Yield of lettuce fertilized with hairy woodrose (*Merremia aegyptia* L.) plus poultry manure.

ABSTRACT

The use of plant resources available in agricultural areas is extremely important for farmers who work in this activity, contributing to an economic return in lettuce production. In view of the above, the objective was to study the yield of lettuce fertilized with hairy woodrose (*Merremia aegyptia* L.) plus poultry manure. The experiment was carried out in a completely randomized design (CRD) ~~(D.I.C)~~ with six treatments and four replications. The treatments consisted of six amounts of the hairy woodrose (*Merremia aegyptia* L.) mixture plus poultry manure (0; 1.4; 2.8; 4.2; 5.6 and 7.0 kg m^{-2}). For the lettuce crop, the cultivar "Babá de Verão". Twenty-two days after transplanting, the crop ~~experiment~~ was harvested ~~where the plants were~~ and transported to the Vegetable Post-Harvest Laboratory of the Department of Agronomic and Forestry Sciences at UFERSA, where the following characteristics were analyzed: plant height (performed from a sample of four plants $plot^{-1}$, measuring the height from the base to the inflection of the leaves using a millimetric ruler, expressed in cm $plant^{-1}$); number of leaves per plant (determined in a sample of ten plants, counting the number of leaves per plant over five centimeters, expressed in $plant^{-1}$ units)fresh lettuce mass (measured by the weight of all plants in the plot on an electronic scale with an accuracy of 1.0 g, expressed in g $plant^{-1}$); lettuce dry mass (was carried out by weighing four plants on an electronic scale with an accuracy of 1.0 g, which were then placed in a heating oven with forced air at 65 °C, until constant mass). The amount of 7.0 kg m^{-2} of the mixture of hairy woodrose (*Merremia aegyptia* L.) plus poultry manure was what promoted the greatest increase in lettuce cultivation, with a maximum value of 237.97 g $plant^{-1}$. The mixture of alternative fertilizer sources is extremely important in the production of leafy vegetables.

Comment [SS1]: The abstract should be very crisp and clear. It should focus on the justification of work and the salient findings.

Comment [SS2]: No need to elaborate how you performed the measurements but you should focus on the results. Please remove all these sentences.

Keywords: Leafy vegetable; organic fertilizer and monoculture.

1. INTRODUCTION

Vegetable production is intense in semi-arid regions, where manure (bovine, goat and poultry) is used exclusively. However, the farmer does not always have this resource available on his property, which increases the cost of vegetable production [1], [2]. Among the vegetable crops produced in the region of Mossoró, RN, Brazil, lettuce (*Lactuca sativa*) stands out [3]. This type of vegetable is the most sold and consumed in Brazil, with low caloric value and as a source of minerals [4].

In this context, the use of a mixture of green manures with sources of fertilizers of animal origin is extremely important, which provides greater availability of nutrients in the soil, conditioning the soil environment for the cultivation of vegetable crops [3].

In the semi-arid region of Brazil, the presence of species with the potential to be used as green manure is quite prominent, notably hairy woodrose (*Merremia aegyptia* L.), which produces green and dry biomass in the order of 40,000 and 6,000 kg ha^{-1}, respectively, with

of nitrogen concentration of 22.4 g kg^{-1} in dry matter and a carbon-nitrogen ratio of 17/1, at the phenological stage of 126 days after emergence [5].

This species has been used as green fertilizer in the development of leafy and root vegetables, as a source of nitrogen in arugula and coriander [6].

Given the importance of using resources present within agricultural areas, as a source of nutrients in the fertilization of vegetables, the objective was to study the yield of lettuce fertilized with hairy woodrose (*Merremia aegyptia* L.) plus poultry manure.

2. MATERIAL AND METHODS

2.1 Location of the experiment installation

The experiment was carried out in a greenhouse in the teaching garden of the Department of Agricultural and Forestry Sciences at the Universidade Federal Rural do Semi-árido (UFERSA), Mossoró, RN, Brazil, from December 2022 to January 2023, in ~~classified soil as~~ Red Yellow Oxisol Argissolic sandy loam soil [5]. According to [6] and the Köppen classification, the local climate is BSwh', dry and very hot, with a dry season, often from June to January, and a rainy season from February to May~~–~~, with average annual precipitation of 673.9 mm and average relative humidity of 68.9%.

