Original Research Article

INFLUENCE OF SOIL TYPES AND QUANTITIES OF THE MIXTURE OF HAIRY WOODROSE (*Merremia aegyptia* L.) PLUS BOVINE MANURE ON THE AGRONOMIC VIABILITY OF CORIANDER IN THE SEMIARID REGION OF BRAZIL

ABSTRACT

Aims: Coriander cultivation is an activity of great importance for family farmers in the Brazilian semi-arid region. In this sense, the objective was to study the influence of soil types and quantities of a mixture of hairy woodrose (*Merremia aegyptia* L.) and cattle manure on the agronomic viability of coriander in semi-arid region of Brazil.
Place of Study: The experiment was carried out in the greenhouse of the Agricultural and Forestry Sciences department of the Universidade Federal Rural do Semi-Árido, Brazil.
Study -Design and Methodology: The design used was completely randomized in a 4 x 2 factorial scheme, with three replications, being the first factor consisting of ~~four~~ five quantities of the mixture of hairy woodrose (*Merremia aegyptia* L.) plus cattle manure (0.0; 1.5; 3.0; 4.5 and 6.0 kg m^{-2} of area) and the second factor consisted of two types of soil (latosol and an argisol) in single cultivation.The coriander cultivar "Frevo" was used, adapted to the edaphic and climatic conditions of the semi-arid region. The spacing used was 0.1 x 0.05 m with five plants pit^{-1}, corresponding to 1000 plants m^{-2} of area. After harvesting the coriander, the following characteristics were evaluated: plant height (expressed in cm $plant^{-1}$); number of stems (expressed in $plant^{-1}$ units); productivity (expressed in grams m^{-2} of area); number of bunches (expressed in $plant^{-1}$ units) and dry mass (expressed in grams m^{-2} of area).
Agronomic characteristics of coriander: plant height (expressed in cm $plant^{-1}$); number of stems (expressed in units $plant^{-1}$); productivity (expressed in grams m^{-2} of area); number of bunches (expressed in units $plant^{-1}$) and dry mass (expressed in grams m^{-2} of area).
Conclusions: There was no interaction between the factors studied, with the amount of 3.0 kg m^{-2} of the hairy woodrose (*Merremia aegyptia* L.) mixture with cattle manure, promoting the greatest increase in coriander cultivation, with values of 1030.6 g m^{-2}, equivalent to 20.87 units of coriander bunches m^{-2}, respectively. In relation to soil types (latosol and an argisol) there was no statistical difference, with values of 841.9 and 709.6 g m^{-2} for productivity, equivalent to 16.7 and 14.0 units of coriander bunches m^{-2}.

Keywords: Edaphic condition, organic fertilizers, family farming, agronomic performance.

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1. INTRODUCTION

The vegetable crop *Coriandrum sativum* L. is widely used in the semi-arid region of Brazil to compose dishes, being one of the most produced and commercialized, which contributes to increasing the profitability of producers who work in this activity [1]. This vegetable crop is from the Apiaceae family; herbaceous, annual, leafy, spicy and strongly perfumed, originating from the Mediterranean [2].

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According to [3], this crop is widely used in cuisine in the Northeast region due to its distinctive aroma and flavor characteristics, which is why production is used almost exclusively for consumption of green leaves. In the Mossoró-RN region, this vegetable is harvested between 30 and 35 days after planting, that is, with a short cycle. Precisely because it is precocious, the crop guarantees the producer a quick return on invested capital [4].

It is worth noting that this crop is cultivated in different types of soils, such as the latosol, where it is characterized as mineral, non-hydromorphic, deep soils (normally greater than 2 m), very thick B horizons (> 50 cm) with sequence of horizons A, B and C that are not very differentiated [5]. Another soil existing in cultivation areas is loam, characterized as moderately deep to deep, moderately drained, with a textural B horizon of red to yellow colors and clayey texture [6].

According to [7], the use of manure is a widely accepted alternative for supplying nutrients, mainly nitrogen and phosphorus, in family farming areas in the semi-arid and harsh regions of the Brazilian Northeast. However, the exclusive use of this input contributes to increased production costs, as the farmer does not always have it available on his property [8].

In this sense, the use of alternative sources exclusively or mixing with manure is very important to increase the availability of nutrients in the soil, such as the use of hairy woodrose (*Merremia aegyptia* L.), spontaneous species from the semi-arid region that produces green phytomass. and drought of the order of 40.000 and 6.000 kg ha^{-1} with a nitrogen content of 24.0 g kg^{-1} and a carbon-nitrogen ratio of 23/1 [9].

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Given the importance of studying alternative sources of organic fertilizers that will contribute to increasing the availability of nutrients in different types of soil, the objective was to evaluate the agronomic viability of coriander as a function of mixing hairy woodrose (*Merremia aegyptia* L.) plus cattle manure in different types of soil.

