RESPONSE OF SOYBEAN CULTIVARS TO *PRATYLENCHUS ZEAE*

E. J. Silva, A. S. Melo, G. Tarini, R. P. Schwengber,
C. Y. Futigami, B. A. Silva, and C. R. Dias-Arieira*

Universidade Estadual de Maringá, Centro de Ciências Agrárias, Campus Regional de Umuarama, 87507-290, Umuarama, PR, Brasil. *Corresponding author: crdarieira@uem.br

ABSTRACT

Silva, E. S., A. S. Melo, G. Tarini, R. P. Schwengber, C. Y. Futigami, B. A. Silva, and C. R. Dias-Arieira. 2020. Response of soybean cultivars to *Pratylenchus zeae*. Nematropica 50:211-217.

In Brazil, soybean is commonly rotated with Poaceae plants, especially maize and brachiaria, which are susceptible to root-lesion nematodes, *Pratylenchus* spp. This study assessed the response of soybean cultivars to *Pratylenchus zeae* in a comparative analysis with *Pratylenchus brachyurus*. The experiment was conducted in a greenhouse, with 12 treatments (soybean cv. DM 5958 IPRO, NS 5959 IPRO, TMG 7262 RR, BMX Potência RR, M5947 IPRO, TMG 7062 IPRO, M6410 IPRO, M6210 IPRO, M5917 IPRO, and NA 5909 RG, with rice and maize as controls) and two evaluation periods. Four soybean cultivars were reevaluated in another experiment to determine the reproduction and penetration of *P. zeae*. Reproduction of *P. zeae* on soybean was lower than that of *P. brachyurus*. However, total number of *P. zeae* in the roots of soybean cv. DM 5958 IPRO, NS 5959 IPRO, and M6210 IPRO was close to the number of nematodes inoculated, demonstrating that *P. zeae* can penetrate and maintain its population on this crop. Similar results were observed in the third experiment, especially for cv. M6210 IPRO. *Pratylenchus zeae* penetrated soybean roots and population density increased with time, however, population density increase was lower than on maize. The results show that *P. zeae* population densities should be closely monitored in fields with a soybean-poaceous rotation.

Key words: Glycine max, lesion root nematode, resistance

RESUMO

Silva, E. S., A. S. Melo, G. Tarini, R. P. Schwengber, C. Y. Futigami, B. A. Silva, e C. R. Dias-Arieira. 2020. Reação de cultivares de soja *Pratylenchus zeae*. Nematropica 50:211-217.

O cultivo de soja no Brasil envolve sistemas de sucessão com poáceas, como milho e braquiária, as quais são suscetíveis ao nematoide das lesões radiculares. Assim, objetivou-se avaliar a reação de cultivares de soja a *P. zeae*, numa análise comparativa com *P. brachyurus*. O experimento foi conduzido em casa de vegetação, com 12 tratamentos (soja cultivares DM 5958 IPRO, NS 5959 IPRO, TMG 7262 RR, BMX Potência RR, M5947 IPRO, TMG 7062 IPRO, M6410 IPRO, M6210 IPRO, M5917 IPRO e NA 5909 RG e arroz e milho como testemunhas), em duas épocas distintas. Quatro cultivares de soja foram reavaliadas em um terceiro experimento, quanto à reprodução e penetração de *P. zeae*. As cultivares de soja foram menos suscetíveis a *P. zeae* do que as testemunhas e a reprodução do nematoide na soja foi inferior àquela observada para *P. brachyurus*. As cultivares DM 5958 IPRO, NS 5959 IPRO e M6210 IPRO, apresentaram população final próxima ao número de indivíduos inoculados. Resultados semelhantes foram observados no terceiro experimento, especialmente para M6210 IPRO. Houve penetração e aumento da população de

P. zeae nas raízes de soja, ainda que inferior ao milho. O nível populacional desta espécie em áreas de cultivo de soja deverá ser monitorado quando em sucessão com poáceas.

