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Agronomic performance of sunflower intercropped with *Urochloa ruziziensis*

Desempenho agronômico do girassol consorciado com *Urochloa ruziziensis*

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Abstract

Sunflower cultivation is a viable alternative for the second crop in Campo Novo do Parecis, state of Mato Grosso; however, its low contribution to the land cover after harvest is an obstacle for the practice of the no - tillage system, which favors the maintenance of straw on the soil. The objective of this study was to evaluate the influence of the intercropping on the agronomic performance and yield of sunflower under different populations of *Urochloa ruziziensis* in the region of Parecis. The experiment was carried out in the experimental field in the Instituto Federal do Mato Grosso, *campus* Campo Novo do Parecis, state of Mato Grosso in the second crop of the 2016/17 agricultural year. The experimental design was a randomized complete block design with six treatments (0, 200, 400, 600, 800 and 1000 points of cultural value ha^{-1} of *U. ruziziensis*) and four replications. Sowing was performed on March 10th, 2017 using variety Helio 250. No significant effect was found among treatments neither did the mathematical regressions present statistical significance. The agronomic characteristics of the sunflower are not influenced by *Urochloa ruziziensis* sowing rates when sowed simultaneously due to the slow initial growth of the grass and the competitive efficiency of the sunflower after 30 days of the cycle.

Additional keywords: grass; *Helianthus annuus;* no-tillage system; soil cover and soil preservation.

Resumo

A cultura do girassol mostra-se uma alternativa viável para segunda safra em Campo Novo do Parecis - MT, porém sua baixa contribuição com a cobertura do solo, após a colheita, dificulta a adoção da prática do sistema plantio direto, o qual preza pela manutenção de palhada no solo. Assim, objetivou-se avaliar a influência do consórcio no desempenho agronômico e na produtividade do girassol sob diferentes populações de *Urochloa ruziziensis* na região do Parecis. O experimento foi realizado no campo experimental do Instituto Federal de Mato Grosso, *Câmpus* Campo Novo do Parecis-MT, na segunda safra do ano agrícola de 2016/2017. O delineamento experimental foi o em blocos casualizados, com seis tratamentos (0; 200; 400; 600; 800 e 1000 pontos de valor cultural ha^{-1} de *U. ruziziensis*) e quatro repetições. A semeadura foi realizada no dia 10-03-17, com a variedade Helio 250. Não houve diferença significativa entre os tratamentos, assim como as regressões matemáticas não apresentaram significância estatística. As características agronômicas do girassol não são influenciadas pelas taxas de semeadura da *Urochloa ruziziensis*, quando semeadas simultaneamente, devido ao lento desenvolvimento inicial da gramínea e a eficiência competitiva do girassol a partir de 30 dias do ciclo.

Palavras-chave adicionais: cobertura vegetal e preservação do solo; gramínea; *Helianthus annuus;* sistema plantio direto.

Introduction

The sunflower (*Helianthus annuus* L.) is an annual dicotyledon plant of the family Asteraceae, highly adaptable to several soil-climate conditions. It is cultivated in all continents for the production of comestible oils, biodiesel, ornamentation, animal feed and others (Souza et al., 2015). Sunflower crop culture in Brazil is feasible as from the second harvest, especially for the state of Mato Grosso in the Central-Western region, represented almost exclusively for the municipality of Campo Novo do Parecis. Cultivated area in Brazil for the 2016/17 harvest reached 62.7 thousand ha, of which 50.1 thousand were cultivated in the three states of the Central-Western region. The state of Mato Grosso featured a 31.8 thousand ha crop area. Brazilian production for the 2016/17 harvest amounted to 103.7 thousand tons. The Central-Western region featured 85.3 thousand tons, with the state of Mato Grosso producing 53.1 thousand tons for the entire region. Once more, Campo Novo do Parecis was the municipality with the highest production rate in the state (Conab, 2018). In fact, the municipality has the best soil-climate conditions, with the best altitude and a well-defined dry season.

