WEEDS INFESTATION IN CORN INTERCROPPED WITH FORAGES AT DIFFERENT PLANTING DENSITIES

Infestação de Plantas Daninhas em Milho Consorciado com Espécies Forrageiras em Diferentes Densidades de Semeadura

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ABSTRACT - Corn is planted in the Center West region of Brazil as a second crop, following soybeans or beans. Intercropping of Brachiaria species with corn as a second crop increases the mulching in the cropping system. This study aimed to evaluate the weeds infestation in soybeans following corn/forages intercrop, as a function of corn plant structure, forage species and density. Experiments were conducted in a completely randomized blocks design with four replications, in Ponta Porã and Dourados municipalities, Mato Grosso do Sul state, Brazil, in 2010/2011. Treatments consisted of three corn hybrids with distinct plant architectures intercropped with three forage species: Brachiaria ruziziensis, B. brizantha and B. decumbens, at five densities, and the resulting dry mass was maintained throughout the winter. During the following cropping season, forages were desiccated prior to planting soybeans, and the dry mass of weeds, dry mass of the mulching, soil coverage by weeds, and the broadleaf/grass weed species index (WPI) were determined 15 days after soybean emergence, submitted to an F-test, and analyzed either by regression or by multiple mean comparison, according to the nature of the data. When intercropping corn with species of Brachiaria, a reduction in the overall weeds infestation may always be expected; among the studied forage species, more problems with weeds may be anticipated in areas with a less competitive species, e.g. B. ruziziensis. Under the conditions of the trials, B. brizantha and B. decumbens were more capable of inhibiting the emergence of weed species in the winter.

Keywords: Brachiaria; weed proportion index; winter crop; mulching

RESUMO - O milho é cultivado na região Centro-Oeste do Brasil na segunda safra, após soja ou feijão. O consórcio de braquiárias com milho segunda safra aumenta o volume de palha no sistema. Objetivou-se com este estudo avaliar a infestação de plantas daninhas na soja pós-consórcio milho/braquiária, em função da arquitetura das plantas do milho, da espécie forrageira e de sua densidade de semeadura. Experimentos foram instalados em blocos casualizados com quatro repetições, nos municípios de Ponta Porã e Dourados, Estado de Mato Grosso do Sul, Brasil, na safra 2010/2011. Os tratamentos constaram de três híbridos de milho com diferentes arquiteturas, consorciados com três espécies forrageiras: Brachiaria ruziziensis, B. brizantha e B. decumbens, em cinco densidades, e a massa resultante foi mantida no inverno. Na estação de cultivo subsequente, as forrageiras foram dessecadas antes do plantio da soja, e a massa seca das forrageiras e das plantas daninhas, bem como o solo coberto por plantas daninhas e a proporção de plantas daninhas (WPI), foram determinados 15 dias após a emergência da soja. Os dados foram submetidos ao teste F e analisados por regressão ou por comparação múltipla de médias, de acordo com sua natureza. Quando o milho é consorciado com espécies de Brachiaria, problemas com plantas daninhas podem ser antecipados em áreas com espécies menos competitivas, como B. ruziziensis. Nas condições dos experimentos, B. brizantha e B. decumbens foram mais capazes de inibir a proliferação de plantas daninhas no inverno.

Palavras-chave: Brachiaria, índice de proporção de espécies, cultivo de inverno, palhada.

1 Recebido para publicação em 12.2.2012 e aprovado em 18.5.2012.
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INTRODUCTION

Corn is planted in the Center West region of Brazil as a second crop, between January and March, following soybeans or beans. These fields usually present low mulching in the soil during the winter due to the small amount of dry mass resulting from corn crop (Brüggemann, 2011), which favors the multiplication of weed species during this period (Oliveira Neto et al., 2010).

According to Oliveira (2001), forages of the Genus *Brachiaria* are the most used for intercropping with corn, being highlighted by its excellent adaptation to low fertility soils, easy establishment, and high production of dry mass. The intercropping of *Brachiaria* species with corn as a second crop represents an important alternative for increasing the volume of mulching in the cropping system (Ceccon et al., 2010), with no reduction in crop yield (Cecon, 2007; Freitas et al., 2008). In fact, under certain circumstances the presence of mulching positively influences the yield potential of corn, due to temperature regulation at shallow soil depths, nitrogen fixation, enhanced soil moisture conservation, and reduction of erosion following heavy rains (Singh et al., 2011).

