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Population Dynamics of Pratylenchus Brachyurus in Succession of Crops in the Cerrado Biome

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Abstract

The nematodes of the root lesions have caused shocking economic losses in several crops and in several regions of Brazil, mainly in soybean, beans, corn, cotton and pasture. The objective of this work was to analyze the population behavior of *P. brachyurus* in a succession of agricultural crops at points with a higher incidence of nematode during three years of collection. The experiment was conducted in an area of commercial grain cultivation in the municipality of Planaltina - Federal District. Several crops were planted during the three years of collection, being: soy, beans and corn in the year 2014; beans, millet and soybeans in the year 2015 and crotalaria, barley and beans in the year 2016. Five reefs were determined and the collection points were marked through a portable GPS device. The samples were always collected in June of each year. Soil and root samples were collected from the bean crops in 2014, millet in 2015 and barley in 2016. All data were submitted to analysis of variance, and the means separated using the Tukey's test (P <0.05). The results obtained here demonstrated that the host nematode culture reinforces the importance of new studies on the population dynamics of nematodes in the soil during the phenological stages of the crop, aiming at finding sustainable alternatives to reduce the population of plant parasites by helping to manage the nematode. soil and increasing crop productivity. The succession of cultures proved to be efficient for population control of *P. brachyurus*. Crotalaria (C. spectabilis) grown in soybean rotation is efficient for the management of *P. brachyurus* infested areas. The cultivated millet showed to be efficient in the succession of crops in areas infested with *P. brachyurus*.

Keywords: Crop rotation, crop succession, root lesion nematode.

INTRODUCTION

The direct and indirect damages caused by nematodes are among the main problems affecting food production (Michereff, 2005). Among the nematodes with the highest occurrence are those of the genus *Pratylenchus* spp, characterized as migratory endoparasite. It destroys the root system of plants during their penetration and movement, allowing the entry of new hosts such as fungi and bacteria (Dias et al., 2010; Goulart, 2008). In the last few seasons, nematodes of the lesions (*Pratylenchus brachyurus*) have caused unexpected economic losses in several crops and several regions of Brazil, mainly in soybeans, beans, corn, cotton and pasture (Ribeiro, 2009; Bellé et al., 2017).

Another concern is the multiplication and proper management of *P. brachyurus* in high soil populations when host plants are cultivated during a long period of the year (Franchini et al., 2014). In Brazil, there are reports of losses of up to 11.93 billion real per year in soybean grain yield, followed by maize and bean crops which together account for a loss of 5.6 billion real in commercial plants infested with *P. Brachyurus* (Conab, 2016).

Once introduced nematodes into a growing area, their eradication becomes impossible and economically unfeasible. The management of nematodes consists of chemical control with the use of nematicides, cultural practices and biological control.

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Among the cultural practices, the use of resistant cultivars including crop rotation or succession of non-host crops is very promising, since it offers the greatest possibilities of success in the control of nematodes (Lima et al., 2015).

Although *P. brachyurus* is widely disseminated in Brazil, there are still few studies on the effects of its parasitism in different cultures. Thus, this study aimed to analyze the population behaviour of *P. brachyurus* in a succession of crops during three years of collection.

MATERIAL AND METHODS

The experiment was carried out in an area of commercial grain cultivation in the municipality of Planaltina - Federal District, with central geographic coordinates: latitude 15 ° 39'39.5 "S, longitude 47 ° 20'24.2" W and an average altitude of 875 m. The area was irrigated by a central pivot irrigation system. The climatic conditions during the collection years varied between 17 and 27ºC.

Several crops were planted during the three years of collection, being: soy, beans and corn in the year 2014; beans, millet and soya in the year 2015 and crotalaria, barley and beans in the year 2016. The study area was chosen due to the history of the presence of *P. brachyurus* in the harvest of 2013/2014. The crop sequence was a standard in which the farmer had employed his property.

Collection points were determined and tagged using a portable GPS device (Garmin eTrex® 30, Garmin International, Olathe, KS). The collections were always carried out in June of each year, and soil and root samples were collected from the bean crops in 2014, millet in 2015 and barley in 2016.

Table 1: Geographic coordinates of the collection points of nematode samples

Points	Latitude	Longitude	Altitude
1	15°39' 47.0"	47°20'20,6"	882
2	15°39' 46,8"	47°20'20,5"	884
3	15°39' 46,6"	47°20'20,5"	883
4	15°39' 46,2"	47°20'20,6"	882
5	15°39' 45,5"	47°20'20,2"	883

Due to the autodissemination of *P. brachyurus* being relatively small, the collection points were in the center of the reefs, resulting in five reefs. Samples of soil (500 g) and root (50 g) were collected at each point (Table 1), taken at depths of 25 to 30 cm. Each collection point was the result of five soil samples and 15 plants with different injury symptoms. The samples were homogenized and stored in plastic bags. After collection, the material sampled was taken to the Phytus Institute of the Federal District for extraction, identification and quantification of *P. brachyurus*, using the method described by Jenkins (1964) for soil and Coolen & D'Herde (1972) for root. In the extraction, an aliquot of 200 cm^3 of soil and 10 g of roots were used. The nematodes were quantified and identified under an optical microscope, using the Peters counting chamber (Southey, 1970).

Statistical analysis: All data were tabulated and submitted to analysis of variance and the means were separated by the Tukey test ($P < 0.05$) by the Sisvar (Universidade Federal de Lavras, Lavras, Minas Gerais) computational program.

