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ANSWERING OF CULTIVARS FROM CORIANDER TO DIFFERENT SPACES AS THE PRESENCE AND ABSENCE OF THINNING

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Abstract

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Factors such as cultivars, cropping techniques, as is the case of planting density, are determinants to ensure good yield in the production of vegetables, especially coriander. As a result, the objective of this work was to develop more efficient techniques for the cultivation of coriander, evaluating cultivars according to different planting methods, as well as the conduction of the plants, regarding the presence and absence of thinning. The experiment was conducted at the Rafael Fernandes Experimental Farm, Federal University of the Semi-Arid (UFERSA), from July to September 2016. The experimental design was a randomized complete block in a 2 x 2 x 2 factorial scheme, whose factors correspond respectively to coriander cultivars (Verdão and Português), sowing forms (in the 0.05 m hole and line) and plant management (with and without thinning). The evaluated characteristics were: plant height, root length, number of stems per plant, yield of green mass and dry mass of shoot. The cultivar Verdão was the most efficient in this cultivation system. Cultivation without thinning and sowing with in-line spacing promoted the highest green mass yield, with mean values of 4.11 and 4.19 t ha^{-1}, respectively.

Key words: Coriandrum sativum L.; plant density; yield of green mass
Abbrevations: Federal Rural Semi-Arid University (UFERSA), hydrogen potential (pH), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), electric conductivity (CE), organic matter (M.O.), base sum (SB), cation exchange capacity (CTC), saturation of sodium (PST), CTC effective (t), base Saturation (V), coefficient of variation (CV)

Introduction

The coriander (*Coriandrum sativum* L.) is an olive grove plenty commercialized in Brazil, of great value and commercial importance, whose exploitation occurs almost exclusively to the production of green leaves. Its nutritional importance is due to the presence of vitamins A, B1, B2 and C, also by being a good source of calcium and iron (Filgueira, 2008), besides its potential for the condiment industry. In the Brazilian semiarid conditions, it is a very favorable crop to be cultivated, due to its adaptation to hot climates. Its cultivation should be preferentially organic, far away from synthetic fertilizers of high solubility (Vaz and Jorge, 2007).

For this crop, the density of planting per unit area is one of the most important production factors, being directly related to the number of stems of coriander per unit area (Linhares et al., 2015). According to Neto et al. (2003), the increase in sowing density, associated with the reduction of line spacing may cause increases in productivity, due to the increase in light interception and better utilization of available water and nutrients. Also, the presence or absence of thinning also is determinant in production, because it is associated with planting density.

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Although it has been a subject widely studied, the variation of planting densities in the several producing regions of this vegetable is still great, planting densities have being influenced by the technique used, that can be done in planting pits or grooves, both spaced between 20 to 30 cm between rows. This affects production (Linhares et al., 2015). These same authors, evaluating spacing to the coriander culture, fertilized with carnauba straw, verified that the spacing 0.10 x 0.05 m, with five plants per holes, was the most efficient as a function of the other spacing, obtaining yield of 1.2 kg m^{-2} of flowerbed.

In addition, the selection of the cultivar is crucial for reaching a good yield in the coriander, because the different types of genotypes are adapted to different environments (Oliveira et al., 2007). Lima et al. (2007) evaluating coriander cultivars under different planting spacings in the first cultivation, they verified that the Tabocas cultivar, when it is cultivated at a spacing of 0.20 x 0.05 m, from November to December, provides greater agronomic performance of coriander.

On the other hand, Marques and Lorencetti (1999) evaluated coriander cultivars sown in two seasons, they verified that the Português and Verdão cultivars had a higher number of stems of coriander per m^2, and the highest leaf/stalk ratio was observed in the Português cultivar, indicating superior quality of the final product.

Faced the above, this work aims to develop more efficient techniques for the coriander cultivation by assessing cultivars in function of different planting methods, as well as the conduction of the plants, regarding the presence and absence thinning.

Material and Methods

The experiment was conducted from July to September 2016, at the Experimental Farm Rafael Fernandes, UFERSA, located in the district of Alagoinha, latitude 5º03'37 "S and longitude 37º23'50" W Gr, distant 20 km from the city of Mossoró-RN. The region presents two well-defined climatic seasons: a dry one, from June to January, and another rainy, from February to May (Alvares et al., 2014), with semi-arid climate, according to Thornthwaite, and type BsWh, dry and very hot, according to the Koppen classification.