Before setting up the experiment, soil samples were collected from the 0-20 cm arable layer, homogenized, and sent to the soil chemistry and fertility laboratory for ~~the following~~ analyses: pH (water) = 6.8; EC = 0.30 dS m^{-1}; O.M. = 3.6 g kg^{-1}; N = 0.75 g kg^{-1}; P = 37.81 mg dm^{-3}; K = 69.45 mg dm^{-3}; Ca= 47.65 c molec dm^{-3}; Mg = 5.14 cmolec dm^{-3}; Na = 1.93 mg dm^{-3}; Cu = 0.45 mg dm^{-3}; Fe = 2.26 mg dm^{-3}; Mn = 8.94 mg dm^{-3}; and Zn = 3.24 mg dm^{-3}.

2.2 Experimental Design

The experiment was carried out in a completely randomized design (CRD) ~~(D.I.C)~~ with six treatments and four replications. The treatments consisted of six amounts of the hairy woodrose (*Merremia aegyptia* L.) mixture plus poultry manure (0; 1.4; 2.8; 4.2; 5.6 and 7.0 kg m^{-2}). For the lettuce crop, the cultivar “Babá de Verão”.

Four holes were opened in each pot, and the plants were placed in the experimental plots. During the period in which the cowpea crop was in the field, weeding was carried out to remove invasive plants that compete for water and nutrients during the crop cycle. Irrigation was carried out by drip, with a daily irrigation shift divided into two applications (morning and afternoon).

Comment [SS3]: It seems that you have mentioned the application rate of mixture as kg/m^2. But what was the ratio of hairy woodrose and poultry manure that was used? Please make it more clear.

To compose the mixture of fertilizers in the research hairy woodrose (*Merremia aegyptia* L.) was used, a spontaneous species from the semi-arid region with production of green and dry phytomass of the order of 42,000 kg ha^{-1} and 6,000 kg ha^{-1}, respectively, with nitrogen content of 24.7 g kg^{-1} at 104 days after emergence (LINHARES et al., 2021).

The hairy woodrose (*Merremia aegyptia* L.) was harvested in an area of semi-arid vegetation adjacent to the Federal Rural University of the Semi-arid 100 days after emergence, being crushed in forage into segments of 2.0 to 3.0 centimeters (Figure 1). The material was then dried in the sun for a period of 80 hours until the moisture content was 15%, after which samples were taken and sent to the soil fertility and plant nutrition laboratory at the Center for Agricultural Sciences at UFERSA for carbon analysis. (W); nitrogen (N); phosphorus (P); potassium (K^+); calcium (Ca^{2+}); magnesium (Mg^{2+}) and carbon/nitrogen ratio, whose values were: 535 g kg^{-1} C, 23.5 g kg^{-1} N, 10.8 g kg^{-1} P, 15.4 g kg^{-1} K, 9, 7 g kg^{-1} Ca, 11.7 g kg^{-1} Mg and a nitrogen/carbon ratio of 23/1.

Poultry manure was collected from the poultry sector of the Department of Animal Sciences at UFERSA, from laying poultry farming and sent to the soil fertility and plant nutrition laboratory at the Center for Agricultural Sciences at UFERSA for carbon (C) analysis. ; nitrogen (N); phosphorus (P); potassium (K^+); calcium (Ca^{2+}); magnesium (Mg^{2+}) and carbon/nitrogen ratio, whose values were: 440 g kg^{-1} C, 28.7 g kg^{-1} N, 12.6 g kg^{-1} P, 17.3 g kg-1 K, 16, 9 g kg^{-1} Ca, 13.2 g kg^{-1} Mg and a carbon/nitrogen ratio of 15/1.

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Comment [SS4]: Please cite the standard reference that was followed for elemental analysis. Also give the make and model of the insturments used in analysis.

