CROP ROTATION WITH CROTALARIA OCHROLEUCA AND UROCHLOA RUZIZIENSIS FOR THE MANAGEMENT OF PLANT-PARASITIC NEMATODES IN SUGARCANE

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ABSTRACT

Plant-parasitic nematodes cause extensive damage each year to sugarcane crops in Brazil. Since it is almost impossible to eradicate nematodes in a field, several practices must be used to manage an infested area, including growing cover crops between sugarcane cycles. This study aimed to determine the effects of *Crotalaria ochroleuca* and *Urochloa ruziziensis* during sugarcane renewal field on the nematode population in subsequent sugarcane roots and soil. Growing *C. ochroleuca* between sugarcane cycles contributes to reducing populations of *Meloidogyne incognita* and a mixed population of *Pratylenchus zeae* and *P. brachyurus* in sugarcane roots and soil at least throughout the first two months after planting. On the other hand, growing *U. ruziziensis* between two sugarcane cycles does not affect the *M. incognita* and *P. zeae* populations in sugarcane roots.

Keywords: cover crops, sun hemp, grass, *Saccharum spp.*

RESUMO

Nematoides parasitos de plantas causam danos significativos à cana-de-açúcar no Brasil. Visto ser quase impossível eliminar esses parasitos do solo, é necessário adotar várias práticas para o manejo de áreas infestadas, entre as quais o plantio de culturas de cobertura entre dois ciclos de cana-de-açúcar. Este estudo teve como objetivo avaliar os efeitos do cultivo de *Crotalaria ochroleuca* e *Urochloa ruziziensis* em áreas de reforma de canaviais sobre as populações de nematoides no solo e nas raízes da cana-de-açúcar plantada em sequência. O plantio de *C. ochroleuca* contribuiu para reduzir as populações de *Meloidogyne incognita* e de populações mistas de *Pratylenchus zeae* e *P. brachyurus* no solo e nas raízes da cana-de-açúcar pelo menos nos primeiros dois meses após o plantio. Por outro lado, o cultivo de *U. ruziziensis* entre dois ciclos de cana-de-açúcar não interferiu nas populações de *M. incognita* e de *P. zeae* nas raízes da cana-de-açúcar.

Palavras-chave: plantas de cobertura, crotalária, braquiária, *Saccharum spp.*

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INTRODUCTION

Plant-parasitic nematodes can reduce sugarcane productivity by up to 40% in the first cycle (plant-cane), reaching more than 50% in cases of high population and very susceptible cultivars in addition to reducing the productivity of ratoons and, consequently, the number of consecutive ratoon crops (BARBOSA et al., 2013; Dinardo-Miranda, 2018).

Since it is almost impossible to eradicate nematodes in a field, several practices must be used to manage an infested area, including growing cover crops between sugarcane cycles (ROSA et al., 2003; DINARDO-MIRANDA & GIL, 2005; AMBROSANO et al., 2011).

For many years, *Crotalaria juncea* L. was the most frequently cultivated cover crop between sugarcane cycles, due to its vigorous growth, good ground coverage, and relatively short cycle, suitable for the period between one sugarcane crop and the next (DINARDO-MIRANDA, 2018). There are numerous reports on the effects of *C. juncea* on reducing the populations of plant-parasitic nematodes, especially *Meloidogyne* spp. (SOARES & NASCIMENTO, 2021). However, studies conducted on fields in Brazil, such as Dinardo-Miranda and Gil (2005) and Ambrosano et al. (2011), where *C. juncea* was cultivated as a cover crop between two sugarcane cycles, showed that *C. juncea* did not interfere with *Meloidogyne* populations on subsequent sugarcane roots, but increased the *P. zeae* population. Regardless, crop rotation with *C. juncea* contributed to increasing sugarcane yield due to the advantages of green manure, such as nitrogen fixation, increasing soil organic matter.

Similarly, Rosa et al. (2003) cultivated *C. juncea* during the renewal of the sugarcane crop. They observed that *M. incognita, M. javanica*, and *P. zeae* populations on sugarcane roots 90 days after its planting were similar to the check plots where crop rotation was not applied. On the other hand, those authors did not observe crop rotation effects on sugarcane yield.

