Australian Journal of
Crop Science

AJCS

AJCS 10(9):1244-1248 (2016) ISSN:1835-2707
DOI: 10.21475/ajcs.2016.10.09.p7624

Influence of different cover crops on the emergence and development of *Digitaria horizontalis*

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Abstract

The physical and / or allelopathic effects caused by cover crops residue can be used to suppress the emergence and / or reduce weed growth. Based on the effects of mulch on soil surface, the objective of this study was to evaluate the influence of cover crops biomass at different residue amount levels in the emergence and development of *Digitaria horizontalis*. The experiment was carried out in a greenhouse from May to August, 2014, in a completely randomized design with four replications in (5 × 4) + 1 a factorial scheme, consisting of 5 cover crop species (millet cv. ADR 300 (*Pennisetum glaucum*), braquiaria (*Urochola brizantha*), sorghum (*Sorghum bicolor*), cowpea (*Vigna unguiculata*) and *Crotalaria ocroleuca*) and four levels of dry mass of the corresponding plant (3, 6, 9 and 12 t ha^{-1}) on soil surface, with another treatment without cover crop (0 t ha^{-1}). The analyzed variables were the number of emerged plants, shoot dry mass, leaf area, root dry mass and root volume. Cover crops have proven potential to reduce D. *horizontalis* in all vegetative stages. The species *C. ochroleuca* and *U. Brizantha* showed a greater efficiency in reducing the number of emerged plants with a reduction of 86% and 91%, respectively. Amounts between 3 and 6 t ha^{-1} of cover crops dry mass have been sufficient to promote significant reduction in emergence and growth of *Digitaria horizontalis.*

Keywords: plant cover, allelopathy, culture management.
Abbreviations: N-P_2O_5-K_2O_ Fertilizer; NEP_Number of emerged plants; LA_Leaf area; SDM_Shoot dry mass; RV_Root volume; RDM_Root dry mass (RDM).

Introduction

The presence of weeds in crops is one of the major challenges for agriculture development, responsible for reductions between 30 % and 40 % in the global agricultural production (Adegas et al., 2010). Among the species of greatest economic importance, stands out *Digitaria horizontalis* for being highly aggressive as weed, being reported as problematic in 60 countries, infecting more than 30 economically important crops (Dias et al., 2007).

The species of the genus *Digitaria*, besides being host of pests and diseases, establish a competitive relationship with the economic crops boosted by environmental factors (Gomes et al., 2014). These species are particularly skilled in the process of competition for water, light and nutrients, causing damage to crops under drought conditions, besides having allelopathic effects on various crop plants (Dias et al., 2007). Another aspect reported by the competition is hampering the harvesting operation, damaging grain or seed quality (Embrapa, 2010).

Through aggressiveness and difficulty of management, the suppression of weeds in agricultural systems has been sustained by the use of herbicides (Pacheco et al., 2013). However, these weeds, via an evolutionary phenomenon, may develop herbicide resistance (Rizzardi et al., 2008). This resistance is acquired and some biotypes of the same specie have the heritable capability to survive and reproduce after exposure to an herbicide dose (Carvalho, 2004). The inefficiency of herbicide action on the resistant biotypes has been decreasing the alternatives to carry out the resistant weed chemical control.

Analyzing this context, the use of techniques that can be added to the integrated management is critical to minimize the chemical negative effects on the environment and reduce the selection pressure caused by the intensive use of the same active substance. In this context, management alternatives as cultural methods, with biomass presence on soil surface has potential to assist the integrated management of weeds

(Moraes et al., 2011), via physical, chemical-allelopathy and microbiological processes (Pacheco et al., 2009; Pergo et al., 2008).

The physical effect of mulch by the interception of solar radiation (Pacheco et al., 2013), contributes to soil shading, inhibiting seed germination and infestation of some weeds, enabling culture to start its development with lower initial competition (Queiroz et al., 2010). The allelochemicals derived from the decomposition of plant residues or roots exudation (Theisen et al., 2000), exert a deleterious effect on seeds germination or interfere at some development processes, so growth is slowed or stalled (Pacheco et al., 2013). The response of the use of soil cover on weed germination depends on the amount and distribution of residues, in addition to its allelopathic potential (Chauhan et al., 2012).

