MANAGEMENTS OF *Ipomoea triloba* IN COMPETITION WITH MAIZE IN ORGANIC SYSTEM

Ana Ligia Geraldeli[1], Anastácia Fontanetti[2], Patrícia Andrea Monquero[2]

[1]São Paulo University – Esalq. PhD in Phytotechnology. E-mail: analigia_giraldeli@hotmail.com
[2]Federal University of São Carlos-Campus Araras. Professor at Federal University of São Carlos. E-mail: anastacia@cca.ufscar.br; pamonque@hotmail.com

ABSTRACT

One of the biggest obstacles to organic maize cultivation is weed management. The aim of this work was to evaluate the mowing and weeding in the control of densities of *Ipomoea triloba* (morning glory) in competition with maize. The experiment was installed in a completely randomized design, with four replications, in the factorial scheme 3 x 3 + 1. The first factor was constituted by three densities of the species *I. triloba* and the second by three weed management. The additional treatment consisted on the cultivation of maize free from *I. triloba* interference. The mowing done in the V4 stage of maize did not minimize the competition of *I. triloba*. Weeding was more efficient for control at higher densities. *I. tribola* showed regrowth and despite accumulating reduced dry mass, it was more efficient in the uptake of N, P, K, and Mg in relation to the uncropped plants.

Keywords: Convolvulaceae, corda-de-viola, nutrition, mowing

MANEJOS DA *Ipomoea triloba* EM COMPETIÇÃO COM MILHO EM SISTEMA ORGÂNICO

RESUMO

Um dos maiores obstáculos para o cultivo do milho em sistema orgânico é o manejo das plantas daninhas. Objetivou-se com o trabalho avaliar a roçada e capina no controle de densidades de *Ipomoea triloba* (corda-de-viola) em competição com o milho. O experimento foi instalado em delineamento inteiramente casualizado, com quatro repetições, no esquema fatorial 3 x 3 + 1. O primeiro fator foi constituído por três densidades da espécie *I. triloba* e o segundo por três manejos da espécie daninha. O tratamento adicional consistiu no cultivo do milho livre da interferência da *I. triloba*. A roçada realizada no estádio V4 do milho não minimizou a competição da *I. triloba*. A capina foi mais eficiente para o controle em maiores densidades. *I. tribola* apresentou rebrota e apesar de acumular reduzida massa seca, foi mais eficiente na absorção de N, P, K e Mg em relação as plantas não roçadas.

Palavras-chave: Convolvulaceae, corda-de-viola, nutrição, roçada

INTRODUCTION

Maize is grown in practically all regions of Brazil with a planted area of almost 17,591.7 thousand hectares in the 2016/2017 harvest. Its production increases every year, but the average yield in the country is still low, about 5,562 kg ha^{-1}, even involving highly skilled producers that reach yield of the order of 9,340 kg ha^{-1} (CONAB, 2018).

In the process of transition from the conventional system to the organic one of maize production, one of the main difficulties is in the control of weeds. In general, chemical control methods are replaced by manuals combined with mechanics, including mowing (DAROLT & SKORA NETO, 2002).

In this study, the use of a weed control system in the field of no-tillage system was carried out in order to establish weed species that showed regrowth and / or vegetative propagation, such as *Bidens pilosa*, making it difficult to manage maize (VAZ DE MELO et al., 2007).

The weeds respond according to Chiovato et al. (2007), unlike the adopted management. The authors found that for *B. pilosa*, the mowing in the V4 and V8 stages of maize, were not efficient to minimize competition, as for *Urochloa plantaginea*, the increase of the population density of the species reduced the leaf dry mass and the stem diameter of the plants regardless of whether the management adopted is weeding or mowing.

In addition to competition for water and light, the reduction of yield can occur due to the difference in nutrient absorption efficiency. Studying weeds in coexistence with maize, different managements fertility, Melo et al. (2015) verified that the *B. pilosa* species extracted and accumulated, on average, higher levels of N, P, K, Ca, S, and Mg.

