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Influence of spacing and harvests on the production of scarlet eggplant and chicory under intercropping system

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ABSTRACT

The aim of this study was to evaluate the fresh mass of scarlet eggplant (kg/pl) and the number of leaves of chicory (nºf/pl) in relation to the spacing used by the farmers of the region for both crops. The experiment evaluated these crops under intercropping cultivation system, varying the number of chicory rows between scarlet eggplant rows as well as harvests (cycle of each crop), for intercropping and monocropping systems. The treatments were T1= scarlet eggplant 0.7x1.1 m (monocropping); T2= intercropped scarlet eggplant, 0.7x1.5 m, with four rows of chicory, 0.2x0.2 m between rows; T3= intercropped scarlet eggplant, 0.7x1.1 m, with three rows and chicory, 0.2x0.2 m; T4= intercropped scarlet eggplant, 0.7x1.3 m, with four rows of chicory, 0.2x0.2 m; T5= intercropped scarlet eggplant, 0.7x1.3 m, with three rows of chicory, 0.2x0.2 m; T6= chicory 0.2x0.1x0.4 m in two double rows, 0.2 m between rows, 0.1 m between plants and 0.4 m between double rows in 1.5 m linear area (monocropping) and T7= chicory 0.2x0.3 m with three simple rows in an 1.5-m area (monocropping). The experimental design was of strip blocks, in a 5x16 factorial scheme, consisting of five spacings of scarlet eggplant (monocropping), 1.5x0.7 m, 1.3x0.7 m and 1.1x0.7 m, alternating the number of chicory rows between rows and 16 harvests in time, once a week. For chicory, the design was also in a 6x12 factorial scheme, with six spacings. The spacing 0.2x0.2 m was intercropped with scarlet eggplant, alternating the number of rows and two monocroppings 0.2x0.1x0.4 m in double rows and 0.2x0.3 m with 12 harvests in time, being performed one harvest per week along with the scarlet eggplant. Intercropped scarlet eggplant in spacing 0.7x1.5 m showed higher averages in some harvests followed by spacing 0.7x1.3 m with four chicory rows between rows. Spacings 0.2x0.1x0.4 m and 0.2x0.3 m were the ones which provided the best averages for chicory crop, except for the 5th harvest, in which spacing 0.2x0.2 m consisting of four chicory rows provided the highest average (5.7 leaves/plant). Regardless of monocropping and intercropping arrangement used for chicory the Area Equivalence Index (IEA) was over 1.6.

Keywords: *Solanum gilo*, *Cichorium intybus*, intercropping.

RESUMO

Influência do espaçamento e colheitas na produção do jiló e almeirão sob cultivo consorciado

O objetivo do presente trabalho foi avaliar a massa fresca do jiló (kg/pl) e número de folhas de almeirão (nºf/pl) em função dos espaçamentos usuais pelos agricultures da região para ambas as culturas em sistema consorciado variando o número de linhas de almeirão na entrelinha do jiló e, colheitas (ciclo de cada cultura), para os consórcios e monocultivos. Os tratamentos foram T1= jiló 0,7x1,1 m (monocultivo); T2= consórcio de jiló, espaçamento de 0,7x1,5 m, com quatro filas de almeirão, 0,2x0,2 m, nas entrelinhas; T3= consórcio de jiló, 0,7x1,1 m, com três filas e almeirão, 0,2x0,2 m; T4= consórcio de jiló, 0,7x1,3 m, com quatro filas de almeirão, 0,2x0,2 m; T5= consórcio de jiló, 0,7x1,3 m, com três filas de almeirão, 0,2x0,2 m; T6= almeirão 0,2x0,1x0,4 m em duas filas duplas com 0,2 m entre linhas, 0,1 m entre plantas e 0,4 m entre filas duplas sobre 1,5 m linear de área (monocultivo) e T7= almeirão 0,2x0,3 m com três filas simples sobre 1,5 m de área (monocultivo). O delineamento foi em faixa, em um fatorial 5x16, contendo cinco espaçamentos de jiló de forma isolada, sendo 1,5x0,7 m, 1,3x0,7 m e 1,1x0,7 m, alternando-se o número de linhas de almeirão na entrelinha e 16 colheitas no tempo, sendo realizada uma por semana. Para o almeirão, o delineamento também foi em faixa em um fatorial 6x12, com seis espaçamentos. O espaçamento de 0,2x0,2 m foi consorciado com jiló, alternando-se o número de linhas e dois monocultivos 0,2x0,1x0,4 m em filas duplas e 0,2x0,3 m com 12 colheitas no tempo, sendo realizada uma por semana juntamente com o jiló. O jiló em consórcio no espaçamento de 0,7x1,5 m apresentou maiores médias em algumas colheitas seguido do espaçamento de 0,7x1,3 m com quatro filas de almeirão na entrelinha. Os espaçamentos 0,2x0,1x0,4 m e 0,2x0,3 m foram os que proporcionaram as melhores médias para a cultura do almeirão, com exceção para a 5° colheita, em que o espaçamento 0,2x0,2 m com quatro filas de almeirão proporcionou a maior média (5.7 folhas/planta). Independente do monocultivo e arranjo de consórcio utilizado para almeirão o IEA foi superior a 1.6.