The use of cover crops has been studied for the purpose of being a complementary alternative to traditional methods of weed control. Thus, the adoption of more sustainable agricultural management practices and lower costs may become dominant. Thus, the objective of this study was to evaluate the potential of cover crops in different levels of biomass on the soil surface to inhibit the emergence and growth of *Digitaria horizontalis* plants under greenhouse conditions.

Results and Discussion

Seedling emergence of D. Horizontalis

To evaluate *D. horizontalis* number of emerged plants, a signifficative ($P<0.01$) interaction was observed between cover crops and residue amount (Table 1). Between the cover crops tested, *C. ochroleuca* and *U. brizantha* presented higher reductions for these variables for initial residue amounts (Table 2). These results can be explained by the physical barrier promoted by the residue on the soil (Pacheco et al., 2013) and the light quality necessary to stimulate germination (Theisen et al., 2000). In studies realized by Monqueiro et al. (2009), it was suggested that the physical barrier promoted by the residue interferes in germination and in the survival rate of some weed species. Kumar et al. (2009) observed allelopathic activity of buckwheat (*Fogopyrum esculentum*) root system in pigweed (*Amaranthus powellii*) growth and emergence. The cover crops presented decreasing exponential behavior for *D. horizontalis* NEP variable (Figure 1A). The results demonstrated that the level of 3 t ha^{-1} of *C. ochroleuca* and *U. brizantha* residue can promote the reduction of 86% and 91% of emerged plants, respectively, when compared to control (0 t ha^{-1} residue). However, after the application of 6 t ha^{-1} the other cover crops (*P. Glaucum*, *C. ochroleuca*, *S. bicolor* and *V. unguiculata*) provided NPE reductions above 70%. Besides the influence of the cover provided by the *U. brizantha* phytomass, these results can be explained by the allelochemical release during biomass decomposition (Alvarenga et al., 2001). Gimenes et al. (2011), analysing the *U. Decumbens* effect on weed infestation verified that the plant was able to reduce from 30 to 2 plants m^{-2} of *Cenchrus echinatus*, when compared to control.

Shoot development of D. horizontalis

Evaluating *D. horizontalis* leaf area (LA) and shoot dry mass (SDM), no significant interaction ($P>0.05$) among cover crops and residue amount (Table 1) was observed. For SDM reduction, cover crops did not differed significantly. For LA, the lowest means were observed in pots seeded with *C. ochroleuca*, *S. bicolor* and *U. brizantha* residues (Table 1). These results can be explained by the fact that cover crops can provide a higher exponential decrease on the number of emerged plants. Thus, the shoot dry mass reduction implies in less competition of weeds with plants with economical potential, demonstrating the importance of using cover crops as a strategy of integrated management of weed plants in a tillage system (Pacheco et al., 2013).

Promising results were founded by Moraes et al. (2010), showing a significant reduction of *Bidens pilosa* LA and SDM with the use of 4 t ha^{-1} of Azevém (*Lolium multiflorium*) phytomass on soil surface. Studies using aqueous extracts of clover Persian (*Trifolium resupinatum*) and clover Alexandrian (*Trifolium alexandrium*) aerial parts, showed height and shoot mass inhibition of bell (*Convolvulus arvensis*), mustard fields (*Sinapasis arvensis*) and pigweed (*Amaranthus retroflexus*) (Maighany et al., 2007).