Guzzo et al. (2010), observed that for *I. hederifolia*, the accumulation of nutrients occurred in the following order: K> N> Ca> Mg> S> P; Showing the importance of studies related to the efficiency of absorption and accumulation of nutrients in weeds and cultivated, to assure the best management, avoiding competition among the species.

Weed control is essential for maize production. Duarte et al. (2002) studied different weed control times according to maize phenological stage and observed that grain weight was not altered when weeding was done until the phenological stage R2.

Among the important weeds in the maize crop, species of the Convolvulaceae family (*Ipomoea* spp. and *Merremia* spp.) (SANTOS et al., 2010; CUGLIERI-CAPORAL et al., 2011; MARTIN et al., 2011). These two genera are particularly undesirable in cereal crops due to the difficulties caused by mechanical harvesting, besides conferring high moisture to the grains (KARAM et al., 2011).

Another aspect to be considered is that morning glory plants are annual species, so all stages of their cycle (germination, development, flowering and seed production) occur within a year, which makes it necessary to control before the production of seeds, preventing their dissemination (MOREIRA & BRAGANÇA, 2011; LORENZI, 2014).

Thus, the mechanical control during the maize crop cycle, especially in the initial stages of development, is necessary so that the interference of this weed does not affect the final production.

Thus, the objective of this work was to evaluate the effect of mowing and weeding on the control of different densities of *I. triloba* (morning glory) in competition with maize, aiming at establishing management for the species in the organic production system.

MATERIAL AND METHODS

The experiment was carried out in experimental pots during the period from October 2012 to March 2013. The design was completely randomized in a 3 x 3 + 1 factorial scheme, with four replications. The first factor was constituted by three densities of the specie *I. triloba*, two, three and five plants per pot, and the second by three weed management, weeding, mowing and uncontrolled. The additional treatment (control) consisted in the cultivation of maize free of *I. triloba* maize interference.

Plastic pot with a volume capacity of 18 dm³ were used. The soil was classified as Red Alicosic Latosol A moderate clayey texture (LE) according to the classification of Embrapa (1999), which was collected at depth of 30 cm in order to minimize possible seeds of other weeds.

The soil chemical analysis showed the following characteristics: pH of 5; 28 g dm^{-3} of MO; 10 mg dm^{-3} of P; 1.2 $mmol_c dm^{-3}$ of K; 16 $mmol^c$ of dm^{-3} Ca; 9 $mmol_c$ of dm^{-3} of Mg; 31 $mmol_c$ dm^{-3} H + Al; 0.6 $mmol_c$ dm^{-3} of Al; 15 mg dm^{-3} of S; 0.41 mg dm^{-3} B; 1.6 mg dm^{-3} Cu; 8 mg dm^{-3} of Fe; 27.2 mg dm^{-3} of Mn; 0.9 mg dm^{-3} Zn; 26.2 mmol dm^{-3} of SB; 57.2 $mmol_c$ dm^{-3} of CTC; 46% base saturation. The soil was sieved and 72 grams of dolomitic limestone (PRNT 95%) was added per pot, 30 days before maize sowing, to raise base saturation from 46% to 60%. 25 g of Biophosphate®, equivalent to 4.3 g of P_2O_5 per pot, was also applied.

The cultivated maize was of the AL-Bandeirante variety, with a semiprecoce cycle (130 to 140 days), medium grain, plant height reaching 2.30 m, mean spike insertion height of 1.25 m and male flowering of 63 to 65 days after the emergency. The weed was sown on the same day as corn sowing. After the emergence of the plants, thinning was performed, maintaining a maize plant and densities of two, three and five plants of *I. triloba* per pot, according to the treatment. Irrigations were done daily in order to maintain soil moisture near 70% of field capacity. The interference period in the same pot between the maize plant and the weed was considered between the emergence of the weeds and the closing of the experiment (50% of the plants with ears in the R2 stage of the maize).