MATERIAL AND METHODS

EXPERIMENT INSTALLATION PLACE

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 September to November 2022. Two types of soils, being the latosol, collected at the Rafael Fernandes experimental farm, in the district of Alagoinha (5º03'37 "S, 37º23'50" W), northwest of Mossoró, State of Rio Grande do Norte, Brazil, with an area of 400 hectares [10], in soil classified as Argissolic Red Yellow Latosol sandy loam [11]. with geographic coordinates of 5º 11' south latitude and 37º 20' west longitude and an altitude of 18 m [12].

Before setting up the experiment, soil samples were taken at a depth of 0-20 cm, which were air-dried and sieved through a 2 mm mesh. They were then analyzed at the UFERSA Soil Chemistry and Fertility Laboratory, the results of which were as follows: pH

(water 1:2.5) = 7.87; Ca = 5.50 cmolc dm^{-3}; Mg = 0.40 cmolc dm^{-3}; K = 0.30 cmolc dm^{-3}; Na = 0.40 cmolc dm^{-3}; P = 0.60 cmolc dm^{-3} and Nitrogen= 7.0 g kg^{-1}.

EXPERIMENTAL DESIGN AND TREATMENTS

The experiment was conducted in a completely randomized design in a 5 x 2 factorial scheme, with three replications. The first factor consisted of five quantities of the mixture of jitirana with cattle manure (0.0; 1.5; 3.0; 4.5 and 6.0 kg m^{-2} of area) and the second factor consisted of two types of soils (latosol and an argisol) in single cultivation. The spacing used was 0.1 x 0.05 m with five plants pit^{-1}, corresponding to 1000 plants m^{-2} of area, according to the recommendation of [13], which corresponds to the density of plants used by family farmers in the region of Mossoró, RN, Brazil. In each pot, five holes were opened per planting line, with three planting lines with eighteen holes, corresponding to ninety pot^{-1} plants.

Daily irrigations were carried out (morning and afternoon) in order to maintain the soil at field capacity for the full development of the crop. Cultural treatments were carried out (removal of invasive plants) preventing competition for water and nutrients with the coriander crop.

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 [14].

The hairy woodrose (*Merremia aegyptia* L.) was harvested in a semi-arid vegetation area 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 until a moisture content between 10 and 15%, and samples were then taken and sent to the soil fertility and plant nutrition laboratory at the UFERSA Agricultural Sciences Center for carbon (C) analysis; nitrogen (N); phosphorus (P); potassium (K+); calcium (Ca2+); magnesium (Mg2+) 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 (Figure 1).

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Figure 1. Inflorescence of the hairy woodrose (*Merremia aegyptia* L.) with the presence of the flower (A) and area with a predominance of the hairy woodrose being harvested with an agricultural machine (B). Photo: Researcher and PhD. Paulo César Ferreira Linhares (Federal Rural University of the Semi-Arid, Brazil).

The cattle manure used came from the creation of heifers in the UFERSA cattle sector, presenting the following values: (pH (water 1:2.5) = 8.06; 15.87 g kg^{-1} of N; 77.62 g kg^{-1} of MO; 853.2 mg dm^{-3} of P; 598.4 mg dm^{-3} of K^{+}; 2500.15 mg dm^{-3} of Na^{+}; 6.92cmolc dm^{-3} of Ca^{2+}; 3.09 cmolc dm^{-3} of Mg^{2+} and 26/1 for carbon/nitrogen ratio.

The fertilizers were mixed and applied to the soil depending on the quantities and types of soil, with the material remaining for an incubation period of thirty days before planting, according to the recommendation of [15]. During the process of decomposition of the mixture of hairy woodrose and poultry manure in the soil, irrigation was carried out on all plots up to field capacity, being of fundamental importance in the nitrification process [16].

EVALUATION OF CORIANDER CHARACTERISTICS

Thirty one days after sowing, the experiment was harvested, where the 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 fifteen plants per plot, measuring the height from the base to the apex of the plant using a millimeter ruler and expressed in cm $plant^{-1}$); number of stems (obtained by counting all stems from a sample of fifteen plants, expressed in $plant^{-1}$ units); productivity (measured by the weight of all plants in the useful area of the plot, expressed in g m^{-2} of area); number of bunches (determined by dividing productivity m^{-2} by

50 g, reference weight for bunch of coriander, expressed in units m^{-2} of area) and dry mass (obtained by weighing fifteen $plot^{-1}$ plants on an electronic scale with an accuracy of 1.0 g, followed by drying in a forced air heating oven at 65 °C, until constant mass).

