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AGRONOMIC EFFICIENCY OF DIFFERENT QUANTITYS OF JITIRANA MIXED WITH CATTLE MANURE IN THE INTERCROPPING OF CORIANDER WITH MINT

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ABSTRACT

The experiment was conducted at the Rafael Fernandes Experimental Farm, in the Alagoinha district, rural area of Mossoró-RN, Brazil, with the purpose of evaluating the agronomic efficacy of different differentquantitys of jitirana mixed with cattle manure in the intercropping coriander and mint. The study was conducted between 11/27/2015 and 03/22/2016, in a randomized whole block design study area set up, arranged in 2 x 4 factorial scheme layouts with three replications. The first factorial scheme consisted of single cropping and intercropping of mint and coriander. The second factorial scheme comprised a different quantity of jitirana mixed with cattle manure (0.0, 1.0, 2.0 and 3.0 kg m^{-2}). The evaluated characteristics for the mint crop were biomass weight, fresh mass, number of bunch, dry mass, oil content and yield, and for the coriander crop these were plant height, number of plants[1] stems, productivity, number of bunches and dry mass. There was an increase in the productive characteristics of the consortium, with a number of peppermint sauces of 5.8 and 15.3 m2 of coriander at doses of 2.2 and 3.0 kg m2, respectively. The equivalent area ratio was agronomic ally efficient, with equivalent area ratio (RAE) of 1.78.

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INTRODUCTION

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. Among the species that are produced by family farmers is *Coriandrum sativum* L., commonly known as coriander, which is a leafy vegetable widely used in Brazilian cuisine, especially in the Northeast region of Brazil, and being a crop of great commercial yield.

The quality of seeds used by farmers is directly related to their physiological potential represented by germination and strength, and equally their ability to propagate the normal seedling (Pereira *et al*., 2011). Another species of importance for the region is pepper mint (*Mentha piperita* L.) which is of great commercial value and widely sold on supermarket shelves. This species, native to Europe and cultivated worldwide, belongs to the Lamiaceae family where it is known as *Mentha*, in Brazil commonly known as mint. Mint is popularly used for medicinal purposes and food (Lorenzi *et al*., 2002). These mint species are grown in single cropping systems and intercropped with other olericultures of different nutritional requirements, such as arugula and lettuce, in predominantly family farming areas. According to Pelloso *et al*. (2012), intercropping is one of the most suitable methods to increase crop yields with several environmental, productive,

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and economic advantages. In the region of Mossoró, Rio Grande do Norte (RN), the most used fertilizer source is cattle manure. Cattle manure can limit production output because the farmer does not always have this resource available on his property, this unavailability of cattle manure contributes to increased production costs (Linhares *et al*., 2012). One of the alternatives to minimize the limitations of the use of cattle manure is its use with green manure (Menezes *et al*., 2007). 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. Within the context cited above, we introduce jitirana (*Merremia aegyptia* L.) which is a spontaneous species of the caatinga biome, an annual climber, and an herbaceous species belonging to the Convolvulaceae family, with a green and dry matter production of around 36000 and 4000 kg ha^{-1}, respectively, an average nitrogen content of 26.2 g kg^{-1} as dry matter, with a carbon / nitrogen ratio of 18/1, making the species feasible for use as a rapid decomposing quantity straw based green manure (Linhares, 2013). Given the importance of seeking alternatives to increase food production per unit area, this study aimed to evaluate the agronomic efficacy of different quantitys of jitirana in the practice of intercropping coriander with mint using cattle manure.

MATERIALS AND METHODS

The study was conducted from 11/27/2015 to 03/22/2016 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 (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 being normally from June to January, and a rainy season being from February to May. The average annual rainfall is 673.9 mm and the average relative humidity is 68.9%. 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) = 6.64; exchangeable cations Ca = 1.30$cmol_c$ dm^{-3}; Mg = 0.60 $cmol_c$ dm^{-3}; K = 34.5 mg dm^{-3}; Na = 10.7 mg dm^{-3}; P (Mehlich) = 1.80 mg dm^{-3} and organic matter = 2.48 g kg^{-1}.

