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Evaluation of Lettuce in Consortium with Carrot in Agroecological Production of Brazil

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Authors' contributions

This work was carried out in collaboration with all authors. Authors JLAMJ, LDFAM and LGS designed the study, Authors RAP, JLAMJ, WOA and LSM performed the statistical analysis, Authors JLAMJ, LDFAM and LFGC wrote the first draft of the manuscript. Authors ACMM, RTAS and JJFCJ managed the bibliographic research. All authors read and approved the final manuscript.

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ABSTRACT

Agroecology is the science that establishes the basis for construction of sustainable farming styles. The consortium usually to stand out as alternative interesting small for producers with structural and financial limitations, because it is an effective cropping system practiced long ago and found in all parts of the world, with greater diversity in the tropics. The experiment was conducted between August to November 2012 in the municipality of Garanhuns-PE/Brazil It had as objective to observe how the lettuce would behave in consortium with the carrot in an agroecological system of production. The parameters evaluated in the experiment were plant height, total weight of the plant,

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weight of leaves and number of leaves. The data obtained were submitted to a statistical comparison test between averages of the consortium and non-consortium beds, using Student's t-test at a significance level of 5%. It was observed that the consortium between lettuce and carrot presented a significant difference for most of the studied variables, negatively influencing its growth.

Keywords: Agricultural systems; agroecology; biodiversity.

1. INTRODUCTION

The lettuce (*Lactuca sativa* L.), is an herbaceous plant originating in Asia, preferred for the salads due to its pleasant and refreshing taste and ease of preparation, its belongs to the Asteraceae family [1].

The carrot (*Daucus carota* L.) is home to Europe (France and Holland) and Asia (Japan). It is cultivated, currently, besides the cultivars originating in the Nantes and Kuroda groups, cultivars of the Brasilia group, obtained of older carrot populations, collected in the south of the country. These besides present good color and shape of root, are productive and adapted to the summer crop [2].

Agroecology is the science that establishes the bases for the construction of sustainable agriculture [3,4]. It is presented as a disciplinary matrix integrative, so that one can understand and apply the knowledge of several disciplines. Generally, Agroecology is not only concerned with the ecologically responsible management of natural resources, but also with the social and ecological integration and its multiple interrelationships and mutual influences [5]. The consortium often stands out as an interesting alternative for small producers with structural and financial constraints, because it is a system of effective cultivation practiced long ago and found in all parts of the world, with greater diversity in the tropics [6]. This system is not associated with the use of high technology, nor with the achievement of high productivity [7,8].

However for many researchers, it is a primitive practice that should be replaced by monoculture as a natural consequence of the development of modern agriculture, known as conventional agriculture. The cultivation system consortium has been pointed out as a fundamental factor in the maintenance of small properties agricultural, being considered as a component of agricultural systems more sustainable [9].

The objective of the work was to observe how the lettuce would behave in consortium with the carrot in an agroecological system of production.

2. MATERIALS AND METHODS

The experiment was conducted between August and November 2012 in the municipality of Garanhuns-PE / Brazil, understood in coordinates 08º53'25" S and 36º29'34" W, the 900 meters of average altitude and that presents average annual temperature of 20,4ºC.

The area was, previously, with a plant cover, which was incorporated into the soil during its preparation. The preparation of five beds, with the use of hoes and tread for its dimensioning, leaving them with 4 m of length by 1 m wide and 20 cm high. The preparation also included fertilization of foundation with manure and soil revolving with the aid of spades. It was not no chemical input was used in the experiment.

The experimental units (consortium and control) were distributed in the five beds, according to the following scheme: beds I, II and III - Growing Lettuce consorted with carrots; Beds IV and V growing single lettuce, control of experiment. The sowing of lettuce (*Lactuca sativa* L.) cultivar curly Cinderella occurred in indirect way, held in a greenhouse, seeded in trays with 200 cells, filling them with the Hortomix® substrate, being careful not to compress them. Three seeds were placed in each cell, to a depth of 1 cm. They were conditioned for a period of 21 days (from 02 September to 23 of the same month). The thinning was carried out still in the greenhouse, on the 16th of September, in order to select the most vigorous plants.

