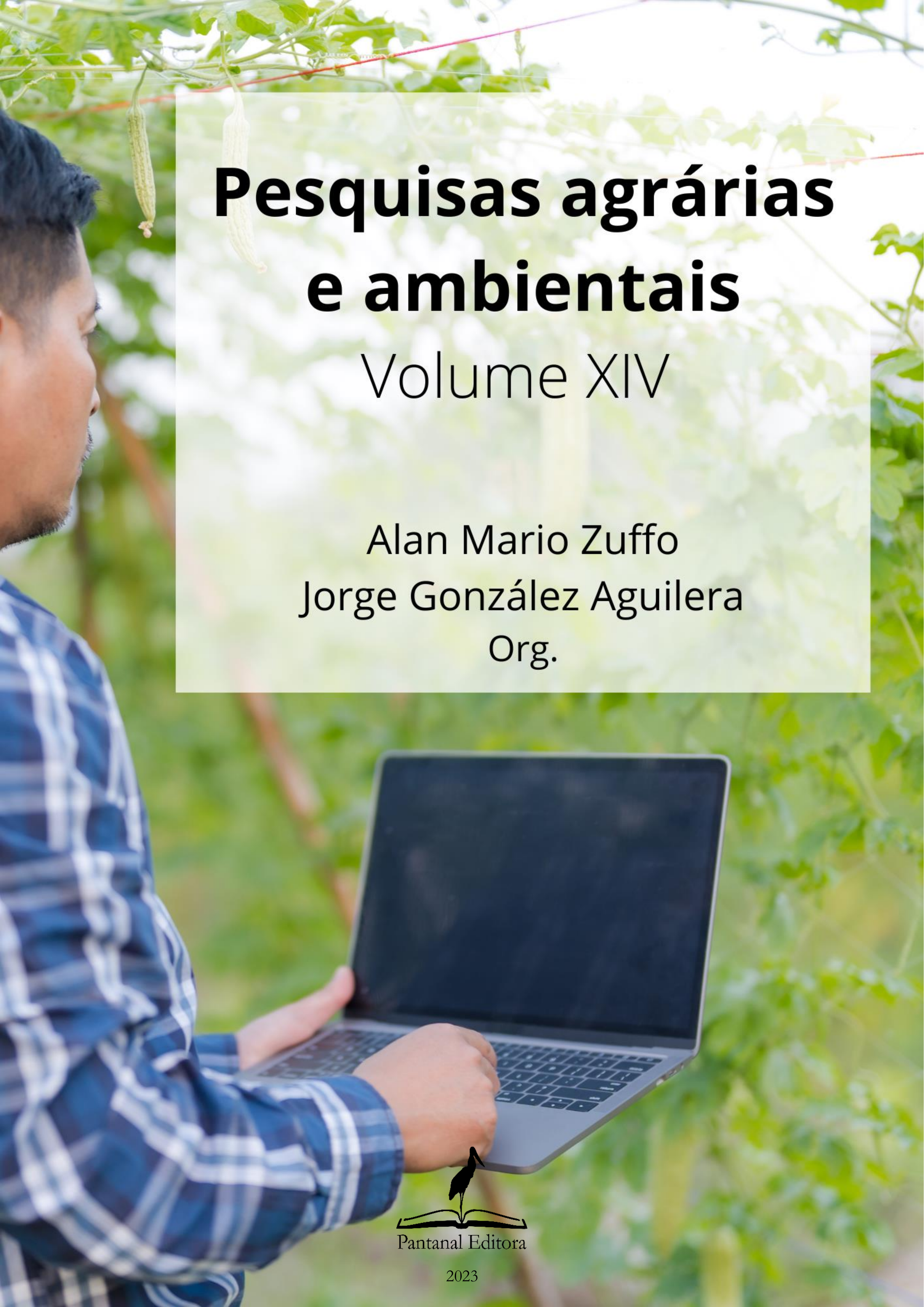

Pesquisas agrárias e ambientais

Volume XIV

Alan Mario Zuffo
Jorge González Aguilera
Org.