The mowing was performed at the four leafs stage of maize (V4), 35 days after maize emergence (DAE) using a pair of scissors, weeding at 5.0 cm from the soil, simulating the use of the brush cutter. Weeding consisted of total weed withdrawal, at the four leaf stage of maize, 35 DAE, following the methodology proposed by Chiovato et al. (2007).

The height of the maize plants was evaluated in the stages of four (V4) and eight (V8) expanded leaves and when 50% of the maize plants had spikes (R2). A ruler was used and the height of the plants from the stem insertion in the soil to the sheath of the last expanded leaf or to the insertion of the tassel in the R2 stage was measured. The stalk diameter was measured at V8 stage and when 50% of the maize plants were in the R2 stage, the diameter was measured at 10 cm from the soil (2^{nd} expanded internal) with the aid of a caliper.

At the end of the experiment (R2 stage) the maize plants were harvested and separated in leaves, stems and ears. The leaves and stems were packed in paper bags and placed in a forced circulation oven with a temperature of 65 ± 3 °C, until constant weight was obtained. After drying, the plant material was weighed separately (leaves and stems) to determine the dry mass.

Then the maize leaves were processed in a Willer type mill and sent to the soil fertility laboratory and plant nutrition to determine the nutrient contents: N, P, K, Ca, Mg, and S. The foliar analyzes followed the methodology proposed by Nogueira & Souza (2005).

The control rape seedlings, as well as the sprouting plants, were cut close to the soil in the R2 stage of the maize, packed in paper bags and taken to the forced circulation oven, with temperature of 65 ± 3 °C until constant weight was obtained. After drying, the plant material was weighed to determine the dry mass. It was then sent to the laboratory to determine macronutrient contents, following the same methodology mentioned previously for maize plants.

Data were submitted to analysis of variance according to Pimentel-Gomes & Garcia (2002), the means were compared by the Tukey test ($p > 0,05$) and the independent variables by regression analysis. For comparing the management methods with the control, we used contrasts between the means, and the significance established according to the F test ($p > 0,05$).

RESULTS AND DISCUSSION

According to the analysis of variance performed for the factorial density of morning glory x management forms no significant difference was observed for the variables: height of the maize plants in the V4, V8 and R2 stages, leaf dry mass and stem of maize plants, weight of spikes and number of spikes per plant.

However, for the stem diameter of maize, analysis of variance revealed a significant effect for the interaction of morning glory density and management forms in the V8 and R2 stages. For the evaluations carried out in the V8 stage, management methods (weeding, mowing, and uncontrolled) did not interfere with the stem diameter of maize living with two plants of morning glory per vase. However, with the increase of morning glory density, higher stem diameter values were observed in the mowing (3 morning glory plants) and weeding (5 morning glory plants), however, these treatments did not differ from uncontrolled treatment. The V8 stage mowing contributed to the increase of maize stem diameter only when it lived with up to three morning glory for vase plants per pot, at five plants density maize stalk diameter was reduced even after mowing (Table 1). These results suggest that at densities above three morning glory per pot plants, weeding is more efficient in minimizing the effects of morning glory competition with maize.

Table 1. Maize stalk diameter in centimeters at V8 stages (eight expanded leaves) and R2 (bubble grains) as function of the density of morning glory (*I. triloba*) and management methods (weeding, mowing and without control). Araras, São Paulo, Brazil, 2012/2013.

Management	Densities of the *I. triloba*					
	Maize Stadium V8			Maize Stadium R2		
	2	3	5	2	3	5
Weeding	1.50 a B	1.23 b AB	2.00 a A	1.35 a A	1.26 a A	1.80 a A
Mowing	1.58 a AB	2.00 ab A	1.05 b B	1.34 a A	1.45 a A	1.08 b A
Uncontrolled	1.60 a A	1.63 a A	1.35 ab A	1.65 a A	1.65 a A	1.03 b A
V.C. (%)		27.20			28.88	

Means followed by the same letters, lowercase in the column and upper case in the row, do not differ according to the Tukey test at 5% probability.

