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EFFECT OF SHADING AND ORGANIC FERTILIZATION ON THE DEVELOPMENT AND PRODUCTION OF ESSENTIAL OIL OF MENTHA ARVENSIS L

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Abstract: Japanese mint (Mentha arvensis L.) is an aromatic plant, belonging to the Lamiaceae family, also known as peppermint, Japanese mint and vick, its oil has high levels of menthol, used in the cosmetics, beverage and pharmaceutical industries, In the Amazon region, little is known about the processes used to obtain the essential oil. Therefore, the present work aimed to evaluate the development and production of Mentha arvensis L. under different levels of shading combined with organic fertilization in the municipality of Itacoatiara-AM. The experiment was carried out in the experimental area of campus 2 of ``*Universidade Federal do Amazonas*``- UFAM, located on the AM-010 highway. The experimental design was conducted in randomized blocks in a 3 x 4 factorial scheme (three levels of shading and four fertilizations with manure cattle: Dry mass of the shoot (MSPA); Dry mass of the root (MSRA); Number of new shoots (NBT); were subjected to analysis of variance using the F test, and the means that were found to be significant were compared using the Scott-Knott test at 5%. The use of shade with an overshoot level of 50% influenced the growth in the number of leaves, as well as. the dosage of 20 t/ha reduced biomass production in Mentha arvensis L, in relation to cultivation in full sun, while the doses of cattle manure did not interfere significantly in biomass production, nor in other variables and physiological indices.

INTRODUCTION

Japanese mint (Mentha arvensis L.) is an aromatic plant, belonging to the Lamiaceae family, also known as peppermint, Japanese mint, spearmint, sweet mint, Japanese pepper and vick pepper. The essential oil is distinguished from other mints by the absence of 1.8 cineole and a high menthol content, used as a flavoring agent for foods, beverages, perfumes, oral hygiene products and pharmaceutical preparations, in the treatment of respiratory and gastrointestinal problems. (BLANK, 2011).

The essential oil of this species consists mainly of monoterpenes, which are attributed with the functions of defending the plant against herbivory, antimicrobial and allelopathic agents (CARDOSO et al. 2001). These oils and their constituents are extensively applied in the food, medicine, cosmetics, fragrance and tobacco industries (GARLET, 2007).

Menthol and menthone are the main components of the oil and those with the greatest economic value, although more than 200 components are known to be present in oils of the Mentha genus (Tavish & Harris 2002). Environmental factors and the plant's development phase can influence the quality and quantity of essential oils (Rodrigues et al. 2004, Rohloff et al. 2005, David et al. 2006).

Light intensity, photoperiod, temperature and soil nutrition can directly influence oil production, or indirectly, through the increase in plant biomass of species that produce essential oils (Lima et al. 2003, Rodrigues et al. 2004, Valmorbida et al. 2006).

It is a plant cultivated in several regions of Brazil, since the entire aerial part of the plant is used for medicinal purposes, demonstrating potential for commercial exploitation in the search for good quality phytotherapeutic products, characteristics that give them great economic importance (AMARO et al, 2013).

Environmental factors and the plant's development phase can influence the quality and quantity of essential oils (RODRIGUES et al. 2004; ROHLOFF et al. 2005; DAVID et al. 2006). Light intensity, photoperiod, temperature and soil nutrition can directly influence oil production, or indirectly, through the increase in plant biomass of species that produce essential oils (LIMA et al. 2003; RODRIGUES et al. 2004; VALMORBIDA et al. 2006).

Several species of mint, as well as M. arvensis, M. x piperita and M. spicata, have already been defined by several authors as very demanding in terms of mineral nutrition in soil and hydroponics cultivation (RAM & KUMAR, 1997; RODRIGUES et al., 2004; VALMORBIDA & BOARO, 2007;

Among the agronomic practices for managing soil fertility, liming and fertilization stand out as the most traditional. Currently, in addition to mineral fertilization, the use of organic fertilization is recommended, not only as an essential part of so-called organic crops, but because of the numerous benefits arising from the application of organic residues to the soil (OLIVEIRA JÚNIOR et al., 2006).