Pantanal Editora

2023

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Organizadores

Pesquisas agrárias e ambientais
Volume XIV

Pantanal Editora

2023

Editor Chefe: Prof. Dr. Alan Mario Zuffo
Editores Executivos: Prof. Dr. Jorge González Aguilera e Prof. Dr. Bruno Rodrigues de Oliveira

Diagramação: A editora. **Diagramação e Arte:** A editora. **Imagens de capa e contracapa:** Canva.com. **Revisão:** O(s) autor(es), organizador(es) e a editora.

Ficha Catalográfica

Catalogação na publicação
Elaborada por Bibliotecária Janaina Ramos – CRB-8/9166

P474

Pesquisas agrárias e ambientais - Volume XIV / Organizadores Alan Mario Zuffo, Jorge González Aguilera. – Nova Xavantina-MT: Pantanal, 2023.

Livro em PDF

ISBN 978-65-81460-76-1
DOI https://doi.org/10.46420/9786581460761

1. Agronomia. 2. Sustentabilidade. 3. Meio ambiente. I. Zuffo, Alan Mario (Organizador). II. Aguilera, Jorge González (Organizador). III. Título.

CDD 630

Índice para catálogo sistemático

I. Agronomia

Pantanal Editora

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https://www.editorapantanal.com.br
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Apresentação

As áreas de Ciências Agrárias e Ciências Ambientais são importantes para a humanidade. De um lado, a produção de alimentos e do outro a conservação do meio ambiente. Ambas, devem ser aliadas e são imprescindíveis para a sustentabilidade do planeta. A obra, vem a materializar o anseio da Editora Pantanal na divulgação de resultados, que contribuem de modo direto no desenvolvimento humano.

O e-book "Pesquisas Agrárias e Ambientais Volume XIV" é a continuação de uma série de volumes de e-books com trabalhos que visam otimizar a produção de alimentos, o meio ambiente e promoção de maior sustentabilidade nas técnicas aplicadas nos sistemas de produção das plantas e animais. Ao longo dos capítulos são abordados os seguintes temas: Qualidade de vida e segurança do trabalho na mineração frente ao risco de rompimento de barragens sustentabilidade na agricultura; os condicionantes socioambientais da dengue na área urbana; estrutura, agregação e erosão do solo: da matéria orgânica à desestabilização; biologia floral do pepino e sua relação com os polinizadores; estressores na abelha sem ferrão; biologia floral e polinização no quiabeiro; adubação orgânica com espécies espontâneas do semiárido na produtividade do coentro; produtividade de hortelã adubada com mistura de jitirana e mata-pasto; floração, frutificação, síndrome de dispersão e de polinização de espécies florestais em projetos de restauração. Portanto, esses conhecimentos irão agregar muito aos seus leitores que procuram promover melhorias quantitativas e qualitativas na produção de alimentos e do ambiente, ou melhorar a qualidade de vida da sociedade. Sempre em busca da sustentabilidade do planeta.

Aos autores dos capítulos, pela dedicação e esforços sem limites, que viabilizaram esta obra que retrata os recentes avanços científicos e tecnológicos na área de Ciência Agrárias e Ciências Ambientais Volume XIV, os agradecimentos dos Organizadores e da Pantanal Editora. Por fim, esperamos que este ebook possa colaborar e instigar mais estudantes e pesquisadores na constante busca de novas tecnologias e avanços para as áreas de Ciências Agrárias e Ciências Ambientais. Assim, garantir uma difusão de conhecimento fácil, rápido para a sociedade.

Os organizadores

Sumário

Capítulo 9

Productivity of mint fertilized with a mixture of jitirana (*Merremia aegyptia* L.) and mata-pasto (*Senna uniflora* L.)

Recebido em: 16/01/2023
Aceito em: 17/01/2023
10.46420/9786581460761cap9

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INTRODUCTION

An activity quite developed in family farming consists of the production of vegetables and medicinal plants in a diversified way, products destined for commercialization and subsistence. This production takes place in small areas with low technological levels. Despite the limitations imposed on the farmer, he works in harmony with nature, seeking to preserve natural resources.

