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The Use of Scarlet Starglory (*Merremia aegyptia* L.) Mixed with Poultry Manure in the Agronomic Viability of Coriander in the Semiarid Region

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This research was aimed to study udy the use of jitirana mixed with poultry manure on the agronomic viability of coriander in the semiarid region.
Study: The experiment site was in the municipality of Mossoró, RN, Brazil, located at 5º 11' south latitude and 37º20' west longitude and altitude of 18 m.
Methodology: The experiment was carried out at the Rafael Fernandes Experimental Farm, belonging to the Universidade Federal Rural do Semi-árido, located in the district of Alagoinha, rural area of Mossoró, Brazil. The experimental design was completely randomized with treatments arranged in a 5 x 2 factorial scheme, with three replications. The treatments consisted of the combination of five amounts of the mixture of scarlet starglory (*Merremia aegyptia* L.) plus poultry manure (0.0; 1.2; 2.4; 3.6 and 4.8 kg m^{-2} of area in dry basis) and the second factor, by the forms of application to the soil (incorporated and covering).
The sown coriander cultivar was the Verdão cultivar. The characteristics evaluated were the following: plant height, number of stems $plant^{-1}$, productivity, number of bunches and dry mass of coriander.
The highest productivity and number of bunches of coriander culture was observed in the amount of 4.8 kg m^{-2} of the mixture of scarlet starglory with poultry manure, with values of 1246.5 g m^{-2} and 24.9 units of bunches m^{-2}, respectively. The mixture It is concluded that the misture of organic fertilizers (scarlet starglory with poultry manure) contributed positively to the agronomic characteristics of the coriander crop.

Keywords: Agroecological production; spontaneous species; organic fertilization; condiment vegetables.

1. INTRODUCTION

"Coriander (*Coriandrum sativum* L.) is a vegetable belonging to the Apiaceae family, widely used in Northeastern cuisine, whose leaves are used in the composition and decoration of various regional dishes" [1]. "Although it is considered a "backyard crop", one large number of producers they are involved in the exploitation throughout all year, which justifies its social and economic importance" [2,3].

In the city of Upanema, RN, Brazil, this vegetable is widely produced and sold by family farmers, who sell their production at fairs and supermarkets. The most planted coriander cultivars in the region are the Verdão and Super-verdão cultivars, which are adapted to climate and soil conditions. According to [4], "among the commercialized coriander cultivars, the Verdão cultivar is considered a sales leader throughout Brazil, with an early cycle, with harvest period of 30 to 40 days for leaf production, depending on the time of year and of the planting region. This cultivar is quite vigorous, with dark green leaves, excellent hardiness and good resistance to pests and diseases" [5].

In these production areas, where family labor is used, the use of organic fertilizer of animal origin, as a source of fertilizers (cattle, goat and poultry manure), being used a lot. However, not every producer has animals on his property to supply manure, which increases production costs with the acquisition of these materials [6]. In this sense, the use of available resources within the production areas is of paramount importance for those who work in this activity.

"The amount of nutrients in production systems, mainly nitrogen, is one of the main challenges faced in the organic agriculture" [7]. "In order for nutrients to be available in the soil to be absorbed by plants, such as nitrogen, phosphorus and potassium, the organic source must be able to recycle nutrients" [8].

Darolt and [9] stated that "the ideal in the agriculture is the practice of direct planting,

adopting the principles of organic agriculture, without desiccants, that is, herbicides, especially when there is incorporation of organic fertilizers, increasing the fertility of the system, boosting production and providing energy savings and reducing the loss of fertile soils" [10]. Among the options for the regeneration of soil fertility, green manure can be mentioned, as one of the practices that contribute to increase and/or sustain soil biological activity [11].

Within this context, the use of non-leguminous plants in organic fertilization is related to the narrow carbon-nitrogen ratio (20 to 30/1) by reducing N losses due to the temporary immobilization of nitrogen by the microbial biomass, being of paramount importance [12] for contributing to soil fertility [13].

Thus, the scarlet starglory (*Merremia aegyptia* L.) , a spontaneous species from the semi-arid region, with rapid vegetative development, belonging to the concolvulaceae family, with production of green and dry phytomass in the order of 42.0 and 6.04 t ha^{-1} respectively [14]. This species has nitrogen content of 26.2g kg^{-1} in dry matter, and a carbon/nitrogen ratio of 17/1 at the phenological stage of 126 days after emergence [14]. Countless works in the organic production of vegetables have been developed with this species [15-18], as well as [19].

