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Optimized amount of hairy woodrose (*Merremia aegyptia* L.) in the productivity of coriander cultivars

Paulo César Ferreira Linhares*, Janilson Pinheiro de Assis, Roberto Pequeno de Sousa, José Roberto de Sá, Maria Francisca Soares Pereira, Whenia Benevides Ramalho, Rita Ianáskara Gomes da Silva, Rogério Alexandrino da Silva, and Karla Elita Viegas Pereira

Federal Rural Semi-Arid University, Department of Agronomic and Forestry Sciences, Jitirana Research Group, Mossoró-RN, 59625-900, Brazil
**Corresponding author:* paulolinhares@ufersa.edu.br

Abstract

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One experiment was conducted at the Rafael Fernandes Experimental Farm, in the Alagoinha district, rural area of Mossoró-Rn, Brazil, with the objective of evaluating optimized amount of hairy woodrose (*Merremia aegyptia* L.) in the productivity of coriander cultivars. The experimental design of randomized complete blocks with the treatments arranged in 5 x 2 factorial scheme with four replicates. The first factor consisted of four amounts of hairy woodrose (0.0, 1.0, 2.0, 3.0 and 4.0 kg/m^2 of dry beds) and the second factor corresponding to coriander cultivars (Verdão and Tabocas). The characteristics evaluated were: plant height, number of stems per plant, productivity, number of bunches and dry mass. The best productive performance for coriander cultivars was obtained in the amount of 3.0 kg/m^2 hairy woodrose incorporated into the soil. Between the coriander cultivars, Verdão was more productive than cultivating Tabocas. The cultivation of coriander cultivars is agronomically viable with the use of hairy woodrose as green manure.

Keywords: coriander; green manure; hairy woodrose; agroecological production
Abbrevations: UFERSA – Federal Rural Semi-Arid University, pH – hydrogen potential, P – phosphorus, K – potassium, Ca – calcium, Mg – magnesium, Na – sodium, M.O. – organic matter, N – nitrogen, C/N – carbon/nitrogen

Introduction

Coriander (*Coriandrum sativum*, Apiaceae) originates from the territories of the Mediterranean Basin. In Brazil, this herb was introduced at the beginning of colonization (Cardoso et al., 2017), the green mass of the leaves is used in natura as a condiment. The dry fruits, besides being used as condiments, are used in pharmaceutical and cosmetics industries (Daflon et al., 2014). According to Pereira (2012), palm trees are the most widely cultivated trees in the state of Rio Grande do Norte, preferably by farmers because it fits well the local climate conditions and its rapid growth ensures faster return compared to Tabocas and Super-Palm trees.

In the region of Mossoró-RN, Brazil, there are the most widely produced and consumed vegetable crops, with plantings made in home gardens, which are conducted by farmers, using family labor and manure (cattle, goat and birds) as a source of fertilizer. This limits production output because the farmer does not always has this resource available on his property, this unavailability of cattle manure contributes

to increased production costs (Menezes and Salcedo, 2007; Linhares et al., 2012).

One of the alternatives to allow these production systems is green manure, since its use in vegetable production may represent an option for producers working in the organic system (Perin et al., 2004).

According to Linhares (2013) the practice of incorporating, or leaving on the top soil, decomposed vegetation matter (used in green manure) brings benefits to the entire system. Additionally, it guarantees the farmer success in production and great optimization of the resources used. The green manure with spontaneous species of the Caatinga is an alternative for the small farmers of the semi-arid region.

The species most frequently used in production systems are legumes, because these have the ability to fix nitrogen by symbiotic bacteria in their root systems, besides having high biomass production. However, spontaneous species may contribute to the fertility of soil in the same way as the legumes.

In this sense, the aim of the study is to evaluate optimized amount of hairy woodrose (*Merremia aegyptia* L.) in the productivity of coriander cultivars.

Materials and Methods

The study was conducted at the Experimental Farm of Rafael Fernandes, in the district of Alagoinha (5°03'37" S, 37°23'50" W), northwest of Mossoró, State of Rio Grande do Norte (RN), Brazil. The farm comprises of some 400 hectares (da Silva Rêgo et al., 2016). The climate in this region by the Köppen classification is BShw, dry and very hot, with two seasons: a dry season, which usually runs from June to January, and a rainy season, from February to May (Alvares et al., 2013). The site soil was classified as sandy loam Argisol Yellow Red Latosol (Embrapa, 2006).