Within the genus *Mentha*, belonging to the family Lamiaceae, Mentha arvensis and *Mentha piperita* stand out and are popularly known, mainly for the commercial exploitation of essential oil extracted from its aerial part and for medicinal use in the combat of stomach disorders, respiratory apparatus and intestinal parasites (Chagas et al., 2011).

In Brazil, the genus *Mentha* is widely used for medicinal and food purposes (Lorenzi; Matos, 2002). One of the factors that interferes with the production of essential oil is soil fertility, since the nutritional conditions of the soil are essential for the balance between the accumulation of biomass and the production of oils in the *Mentha* culture (Valmorbida; Boaro, 2007).

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Among farmers working in the family production system, the presence of this species in their production areas is very common, considering their use in folk medicine as well as in cooking. Its production occurs in organic systems on the farms of family-based farmers who cultivate sustainably for consumption and commercialization (Linhares et al., 2018).

A very important factor is the time of harvest, and care should be taken to do so at the ideal time to avoid interfering with the production and yield of the essential oil. To obtain high levels of essential oil, it is preferable to collect plants in the morning, as the period of exposure to the sun can cause an important quantitative loss of the essential oil existing in the plant.

Veronese et al. (2001) stated that mint and mint oil yield are modified by biotic and abiotic factors. This statement is supported by some agronomic studies recorded in the literature, especially those investigating the influence of fertilization on the development of this species. Organic fertilization represents a nutrient source for plants that helps to improve the physical, chemical and biological structure of the soil in addition to providing adequate nourishment.

In the region of Mossoró-RN, Brazil, the most commonly used fertilizer source is cattle manure, which limits production, given that farmers do not always have this resource available, contributing to the increase in production costs (Linhares et al., 2012; Linhares et al., 2014). Thus, the use of plant species as green manuring promotes benefits for the whole system. Additionally, it guarantees farmer success in production and optimization of the resources used (Linhares, 2013).

Legumes are the most commonly used plants for green manuring because they contain a high percentage of phosphorus, potassium, calcium, and mainly nitrogen, given the symbiotic N fixation by the bacteria belonging to the genus Rhizobium that develop in its roots (Tavares Junior et al., 2016). However, species from other families may be used.

Within this context, jitirana (*Merremia aegyptia* L.), which is a spontaneous species of the caatinga biome, semiarid region of northeastern Brazil and frequent during the rainy season, is an herbaceous species belonging to the Convolvulaceae family, with green and dry biomass production on the order of 42000 and 6000 kg ha^{-1}, respectively, an average nitrogen content of 22.2 g kg^{-1} as dry matter, and a carbon/nitrogen ratio of 18/1, making the species feasible for use as a rapid decomposing quantity straw-based green manuring (Linhares et al., 2021; Linhares, 2013). For the forest crop mata-pasto (*Senna uniflora* L.) nitrogen content is 18.5 g kg^{-1} and carbon-nitrogen ratio of 25/1, with green biomass production of 35.0 t ha^{-1} and dry mass of 8.7 t ha^{-1}.

Jitirana (*Merremia aegyptia* L.) is a spontaneous species that occurs in the semiarid regions of Brazil and is used as a green manure in vegetable crops, such as coriander (Linhares et al., 2018; Linhares 2009a; Linhares et al., 2009b; Linhares et al., 2012a; Linhares et al., 2012b; Linhares et al., 2012c; Linhares et al., 2011), arugula (Linhares et al., 2008), radish (Linhares, 2013; Linhares et al., 2010) and carrot (Linhares et al., 2014).

Studies have shown that spontaneous species of the Caatinga biome may present the same performances of leguminosae as green manuring (Linhares et al., 2021; Linhares et al., 2011b and Linhares et al., 2009b).

Given the importance of using spontaneous species from the semiarid region as organic fertilizer, the objective was to evaluate the productivity of mint fertilized with a mixture of jitirana and pasture.