The study area was designed in a randomized block area, arranged in a 2 x 4 factorial scheme set up, with three replications. The first factor set up consisted of single cropping and intercropping of coriander and mint, and the second was comprised of a mixture of jitirana and cattle manure (in 0.0, 1.0, 2.0 and 3.0 kg m^2). The mixture of jitirana with cattle manure was decomposed for a period of 30 days before sowing of the coriander and mint intercrop (Linhares *et al*., 2012). The preparation of the ground consisted of the harrowing and preparing 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 (Novaes, 2007). For the coriander crop in both cultivars, the plot was 1.4 m x 1.4 m, with a total area of 1.96 m^2, containing 1560 coriander plants with 0.1 m x 0.05 m spacing with five planting holes[1] for single crops (Linhares *et al*., 2014). In intercropping the coriander was placed in the middle of the mint. The coriander crop variety used was Verdão cultivar. Mint (*Mentha piperita* L.) was used in this study as it was considered the most popular and a familiar product sold on the supermarket shelves in Mossoro-RN. Each block was 17.0 m in length by 1.4 m in width. The study plots were 1.4 m x 1.4 m, with a total area of 1.96 m^2, with 20 plants in each of the single crop and intercropping with coriander, spaced 0.35 mx 0.4 m respectively. The yielding area, with six plants, was therefore 0.8 m^2. The propagation of the seedlings was carried out by clipping the apical buds, picked from select *Menthe piperita* plants, and cultivated in expanded polystyrene trays of 128 cells which contained a commercially available vermiculite substrate. The seedlings were transplanted in September 2015 after being grown in a greenhouse for 15 days, with 50% shading, and until they reached approximately 10 cm in height. The jitirana used was collected from the native vegetation in the vicinity of the campus of UFERSA during the flowering season. It is at this time that the plant has the maximum concentration of nutrients and chemical properties of: 570 g kg^{-1} C; 25.0 g kg^{-1} N; 12.5 g kg^{-1} P; 18.0 g kg^{-1} K; 12.0 g kg^{-1} Ca; 16.0 g kg^{-1} Mg and carbon / nitrogen ratio (23/1). The cattle manure used was stabilized and sourced from the heifers of the UFERSA cattle herd, which are raised in an intensive system, fed with corn-based concentrate, soy bean and wheat bran, and having as bulk Canarian grass (*Echinocloa polystochya*), which has a chemical concentration of: pH (water 1: 2.5) = 8.06; and the total contents of 19.7 g kg^{-1} of N; 0.767 g kg^{-1} of P; 6.827 g kg^{-1} of K^+; 2.449 g kg^{-1} of Na^+; 0.197 g kg^{-1} of Ca^{2+} and 0.037 g kg^{-1} of Mg^{2+}). The crops were harvested according to crop cycles (mint and coriander). At thirty days after the sowing coriander, harvesting was done on 02/10/2016, and at sixty days after transplanting the mint crop, harvesting was on 03/15/2016.