2.3 Agronomic characteristics of lettuce crop

Twenty-two days after transplanting, the crop ~~experiment~~ was harvested ~~where the~~ and ~~plants were~~ transported to the Vegetable Post-Harvest Laboratory of the Department of Agronomic and Forestry Sciences at UFERSA, where the following characteristics were analyzed: plant height (performed from a sample of four plants $plot^{-1}$, measuring the height from the base to the inflection of the leaves using a millimetric ruler, expressed in cm $plant^{-1}$); fresh lettuce mass (measured by the weight of all plants in the plot on an electronic scale with an accuracy of 1.0 g, expressed in g $plant^{-1}$); lettuce dry mass (was carried out by weighing four plants on an electronic scale with an accuracy of 1.0 g, which were then placed in a heating oven with forced air at 65 °C, until constant mass).

Statistical analysis

Statistical analysis was performed according to conventional methods of analysis of variance [7], using ESTAT statistical software [8]. The response curve fitting procedure was

performed using the ESTAT Software [8], applying regression analysis and conducting hypothesis testing that helps the researcher accept or reject a statistical hypothesis based on experimental results [9], [10].

3. RESULTS AND DISCUSSION

It was observed that there was a significant effect on ~~the characteristics of~~ plant height, number of leaves, green and dry mass of lettuce depending on the amounts of hairy woodrose (*Merremia aegyptia* L.) plus poultry manure (Figure 2 to 5). The mixture of alternative fertilizer sources is extremely important for soil fertilization in vegetable cultivation (LINHARES et al., 2024).

For plant height, the~~re was a~~ maximum ~~point with a~~ value of 14.63 cm ~~plant~~ was observed ~~in the amount~~ with the application of 5.8 kg m^{-2} of the mixture of hairy woodrose (*Merremia aegyptia* L.) plus poultry manure (Figure 2). It is worth noting that, as it is a hardwood, it is greatly influenced by the addition of organic material rich in nitrogen. Linhares et al. (2024), studying ~~P~~productivity of lettuce with different amounts of the mixture of scarlet starglory (*Merremia aegyptia* L.) with rooster tree (*Calotropis procera*) applied in soil cover, found a plant height of 15.43 cm/plant with an application of 3.5 kg m^{-2} of the mixture of scarlet starglory and rooster tree, higher than the aforementioned research. Bezerra Neto et al. (2011), studying different quantities and decomposition times of scarlet starglory (*Merremia aegyptia* L.) in lettuce, found an average height of 21.14 cm $plant^{-1}$, using spacing between plants greater than the aforementioned research.

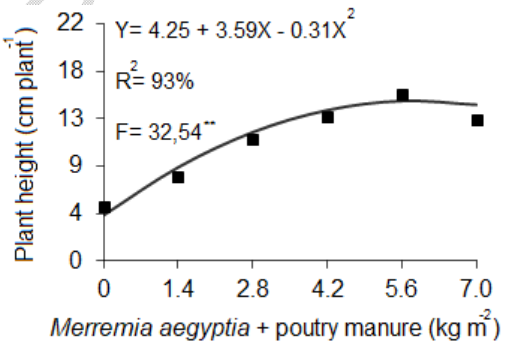

Figure 2. Lettuce plant height as a function of different amounts of *Merremia aegyptia* mixture with poultry manure.

In relation to the number of leaves, the different amounts of the mixture of hairy woodrose (*Merremia aegyptia* L.) plus poultry manure had a significant influence, with a

maximum value of 8.21 plant units, in the amount of 4.2 kg m^{-2} (Figure 3). According to Linhares et al. (2024) the number of leaves is extremely important, being the vegetative part where photosynthesis takes place. Moura et al. (2020), studying the agronomic development of lettuce crops fertilized with organic compost, obtained a maximum number of 11.3 leaves, lower than the aforementioned research.