Palavras-chave: Glycine max, nematoide das lesões radiculares, resistência

INTRODUCTION

Soybean is one of the most important agricultural commodities in Brazil. Because of its economic importance, soybean cultivation has expanded from regions with mild climates and high-fertility soils to regions with medium-textured to sandy soils that are low in organic matter and fertility (Ferreira *et al*., 2015). To remediate poor soil conditions for soybean cultivation, farmers have adopted no-till management, which increases the amount of crop residues on the soil surface and reduces the risks of erosion and nutrient loss, as commonly occurs in conventionally managed areas (Balbinot Junior *et al*., 2009; Ferreira *et al*., 2015; Debiasi *et al*., 2016).

Maize and forage grasses are the most common rotation crops in no-till soybean fields, especially grasses in the genus *Urochloa* (=*Brachiaria*) in integrated crop-livestock systems. This mixed farming system is characterized by rotation or intercropping of grain and pasture species. Plants benefit from the effects of the other crop on soil physicochemical properties (Franchini *et al*., 2014; Ferreira *et al*., 2015). Although crop-livestock systems are characterized by variability in plant species (Torres *et al*., 2014), it is not uncommon that the rotation crops are hosts to nematodes that can also infect soybean.

Integrated crop-livestock systems not only contain soybean but also various Poaceae crops susceptible to root lesion nematode (*Pratylenchus* spp.), such as maize (Inomoto, 2011; Uebel *et al*., 2013; Matias *et al*., 2018) and brachiaria (Inomoto *et al*., 2007; Queiróz *et al*., 2014). It is well known that *P. brachyurus* reproduces well on soybean, maize, and bachiaria (Uebel *et al*., 2013; Queiróz *et al*., 2014; Belle *et al*., 2017; Brida *et al*., 2017), but little is known about the susceptibility of soybean to *P. zeae*.

Pratylenchus zeae is commonly associated with grasses (Biela *et al*., 2015; Santana-Gomes *et al*., 2018) and has been reported as a potential parasite of soybean (Acosta and Malek, 1979; Fourie *et al*., 2001). Recent field analyses of nematodes showed that *P. zeae* was present in several soybean-growing areas, raising concern among agricultural technicians and researchers. However, further research is needed to understand the response of soybean cultivars to *P. zeae*. Therefore, this study aimed to assess the susceptibility of soybean cultivars to *P. zeae* in a comparative analysis with *P. brachyurus*.

MATERIALS AND METHODS

Two experiments (Experiments 1 and 2) were conducted in a greenhouse (23°78′91.17″S 53°25′85.12″W) to evaluate the susceptibility of soybean to *P. zeae* compared with that of *P. brachyurus*. Experiment 1 was conducted between February and May 2017, when the average minimum and maximum temperatures in the greenhouse were 20.5 and 31.5°C, respectively. Experiment 2 was carried out between November 2017 and February 2018, with average minimum and maximum temperatures in the greenhouse of 20.9°C and 30.4°C, respectively. A completely randomized design was used in a 12 × 2 factorial arrangement, with 12 crops (10 soybean cultivars and 2 controls) and 2 nematode species (*P. zeae* and *P. brachyurus*); treatment combinations were replicated six times. The following soybean cultivars were evaluated: DM 5958 IPRO, NS 5959 IPRO, TMG 7262 RR, BMX Potência RR, M5947 IPRO, TMG 7062 IPRO, M6410 IPRO, M6210 IPRO, M5917 IPRO, and NA 5909 RG. Hybrid maize cv. Status and rice cv. IRGA 482 were included as controls.

Each experimental unit consisted of a polystyrene pot containing 700 mL of a 2:1 (v/v) mixture of soil and sand, previously autoclaved at 120°C for 2 hr. Two 2 cm deep holes were made in each pot, and two seeds of soybean, maize, or rice were planted. After germination, the plants were thinned to one per pot. Seven days after germination, two holes (3 cm deep) were made in the soil next to the root system, and 1 mL containing 500 mixed-stage individuals of *P. zeae* or *P. brachyurus* were inoculated into the holes. Nematode inocula were obtained from single-species populations maintained on maize under greenhouse conditions. Nematodes were obtained from roots by maceration and sugar centrifugation using the method of Coolen and D'Herde (1972), and the inocula were calibrated to 500 nematodes/mL using a Peter's counting slide under an optical microscope. The plants were irrigated two to three times a day, as needed.