After harvesting, plants were transported to the Post-Harvest of Vegetables Laboratory at the Department of Plant Sciences at UFERSA where they were analyzed. For the coriander crop an evaluation of the differences was performed: plant height (was measured from base to was apex in twenty plant sample batches, using a millimeter ruler and recorded in cm $plant^{-1}$), number of stems per plant (was determined in twenty plant sample averages), 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 100 m^{-2} in a cultivating area where family farmers are typical in the region of Mossoró-RN, Brazil), 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 of Mossoró-RN, and measured in units 100 m^{-2}), and dry mass (was obtained from a forced-air heating oven at 65 ºC, until constant mass was attained and measured in kg 100 m^{-2}). For the mint crop, the following differences were evaluated: biomass height (was measured in the field, in centimeters using millimeter ruler, ten plants per plot), green mass (was obtained by cutting above ground, was weighed on a precision scale of 1.0g and expressed as 100m^{-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 m^2 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}). In determining the essential oil content and yield, the Simões et al. (2003) methodology was used. Samples of the above ground part of the dried plants were subjected to hydro distillation in a modified Clevenger apparatus for 1.5 h, using 600 mL of distilled water in 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}. The oil yield (the oil content (%) x the dry matter (in kg 100 m^{-2}) of the area portion divided by 100) was determined. The intercropping was evaluated using the equivalent area ratio (RAE) measure as proposed by Caetano *et al*. (1999), namely: RAE = (Cc / Mc) + (Ch / Mh), where Cc and Ch are, respectively, the productivities in the intercropping of coriander and mint crops and Mc and Mh are the monoculture productivities of the cultures of cilantro and mint crops, respectively also. For the calculation of the RAE, productivity values were used based on an effective area of 1.0 m^2 of land for monocultures and intercropping. There were two analyses carried out for the conformation of variances: one to evaluate the agronomic characteristics of the coriander in the randomized complete block design in a factorial scheme 2 (cultivation systems [single cropping and intercropping]) x 4 (four different quantitys of jitirana mixed with cattle manure), and the other to establish the agronomic characteristics of mint as a function of single cropping, as well as the intercropping of mint, with a mixture of jitirana and cattle manure, in a 2 x 4 factorial scheme. The statistical application used was ESTAT (Kronka *et al*., 1995). The response curve adjustment procedure for the quantitative factor (the mixture of jitirana and cattle manure) was performed using Table Curve Software (Jandel Scientific, 1991) and, for the qualitative factor (single cropping, and intercropping, of coriander and Mint) the F test, obtained in the analysis of variance, was used.

RESULTS AND DISCUSSION

No significant interaction was observed between the factors studied in any of the evaluated characteristics (Table 1). However, there was an isolated effect at the level of probability ($p < 0.01$) in the different quantity of jitirana mixed with cattle manure for all characteristics studied (Table 1). In relation to the cultivation systems (single cropping, and intercropping), there was a statistical difference in the level of probability ($p < 0.01$) for biomass height, green mass, number of bunches, dry mass, and oil percentage (Table 1). For biomass height, there was no maximum point in relation to the different different quantitys of jitirana mixed with cattle manure, with an average value of 21.76 cm in the different quantity of 3.0 kg m^{-2} (Figure 1). In relation to the cultivation system (single cropping and intercropping) there was a statistical difference with average values of 20.55 and 16.97 cm, respectively (Table 2). Vicente *et al*. (2008), when evaluating the production of medicinal plants with filter cake, reached a greater average height of 45 cm for mint, being a superior result to that achieved in this study. This greater average height is probably due to an extended time in the field for the species which was evaluated at 240 days after planting, and a different parameter for this study which was measured at 60 days after the transplanting of mint seedlings.

For the characteristics of green mass and number of bunches there was no maximum yield recorded with average values of 56.4 kg 100 m^{-2} and 1691.1 units 100 m^{-2}, respectively, at a quantity of 3.0 kg m^{-2} of the different quantity of jitirana mixed with cattle manure (Figures 2A and 2B). In the cultivation systems (single cropping, and intercropping) a statistical difference was observed with average values of 51.92 and 38.88 kg 100 m^{-2} of green mass and 1437 and 852 m^{-2} units of mint Table 2). Vicente, Maia and Oliveira (2008), when studying the production of medicinal plants with filter cake, found green biomass production of mint at 400 g m^{-2}, equivalent to four bunches, an amount inferior to the results of the above referenced research. This inferiority is due to the mint being measured at 240 days after sowing, which in turn causes the senescence of the basal leaves which later decrease in the green mass foliage–growth of the plant, since it is basically made up of leaves. Similar dry mass behavior was observed for the dry mass of mint, with an average value of 6.56 kg 100 m^{-2} in the different quantity of 3.0 kg m^{-2} of jitirana mixture with cattle manure (Figure 3).