Given the importance of researching available organic materials within arable areas, the objective was to evaluate the use of jitirana mixed with poultry manure on the agronomic viability of coriander in the semi-arid region.

2. MATERIALS AND METHODS

2.1 Characterization of the Experimental Area

The experiment was carried out in a greenhouse of the didactic garden of the Department of Agronomic and Forestry Sciences of the Federal Rural University of the Semi-arid (UFERSA), Mossoró, RN, Brazil, in the period from October to December 2022, in soil classified as Oxisol Red Yellow Argisolic sandy loam [20]. The experiment site was in the municipality of Mossoró, RN, Brazil, located at 5º 11' south latitude and 37º 20' west longitude and altitude of 18 m. According to Thornthwaite, the local climate is DdAa', that is, semi-arid, megathermal with little or no excess of water during the year, and according to Köppen it is BSwh', as dry and very hot, with two seasons: a dry period, which generally covers the period from June to January, and a rainy period, between February and May [21].

The soil was collected at a depth of 0.20 m to compose the pots with dimensions of 0.4 m x 0.32 m used for the development of the coriander crop. Before the installation of the experiment, soil samples were taken at a depth of 0-0.20 m, which were air-dried and sieved through a 2 mm mesh and subsequently analyzed at the UFERSA Laboratory of Soil Chemistry and Fertility. The results were as follows: pH (water 1:2.5) = 7.0; Ca = 2.2 cmol dm^{-3}; Mg = 0.8 cmolc dm^{-3}; K = 25.0 mg dm^{-3}; Na = 8.8 mg dm^{-3}; P = 26.8 mg dm^{-3} and M.O. = 0.6 g kg^{-1}.

2.2 Experimental Design

The experimental design used to study the viability coriander was the completely randomized with treatments arranged in a 5 x 2 factorial scheme, with 3 replications, with 90 plants per plot. The first factor consisted of five amounts of the mixture of scarlet starglory with poultry manure (0.0; 1.2; 2.4; 3.6 and 4.8 kg m^{-2} of area in dry basis), and the second factor consisting of two forms of application to the soil (incorporated and cover) in single cultivation. The spacing used was 0.1 x 0.05 m with five plants pit^{-1}, corresponding to 1000 plants m^{-2} area, as recommended by Linhares et al. [6], corresponding to the density of plants used by family farmers in the region of Mossoró, RN, Brazil. In each plot, three planting rows with six holes were opened, totaling eighteen holes with five plants, corresponding to ninety plants per experimental plot.

Irrigations were carried out (morning and afternoon) in order to maintain the soil at field capacity for the full development of the crop. Cultural practices were carried out (removal of invasive plants) preventing competition for water and nutrients with the coriander crop. No chemical pesticides were used to control undesirable plants, the control being made manually.

To compose the mixture of fertilizers in the research, scarlet starglory (*Merremia aegyptia* L.) was used, a spontaneous species from the semi-arid region with production of green and dry phytomass in the order of 42000 kg ha^{-1} and 6000 kg ha^{-1}, respectively, with nitrogen content of 24.7 g kg^{-1} at 104 days after emergence (Fig. 1) [14].

The scarlet starglory (*Merremia aegyptia* L.) was harvested in a semi-arid vegetation area adjacent to the Federal Rural University of the Semi-arid one hundred days after emergence, and crushed into forage in 2.0 to 3.0 cm segments. Then, the material was dried in the sun for a period of eighty hours until a moisture content of 15%, being samples were taken and sent to the soil fertility and plant nutrition laboratory of the Center for Agricultural Sciences at UFERSA for analysis of carbon (C); 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 [22].

The poultry manure was collected in the poultry sector of the Department of Animal Sciences at UFERSA, from laying hens and sent to the laboratory of soil fertility and plant nutrition at the Center for Agricultural Sciences at UFERSA, for carbon analysis (C); 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.

The fertilizers were mixed and applied to the soil depending on the amounts and forms of application, with the material remaining for an incubation period of thirty days before planting, according recommended by Linhares et al. [23]. During the decomposition process of the mixture of jitirana plus poultry manure in the soil, irrigation of all plots was carried out to field capacity, being of fundamental importance in the nitrification process [24].

2.3 Measurement of Agronomic Characteristics of Coriander

Thirty-five days after sowing, the experiment was harvested, where the plants were harvested 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 twenty 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 twenty plants, expressed in $plant^{-1}$ units); productivity (performed by the weight of all the plants in the useful area of the plot, expressed in g m^{-2} of area); number of bunches (determined by dividing the m^{-2} productivity by 50 g, reference weight for a coriander bunch, expressed in m^{-2} area units) and dry matter mass (obtained by weighing twenty plants $plot^{-1}$ on an electronic scale with a precision of 1.0 g, followed by drying in a heated oven with forced air at 65 °C, until constant mass).