More recently, growers have chosen *Crotalaria ochroleuca* G. Don and *Urochloa ruziziensis* (Gem & C. M. Evrard) as cover crops between sugarcane cycles because they grow in chemically poor soils with low organic matter content (AMABILE et al., 2000). *Urochloa ruziziensis* stands out due to its tolerance to high temperature, its active and continuous root growth, but with few clumps formation, facilitating its management with herbicides, and high biomass production, which protect the soil from erosion (PACHECO et al., 2011). Since *C. ochroleuca* and *U. ruziziensis* can multiply certain important nematode species for sugarcane (Chidichima et al., 2020; Soares & Nascimento, 2021), this study aimed to determine the effects of *C. ochroleuca* and *U. ruziziensis* on nematode populations in subsequent sugarcane roots and soil.

MATERIALS AND METHODS

Three experiments were conducted in sandy soil areas, in Serrana São Paulo State, where a previous survey showed the extent of the nematode problem. In the area of Experiment 1, the sugarcane ratoon was destroyed in August 2019 and on November 16, 2019, 12 plots 9 m wide × 600 m long were demarcated. *Crotalaria ochroleuca* was sown in six of them, while the other six remained without plants. On January 29, 2020, *C. ochroleuca* was incorporated into the soil. In the plots where *C. ochroleuca* was not sown, the soil was harraowed to destroy weeds. Then, the CTC9001 sugarcane variety was planted in all plots in furrows spaced 1.5 m apart. Each plot consisted of six furrows each 600 m long, having received one of two treatments: with and without rotation with *C. ochroleuca*. The experiment was arranged in a randomized block design with six replications.

In experiments 2 and 3 areas, the sugarcane ratoon was destroyed in August 2019. In experiment 2, on November 26, 2019, 12 plots of 12 m wide × 600 m long were demarcated and *U. ruziziensis* was sown in six plots, while the other six remained without plants. In experiment 3, on November 29, 2019, 24 plots of 12 m wide × 600 m long were demarcated and *U. ruziziensis* was sown in 12 plots, while the other 12 remained without plants. On January 27, 2020 in experiment 2 and on February 15, 2020 in experiment 3, glyphosate 1000 g i.a./ha $^{-1}$ was applied to all plots to kill *U. ruziziensis* and weeds. In experiment 2, on February 2, 2020, the CTC15 sugarcane variety was planted in all plots. Meanwhile in experiment 3, the CTC9001 sugarcane variety was planted on March 06, 2020. Thus, in both experiments, the sugarcane plots were represented by nine furrows with 600 m, spaced apart by 1.5 m, receiving one of two treatments: with and without rotation with *U. ruziziensis*. The experiments were arranged in a randomized block design with six (experiment 2) and 12 replications (experiment 3).

The nematode populations were evaluated two, four and twelve months after planting. In all experiments, in each sampling, along each plot, three samples were collected, each comprising two subsamples of soil and sugarcane roots spaced apart by around 4 m. Nematodes were extracted from the 1-L soil and 50 g roots by combining sieving and centrifugation with sucrose solution (Coolen & D'Herde, 1972; Jenkins, 1964).

For statistical analysis, the population data was transformed using the square root of (x + 1). All data underwent analysis of variance, considering, in each experiment, a randomized block design with six (experiment 1 and 2) or 12 blocks (experiment 3) and three replicates within each block. The means were compared by the Tukey test at 5 % significance using the Agroestat software program (BARBOSA & MALDONADO, 2015).

RESULTS AND DISCUSSION

Among the most important nematode species for sugarcane, *Meloidogyne incognita, Pratylenchus zeae* and *P. brachyurus* were found in Experiment 1; *M. incognita* and *P. zeae* in Experiment 2; and *P. zeae* in experiment 3.

In experiment 1, two months after sugarcane planting, population densities of *M. incognita* and a mixed population of *P. zeae* and *P. brachyurus* were lower on sugarcane roots in plots where crop rotation with *C. ochroleuca* was performed than in plots without rotation. At four and twelve months after planting, *M. incognita* and *P. zeae* + *P. brachyurus* populations were higher in sugarcane roots and soil than at two months in both treatments. At four months, these populations were still lower in sugarcane roots in plots where *C. ochroleuca* rotation was performed. However, no differences were observed between treatments. Nevertheless, twelve months after planting, there were no differences between the two treatments regarding the nematode populations in the roots and soil (Table 1).

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Table 1. Second-stage juvenile population *of Meloidogyne incognita* (Mi) and adult and juvenile populations of *Pratylenchus zeae* and *Pratylenchus brachyurus* (Pz+Pb) in sugarcane roots (50 g) and in the soil (1 L) at two, four and twelve months after planting, according to crop rotation with or without *Crotalaria ochroleuca* between two sugarcane cycles (during field renewal) in Experiment 1.