Before set up of the study, samples of soil were removed from the 0-20 cm layer, which were air dried and sieved in a 2 mm mesh, then analyzed at the Soil Chemistry and Fertility Laboratory of Universidade Federal Rural do Semi-Árido (UFERSA). The results from the laboratory testing at UFERSA were the following: pH (water 1:2,5) = 6.5; exchangeable cations Ca = 1.00 $cmol_c$ dm^{-3}; Mg = 0.60 $cmol_c$ dm^{-3}; K = 50.5 mg dm^{-3}; Na = 9.7 mg dm^{-3}; P (Mehlich) = 15.80 mg dm^{-3} and M.O = 1.48 g kg^{-1}.

The experimental design was a randomized complete block with treatments arranged in a factorial 5 x 2 with four replications. Treatments included a combination of five amounts of hairy woodrose incorporated into the soil (0.0, 1.0, 2.0, 3.0 and 4.0 kg/m^2 on a dry basis), four periods of incorporation (0, 10, 20 and 30 days before sowing coriander), two coriander cultivars (Verdão and Tabocas).

For the coriander crop in both cultivars, the plot was 1.4 x 1.4 m, with a total area of 1.96 m^2, floor area of 1.0 m^2 with 1000 plants in the 0.1 x 0.05 m spacing, being the density of plants used by family-based farmers in the region the Mossoró-RN, Brazil (Linhares et al., 2014). Soil preparation consisted of manual cleaning, removal of natural vegetation present in the experimental area and manual lifting of the beds, using as a tool to hoe.

The hairy woodrose (*Merremia aegyptia* L.) used as green manure was collected before the start of flowering in various locations of the rural zone of the Mossoró-RN municipality. After collecting, the plants were crushed in a conventional forage machine to obtain fragmented particles approximately 2.0 to 3.0 cm in size, which were dried in sun to reach a moisture content of 12%; a sample of this material then was subjected to laboratory analyses, which revealed the following chemical composition: N = 22.5 g/kg; P = 7.8 g/kg; K = 25.7 g/kg; Ca = 10.2 g/kg; Mg = 4.3 g/kg; S = 1.8 g/kg and a C/N ratio of 20/1. The plant material was quantified as a function of dry matter, taking into account the 12% humidity, being incorporated in the 0-20 cm soil.

During the period of stay of residues in the soil, prior to planting, irrigations were made in order to maintain soil moisture at 70% of field capacity, and this is an ideal condition for nitrification (Novais, 2007).

After the incorporation of velvet mallow, the coriander was planted. Eight days after emergence, thinning occurred. Hand weeding and irrigation were carried out by micro sprinkler with daily irrigation in two applications (morning and afternoon). At thirty days after the sowing coriander, harvesting was done on. After harvesting, plants were transported to the Post-Harvest of Vegetables Laboratory at the Department of Agronomic and Forestry Sciences at UFERSA where they were analyzed.

For the coriander cultivars the following characteristics were evaluated: plant height (measured from base to apex in twenty plant sample batches, using a millimeter ruler and recorded in cm/plant), number of stems per plant (determined in twenty plant sample averages), green mass (obtained from a cut of the shoot system and weighted with an electronic scale at a precision of 1.0 g, measured in kg/m^2), number of bunches (this was evaluated dividing the green mass by 50 g, equivalent to the weight of a coriander bunch, according to information from organic producers in the region of Mossoró-RN, and measured in units 100/m^2), and dry mass (obtained from a forced-air heating oven at 65ºC, until constant mass was attained and measured in kg 100/m^2).

Analyses of variance were conducted for the evaluated characteristics using the ESTAT software (Kronka and Banzato, 1995). Tukey's test at ($p < 0.05$) probability was

used for comparisons between the cultivars of coriander. Response curve adjustment for the quantitative factor was performed using the Table Curve software (Jandel Scientific, 1991). The response functions were evaluated based on the following criteria: biological rationale, significance of the mean square of the regression (QMRr), high coefficient of determination (R2), significance of the regression parameters, using the t test at $p < 0.01$ probability.

Results and Discussion

There was significant interaction between the factors studied only for plant height (Table 1).

The interaction of amounts of hairy woodrose with plant height of coriander cultivars Verdão and Tabocas is shown in Figure 1. The maximum plant height was 20.5 and 19.6 cm plant^{-1}, respectively, at amount of 3.0 kg/m^2 of hairy woodrose (Figure 1).

For the coriander cultivars, there was unfolding within the amounts of hairy woodrose, with maximum values of 20.7 and 18.6 cm/plant to cultivars Verdão and Tabocas, respectively (Table 2). The results obtained were superior to that found by Linhares (2009) when evaluating different amounts, types of green fertilizers, and plant^{-1} average heights of 14.18; 13.66 and 11.90 cm for coriander and evaluated using jitirana, silk flower, and pasture, respectively in the amount of 15.6 t/ha, equivalent to 1.56 kg/m^2.