Palavras-chave: *Solanum gilo*, *Cichorium intybus*, consórcio.

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Horticultural production is a massive activity concerning the use of resources, such as soil, water and nutrients. The production needs high investments per unit of planted area, intercropping system can be an interesting option, though (Puiatti *et al.*, 2015).

Among the challenges for a successful intercropping cultivation, besides the management adopted, selecting appropriate crops is essential. The effectiveness of intercropping largely depends on competitiveness between the crops, in order to reduce the negative effects between the growing plants; this is the reason why a criterious choice of crops to be cultivated is fundamental, in order to increase economic yield (Lopes & Lima, 2015). Concerning the above, chicory and scarlet eggplant intercropping tends to show a variation in relation to cultural practices. The available resources and the production of scarlet eggplant and chicory under intercropping system undergo changes depending on adopted spacing. Studies on spacings between rows with harvest time were not found in literature.

Variations between harvests can be related to shading rate or due to the maximum competition between plants for soil nutrients, being verified a decrease in the following harvest. In some crops, plants, such as scarlet eggplant and chicory, demand some time to recover, videlicet, two or three weeks until the following harvest. Thus, the choice of spacing varied according to that used by farmers in the region. The most used spacing was 0.7x1.1 m for monocropped scarlet eggplant. In general, spacing for scarlet eggplant cultivation ranged from 1.1 to 1.5 m between rows in intercropping cultivations in the region. For chicory, many growers use 0.2x0.2 and 0.2x0.3 m spacing in monocropping and intercropping, respectively. Using larger spacing between lines, each plant has more space and can develop better. On the other hand, in intercropping, the productivity of number of leaves per area tends to be reduced.

Thus, the Area Equivalence Index (IEA) is an important parameter to be used in order to check the efficiency of intercropping system when compared with monocropping. Intercropping becomes efficient when IEA is equal or superior to 1.0 and not efficient when IEA is lower than 1.0. Nevertheless, values superior to 1.0 show a higher yield for intercropping cultivation (Montezano & Peil, 2006).

In literature, studies on intercropping between vegetables, which show agronomic performance superior to monocropping, are easy to find. Moreover, this practice is considered an economic practice and efficient in relation to soil use (Brito *et al.*, 2017). Considering the studies carried out, we can mention: chicory with roquette (Cecílio Filho *et al.*, 2008); lettuce with roquette (Costa *et al.*, 2007); cucumber with roquette (Rezende, 2016); carrot with roquette (Lima, 2008); onion with lettuce (Paula *et al.*, 2009); broccoli with lettuce (Ohse *et al.*, 2012); taro with broccoli (Brito *et al.*, 2017); taro with chinese cabbage (Brito *et al.*, 2017) and taro with eggplant (Brito *et al.*, 2017).

Chicory (*Cichorium intybus*) is a leaf vegetable, belonging to Asteraceae family, scarlet eggplant *(Solanum aethiopicum g r. Gilo)* belongs to Solanaceae family, with green fruits; however, both have pronounced bitter taste, presenting nutritional and pharmacological properties (Franco, 1987). We highlight that both crops present large-scale production per unit area and a high demand for labor (Heredia Zárate *et al.*, 2009). These crops are characterized by a low-cost production and for being low-demanding concernig soil fertility and inputs (Heredia Zárate *et al.*, 2009).