Treatment	2 months				4 months				12 months			
	roots		soil		roots		soil		roots		soil	
	Mi	Pz+Pb	Mi	Pz+Pb	Mi	Pz+Pb	Mi	Pz+Pb	Mi	Pz+Pb	Mi	Pz+Pb
With crop rotation	205	1286	237	30	2639	13948	380	676	4629	11333	3235	1960
	a	a	a	a	a	a	a	a	a	a	a	a
Without crop rotation	654	2877	443	80	4179	20489	500	866	992	14858	1835	1705
	b	b	a	a	a	a	a	a	a	a	a	a

Means within the same column followed by the same letter do not differ significantly according to the Tukey's test, $p \leq 0.05$.

The results obtained here showed that growing *C. ochroleuca* between sugarcane cycles contributed to reducing populations of root-knot and lesion nematodes in sugarcane roots and soil at least during the first two months after planting. Considering that plants, in general, are more susceptible to damage caused by nematodes at the beginning of their development, the fact that nematode populations remained lower in areas where *C. ochroleuca* was used as a cover crop for at least two months after planting likely contributed to sugarcane development.

C. ochroleuca reduces nematode populations because it is resistant or immune to *P. brachyurus* (INOMOTO et al., 2006; VEDOVETO et al., 2013; COSTA et al., 2014; CRUZ et al., 2020) and *M. incognita* (LOPES et al., 2019). However, it is susceptible to *P. zeae* (DESAEGER & RAO, 2003). Moreover, *Crotalaria* species contribute to nematode population reduction by acting as trap plants. They allow nematodes to penetrate the roots but do not permit subsequent development. Furthermore, they produce pyrrolizidine alkaloids, such as monocrotaline, which are toxic to nematodes (VEDOVETO et al., 2013).

The results observed here, in which crop rotation with *C. ochroleuca* decreased nematode populations in sugarcane roots, differed from those reported by Dinardo-Miranda and Gil (2005), who worked with *C. juncea*. These authors reported that growing *C. juncea* for five months between two sugarcane cycles did not interfere with *M. javanica* populations on subsequent sugarcane roots. Instead, it increased the *P. zeae* population. Ambrosano et al. (2011) also observed that the *Pratylenchus* spp. population was higher in sugarcane roots in plots where crop rotation with *C. juncea* was performed than in plots with no rotation. A possible reason for the differences between *C. juncea* and *C. ochroleuca* regarding the reduction of the nematode population in the subsequent sugarcane crop may be the amount and types of alkaloids produced. Different *Crotalaria* species produce several types and quantities of alkaloids, such as pyrrolizidines, which have a nematicidal effect (RECH et al., 2024).

In Experiment 2, the populations of *M. incognita* and *P. zeae* in the sugarcane roots and soil were similar in plots where crop rotation with *U. ruziziensis* was performed and in plots without crop rotation (Table 2). Furthermore, growing *U. ruziziensis* between two sugarcane cycles did not affect the *P. zeae* populations in soil and sugarcane roots planted in sequence, in Experiment 3 (Table 3).

Table 2. Second-stage juvenile population *of Meloidogyne incognita* (Mi) and adult and juvenile populations of *Pratylenchus zeae* (Pz) in sugarcane roots (50 g) and in soil (1 L) at two, four and twelve months after planting, according to crop rotation with *Urochloa ruziziensis* or without between two sugarcane cycles in Experiment 2.

Treatment	2 months				4 months				12 months			
	roots		soil		roots		soil		roots		soil	
	Mi	Pz	Mi	Pz	Mi	Pz	Mi	Pz	Mi	Pz	Mi	Pz
With crop rotation	13	2125	47	150	50	2447	10	97	925	4136	330	1093
	a	a	a	a	a	a	a	a	a	a	a	a
Without crop rotation	19	1797	70	117	596	4046	76	127	652	4172	216	733
	a	a	a	a	a	a	a	a	a	a	a	a

Means within the same column followed by the same letter do not differ significantly according to the Tukey's test, $p \leq 0.05$.

Table 3. Adult and juvenile populations of *Pratylenchus zeae* (Pz) in sugarcane roots (50 g) and in soil (1 L) at two, four and twelve months after planting, according to crop rotation with *Urochloa ruziziensis* or without between two sugarcane cycles in Experiment 3.

