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Article

# Interference of Morning Glory in Soybean Yield

*Interferência de Cordas-de-Viola na Produtividade da Soja*

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ABSTRACT - Weed control using herbicides with the same mechanism of action can encourage the emergence of resistant biotypes or tolerant plants. An example of this is the occurrence of morning-glory (*Ipomoea* sp.) in soybean crops in southern Brazil. In this sense, the aim of this study was to quantify the losses arising from two species of morning-glory weeding coexisting with soybean crop. A field study was conducted in the 2013/2014 season. The experimental design was a randomized block with four replications, with treatments being distributed in a factorial arrangement (2x2x5), which assessed the effect of competition on two soybean cultivars (TEC6029 and TEC7849) of morning-glory species (*I. triloba* and *I. purpurea*) in different population (0, 4, 8, 16 and 32 plants $m^{-2}$). The interaction of soybean with different densities of morning-glory affects yield components. The first eight morning glory plants have a more intense competition, reducing productivity by 45% and 27% for TEC6029 and TEC7849 cultivars, respectively.

**Keywords:** competition, *Ipomoea triloba*, *Ipomoea purpurea*, *Glycine max*.

*RESUMO - O controle de plantas daninhas utilizando herbicidas com o mesmo mecanismo de ação pode favorecer o aparecimento de biótipos resistentes ou plantas tolerantes. Exemplo disso é a ocorrência de cordas-de-viola (**Ipomoea** sp.) em lavouras de soja na região Sul do Brasil. Nesse sentido, objetivou-se quantificar os prejuízos decorrentes da competição de duas espécies de corda-de-viola em convivência com a soja. O estudo foi realizado em campo, na safra agrícola 2013/2014. O delineamento experimental foi de blocos ao acaso com quatro repetições, com os tratamentos sendo distribuídos em arranjo fatorial (2x2x5), em que se avaliou o efeito da competição sobre dois cultivares de soja (TEC6029 e TEC7849), das espécies de corda-de-viola (**I. triloba** e **I. purpurea**), em diferentes densidades de infestação (0, 4, 8, 16 e 32 plantas* $m^{-2}$*). A convivência da soja com diferentes densidades de corda-de-viola afetou os componentes de produtividade. As primeiras oito plantas de corda-de-viola mostraram uma competição mais intensa, tendo reduzido a produtividade em 45% e 27% para os cultivares TEC6029 e TEC7849, respectivamente.*

**Palavras-chave:** competição, *Ipomoea triloba*, *Ipomoea purpurea*, *Glycine max*.

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## INTRODUCTION

Due to the optimization of the tillage adopted by the farmers and mainly to the development of new cultivars, an increase in productivity means of soybean crops has been observed *Glycine max* in the last harvests (Conab, 2014). However, yields are below the crop productive potential, with pest and pathogen attacks and weed interference being the main factors responsible for this low productivity (Silva et al., 2007).

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The presence of weeds can cause direct damage to the crop such as competition for environmental resources or even depreciation of the product harvested. Added to this are the indirect losses due to the lower efficiency of the use of the area, the behavior as alternative hosts of pests and pathogens, the increase in production costs and also the difficulty of operations with the use of machines (Concenço et al., 2014).

In the evolutionary process of the species, weeds have acquired mechanisms of competitiveness and survival, allowing their development under adverse conditions. The main characteristics that give this ability are the forms of propagation that the species present, and they can be by rhizomes, stolons, tubers, bulbs and, mainly, by seeds (Radosevich et al., 2007). In RR® soybean crops the selection of resistant and/or tolerant weed biotypes is attributed to the misuse of the Roundup Ready (RR®) technology, which uses genetically modified soybeans that are tolerant to glyphosate herbicide belonging to the EPSPS (5-enolpyruvylhikimate-3-phosphate) mechanism of action. Because there is no rotation of different mechanisms of action, the intensified use of glyphosate leads to selection pressure in the weed population (Christoffoleti et al., 2006), causing the emergence of resistant or tolerant biotypes. Of weeds with tolerance to glyphosate it is possible to mention those belonging to the Convolvulaceae family, more specifically of the genus *Ipomoea* sp., commonly known as the bindweed or morning glory family. These plants occur in the South, Southeast and Central-West regions of Brazil (Kissmann and Groth, 1999. They are annual plants, which reproduce by seeds with emergence flows in spring and summer, in large part because the seeds present dormancy (Pazuch et al., 2015). The integument of seeds of the genus *Ipomoea* sp. is hard, constituting a mechanism of survival, thus allowing the seeds to remain viable for several years in the soil (Chandler et al., 1977).