MATERIALS AND METHODS

Characterization of the Experimental Area

The study was conducted in the research area of the Rafael Fernandes Experimental Farm of the Federal Rural Semi-Arid University (UFERSA), located in the Alagoinha district, 20 km from the Mossoró-RN, Brazil, municipality (5° 03' 37" S and 37° 23' 50" W, 70 m altitude). The farm comprises approximately 400 hectares (Rêgo et al., 2016). According to Carmo Filho et al. (1995) and the classification of Köppen, the local climate is BSwh ', dry and very hot, the dry season is normally from June to January, and the rainy season is from February to May. The average annual rainfall is 673.9 mm, and the average relative humidity is 68.9%. The soil of the research area was classified as sandy loam Argisol Yellow Red Latosol (EMBRAPA, 2006).

Before the installation of the field experiment, soil samples were collected to a 0-20 cm layer and then sent to be processed and analyzed in the UFERSA Water, Soil and Plant Analysis Laboratory, providing the following results: pH (water 1:2,5) = 7.54; exchangeable cations Ca = 3.50 $cmol_c$ dm^{-3}; Mg = 0.70 $cmol_c$ dm^{-3}; K = 34.5 mg dm^{-3}; Na = 11.3 mg dm^{-3}; P (Mehlich) = 2.65 mg dm^{-3} and organic matter = 0.85 g kg^{-1}.

Experimental design and treatments

The experimental design used was complete randomized blocks, with six treatments and five replications. The treatments consisted of six amounts of jitirana mixture with carnauba straw (0.0, 1.2, 2.4, 3.6, 4.8 and 6.0 kg m^{-2} of beds on a dry basis). Each experimental plot had 42 plants, spaced 1.2 x 1.75 m, with a total area of 2.1 m^2, a useful area of 1.0 x 1.40 m, 20 plants, and an area of 1.40 m^2.

The preparation of the ground consisted of the harrowing and preparation of the seedling beds. During the course of the study, manual weeding was performed to keep the crop free from spontaneous weed growth. Before sowing, irrigation was performed to maintain ideal soil moisture conditions for the mineralization process (Novais, 2007).

The propagation of the seedlings was carried out by clipping the apical buds, picked from select *Mentha piperita* plants, and cultivated in expanded polystyrene trays of 128 cells containing a commercially available vermiculite substrate. The seedlings were transplanted after being grown in a greenhouse for 15 days with 50% shading until they reached approximately 10 cm in height.

Jitirana (*Merremia aegyptia* L.) and mata-pasto (*Senna uniflora* L.) were collected from the native vegetation in the vicinity of the campus of UFERSA during the flowering season. At this time, the plants had the maximum concentration of nutrients with chemical properties of the fertilizer mixture of 550 g kg^{-1} C, 21.0 g kg^{-1} N, 13.5 g kg^{-1} P, 20.0 g kg^{-1} K, 12.0 g kg^{-1} Ca, and 9.5 g kg^{-1} Mg, with a carbon/nitrogen ratio of 26:1.

Characteristics evaluated of mint

The harvest was carried out 90 days after the mint transplant, cutting all the plants in the useful area. After harvesting, plants were transported to the PostHarvest of Vegetables Laboratory at the Department of Plant Sciences at UFERSA, where they were analyzed.

For the mint crop, for the culture of mint, the following characteristics were evaluated: biomass height (was measured in the field, in centimeters using a millimeter ruler, ten plants per plot), green mass (was obtained by cutting above ground, was weighed on a precision scale of 1.0 g and expressed as 100 m^{-2}, corresponding to family farmers cultivating areas in the region of Mossoró-RN, Brazil), number of bunches (was determined by dividing the fresh mass in an area of 100 m2 per 100 g, comparable to the weight of a mint bunches sold at the local agroecological fair and on the supermarket shelves in Mossoró-RN and measured in units 100 m-2), dry mass (was obtained from a forced-air heating oven at 65 °C, to constant mass and expressed in g 100 m^{-2}), oil content (%) and oil yield (g 100 m^{-2}).