Infestation by weed species may be a concern in such intercropping systems if they occur at high levels, mainly due to the limitation on herbicides and doses allowed to be applied in the intercropping (Cecon et al., 2010; Parwada & Mudimu, 2011). Thus, understanding not only the level of occurrence but also the composition of the weed community under each cropping system is important for achieving efficient control (Suresh & Reddy, 2010). Introduced intercropping species should be, by themselves, efficient in minimizing the occurrence of weed species in the intercrop, but while the presence of straw reduces the percentage of emergence of some weed species, it may increase the occurrence of others (Voll et al., 2005), mainly in terms of differential carbon metabolism (Silva et al., 2007).

This study aimed to evaluate the weeds infestation in soybeans following corn/forages intercrop, as a function of corn plant structure, forage species, and density.

MATERIAL AND METHODS

Trials were installed in two experimental areas owned by the Brazilian Agricultural Research Corporation – EMBRAPA, Western Region Agriculture Center, one of them located in Dourados (Lat -22.2844°, Lon -54.8068°, Alt 400m), and the other at Ponta Porã city (Lat -22.5489°, Lon -55.6515°, Alt 655m), state of Mato Grosso do Sul, Brazil. Soil is classified as clayey Oxisoil in both areas. The experiment was installed in a completely randomized blocks design, and plots were arranged in a split-split plot design 3x3x5, with four replications. The main plots comprised three corn hybrids, sub-plots by three *Brachiaria* species and sub-sub-plots by five populations of *Brachiaria*. Experimental plots comprised four rows of corn with 5 m long spaced in 0.9 m, intercropped with three rows of one of the *Brachiaria* species and density, according to the treatments. Both lateral corn rows, as well as 1 m at the beginning and at the end of the plot, were not considered in the evaluations.

Corn hybrids were chosen by contrasting features: AG9010 (very short cycle, upright leaves); BRS1010 (short cycle, semi-decumbent leaves) and DOW2B710 (short cycle, decumbent leaves), being planted in intercropping with populations of 0, 5, 10, 20 and 40 plants m$^{-2}$ of *B. ruziziensis* and *B. decumbens*, or 0, 2, 4, 8 and 16 plants m$^{-2}$ of *B. brizantha* cv. Piatã. This difference in density for Piatã is due to its known higher aggressiveness in accumulating dry mass. Planting was accomplished under the no-till system on February 18 and 25, 2010, respectively, for Dourados and Ponta Porã locations, by using a pneumatic drill Semeato PAR 2800 for planting corn, and Wintersteiger Plotseed TC with adaptations, for planting the intercropped populations of forages.

Fertilization was done at the seeding furrow of corn by applying 200 kg ha$^{-1}$ of NPK 05-20-20. Weed control was done by the application of the herbicide atrazine at a dose of 1.5 L ha$^{-1}$ in early post-emergence of both crop and weeds. Pests were controlled with two applications of deltamethrin 10 and 30 days after emergence (DAE) of the corn at a dose of 0.005 L ha$^{-1}$. 
Weeds infestation in corn intercropped with forages at different ...
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Figure 1 - Dry mass of weed species (g m⁻²) as a function of forage planting density, location (Ponta Porã and Dourados), forage species (B. ruziziensis; B. brizantha cv. Piatã; B. decumbens), and plant group (● broadleaved weeds; ○ grass weeds). Embrapa Western Region Agriculture, Dourados-MS, Brazil, 2011.

an adjusted regression to data (Massey, 1951) with a WPI of 0.90 in the absence of B. ruziziensis, and about 0.98–1.0 for the other densities (Figure 2). Although the data indicates that the influence of forage density was almost null on the proportion of...
broadleaved weeds observed at the treatments in Ponta Porã, this is due to the very low occurrence of grass weeds, so the results of WPI at the location of Ponta Porã should be considered with some reservation.

On the other hand, the emergence of grass weed species in Dourados decreased (WPI increased) as the density of forages was increased (Figure 2), except for *B. brizantha* where it was constant at about 0.70 for all densities. For *B. ruziziensis*, WPI increased from 0.61 at the check to 0.80 under 40 plants m⁻² of the forage; the same was observed for *B. decumbens*, where WPI increased from 0.47 at the check to 0.82 under 40 plants m⁻².

Reduction in the occurrence of weed species may be attributed to the competitive and allelopathic effects of the forage over the weed community. To cause changes in WPI, the mulching on the soil should either inhibit the germination of photoblastic positive seeds, or present an allelopathic effect on the germination of these seeds (Salvador, 2007). Such features are essential in choosing the most adequate species for intercropping when aiming at weed suppression (Gimenes et al., 2009). Borghi et al. (2008) studied crop row spacing of corn intercropped with *B. brizantha* planted at the crop row, inter-row and both, and concluded that when *B. brizantha* was drill seeded both in rows and inter-rows of the crop, 

Figure 2 - Index describing the relation between Broadleaved and Grass weeds (Weed Proportion Index - WPI), as a function of species and density of the forage plants, and location of the trial. Index was arranged so that 1 = only broadleaved weeds present, and 0 = only grass weeds present. Locations: • Ponta Porã; ○ Dourados. Embrapa Western Region Agriculture, Dourados-MS, Brazil, 2011.
it was able to inhibit weeds infestation by 95%, independently of crop row spacing (45 or 90 cm).