The no-tillage system (NTS) is widely employed in the region since it minimizes soil and nutrient losses by erosion. The sunflower crop is not efficient for soil coverage. Least soil coverage after harvest lies in residues, predominantly by stalks (Marcelo et al., 2012).

In the case of the maintenance of straw and chaff for the feasibility of NTS, grasses produce great mass volumes. Since they have a high C/N ratio, they endure longer in soil coverage (Noce et al., 2008). Intercropping requires defining grass population so that high population rates of the latter do not impair the development of the main crop and benefit soil coverage.

Species of the genus *Urochloa* are widely used in intercropping for soil coverage during the inter-harvest period or in the formation of pasture within integrated systems. As a rule, *Urochloa* grasses are the main options in chaff formation for NTS due to the production of good dry matter and to high C/N ratio in their composition formed by great lignin concentrations which prolong their decomposition span (Nepomuceno et al., 2012). Machado & Assis (2010) report that *Uruchloa ruziziensis* and *Uruchloa decumbens* may be better employed for soil coverage since they have continuous growth during the dry season and fast drying rates.

Although the sunflower may be intercropped with grass species, negative effects (with loss of productivity) may occur due to greater interspecies competition (Alves et al., 2013). Gontijo Neto et al. (2009) assessed sunflower intercropping with Xaraés, Piatã and Massai cultivars and reported a 27% decrease in sunflower productivity when compared to sunflower crop alone. When Souza et al. (2015) compared sunflower intercropped with *U. ruziziensis* planted in the first fortnight in February, they registered a 540 kg ha^{-1} (1180.0 – 1720.0 kg ha^{-1}) increase in sunflower productivity in contrast to sunflower crop alone. The above signaled the need for more in-depth studies on the intercropping sunflower culture to define the correct parameters for the system´s best efficiency.

Sunflower intercropping with grass has become an interesting technique to solve the issue of low vegetal coverage after harvest within the sunflower crop alone system. However, the system´s influence on crop development and productivity should be evaluated to avoid possible negative effects on it. Current assay assessed the influence of intercropping in agronomic performance and productivity of the sunflower under different populations of *Urochloa ruziziensis* in the Campo Novo do Parecis region.

Material and methods

Current assay was performed in Campo Novo do Parecis MT Brazil, in the second 2016/2017 harvest. The area lies at 13º40'37" S and 57º47'30"' W and altitude 564 m. The soil of the experimental area is typical dystrophic Red-Yellow Latosol, following the Brazilian Soil Classification System (Embrapa, 2013). According to Köppen´s classification (Vianello & Alves, 2004), local climate is Aw, or rather, tropical climate with a well-defined dry season between May and September. The dry and rainy seasons are well-defined, the former between May and September, the latter between October and April (Dallacort et al., 2011). Figure 1 provides data on mean rainfall and temperature rates during the experimental period. Mean rates were 31.0; 23.2 and 18,2 ºC for maximum, mean and minimum temperatures, respectively; rainfall reached 510.4 mm during the experimental period, complying with sunflower´s water demands, between 500 and 700 mm, regularly distributed throughout the cycle (Castro & Farias, 2005).

The experiment consisted of randomized blocks with six treatments (seeding rates of *U. ruziziensis*), with four replications. Treatments comprised 0, 200, 400, 600, 800 and 1000 scores of crop value (CV) per ha^{-1}. To calculate number of seeds, CV percentage was determined by Equation 1 (Gontijo Neto et al., 2006):

$$CV\ (\%) = (\%\ purity \times \%\ germination) / 100 \qquad (1)$$

Wherein: % purity is the physical quality of *U. ruziziensis* seeds, or rather, the number of *U. ruziziensis* seeds on total number of seeds of the sample, including dirt (stones and chaff); % germination is the number of viable seeds.

Quantity of seeds was calculated by Equation 2 (Gontijo Neto et al., 2006):

$$AS\ (kg\ ha^{-1}) = SCV / CV\ (\%) \qquad (2)$$

Wherein: AS is the amount of seeds (kg ha^{-1}); CV score is the desired seeding rate.