Eighty days after inoculation, plants were harvested, and shoots discarded. Roots were washed thoroughly, blotted dry on paper towels, and weighed to obtain root fresh weights. Nematodes were then extracted from roots (Coolen and D'Herde, 1972). The total nematode density was determined using a Peter's counting slide under an optical microscope. Total nematode number was divided by the root fresh weight to obtain the nematode population density, expressed as nematodes per gram of root.

A third experiment (Experiment 3) was conducted to assess the response of soybean cultivars (DM 5958 IPRO, NS 5959 IPRO, and M6210 IPRO) with observed higher reproduction of *P. zeae* in Experiments 1 or 2. Soybean cv. TMG 7062 IPRO was also selected because the population density of *P. zeae* on this cultivar was equal to that of *P. brachyurus* in one of the experiments. This experiment was carried out in a completely randomized design with five treatments (four soybean cultivars and maize as the control) replicated five times, under the same conditions as described above. The experimental period was from September to December 2019, when the average minimum and maximum temperatures in the greenhouse were 19.4 and 29.9°C, respectively. At 80 days after inoculation, the plants were collected and evaluated as previously described.

The four soybean cultivars (DM 5958 IPRO, NS 5959 IPRO, M6210 IPRO, and TMG 7062 IPRO) and maize as a control were also evaluated for *P. zeae* penetration in roots. The experiment was conducted under the same conditions described for the other experiments in a completely randomized design with five replications. Plants were collected at 7, 12, 17, and 22 days after inoculation and subjected to nematode analysis. Briefly, roots were washed thoroughly, stained with acid fuchsin (Byrd *et al*., 1983), and stored in acidified glycerin until assessed. Root fragments were placed between two microscope slides and analyzed using an optical microscope at 40× magnification. The number of nematodes inside the roots was determined.

For each experiment, the normality was tested by the Shapiro-Wilk test. Then, to meet normality assumptions, data were transformed to $(x + 0.5)^{1/2}$ and subjected to analysis of variance (ANOVA) at 5% level of significance. Comparisons between cultivars were made using the Scott-Knott test and those between nematode species were performed using the Bonferroni t-test, both at the 5% level of significance. For the nematode penetration experiment, *P. zeae* population density in roots with time was assessed using linear and quadratic regression models. All statistical analyses were performed using Sisvar statistical software (Ferreira, 2011).

RESULTS AND DISCUSSION

Pratylenchus zeae reproduced on rice and maize (positive controls) (Table 1), confirming the viability of the inoculum. Both crops are known to be susceptible to *P. zeae* (Inomoto, 2011; Biela *et al*., 2015; Matias *et al*., 2018). Total *P. zeae* population densities were higher in Experiment 1 compared to Experiment 2. In Experiment 1, all of the soybean cultivars had lower total *P. zeae* densities than the maize and rice controls (Table 1). However, *P. zeae* per gram of root was similar for soybean cv. M6210, TMG 7062, and NS 5959 compared to rice and maize. In Experiment 2, all of the soybean cultivars had lower total *P. zeae* densities than rice, while only some had different *P. zeae* per gram of root than maize. When *P. zeae* population densities per gram of root were considered, in Experiment 1 soybean cvs. M6210, TMG 7062, and NS 5959 had similar densities to those observed in rice and maize. In Experiment 2, all of the soybean cultivars had lower *P. zeae* per gram of root compared to rice and maize (Table 1). No *P. zeae* were recovered from roots of soybean M5947 IPRO or NA 5909 RG in either experiment.

Across the soybean cultivars evaluated, the total density of *P. brachyurus* was higher than for *P. zeae* in both experiments (Table 1). However, when population densities were expressed per gram of root, there was no differences between *P. zeae* and *P. brachyurus* for soybean cv. TMG 7062 IPRO in Experiment 1. Different soybean genotypes have been reported to be susceptible to *P. brachyurus* (Alves *et al*., 2011; Silva *et al*., 2015; Brida *et al*., 2017), including NS 5959 IPRO, BMX Potência RR, and NA 5909 RG with reproduction factors of 1.4, 1.8, and 2.4,

Table 1. *Pratylenchus zeae* (Pz) and *P. brachyurus* (Pb) population densities expressed as total in roots and number per gram of root on soybean cultivars 80 days after inoculation.