Given the above, the aim of this study was to evaluate the fresh mass of scarlet eggplant (kg/pl) and number of leaves of chicory per plant (nºf/pl) in relation to spacings used by growers in the South Region of Espírito Santo for both crops in intercropping system varying the number of rows of chicory and between the rows of scarlet eggplant, as well as, harvests (cycle of each crop) for intercropping and monocropping systems.

MATERIAL AND METHODS

The experiment was carried out at Setor de Agroecologia at Instituto Federal do Espírito Santo (IFES), Alegre campus (20º44’05”S, 41º25’50”W, 134 m altitude). According to Köppen classification, the local climate is Cwa, hot, under humid tropical conditions, with cold dry winter and hot rainy summer, 23.1ºC average temperature and 1,341 mm total average rainfall.

In order to produce seedlings of Tingua Verde Claro (scarlet eggplant variety), the authors used 200-mL plastic cups (white polyethylene) and, fifteen days after plant emergence (March 5th, 2017), the plants were thinned, leaving just one seedling per cup. Chicory and scarlet eggplant were allocated in a joint field experiment, being each of them studied as monocropped and intercropped cultivations, completing 7 spatial arrangements, considering T1= scarlet eggplant 0.7x1.1 m (monocropping); T2= intercropped scarlet eggplant, spacing 0.7x1.5 m, with four rows of chicory, 0.2x0.2 m, between rows (Figure 1A); T3= intercropped scarlet eggplant, 0.7x1.1 m, with three rows of chicory, 0.2x0.2 m; T4= intercropped scarlet eggplant, 0.7x1.3 m, with four rows of chicory, 0.2x0.2 m; T5= intercropped scarlet eggplant, 0.7x1.3 m, with three rows of chicory, 0.2x0.2 m; T6= chicory 0.2x0.1x0.4 m in two double rows with 0.2 m between rows, 0.1 m between plants and 0.4 m between double rows on an 1.5 m linear area (monocropping) (Figure 1B); and T7= chicory 0.2x0.3 m with three simple rows in an 1.5 m linear area (monocropping). All intercropped crops can be seen in Figure 1A.

The scarlet eggplant plants were sown in two rows, and each treatment consisted of four plants per row. The first and last plants of each treatment were discarded as borders. That means, each scarlet eggplant treatment consisted of four useful plants to be evaluated. Chicory was planted between these two rows of scarlet eggplant, considering the central rows of chicory as useful area. For monocropped chicory, we discarded 0.25 linear meters at the beginning and the end of the row as a border.

Japanese chicory was sown in 200 cells polyethylene trays, and 15 days after germination, the seedlings were transplanted to seedbeds (April 5th, 2017), putting just one seedling per pit. The harvests were evaluated as a factor to show variation between harvests. So, for a field trial evaluation, the experimental design was a strip-plot, due to the harvests which were performed in time in a 5x16 factorial scheme, consisting of 5 treatments, which are the usual spacing used by growers in that region, 1.5x0.7 m, 1.3x0.7 m and 1.1x0.7 m. We performed 16 harvests, once a week, throughout the scarlet eggplant reproductive cycle with four replicates. For chicory, we performed 6x12 factorial scheme with six treatments, with spacings 0.2x0.2 m and 0.2x0.3 m and 12 harvests, performed once a week, troughout the chicory cycle, with four replicates, according to the following statistic model:

$$y_{ijk} = \mu + \beta_j + \alpha_i + \varepsilon_{ij} + \gamma_k + \varepsilon_{jk} + (\alpha\gamma)_{ij} + \varepsilon_{ijk}\ onde\ \varepsilon_{ijk} \overset{IDD}{\sim} N\left(0, \sigma^2\right)$$

in which: y_{ijk} is the value of the i-th treatment A and k-th treatment B in j-th block; μ is the general constant of the model (usually average); βj is the effect of j-th block; α_i is the effect of i-th treatment A; ε_{jk} is the experimental error between i-th level of factor A and j-th block; γ_k is the effect of the k-th level of factor B; ε_{jk} is the experimental error between the k-th level of factor B and j-th block; $(\alpha\gamma)_{ij}$ is the effect of the interaction between the i-th level of factor A and the k-th level of factor B; ε_{ijk} is the experimental error between i-th level of factor A and k-th level of factor B in the j-th block.