Treatment	2 months		4 months		12 months	
	roots	soil	roots	soil	roots	soil
With crop rotation	4372	368	4089	198	8390	3737
	a	a	a	a	a	a
Without crop rotation	4345	421	5503	253	13202	3922
	a	a	a	a	a	a

Means within the same column followed by the same letter do not differ significantly according to the Tukey's test, $p \leq 0.05$.

The results obtained in Experiment 2 regarding *M. incognita* differ from those observed by Dias-Arieira et al. (2003), who observed that growing *U. ruziziensis* for 60 days reduced *M. incognita* and *M. javanica* populations in tomato roots planted afterward, although the reduction was lower than other grass species, such as *Urochloa brizantha* and *U. decumbens*.

In Experiment 2, the inclusion of *U. ruziziensis* in a crop rotation system did not promote a reduction in *M. incognita* populations, since the populations of this species in the roots of sugarcane in rotated and non-rotated plots were similar. Considering that *U. ruziziensis* is not a good host for *M. incognita*, as revealed by Dias-Arieira et al. (2023), the data obtained in Experiment 2 showed that the CTC9001 sugarcane variety is a good host for this species and, by remaining in the field for long periods, the populations of *M. incognita* gradually increased, reaching the high values observed in experiment. If *U. ruziziensis* had been cultivated for a period longer than that used in Experiment 2 (60 days), perhaps the population reduction of *M. incognita* could have been perceived in the sugarcane field cultivated subsequently.

Pratylenchus zeae is often cited as an important parasite of grasses (Poaceae), including those of the genus *Urochloa* (CARVALHO et al., 2013; BELLÉ et al., 2017). However, there is no information regarding the host reaction of *U. ruziziensis* to *P. zeae*. In the present study, growing *U. ruziziensis* between two sugarcane cycles did not interfere with *P. zeae* populations in sugarcane roots grown subsequently. It is

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possible that, in the area without crop rotation with *U. ruziziensis,* weeds, mainly grasses, grew abundantly, and many of them are also good hosts for *P. zeae*.

CONCLUSION

Crop rotation with *C. ochroleuca* reduces *M. incognita* and *P. zeae* and *P. brachyurus* in sugarcane roots and soil at least during the first two months after sugarcane planting. Meanwhile, growing *U. ruziziensis* between two sugarcane cycles does not interfere with *M. incognita* and *P. zeae* populations in sugarcane roots.

REFERENCES

AMABILE, R.F.; FANCELLI, L.A.; CARVALHO, A.M. et al. 2000. Comportamento de espécies de adubos verdes em diferentes épocas de semeadura e espaçamentos na região dos Cerrados. **Pesquisa Agropecuária Brasileira**, v. 35, n.1, p. 47-54.

AMBROSANO, E.J.; CANTARELLA, H; AMBROSANO, G.M.B.; SCHAMMAS, E.A.; DIAS, F.L.F; ROSSI, F.; TRIVELIN, P.C.O.; MURAOKA, T.; SACHS, R.C.C.; AZCÓN, R. 2011. Produtividade da cana-de-açúcar após o cultivo de leguminosas. **Bragantia,** v. 70, v.4, p. 810-818.

BARBOSA, B.F.F.; SANTOS, J.M.; BARBOSA, J.C.; SOARES, P.L.M.; RUAS, A.R.; CARVALHO, R.B. 2013. Aggressiveness of *Pratylenchus brachyurus* to sugarcane, compared with key nematode *P.zeae*. **Nematropica**, v. 43, n. 1, p. 119-130.

BARBOSA, J. C.; MALDONADO JR., W. 2011. **AgroEstat. Sistema para análise estatística de ensaios agronômicos, Versão 1.1.0626.** Jaboticabal: FCAV/UNESP.

BELLÉ, C.; KULCZYNSKI, S.M.; KUHN, P.R.; DONINI, L.P.; GOMES, C.B. 2017. Reaction of sugarcane genotypes to parasitism of *Meloidogyne javanica* and *Pratylenchus zeae*. **Revista Caatinga**, v. 30, p. 530-535, 2017. Doi: 10.1590/S0100-83582017350100006.

CARVALHO, C.; FERNANDES, C.D.; SANTOS, J.M.; MACEDO, M.C.M. 2013. Densidade populacional de *Pratylenchus* spp. em pastagens de *Brachiaria* spp. e sua influência na disponibilidade e na qualidade da forragem. **Revista Ceres**, v. 60, n.1, p. 30-37.