	Experiment 1		Experiment 2		Experiment 1		Experiment 2	
Treatments	*Pz* total	*Pb* total	*Pz* total	*Pb* total	*Pz*/g root	*Pb*/g root	*Pz*/g root	*Pb*/g root
Rice cv. IRGA 482	3459 aA[z]	2738 aA	132 aA	124 dA	59 aB	363 bA	1361 aB	3018 aA
Maize hybrid cv. Status	1491 aB	3668 aA	14 bA	38 eA	79 aA	166 dA	1773 aB	3117 aA
Soybean cv. DM5958 IPRO	484 cB	2440 aA	37 bB	165 dA	18 bB	203 dA	95 cB	1178 bA
Soybean cv. M5917 IPRO	34 cB	3749 aA	2 cB	251 cA	7 bB	338 bA	33 dB	2210 aA
Soybean cv. M6210 IPRO	51 cB	2775 bA	6 cB	204 cA	127 aB	525 aA	735 bB	2602 aA
Soybean cv. TMG 7062 IPRO	196 cB	2544 aA	14 bB	332 bA	48 aA	96 dA	265 cB	573 bA
Soybean cv. M6410 IPRO	115 cB	3247 aA	12 bB	456 aA	31 bB	258 cA	223 cB	923 bA
Soybean cv. M5947 IPRO	0 cB	2753 aA	0 cB	223 cA	0 bB	249 cA	0 dB	1328 bA
Soybean cv. BMX Potência RR	168 cB	1943 aA	16 bB	227 cA	0 bB	229 cA	0 dB	1045 bA
Soybean cv. TMG 7262 RR	76 cB	2544 aA	7 cB	165 dA	17 bB	138 dA	157 cB	1235 bA
Soybean cv. NS 5959 IPRO	0 cB	1228 bA	0 cB	93 dA	55 aB	221 cA	517 bB	2331 aA
Soybean cv. NA 5909 RG	0 cB	315 cA	0 cB	46 eA	0 bB	259 cA	0 dB	1410 bA
CV (%)	35.26		31.07		33.92		33.81	

[z]Within each experiment, means followed by the same lowercase letters in a column and uppercase letters in a row do not differ by the Scott-Knott test at the 5% significance level. Data were transformed to $(x + 0.5)^{1/2}$ before statistical analysis. CV = coefficient of variation.

respectively (Bellé *et al*., 2017).

All soybean cultivars selected for evaluation in Experiment 3 had total *P. zeae* densities lower than that of maize (Table 2). However, no differences were observed between soybean cultivars and maize in *P. zeae* densities per gram of root (Table 2).

In the penetration experiment, regression analysis showed that *P. zeae* penetration increased linearly over the first 21 days after inoculation on maize (Fig. 1). A similar linear increase was observed on the soybean cultivars, except NS 5959 IPRO, whose equation was quadratic (Fig.1). In the first evaluation period (7 days after inoculation), there were no differences between soybean cultivars and maize (control). At 12, 17, and 22 days after inoculation, soybean cultivars had lower *P. zeae* numbers in roots than maize. There was no difference in *P. zeae* root penetration among the soybean cultivars.

There is little information on the interaction of *P. zeae* with soybean. In a previous study, reproduction of *P. brachyurus* was greater than that of *P. zeae* on soybean cv. Lee and Pecking (Endo, 1959), similar to what was observed in our experiments. Acosta and Malek (1979) found that *P. zeae* is one of the *Pratylenchus* species capable of parasitizing soybean, but the efficiency of *P. zeae* reproduction on soybean seems to be directly related to temperature, as nematode density was shown to vary from 100 nematodes per pot at 15°C to 138,500 nematodes per pot at 30°C. This is because the nematode typically occurs in tropical and subtropical countries and development is optimal at about 30°C (Dababat and Fourie, 2018). *Pratylenchus zeae* parasitism on soybean was not associated with soil type, as the nematode was found in soils with textures ranging from sand to clay (Fourie *et al*., 2001).