The maize stalk not only acts as a support for leaves and inflorescences, but mainly as a structure for the storage of soluble solids, which will be used later in grain formation (WINCLER, 2006). Plants subjected to competition stress due to water, light and nutrients tend to have stems with smaller diameter and short internodes with little accumulation of photoassimilates, resulting in a decrease in yield.

Regarding the stem diameter evaluated at the R2 stage at 81 days after emergence (DAE) of maize, a significant difference was observed only for the density of five morning glory plants per pot; weeding provided the greater stem diameter of maize, differing from mowing and treatment uncontrolled (Table 1). Corroborating with the results observed in the V8 stage, that is, in higher morning glory densities, the most efficient management is weeding.

Concerning maize leaf nutrient contents in competition with *I. triloba*, the analysis of variance revealed a significant effect of the interaction forms of management x morning glory density only for the nutrients nitrogen and phosphorus.

The leaf N content of maize was reduced when it coexisted with five plants of morning glory during the whole cycle. There was no difference between management, weeding and mowing, for the N contents in the maize leaves (Table 2). Carvalho et al. (2014), verified that plants of *I. hederifolia* in coexistence with maize plants, besides causing disorders during the mechanical harvesting, can cause reduction in the growth and accumulation of macronutrients by maize plants, among them, nitrogen, which was the nutrient accumulated in *I. hederifolia* plants. This is in agreement with this work, where at higher weed densities there was a reduction in nitrogen accumulated in maize leaves.

Table 2. Nitrogen and leaf phosphorus content of maize (percentage) as a function of the density of *I. triloba* and of the management (mowing, weeding and uncontrolled weed) at the four leafs stage of maize. Araras, São Paulo, Brazil, 2012/2013.

Management	Densities					
	Nitrogen			Phosphorus		
	2	3	5	2	3	5
Mowing	1.65 a	1.86 a	2.02 a	0.23 b	0.36 a	0.37 a
Weeding	1.61 a	2.41 a	2.17 a	0.35 a	0.29 a	0.31 ab
Uncontrolled	2.07 a	2.52 a	0.88 b	0.36 a	0.34 a	0.27 b
V.C. (%)	28.73			16.76		

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

Silva et al. (2015), studying the maize consortium with brachiaria (*U. brizantha*), verified that nitrogen content in maize leaves was only reduced to population densities above 22 brachiaria m^{-2} plants, indicating that some weeds are more competitive when in higher plant densities. For *I. triloba*, in the present work, there was a reduction of nitrogen in maize leaves when the culture lived with 5 plants per pot.

The mowing and weeding provided the highest levels of P in maize leaves when living with five morning glory plants per pot, but the weeding treatment did not differ from that uncontrolled (Table 2).

Several studies report negative effects of weeds when competing for P with cultivated plants. Ponce et al. (1996) observed that the uptake of P by tomato plants dropped from 1.37 to 0.90 g $plant^{-1}$ of P when they were submitted to competition with *Solanum nigrum*. Galon et al. (2012), observed that sugarcane plants in competition with *U. brizantha*, had the phosphorus levels reduced with the population increase of the weed.

Pereira et al. (2012) verified different responses regarding phosphorus, when studied cassava, *B. pilosa* and *Brachiaria decumbens,* weeds grew better at lower doses of phosphorus, being more competitive than cassava in areas with phosphate fertilization.

This demonstrates that control methods are necessary so that there is no phosphorus competition between the crop and the weed. In the case of the present study, when the mowing and the weeding of the morning glory were carried out, the maize plant had higher levels of phosphorus even with high infestation of the weed species.

The differences between the treatments and the control (maize without cohabitation with the morning glory) revealed only a significant difference between the treatment of five morning glory plants / uncontrolled *versus* control. The uncontrolled treatment reduced leaf N content of maize by 1.04%. The other treatments did not differ from the control, indicating that the forms of management, mowing and weeding avoided N competition between maize and morning glory (Table 3). For leaf P content of maize, the treatment of five ratoon stringed plants increased the P content of maize leaves by 0.08% when compared to the control. The remaining treatments did not differ from the control (Table 3).

