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AGROECOLOGICAL CULTIVATION OF VEGETABLES IN A GARDEN AT DOM JOSÉ TUPINAMBÁ DA FROTA STATE SCHOOL, SOBRAL, CEARÁ, BRAZIL

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ABSTRACT

Coriander and arugula are fast-growing, short-cycle herbaceous leafy vegetables. Organic fertilizers increase plant yields by providing nutrients, improving soil physical and biological properties.The objective of this work was to carry out a practical experience of agroecology at Dom José Tupinambá da Frota State College, Sobral, Ceará, Brazil. The study was conducted in a garden in the courtyard of the College. Coriander cultivation was carried out from August 24 to September 19, 2018, in three beds prepared with manual hoe. The total area of each flowerbed (5 m x 0.8 m) is 4 m2. Plants were evaluated in part of the beds of goat manure fertilized and in part of the non fertilized bed. Two beds of 2.0 meters long and 0.8 meters wide were used, both in the presence and absence of 80 t ha^{-1}. Arugula (*Eruca sativa*) was cultivated, cultivated cultivar and coriander (*Coriandrum sativum*) cultivated, cultivated verder. For arugula culture, the following characteristics were evaluated: plant height, number of leaves, green mass and number of sauces. For the coriander culture, the following characteristics were evaluated: plant height, number of stems, green mass and number of sauces. Higher plant height and green mass production and number of coriander sauces were obtained from plants fertilized with 80 tha-1 goat manure. Higher plant height, green mass and number of leaves per arugula plant were obtained from plants cultivated in the part of the fertilized bed in March 2018, followed by plants fertilized with goat manure in August 2018, in the amount of 80 t ha^{-1}.

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INTRODUCTION

Coriandrum sativum L.; *Eruca sativa*; Organic fertilizer; Production.

A very popular familiar practice in family farming is the production of vegetables and herbs in diversified forms, which consists of the production of various hortals and medicinal species destined for commercialization and subsistence. 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). This vegetable has an average height of 15 to 20 cm $plant^{-1}$ in production areas in the region of Mossoró-RN, which is an important feature, since the coriander sauces marketed have as their main feature the size of the plant (LINHARES *et al* ., 2014). Arugula (*Eruca sativa* L.), also called arugula salad, is a herbaceous vegetable of the Brassicaeae family (Borges *et al.*, 2014). Its leaves are elongated with deeply cut blades, dark green color and spicy flavor, rich in potassium, sulfur, iron and vitamins A and C (Gonzalez *et al.* 2006). According to Carvalho *et al.* (2012), arugula is gaining more space in the table of the Brazilian population and prominence in the market, due to its nutritional composition. According to Figueiredo *et al*. (2012), coriander and arugula can be grown using organic fertilization such as manure. However, it is necessary to properly manage the quantity in favor of nutrient mineralization dynamics, seeking optimization regarding the synchronization of crop demand in relation to soil availability. Organic fertilization with organic fertilizers among them, animal manure and organic compounds have been widely used in the production of vegetables, seeking to reduce the use of mineral fertilizers and promote the physical, chemical and biological properties of the soil, favoring the development of the root system making them more adept at absorbing water and nutrients (STEINER *et al*., 2012). Organic fertilizer management becomes efficient in the soil when the quality of the organic waste used is known, through its C/N ratio that indicates the dynamics of decomposition and mineralization, whose process favors the availability of nutrients in sync with the requirements nutritional status of plants.

The objective of this work was to carry out a practical experience of agroecology with the teachers, students and staff of Dom José Tupinambá da Frota State College, urban area of Sobral, Ceará, Brazil.

MATERIALS AND METHODS

The study was carried out in a garden of Dom José Tupinambá da Frota State College, located at 1100 Dr. Guarany Avenue, Cidao neighborhood, Sobral Ceará. The municipality is located in the semiarid region of Ceará and is at 3º 41 'S and 40º 20' W, with an altitude of 69 m. The annual averages of temperature and precipitation are 30 ºC and 798 mm, respectively. The work was conducted by volunteer monitors, staff and students of the Dom José Tupinambá da Frota State College who assisted in the preparation of the flower beds, soil tillage, incorporation of manure into the soil, sowing of the studied vegetables and irrigation (Figure 1).