Fourie *et al*. (2001) found 25 plant-parasitic nematode species from 12 genera in soybean-producing regions of South Africa. *Pratylenchus zeae* and *P. brachyurus* were found in 87 and 33% of samples, respectively. It is important to mention that the occurrence of *P. zeae* in soybean fields does not necessarily imply parasitism; nematodes may be present in the soil, surviving in root fragments of previously cultivated host plants or on the roots of weeds. *P. zeae* penetration and reproduction on soybean roots is a reminder that management systems can contribute to selecting more aggressive nematode populations. An example of this occurred with *P. brachyurus* in no-till soybean fields covered with maize straw; it was hypothesized that the presence of root fragments in the soil contributed to *P. brachyurus* survival and multiplication (Favoreto *et al*., 2019). Because grasses such as *Urochloa*, which can be susceptible to nematodes, are usually rotated with soybean in no-till systems, care must be taken to prevent the selection of *P. zeae* populations adapted to soybean parasitism (Inomoto *et al*., 2007; Balbinot Junior *et al*., 2009).

Although *P. zeae* reproduction on soybean was not high, it is important to monitor nematode populations in the field and alternate the crops used for rotation and introduce antagonist species, such as *Crotalaria juncea*, *C. spectabilis* (Santana-Gomes *et al*., 2019a, 2019b), pigeon pea cv. IPR 43, and black velvet bean (*Stizolobium aterrimum*) (Santana-Gomes *et al*., 2019b). Crops such as dwarf velvet bean (*Mucuna deeringiana*) and jack bean (*Canavalia ensiformis*) should be avoided because of their variable response to *P. zeae* (Santana-Gomes *et al*., 2019a, 2019b). Another recommendation for *P. zeae* management with cover crops is to not adopt intercropping with maize; rather, crops should be grown separately (Santana-Gomes *et al*., 2018).

Our results show that although *P. zeae*

Table 2. *Pratylenchus zeae* population densities expressed as total in roots and number per gram of root on soybean cultivars at 80 days after inoculation.

Treatments	Total	# *P. zeae*/g root
Maize hybrid Status	2664 a[z]	66[ns]
Soybean cv. M6210 IPRO	594 b	82
Soybean cv. NS 5959 IPRO	412 b	52
Soybean cv. TMG 7062 IPRO	380 b	51
Soybean cv. DM 5958 IPRO	292 b	50
CV (%)	39.34	46.41

[z]Means followed by the same letter in a column do not differ by the Scott-Knott test at the 5% significance level. Data were transformed to (x + 0.5)1/2 before statistical analysis. Ns = not significant. CV = coefficient of variation.