Studies on the biology and competitive potential between cultivated plants and weed plants are important for defining management strategies in order to reduce infestation or to support control techniques (Fu and Ashley, 2006). Voll et al. (2002) have shown that weeds coexisting with soybean crops during the whole cycle have reduced grain yield in 54%, 48% and 23% when competitors were *Senna tora*, *Euphorbia heterophylla* and *Urochloa plantaginea*, respectively. According to Silva et al. (2009), the productivity component most affected by weed interference in soybean crops is the number of legumes (pods), directly affecting grain yield.

In this sense, the hypothesis tested in the present study is that the species of the genus *Ipomoea* sp. affect soybean yield differently, depending on species and plant density $m^{-2}$. Therefore, the objective of this study was to determine the interference of Aiea morning glory/common morning-glory *I. triloba* e *I. purpurea*, in different densities, in the productivity components of soybean cultivars.

## MATERIAL AND METHODS

The experiment was conducted in the field in the 2013/14 agricultural harvest in the Brazilian city of Santa Maria, in the state of Rio Grande do Sul. The site altitude is 116 m and the region climate is humid subtropical, Köppen climate classification Cfa (Heldwein et al., 2009). The soil is classified as sandy Dystrophic Red Ultisol, belonging to the São Pedro mapping unit (Embrapa, 2013). Fertilization was done according to the recommendation for soybean crops.

Treatments were arranged in a three-factor design (2x2x5) in a randomized block arrangement with four replications. Factor A consisted of soybean cultivars TEC6029 and TEC7849. Factor B consisted of species *I. triloba* (Aiea morning glory) and *I. purpurea*; (common morning-glory). And Factor C by the densities of Aiea morning glory/common morning-glory (0, 4, 8, 16 and 32 plants $m^{-2}$). The plots consisted of five rows of soybeans spaced 0.50 m and measuring 7 m long. The soybean population used was of 360,000 plants $ha^{-1}$. The three central rows were considered as floor area, discarding one meter from each end (7.5 $m^2$).

The soybean was sown in the direct seeding system, in an area that presented crop remains of wheat. Parallel to sowing soybeans in the field, seedlings were produced in a greenhouse *I. triloba* and *I. purpurea* in Styrofoam trays containing 128 cells filled with soil from the experimental area. In the trays the emergence of Aiea morning glory/common morning-glory was coincident with the emergence of soybeans in the field. Seven days after the emergence

(DAE), seedlings were randomly transplanted in the soybean row and between rows and the distribution followed the same model for all plots. The Aiea morning glory/common morning-glory plants remained until the end of the experiment. The control of the other weeds was carried out by manually removing the plants and the phytosanitary management of pests and pathogens followed the technical recommendations for soybean crops (Reunião..., 2012).

In advance of the soybean harvest, the Aiea morning glory/common morning-glory shoots were collected with the aid of a 50 x 50 cm sample frame. They were oven dried at 60 °C until constant dry matter was obtained. Ten soybean plants were collected to determine the plants height (PH, cm), number of branches (NB), number of nodes in the main stem (NN), number of legumes (NL), average number of grains per legume (NG), thousand seed-weight (TSW, g), biological productivity (BPa) and harvest rate (HR). BPa consisted in the sum of the plants shoots mass, including grains. Dividing the grain mass by the BPa supplied HR, expressed in percentage.