According to Brazilian Soil Classification System (EMBRAPA, 1999), the soil was classified as Red-Yellow Latosol, with rugged topography. The field was plowed, harrowed and seedbeds were built with the aid of a seedbed tiller.

No specific fertilization management was performed for the crops, due to the difficulty in differentiating doses. Moreover, the experiment was implanted in a transitional agroecological area, where organic fertilization management is carried out whenever necessary. For that, we consider that the levels of each essential nutrient for the plants, especially vegetables, are present in soil, as well as organic matter content. For organic fertilizers, we used cattle manure, bean straw, corn straw, tree leaves, among others.

The soil used in the experiment showed the following contents: MO= 14 g/dm^3, pH= 5.8, P= 34.2 mg/dm^3, K= 72 mg/dm^3, Ca= 2.6 cmol/dm^3, Mg= 0.8 cmol/dm^3, Al= 0.18 cmol/dm^3, H+Al= 5.30 cmol/dm^3, SB= 4.58 cmol/dm^3, CTC= 8.88 cmol/dm^3, V= 50%, K= 2% on the CTC, P-rem= 32.7 mg/L, monoic S= 20 mg/dm^3, B= 0.60 mg/dm^3, Zn= 1.2 mg/dm^3, Mn= 1.1 mg/dm^3, Cu= 0.3 mg/dm^3, Fe= 1.2 mg/dm^3. Sprinkler irrigation was performed, using daily irrigation shifts to meet the demand during the crop cycle. Weed control was done with the aid of hoes between rows and hand plucking between plants.

Scarlet eggplant harvest began on May 5th 2017, being the green fruits harvested weekly, throughout the crop cycle, until September 5th, 2017, with 16 harvests, measuring fresh mass of fruits per plant (kg/pl). Chicory harvest began on May 10th, 2017, being the green leaves harvested once a week throughout the crop cycle, until Agust 10th, 2017, with 12 harvests. The harvests of scarlet eggplant and chicory were always performed in the same plants. We used as an evaluation criterion, the way scarlet eggplant and chicory are commercialized in the markets of the region. Generally, scarlet eggplant is sold by weight of fruit (kg/pl), chicory is sold by (moles) of leaves.

Chicory was harvested when leaves were 20 to 30 cm long; it shall not be less, or more, since leaves smaller than 20 cm are considered too fragile to be transported. Moreover, the small leaves do not meet the demand. Leaves larger than 30 cm, present bitterness characteristics, and are considered old for consumption.

To calculate the Area Equivalence Index (IEA), we used the following formula:

$$IEA = \frac{CA}{MA} + \frac{Cl}{M}$$

in which: CA represents the productivity of intercropped scarlet eggplant (kg/ha); MA is the productivity of monocropped scarlet eggplant (kg/ha); CB represents the productivity of intercropped chicory (nºf/ha) and MB is the productivity of monocropped chicory (nºf/ha).

Data were statistically analyzed using variance analysis (F test) and average test (Tukey), unfolding the spacing in each harvest of scarlet eggplant and chicory separately. The harvests were unfolded in each spacing to study the regression adjustments.

RESULTS AND DISCUSSION

The authors verified interaction among the spacings used in the experiment and harvests for the evaluated traits ($p<0.05$). Both for fresh mass of scarlet eggplant (kg/pl) and for number of chicory leaves (nºf/pl) variation coefficient (CV) was above 40%, showing reasonable experimental accuracy, considering that the variation between harvests is difficult to control. Moreover, environmental influence on harvests for both crops is related to "non-randomization in time", so that a strip-plot design was used.

Another important factor concerning this variation might have been the unevenness of water supply, since the sprinkler irrigation was not 100% uniform. Thus, even showing a high variation coefficient, the authors could verify differences among the spacings between rows. There exist very few studies in literature about variation between spacings on horticultural crops. Minami *et al.* (1998) reported no significant difference for spacings between rows of radish, even showing a lower CV compared to this study.