Table 1. F values for biomass height, expressed in cm (AT), green mass, expressed in kg 100 m^{-2} (MV), number of bunchs, expressed in units 100 m^{-2} (NM), dry mass, expressed as g m^{-2} (DM), percentage of oil, expressed as% (PO) and oil yield, expressed in g 100 m^{-2} (RE) of mint fertilized with jitirana plus bovine manure. Pombal-PB, Brazil, UFCG, 2016

Causes of variation	GL	AT	MV	NM	MS	PO	RE
Fertilizer doses (A)	3	6.33^{**}	22.82^{**}	52.59^{**}	25.99^{**}	13.71^{**}	36.86^{**}
Cultivation system (B)	1	12.17^{**}	43.13^{**}	79.90^{**}	4.07^{**}	16.51^{**}	0.55^{ns}
A X B	3	0.77^{ns}	2.00^{ns}	2.66^{ns}	1.50^{ns}	0.93^{ns}	0.90^{ns}
Treatments	7	----	----	----	----	----	----
Blocks	2	0.64^{ns}	1.29^{ns}	2.10^{ns}	0.79^{ns}	0.78^{ns}	0.50^{ns}
Residue	14	----	----	----	----	----	----
CV (%)	----	13.41	10.70	14.0	10.70	8.88	6.95
Average Overall	----	18.76	45.40	1144.5	5.21	0.59	47.67

** = P <0.01; * = P <0.05; ^{ns} = not significant

Table 2. Evaluation of biomass height, expressed in cm (AT), green mass, expressed in kg 100 m^{-2} (MV) and number of mint bunches, expressed in units 100 m^{-2} (NM). Pombal-PB, Brazil, UFCG, 2016

Growing systems	AT	MV	NM
Single	20.55 a	51.92 a	1437.0 a
Intercropping	16.97 b	38.88 b	852.0 b

The average defined by lowercase letters, being different in the column, do not differ from each other in F testing at the level of ($p < 0.01$) of probability.

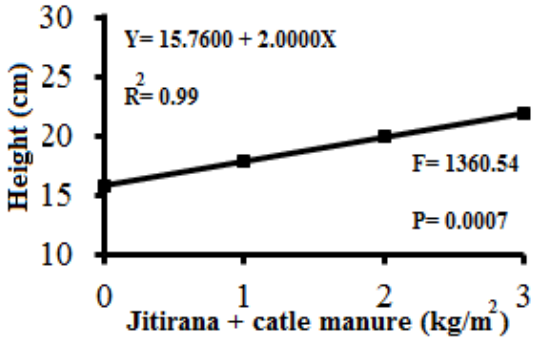

Figure 1. Height of the biomass of the mint using a different different quantity of jitirana mixed with cattle manure. Pombal-PB, Brazil, UFCG, 2016

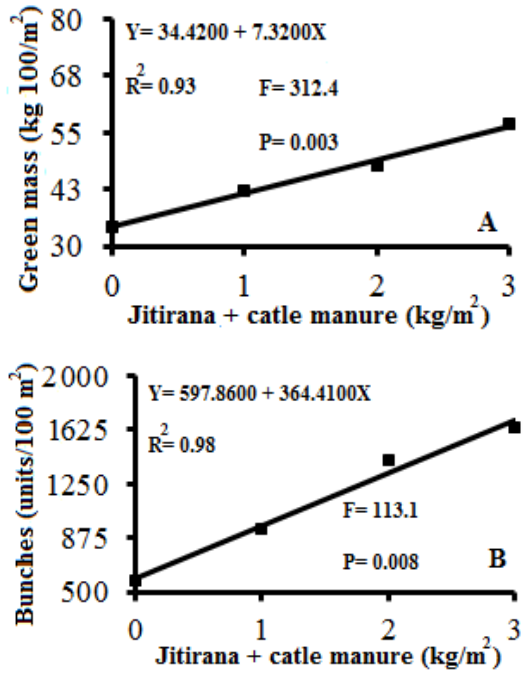

Figure 2. Green mass (A) and number of bunches (B) of mint using different a different quantity of jitirana mixture with cattle manure. Pombal-PB, Brazil, UFCG, 2016