After that, harvest of the remaining floor area was carried out and the material was threshed, cleaned and weighed and the grain mass was corrected for 13% of moisture. The data were submitted to an analysis of the presuppositions of the mathematical model (Martin and Storck, 2008). For the quantitative factor, the polynomial regression until the third degree was used and the confidence interval (95%) was represented in the charts. As for the qualitative factor, a comparison of means by the F test was used ($p<0.05$). The program used in the statistical analysis was Sisvar (Ferreira, 2011).

## RESULTS AND DISCUSSION

In the analysis of variance (ANOVA) it was verified that there significance for the main effect of Factor A (soybean cultivar), as well as for Factor C (weeds densities, PD, pl $m^{-2}$) for the following variables: number of branches, number of nodes in the main stem, number of legumes, number of grains per legume, thousand seed-weight, biological productivity and soybean harvest rate. There was an interaction between Factors A x B (soybean cultivars and Aiea morning glory/common morning-glory species) for variables soybean grain productivity and plant height. And an interaction between Factors A x C (soybean cultivars and Aiea morning glory/common morning-glory plants density) and for variables plant height, shoots dry matter of Aiea morning glory/common morning-glory and soybean grain productivity.

Table 1 shows the variables that significantly differed by the analysis of variance for Factor A. Cultivar TEC6029 presented higher NB, TSW, NG and HR. And TEC7849 presented higher NN, NL and ABP. Cultivar TEC7849, due to being from the group of maturation 7.8, had its development cycle higher than in cultivar TEC6029, which is from the group of maturation 6.0. Therefore, cultivar TEC7849 obtained higher growth and accumulation of dry matter. However, this has not reflected on productivity. And TEC6029 presented better relationship between dry matter accumulated in the shoots and grain mass due to being able to direct a higher amount of photoassimilates to the production of grains.

Rapid accumulation of dry matter at the beginning of development, branching capacity, preferential allocation of dry matter for the branches, high stature, lodging tolerance and low productivity reduction under competition stress (Bianchi et al., 2011) allow better competitive ability of soybean cultivars. In this way, the characteristics act simultaneously to maximize the competitive ability.

***Table 1 -*** Number of branches (NB), number of nodes in the main stem (NN), number of legumes (NL), average number of grains per soybean legume (NG), thousand seed weight (TSW, g), biological productivity (BPa, %) and harvest rate (HR, %) for cultivars TEC6029 and TEC7849

| Cultivar/variable | NB | NN | NL | NG | TSW | ABP (%) | HR (%) |
|---|---|---|---|---|---|---|---|
| TEC6029 | 2.44 a | 18.46 b | 42.32 b | 2.30 a | 165.55 a | 33.02 b | 45.13 a |
| TEC7849 | 1.26 b | 26.00 a | 49.45 a | 2.16 b | 154.74 b | 39.88 a | 35.91 b |
| Mean | 1.85 | 22.23 | 45.88 | 2.23 | 160.14 | 36.45 | 40.52 |
| VC (%) | 39.46 | 11.80 | 19.45 | 3.99 | 4.17 | 22.48 | 8.46 |

Means followed by a different letter in the vertical differ by the F test at 5%.

Regarding competition for solar radiation, height and leaf characteristics are the ones that most interfere in the interception of this input. In the case of competition for water and nutrients, the root system is the most important one (Lemerle et al., 2001). According to Bianchi et al. (2006), soybean cultivars with higher ground cover canopy yield a greater amount of dry matter in the stem and leaves at 45 days after emergence, as well as a higher amount of dry matter in the shoots at 60 days after emergence, which contributes to a larger competitiveness for soybean plants against competing plants.