Peppermint oil extraction

In determining the essential oil content and yield, the Simões et al. (2003) methodology was used. Samples of the aboveground part of the dried plants were subjected to hydrodistillation in a modified Clevenger apparatus for 1.5 h using 600 mL of distilled water in a 1 L distillation flask. The oil content was defined as the ratio between the mass, in grams of essential oil, and the mass of dried leaves, inserted into the distillation flask x 100, expressed in g $kg^{-1,}$ and the oil yield (the oil content (%) x the dry matter (in kg 100 m^{-2}) of the area portion divided by 100) was determined.

For the determination of oil content and yield, dry leaves were used, as recommended by Martins (2000), which states that the water content in the leaves, after drying, allows the vapor stream generated in the extractor to remove the volatile substances stored in cells when compared to the green material. Second Guenther (1972), due to the high moisture content in the plants, there is a tendency of agglutination, preventing the vapor from penetrating evenly in the tissues of the plant. To determine the essential oil content and yield, dry mass samples were subjected to hydrodistillation in a modified Clevenger apparatus for 1.5 h using 600 mL of distilled water in a 1 L distillation flask (Simões et al., 2003).

Statistical Analysis

Statistical analysis was performed according to conventional methods of analysis of variance (Banzatto; Kronka, 2006), using ESTAT statistical software. The response curve fitting procedure was performed using the ESTAT Software.

RESULTS AND DISCUSSION

Given the importance of using spontaneous species from the semiarid region as organic fertilizer, the objective was to evaluate the productivity of mint fertilized with a mixture of jitirana and pasture.

The height of mint biomass increased to 6.0 kg m^{-2}, with a maximum value of 60.56 cm $plant^{-1}$ (Figure 3). Vicente, Maia and D'Oliveira (2008), when evaluating the production of medicinal plants with filter cake, reached a height greater than 45 cm for mint, a lower result than that obtained in this study. This greater height is probably due to the amount of the mixture of jitirana with mata-pasto, providing better chemical and physical conditions in the soil, favoring the development of the mint.

Amorim et al. (2021) studied the evaluation of different organic substrates in the production of mint biomass (*Mentha piperita* L.), obtained a plant height of 46.5 cm $planta^{-1}$. Linhares et al. (2018) studied the agronomic efficiency of organic fertilizer in the production of the intercropping of coriander and mint and found a biomass height of 29 cm in the amount of 6.0 kg 2.0 m^{-2}, which was higher than the data obtained in this study.

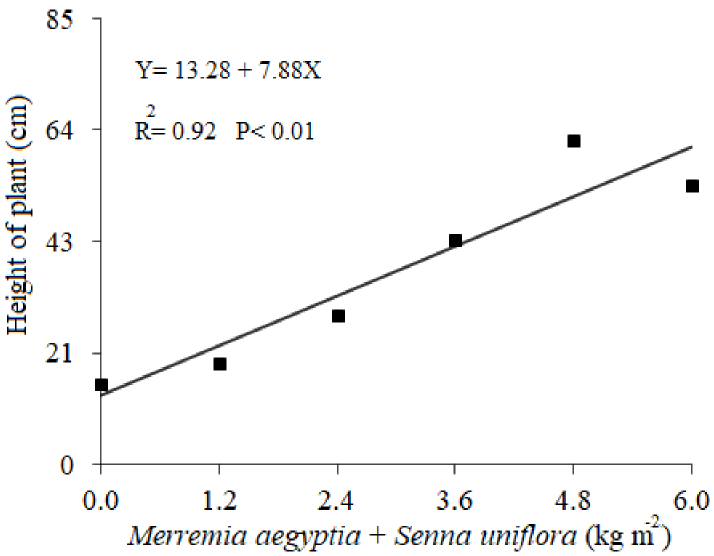

Figure 3. Mint plant height under different amounts of the mixture of jitirana (*Merremia aegyptia* L.) with mata-pasto (*Senna uniflora* L.).