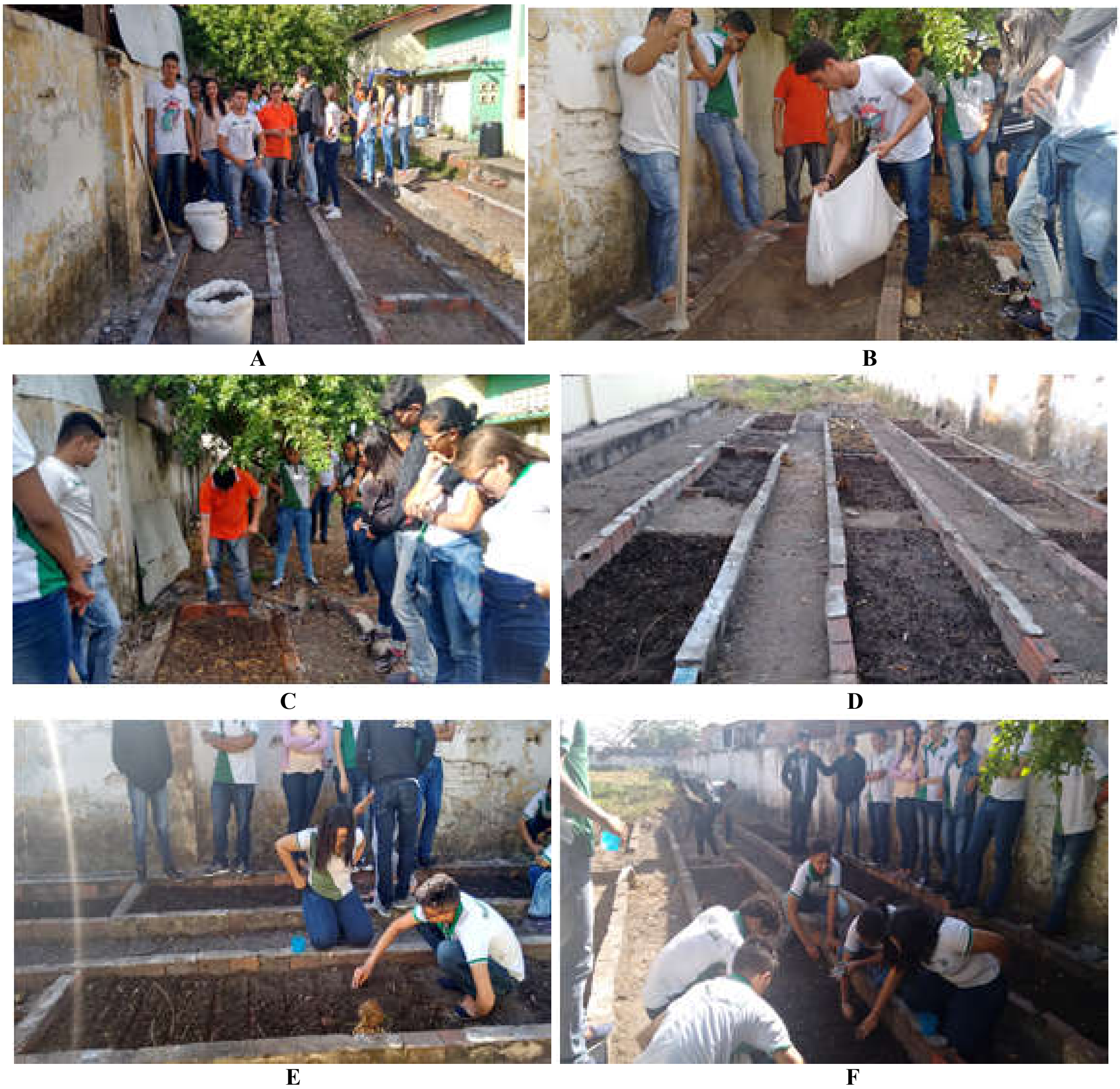


Figure 1. Soil preparation from the Dom José Tupinambá da Frota State School garden in Sobral Municipality, Ceará, Brazil. (A) soil decompression, (B) incorporation of goat manure into the soil, (C) irrigation of manure incorporated into the soil , (d) beds with decomposed manure and (E and F) vegetable sowing

This condition tells us the ideal time for incorporation of organic waste into the soil and the time of sowing or planting crops. The time of incorporation of manure in the soil provides information on the availability of nutrients to plants during the period of crop nutritional requirement during their phenological cycle (LINHARES *et al*, 2015).

