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Full Length Research Paper

High sourgrass threshold interfere on chick-peas development in tropical conditions

Carita Liberato do Amaral[1]*, Marcelo Claro de Souza[4], Guilherme Bacarim Pavan[2], Marina Alves Gavassi[2] and Pedro Luis da Costa Aguiar Alves[3]

[1]Programa de Pós-Graduação em Agronomia (Produção Vegetal) – Departamento de Biologia Aplicada à Agropecuária, FCAV-UNESP, Jaboticabal-SP, Brazil.
[2]Bolsista de Iniciação Científica - Departamento de Biologia Aplicada à Agropecuária, FCAV-UNESP, Jaboticabal-SP, Brazil.
[3]FCAV-UNESP - Departamento de Biologia Aplicada à Agropecuária, Jaboticabal-SP, Brazil.
[4]Programa de Pós-Graduação em Biologia Vegetal – Departamento de Botânica, IB-UNESP, Rio Claro-SP, Brazil.

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The grains of *Cicer arietinum* (chick-peas) is one of the richest sources of proteins among worldwide grain crops. However, 100% of chick-peas grains consumed in Brazil are imported. Aiming to contribute with agricultural technologies to yield this crop in Brazil, we studied the interference of sourgrass thresholds at the initial development of chick-peas in tropical conditions. We evaluated the competition effects of seven sourgrass densities on chick-peas crops from 15 to 45 days after sowing. These effects were evaluated according to interferences on chick-peas height, number of leaves and offshoots, stem diameter, leaf area and dry mass. We observed low interferences with up to 8 sourgrass plants m^{-2} and several interferences from 16 to 128 plants m^{-2} justifying the control of sourgrass at the initial development of chick-peas.

Key words: *Cicer arietinum*, *Digitaria insularis*, competition, interference, weed.

INTRODUCTION

The chick-peas (*Cicer arietinum* L.), belongs to the Fabaceae family, is an annual crop, diploid (2n=16), autogamous with complete pollination before opening (Maiti and Wesche-Ebeling, 2001; Biçer and Sakar,. 2010) rich in proteins, vitamins and minerals (El-Adawy, 2002), being considered the best source of proteins among legume crops around the world (Ferreira et al., 2006). Nowadays we import 100% of the grains of chick-peas consumed in Brazil increasing, the final market prices (FAO, 2011). If irrigated, this crop could be cultivated in São Paulo state, Brazil, as a potential autumn/winter crop (Valim and Batistuti, 2000), verifying the need of studies for the feasibility of its commercial production in Brazil.

This crop has low initial development which can be responsible for difficulties on its development in cohabitation with weeds (Maiti and Wesche-Ebeling, 2001), mainly at the initial stages (Chaudhary and Hussain, 2011). Weeds causes quantitative and qualitative losses to agricultural products, limiting the crop yield by direct competition for nutrients, light and water (Liu et al., 2009), affecting the development of crops, reducing their growth and production of grains (Pitelli, 1985). The degree of weed interference in crops is determined by crop strategies (variety, spacing and density), weed community

*Corresponding author. E-mail: caritaliberato@gmail.com. Tel: + 55 16 3202 4702. Fax: + 55 16 3209 2600.

(species, density and distribution), abiotic factors, edaphic conditions and period that weeds coexist with crop (Lemes et al., 2010).

The competitive threshold has been defined as the weed density above which crop yield is reduced beyond an acceptable amount (Oliver, 1988). Not only density, but also the physical position that one given species occupies in a plant community and its function determines its ecological niche (Lamego et al., 2005). In this way, the greater the overlap of species, more intense the competition for environmental resources can be (Radosevich and Holt, 1984), changing the morphology of the plants, affecting the weed-crop competition relationship (Lamego et al., 2005) mainly at the initial vegetative period.

The sourgrass [*Digitaria insularis* (L.) Mez ex Ekman] is a herbaceous perennial species that can reproduce by seed and/or rhizomes (Kissmann and Groth, 1997), and it can be considered as one of the most important weeds infesting perennial and annual crops in Brazil (Carvalho et al., 2011). In addition, the sourgrass seeds have high percentage of germination enabling this species to increase rapidly in number (Correia and Durigan, 2009). Actually there are observations of resistant-biotypes to the herbicide glyfosate in soybean and maize crops as well as in citrus and coffee orchards (Timossi, 2009). In this way, sourgrass may be a problem, in the future, in chick-peas crops mainly at the initial development of the culture.