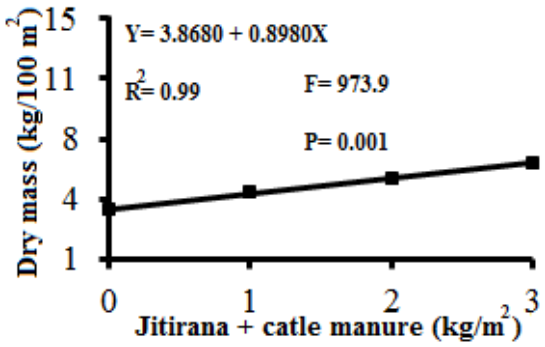

Figure 3. Dry mint mass using a different quantity of jitirana mixed with cattle manure mixed into the soil. Pombal-PB, Brazil, UFCG, 2016

Regarding the cultivation systems, there was a statistical difference, with average values of 5.93 and 4.49 kg 100 m^{-2} respectively (Table 3). Greater results were observed by Vicente, Maia and Oliveira (2008) when studying the production of medicinal plants with filter cake and found dry mint biomass production of 100 g m^{-2}, equivalent to 10 kg 100 m^{-2}.

In relation to the percentage of oil, there was a statistical difference, with an average value of 0.68% in the 3.0 kg m^{-2} different quantity, as a function of the different quantity of jitirana mixed with cattle manure (Figure 4). For the cultivation systems (single cropping and intercropping) there was a statistical difference, with average values of 0.64% and 0.55%, respectively (Table 3). 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, 2010). As regards oil yield, there was no maximum yield with an average value of 57.1 g 100 m^{-2} at a 3.0 kg m^{-2} different quantity of jitirana mixed with cattle manure mixed into the soil (Figure 5). There were no significant statistically differences in the planting systems (neither in single cropping, nor in intercropping), with average values of 48.2 and 47.2 g 100 m^{-2} (Table 3).

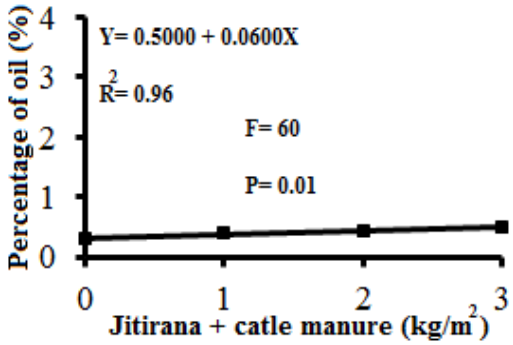

Figure 4. Percentage of mint oil under a different quantity of jitirana mixed with cattle manure mixed into the soil. Pombal-PB, Brazil, UFCG, 2016

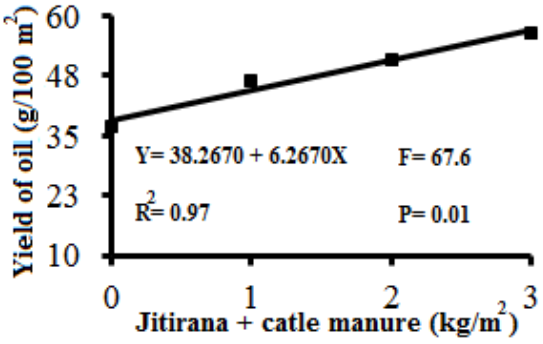

Figure 5. Yield of oil under different different quantity of jitirana mixed with cattle manure mixed into the soil. Pombal-PB, Brazil, UFCG, 2016

Table 3. Evaluation of dry mass characteristics, expressed in kg 100 m^{-2} (DM), percentage of oil, expressed in% (TO) and oil yield, expressed in g 100 m^{-2} (RO). Pombal-PB, Brazil, UFCG, 2016

Growing systems	MS	PO	RO
Single	5.93 a	0.64 a	48.2 a
Intercropping	4.49 b	0.55 b	47.2 a

The average defined by lowercase letters, being different in the column, do not differ from each other in F testing at the level of probability ($p < 0.01$).