Organic fertilizer also represents an interesting alternative, especially as an option for small properties, with potential for application in areas cultivated with medicinal and aromatic plants, offering small producers another income alternative and justifying the carrying out of agronomic and phytotechnical studies. in relation to the production of dry biomass and secondary metabolites.

Thus, the genetic potential of mint can be maximized through better crop management, especially in nutritional terms, which must provide a qualitative and quantitative improvement in the product supplied by farmers.

By knowing the information reported, the present work aims to evaluate the effect of different levels of shading and organic fertilization on the development and production of Japanese mint (Mentha arvensis L.) essential oil in the Itacoatiara-AM region.

OBJECTIVES

GENERAL OBJECTIVE

To evaluate the development and production of mentha arvensis L. essential oil under different levels of shading combined with organic fertilization in the municipality of Itacoatiara-AM.

SPECIFIC OBJECTIVES

- Determine the best shading for plant production of Mentha arvensis L.
- Determine the best dosage of organic fertilizer.
- Determine the best shading for Mentha oil production
- Determine the best dosage of organic fertilizer for the production of essential oil from Mentha arvensis L.
- Determine the interaction of shading and fertilization factors in relation to plant production and the amount of essential oil produced.

METHODOLOGY

STUDY AREA

This project was developed in the experimental area of the Agronomy course at the Institute of Exact Sciences and Technology– ICET campus II, at ``Universidade Federal do Amazonas`` - UFAM, in the municipality of Itacoatiara – AM. Located at 3º08'31" S, 58º25'54" W and an altitude of 18m above sea level, (Figure 01).

The region's climate is classified as tropical rainy (humid) (ALVARES et al., 2013) with annual precipitation of 2,261mm, 29.9ºC and relative air humidity of 83% (INMET, 2021). The plants were grown in a greenhouse with two environments, the first protected with black shade of 80% and 50% shade respectively, and the second outdoors.

Figure 01: Aerial photo of the location delimited for the study.
Source: the own author (2023)

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EXPERIMENTAL DESIGN

The experimental design was conducted in randomized blocks in a 3 x 4 factorial scheme (three levels of shading and four fertilizations with cattle manure), with 3 replications and 4 plants per experimental unit, totaling 144 plants. Shading levels were: 0%; 50% and 80%. and manure fertilization at dosages of: 0 t/ha; 5 t/ha; 10 t/ha and 20 t/ha.

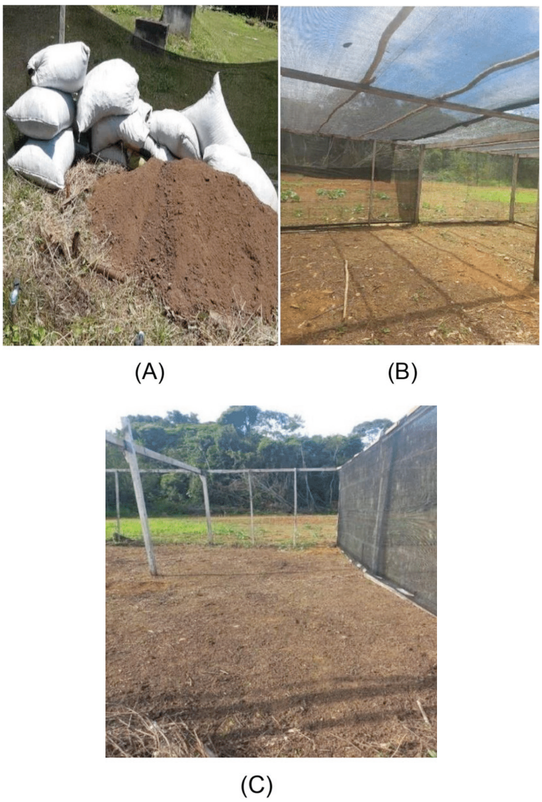

Figure 02: (A) Cattle manure (B) Screened nursery with 50% and 80% shading; (C) 0% shading.

Source: Author himself (2023)

SUBSTRATE COLLECTION

The cattle manure was collected on the Altamira farm, located on the AM-010 highway at km 13 thereof (Figure 03). The manure was subjected to an anaerobic biological fermentation process at temperature, for nutrient availability, and to reduce possible harmful agents to the species (Figure 3).