The cover crops presented decreasing exponential behavior for the variables LA and SDM for *D. horizontalis* (Figure 1), with more reductions of these variables for initial amounts of residue on soil surface, Thus, higher reductions were observed for SDM when the amount of 6 t ha^{-1}of residue was used, reducing 82.82%, when compared to control (0 t ha^{-1}) (Figure 1B). For the LA variable, the highest reductions were observed when the amount of residue of 6 t ha^{-1} was used, with reductions above 80%, when compared to control (residue amount of 0 t ha^{-1}) (Figure 1C). Gimenes et al. (2011) showed that 10 t ha^{-1} of residue provided by *Brachiaria decumbens* after 60 days of emergency reduced more than 80% the *D. horizontalis* and *C. echinatus* weeds leaf area. Pacheco et al. (2013) also observed effective results with the use of 4 t ha^{-1} of *U. ruziziensis* on soil surface with the reduction of *B. pilosa* LA and SDM in 71.24% and 76.66 %, respectively.

D. horizontalis root development

For *D. horizontalis* root dry mass (RDM) and root volume (RV), a significant interaction was observed ($P<0.01$) between cover crops and residue amount only for RDM, but the RV was influenced by the factors separately, without interaction (Table 1). The cover crops presented potential to reduce *D. horizontalis* plants root system, with *S. bicolor* and *U. brizantha* presenting higher reductions of RDM, mainly for the initial amounts of residue studied (Table 2 and Figure 2A).

For RV, even with no difference for the studied cover crops, all species were efficient to reduce this variable (Table 1). The reduction of *D. Horizontalis* root system could be explained by the exponential reduction of number of emerged plants provided by the cover plants on soil surface (Figure 1). Thus, the *D. horizontalis* root system lower development observed in this study results in less competitive plants by the reduction of water and nutrients capacity (Pacheco et al., 2013).

Cover crops presented decreasing exponential reduction for *D. horizontalis* RDM and RV and the amount of 3 t ha^{-1} of *S. bicolor* and *U. Brizantha* residue provided RDM reductions above 85% and 75%, respectively, when compared to control (residue amount of 0 t ha^{-1}) (Figure 2A). For RV, all cover crops with the residue amount of 6 t ha^{-1} presented more than 77% of reduction for this variable, when compared to control (residue amount of 0 t ha^{-1}) (Figure 2B). Pacheco et al. (2013) studying cover crops on *B. pilosa* control verified a reduction of more than 50% of the specie

Table 1. Variance analysis (F values) and means for *D. horizontalis* variables according to studied cover crop and residue amount.

Source/ Variation	NEP	LA	SDM	RDM	RV
Cover crops (CC)	2.99**	253922.63**	22.12^{ns}	1.37^{ns}	29.87^{ns}
P. glaucum ADR 300	2.86 a	403.42 a	5.58 a	1.28 a	6.18 a
C. ochroleuca	2.13 b	158.48 b	3.90 a	0.71 a	3.32 a
S. bicolor	2.73 a	196.39 b	3.55 a	0.69 a	3.79 a
U. brizantha	2.00 b	247.49 ab	3.94 a	0.66 a	3.49 a
V. unguiculata	2.66 a	392.86 a	5.80 a	0.95 a	5.05 a
Residue amount (RA)	178.68**	1286985.94**	556.58**	20.97**	435.41**
CC x RA	1.59**	54301.17^{ns}	10.13^{ns}	0.31**	8.46^{ns}
CV (%)	23.12	27.50	24.38	23.93	26.90

**significant at 1%; ^{ns}not significant. CV – coefficient of variation. Means followed by the same letter in column are not different according to Tukey´s test at 5% of probability. NEP - number of emerged plants, LA - leaf area, SDM - shoot dry mass, RDM - root dry mass, RV - root volume.