No significant difference for spacings in harvests 1st, 3rd, 4th, 6th, 7th, 9th, 10th, 12th, 14th, 15th and 16th for fresh mass of scarlet eggplant (kg/pl) (Table 1) was noticed. Intercropped scarlet eggplant in spacing 0.7x1.5 m showed higher averages in some harvests followed by spacing 0.7x1.3 m, both consisting of four rows of chicory between rows.

Spacings used for chicory did not differ among each other during the first harvests, 1st, 2nd and 3th (Table 2). Monocropping with a lower number of plants per hectare showed higher averages of leaf production per plant when compared with other treatments, except for the 5th harvest, in which the spacing 0.2x0.2 m with four rows of chicory provided the highest average, 5.7 leaves/plant.

When spacing between rows and plants is smaller, the microclimate formed induces a better use of the water resource in the place, avoiding evapotranspiration, increasing productivity (Minami *et al.*,1998). The same authors reported that a better efficiency in nutrient uptake is noticed when these nutrients are widely available in soil and when the competition between plants, for area, is lower.

Some studies report that plants under lower competition in the row, produce more and are able to accumulate higher quantity of photosynthesized reserves. Plant biomass shows that larger spacings in the row stimulate photosynthetic activity (Correa *et al.*, 2014). Purquerio *et al.* (2007), working with roquette, verified that spacings over 0.5 m between plants provided satisfactory production since no standardization for this crop, and also for chicory, which makes it possible to classify the leaf size, obtained in different spacings, was reported.

The authors highlight that due to a smaller spacing had been superior to the

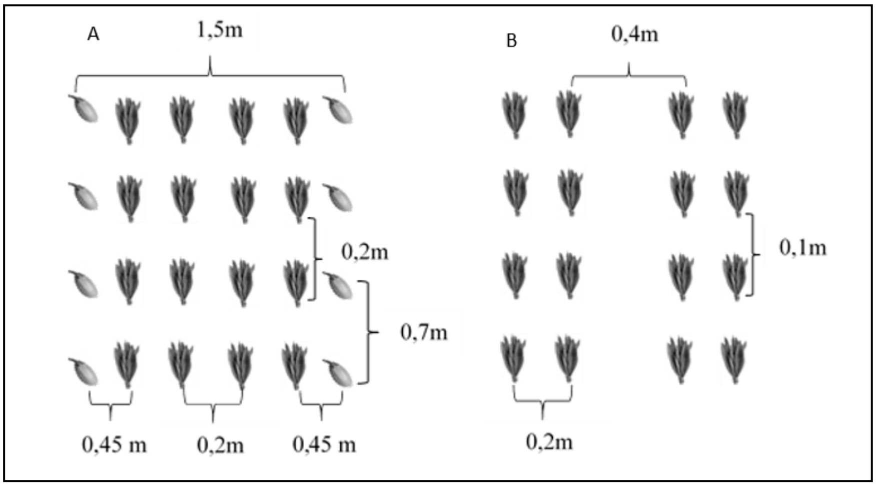

Figure 1. (A) intercropped scarlet eggplant, spacing 0.7x1.5 m, with four rows of chicory, 0.2x0.2 m between rows related to T2 and **(B)** monocropped chicory in double rows, 0.2x0.1x0.4 m with 0.2 m between rows, 0.1 m between plants and 0.4 m between double rows related to T6. Alegre, IFES, 2018.

Table 1. Comparison of averages for fresh mass of scarlet eggplant (kg/pl), unfolding of spacings between lines for each harvest under intercropping system using chicory crop. Alegre, IFES, 2018.

Treatments	Harvests															
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
1	0.04a	0.31a	0.05a	0.10a	0.69a	0.16a	0.07a	0.42a	0.13a	0.29a	0.42a	0.13a	0.45a	0.17a	0.13a	0.14a
2	0.12a	0.21ab	0.08a	0.22a	0.59ab	0.28a	0.24a	0.34ab	0.30a	0.28a	0.39a	0.20a	0.41a	0.32a	0.17a	0.33a
3	0.11a	0.11ab	0.11a	0.20a	0.44bc	0.26a	0.14a	0.29ab	0.24a	0.25a	0.34ab	0.25a	0.29ab	0.27a	0.17a	0.18a
4	0.05a	0.07b	0.17a	0.30a	0.33cd	0.40a	0.19a	0.27ab	0.25a	0.12a	0.26ab	0.35a	0.28ab	0.39a	0.25a	0.33a
5	0.09a	0.05b	0.17a	0.29a	0.20d	0.33a	0.17a	0.12b	0.28a	0.08a	0.13b	0.28a	0.16b	0.31a	0.28a	0.17a