NL was affected by the increase of populations of Aiea morning glory/common morning-glory. In the larger population this reduction reached 39% in relation to the control without weeds (Figure 1). As for NG, it presented behavior linear with the increase in populations of Aiea morning glory/common morning-glory due to the fact that the soybean plants, in the larger population of Aiea morning glory/common morning-glory, presented lower number of legumes. This caused the average plant grain per legume to be higher. TSW was also more impaired in the largest populations of Aiea morning glory/common morning-glory, reflecting the effect of competition on one of the main components of soybean yield. BP was affected by the competition with Aiea morning glory/common morning-glory plants. In the population of 8 pl $m^{-2}$ the damage stabilized, reaching a plateau. And there was no significant reduction in productivity, with densities higher than 8 pl $m^{-2}$. NN and HR presented a decreasing linear model with the increase in populations of Aiea morning glory/common morning-glory.

Table 2 shows the interaction between soybean cultivar factors TEC6029 and TEC7849 and the species Aiea morning glory/common morning-glory. It is observed in cultivar TEC7849 that the lower grain yield was significant when coexisting with *I. purpurea*, while for cultivar TEC6029 the general average grain yield was lower when in coexistence with the species *I. trilola* in absolute values, without, however, significantly differing ($p<0.05$).

Comparing both cultivars in coexistence with *I. triloba,* the highest average productivity was of TEC7849, but coexisting with *I. purpurea* the highest average productivity was of TEC6029. This behavior is due to the fact that the species *I. triloba* presents its reproductive cycle lower than *I. purpurea*. Therefore, for the lower cycle cultivar there was higher interference due to the fact that *I. purpurea* presents the higher accumulation of dry matter when it no longer caused interference in this cultivar, them impairing cultivar TEC7849, which has a higher vegetative cycle. PH of cultivar TEC6029 was lower in coexistence with *I. triloba,* as well as for cultivar TEC7849. The species *I. triloba*, at the moment of the harvest of cultivar TEC7849, was ending its cycle and for *I. purpurea* it was in the beginning of the reproductive period.

Figure 2 shows the charts with interaction models between the soybean cultivars and the populations of Aiea morning glory/common morning-glory for variables PH, SDMM and GP. The interference of the soybean plant height on the Aiea morning glory/common morning-glory shoot dry matter and on grain productivity was not influenced by the species separately, showing that competition ability does not differ between the species in these plant densities and in the conditions in which the study was carried out.

Figure 2A presents the soybean plant height due to the increase in Aiea morning glory/ common morning-glory densities. It is possible to see that cultivar TEC7849 presented higher plant height when compared with cultivar TEC6029. Under competition, the crop plants tend to increase their height as a way to maximize the radiation uptake and shade weeds. With that the accumulation of dry matter, the leaf area and the leaves/branches ratio are reduced (Silva et al., 2009).

Figure 2B shows that the increase in Aiea morning glory/common morning-glory densities caused higher accumulation of Aiea morning glory/common morning-glory shoots dry matter (g $m^{-2}$). In coexistence with cultivar TEC6029, there was an even higher accumulation of SDMM. According to Duarte et al. (2008), leaves and stems are the main organs responsible for the accumulation of dry matter per plant of *Ipomoea nil* in the first and second halves of this species development cycle. Potassium (K) and nitrogen (N) are the macronutrients extracted in greater quantity by plants of these species.

Generally, soybean presents greater ability in competition with weeds due to growth characteristics of each genotype, such as emergence speed, plant height, canopy architecture,