STATISTICAL ANALYSIS

Statistical analysis was carried out according to conventional methods of analysis of variance [17], using the statistical software ESTAT [18]. The response curve adjustment procedure was carried out with the ESTAT software [19] and for the qualitative factor (soil types) the F test of the analysis was used.

RESULTS AND DISCUSSION

There was no significant interaction for the factors studied (amounts of hairy woodrose plus cattle manure and types of soil), however, there was a statistical difference for the quantitative factor (amounts of hairy woodrose plus cattle manure) at the level of $p<0.01$ probability for plant height, number of stems, productivity, number of bunches and dry mass of coriander (Figures 2 to 6). For the qualitative factor (soil types), there was a difference at $p < 0.05$ using the F test of the analysis (Table 1).

For the plant height characteristic, there was an increase of 5.7 cm in relation to the treatment without fertilization, with a maximum value of 17.97 cm $plant^{-1}$ in the amount of 4.6 kg m^{-2} (Figure 2). In relation to soil types (argisol and latosol) there was no statistical difference, with values of 16.5 and 16.3 cm $plant^{-1}$, respectively (Table 1). [20], studying organic fertilization with spontaneous species in the semi-arid region on coriander productivity, found a plant height of 18.38 cm $plant^{-1}$, higher than the aforementioned research. [21], evaluating the use of hairy woodrose (*Merremia aegyptia* L.) mixed with poultry manure in the agronomic viability of coriander in the semi-arid region, found a value for plant height of 18.02 cm $plant^{-1}$, differing from the aforementioned research.

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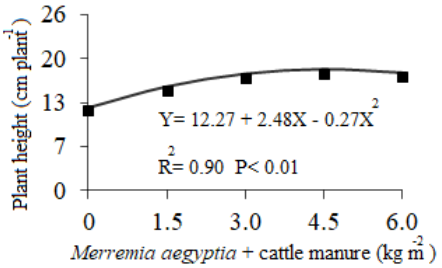

Figure 2. Height of coriander plant depending on different amounts of the hairy woodrose (*Merremia aegyptia* L.) mixture with cattle manure incorporated into the soil.

For the number of stems, the data was adjusted using a linear equation, with a maximum value of 5.28 stems plant^{-1} in the amount of 6.0 kg m^{-2} of the mixture of hairy woodrose plus cattle manure (Figure 3). In relation to soil types (argisol and latosol), there was a similar behavior in terms of height, with values of 4.44 and 4.38 plant^{-1} units, respectively (Table 1). The number of stems is extremely important for coriander cultivation, as it is characterized by the plant's leaf area [22]. [23], studying organic fertilization with spontaneous species in the semi-arid region on coriander productivity, found a number of stems of 6.78 plant^{-1} units, which is higher than the aforementioned research, as well as [24], evaluating the use of *Gliricidia sepium* mixed with *Mimosa caesalpiniifolia* on the agronomic performance of coriander, with a value of 7.6 stems plant^{-1}. Similar behavior to the authors was observed by [25], evaluating the use of hairy woodrose (*Merremia aegyptia* L.) mixed with poultry manure in the agronomic viability of coriander in the semi-arid region, found a value of 7.97 plant^{-1} stems, differing from the aforementioned research.

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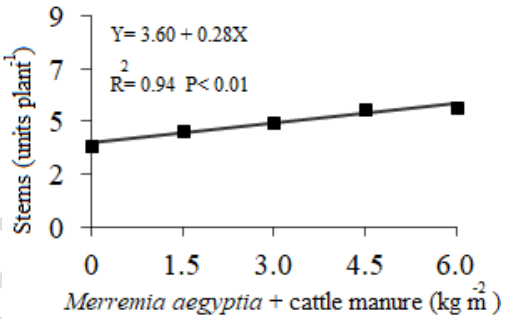

Figure 3. Number of coriander stems depending on different amounts of the hairy woodrose (*Merremia aegyptia* L.) mixture with cattle manure incorporated into the soil.

Different behavior was observed for productivity and number of bunches of coriander with maximum values of 1030.6 g m^{-2} and 20.87 units m^{-2}, respectively, with the application of 3.0 kg m^{-2} of the mixture of hairy woodrose with cattle manure, with a value greater than 100% in the absence of fertilizer treatment (Figures 4A and 4B). In relation to soil types (argisol and latosol), no statistical difference was observed with values of 841.9 and 709.6 g m^{-2} for productivity and 16.7 and 14.0 units m^{-2} for number of sauces (Table 1). The number of sauces is an extremely important characteristic, it represents the way in which the farmer markets his production [26]. [27], studying the agroeconomic performance of coriander at different sowing densities, found fresh mass of coriander of 962 g m^{-2} at a density of 5.4 g m^{-}

[1], a value lower than that of the aforementioned research. This inferiority is probably due to the quantities of fertilizers used.