T1= 0.7x1.1 m (monocropped scarlet eggplant); T2= 0.7x1.5 m (4 rows of chicory); T3= 0.7x1.1 m (3 rows of chicory); T4= 0.7x1.3 m (4 rows of chicory); T5= 0.7x1.3 m (3 rows of chicory). Averages folled by the same lowcase letter in the column do not differ statistically among each other by Tukey test at 5%.

Table 2. Comparison of averages for number of chicory leaves (units), unfolding of spacings between rows for each harvest under intercropped cultivation for scarlet eggplant crop. Alegre, IFES, 2018.

Treatments	Harvests											
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
2	4.20a	4.50a	3.05a	2.75b	3.85bc	2.80b	3.60b	4.90bc	4.05b	4.20b	3.00b	2.80b
3	3.50a	3.85a	2.75a	3.35ab	3.50c	2.30b	3.55b	3.95c	3.35b	3.75b	2.10b	2.55b
4	4.45a	3.85a	2.95a	3.75ab	5.70a	2.80b	4.20ab	3.75c	3.65b	3.70b	2.60b	2.65b
5	3.95a	3.75a	3.10a	3.40ab	5.15ab	2.35b	3.85b	4.00c	3.45b	4.65b	2.55b	2.70b
6	3.50a	4.65a	3.60a	4.55a	4.65abc	5.35a	5.40a	6.25ab	5.55a	6.25a	3.40b	4.75a
7	3.60a	4.30a	3.60a	4.40a	4.45abc	4.90a	5.55a	6.70a	6.25a	7.40a	5.10a	6.05a

T2= 0.2x0.2 m (4 rows of chicory); T3= 0.2x0.2 m (3 rows of chicory); T4= 0.2x0.2 m (4 rows of chicory); T5= 0.2x0.2 m (3 rows of chicory); T6= 0.2x0.1x0.4 m (monocropped chicory); T7= 0.2x0.3 m (monocropped chicory). Averages followed by the same lowcase letter in the column do not differ statistically among each other by Tukey test at 5%.

Table 3. Regression analysis for fresh mass scarlet eggplant (kg/pl) and number of chicory leaves (units) with unfolding of harvests within each level of spacing for both crops under intercropping system. Alegre, IFES, 2018.