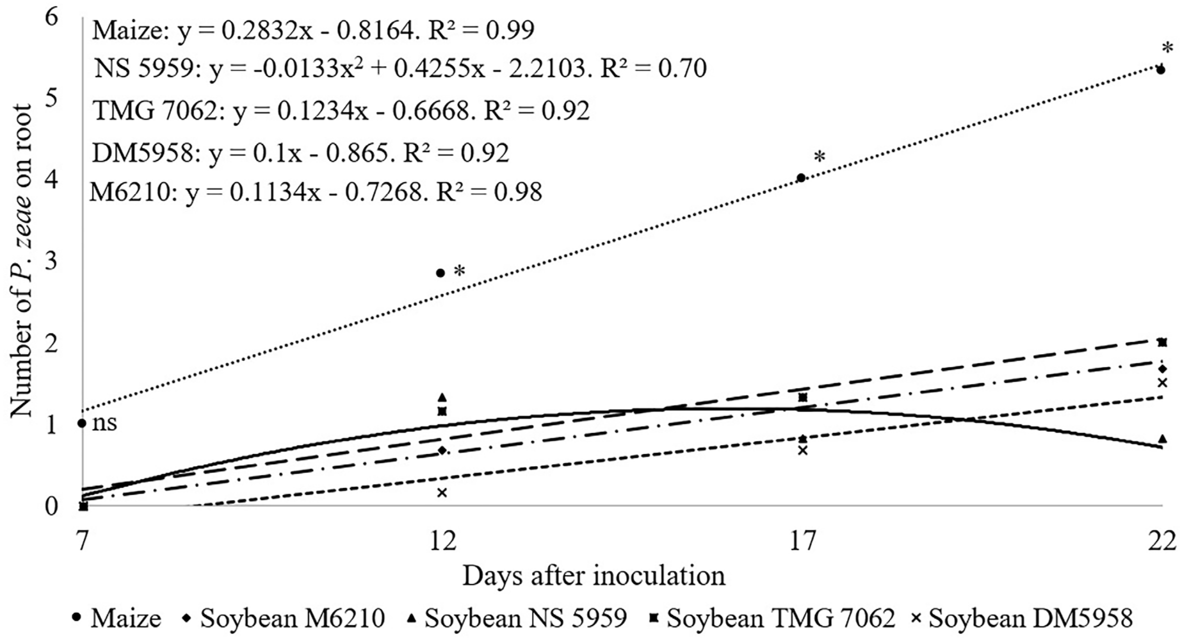

Figure 1. *Pratylenchus zeae* number in roots of maize (control) and soybean cultivars at 7, 12, 17, and 22 days after inoculation. Ns = not significant at the 5% significance level. * significant at the 5% significance level.

population densities do not increase considerably on soybean, rather, population densities are maintained in some cultivars, which might cause damage to susceptible rotation crops. It is important to highlight that there is little information regarding the tolerance of soybean to *P. zeae* parasitism and, in addition, even with low penetration, the nematode can predispose the plant to infection by other soilborne pathogens. It is recommended to monitor plant-parasitic nematode levels in soybean-poaceous succession fields and periodically assess the susceptibility of additional soybean cultivars to *P. zeae*.

ACKNOWLEDGEMENTS

We are grateful to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Brasil, for granting the scholarship to the first author, and to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for granting the research productivity scholarship to the last author.

LITERATURE CITED

Acosta, N., and R. B. Malek. 1979. Influence of temperature on population development of eight species of *Pratylenchus* on soybean. Journal of Nematology 11:229-232.

Alves, T. C. U., R. A. Silva, D. C. Borges, L. C. C. Motta, and L. Kobayasti. 2011. Reação de cultivares de soja ao nematoide das lesões radiculares *Pratylenchus brachyurus*. Revista Biodiversidade 10:73-79.

Balbinot Junior, A. A., A. de Moraes, M. Veiga, A. Pelissari, and J. Dieckow. 2009. Integração lavoura-pecuária: Intensificação de uso de áreas agrícolas. Ciência Rural 39:1925-1933.

Bellé, C., P. R. Kuhn, T. E. Kaspary, and J. Schmitt. 2017. Reação de cultivares de soja a *Pratylenchus brachyurus*. Revista Agrarian 10:136-140.

Biela, F., C. R. Dias-Arieira, A. C. Z. Machado, S. M. Santana-Gomes, M. R. Cardoso, I. Hernandes, and H. H. Puerari. 2015. Genetic diversity of rice genotypes from Brazil for their resistance to *Pratylenchus zeae*. Tropical Plant Pathology 40:208-211.

Brida, A. L. D., E. C. S. D. S. Correia, and S. R. S. Wilcken. 2017. Susceptibility of soybean cultivars to the root lesion nematode. Summa Phytopathologica 43:248-249.

Byrd Júnior, D. W., T. Kirkpatrick, and K. R. Barker. 1983. An improved technique for clearing and staining plant tissues for detection of nematodes. Journal of Nematology 15:142-143.

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

Dababat, A. A., and H. Fourie. 2018. Nematode parasites of cereal. Pp. 162-221 *in* R. A. Sikora, D. Coyne, J. Hallmann, P. Timper (eds.) 3rd ed. Plant parasitic nematodes in subtropical and tropical agriculture. Boston, MA: CABI.

Debiasi, H., J. C. Franchini, W. P. Dias, E. U. Ramos Junior, and A. A. Balbinot Junior. 2016. Práticas culturais na entressafra da soja para o controle de *Pratylenchus brachyurus*. Pesquisa Agropecuária Brasileira 51:1720-1728.