The percentage of soil covered (SC) by each group of weed species was only significant for Ponta Porã. SC by broadleaved weeds was only influenced by the density of *B. decumbens* (Table 1), where the check presented 18.9% of the soil covered by this group of weeds; densities of 5 and 10 plants m⁻² presented around 11.9% of the soil covered, and the two highest densities (20 and 40 plants m⁻²) presented around 5.5% of SC% (Table 1). For *B. ruziziensis* and *B. brizantha*, SC% was not affected by the planting density (Table 1).

Grass weeds did not differ as the density of *B. decumbens* was increased (Table 1), probably due to the low infestation observed, with average SC% equal to 0.27 (Table 2). On the other hand, for treatments with *B. ruziziensis*, infestation by grasses was lower than the check from the density of 5 plants m⁻², and for *B. brizantha*, grass infestation was reduced only at the highest planting density (Table 1).

Gimenez et al. (2009) highlights that, from 60 DAE, *B. brizantha* planted at a density of 20 kg ha⁻¹ of seeds is able to cover 100% of the available space with its canopy, allowing for the maximum suppression of weed species. The authors also highlight that *B. brizantha* was able to suppress *C. echinatus* more efficiently than *I. grandifolia*, and this is probably related to the photosynthetic physiology of these weed species: the first is a C₄ grass while the latter is a C₃-carbon fixation species. Although most efficient in water use and capable of reaching higher photosynthesis rates, the C₄ species demands more radiation to allow its positive Net Assimilation Rate (NAR), thus these species are more seriously affected by shade (Silva et al., 2007).

When SC% is analyzed independently of planting density (Table 2), *B. brizantha* and *B. decumbens* presented lower infestation by broadleaved weeds than *B. ruziziensis*, and *B. decumbens* presented lower infestation by grass weed species than *B. ruziziensis* and *B. brizantha* (Table 2). On average, *B. ruziziensis* was less efficient than the other species in inhibiting the occurrence of weed species (Table 2).

In Figure 3 the remaining amount of straw left by the species of *Brachiaria* 36 days after desiccation is shown for both locations (Ponta Porã and Dourados). In Ponta Porã, all the species were able to leave similar amounts of

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<th>Forage density</th>
<th>Broadleaved Weeds</th>
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<td>Brizantha</td>
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<td>13.5 a</td>
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<td>16.2 a</td>
<td>9.1 a</td>
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¹ Densities 0, 1, 2, 3 and 4 are equivalent, respectively, to 0, 5, 10, 20 and 40 plants m⁻² for *B. ruziziensis* and *B. decumbens*, and to 0, 2, 4, 8 and 16 plants m⁻² for *B. Brizantha*. ² Means followed by the same letter, at the columns, did not differ according to the DMRT test at 5% probability.
straw on the soil surface by the time of the evaluation of weeds occurrence, while in Dourados B. ruziziensis was able to produce higher amounts of straw in comparison to B. brizantha and B. decumbens at the lower planting densities; at higher densities the amount of straw was similar among species (Figure 3). These differences were tested according to Regazzi & Silva (2010). In addition, at the highest forage density, the absolute amount of straw deposited at the soil surface was about 3000 kg ha⁻¹ in Ponta Porã and about 4000 kg ha⁻¹ in Dourados (Figure 3), which could help explain the lower levels of absolute infestation in Dourados at the highest forage density in comparison to Ponta Porã (Figure 1).

Cobucci (2001) reports that, according to the optimal population for each species, forages are efficient in reducing infestation by weed species. However, even the best of the species fails in occupying all environmental niches, leaving room for more aggressive species (Gimenes et al., 2009). In this way, although forages should be used as effective tools for weed suppression, it is often necessary to use additional control techniques to avoid allowing weeds to increase their frequency in the area (Cecon et al., 2010; Parwada & Mudimu, 2011).

The choice of the species to be intercropped with corn should rely mainly on its agronomical performance in the intercrop. When intercropping corn with Brachiaria, a reduction in the overall weeds infestation may always be expected; among the studied forage species, more problems with weeds may be anticipated in areas with less competitive species, like B. ruziziensis. Under the conditions of the trials, B. brizantha and B. decumbens were more capable of inhibiting the emergence of weed species in the winter.

**LITERATURE CITED**


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