Since *U. ruziziensis* seed is 100% pure and 88% germination, amount of seeds for CV scores were 2.27; 4.55; 6.82; 9.09 and 11.36 kg ha^{-1} respectively for 200, 400, 600, 800 and 1000 SCV.

The planting of sunflower, cultivar Helio 250, was done mechanically with broadcast spreader on 10-03-2017. Splits comprised six 7 m rows, spaced 0.45 m, with 45,000 plants ha^{-1}. Useful area comprised two central rows, excluding 1 m from each edge. *U. ruziziensis* was seeded manually, posterior to seeding of sunflower, followed by surface incorporation by rake. The sunflower plant emerged some 5 days after seeding (DAS) and *U. ruziziensis* emerged between 8 and 20 DAS.

Basic fertilization for sunflower requirements complied with recommendations by Leite et al. (2005) through the chemical analysis of soil. The following were applied: 10 kg ha^{-1} N; 70 kg ha^{-1} P_2O_5; 60 kg ha^{-1}

K_2O; 2 kg ha^{-1} B. Source comprised the formula 10-30-20 in a dose of 200 kg ha^{-1}, plus 10 kg ha^{-1} P_2O_5 (simples super phosphate) and 20 kg ha^{-1} K_2O (potassium chloride). Fertilization with B had Borosol as source (14.6% B). Fertilization of nitrogen coverage at a dose of 60 kg ha^{-1} (urea) was performed after 30 days after emergence (DAE) of the sunflower.

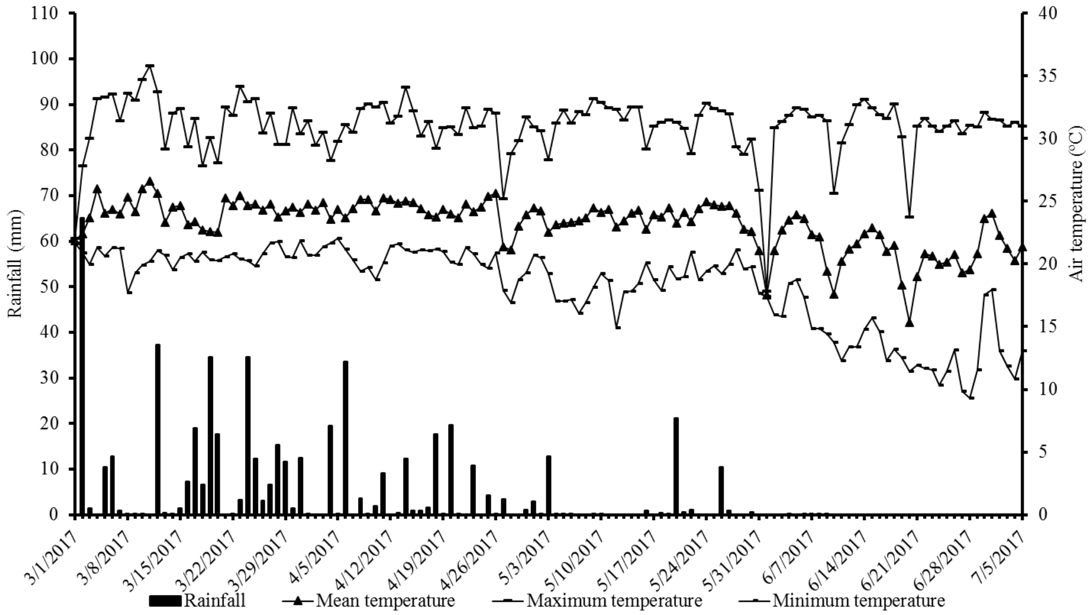

Figure 1 - Rainfall and mean air temperatures in the experimental area during 2017.