There was an increase of 179 g/100 m^2 between the smallest amount (0 kg m^{-2}) and the largest (4.8 kg m^{-2}) with a maximum value of 200 kg 100 m^{-2}, in the amount of 4.8 kg m^{-2}, equivalent to 1998 units/100 m^2 (Figures 4 and 5), evidencing the effectiveness of the mixture of spontaneous species from the semiarid region as organic fertilizer. Linhares et al. (2008) stated that the increase in the production of phytomass results from a decrease in the nitrogen content through the dilution process, which possibly occurred in the present research. Cunha et al. (2018) reported the agronomic efficiency of different quantities of jitirana {*Merremia aegyptia* (L.) Urb.} mixed with cattle manure in the intercropping of coriander with mint, with a green mass of 56.4 kg 100 m^{-2} in a quantity of 3.0 kg m^{-2}, lower than that in the present study.

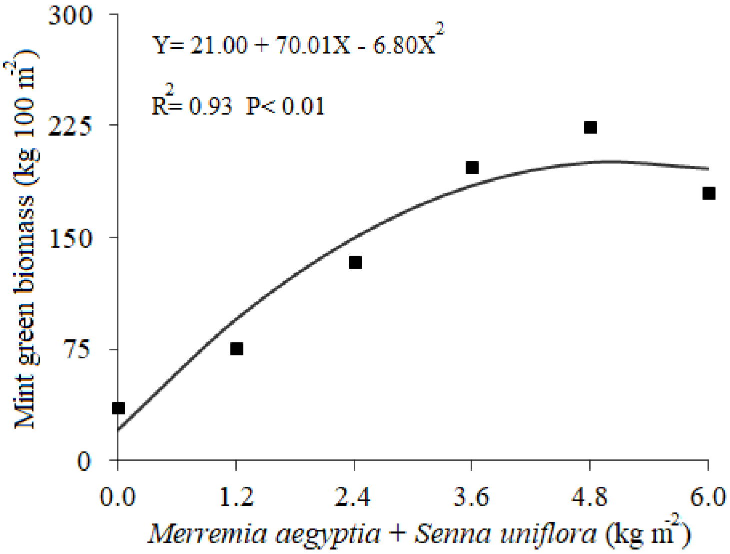

Figure 4. Production of mint biomass under different amounts of the mixture of jitirana (*Merremia aegyptia* L.) with mata-pasto (*Senna uniflora* L.).

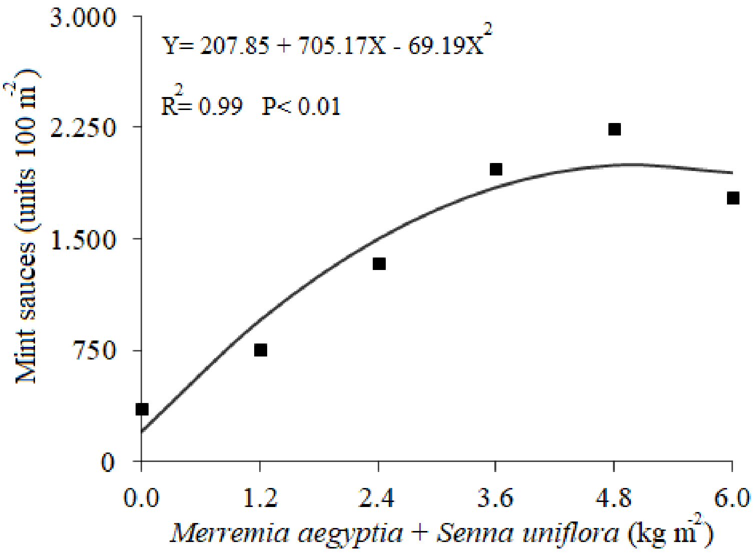

Figure 5. Number of bunches of mint under different amounts of the mixture of jitirana (*Merremia aegyptia* L.) with mata-pasto (*Senna uniflora* L.).