	Model	Parameter	Estimates	Standard error	t_c	p value	R^2 (%)
Scarlet eggplant							
T2	Linear	β_0	0.1654	0.0285	5.7976	0*	0.254377
		β_1	0.0109	0.0030	3.6907	0.0003*	
	Quadratic	β_0	0.0256	0.0465	0.5517	0.5818ns	0.525010
		β_1	0.0575	0.0126	4.5658	0.00001*	
		β_2	-0.0027	0.0007	-3.8068	0.0002*	
	Cubic	β_0	-0.0337	0.0701	-0.4799	0.6318ns	0.548833
		β_1	0.0939	0.0346	2.7110	0.0073*	
		β_2	-0.0079	0.0047	-1.7036	0.0900ns	
		β_3	0.0002	0.0002	1.1294	0.2601ns	
T3	Linear	β_0	0.1865	0.0285	6.5363	0*	0.087189
		β_1	0.0062	0.0030	2.1163	0.0356*	
	Quadratic	β_0	0.0395	0.0465	0.8497	0.3965ns	0.399214
		β_1	0.0552	0.0126	4.3879	0.00002*	
		β_2	-0.0029	0.0007	-4.0034	0.0001*	
	Cubic	β_0	0.0508	0.0701	0.7238	0.4700ns	0.400110
		β_1	0.0483	0.0346	1.3943	0.1648ns	
		β_2	-0.0019	0.0047	-0.4062	0.6850ns	
		β_3	-0.00004	0.0002	-0.2145	0.8304ns	
T4	Linear	β_0	0.2170	0.0285	7.6068	0*	0.109943
		β_1	0.0093	0.0030	3.1441	0.0019*	
	Quadratic	β_0	0.1365	0.0465	2.9362	0.0037*	0.163422
		β_1	0.0361	0.0126	2.8687	0.0046*	
		β_2	-0.0016	0.0007	-2.1928	0.0295*	
	Cubic	β_0	-0.0149	0.0701	-0.2123	0.8321ns	0.255873
		β_1	0.1292	0.0346	3.7283	0.0002*	
		β_2	-0.0149	0.0047	-3.1871	0.0017*	
		β_3	0.0005	0.0002	2.8831	0.0044*	
T5	Linear	β_0	0.2930	0.0285	10.2692	0*	0.000104
		β_1	0.0003	0.0030	0.0967	0.9231ns	
	Quadratic	β_0	0.1731	0.0465	3.7240	0.0003*	0.118671
		β_1	0.0402	0.0126	3.1959	0.0016*	
		β_2	-0.0023	0.0007	-3.2641	0.0013*	
	Cubic	β_0	0.0648	0.0701	0.9239	0.3567ns	0.166039
		β_1	0.1068	0.0346	3.0832	0.0023*	
		β_2	-0.0119	0.0047	-2.5424	0.0118*	
		β_3	0.0004	0.0002	2.0631	0.0404*	
Chicory							
T2	Linear	β_0	3.8780	0.2053	18.8869	0*	0.030851
		β_1	-0.0364	0.0279	-1.3034	0.1927ns	
	Quadratic	β_0	3.7750	0.3448	10.9482	0*	0.033363
		β_1	0.0078	0.1220	0.0639	0.9491ns	
		β_2	-0.0034	0.0091	-0.3720	0.7100ns	
	Cubic	β_0	5.9652	0.5458	10.9286	0*	0.519885
		β_1	-1.6850	0.3490	-4.8275	0*	
		β_2	0.3095	0.0611	5.0624	0*	
		β_3	-0.0160	0.0031	-5.1761	0*	

Table 3. continuation

Chicory							
	Model	**Parameter**	**Estimates**	**Standard error**	t_c	**p value**	R^2 **(%)**
T3	Linear	β_0	3.5856	0.2053	17.4628	0*	0.112580
		β_1	-0.0580	0.0279	-2.0805	0.0377*	
	Quadratic	β_0	3.2318	0.3448	9.3729	0*	0.155009
		β_1	0.0936	0.1220	0.7674	0.4430ns	
		β_2	-0.0117	0.0091	-1.2772	0.2018ns	
	Cubic	β_0	4.3702	0.5458	8.0065	0*	0.343275
		β_1	-0.7863	0.3490	-2.2527	0.0245*	
		β_2	0.1510	0.0611	2.4694	0.0137*	
		β_3	-0.0083	0.0031	-2.6904	0.0072*	
T4	Linear	β_0	4.3697	0.2053	21.2815	0*	0.194085
		β_1	-0.1075	0.0279	-3.8539	0.0001*	
	Quadratic	β_0	3.7148	0.3448	10.7735	0*	0.267134
		β_1	0.1732	0.1220	1.4200	0.1559ns	
		β_2	-0.0216	0.0091	-2.3643	0.0182*	
	Cubic	β_0	4.4510	0.5458	8.1546	0*	0.306697
		β_1	-0.3959	0.3490	-1.1342	0.2570ns	
		β_2	0.0836	0.0611	1.3673	0.1718ns	
		β_3	-0.0054	0.0031	-1.7400	0.0821ns	
T5	Linear	β_0	3.9250	0.2053	19.1157	0*	0.054180
		β_1	-0.0538	0.0279	-1.9301	0.0538ns	
	Quadratic	β_0	3.4114	0.3448	9.8936	0*	0.104189
		β_1	0.1663	0.1220	1.3635	0.1730ns	
		β_2	-0.0169	0.0091	-1.8543	0.0640ns	
	Cubic	β_0	4.4737	0.5458	8.1962	0*	0.195875
		β_1	-0.6548	0.3490	-1.8761	0.0609ns	
		β_2	0.1348	0.0611	2.2056	0.0276*	
		β_3	-0.0078	0.0031	-2.5107	0.0122*	
T6	Linear	β_0	4.1227	0.2053	20.0787	0*	0.157143
		β_1	0.1080	0.0279	3.8727	0.0001*	
	Quadratic	β_0	2.6136	0.3448	7.5800	0*	0.468126
		β_1	0.7548	0.1220	6.1894	0*	
		β_2	-0.0498	0.0091	-5.4479	0*	
	Cubic	β_0	3.7874	0.5458	6.9387	0*	0.548751
		β_1	-0.1524	0.3490	-0.4366	0.6625ns	
		β_2	0.1179	0.0611	1.9290	0.0540ns	
		β_3	-0.0086	0.0031	-2.7739	0.0056*	
T7	Linear	β_0	3.4326	0.2053	16.7175	0*	0.643755
		β_1	0.2706	0.0279	9.7004	0*	
	Quadratic	β_0	2.7250	0.3448	7.9030	0*	0.688394
		β_1	0.5739	0.1220	4.7058	0*	
		β_2	-0.0233	0.0091	-2.5544	0.0108*	
	Cubic	β_0	4.4025	0.5458	8.0658	0*	0.795924
		β_1	-0.7227	0.3490	-2.0705	0.0386*	
		β_2	0.2163	0.0611	3.5385	0.0004*	
		β_3	-0,0123	0,0031	-3,9646	0,0001*	