The teachers were also present at the vegetable harvest and at the workshop held in the garden (Figure 2). The soil of the area was not classified. Prior to vegetable cultivation, three single samples per plot were carried out, totaling nine single soil samples at a depth of 0-20 cm, to obtain a composite sample which was sent to the IFCE Campus Soil Fertility

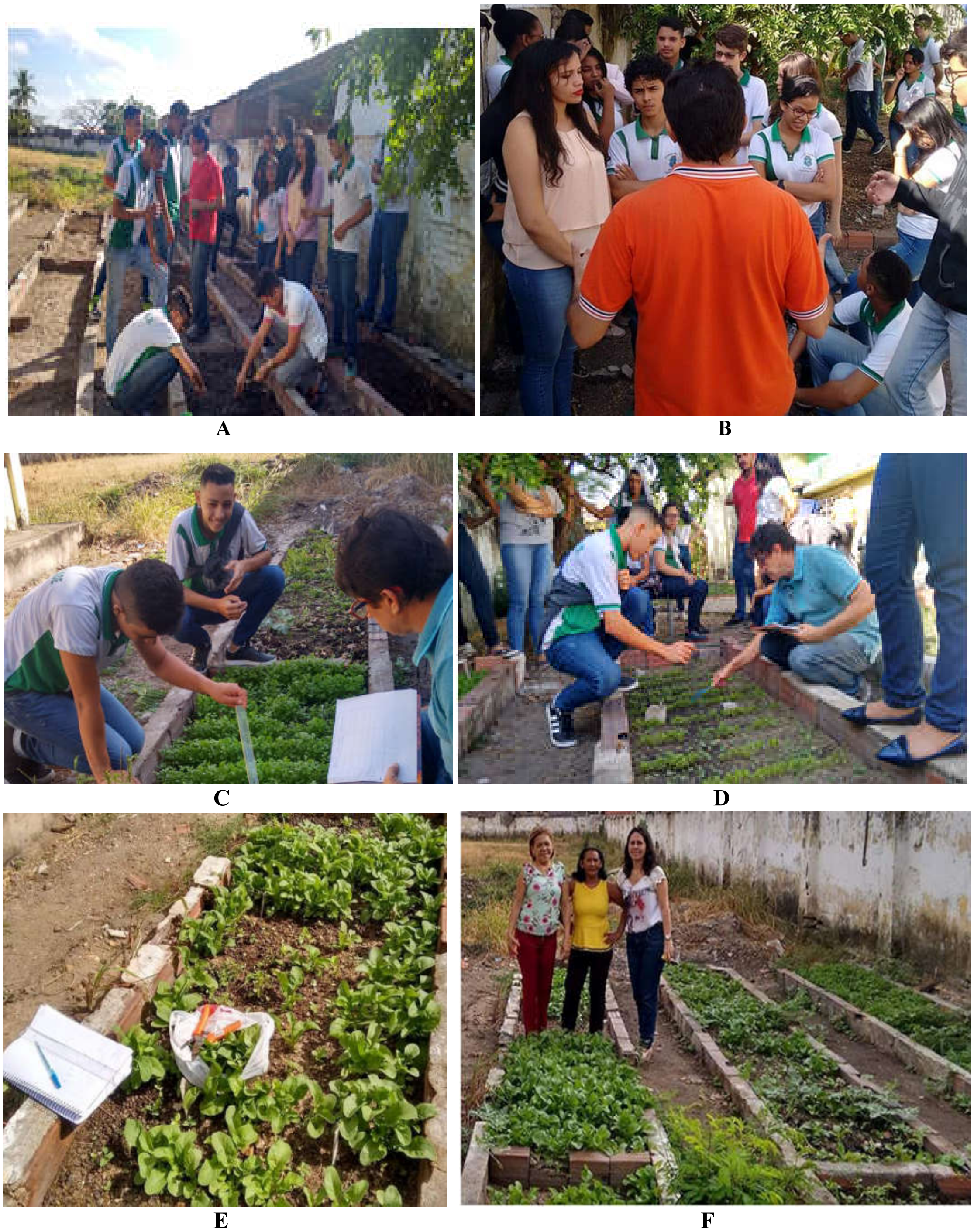


Figure 2. Extension project in the garden of Dom José Tupinambá da Frota State College, Sobral, Ceará (A and B) workshop with teacher and students, (C and D) coriander harvest and (E and F) arugula