Weed control was done manually at 7, 20 and 35 DAE. Pest and disease control was achieved by constant monitoring of the area. Control of inspect-pests, such as cucurbit beetle (*Diabrotica speciosa*), sunflower patch (*Chlosyne lacinia*) and scarab beetle (*Cyclocephala melanocephala*), was performed by two applications of thiamethoxam + lambda cyhalothrin (141 g L^{-1} + 106 g L^{-1} i.a., respectively) at dose 250 mL ha^{-1} at stages V4 and V6 of the plant; one application of alpha-cypermithrin (1000 g L^{-1} i.a.) at dose 100 mL ha^{-1} at stage R1; and one application of acephate (750 g kg^{-1} i.a.) at dose 1 kg ha^{-1} at stage R5. Difeconazole (250 g L^{-1} i.a.) was applied twice for the control of *Alternaria helianthi*, at dose 0.3 L ha^{-1}, at stages V6 and R1. Applications were done with shoulder pump with compressed CO_2 at constant pressure of 413,69 kPa (60 psi).

Sunflowers were harvested manually with pruning shears on 05/07/2017 when the crop reached phenological stage R9 (physiological maturity). The crop was left to dry naturally; it was then weighed and corrected for humidity at 11% (hb), following Dalchiavon et al. (2011). The agronomic characteristics in R5.5 (full bloom) in five plants per split comprised plant height (PLH; cm), measured by tape, from soil level to the highest tip of the plant; stalk diameter (STD; mm), measured by caliper from 5 cm above soil level; shoot dry mass (DMA; t ha^{-1}), after drying of plants in an oven at 105 ºC. Five capitula in R9 were evaluated: diameter of the capitulum (DCA; cm) by tape; mass of capitulum (MCA; g) and mass of achene per capitulum (MAC, g) by a semi-analytic scale (sensitiveness 0.001 g); number of achenes per capitulum (NAC), by grain counter (Modelo NV-C/01); mass of one thousand achenes (MTA, g); harvest index (HRI), by dividing the mass of achenes by the mass of the capitula. Productivity of achenes (PRA, kg ha^{-1}) was obtained by the production of all plants within the split´s useful area.

Data underwent analysis of variance ($p<0.05$) and regression, with SISVAR (Ferreira, 2011).

Results and discussion

There was no influence of treatments on the development of the sunflower (Table 1). Analysis of variance was not significant and mathematic regressions had no statistical significance. Coefficients of variance (CV) for agronomic characteristics of the sunflower were classified low or average, following classification suggested by Pimentel-Gomes (2009). They were similar to those reported by Souza et al. (2015) and Santos et al. (2016), who evaluated the agronomic characteristics of the sunflower intercropping species of the genus *Urochloa*.

Lack of influence of seeding rates of *U. ruziziensis* on the sunflower´s characteristics (Tables 1 and 2) is due to the slow initial development of the grass when compared to that of the sunflower, registered by Timossi et al. (2007). The authors reported slow initial development of the species of the genus *Urochloa*. Similarly, Pacheco et al. (2008) observed low rates for plant height in species of the genus *Urochloa* when compared to millet, yardgrass and sorghum 30 days after seeding (DAS) and in four seeding periods.

Pacheco et al. (2008) stated that, whereas mean heights of the four periods for the species *Urochloa* (*ruziziensis*, *decumbens* and *brizantha*) were respectively 12.64, 14.88 and 14.4 cm, height of millet reached 18.05 cm, yardgrass reached 19.21 cm and sorghum reached 29.49 cm, or rather, higher rates than those by *Urochloa* species. Further, Pacheco et al. (2011) insisted that species of the genus *Urochloa* (*ruziziensis* and *brizantha*) at 60 and 75 DAS had the lowest dry matter rates when compared to millet. After this period, accumulation of the two was higher than that of millet and confirmed the slow initial growth of *Urochloa*.