Figure 03: (A) Collection of cattle manures at Altamira farm; (B) Bagged cattle manure; (C) Tanned cattle manure

Source: the own author (2023)

SIEVING SUBSTRATES

The cattle manure was subsequently subjected to an outdoor drying process for a period of 15 days. This process favored the treatment and screening of this waste, with the intention of reducing the particle size of the waste. Sieving was carried out using a manual sieve, widely used in construction to sift sand (Figure 4).

Figure 04: Granulosity of sifted cattle manure.

Source: the own author (2023)

EXPERIMENT SETUP

A screened nursery with 50% and 80% shading was built in the experimental area of the agronomy course, measuring 72 *m*2, to house the plants containing the substrates (Figure 8).

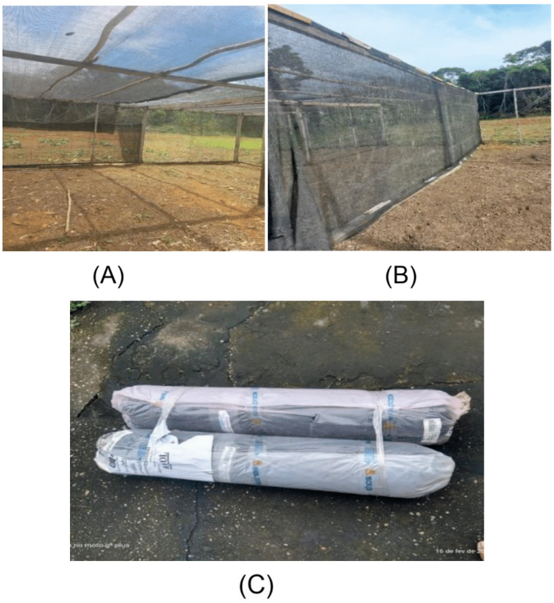

Figure 06: (A) Screened nursery with 50% and 80% shading; (B) Nursery with 0% shading; (C) Shading shades containing 50 and 80% shading (packaged).

Source: the own author (2023)

ANALYZED PARAMETERS

After 120 days of planting, the following characteristics were evaluated in the field and in the food production technology laboratory of the Agronomy course at the Institute of Exact Sciences and Technology – ICET campus II, at ``*Universidade Federal do Amazonas*`` - UFAM: aerial part (MSPA); Root dry mass (MSRA); Plant height (AP); Number of leaves (NF) and number of shoots (NBT).

DATA ANALYSIS

The data were subjected to analysis of variance using the F test, and the means that were significant were compared using the Scott-Knott test at 5% probability.

RESULT AND DISCURSION

Table 1 contains summarized data from the analysis of variance, for the sources of variation block, fertilization with cattle manure, shading levels and the interaction Cattle manure x shading. In the present study, the variable block was not significant for any of the characteristics evaluated, demonstrating that there was uniformity in the arrangement of blocks in the field, likewise the variable interaction between cattle manure and shading, did not present a significant effect on the characteristics evaluated, demonstrating that the factors were independent of each other. For the factors alone, cattle manure was significant only for the characteristic Number of shoots (NBT), while the effect of shading was significant for the characteristics Plant height (AP); and number of sheets (NF).

FV	Pr > FC				
	AP	NF	NBT	MSPA	MSRA
BLOCK	0.0854	0.0689	0.3400	0.3165	0.2653
MANURE B.	0.8385	0.6046	0.3946	0.7817	0.4482
SHADOWING	0.0995	0.0988	0.0600	0.3763	0.1034
MANURE B. + SHADOWING	0.1413	0.2839	0.2684	0.9805	0.4450
CV (%)	27.96	31.24	49.11	35.90	40.38

Table 1: Variance analysis table for the variables: AP; NF; NBT; MSPA and MSRA.

FV = source of variation; CV= coefficient of variation; MANURE B. = cattle manure; SHADOWING. = shading; MANURE B. + SHADE = Interaction between cattle manure and shading; shoot length (CAP); number of sheets (NF); number of shoots (NBT); Dry mass of the aerial part (MSPA) and Dry mass of the root (MSRA). The analysis of variance data was transformed.