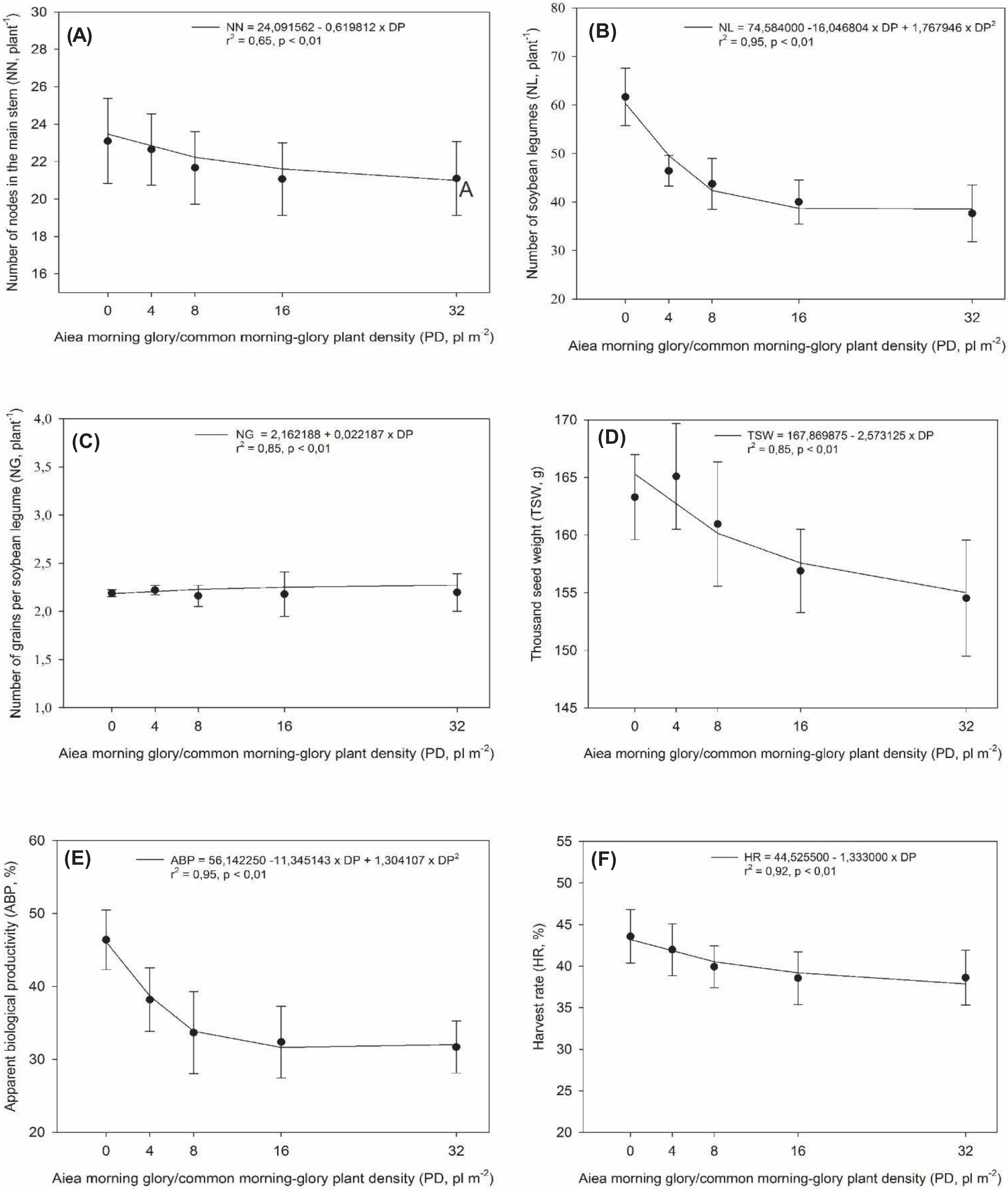


***Figure 1*** - Effect of different densities of Aiea morning glory/common morning-glory (PD, pl m$^{-2}$) on the number of branches (NB), number of nodes in the main stem (NN), number of legumes (NL), number of grains per legume (NG), thousand seed-weight (TSW, g), biological productivity BPa, %) e soybean harvest rate (HR, %).