There was an increase in number of stems of coriander, with increasing amounts of hairy woodrose applied, with an average of 7.27 number/plant in the amount of 3.0 kg/m^2 (Figure 2) was recorded. There was statistical

Table 2
Unfolding the interaction of the coriander cultivars inside of the amounts of hairy woodrose in the plant height of coriander, expressed in cm

Cultivars	Amounts of hairy woodrose (kg/m^2)				
	0	1.0	2.0	3.0	4.0
Verdão	4.87 a	10.3 a	17.7 a	20.7 a	18.7 a
Tabocas	5.60 a	9.9 a	17.2 b	18.6 b	17.7 b

*Means followed by different lowercase letters in the column differ statistically by Tukey test at 5% probability.

Table 1
Factor values for plant height, expressed in cm (HP); number of stems, expressed in terms of average (NS); productivity of coriander, expressed in kg 100/m^2 (PC), number of bunches, expressed in units 100/m^2 (NB) and dry mass, expressed in kg 100/m^2 (DM) of coriander cultivars with different amounts of hairy woodrose

Variations	GL	HP	NS	PC	NB	DM
Amounts (A)	4	745.90**	68.30**	164.62**	154.63**	280.38**
Cultivars (C)	1	9.66**	1.57^{ns}	21.05**	20.05**	20.18**
A X C	4	5.03**	0.58^{ns}	1.77^{ns}	2.70^{ns}	1.43**
Treatments	9					
Blocks	3	0.77^{ns}	0.29^{ns}	1.16^{ns}	1.30^{ns}	2.01^{ns}
Residue	27	----	----	----	----	----
CV (%)	----	4.5	14.70	15.20	14.00	10.7
Average overall	----	14.12	5.20	59.30	593.00	6.30

** = $P < 0.01$, statistical significance at 1% probability; ns = not significant;
HP = plant height; NS = number of stems; PC = productivity of coriander; NB = number of bunches; DM = dry mass

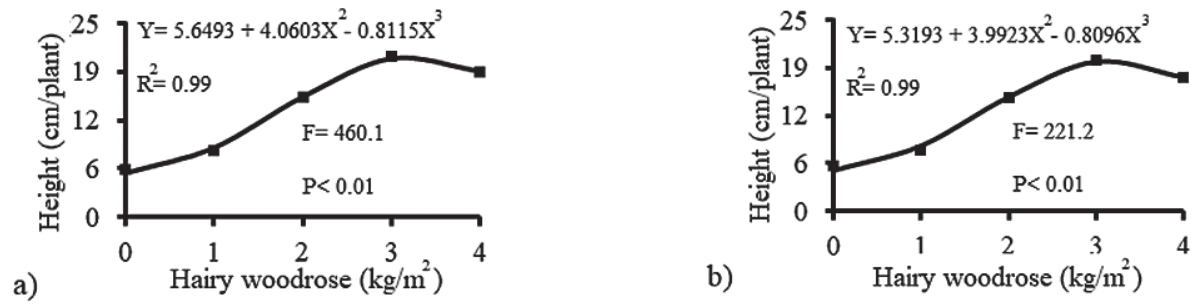

Fig. 1. Plant height of coriander cultivars, Verdão (a) and Tabocas (b) under different amounts of hairy woodrose incorporated into the soil

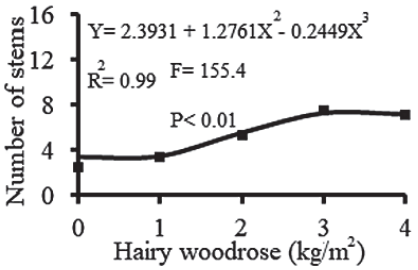

Fig. 2. Number of stems of coriander under different amounts of hairy woodrose incorporated into the soil

similarity in the coriander cultivars, with mean values of 5.3 and 5.0 stems for the coriander cultivars Verdão and Tabocas, respectively (Table 3). Linhares et al. (2010) evaluated the decomposition of forest-pasture in coriander, found 6.0 stems plant^{-1}, lower than the present work. Cunha et al. (2018) has studies agronomic efficiency of different quantities of hairy woodrose mixed with cattle manure in the intercropping of coriander with mint, and has established number of stems of 4.7 in the quantity of 3.0 kg m^{-2}, lower than the present study.