Scarlet eggplant: T2= 0.7x1.5 m (4 rows of chicory); T3= 0.7x1.1 m (3 rows of chicory); T4= 0.7x1.3 m (4 rows of chicory); T5= 0.7x1.3 m (3 rows of chicory). Chicory: T2= 0.2x0.2 m (4 rows of chicory); T3= 0.2x0.2 m (3 rows of chicory); T4= 0.2x0.2 m (4 rows of chicory); T5= 0.2x0.2 m (3 rows of chicory); T6= 0.2x0.1x0.4 m (monocropped chicory); T7= 0.2x0.3 m (monocropped chicory).

Table 4. The Area Equivalence Index (IEA) for total production of scarlet eggplant (kg/pl) and chicory (nºf/pl) under intercropping system. Alegre, IFES, 2018.

Treatments	Scarlet eggplant	Chicory	IEA 1	IEA 2
Intercropping	0.7x1.5 m	0.2x0.2 m (4 rows)	1.83	1.94
Intercropping	0.7x 1.1 m	0.2x0.2 m (3 rows)	1.81	1.91
Intercropping	0.7x1.3 m	0.2x0.2 m (4 rows)	1.86	1.97
Intercropping	0.7x1.3 m	0.2x0.2 m (3 rows)	1.63	1.74

IEA 1= using monocropped chicory in spacing between double rows 0.2x0.1x0.4 m; IEA 2= using monocropped chicory in spacing 0.2x0.3 m.

other spacings for scarlet eggplat crop in some harvests, the same spacing is viable due to the increase in the number of plants per area, considering that more dense plants obtain a better supply of water and nitrogen (Correa *et al.*, 2014). Furthermore, smaller spacings encourage plants to compete for light, while reducing the loss of essential elements due to erosion (Nomura *et al.*, 2018).

Using the harvest unfolding in each spacing, the authors observed that no adjustment in almost all unfoldings was observed (Table 3). The linear, quadratic and cubic group are not in T1, spacing 0.7x1 m, since no significant difference among harvests was noticed. For chicory, significant difference was observed in all harvests, and for that reason, the linear, quadratic and cubic group shows six times according to the order of treatments.

The Area Equivalence Index (IEA) was used to evaluate land-use efficiency, since this ratio is related to the land area required in monocropping system, aiming to obtain the same production when cultivated under intercropping system (Vieira, 1984). Also, according to Vieira (1984), for being efficient, the intercropped cultivation needs to show IEA superior to 1.0.

In this experiment, we observed that intercropping between scarlet eggplant and chicory provided values superior to 1.0 (Table 4). The increase in productivity can be obtained with greater populations, taking into consideration the size and qualitative traits, as these traits may restrict marketing (Sala *et al*., 2004).

Generally, monocropped chicory was more efficient when unfolding the spacings for each harvest through the average test. Even if it is not possible to recommend a better intercropping between these crops, it is possible to say that farmers will have weekly harvests reducing cost and area. Monocropped scarlet eggplant was as efficient as the intercroppings 0.7x1.5 m and 0.7x1.3 m, since they show higher averages in some harvests.

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