Endo, B. Y. 1959. Responses of root-lesion nematodes, *Pratylenchus brachyurus* and *P. zeae*, to various plants and soil types. Phytopathology 49:417-421.

Favoreto, L., M. C. Meyer, C. R. Dias-Arieira, A. C. Z. Machado, D. C. Santiago, and N. R. Ribeiro. 2019. Diagnose e manejo de fitonematoides na cultura da soja. Informe Agropecuário 40:18-29.

Ferreira, D. F. 2011. Sisvar: A computer statistical analysis system. Ciência e Agrotecnologia 35:1039-1042.

Ferreira, G. A., P. S. R. Oliveira, S. J. Alves, and A. C. T. Costa. 2015. Soybean productivity under different grazing heights of *Brachiaria ruziziensis* in an integrated crop-livestock system. Revista Ciência Agronômica 46:755-763.

Fourie, H., A. H. McDonald, and G. C. Loots. 2001. Plant-parasitic nematodes in field crops in South Africa. Nematology 3:447-454.

Franchini, J. C., A. A. Balbinot Junior, H. Debiasi, and O. Conte. 2014. Soybean performance as affected by desiccation time of *Urochloa ruziziensis* and grazing pressures. Revista Ciência Agronômica 45:999-1005.

Inomoto, M. M. 2011. Resistance evaluation of 12 maize hybrids to *Pratylenchus brachyurus*. Tropical Plant Pathology 36:308-312.

Inomoto, M. M., A. C. Z. Machado, and S. R. Antedomênico. 2007. Reação de Brachiaria spp. e *Panicum maximum* a *Pratylenchus brachyurus*. Fitopatologia Brasileira 32:341-344.

Matias, J. P., A. A. P. Silva, E. O. Helvig, C. D. G. Maciel, C. R. Dias-Arieira, and D. Karam. 2018. Suscetibilidade de milho, soja e capim amargoso ao nematoide das lesões radiculares. Revista Brasileira de Milho e Sorgo 17:357-358.

Queiróz, C. D. A., C. D. Fernandes, J. R. Verzignassi, C. B. D. Valle, L. Jank, G. Mallmann, and M. V. Batista. 2014. Reaction of accessions and cultivars of *Brachiaria* spp. and *Panicum maximum* to *Pratylenchus brachyurus*. Summa Phytopathologica 40:226-230.

Santana-Gomes, S. M., C. R. Dias-Arieira, M. R. Cardozo, H. H. Puerari, R. P. Schwengber, and S. S. Baldisera. 2018. *Pratylenchus zeae* and *P. brachyurus* reproduction in green manure maize/soybean consortium systems. Journal of Phytopathology 2018:1-7.

Santana-Gomes, S. M., C. R. Dias-Arieira, F. Biela, M. R. Ragazzi, S. S. Baldisera, and R. P. Schwengber. 2019a. Planting different crops in succession to manage *Pratylenchus zeae* in sugarcane. Nematropica 49:63-70.

Santana-Gomes, S. M., C. R. Dias-Arieira, J. C. A. Ferreira, R. P. Schwengber, and S. S. Baldisera. 2019b. Reproduction of *Pratylenchus zeae* and *P. brachyurus* reproduction in cover crops. Revista Caatinga 32:295-301.

Silva, R. G., T. F. S. Santos, I. C. S. Duarte, M. B. S. Silva, and G. A. B. Neris. 2015. Reação de genótipos de soja ao nematoide das lesões radiculares. Enciclopédia Biosfera 11:2491-2497.

Torres, J. L. R., M. G. S. Silva, M. A. Cunha, D. X. P. Valle, and M. G. Pereira. 2014. Produção de fitomassa e decomposição de resíduos culturais de plantas de coberturas no cultivo da soja em sucessão. Revista Caatinga 27:247-253.

Uebel, M., L. F. Garbin, R. A. Silva, and P. S. Santos. 2013. Reação de cultivares de Brachiaria spp. a *Pratylenchus brachyurus*. Connect Online 10:1-8.

Received: *22/VI/2020* *Accepted for publication:* *21/IX/2020*

Recibido: *Aceptado para publicación:*