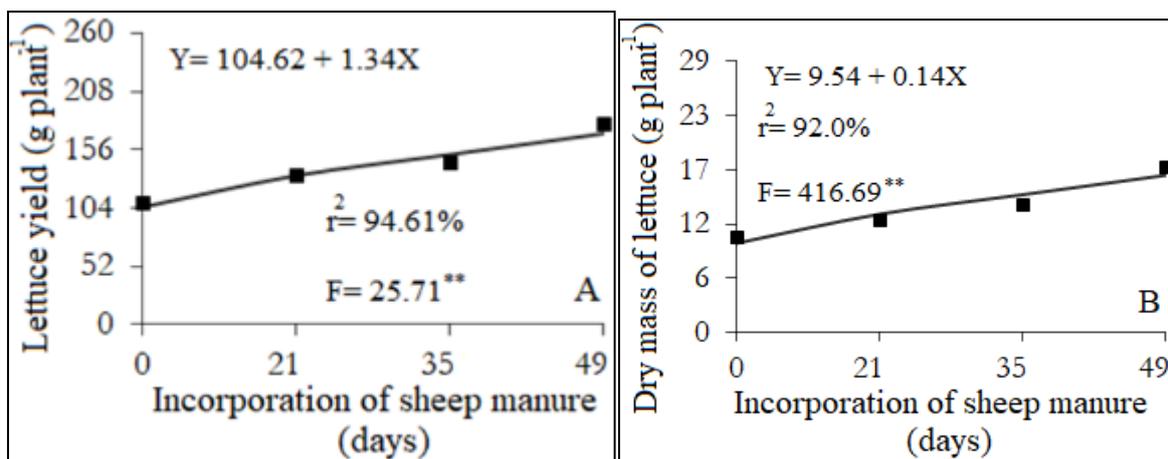


Figure 4 Lettuce yield (A) and dry mass (B) of lettuce under periods of sheep manure incorporation in a soil classified as Oxisol

4. Conclusion

The maximum yield of lettuce was observed during the incorporation period of 49 days before transplanting, with a maximum value of 170.30 g plant⁻¹. The use of sheep manure is of paramount importance for farmers who cultivate vegetables in the semi-arid region.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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