In order to better understand the competition between chick-peas and sourgrass in Tropical conditions we evaluated the interference of sourgrass thresholds at the initial chick-peas development (height, diameter of stem, leaf number and area, dry mass and number of offshoots). Based on the assumption that sourgrass is one of the most aggressive weeds in Brazilian fields, we hypothesized this weed could be a potential problem in chick-peas crops reducing their development in different degrees depending on its threshold.

MATERIALS AND METHODS

Site description

The experiments were conducted in an open field at the São Paulo State University, Jaboticabal municipality, Brazil, using cement boxes (50 × 50 × 25 cm) filled with red latosol. According to Köppen (1948) climate classification system, the Jaboticabal-SP region can be described as Cwa with a dry season from April to September and a wet from October to May.

Chemical soil characteristics (Table 1) were determined according to Brazilian procedures (EMBRAPA, 1997). We determined pH, organic matter (OM), P, K, Ca, Mg, H + Al, base saturation (BS = K + Ca + Mg), cation exchange capacity (CEC = K + Ca + Mg + H + Al) and fertility rate [V% = 100(K + Ca + Mg)CEC^{-1}]. Based on the chemical soil analysis, we performed the correction of soil fertility before sowing the plants (Van Raij et al., 1997). Topdressing was done 20 days after sowing (DAS).

Experimental design

A randomized complete block design with four replicates was used for this experiment. We performed the evaluations at 15, 30 and 45 days after the beginning of the competition period between chick-peas and sourgrass. We considered the beginning of competition period immediately after planting the sourgrass seedlings together with the chick-peas crop.

Plant samples

The seeds of sourgrass were sown in trays with horticultural substrate Plantimax HT®. Thirty days after the emergence of the sourgrass seedlings, two seeds of chick-peas were sown in the center of each box along with the transplanting of seedlings of sourgrass, when they were approximately 3 to 4 cm shoot long. The seedlings of sourgrass were planted into seven densities (threshold) per box, being the treatment C used as a control group (C, T1, T2, T3, T4, T5, T6 corresponding to 0, 4, 8, 16, 32, 64 and 128 sourgrass plants m^{-2} respectively). When the seedlings of chick-peas reached about 7 cm shoot long was performed, the thinning to one plant of chick-peas per box. Daily, the plants were wet according to necessity.

At 15 and 30 DAS after the beginning of competition period, we evaluated the chick-peas height, stem diameter, number of leaves and offshoots. Forty-five days after the competition period started, we evaluated the same parameters at 15 and 30 DAS plus chick-peas leaf area and dry mass. The biometric evaluations were done by a graduate scale and the leaf area was measured with a Li-cor LI-3000A leaf area mater. The chick-peas plants were dried in an oven (60°C) up to constant mass for dry mass determination.

Statistical analysis

For all parameters evaluated among 15 and 45 DAS, we performed the one-way ANOVA comparing the averages by Tukey test at 5%.

RESULTS

The competition between chick-peas and sourgrass interfered negatively at the development of chick-peas. At 15 DAS, we observed significant reduction on chick-peas height, 16.8% for T5 and 15.2% for T6 treatments in relation to C, which grew up weed free. This interference was clearer from 30 to 45 DAS, when we observed several reductions on chick-peas height from T3 to T6 (Figure 1). At 30 DAS, we observed reductions between 21.6 and 25.8% and at 45 DAS the reductions were between 21.2 to 22.7%.

We also observed several interferences at the development of chick-peas stem diameter. At 15 DAS, all treatments (from T1 to T6) differed significantly in relation to control group C, reducing the diameter of stems from 17.1 to 22.5%. Indeed, we observed this interference reduced from 30 to 45 DAS, being more expressive in T2 for 30 DAS and T3 for 45 DAS (Figure 2). For 30 DAS, we observed reductions in the order of 11.7 and 25.9% and at 45 DAS we observed reductions between 25.2 and 28.0%.