Table 3. Estimates of the differences between the management and control forms for the nitrogen and phosphorus (percentage) foliar contents of maize. Araras, São Paulo, Brazil, 2012/2013.

	Plants of *Ipomoea triloba*					
	2		3		5	
	Average	Estimate	Average	Estimate	Average	Estimate
	Nitrogen					
Mowing vs control	1.62	-0.31 ns	2.41	+0.48 ns	2.18	+ 0.25 ns
Weeding vs control	1.65	-0.28 ns	1.65	-0.28 ns	2.03	+1.93 ns
Uncontrolled vs control	2.07	+0.14 ns	2.53	+0.6 ns	0.89	-1.04*
V.C. (%)	28.29					
	Phosphorus					
Mowing vs control	0.35	+0.06	0.29	0.00	0.35	+0.06
Weeding vs control	0.23	-0.06	0.37	+0.08	0.37	+0.08*
Uncontrolled vs control	0.36	+0.07	0.34	+0.05	0.27	-0.02
V.C. (%)	18.89					

* Significant by F test at 5% probability, ns: not significant.

The average leaf N contents in maize in all treatments, including in the control, were lower than 2.75% reference value for the interpretation of results of plant tissue analyzes for maize, but the P contents of all treatments presented adequate levels of 0.25 to 0.35% according to the values proposed by Ribeiro et al. (1999).

It should be noted that for leaf analysis all leaves of the plant were used, not just the recommended leaf (1st leaf below and opposite the spike). In addition, at the time of harvesting the leaves, stage R2, the reallocation of N and P from the vegetative part to maize ear had already started (MAGALHÃES et al., 2002).

Regarding the regrowth of *I. triloba*, the analysis of variance for the dry mass of the weed species in the R2 stage of maize showed a significant effect only for the management factor. The uncontrolled treatment yielded 43.35 g of dry mass and the treatment of 15.07 g of dry mass (at 30 days after mowing), a fact already expected.

Most plants of *I. triloba* regrowth. However, it is worth mentioning that apparently the cutting height of plants can interfere with regrowth. This fact deserves better investigation, because under field conditions the plants will hardly be cut close to the ground. In addition, the climbing habit of the morning glory can make it difficult to cut, and / or favor the leaves remain in the plant, which would allow the rapid production of photoassimilates, stimulating regrowth.

Sprouting indicates the likely efficiency of the species in the absorption and use of nutrients extracted from the soil. The analysis of variance for nutrient contents in the dry mass of the morning glory, regrowth and uncontrolled, revealed an isolated effect of the management forms for N, K and Mg nutrients. The dry mass of the regrowth of *I. triloba* plants presented higher nutrient contents than the non-crop plants (Table 4). However, it is emphasized that the total amount extracted from the soil is higher in the uncontrolled plants due, obviously, the higher dry mass production, as reported.

Table 4. Leaf nutrient contents (nitrogen, potassium and magnesium) in *I. triloba* as a function of management (regrowth of the morning glory after mowing and uncontrolled). Araras, São Paulo, Brazil, 2012/2013.

Management	Nitrogen	Potassium	Magnesium
Regrowth	2.73 a	3.19 a	0.71 a
Uncontrolled	2.11 b	2.81 b	0.63 b
V.C. (%)	17.11	10.55	10.00

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

The efficiency in the extraction of nutrients from the soil by the morning glory plants was also verified by Duarte et al. (2008) in which *I. nil* accumulated more N and K between 119 and 125 days after the emergence of the plants, with the leaves and stems being the most accumulated parts.

For the content of P in the dry mass of the morning glory, there was interaction effect of plant density x management. The plants that sprouted had a higher content of P in the dry mass at the density of two and five plants per pot. However, uncontrolled plants reduced the P content in the dry mass with increasing plant density, probably due to intraspecific competition (Figure 1).