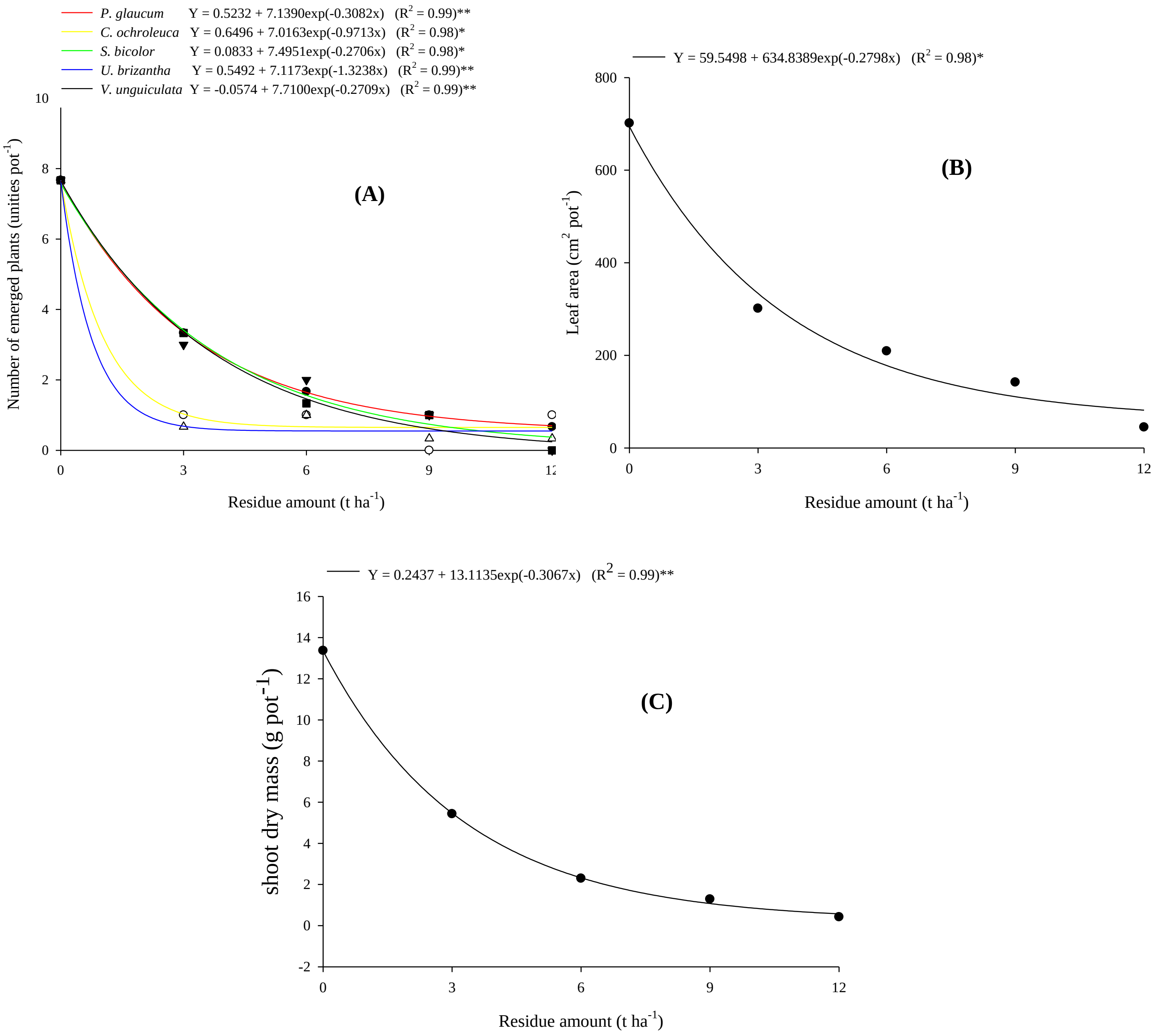

Fig 1. Number of emerged plants (A), leaf area (B) and shoot dry mass (C) of *D. horizontalis* according to cover crops residue amount. ** significant at 1%; * significant at 5%.

Table 2. Significant interactions for *D. horizontalis* number of emerged plants and root dry mass.