2.4 Statistical Analysis

Statistical analysis was performed according to conventional methods of analysis of variance [25], using ESTAT statistical software. The response curve fitting procedure was performed using the ESTAT Software.

Fig. 1. Illustration of the scarlet starglory (*Merremia aegyptia* L.) in full vegetative development in the semiarid region of Brazil. Photo: Researcher: D.Sc. Paulo César Ferreira Linhares

3. RESULTS AND DISCUSSION

There was a significant effect at the P< 0.01 probability level for all the characteristics evaluated in terms under condition of the different amounts of the mixture of scarlet starglory (*Merremia aegyptia* L.) with poultry manure (Table 1). The increase in all coriander evaluated characteristics is probably due to the availability of nitrogen in the soil, being absorbed by the crop, considering that this element is responsible for leaf expansion [26].

It was observed that there was a growth in plant height depending on the amounts of the mixture of scarlet starglory (*Merremia aegyptia* L.) with poultry manure, with values of 4.23 and 18.05 cm plant^{-1} in the amounts of 0 and 4.8 kg m^{-2}, respectively (Fig. 1). Regarding the forms of application to the soil of scarlet starglory (*Merremia aegyptia* L.) mixed with poultry manure (incorporated and cover) there was a statistical difference, with values of 12.6 and 14.6 cm plant^{-1}, respectively (Table 2). Linhares et al. [27] studying organic fertilization with spontaneous species from the semi-arid region on coriander productivity, they found plant height of 18.38 cm plant^{-1} lower than the present work. Linhares et al. [23] studying the amounts and times of decomposition of jitirana in the agronomic performance of coriander, observed a maximum height of 15.0 cm plant^{-1}, lower value than that research. Linhares et al. studying agronomic efficiency of organic fertilized in the production of the intercropping of coriander and mint in the northeastern Brazil found a plant height of 22.0 cm plant^{-1}, which differs from the result of this research.

Table 1. F values for plant height, expressed in cm plant^{-1} (AT), number of stems per plant, expressed in units plant^{-1} (NH), coriander productivity, expressed in grams m^{-2} of area (PC), number of bunches, expressed in units m^{-2} of area (NM) and dry mass, expressed in grams m^{-2} of area (MSC) of coriander fertilized with a mixture of scarlet starglory (*Merremia aegyptia* L.) and poultry manure

Causes of Variation	GL	AT	NH	PC	NM	MSC
Amounts of starglory with poultry manure (A)	4	8.04**	9.39**	20.12**	15.10**	27.00**
Forms of application (B)	1	3.92*	7.57**	19.27**	14.27**	16.05**
A X B	4	1.53^{ns}	1.24$^{n.s}$	8.05**	9.05**	16.27**
Treatments	9	14.79**	7.64**	14.96**	13.14**	22.40**
Blocks	2	0.37$^{n.s}$	4.84*	6.22**	7.35**	12.01**
Residue	18	-----	-------	-------	------	------
CV (%)	----	10.5	8.47	7.15	8.94	8.20

*** = P <0.01, statistical significance at 1% probability * = P <0.05, statistical significance at 5% probability and ^{ns} = not significant, Gl= degree of freedom*

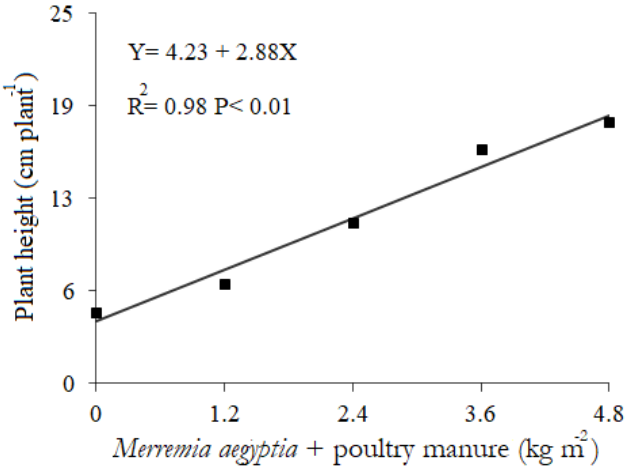

Fig. 2. Plant height of coriander under different amounts of scarlet starglory (*Merremia aegyptia* L.) plus poultry manure