Table 1 - Summary of analyses of variance for plant height (PLH), stem diameter (STD), dry mass of the aerial part (DMA), diameter of the capitulum (DCA), mass of achenes per capitulum (MAC), number of achenes per capitulum (NAC), mass of one thousand achenes (MTA), harvest index (HRI) and productivity of achenes (PRA) (Campo Novo do Parecis - MT, 2017)

Characteristics	F value[1]	CV (%)[2]	GA[3]
PLH (cm)	0.29	7.21	167.1
STD (mm)	1.08	7.68	23.8
DMA (t ha^{-1})	0.96	15.66	6.11
DCA (cm)	0.17	8.96	16.6
MAC (g)	0.71	22.28	41.5
NAC	0.45	14.23	1003
MTA (g)	0.21	12.53	56.9
HRI	0.96	14.63	0.44
PRA (kg ha^{-1})	1.35	12.56	2766.6

[1] significant at 5% probability, [2]CV = Coefficient of variation; [3] GA = general average.

Table 2 – Means of the treatments for plant height (PLH), stem diameter (STD), aerial part dry mass (DMA), diameter of the capitulum (DCA), mass of achenes per capitulum (MAC), number of achenes per capitulum (NAC), mass of one thousand achenes (MTA), harvest index (HRI) and productivity of achenes (PRA) (Campo Novo do Parecis - MT, 2017).

Characteristics	Seeding rates					
	0	200	400	600	800	1000
PLH (cm)	171.3	169.3	166.2	162.5	168.8	164.7
STDT (mm)	22.26	24.88	23.15	24.5	24.13	23.98
DMA (t ha^{-1})	6.06	6.52	5.40	6.55	5.72	6.38
DCA (cm)	16.5	16.6	17.1	16.6	16.7	16.2
MAC (g)	47.6	41.4	43.0	41.2	35.7	40.0
NAC	986	1069	1002	1015	925	1025
MMA (g)	57.1	57.2	58.0	59.0	54.7	55.3
HRI	0.50	0.41	0.44	0.42	0.44	0.45
PRA (kg ha^{-1})	2721.9	3138.0	2847.8	2609.3	2670.1	2612.9

Regard to competition with other species, the sunflower crop is efficient 30 days after emergence. According to Silva et al. (2013), the plant exerts crop control and overshadows the other species. However, since in current analysis seedlings of *U. ruziziensis* started to emerge only 8 DAS, or rather, 3 DAE of sunflower seedlings, a low scale interspecies competition ensued, with low negative effects on the sunflower development.

It should be underscored that total prevention period against interference (PPAI), or rather, the period in which the crop should be maintained free of weeds, is approximately 39 DAE in the summer and 34 DAE in the winter. Consequently, weeds that infest the area after this period do no cause any significant damage to the crop (Silva et al., 2013). The above corroborates reports by Alves et al. (2013) who registered that PPAI was 37 and 43 DAE respectively for genotypes Embrapa 122 and Helio 358.

The non-interference of intercropping on the sunflower development may be due to the fact that *U. ruziziensis* has a slow development up to 60 DAS and also to the fact that the sunflower is an efficient crop competing with other species as from 30 DAS, corroborating evidence by Timossi et al. (2007) and Pacheco et al. (2008). Further, Souza et al. (2015) did not report any influence of intercropping (sunflower + *U. ruziziensis*) as a single factor in the sunflower´s characteristics. However, interaction between intercropping and seeding period and between intercropping and spacing between rows (0.45 and 0.90 m) was influential and demonstrated that intercropping influence is related to other factors in the system.

In their research in which they evaluated productive and nutritional characteristics of sunflower and *U. brizantha* in different forager systems and in offseason intercropping in Rio Verde GO Brazil, Santos et al. (2016) reported differences in the productivity of achenes only when intercropping occurred on the same seeding row of the sunflower. One may conclude that the intercropping of sunflower and species of the genus *Urochloa* is feasible to produce chaff impairing the development and productivity of the sunflower crop.

Further studies may be undertaken involving technical factors such as spacing, plant populations, intercropping by different species, delayed seeding when compared to simultaneous one, seeding periods and others that affect the system. Research would repeat assays in consecutive years to evaluate the influence of environmental factors and take into account eventual climatic difference between agricultural years.

Conclusion

The development and productivity of the sunflower are not affected by seeding rates of *Urochloa ruziziensis* when seeded simultaneously.

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