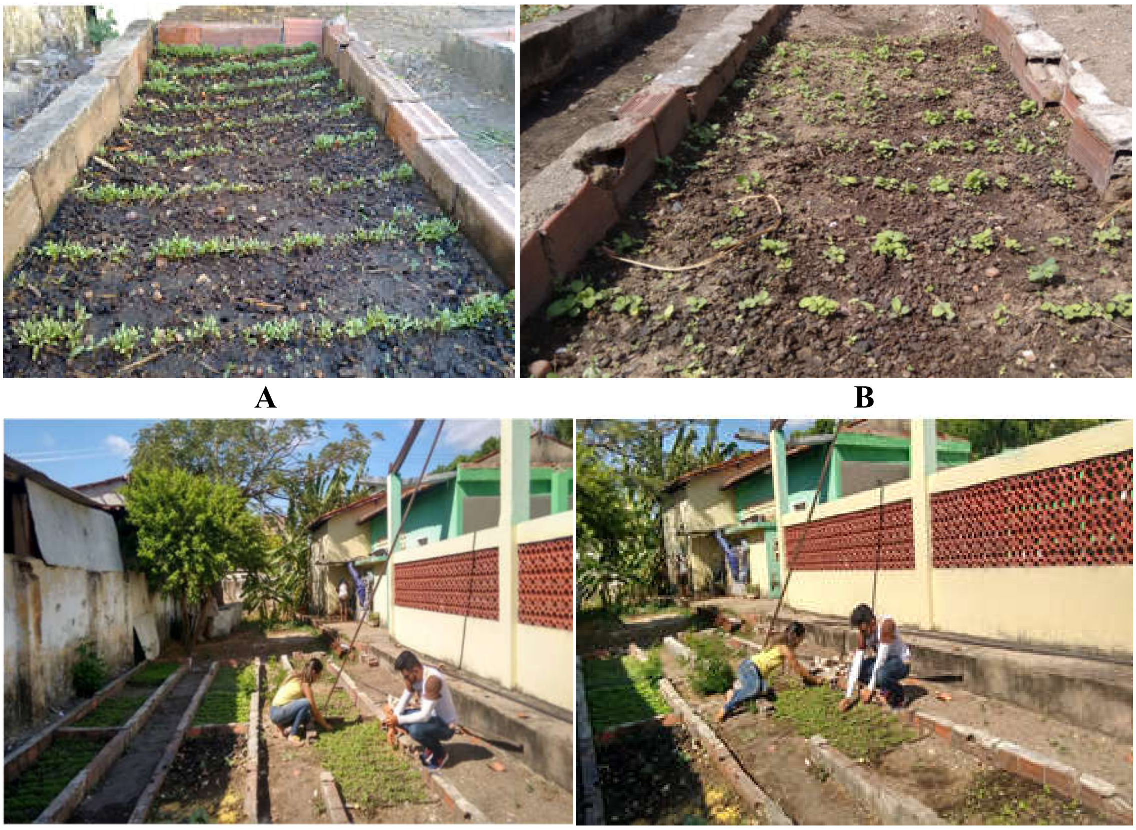
Laboratory. Sobral, CE which was air dried and sieved in a 2 mm mesh, were then analyzed, the results of which were as follows: CO = 1,2 $dakg^{-1}$; MOS. = 2,01$dakg^{-1}$; pH (água 1:2,5) = 8,2; K = 0,716 $cmol_c$ dm^{-3}; Ca = 8,05 $cmol_cdm^{-3}$; Mg = 1,1 $cmol_cdm^{-3}$; Na= 0,348 $cmol_cdm^{-3}$; P (Mehlich) = 24 mg dm^{-3}; Al3+ = 0,0; (H+Al) = 2,65 $cmol_cdm^{-3}$; SB = 10,214 $cmol_cdm^{-3}$; CTCpH7,0 = 12,864 $cmol_cdm^{-3}$; V(%) = 79; PST(%) = 3 e CEes = 0,30 dSm^{-1}. The goat manure used came from the FAEX goat sector, whose animals live in semi-intensive cultivation systems, fed with concentrate and having as tifton 85 (Cynodon spp.) Grass and native species of caatinga. At the time of the extension work installation, five samples were taken from the amount of manure used to form a composite sample, which was sent to the IFCE soil fertility laboratory, Sobral campus for chemical analysis of the manure, the results of which were: pH (água 1:2,5) = 8,6; CO = 231gkg^{-1}; MOS. = 398,24 $gakg^{-1}$; relationship C/N= 11; NT = 19,912 gkg^{-1}; K = 23,35 $cmol_c$ dm^{-3}; Ca = 9,65 $cmol_cdm^{-3}$; Mg = 0,35 $cmol_cdm^{-3}$; Na= 4,783 $cmol_cdm^{-3}$; P (Mehlich) = 114 mg dm^{-3}; Al^{3+} = 0,0; (H+Al) = 1,55 $cmol_cdm^{-3}$; SB = 38,133 $cmol_cdm^{-3}$; CTCpH7,0 = 39,683 $cmol_cdm^{-3}$; V(%) = 96; PST(%) = 12 e CE = 0,08 dSm^{-1}. The manure underwent composting on the UVA - FAEX Experimental Farm manure during a 14-day period, which began on July 6, 2018, and was rolled up until July 20, and between August 3 and 10 the manure was transported to the garden site located in the school yard. The work began on August 10, 2018 with the measurement of the beds in the school garden and the preparation of the beds (cleaning of the beds removing the vegetable debris, shredding and leveling them with manual hoe).