For the number of stems, there was a behavior similar to that which occurred in plant height, with an increase in the amounts of scarlet starglory (*Merremia aegyptia* L.) plus poultry manure, with a maximum value of 7.97 stems plant^{-1} (Fig. 3). Regarding the forms of application to the soil (incorporated and covering), there was a statistical difference with values of 5.6 and 8.0 units of plant^{-1} stems, respectively (Table 2). Linhares et al. [27] studying organic fertilization with spontaneous species form the semiarid region in the coriander culture productivity with a number of stems of 7.6 plant^{-1}, a value that is similar to that research. Linhares et al. [2], studying the yield of coriander (*Coriandrum sativum* L.) fertilized with cattle manure at different doses and times of incorporation into the soil, found a number of stems of 6.3 plant^{-1}, which is lower than the present study.

In terms of productivity and number of bunches of coriander, the amount of 4.8 kg m^{-2} of the mixture of jitirana plus poultry manure contributed significantly to these characteristics, with maximum values of 1246.5 g m^{-2} and 24.9 units of bunches m^{-2} of coriander (Figs. 4 and 5). Regarding the forms of application to the soil of the mixture of jitirana with poultry manure (incorporated and cover), there was a statistical difference with productivity values of 563 and 712 g m^{-2}, corresponding to 11.0 and 14.0 units of bunches m^{-2}, respectively (Table 2). The number of sauces is of paramount importance, considering that this is the commercialization model in supermarket shelves and agroecological fairs. This productivity is within the production reality of family farmers in the semiarid region, Mossoró, Brazil [28].

Linhares et al. [22], studying the cultivation of coriander in succession of the lettuce culture, found coriander productivity of 3180 kg ha^{-1}, equivalent to 318 g m^{-2}, which is lower than the aforementioned work. Novaes et al. [29], studying sources of organic fertilization in the consortium of coriander and arugula in Cruz das Almas, found fresh mass of the area of 316 g m^{-2}, different from the aforementioned research. Linhares et al. [27] studying organic fertilization with spontaneous species form the semiarid region in the of coriander productivity with a maximum value of 1210 g m^{-2} and 24.2 units of bundles m^{-2}, which is similar to that work.

In the dry matter characteristic, there was a similar behavior to productivity and number of bunches, with an increase with the increase in the amounts of scarlet starglory (*Merremia aegyptia* L.) plus poultry manure, with a maximum value of 132.86 g m^{-2} in the amount of 4.8 kg m^{-2} (Fig. 6). Regarding the forms of application to the soil of jitirana plus poultry manure (incorporated and in coverage) there was a statistical difference, with values of 58.8 and 65.2 g m^{-2}, respectively (Table 2). Dry matter is a characteristic that reflects plant growth [26], being of paramount importance in verifying the behavior of treatments applied to the soil. Dry matter is a characteristic that reflects plant growth [26], and is of paramount importance in verifying the behavior of treatments applied to the soil. Linhares et al. [30] studying the application of rooster (*Calotropis procera* (Aiton) W.T. Aiton} as a green fertilizer in leafy vegetables (coriander, arugula and lettuce) found a dry mass yield of 26.0 g m^{-2} in the coriander culture, lower than that of the cited research.

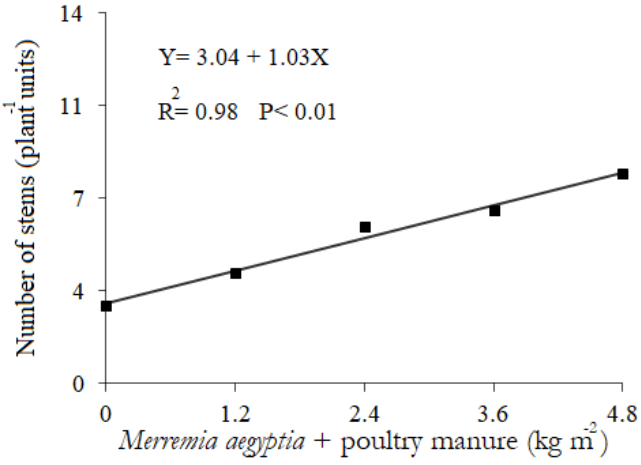

Fig. 3. Number of stems of coriander under different amounts of scarlet starglory (*Merremia aegyptia* L.) plus poultry manure