Table 1. Macronutrient contents and fertility parameters, Jaboticabal – SP, Brazil.

pH	OM	P	K	Ca	Mg	H+AL	BS	CEC	V
$CaCl_2$	g dm^{-3}	mg dm^{-3}			mMol$_c$ dm^{-3}				%
5.2	12.0	35.0	1.7	19.0	8.0	25.0	28.7	53.7	53.0

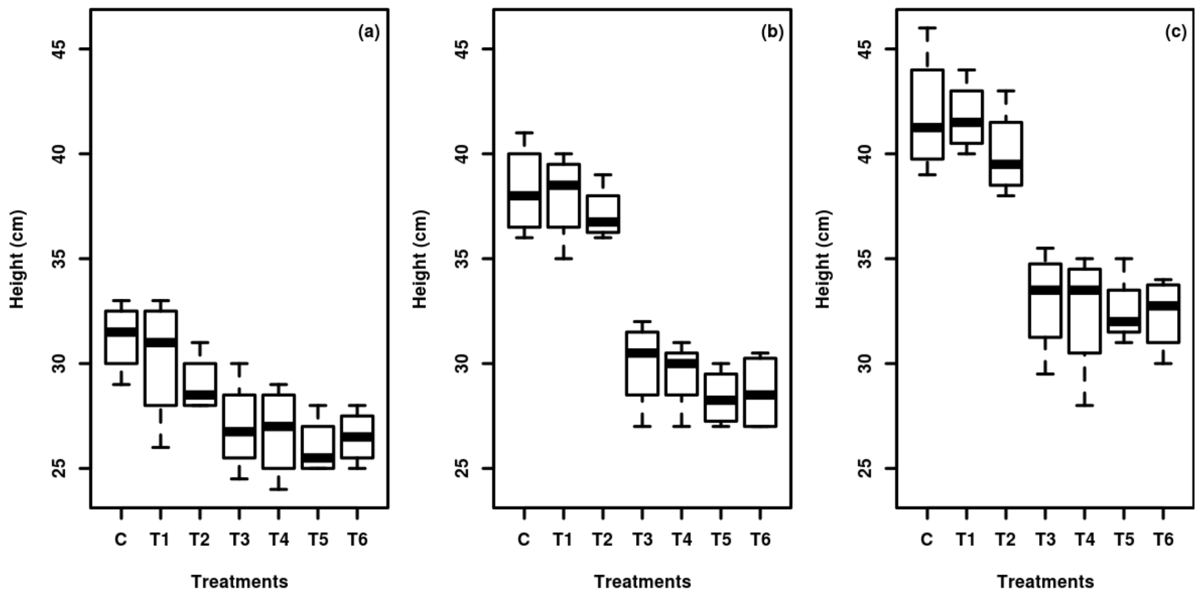

Figure 1. Boxplot of sourgrass plant densities effects on chickpeas height at 15 (a), 30 (b) and 45 (c) days after sowing. The line in the middle of each box indicates the 50th percentile of the observed distribution data; the pot and bottom parts of each box represent the 25th and 75th percentiles of the observed distribution data, respectively; the bottom and top error bars of each box are the 5th and the 95th percentiles of the observed distribution data.