The culture of coriander

In the second crop study, there was no significant interaction between the factors studied for the characteristics of coriander. However, there was a significant result for the different

quantity of jitirana mixed cattle manure at the level of ($p < 0.01$) of probability for plant height, number of stems, green mass, number of bunches and dry mass. There was also a significance level of probability of $p < 0,01$ for plant height, green mass, number of bunches and dry mass, as well as a significant effect at the level of ($p < 0.05$) probability for the number of stems (Table 4). There was an average increase of 9.7 cm in plant height for plant^{-1} between the measure 0 kg (5.8 cm plant-1) and 3.0 kg m^{-2} (15.5 cm plant^{-1}) (Figure 5).

For the cultivation system (single cropping and intercropping) there was a statistical difference, with average values of 4.5 and 3.8 plant^{-1} stems, respectively (Table 5). Ramalho (2015), when studying the coriander intercropping of beetroot fertilized with a different quantity of jitirana mixed with cattle manure, in an agroeconomic performance measure, found stems at an average of 8.0 cm when using a different quantity of 4.0 kg m^{-2}, this result being superior to those of the above referenced study.

Table 4. F values for plant height, expressed in cm (AT), number of stems, expressed in terms of average (NH), green mass, expressed in kg 100 m^{-2} (MV), number of bunches, expressed in units 100 m^{-2} (NM) and dry mass, expressed in kg 100 m^{-2} (DM) of coriander fertilized with a different quantity of jitirana mixed with cattle manure. Pombal-PB, Brazil, UFCG, 2016

Causes of variation	GL	AT	NH	MV	NM	MS
Fertilizer doses (A)	3	18.42**	5.78**	57.59**	52.59**	144.52**
Cultivation system (B)	1	29.35**	8.58*	79.90**	79.90**	164.24**
A X B	3	0.69^{ns}	0.84^{ns}	2.66^{ns}	2.66^{ns}	6.52**
Treatments	7					
Blocks	2	0.90^{ns}	0.31^{ns}	2.10^{ns}	2.10^{ns}	5.16*
Residue	14	----	----	----	----	----
CV (%)	----	22.35	13.88	14.01	14.00	9.47
Average Overall	----	10.70	4.12	57.23	1144.50	6.10

** = P <0.01; * = P <0.05; ns = not significant

In relation to the cultivation system (single cropping and intercropping) there was a statistical difference, with average values of 13.3 and 8.1 cm plant^{-1} (Table 5).

Table 5. Evaluation of plant height characteristics, expressed in cm plant^{-1} (AT), and number of stems, expressed in terms of average (NH). Pombal-PB, UFCG, Brazil, 2016

Growing systems	AT	NH
Single	13.4 a	4.5 a
Intercropping	8.1 b	3.8 b

The average defined by lowercase letters, being different in the column, do not differ from each other in F testing at the level of probability ($p < 0.01$).

Table 6- Evaluation of the characteristics of green mass, expressed in kg 100 m^{-2} (MV) and number of bunches, expressed in units 100 m^{-2} (NM). Pombal-PB, Brazil, UFCG, 2016

Growing systems	MV	NM
Single	71.9 a	1437 a
Intercropping	42.6 b	852 b

The average defined by lowercase letters, being different in the column, do not differ from each other in F testing at the level of probability ($p < 0.01$).

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^{-1} equivalents to 1.56 kg m^{-2}. These superior results are likely the consequence of the use of the different quantity mixture of jitirana mixed with cattle manure (3.0 kg m^{-2}), resulting in1.9 times the different quantity used by Linhares (2009). Already Nunes *et al*. (2007), when evaluating the effects of source, different quantity, and time frame in the application of organic compounds used when producing cabbage and coriander, recorded a height of 29.6 cm for the coriander plant when using 40 Mg ha^{-1} of organic compost. The use of a high quantity of organic compost was probably what contributed to such an impressive result in height. In relation to the number of stems with an average value of 4.7 plant^{-1} stems, the 3.0 kg m^{-2} different quantity of jitirana mixed with cattle manure promoted the largest increase (Figure 6).