The planting of the carrot (*Daucus carota* L.) occurred on September 04, 2012, two days after sowing the lettuce, directly in the beds, to a maximum of 1 cm of depth. The arrangement of the plants in the bedside occurred with inferior and superior border of 5 cm and 10 cm of the lateral borders, with a spacing of 30 cm between rows and 25 cm between columns.

The transplanting of the lettuce was performed after presenting 3 to 4 leaves (day September 23, 2012), having the same spacing conditions in the consortium and non-consortium beds.

The beds were submitted to periodic maintenance, involving weeding manual repairs, edge repair due to erosion caused by irrigation, fertilization of cover with manure, manual harvesting of pests that attacked both crops (*Diabrotica speciosa* (kitty) and *Elasmopalpus lignosellus* (caterpillar-elasmo) and the carrots that were exposed to the surface with the soil were covered, avoiding exposure of the them the sun.

Irrigation management was done manually, twice a day using watering cans during the course of the experiment; each plot received the volume of water corresponding to two watering cans (approximately 10 liters each) twice a day. In the vegetation house, each tray received enough water to reach the drainage point of the substrate.

At the end of the experiment, one of three consortium beds (bed III) was discarded to match the number of samples between the consorted beds and not consortium members. The lettuce samples were taken from each bed, discarding those of the edges, because they were the most exposed to the inclemency of the environment. The performance of the carrot was not evaluated, because there was no control (bed with single carrot) for comparisons.

Harvesting of lettuce and carrot was performed 58 days after sowing of lettuce, having its outlet directed to the local community (Academic Unit of Garanhuns).

The parameters evaluated in the experiment were plant height, total weight of plant, fresh weight of leaves and number of leaves. The data obtained were submitted to a statistical test of comparison between averages of the consortium and non-consortium beds, using Student's t-test at a significance level of 5%.

3. RESULTS AND DISCUSSION

Based on the parameters evaluated (Table 1), it could be observed that, the comparison of means of the variables in question. For plant height variable (AP) there was no significant difference between the C1 and C4 beds and between C1 and C5. However, there was a significant difference between the C2 and C4 beds and between C2 and C5 (Table 1). In relation to the total weight of the plants (PTP) it is noticed that there was no significant difference between the beds C1 and C4, but for the other comparisons, this difference observed. For the leaf weight variable (PF) a significant difference was observed for the comparisons between C1 and C5, C2 and C4, and C2 and C5. Although, C1 and C4 did not present significant difference. The number of leaves (NF) presented significant differences only for the comparison C1 and C5, being insignificant in the other comparisons. The number of leaves (NF) presented significant differences only for the comparison C1 and C5, being insignificant in the other comparisons.

In Fig. 1A, it is observed that single crop (monoculture), in beds 4 and 5, show higher growth in relation to plant height, with averages of 27.69 and 27.38 cm, respectively, while the second showed the lowest height, with a mean of 25.63 cm.

In Figs. 1B and 2A, it was observed that the single layer cultivar 5 (lettuce single crop) was the one that obtained the highest yield with respect to the weight of the leaves and the total weight of the plants, with respective averages of 0.25 and 0.41 kg. The plat 2 was the one that obtained a smaller weight of the leaves and a smaller total weight of the plants, with averages of 0.16 and 0.26 kg.

In Fig. 2B, it is observed that for the number of leaves, the values of the means between the beds were more uniform than those observed for the other variables. The greatest differences were between beds 1 and 5, presenting averages 18 and 22 leaves, respectively. The beds that exhibited a greater biodiversity (1 and 2) obtained the lowest yields for the evaluated parameters. The beds that exhibited a greater

Table 1. Comparison between consortium and non-consortium plant parameters

Parameters	C1	C4	T-value	C1	C5	T-value	C2	C4	T-value	C2	C5	T-value
	Mean±SE			Mean±SE			Mean±SE			Mean±SE		
AP plant height	±	±	1.00 ^{NS}	±	±	1.75 ^{NS}	±	±	1.46 ^{NS}	±	±	1.59 ^{NS}
Total plant weight	±	±	0.40 ^{NS}	±	±	3.20*	±	±	4.27*	±	±	3.66*
Leaf weight	±	±	3.15*	±	±	5.30*	±	±	3.12*	±	±	0.12 ^{NS}
Number of leaves	±	±	2.17*	±	±	7.60*	±	±	8.09*	±	±	1.16 ^{NS}