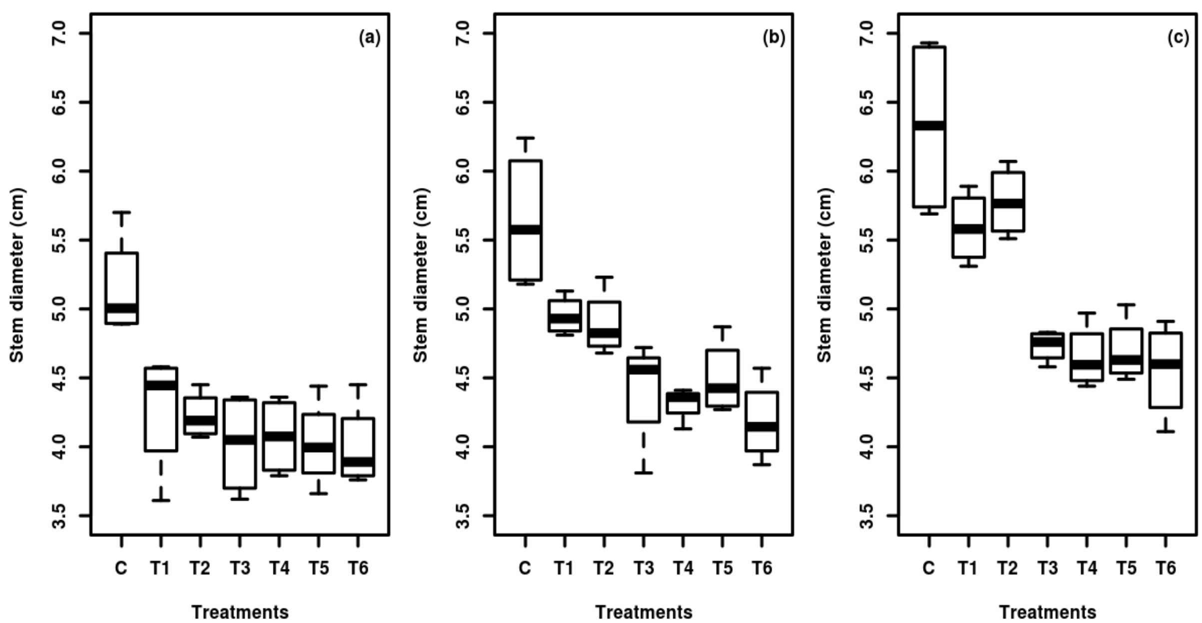

Figure 2. Boxplot of sourgrass plant densities effects on chickpeas stem diameter at 15 (a), 30 (b) and 45 (c) days after sowing. Boxplot characteristics are as described in Figure 1.

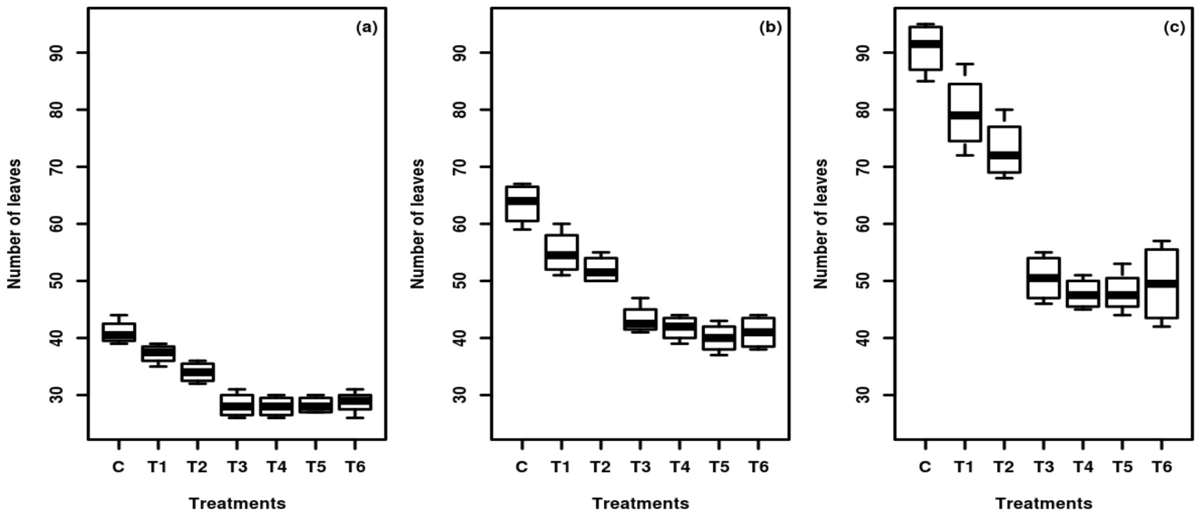

Figure 3. Boxplot of sourgrass plant densities effects on chickpeas number of leaves at 15 (a), 30 (b) and 45 (c) days after sowing. Boxplot characteristics are as described in Figure 1.

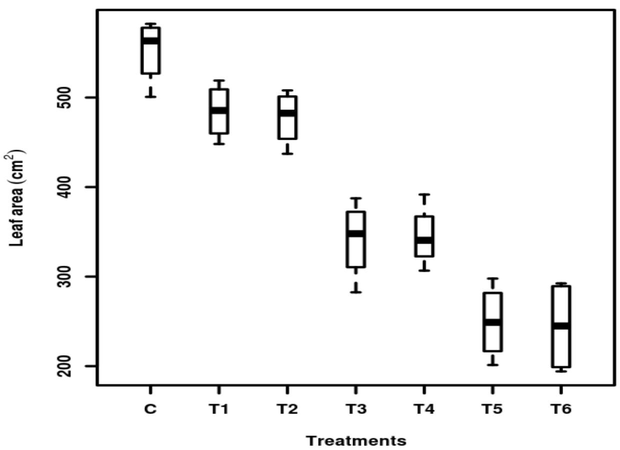

Figure 4. Boxplot of sourgrass plant densities effects on chickpeas leaf area 45 days after sowing. Boxplot characteristics are as described in Figure 1.