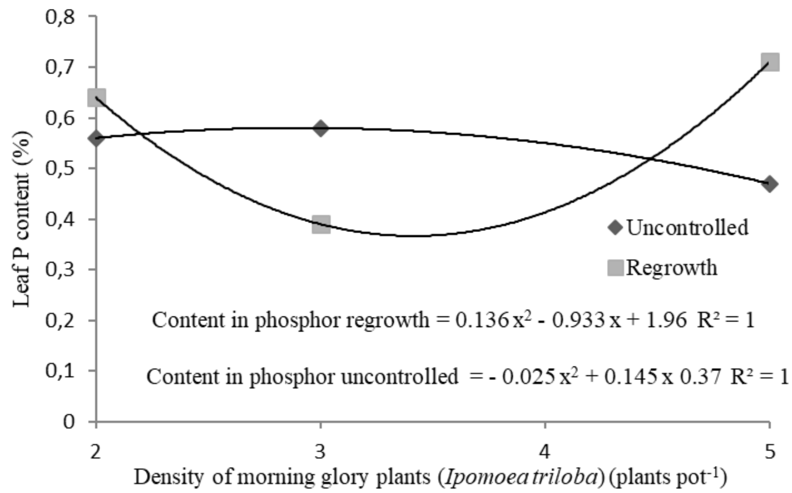

Figure 1. Phosphorus content in the dry mass of *Ipomoea triloba* plants as a function of weed density and management (regrowth and uncontrolled). Araras, São Paulo, Brazil, 2012/2013.

Procópio et al. (2005) studied the efficiency in the absorption and utilization of P by beans, soybean and common weeds in agricultural areas, verified that in the phase of formation of the propagules, the soybean and the weed *Desmodium tortuosum* absorbed larger amounts of P, being that *D. tortuosum* was superior to the other species, absorbing almost 40% of the P applied to the soil at the highest dose.

Information such as height, diameter and nutrient extraction by the crop and weeds helps to search for the best periods of control. Galon et al. (2008) verified a total period of interference prevention (TPIP) 27 days after the emergency (DAE), period preceding interference (PPI) of 11 DAE, with the critical period of interference prevention occurring from 11 to 27 DAE, when the maize coexisted with *Urochloa plantaginea*.

Already Kozlowski (2002) observed the TRIP between the stages of two to seven leaves, with a reduction of 87% in the productivity when the culture lived during the whole cycle in the presence of weeds. In another paper, Kozlowski et al. (2009) verified three PPI (17, 24 and 28 DAE of maize), which corresponds, respectively, according to the authors to the phenological stages V4, V6 and V7. This shows the importance of the initial control of weeds in the crop.

More studies are needed to evaluate the sprouting of the morning glory, especially in relation to its physiology, evidencing factors that can directly or indirectly influence its development after mowing.

CONCLUSIONS

The mowing done in the V4 stage of the maize does not minimize the competition of the morning glory with the cereal, mainly in higher weed population densities.

Weeding is more efficient than mowing to minimize the effects of high density morning glory competition with maize.

Morning glory plants show regrowth and, although they accumulate less dry mass, they are more efficient in the absorption of N, P, K and Mg in relation to unrooted plants.

REFERENCES

CARVALHO, L.B.; BIANCO, S.; BIANCO, M.S. 2014. Estudo comparativo do acúmulo de massa seca e macronutrientes por plantas de *Zea mays* e *Ipomoea hederifolia*. **Planta Daninha**, Viçosa, v.32, n.1, p. 99-107.

CHIOVATO, M.G.; GALVÃO, J.C.C.; FONTANETTI, A.; FERREIRA, L.R.; MIRANDA, G.V.; RODRIGUES, O. L.; BORBA, A.N. 2007. Diferentes densidades de plantas daninhas e métodos de controle nos componentes de produção de milho orgânico**. Planta Daninha**, Viçosa, v.25, n.2, p. 277-283.