RESULTS AND DISCUSSION

An increasing number of *P. brachyurus* have been observed that have multiplied throughout host crops planted in the area. In the year 2016 there was a decrease in the population of this nematode which may be due to the influence of non-host crops that were planted in the year 2016 as shown in Table 2. The specimens of *P. brachyurus* were found to be found in small amounts or no amount. The area that was evaluated may have been cultivated by non-host plants to the nematode prior to the first evaluations, associating with the low initial population.

Table 2: Result of the count of the nematodes present in 200 cm^3 soil and 5 grams of root in a central pivot cultivation area in the Central Plateau region, Planaltina - Federal District, during three years of sampling.

Year	Variable	Point 1		Point 2		Point 3		Point 4		Point 5	
		Soil	Root	Soil	Root	Soil	Root	Soil	Root	Soil	Root
2014	*P. brachyurus*	0	433	0	450	20	383	0	281	20	350
	P. brachyurus eggs	40	683	40	266	100	270	20	300	60	450
2015	*P. brachyurus*	80	1360	20	10430	0	100	40	1160	40	830
	P. brachyurus eggs	30	500	0	4060	40	130	10	760	10	330
2016	*P. brachyurus*	0	106	0	226	0	75	0	65	0	76
	P. brachyurus eggs	0	45	0	53	0	19	0	0	0	0

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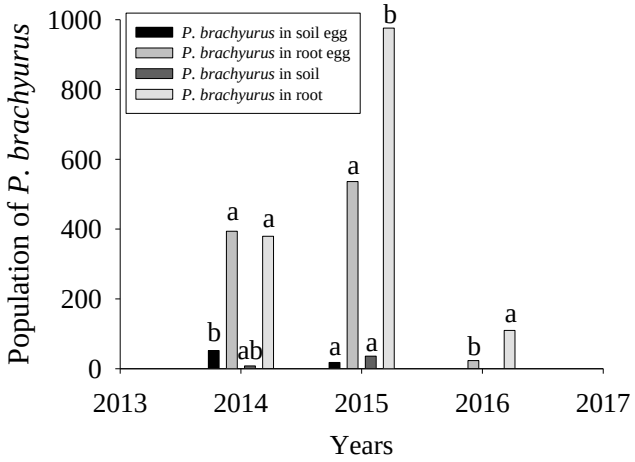
The reflex symptoms in the years 2014 and 2015 caused in the plants of the foci of infestation presented typical symptoms caused by *P. brachyurus*, including the uneven growth of the plants, necrotic roots, dark and less secondary roots. These damages were evident in the two years of collection as shown in Figure 1.

Figure 1: Bean culture in different years: A- bean culture in 2014; B - bean culture in 2015.

When comparing the average population of *P. brachyurus*, the results showed a gradual increase of the population of its population between the years 2014 and 2015 and a decrease of the population in the year 2016 due to the crops planted in that year. In figure 2 the results were significant between the average of the three years of collection. To understand the great increase in the population of *P. brachyurus*, we observe the history of crops planted in those respective years. Cultures susceptible to the nematode were planted, thus justifying the increase in reproduction by a large amount of nutrients in the area. In this way, it was suggested the adoption of crop rotation being planted non-host strains to the *P. brachyurus* nematode. Due to the population increase of the nematode, the cultivation of millet "ADR 300" and Crotalaria spectabilis (Crotalaria spectabilis) were planted after soybean planting, which are recommended crops due to their efficiency in nematode control. It is also observed that for all the years of collection, that there was a greater population of *P. brachyurus* in the soil than in the root (nematoid and egg). As the area management with crop rotation was properly used, there was a significant reduction of the nematodes and eggs present in the soil, being able to find high populations of nematodes and eggs only in the root in the samplings of 2016.

Figure 2 - Population of *P. brachyurus* (specimens and eggs) in the soil and root of the three years of sampling.



* The letters compare differences of the population of *P. brachyurus* during sampling times, at the 0.05 level of probability by the Tukey test.

The results emphasize the importance of crop rotation in nematode control. According to Silva (2018), the period of rotation with antagonistic or non-host plants makes nematode reproduction difficult and allows natural mortality factors to reduce their population. Thus, the succession of the crops made by the producer of this area proved to be efficient in 2016. Although soil population density is not the best way of estimating the development of the nematode in question (Galbieri and Asmus, 2016), it can be observed that the year cultivated with crotalaria were those that maintained the lowest population densities of *P. brachyurus* throughout the years of sampling.

The resistance of Crotalaria, mainly of C. spectabilis, and of pearl millet to *P. brachyurus* have been efficient in experiments conducted in greenhouse (Inomoto and Asmus, 2010; Ribeiro et al., 2007; Inomoto et al., 2006). The effect of crotalaria where

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higher soil cover is observed, greater amount of green mass and lower occurrence of chlorotic plants compared to previous crops (Silva, 2018). In the case of millet, resistance to the nematode is inconsistent and varies according to the cultivar and the reaction period (Borges, 2009; Inomoto and Asmus, 2010).

The results obtained here demonstrate that the planted host crop of the nematodes belonging to this group is dominant in the soil, which reinforces the importance of further studies on the population dynamics of nematodes in the soil during the phenological phases of the crop, aiming to find sustainable alternatives to decrease the population of plant parasites assisting in soil management and increasing crop productivity. The succession of cultures proved to be efficient for population control of *P. brachyurus*. Crotalaria (C. spectabilis) grown in soybean rotation is efficient for the management of *P. brachyurus* infested areas. The cultivated millet showed to be efficient within the succession of crops in areas infested with *P. brachyurus.*

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