On August 17, goat manure was incorporated into the soil and irrigated for seven days to promote soil wetting and further decomposition / mineralization of the manure. Such procedures were also applied for arugula cultivation in part of the flower beds. Arugula was cultivated in part of the fertilized beds in March 2018 and in another part of the fertilized beds in August 2018. The amount of manure added to the soil was based on a recommendation of 80 tha^{-1} in the literature, and 12.8 kg-1 goat manure was added and incorporated to the soil in each fertilized plot by calculating the area by area m^2. Coriander cultivation was conducted from August 24, 2018 to September 19, 2018, beginning with furrow opening, followed by seed sowing and harvesting. In this study the harvest was performed at 25 days after germination. For the arugula the study was also conducted in the same garden of the College from August 29 to September 26, 2018. Cultivation was carried out in three beds prepared with manual hoe. The total area of each flowerbed (5 m x 0.8 m) is 4 m^2. Three beds were worked and in each bed plants were evaluated in beds fertilized with goat manure and not fertilized. The area cultivated with coriander per bed both in the absence and presence of 80 tha^{-1} goat manure was 2 m long by 0.8 m wide, maintaining a 1.0 m corridor. After measuring the beds, the goat manure was incorporated into the soil, where during a period of seven days the manure was decomposed, irrigated and turned. Irrigation was manual with hose at three times due to the high local temperature. 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 (NOVAES, 2007).

season (July to December), under no-tillage, placing the seeds randomly in the 5 furrows depth cm 0,8 m and 0,2 m between furrows. The spacing between plants was 0.05 m. Three weeding weeds were carried out in the soil of the beds during the coriander cultivation period to control the competition for water, light and nutrients between the invasive plants and the coriander plants. At 30 days after coriander planting, the harvest was done, and the following characteristics were evaluated: plant height (was measured from base to was apex in twenty plant sample batches, using a millimeter ruler and recorded in cm $plant^{-1}$), green mass (was 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 50g, equivalent to the weight of a coriander bunch, according to information from organic producers in the region and measured in units m^{-2}). For the arugula cultivar, harvested at 35 days after sowing, the following characteristics were evaluated: plant height (was measured from base to was apex in twenty plant sample batches, using a millimeter ruler and recorded in cm/plant), number of leaf per plant (was determined in twenty plant sample averages), green mass production (was 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).

RESULTS AND DISCUSSION

For the characteristics plant height, green mass and number of coriander sauces, were obtained with the application of 80 tha^{-1} goat manure.