CONAB. 2018. **Acompanhamento da safra brasileira**: grãos: safra 2017/2018, quinto levantamento, fevereiro de 2018. Brasília. 142p.

DAROLT, M.R.; SKORA NETO, F. 2002. Sistema de plantio direto em agricultura orgânica. **Revista Plantio Direto**, Passo Fundo, n.70, p. 28-31.

DUARTE, D.J.; BIANCO, S.; MELO, M.N.; CARVALHO, L.B. 2008. Crescimento e nutrição mineral de *Ipomoea nil*. **Planta Daninha**, Viçosa, v.26, n.3, p. 577-583.

DUARTE, N.F.; SILVA, J.B.; SOUZA, I.F., 2002. Competição de plantas daninhas com a cultura do milho no município de Ijaci, MG. **Ciência e Agrotecnologia**, Lavras, v.26, n.5, p. 983-992.

EMBRAPA. 1999. **Sistema brasileiro de classificação de solos**. Brasília: Embrapa Produção de Informação; Rio de Janeiro: Embrapa Solos, 412 p.

GALON, L.; PINTO, J.J.O.; ROCHA, A.A.; CONCENÇO, G.; SILVA, A.F.; ASPIAZÚ, I.; FERREIRA, E.A.; FRANÇA, A.C.; FERREIRA, F.A.; AGOSTINETTO, D.; PINHO, C.F. 2008. Interference periods of *Brachiaria plantaginea* in corn crops in Southern Rio Grande do Sul. **Planta daninha**, Viçosa, v.26, n.4, p. 779-788.

GALON, L.; TIRONI, S.P.; SILVA, A.F.; BEUTLER, A.N.; ROCHA, P.R.R.; FERREIRA, E.A.; SILVA, A.A. 2012. Disponibilidade de macronutrientes em cultivares de cana-de-açúcar submetidas à competição com *Brachiaria brizantha*. **Ciência Rural**, Santa Maria, v.42, n.8, p. 1372-1379.

GUGLIERI-CAPORAL, A.; CAPORAL, F.J.M.; KUFNER, D.C.L.; ALVES, F.M. 2011. Flora invasora de cultivos de aveia-preta, milho e sorgo em região de cerrado do Estado de Mato Grosso do Sul, Brasil. **Bragantia**, Campinas, v. 70, n. 2, p. 247-254.

GUZZO, C.D.; CARVALHO, L.B.; BIANCO, M.S.; BIANCO, S. 2010. Crescimento e nutrição mineral de *Ipomoea hederifolia*. **Planta Daninha**, Viçosa, v.28, n. especial, p. 1015-1021.

KARAM, D.; MELHORANÇA, A.L.; OLIVEIRA, M.F.; SILVA, J.A.A. 2011. **Cultivo do milho: Plantas Daninhas**. Available at:

<http://www.cnpms.embrapa.br/publicacoes/milho_7_ed/plantasdaninhas.htm>. Access in: 19 Nov. 2016.

KOZLOWSKI, L.A. 2002. Período crítico de interferência das plantas daninhas na cultura do milho baseado na fenologia da cultura. **Planta Daninha**, Viçosa, v.20, n.3, p. 365-372.

KOZLOWSKI, L.A.; KOEHLER, H.S.; PITELLI, R.A. 2009. Épocas e extensões do período de convivência das plantas daninhas interferindo na produtividade da cultura do milho (*Zea mays*). **Planta Daninha**, Viçosa, v.27, n.3, p. 481-490.

LORENZI, H. 2014. **Manual de identificação e controle de plantas daninhas:** plantio direto e convencional. 7ed. Instituto Plantarum, Nova Odessa, 383p.

MAGALHÃES, P.C.; DURÃES, F.O.M.; CARNEIRO, N.P.; PAIVA, E. 2002. **Fisiologia do Milho.** EMBRAPA, Sete Lagoas, 62 p.

MARTIN, T.N.; VENTURINI, T.; API, I.; PAGNONCELLI, A.; JÚNIOR, P.A.V. 2011. Perfil do manejo da cultura de milho no sudoeste do Paraná. **Revista Ceres**, Viçosa, v.58, n.1, p.1-8.