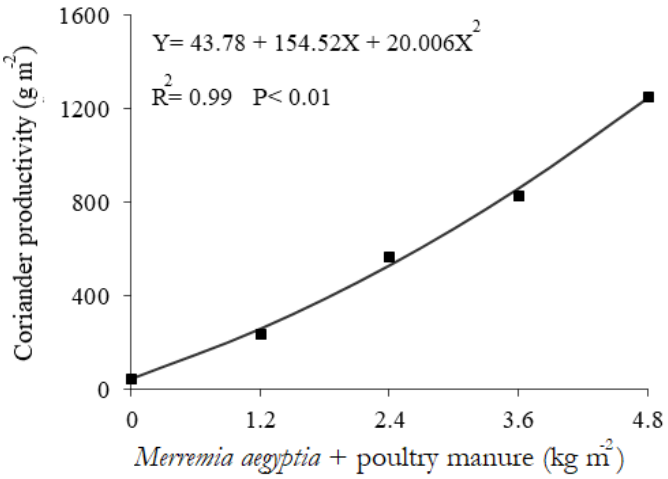

Fig. 4. Coriander productivity of coriander under different amounts of scarlet starglory (*Merremia aegyptia* L.) plus poultry manure

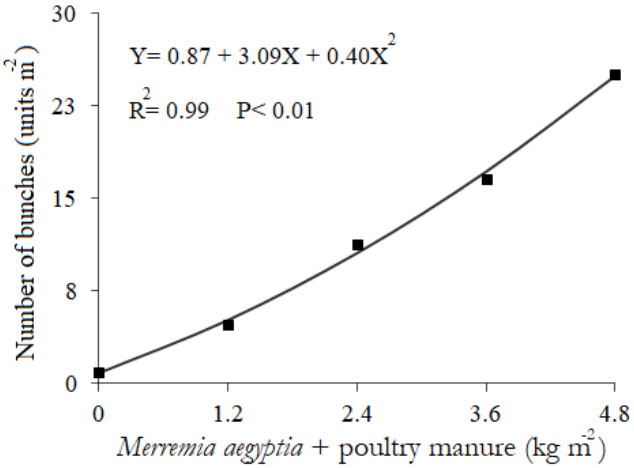

Fig. 5. Number of bunches of coriander under different amounts of scarlet starglory (*Merremia aegyptia* L.) plus poultry manure

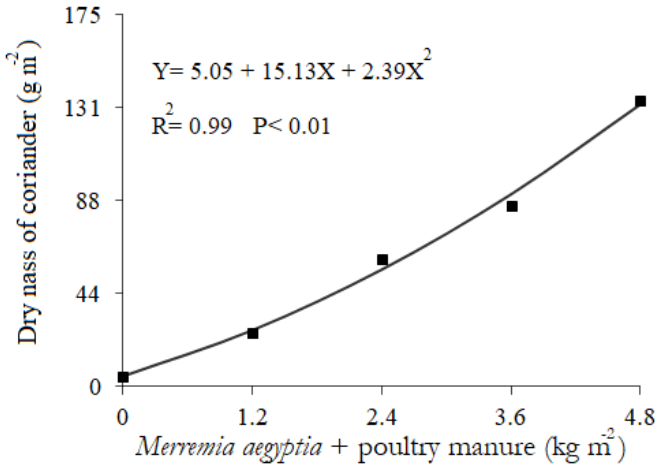

Fig. 6. Dry mass of coriander under different amounts of scarlet starglory (*Merremia aegyptia* L.) plus poultry manure

Table 2. Plant height values expressed in cm plant^{-1} (AT), number of stems per plant, expressed in units plant^{-1} (NH), coriander productivity, expressed in grams m^{-2} of area (PC), number of bunches, expressed in units m^{-2} of area (NM) and dry mass, expressed in grams m^{-2} of area (MSC) of coriander under on the mixture of scarlet starglory and poultry manure incorporated and coverage

Forms of application to the soil	AT	NH	PC	NM	MSC
Incorporated	12.6 b	5.6 b	563 b	11.0 b	58.8 b
Coverage	14.6 a	8.0 a	712 a	14.0 a	65.2 a

Means followed by different letters in the column differ at the 5% level of probability by Tukey's test

4. CONCLUSIONS

The highest productivity and number of bunches of coriander culture was observed in the amount of 4.8 kg m^{-2} of the mixture of scarlet starglory with poultry manure, with values of 1246.5 g m^{-2} and 24.9 units of bunches m^{-2}, respectively. The mixture of organic fertilizers (scarlet starglory with poultry manure) contributed positively to the agronomic characteristics of the coriander crop.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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