Cover crops	Residue amount (t ha^{-1})				
	0	3	6	9	12
	Number of emerged plants (unities pot^{-1})				
P. glaucum ADR 300	7.66 a	3.33 a	1.66 a	1.00 a	0.66 a
C. ochroleuca	7.66 a	1.00 b	1.00 a	0.00 a	1.00 a
S. bicolor	7.66 a	3.00 a	2.00 a	1.00 a	0.00 a
U. brizantha	7.66 a	0.66 b	1.00 a	0.33 a	0.33 a
V. unguiculata	7.66 a	3.33 a	1.33 a	1.00 a	0.00 a
	Root dry mass (g pot^{-1})				
P. glaucum ADR 300	2.61 a	1.84 a	0.98 a	0.57 a	0.40 a
C. ochroleuca	2.61 a	0.85 ab	0.08 a	0.00 a	0.00 a
S. bicolor	2.61 a	0.34 ab	0.36 a	0.18 a	0.00 a
U. brizantha	2.61 a	0.22 b	0.32 a	0.15 a	0.00 a
V. unguiculata	2.61 a	1.30 ab	0.40 a	0.47 a	0.00 a

Means followed by the same letter in column are not different according to Tukey´s test at 5% of probability.

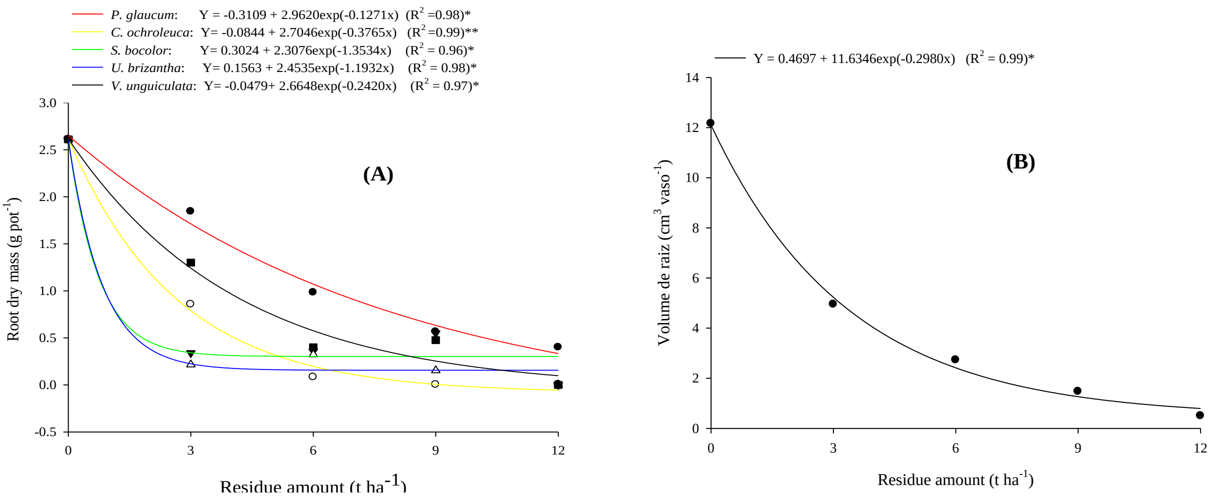

Fig 2. *D. horizontalis* root dry mass (A) and root volume (B) according to cover crops residue amount. ** significant at 1%; * significant at 5%.

root system when the residue amount of 4 t ha^{-1} of *U. ruziziensis* was used. Moraes et al. (2010) observed reduction of RDM of *B. pilosa* when *Trifolium visiculosum* was used as a cover crop, when the residue amount of 6 t ha^{-1} on soil surface was used.

Materials and Methods

Location and characterization of the experimental area

The experiment was carried in a greenhouse from May to August, 2014, at the Campus Professora Cinobelina Elvas of the Federal University of Piauí, located in Bom Jesus (Latitude 9^{o}16 '78"S, Longitude 44^{o} 44' 25"W and altitude of 300 meters) in the state of Piaui, Brazil.

Experiment establishment and management

The experiment was carried out in a completely randomized design block with four replications in a (5x4)+1 factorial scheme, consisting 5 cover crops(millet cv. ADR300 (*Pennisetum glaucum*), braquiaria (*Urochola brizantha*), sorghum (*Sorghum bicolor*), cowpea (*Vigna unguiculata*) and *Crotalaria ocroleuca*), with four levels of dry mass of the corresponding plant (3, 6, 9 and 12 t ha^{-1}) on soil surface, and another treatment without the use of cover plants (0 t ha^{-1}), making a total of 84 experimental units.