MELO, C.A.D.; GUIMARÃES, F.A.R.; GONÇALVES, V.A.; BENEVENUTE, S.S.; FERREIRA, G.L.; FERREIRA, L.R.; FERREIRA, F.A. 2015. Acúmulo de macronutrientes por plantas daninhas e de milho cultivadas em convivência em solo com diferentes manejos de fertilidade. **Revista Semina: Ciências Agrárias**, Londrina, v.36, n.2, p.669-682.

MOREIRA, H.J.C.; BRAGANÇA, H.N.P. 2011. **Manual de identificação de plantas infestantes**. FMC Agricultural Products, Campinas, 1017p.

NOGUEIRA, A.R.R.; SOUZA, G.B. 2005. **Manual de laboratórios: Solo, água, nutrição vegetal, nutrição animal e alimentos**. São Carlos. Embrapa Pecuária Sudeste, 334p.

PEREIRA, G.A.M.; LEMOS, V.T.; SANTOS, J.B.; FERREIRA, E.A.; SILVA, D.V.; OLIVEIRA, M.C.; MENEZES, C.W.G. 2012. Crescimento da mandioca e plantas daninhas em resposta à adubação fosfatada. **Revista Ceres**, Viçosa, v.59, n.5, p. 716-722.

PIMENTEL-GOMES, F.; GARCIA, C. H.2002. **Estatística aplicada a experimentos agronômicos e florestais:** exposição com exemplos e orientações para uso de aplicativos. Piracicaba: FEALQ, 309p.

PONCE, R.G.; ZANCADA, C.; VERDUGO, M.; SALAS, L. 1996. Plant height as a factor in competition between nightshade and two horticultural crops (tomato and pepper). **Journal of Horticultural Science & Biotechnology**, Oxford, v. 71, n.3, p. 453-460.

PROCÓPIO, S.O; SANTOS, J.B.; PIRES, F.R.; SILVA, A.A.; MENDONÇA, E.S. 2005. Absorção e utilização de fósforo pelas culturas de soja e do feijão e por plantas daninhas. **Revista Brasileira de Ciência do Solo**, Viçosa, v. 29, n.6, p. 911-921.

RIBEIRO, A.C.; GUIMARÃES, P.T.G.; ALVAREZ, V.V.H. 1999. **Recomendações para o uso de corretivos e fertilizantes em Minas Gerais: 5ª aproximação**. Viçosa, MG: Comissão de Fertilidade do solo do Estado de Minas Gerais, 180 p.

SANTOS, M.M.; GALVÃO, J.C.C.; FERREIRA, L.R.; MELO, A.V.; FONTANETTI, A. 2010. Dinâmica populacional de plantas daninhas na cultura do milho sob diferentes manejos em plantio direto. **Revista Caatinga**, Mossoró, v. 23, n. 3, p. 26-32.

SILVA, D.V.; PEREIRA, G.A.M.; FREITAS, M.A.M.; SEDIYAMA, T.; SILVA, G.S.; FERREIRA, L.R.; CECON, P.R. 2015. Produtividade e teor de nutrientes do milho em consórcio com braquiária. **Ciência Rural**, Santa Maria, v.45, n.8, p. 1394-1400.

VAZ DE MELO, A; GALVÃO, J.C.C.; FERREIRA, L.R.; MIRANDA, G.V.; TUFFI SANTOS, L.D.; SANTOS, I.C.; SOUZA, L.V. 2007. Dinâmica populacional de plantas daninhas em cultivo de milho-verde nos sistemas orgânico e tradicional. **Planta Daninha**, Viçosa, v.25, n.3, p.521-527.

WINCLER, L. 2006. **Melhoramento Genético de Plantas por meio de Biótipos**. Cruz Alta, p.7 (Informativo Fundacep, 2).

Received in: October 20, 2016
Accepted in: July 15, 2019