Table 3

Number of stems, expressed in terms of average (NS), productivity, expressed in kg/100 m² (PC), bunches, expressed in units/100 m² (BC) and dry mass, expressed in kg/100 m² (DM) as a function de coriander cultivars

Cultivars	NS	PC	BC	DM
Verdão	5.3 a	65.4 a	654.0 a	6.78 a
Tabocas	5.0 a	53.2 b	532.0 b	5.82 b

*Means followed by different lowercase letters in the column differ statistically by Tukey test at 5% probability.

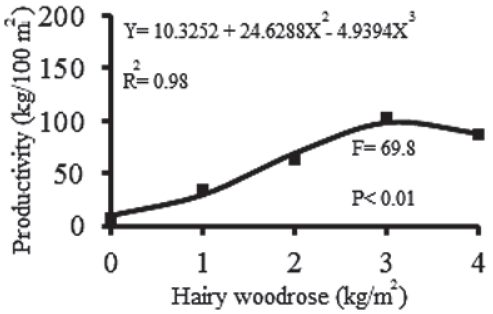

Fig. 3. Productivity of coriander under different amounts of hairy woodrose incorporated into the soil

In characteristics of productivity, and number of coriander bunches, we observed maximum productivity of 98.6 kg/100 m² and 986 100/m² bunches using 3.0 kg/m² of hairy woodrose incorporated into the soil (Figures 3 and 4). There was superiority of Verdão cultivar in relation of Tabocas, with values of 65.4 and 53.2 for productivity, corresponding to 654 and 532 coriander bunches, respectively (Table 3). Ramalho (2015) studied the coriander consortium with beetroot fertilized with hairy woodrose more cattle manure, with agronomic performance of coriander 525 g m² of green mass, equivalent to 52.5 kg 100 m^{-2} corresponding to 525 bunches in 100 m^{-2}, being less than said research.

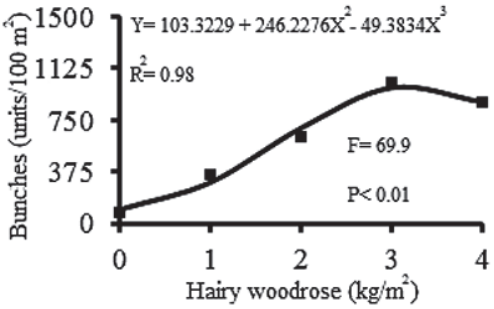

Fig. 4. Bunches of coriander under different amounts of hairy woodrose incorporated into the soil

Tavella et al. (2010) studied the organic cultivation of coriander tillage using dead cover, fertilized with compost, found productivity of 3454 kg/ha at planting with weeds, equivalent to 34.5 kg/100 m², corresponding to 690 bunches in 100 m², being less than said research. Linhares et al. (2014) studying the roostertree (*Calotropis procera*) under different amounts and periods of incorporation on yield of coriander with an average yield of 4404 kg/ha, equivalent to 44 kg/100 m², corresponding to 880 bunches in 100 m² short of the results of that research. This productive superiority is probably due to the hairy woodrose nitrogen concentration (22.5 g/kg), given that this element is responsible for leaf expansion, which favored the coriander consisting of leaves.

Increase was observed for dry mass of coriander, with a maximum value of 10.45 kg/100 m² of hairy woodrose incorporated into the soil (Figure 5). In the cultivars of coriander, there was superiority of cultivar Verdão in relation of Tabocas, with averages values of 6.78 and 5.82 kg/100 m² (Table 3). The dry mass is a characteristic that reflects the growth of the vegetable (Taiz and Zeiger, 2009). Cunha et al. (2018) has established dry mass of 11.0 kg/100 m² in isolated cultivation, in the quantity of 3.0/kg m², lower than the present study, when studying agronomic efficiency of different quantities of hairy woodrose mixed with cattle manure in the intercropping of coriander with mint.

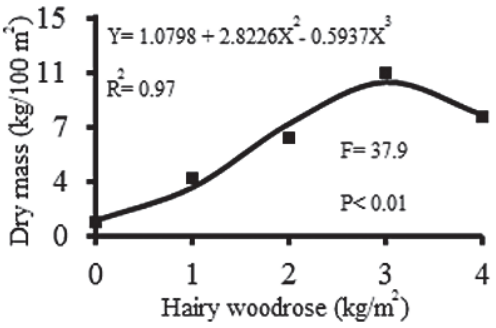

Fig. 5. Dry mass of coriander under different amounts of hairy woodrose incorporated into the soil

Conclusions

The best productive performance for coriander cultivars was obtained in the amount of 3.0 kg/m^2 hairy woodrose incorporated into the soil.

Between the coriander cultivars, Verdão was more productive than Tabocas. The cultivation of coriander cultivars is agronomically viable with the use of hairy woodrose as green manure.

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