The experimental area presented a soil classified as Eutrophic Yellow Red Argissolo (Santos et al., 2006). From this area, prior to the installation of the experiment, soil samples were taken at 0-20 cm depth, which were then sent for chemical analysis in the Laboratory of Soil Fertility and Plant Nutrition of the Department of Environmental and Technological Sciences of UFERSA, whose Results were: pH = 6.12; P = 3.75 mg dm^{-3}; K = 70.82 mg dm^{-3}; Ca = 1.98 $cmol_c$ dm^{-3}; Mg = 0.68 $cmol_c$ dm^{-3}; Na = 7.8 mg dm^{-3}; CE = 0.18 dS m^{-1}; M.O. = 7.82 g kg^{-1}; SB = 2.88 $cmol_c$ dm^{-3}; CTC = 3.48 $cmol_c$ dm^{-3}; PST = 1.0%; t = 2.88 $cmol_c$ dm^{-3} and V = 83%. Before the installation of the experiment, a solarization in pre-planting was carried out during 45 days for disinfestation of soil phytopathogens (Silva et al., 2006).

The experimental design was a randomized complete block, in a 2 x 2 x 2 factorial scheme, with six replications. The first factor corresponded to the coriander cultivars used (Verdão and Português), the second to the sowing [with spacing in the hole (0.20 x 0.05 m) and in the line (0.20 x line)], and the third factor, to the plants conduction (with and without thinning).

The total plot area was 1.44 m^2, with a useful area of 0.80 m^2. The lateral lines were considered border, also the last two plants of each line for planting in hole, and in the case of in-line crop, a equivalent measure to the spacing of two plants was estimated. The population of plants for coriander in the conduction with spacing (0.20 x 0.05 m) was of 1 000 000 plants per hectare, recommended for the single cultivation in the region (Lima et al., 2007).

Fertilization was carried in two seasons, a on foundation with bovine manure, adding an amount of 27.78 t ha^{-1}, as recommended by Nunes et al. (2007). Before incorporation, this material was tanned for a period of 30 days (Makishima et al., 2010). The planting was carried out in holes and grooves, on July 25, 2016. In the holes an average of 5 to 6 seeds were placed, and in the grooves an average amount of 600 seeds, uniformly. Six days after planting, the thinning was done, defining to the plots the respective treatment, leaving one plant per hole, and replanting, to compensate for some germination failures.

Daily irrigation was made in two turns morning and afternoon irrigations, by the micro-sprinkler system, with a water blade whit of approximately 8.0 mm dia^{-1} (Lima et al., 2010) in order to facilitate the decomposition process of the incorporated material to the soil. The manual weeding of daninhas plants was performed periodically to keep the crop free from competition with weeds.

The coriander harvest was carried out 36 days after planting, in which the following characteristics were analyzed: plant height (taking a sample of 20 plants per plot, expressed in cm, whose measurement was performed from the base to the apex of the aerial part); length of roots (measured in the same previous sample, measured from stem base to root tip, expressed in cm); number of stems per plant (counted in the same sample of plant height and expressed in terms of average); yield of green mass (obtained from fresh shoot mass of all plants in the plot area expressed in t ha^{-1}), and and yield of dry mass yield (determined from the sample of twenty plants, dried in a greenhouse with forced air circulation at 65 °C, until reaching constant mass and expressed in t ha^{-1}).

A variance analysis was performed using the SISVAR software application for the observed characteristics (Ferreira, 2011). The Tukey test was applied to compare the means among the treatments studied.

Results and Discussion

There was a significant interaction between spacing and thinning for the characteristics of number of stems per plant and dry mass yield, indicating that the response of each spacing was different due to the use and the absence of thinning (Table 1).

The spacing 0.20 x 0.05 m provided a greater number of stems per plant, its use promoted a significant difference, showing superior for this characteristic in this spacing in both cases with or without thinning. For the line spacing there was no significant difference in the thinning (Table 2). These results are superior to those found by Linhares et al. (2014), which evaluated the spacing for coriander cultivation, using carnauba straw in Mossoró-RN conditions, was obtained an average value of 6 stems per plant using a spacing of 0.20 x 0.05 m, with one plant per hole.

With respect to the dry mass yield, it can be verified that, differently, the spacing 0.20 x 0.05 m, a superior response without the thinning was obtained, and the line spacing was not influenced as to the realization or not the thinning. Corroborating with these results, Lima et al. (2007), evaluating coriander cultivars under different planting spacing in the first crop, was verified that the spacing of 0.20 x 0.05 m, in relation to other more thickened, it contributed to an increase in yield equivalent to 6.25 t ha^{-1}. This happened, possibly, because as the spacing within certain limits decreases, there is an increase in total production by area (Janick, 1986).

In summary, the superiority of the 0.20 x 0.05 m spacing for these characteristics occurred, supposedly, due to the equidistant arrangement of plants, which minimizes auto shading and delays the beginning of intraspecific competition by soil resources, leading to a maximum efficiency in the capture and use of available resources (Zanine and Santos, 2004).