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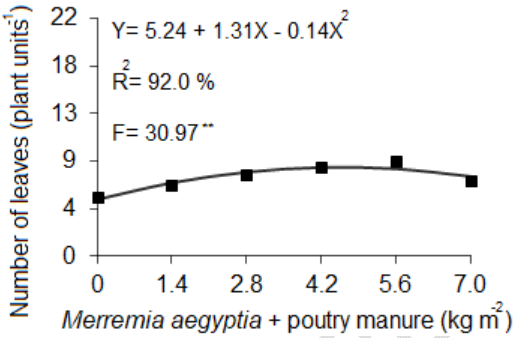

Figure 3. Number of leaves as a function of different amounts of *Merremia aegyptia* mixture with poultry manure.

Regarding the fresh and dry mass of lettuce, the observed data fit an increasing linear equation, with maximum values of 237.97 and 19.10 g $plant^{-1}$ in the amount of 7.0 kg m^{-2}, respectively (Figure 4 and 5). Peixoto Filho et al. (2013), studying lettuce productivity with doses of chicken, cattle and sheep manure in successive crops, found a maximum lettuce weight of 296.7 g $plant^{-1}$, different from the present research. Santos et al. (2021) studying the productivity of *Lactuca sativa*, cultivated under doses of organic compost and biofertilizer, found a maximum weight of fresh lettuce mass of 71.72 g $plant^{-1}$ at a dose of 9.0 kg m^{-2} of biofertilizer lower than the aforementioned research. Linhares et al. (2011), evaluating different periods of incorporation of hairy woodrose (*Merremia aegyptia* L.) in lettuce, found a maximum value of 64.7 g plant, lower than the aforementioned research. According to Silva et al. (2011) organic fertilizer increases productivity, ~~in addition to producing~~ plants with better qualitative characteristics to the detriment of plants grown exclusively with mineral fertilizers. For Sediyama et al. (2016) organic fertilizer is a viable alternative, with great potential for lettuce cultivation.

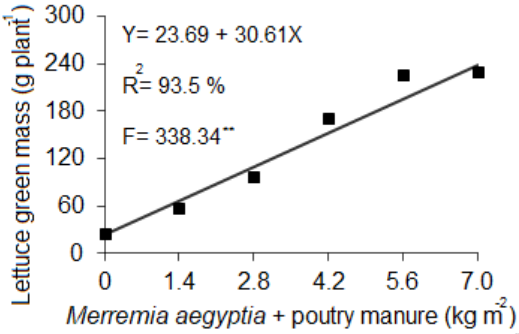

Figure 4. Lettuce green mass as a function of different amounts of *Merremia aegyptia* mixture with poultry manure.

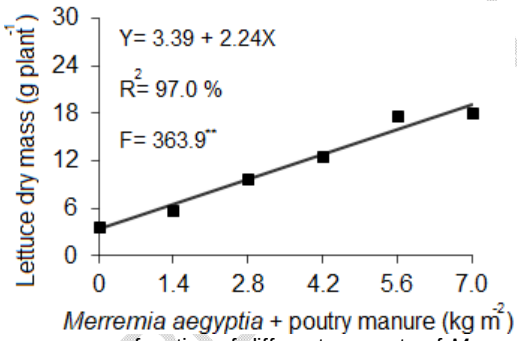

Figure 5. Lettuce dry mass as a function of different amounts of *Merremia aegyptia* mixture with poultry manure.

CONCLUSION

The amount of 7.0 kg m^{-2} of the mixture of hairy woodrose (*Merremia aegyptia* L.) plus poultry manure was what promoted the greatest increase in lettuce cultivation, with a maximum value of 237.97 g $plant^{-1}$.

The mixture of alternative fertilizer sources is extremely important in the production of leafy vegetables.

Comment [SS5]: How have you concluded that the application of 7.0 kg/m^2 of the mixture was best. No. of leaves and plant height seems to be maximum at 5.6 kg/m^2. Are the doses 5.6 and 7.0 statistically at par? If yes then you could have recommended 5.6 as the optimum dose.

Comment [SS6]: In treatments you could have kept at least one treatment i.e the standard package and practice used by the local farmers. To make your study more relevant you could have done the economic analysis also. This would let us know how much of production cost can be saved using this mixture.

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