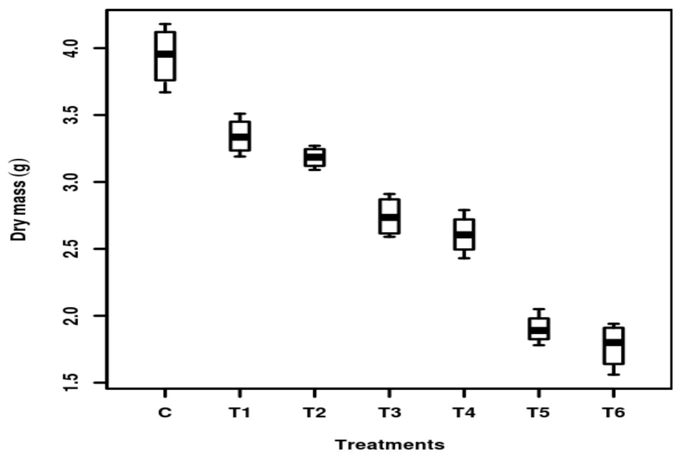

Figure 5. Boxplot of sourgrass plant densities effects on chickpeas dry mass 45 days after sowing. Boxplot characteristics are as described in Figure 1.

We observed a small interference at the number of leaves at T2 and T3 (between 17.0 and 19.6% from 15 DAS to 45 DAS respectively) in relation to C, and an aggressive interference caused by T3, T4, T5 and T6 (Figure 3). At 15 DAS, the number of leaves was reduced between 29.9 and 31.7%; for 30 DAS, the reduction was among 31.9 to 37.0% and for 45 DAS the reduction was from 44.4 to 47.7% respectively. The number of offshoots was not affected by the competition between chick-peas and sourgrass (data not shown). The leaf area of chick-peas suffered different levels of interference, being possible to observe three different levels in relation to C: no interference for the treatments T1 and T2, intermediate for T3 and T4 (38.0% of reduction) and high interference for T5 and T6 (55.0% of reduction) (Figure 4). Similar interference could be observed for dry mass when we observed low interference for T1 and T2 (from 16.0 to 19.0% of reduction), intermediate for T3 and T4 (from 30.0 to 39.0% of reduction) and high interference for T5 and T6 (from 52.0 to 55.0% of reduction) (Figure 5).

DISCUSSION

Agricultural producers cannot tolerate excessive yield losses from weeds, being weed control necessary when the costs of control are smaller than the losses caused by competition (Oliver, 1988). To determine the relation costs/losses it does necessary a have a better understand about the thresholds of weeds on the culture. The increase in weeds density in an agricultural system can affect the quantity and quality of available resources for crops, affecting their development (Ballare and Casal, 2000).

It is easy to find several papers talking about sourgrass chemical control (Melo et al., 2012; Correia et al., 2010) and sourgrass glyphosate resistance (Carvalho et al., 2012, 2011), but we lack information about the interferences caused by this weed on crop development and crop losses caused by the competition between sourgrass and crops. In our study we clearly observed that high densities of sourgrass interfered negatively at the initial development of chick-peas reducing the height, stem diameter, leaf area and dry mass. Reductions caused by weeds on crop leaf area represent the competitive ability of the weeds (Procópio et al., 2004) and the interferences caused competition between weeds and crops reflect the weed aggressiveness (Silva et al., 2009). This interference acts on the CO_2 balance reducing photosynthesis, development and dry mass accumulation. In this job we observed several reductions on chick-peas dry mass accumulation and leaf area mainly for the treatments with high thresholds, suggesting that chick-peas plants can compete, without suffering severe damages, just in small infestations of sourgrass.

These observations make sense because, as observed for other crops, sourgrass plants have low capacity of interference in low densities due to its slow initial growth (Machado et al., 2006). Not only high densities of sourgrass can interfere on chick-peas development. Whish et al. (2002) observed that increasing densities of *Avena sterilis* and *Rapistrum rugosum* reduced the chick-peas production. So as observed for *A. sterilis* and *R. rugosun*, high infestations of sourgrass can be responsible for losses in chick-peas production, affecting its dry mass accumulation and leaf area, reducing the grains production.

The interference of weeds at the initial crop development could reduce the grain yield, stressing the culture and causing morpho-physiological changes (Lamego et al., 2005). Considering we are interested at the development of agricultural technologies to produce chick-peas in Brazil, the knowledge of weed threshold levels is essential for efficient herbicide use (Van Heemst, 1985) reducing environmental pollution and yield loses.

Conclusions

We conclude that chick-peas crop is sensitive to sourgrass competition threshold. Based on our results we observed tolerable interference up to 8 plants m^{-2} and severe interference since 16 plants m^{-2}, justifying a weed control to avoid yield losses. Nonetheless, sourgrass is not the only potential weed that can interfere on chick-peas crops in São Paulo state, being necessary to enlarge this study for more potential weeds.

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