The experimental units were composed by pots with 8 dm^{3} of soil 35 cm of diameter, being samples taken from the layer of 40-60 cm of a Dystrophic Yellow Latosol were used as substrate. This depth was adopted to avoid existing weed seeds in the upper layers. The soil was fixed with dolomitic limestone to reach the base saturation of 50% and fertilized with N-P_2O_5-K_2O (10:20:20) at a dose of 0.4 g dm^{-3} of soil, which corresponds to 800 kg ha^{-1}. Twenty-five seeds of *D. Horizontalis* weed were randomly sown per pot and covered with a soil layer with the thickness of 1.0 cm. Then, the fresh plant cover was incorporated and part of it was added upon the soil surface in amounts corresponding to each treatment. The plant material was harvest and fractionated at the same day of the experiment to avoid allelochemicals loss.

To obtain the biomass, cover crop seeds were sown by hand and in 5 m² beds and their shoot parts were collected during the reproductive stage (beginning of the flowering stage ± 60 days), considering the crop cycle. The fresh plant residues were divided into sections of about 2 to 3 cm, with the weight fixed by dry basis reference (placed in the oven at

60 °C for 72 hours until constant weight). The fresh material was calculated to obtain the desired amount of dry matter per hectare, and was subsequently incorporated on the soil surface (pot), according to the treatment. The irrigation was performed daily to maintain the pots in 80% of the field capacity (FC). Soil moisture control was determined as follows: a) the pot weight at FC was measured according to Bonfim-Silva et al. (2011), where the pots were saturated and drained for 12 hours, when the weight was measured. Then, with the FC value, the appropriate moisture condition of 80% of FC was calculated and used.

Variables determined

The variables were: number of emerged plants (NEP), leaf area (LA), shoot dry mass (SDM), root volume (RV) and root dry mass (RDM). The NEP was determined by counting the total number of plants in each experimental unit at the end of the experiment. The leaf area (LA) was obtained when most of the weeds achieved the pre-flowering stage with the use of LI-3100 area meter (LI-COR, Inc. Lincoln, NE, USA), when the leaf were separated from the stem for the measure, expressed in cm^2 pot^{-1}. Besides that, the root were separated from the shoot, washed with water and removed from the soil to obtain root volume, expressed in cm^3 pot^{-1}, using the graduated cylinder method (Basso, 1999). For dry mass data, the shoot and root were submitted to oven dry at 65 ºC until constant weight.

Statistical analysis

Data were submitted to variance analysis (F test, p<0,05) and when significant, the qualitative data were submitted to Tukey´s test at 5% of probability with Assistat 7.7 software. The quantitative treatments were adjusted with regression equations, with Sigma Plot software 10.1.

Conclusion

All cover crops showed potential to control the emergence and development of *D. horizontalis* when the residue amount from 3 t ha^{-1} was used. *U. brizantha* provides more efficiency in reducing weed emergence and development.

References

Adegas FS, Gazziero DLP, Voll E, Osipe R (2010) Diagnóstico da existência de *Digitaria insularis* resistente ao herbicida glyphosate no sul do brasil. Paper presented at the XXVII Congresso Brasileiro da ciência das plantas daninhas, Ribeirão Preto, SP, Brasil, 21-27 August 2010.

Alvarenga RC, Cabezas WAL, Cruz JC, Santana DP (2001) Plantas de cobertura de solo para sistema plantio direto. Rev Inf Agrop. 22(208):25-36.

Basso SMS (1999) Caracterização morfológica e fixação biológica de nitrogênio de espécies de Adesmia DC e Lotus L. 268p. Thesis (Doctorate) - Federal University of Rio Grande do Sul, Porto Alegre, Brazil.

Bomfim-Silva EM, Silva TJA, Cabral CEA, Kroth BE, Rezende D (2011) Initial development of grasses under water stress. Rev Caat. 24(2):180-186.