[28], studying the cultivation of coriander in succession to lettuce cultivation, found coriander productivity of 3180 kg ha^{-1}, equivalent to 318 g m^{-2}, corresponding to 6.36 units of sauces, values lower than the work cited. However, [29] studying organic fertilization with spontaneous species from the semi-arid region on coriander productivity with a maximum value of 1210 g m^{-2} and 24.2 units of bunches m^{-2}, being higher than the aforementioned research, as well as [30], studying the use of hairy woodrose (*Merremia aegyptia* L.) mixed with poultry manure in the agronomic viability of coriander in the semi-arid region, found productivity and number of bunches of 1246.5 g m^{-2} and 24.9 units of sauces m^{-2} of coriander.

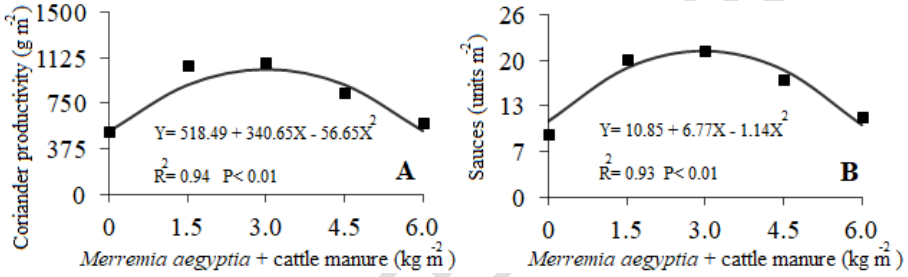

Figure 4. Productivity (A) and number of bunches (B) of coriander depending on different amounts of the mixture of hairy woodrose (*Merremia aegyptia* L.) with cattle manure incorporated into the soil.

Dry mass is an extremely important characteristic in evaluating crop development, as it depicts vegetative growth. The data for this characteristic fit a quadratic equation with a maximum value of 154.6 g m^{-2} in the amount of 3.0 kg m^{-2} of the mixture of hairy woodrose and cattle manure (Figure 5). In relation to soil types (argisol and latosol) there was no statistical difference, with values of 126.3 and 106.4 g m^{-2}, respectively (Table 1). [31], evaluating the production of coriander with organic compost in Irituia-PA, found dry mass production of 1614 kg ha^{-1}, equivalent to 161.4 g m^{-2} with the application of 60 t ha^{-1} of organic compost, This value is higher than this research. Probably, the greater amount of compost applied to the soil greatly contributed to expressive value.

Dry matter mass is an extremely important characteristic, as it most directly reflects plant growth, being the most appropriate for growth analysis [32], reflecting the influence of treatments imposed on the crop.

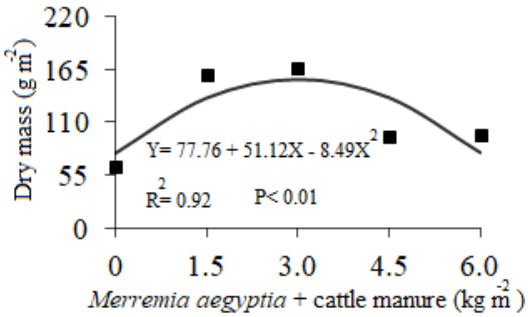

Figure 5. Dry mass of coriander depending on different amounts of the mixture of hairy woodrose (*Merremia aegyptia* L.) with cattle manure incorporated into the soil.

Table 1. Plant height (expressed in cm plant^{-1}) (AT), number of stems (expressed in units plant^{-1}) (NH), productivity (expressed in g m^{-2}) (PC), number of bunches (units m^{-2}) (NM) and dry mass (expressed in g m^{-2}) (DM) of coriander as a function of different types of soil (Oxisol and Argisol) in the semi-arid region of Brazil.

Soil types	AT	NH	PC	NM	MS
latosol	16.5 a	4.4 a	841.8 a	16.7 a	126.3 a
Argisol	16.3 a	4.4 a	709.6 a	14.0 a	106.4 a
Average	16.4	4.4	775.7	15.4	116.4
Coefficient of variation (%)	10.8	8.6	14.8	14.3	15.0

*Averages followed by the same letter do not differ statistically at the 5% probability level.

CONCLUSION

There was no interaction between the factors studied, with the amount of 3.0 kg m^{-2} of the hairy woodrose (*Merremia aegyptia* L.) mixture with cattle manure, promoting the greatest increase in coriander cultivation, with values of 1030.6 g m^{-2}, equivalent to 20.87 units of coriander bunches m^{-2}, respectively.

In relation to soil types (argisol and latosol) there was no statistical difference, with values of 841.9 and 709.6 g m^{-2} for productivity, equivalent to 16.7 and 14.0 units of coriander bunches m^{-2}.

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