Linhares et al. (2018) studied the agronomic efficiency of organic fertilizer in the production of the intercropping of coriander and mint, green mass production and number of bunches of 3.94 kg 2.0 m^{-2} and 39.4 units 2.0 m^{-2}, equivalent to 1.97 kg m^{-2} and 19.7 units m^{-2}, respectively, which were higher than the data obtained in this study. Vicente et al. (2008) studied the production of medicinal plants with filter cake and found a productionof 400 g m^{-2} mint biomass, equivalent to 0.4 kg m^{-2} corresponding to 4.0 bundles, which was higher than the data obtained in this study. This inferiority is probably because the mint harvest was carried out 240 days after planting, causing leaf senescence, with reduced green mass production of the plant. Amorim et al. (2021) studied the evaluation of different organic substrates in the production of mint biomass (*Mentha piperita* L.), obtained a fresh mass on the order of 130.28 g. Guerra et al. (2015) studied the intercropping of lettuce with medicinal plants in Amazonian conditions and found fresh peppermint masses of 0.55 and 0.33 kg m^{-2} in single and intercropping cultivation, respectively, which was inferior to the results of this research.

For mint dry mass, there was a point of maximum production with the application of 4.8 kg m^{-2}, with a maximum value of 26.3 kg/100 m^2 (Figure 6). The dry mass is an important characteristic for growth analysis. Lower behavior was observed by Vicente et al. (2008), who studied the production of medicinal plantswith filter cake and found a dry biomass of mint of 100 g m^{-2}. Cunha et al. (2018) reported the agronomic efficiency of different quantities of jitirana mixed with cattle manure in the intercropping of coriander with mint, with a dry mass of 6.56 kg 100 m^{-2} and a quantity of 3.0 kg m^{-2}, which was lower than that in the present study.

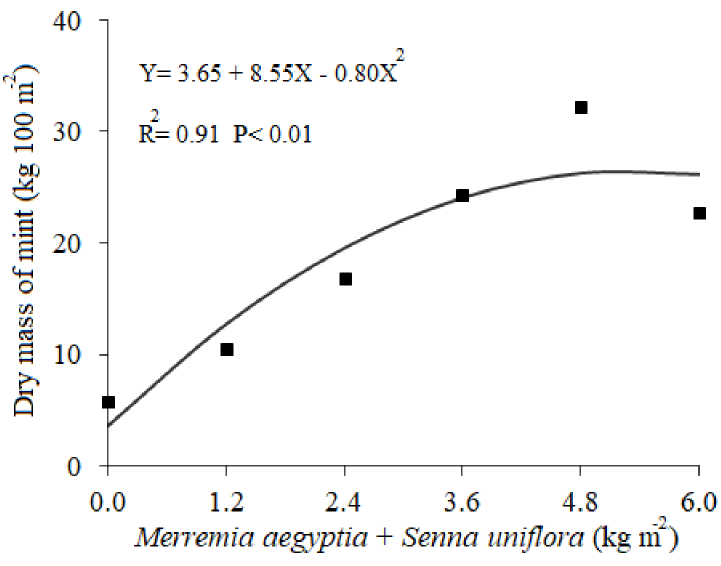

Figure 6. Mint dry mass under different amounts of the mixture of jitirana (*Merremia aegyptia* L.) with mata-pasto (*Senna uniflora* L.).

The essential oil content increased as a function of the different amounts of the mixture of jitirana with mata-pasto, with a maximum value of 2.36 g kg^{-1} and oil production of 454.35 g/100 m^2, in the amount of 6.0 kg m^{-2} of jitirana with pasture (Figures 7 and 8). The essential oil content is a genetic characteristic and is independent of the amount of biomass produced by the plant. The essential oil content is a genetic characteristic and independent of the amount of biomass produced by the plant, making it more difficult to change when comparing the yield of essential oil (Oliveira, 2011).

Cunha et al. (2018) reported the agronomic efficiency of different quantities of jitirana mixed with cattle manure in the intercropping of coriander with mint, with an oil yield of 57.4 g 100 m^{-2} at a quantity of 3.0 kg m^{-2}, which was lower than that in the present study. Santos (2013) studied the biomass production, content and composition of the essential oil of *Mentha spicata* under organic production and found an oil content of 0.96%, equivalent to 9.6 g kg^{-1}, which was higher than that in this research. Linhares et al. (2018) studied the agronomic efficiency of organic fertilizer in the production of the intercropping of coriander and mint and found an oil content of 2.1 g kg^{-1}, which is small for this research. The inferiority is possibly due to the smaller amount of fertilizer used compared to the present work.