***Table 2*** **-** Development of the interaction between soybeans cultivars TEC6029 and TEC7849 and the Aiea morning glory/common morning-glory species *I. triloba* and *I. purpurea* for the variables grain productivity (GP, kg $ha^{-1}$) and plant height (PH, cm per plant)

| Cultivar/species | Soybeans grain productivity (GP, kg $ha^{-1}$) | | Plant height (PH, cm per plant) | |
|---|---|---|---|---|
| | *I. triloba* | *I. purpurea* | *I. triloba* | *I. purpurea* |
| TEC6029 | 2256.45 Aa | 2398.83 Aa | 104.99 Aa | 106.46 Aa |
| TEC7849 | 2400.51 Ba | 2213.77 Ab | 156.65 Ba | 163.13 Ba |
| VC % | 13.14 | | 23.42 | |

Means followed by uppercase letter in the column and lowercase letter in the row differ by the F test at 5%; ns non-significant.

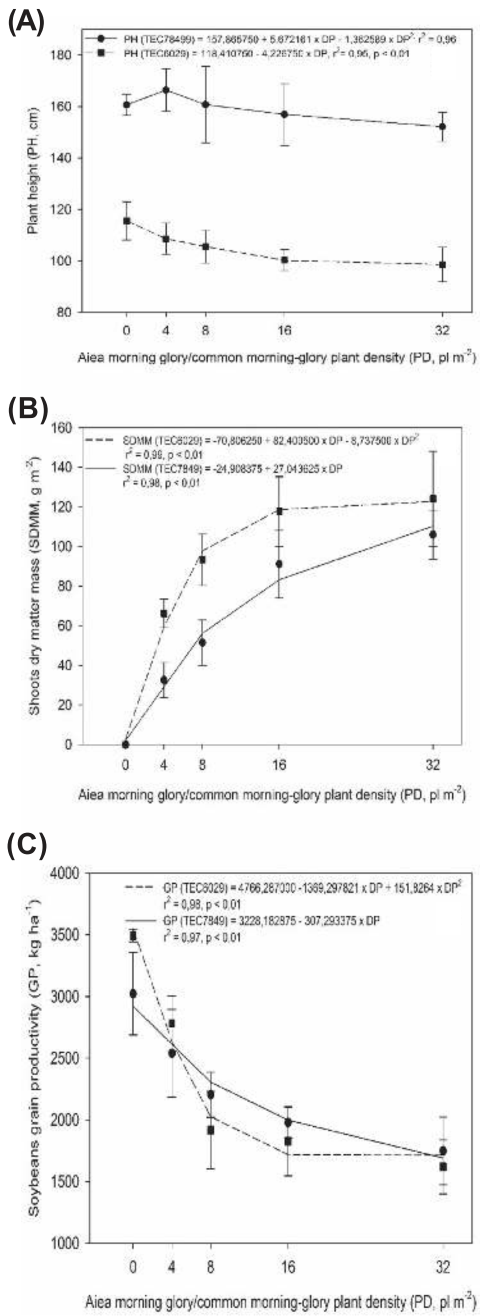


***Figure 2*** **-** Effect of the interaction between the soybean cultivars (TEC6029 and TEC7849) and different densities of Aiea morning glory/common morning-glory (PD, pl $m^{-2}$) in plant height (PH), Aiea morning glory/common morning-glory shoots dry matter (SDM) and soybeans grains productivity (GP).

spatial arrangement and dry matter accumulation by plants (Place et al., 2011). However, in agricultural crops, weeds occurring at high densities may be more competitive (Bianchi et al., 2006). In addition to density, the distribution of these plants in relation to the crop is also important in the effect that weeds exert on the crop. *Amaranthus palmeri* plants 15 cm near soybean reduced grain yield by 34% and as there was distancing the interference was reduced (Chandi et al., 2012).