Carvalho, JC (2004) Mecanismo de ação dos herbicidas e sua relação com a resistência a herbicidas. In: Christoffoleti, PJ (ed) Aspectos de resistência de plantas daninhas a herbicidas. HRAC-BR, Campinas, São Paulo.

Chauhan BS, Singh RG, Mahajan G (2012) Ecology and management of weeds under conservation agriculture: A review. Crop Prot. 38(1):57-65.

Dias ACR, Carvalho SJP, Nicolai M, Christoffoleti PJ (2007) Problemática da ocorrência de diferentes espécies de capim-colchão (*Digitaria* spp.) na cultura da cana-de-açúcar. Planta Daninha 25:489-499.

Embrapa - Empresa Brasileira de Pesquisa Agropecuária (2010) Tecnologias de produção de soja - Região Central do Brasil - 2009 e 2010. Londrina: Embrapa.

Gimenes MJ, Prado EP, Pogetto MHFAD, Costa SIA (2011) Interferência da *Brachiaria Decumbens Stapf.* sobre plantas daninhas em sistema de consórcio com o milho. Rev Caat. 24(3):215-220.

Gomes DS, Bevilaqua NC, Silva FB, Monquero PA (2014) Supressão de plantas espontâneas pelo uso de cobertura vegetal de crotalária e sorgo. Rev Bras Agroec. 9:206-213.

Kumar V, Brainard DC, Bellinder RR (2009) Supression of Powell amaranth (*Amaranthus powellii*) by buckwheat residues: role of allelopathy. Weed Sci. 57(2):66-73.

Maighany F, Khalghani J, Mohammad AB, Najafpour M (2007) Allelopathic potential of *trifolium resupinatum* L. (Persian clover) and *Trifolium alexandrium* L. (Berseem clover). Weed Biol Manag. (3):178-183.

Monqueiro PA, Amaral LR, Inácio EM, Brunhara JP, Binha DP, Silva PV, Silva AC (2009) Efeito de adubos verdes na supressão de espécies de plantas daninhas. Planta Daninha 27:85-95.

Moraes PVD, Agostinetto D, Panozzo LE, Brandolt RR, Tironi SP, Oliveira C, Markus C (2010) Efeito alelopático de plantas de cobertura, na superfície ou incorporadas ao solo, no controle de picão-preto. Rev da FZVA 17(1):51-67.

Moraes PVD, Agostinetto D, Panozzo LE, Oliveira C, Silva JMBV, Silva RO (2011) Manejo de culturas de cobertura com potencial alelopático sobre o crescimento inicial de *Digitaria* spp. Rev Bras Cienc Agrar. 6(2):300-308.

Pacheco LP, Monteiro MMS, Petter FA, Neto FA, Almeida FA (2013) Plantas de cobertura no desenvolvimento de picão-preto. Pesq Agrop Trop. 43(2):170-177.

Pacheco LP, Pires FR, Monteiro FP, Procópio SO, Assis RL, Cargnelutti Filho A, Carmo MLE, Petter FA (2009) Sobressemeadura da soja como técnica para supressão da emergência de plantas daninhas. Planta Daninha 27(3):455-463.

Pergo EN, Abrahim D, Soares SPC, Kern KA, Silva LJ, Voll E, Ishiiiwamoto EL (2008) *Bidens pilosa* L. exhibits high sensitivity to coumarin in comparison with three other weed species. J Chem Ecol. 34(4):499-507.

Queiroz LR, Galvão JCC, Cruz JC, Oliveira MF, Tardin FD (2010) Supressão de plantas daninhas e produção de milho-verde orgânico em sistema de plantio direto. Planta Daninha 28(2):263-270.

Rizzardi MA, Neves R, Lamb TD, Johann LB (2008) Potencial alelopático da cultura da canola (*Brassica napus* L. var. oleifera) na supressão de picão-preto (*Bidens* sp.) e soja. Rev Bras de Agroc**.** 14(2):239-248.

Theisen G, Vidal RA, Fleck NG (2000) Redução da infestação de *Brachiaria plantaginea* em soja pela cobertura do solo com palha de aveia-preta. Pesq Agrop Bras. 35:753-756.