A B C D

Figure 3. Extension project in the garden of Dom José Tupinambá da Frota State School, in Sobral Municipality, Ceará (A and B) weeding of weeds after germination and (C and D) throughout the vegetative cycle of the studied vegetables

The coriander cultivar used was "Super verdad", For arugula cultivation, the cultivated cultivar used in the Northeastern region both in the rainy season (January to June) and in the dry

A mean value of 93.33 g, corresponding to 2333.25 kg ha^{-1} of coriander green mass, was obtained in the three parts of the 0.4 m^2 acreage cultivated with coriander without goat manure.

Table 1. Plant height (PH), number of sauces (NS) and green mass weight (GMW) of coriander (*Coriandrum sativum* L.) plants grown in the absence and presence of organic fertilizer (goat manure) in the Dom José Tupinambá High School, Sobral, Ceará, Brazil

Plots by flower bed	PH (cm)		NS		GMW (g)	
	NGM	WGM	NGM	WGM	NGM	WGM
Plot of the flowerbed 1	4.3	12.83	4	10	108	370
Plot of the flowerbed 2	6.1	12.66	2	7	74	204
Plot of the flowerbed 3	6.2	13.33	3	9	98	196
Average value / 3 flowerbeds	5.53	12.94	3	8.66	93.33	256.66

NGM = No goat manure. WGM= With goat manure

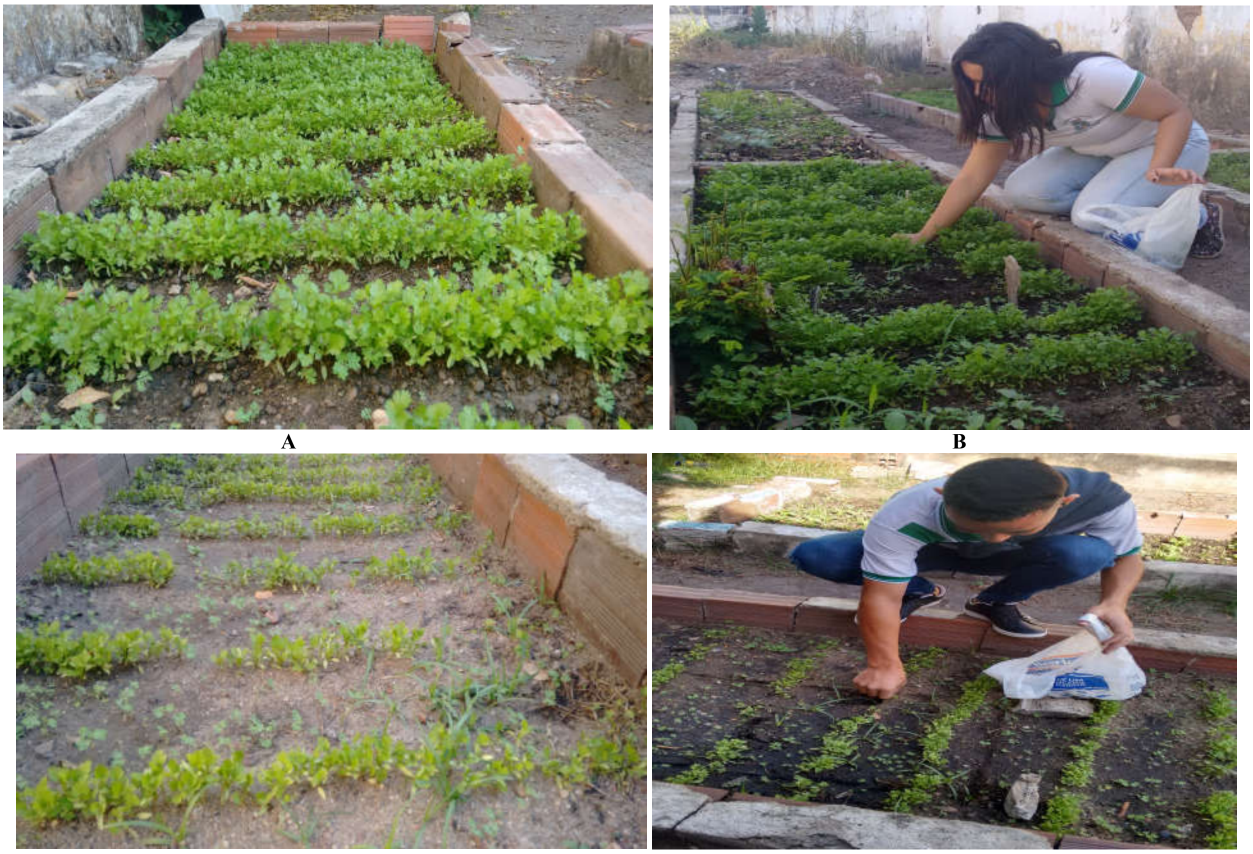


Figure 4. Extension project in the garden of the Dom José Tupinambá da Frota State College in Sobral Municipality, Ceará (A and B) coriander plant growth in goat manure beds and (C and D) plant growth coriander in fertilized beds