Information on the reduction of soybean productivity due to competition with *Ipomoea* sp., specially for *I. triloba* and *I. purpurea* is still scarce in the literature. There are inferences that two to eight plants of *Ipomoea* sp. per $m^2$ reduced grain yield from 25 to 43% and that in higher densities the reduction may reach 90% (Howe and Oliver 1987; Stoller et al., 1987). In a similar study developed by Mosier and Oliver (1995), soybean grain yield in competition with *Ipomoea* sp. was 21% lower when the crop was irrigated, in comparison with 12% losses in the absence of irrigation. As for Voll et al. (2002), they have verified that three plants of Aiea morning glory/common morning-glory may reduce soybean yield in up to 10%.

The interference caused by dicotyledonous weeds in soybean crops depends on the species present and the population density in which it occurs. Such factors can be modified mainly by the emergence time of weeds in relation to the crop because in this condition weeds are privileged in the use of the environment resources and consequently they form plants with higher size and greater competitive potential (Fleck et al., 2003).

Grain yield (Figure 2C) decreased with increase in Aiea morning glory/common morning-glory plants density per $m^2$. It is possible to observe that for the lower density tested, of four Aiea morning glory/common morning-glory plants per $m^2$, there was a reduction of approximately 709 and 482 kg $ha^{-1}$

for cultivars TEC6029 and TEC7849, respectively, in comparison with the treatment without weeds. This demonstrates the impact that these weed species can have on soybean crops even at lower densities. With the increase in density of Aiea morning glory/common morning-glory per $m^2$, the higher impact was on grain yield. For the higher density of plants tested, 32 plants of Aiea morning glory/common morning-glory per $m^2$, the reduction of the soybean grain yield was of 1,872 and 1,273 kg $ha^{-1}$, respectively cultivars TEC6029 and TEC7849, representing 50 and 42% of loss due to the negative interference effect exerted by the Aiea morning glory/common morning-glory plants.

For cultivar TEC6029, the first eight Aiea morning glory/common morning-glory plants reduced yield from 3,492 to 1,918 kg $ha^{-1}$, i.e., a reduction of 45%. Each Aiea morning glory/common morning-glory plant reduces grain yield in 196.75 kg $ha^{-1}$. As for cultivar TEC7849, the first eight Aiea morning glory/common morning-glory plants reduce yield from 3,022 to 2,205 kg $ha^{-1}$, i.e., a reduction of 27.04%. In this case, each Aiea morning glory/common morning-glory plant reduces grain yield in 102.18 kg $ha^{-1}$. In such situation of lower populations of Aiea morning glory/common morning-glory, the interspecific competition effect had great influence on the reduction of grain yield. For cultivar TEC6029, the interval of 8 to 32 plants (24 Aiea morning glory/common morning-glory plants) represents a reduction of 15.53%, assigning to each Aiea morning glory/common morning-glory plant a reduction in soybean yield of 12.41 kg. In cultivar TEC7849 the reduction was of 20.68%, equivalent to 19 kg $ha^{-1}$ for each Aiea morning glory/common morning-glory plant per square meter.

## REFERENCES


Bianchi M.A. et al. Interferência de *Raphanus sativus* na produtividade de cultivares de soja. **Planta Daninha**. 2011;29:783-92.

Bianchi M.A, Fleck N.G., Federizzi L.C. Características de plantas de soja que conferem habilidade competitiva com plantas daninhas. **Bragantia**. 2006;65:623-32.

Chandi A. et al. Interference of elected Palmer Amaranth (*Amaranthus palmeri*) Biotypes in Soybean (*Glycine max*). **Inter J Agron.** 2012;online:7, 2012.

Chandler J.M., Munson R.L., Vaughan C.E. Purple moonflower: emergence, growth, reproduction. **Weed Sci.** 1977;25:163-7.

Christoffoleti P.J. et al. Herbicidas alternativos para o controle de biótipos de buva (*C. bonariensis* e *C. canadensis*) supostamente resistentes ao herbicida glyphosate. In: **Resumos** de Congresso Brasileiro de Ciência das Plantas Daninhas. Londrina: SBCPD, 2006. p.553.