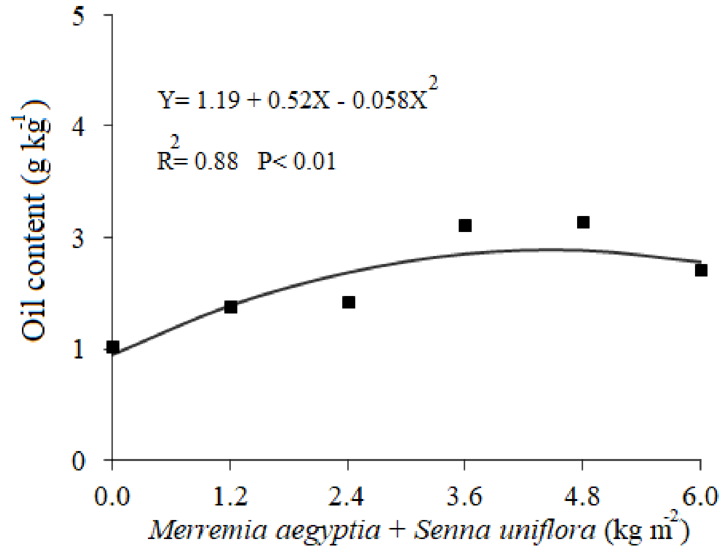

Figure 7. Peppermint essential oil content under different amounts of the mixture of jitirana (*Merremia aegyptia* L.) with mata-pasto (*Senna uniflora* L.).

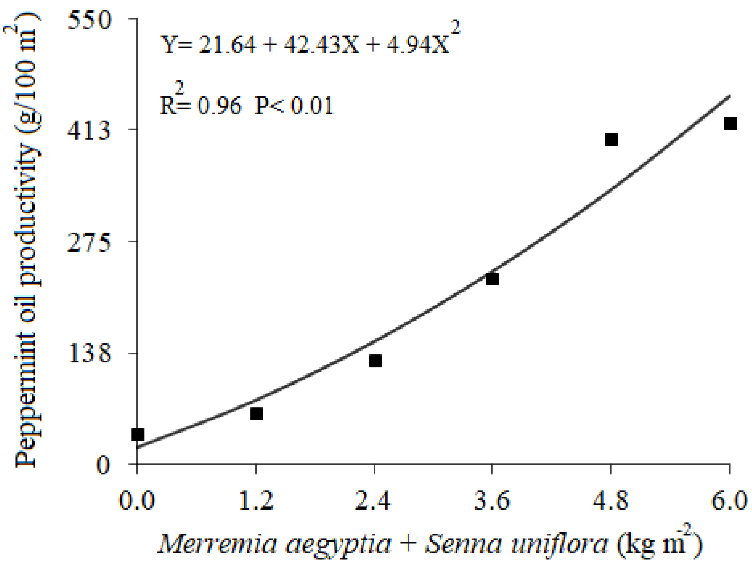

Figure 8. Essential oil production under different amounts of the mixture of jitirana (*Merremia aegyptia* L.) with mata-pasto (*Senna uniflora* L.).

FINAL CONSIDERATIONS

The best productive performance referred to biomass production, number of bunches, oil content and production, with values of 4.8, 4.8, 4.8 and 6.0 kg m^{-2} for the mixture of jitirana with mata-pasto, respectively, with values of 200 kg/100 m^2, 1998 units/100 m^2, 2.36 g kg^{-1} and 454.35 g/100 m^2, respectively.

The use of spontaneous species from the semiarid region as an organic fertilizer was efficient in fertilizing the soil and providing an increase in mint characteristics.

ACKNOWLEDGMENT

Special thanks to the jitirana (*Merremia aegyptia* L.) research group, committed to the study of spontaneous species from the semiarid region as green manure in olericolas, beyond the Department of Agronomic and Forestry Sciences the Federal Rural SemiArid University (UFERSA), for support in conducting research.

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