What gave such an increase in stem height is likely to be the higher composite mixture used in the study**.** Linhares *et al.* (2010) observed higher performance in evaluating the dedifferent quantity of mata-pasto (*Senna obtusifolia* L.) in coriander, and finding maximum results at 6.0 plant^{-1} stems In the characteristics of the green mass, and number of coriander bunches, we observed average production of 84.6 kg 100 m^{-2} and 1691.1 100 m^{-2} bunches using 3.0 kg m^{-2} different quantitys of jitirana mixed with cattle manure (Figures 7A and 7B). In relation to the cultivating technique (single cropping and intercropping) there was a statistical difference for the green mass and the number of bunches, with average values of 71.9 and 42.6 kg 100 m^{-2}, respectively, and with 1437 and 852 of 100 m^{-2}, respectively also (Table 6).

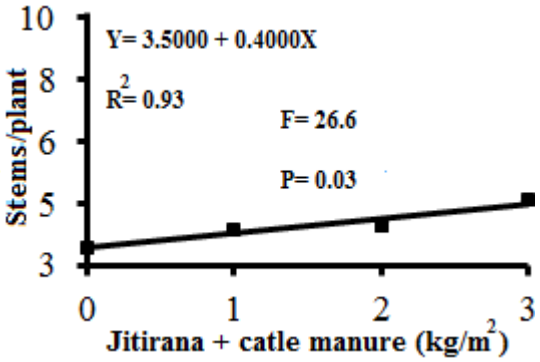

Figure 6. Number of coriander stems under different conditions incorporating jitirana and cattle manure mixed into the soil. Pombal-PB, Brazil, UFCG, 2016

The difference for the green mass between the cropping systems corresponded to 29.3 kg 100 m^{-2} for the single cropping system. This increase being likely due to the fact that in the single crop there was a population of 1000 plants m^{-2}, and in addition to this, the competition was intraspecific and greater for the coriander growth in the intercrop system (400 plants m^{-2}). Ramalho (2015) studied the coriander intercrop with a beetroot fertilized mixture of jitirana cattle manure and found, in agroeconomic performance measures, 525 g m^{-2} green mass, equivalent to 52.5 kg 100 m^{-2} corresponding to 525 100 m^{-2}, this being less green mass and a lesser number of bunches.

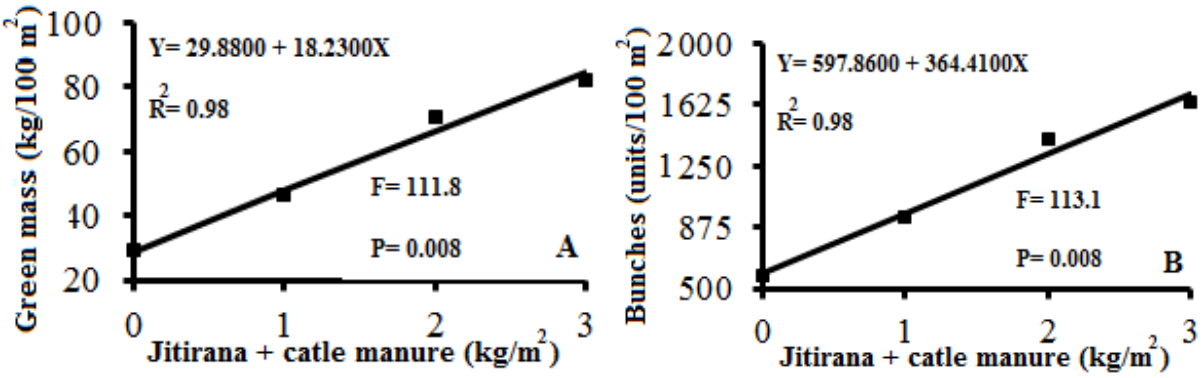

Figure 7. Green mass (A) and number of bunches (B) of coriander, incorporating jitirana and cattle manure mixed into the soil. Pombal-PB, Brazil, UFCG, 2016