Companhia Nacional de Abastecimento – Conab. 12º Levantamentos de grãos safra 2013/14. [acesso em: 16/11/2014]. Disponível em: http://www.conab.gov.br/conteudos.php?a=1253&.

Concenço G. et al. **Aspectos da biologia e manejo das plantas daninhas**. São Carlos: RiMa, 2014. p.1-31.

Duarte D.J. et al. Crescimento e nutrição mineral de *Ipomoea nil*. **Planta Daninha**. 2008;26:577-83.

Empresa Brasileira de Pesquisa Agropecuária – Embrapa. **Sistema Brasileiro de Classificação de Solos.** 3ª.ed. Brasília, DF: 2013. 353 p.

Ferreira D.F. Sisvar: a computer statistical analysis system. **Ci Agrotecnol.** 2011;35:1039-42.

Fleck N.G. et al. Produção de sementes por picão-preto e guanxuma em função de densidades das plantas daninhas e da época de semeadura da soja. **Planta Daninha**. 2003;21:191-202.

Fu R., Ashley R.A. Interference of large crabgrass (*Digitaria sanguinalis*), redroot pigweed (*Amaranthus retroflexus*) and hairy galinsoga (*Galinsoga ciliata*) with bell pepper. **Weed Sci.** 2006;54:364-72.

Heldwein A.B., Buriol G.A., Streck N.A. O clima de Santa Maria. **Ci Amb.** 2009;38:43-58.

Howe O.W., Oliver L.R. Influence of soybean (*Glycine max*) row spacing on pitted morning glory (*Ipomoea lacunosa*) interference. **Weed Sci.** 1987;35:185-93.

Reunião de Pesquisa da Soja da Região, 39º; Sul 24 a 26 de julho de 2012. **Indicações Técnicas para a Cultura da Soja no Rio Grande do Sul e em Santa Catarina, safras 2012/2013 e 2013/2014**. Passo Fundo: 2012. Disponivel em: http://www.cnpt.embrapa.br/culturas/soja/indicacoes_soja2012-2013.pdf

Kissmann K.G., Groth D. **Plantas infestantes e nocivas**. 2ª ed. São Paulo: BASF, 1999. Tomo II. 978 p.

Lemerle D. et al. Genetic improvement and agronomy for enhanced wheat competitiveness with weeds. **Austr J Agric Res.** 2001;52:527-48.

Martin T.N., Storck L. Análise das pressuposições do modelo matemático em experimentos agrícolas no delineamento blocos ao acaso. In: Martin T.N., Ziech M.F., organizadores. **Anais do 2º. Seminário: Sistemas de Produção Agropecuária**. Curitiba: UTFPR, 2008. v.1. p.177-96.

Mosier D.G., Oliver L.R. Common cocklebur (*Xanthium strumarium*) and entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula*) interference on soybeans (*Glycine max*). **Weed Sci.** 1995;43:239-46.

Pazuch D. et al. Superação de dormência em sementes de três espécies de *Ipomoea*. **Ci Rural**. 2015;45:192-9.

Place G.T. et al. Identifying soybean traits of interest for weed competition. **Crop Sci.** 2011;51:2642-54.

Radosevich S.R., Holt J.S., Ghersa C.M. **Ecology of weeds and invasive plants:** relationship to agriculture and natural resource management. 2ª ed. Hoboken: John Wiley & Sons, 2007.

Silva A.A. et al. Biologia de plantas daninhas. In: Silva A.A., Silva J.F. **Tópicos em manejo de plantas daninhas**. Viçosa, MG: UFV, 2007. p.17-61.

Silva A.F. Interferência de plantas daninhas em diferentes densidades no crescimento da soja. **Planta Daninha**. 2009;27:75-84.

Stoller E.W. et al. Weed interference in soybeans (*Glycine max*). **Weed Sci.** 1987;3:155-81.

Voll E. et al. Competição relativa de espécies de plantas daninhas com dois cultivares de soja. **Planta Daninha**. 2002;20:17-24.