*C1 * C2 - consorted flowerbeds; C4 * C5 - Non-consortium beds;*
**=Significant; NS not significant (at the 5% level of probability)*

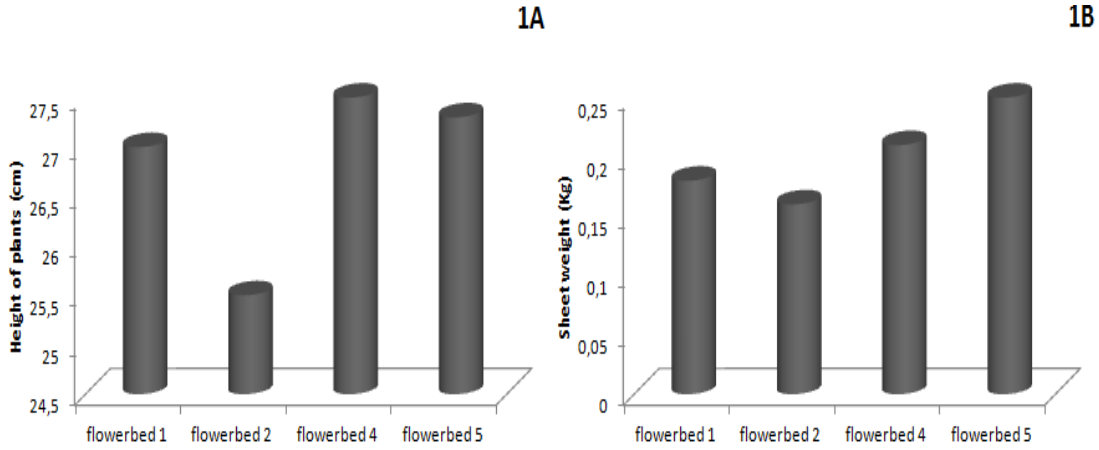

Fig. 1. Mean values of lettuce plants submitted to intercropped and non-intercropped treatments

(A) Plant height (cm) (B) Leaf weight

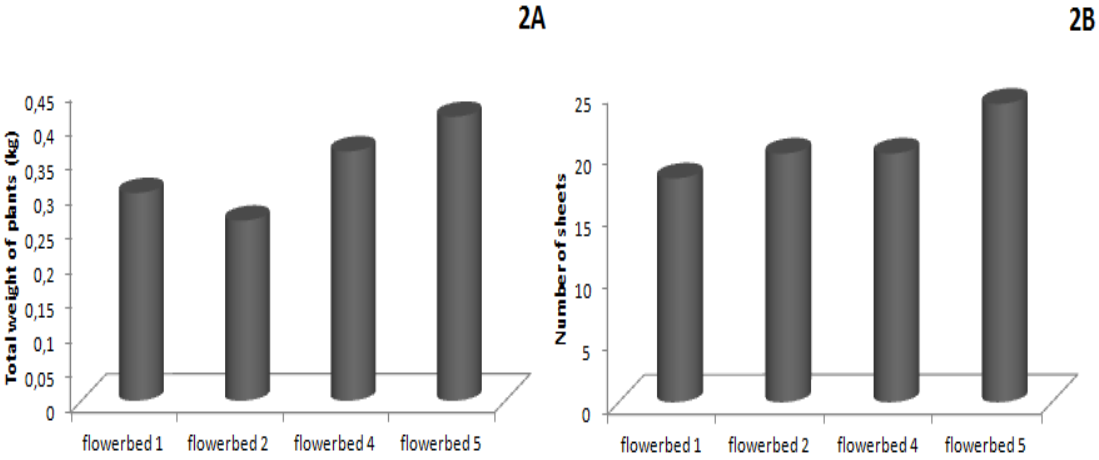

Fig. 2. Mean values of lettuce plants submitted to intercropped and non-intercropped treatments

(A) Mean values of total weight (B) Mean values of leaf number

biodiversity (1 and 2) obtained the lowest yields for the evaluated parameters. The data found in the Figs. 1 and 2 contradict Caporal et al. (2006), which demonstrates that a greater biodiversity increases the amount of natural enemies of pests, thus taking a biological control.

4. CONCLUSIONS

Based on the comparative statistical test between means, Student t-Test, it was observed that the consortium between lettuce and carrot presented a significant difference for large part of the studied variables, negatively influencing its growth.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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