There was also a significant effect of cultivars for root length and yield of dry mass. Likewise, there was a significant effect of both spacing and thinning for green mass yield (Table 1).

It can be verified that the cultivar Verdão excelled in relation to Português in root length and yield of dry mass (Tables 2

Table 1
"F" values of plant height (PH), number of stems per plant (NS), root length (RL), green mass yield (GMY) and dry mass yield (DMY) of coriander in function of different cultivars, spacing with and without thinning

Source of variation	GL	PH	NS	RL	GMY	DMY
Block	5	31.00^{**}	1.55^{ns}	17.08^{**}	1.01^{ns}	1.71^{ns}
Cultivars (C)	1	2.90^{ns}	0.27^{ns}	11.54^{**}	0.45^{ns}	22.98^{**}
Spacing (S)	1	0.93^{ns}	21.93^{**}	3.76^{ns}	33.75^{**}	70.94^{**}
Thinning (T)	1	0.94^{ns}	31.44^{**}	0.81^{ns}	40.16^{**}	102.11^{**}
C x S	1	0.39^{ns}	0.29^{ns}	1.78^{ns}	0.00^{ns}	0.21^{ns}
C x T	1	0.94^{ns}	0.13^{ns}	1.32^{ns}	0.28^{ns}	0.02^{ns}
S x T	1	0.11^{ns}	6.05^{*}	0.28^{ns}	0.27^{ns}	36.03^{**}
C x S x T	1	2.07^{ns}	0.30^{ns}	1.50^{ns}	0.02^{ns}	0.36^{ns}
CV (%)	-	11.86	18.72	15.69	28.88	32.57

ns = not significant; * = significant at 5% probability; ** = significant at 1% probability

Table 2
Mean values of the number of stems per plant (NS) and dry mass yield (DMY) of coriander as a function of spacing and presence or absence of thinning

Spacing	NS		DMY (t ha^{-1})	
	Thinning			
	With thinning	Without thinning	With thinning	Without thinning
0.20 x 0.05 m	6.95 aA	4.95 aB	0.24 aB	0.99 aA
0.20 x line	4.70 bA	4.07 bA	0.07 bA	0.05 bA
Cultivars				
Verdão	5.24 a		0.14 a	
Português	5.10 a		0.09 b	

*Means followed by the same lowercase letters in the column and upper case in the row do not differ from each other by the Tukey test at the 5% probability level

Table 3
Mean values of plant height (PH), root length (RL) and green mass yield (GMY) of coriander as a function of coriander cultivars, spacing and presence or absence of thinning

Cultivars	PH (cm)	RL (cm)	GMY (t ha^{-1})
Verdão	12.88 a	8.25 a	3.41 a
Português	12.15 a	7.07 b	3.22 a
Thinning			
With thinning	12.73 a	7.51 a	2.44 b
Without thinning	12.31 a	7.82 a	4.19 a
Spacing			
0.20 x 0.05m	12.73 a	8.00 a	2.51 b
0.20 x line	12.31 a	7.33 a	4.11 a

*Means followed by the same lowercase letters in the column do not differ from each other by the Tukey test at 5% probability

and 3). This superiority is possibly due to the adaptation of this cultivar to the environmental conditions (temperature and low insolation and high relative humidity) under which the experiment was conducted (Lima et al., 2007), hence, obtaining a better root development and higher yield.

With respect to the plant height characteristics, number of stems per plant and dry mass yield, no significant difference was observed between the two cultivars, however, the best results were recorded in the cultivar Verdão (Tables 2 and 3). Similar results were recorded by Marques and Lorecentti (1999), evaluating cultivars of coriander sown in two seasons, was obtained a superior response in the cultivar Verdão in relation to Português, but with results superior to those in this experiment, with yields of 10.5 and 4.5 t ha^{-1}. According to Curione et al. (1995) these results can be justified by the requirement of this crop in cold periods to better grow and develop.

There was significant difference between the spacings and thinning for the yield of green mass, where the line-spaced cultivation and without thinning increased yields to 4.11 and 4.19 t ha^{-1} (Table 3). This increase was possibly due to the increase in plant densities, which predisposes them to the exploitation of the whole nutrient solution of the plot soil, since its root systems intertwine, probably allowing that the contact with elements of low mobility in the soil, such as phosphorus and potassium, contributing to a higher productive efficiency. A similar result was recorded by Lima et al. (2007), evaluating agronomic performance of coriander in function of spacing and in two cultivation, yield of 4.13 t ha^{-1} was obtained by using spacing of 0.20 x 0.10 m.

Conclusions

The cultivar Verdão stood out in relation to the Português cultivar.

The cultivation in the 0.20 x line spacing and the non-thinning were the ones that provided a better productive performance of coriander, and could be recommended for this type of cultivation.

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