Table 2. Plant height (PH), number of leaves per plant (NLP) and fresh shoot mass (FSM) of arugula (*Eruca sativa*) plants cultivated in the absence and presence of organic fertilizer (goat manure) in the vegetable garden. Dom José Tupinambá High Schoo, Sobral, Ceará, Brazil

	PH (cm)		NLP		FSM (g)	
Flower 1	FLOWER	FT/08/2018	FLOWER	FT/08/2018	FLOWER	FT/08/2018
	9,5	12	4	5	216	282
Flower 2	FT/03/2018	FT/08	FT/03/2018	FT/08/2018	FT/03/2018	FT/08/2018
	15	12	9	6	798	304

Flower 1- Part 1 Fertilizer (FT) - No goat manure. Flower 1- Part 2 AD / 08/2018 - Fertilizer with 80 tha^{-1} manure in August 2018. Flower 2- Part 1 - FT/03/2018 Fertilizer with 80 tha^{-1} manure in March 2018. Flower 2- FT/08/2018 Fertilized with 80 tha^{-1}.

parts of the beds with a useful area of 0.4 m^2fertilized with goat manure the green mass obtained was 256.66 g, corresponding to 6,416.5 kg ha^{-1} of green mass (Table 1) and as demonstrated by the plants harvested in the presence of and absence of goat manure incorporated into the soil (Figure 4). These results confirm the importance of goat manure to increase coriander production and promote the quality of products for human consumption. Linhares et al. (2015), when evaluating coriander height, harvested at 35 days after germination, observed a maximum height of 18.1 cm from fertilized plants with a dose of 60.0 t of cattle manure. The authors also observed that the coriander yield increased as a function of the cattle manure dose incorporated into the soil, obtaining 6.453 kg ha^{-1} of green mass at the 60 t ha^{-1} dose of cattle manure. From the results obtained, we highlight the importance of incorporating goat manure into the soil and the time of incorporation of manure into the soil to increase arugula production, in addition to promoting the quality of hardwood products to consumers (Figure 5).

Figure 5. Extension project in the garden of Dom José Tupinambá da Frota State College, Sobral, Ceará, Brazil. (A and B) arugula plant growth in part of the goat manure beds in March 2018 and (C and D) arugula plant growth in part of the goat manure beds in August 2018

The results can be explained by the higher nutrient availability probably provided by the goat manure incorporated with longer time before sowing. This period probably provided higher yields due to a greater synchronization in the period of maximum crop nutritional requirement in relation to goat manure mineralization and consequently the nutrient availability to the soil which is determined by the C/N ratio. For Souza and Rezende (2006) the decomposition and rapid release of nutrients are of great importance for short cycle crops, such as arugula, as it allows the availability of nutrients in a timely manner for use during the crop cycle. Silva et al. (2008), when evaluating the cultivation of arugula fertilized with different organic residues, such as cattle manure, sheep / goat manure and earthworm humus, observed that the number of arugula leaves increased, whose increase was more accentuated with better manure plant performance. For Souto et al. (2005) the difference in manure decomposition time ensures a continuous flow of nutrients in the soil. Fontanétti et al. (2006), found that the absorption of nutrients from organic fertilizer mineralization by vegetables depends largely on the synchrony between decomposition and mineralization of waste and the time of greatest nutritional requirement of the crop.

Conclusions

The amount of goat manure used in the goat beds promoted the highest yield in the production of the studied vegetables. Higher arugula yield was obtained from plants cultivated in the part of the fertilized bed in March 2018, followed by plants fertilized with goat manure in August 2018. The teachers, students and college staff involved in the project became aware of the importance of goat manure used in vegetable cultivation, changing their perception of theoretical concepts and the practice of agroecology in food production.

Acknowledgment

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