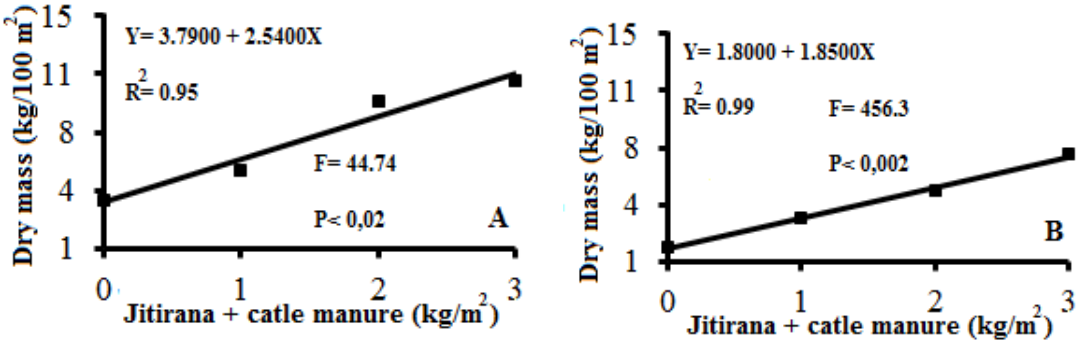

Figure 8. Deployment of a mixture of jitirana mixed with cattle manure in the single cropping (A) and intercropped (B) coriander dry mass study. Pombal-PB, Brazil, UFCG, 2016

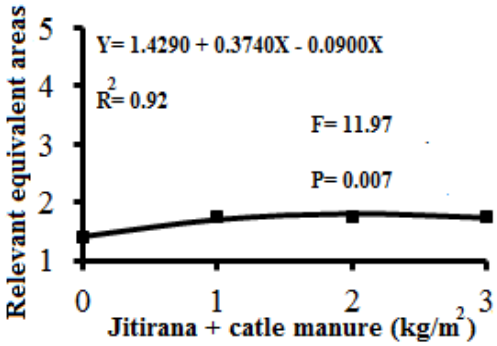

Figure 9. Relevant equivalent areas of mint intercropped with coriander, in the second crop, fertilized with the jitirana and cattle manure mix in the soil. Pombal-PB, Brazil, UFCG, 2016

The possible increase in stem volume is the likely higher dosage used in the study The average values of 11,41 and 7,35 kg 100 m^{-2}, at the 3,0 kg m^{-2} quantity, were evaluated and determined by dividing the different different quantity of jitirana mixed with cattle manure into the cultivation system (single cropping and intercropping) (Figures 8A and 8B). For the cultivation system, in the different quantity mixtures of jitirana mixed with cattle manure, statistical differences were found for all studied different quantity mixtures (0,0, 1.0, 2.0 and 3.0 kg m^{-2}), with average of 3.9 and 1,9; 5,7 and 3,6; 9.8 and 5,3 and 11,0 and 7,4 in the single cropping and intercropping cultivars, respectively (Table 7).

REASON FOR EQUIVALENT AREA

According to Santos (1998), and from the agronomic perspective, two crops are suitable to be intercropped if the equivalent area ratio (RAE) is greater than 1.0.

In this case therefore, the mint and coriander consortium was considered to be productive since the SAR was of a value of 1,78 (Figure 9), this being an increase equivalent to 78% of cultivated area, using the single cropping arrangement, yielding an output of production equivalent to that reached in the mint-coriander consortium. According to Gliessmann (2001), there is strong evidence to suggest that the negative interference of a species is minimal in intercropping, and that a positive interference of a species allows at least one participating crop to do better in an intercrop set up, rather than in a single crop set up. Grangeiro *et al*. (2011), who evaluated beet and coriander crops agronomically, in accordance with the function of intercropping, and in all instances found that the land use index was greater than 1.00 thus indicating that the intercropping systems tested made better use of available environmental resources in relation to single cropping, found a similar result.

CONCLUSION

The use of jitirana, mixed with cattle manure, contributed to the increased productive characteristics of the intercropping study in the two growing seasons, with mint bunch yield of 5.8 per 2.2 kg m^{-2}. For the coriander cultivation, the mint bunch yield was 15.3 m^{-2} at 3.0 kg m^{-2}. Thus the equivalent area ratio, assessed in this study, confirms that the intercropping of mint with coriander was efficient from an agronomic perspective with an RAE of 1.78 respectively.

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