The table 2 shows the average data for each characteristic evaluated in relation to the cattle manure factors and shading levels for the variables: CAP; NF; NBT; MSPA and MSRA.

FV	T	AP (cm)		NF (uni)		NBT (uni)		MSPA (g)		MSRA (g)	
BOVINE MANAGE	0	24.55	a	103.07	A	6.41	b	14.33	a	15.33	a
	5	22.57		108.42	A	7.67		12.67		15.00	a
	10	21.18	a	102.95	a	4.44	b	12.44	a	10.11	a
	20	25.97	a	111.50	a	15.29	b	10.89	a	10.44	a
SHADOWING	0 50	19.70	b a	102.74	b	6.61	a	11.00	a	8.50	a
		20.66		143.88		14.63		12.25		12.50	a
	80	30.35	a	93.09	b	4.12	a	14.50	a	17.17	a

Table 2: Means of the variables analyzed in relation to the factor cattle manure and vegetable ash in the Municipality of Itacoatiara-Am.

Means followed by the same letter do not differ from each other using the skott-knott test at 5% probability.

FV = source of variation; T = treatment; *significant at 5% probability using the F test; MANURE B. = manure bovine; SHADOWING. = shading; shoot length (CAP); number of sheets (NF); number of shoots (NBT); Dry mass of the aerial part (MSPA) and Dry mass of the root (MSRA).

In this experiment it was found that the doses of cattle manure did not significantly influence the physiological aspects of the growth and biomass production of Mentha arvensis L., the variables AP, NF, MSRA and MSPA did not obtain significant averages for the treatments of 0, 5, 10 and 20 tons of cattle manure, however the dose of 20 tons of cattle manure showed significant averages for the NBT characteristic. While the 50% shading level had a significant effect on the number of leaves (NF) variable. However, it was observed that the other shading levels did not significantly influence the other variables.

Under shading, a greater number of leaves was observed in plants grown under shade nets, which differed significantly from those grown in full sun. Similar results were observed in Japanese mint, a species from the same family as Mentha piperita, cultivated under different meshes by Chagas et al. (2010), who attributed the increase in leaf area in plants to intensity rather than spectral quality of light. According to Taiz & Zeiger (2010), as an adaptive strategy, plants subjected to low levels of irradiance expand their leaves to increase the capture of light energy and allow greater photosynthetic efficiency and, consequently, greater carbon fixation.

Ming et al. (1998) report that a substrate considered suitable for rooting must present some important characteristics, such as the ability to support the cuttings throughout the process, providing humidity and aeration at their bases. Thus, the addition of organic material (cattle manure) to the soil contributes to improving its physical characteristics, providing better conditions for root formation, as verified in the present work.

CONCLUSION

The use of shading with an overhang level of 50% influenced the growth of the number of leaves, as well as the dosage of 20 t/ha the production of biomass in Mentha arvensis L, in relation to cultivation in full sun, while the doses of Cattle manure did not interfere significantly in biomass production, nor in other physiological variables and indices.

Furthermore, the results obtained could serve as a research practice in order to study the role of the level of shading and mineral nutrition in the therapeutic efficiency of this plant in relation to chemical compounds, mainly the essential oil, which is one of the active principles of this species, thus expanding the focus of scientific information through research on the quality of light in the physiological aspects of medicinal plants.

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TIMELINE

Activity	8/2022	9/2022	10/2022	11/2022	12/2022	1/2023	2/2023	3/2023	4/2023	5/2023	6/2023	8/2023
LITERATURE REVIEW	x	x	x	x	x	x	x	x	x	x	x	x
SEEDLING PRODUCTION	x	x	x									
MANURE COLLECTION	x											
PREPARATION OF MANURE	x	x	x									
PREPARATION OF THE GROWING AREA		x	x	x								
TRANSPLANTING THE SEEDLINGS			x	x								
CULTURAL TREATMENTS			x	x	x	x	x					
FIELD DATA COLLECTION							x	x				
LABORATORY TESTS								x	x	x		
LABORATORY DATA COLLECTION								x	x	x		
STATISTICAL ANALYSES										x	x	
PREPARATION OF THE PARTIAL REPORT			x	x	x	x	x					
PREPARATION OF THE FINAL REPORT								x	x	x	x	x

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