CHIDICHIMA, L.P.S.; GOMES, C.B.; LOPES, A.P.M.; MIAMOTO, A.; SOARES, M.R.C.; SILVA, R.A.; DIAS-ARIEIRA, C.R. 2010. **Reação de espécies de** Crotalaria **a diferentes populações de** Meloidogyne javanica. Pelotas: Embrapa Clima Temperado, 2020, 15 p. (Boletim Técnico 338).

Coolen, W.A.; D’Herde, C.J. 1972. **A method for the quantitative extraction of nematodes from plant tissue.** Ghent: State Nematology and Entomology Research Station. 1972.

COSTA, M.J.N.; PASQUALLI; PREVEDELLO, R. 2014. Effect of soil organic matter content, cover crop and planting system on the control of *Pratylenchus brachyurus* in soybean. **Summa Phytopathologica**, v.40, n.1, p.63-70.

CRUZ, T.T.; ASMUS, G.L.; GARCIA, R.A. 2020. *Crotalaria* species in succession to soybean for the management of *Pratylenchus brachyurus.* **Ciência Rural**, v.50, n.7, e20190645. Doi: 10.1590/0103-8478cr20190645

DESAEGER, J.; RAO, M.R. 2003. Significance of lesion and spiral nematodes in *Crotalaria*–maize rotation in western Kenya. **Nematropica**, v. 33, n.1, p. 27-39.

DIAS-ARIEIRA, C.R, FERRAZ, S.; FREITAS, L.G.; MIZOBUTSI, E.H. 2003. Avaliação de gramíneas forrageiras para o controle de *Meloidogyne incognita* e *M. javanica* (Nematoda). **Acta Scientiarum**, v. 25, n. 2, p.473-477.

Dinardo-Miranda, L.L. 2018. **Nematoides e pragas da cana-de-açúcar.** 2. ed**.** Campinas: Instituto Agronômico. 440p.

DINARDO-MIRANDA, L.L.; GIL, M.A. 2005. Efeito da rotação com *Crotalaria juncea* na produtividade da cana-de-açúcar, tratada ou não com nematicidas no plantio. **Nematologia Brasileira**, v. 29, n.1, p. 63-66.

INOMOTO, M. M.; MOTTA, L.C.C.; BELUTI, B.D.; MACHADO, A.C.Z. 2006. Reação de seis adubos verdes a *Meloidogyne javanica* e *Pratylenchus brachyurus*. **Nematologia Brasileira**, v. 30, n.1, p. 39-44.

Jenkins, W.R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. **Plant Disease Reporter,** v.48, p.692.

LOPES, A.P.M.; SOARES, R.M.C.; CHIDICHIMA, L.P.S.; DIAS-ARIEIRA, C.R. 2019 Weed hosts of Meloidogyne spp. and the effect of aqueous weed extracts on egg hatching. **Weed Research.** Doi: 10.1111/wre.12399.

PACHECO, L. P.; LEANDRO, W.M.; MACHADO, P.L.O.A.; ASSIS, R.L.; COBUCCI, T.; MADARI, B.E.; PETTER, F.E. 2011. Produção de fitomassa e acúmulo e liberação de nutrientes por plantas de cobertura na safrinha. **Pesquisa Agropecuária Brasileira**, v. 46, n.1, p.17–25.

RECH, C.; RIBEIRO, L.P.; BENTO, J.M.S.; POTT, C.A.; NARDI, C. 2024. Monocrotaline presence in the Crotalaria (Fabaceae) plant genus and its influence on arthropods in agroecosystems. **Brazilian Journal of Biology,** v. 84, e256916. Doi: 10.1590/1519-6984.256916.

ROSA, R.C.T.; MOURA, R.M.; PEDROSA, E.M.R. 2003. Efeitos do uso de *Crotalaria juncea* e carbofuran observados na colheita de cana planta. **Nematologia Brasileira**, v.27, n.1, p.167-171.

SOARES, P.L.M.; NASCIMENTO, D.D. 2021. Integrated nematode management of root lesion and root-knot nematodes in soybean in Brazil. In: SIKORA, R.A. et al. **Integrated Nematode Management: State-of-the-art and visions for the future**. CAB International. Cap. 15, p. 103-110.

VEDOVETO, M.V.V.; DIAS-ARIEIRA, C.R.; RODRIGUES, D.B.; ARIEIRA, J.O.; ROLDI, M.; SEVERINO, J.J. 2013. Adubos verdes no manejo de *Pratylenchus brachyurus* em soja. **Nematropica,** v. 43, n. 2, p. 226–232.

WANG, K.H. et al. Crotalaria as a cover crop for nematode management. **Nematropica**, v. 32, n.1, p. 35–57.

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