Conservation of biodiversity through sustainable management of Phytonematodes in soils cultivated with plantain (*Musa* AAB SIMONDS)

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INTRODUCTION

In 2017, plantain cultivation in Colombia occupied 474,612 ha, of which 4,111,696 t were produced, with a yield of 9.89 t ha^{-1} (MADR, 2018), being of vital importance for the country's food security. Of the various pests that affect musaceous crops, phytoparasite nematodes as inhabitants of the rhizosphere cause serious problems of anchorage and considerable damage to the root system, which in turn serve as a gateway to other pathogens that seriously affect plant development and productivity. According to the previous considerations, the purpose of the present research was to evaluate the effect of inoculation of arbuscular mycorrhizal fungi (AMF), compost leaching from plantain rachis and earthworms compost, on nematode populations and beneficial organisms present in soils cultivated with plantain “Dominico Hartón” [in Spanish] (*Musa* AAB SIMONDS).

METHODS

Study site and treatment. The study was carried out in the municipality of La Tebaida, Quindío, Colombia (Fig. 1). An experimental design of complete randomized blocks under a divided plots arrangement, with nine plants and three replications, was used. The application of AMF (M); earthworms compost (L); AMF plus earthworms compost (ML); the combination of the latter with plantain rachis leachate (MLx, LLx and MLLx) and the traditional management of the producer (P) evaluated as control, were evaluated during two productive cycles of Dominico Hartón.

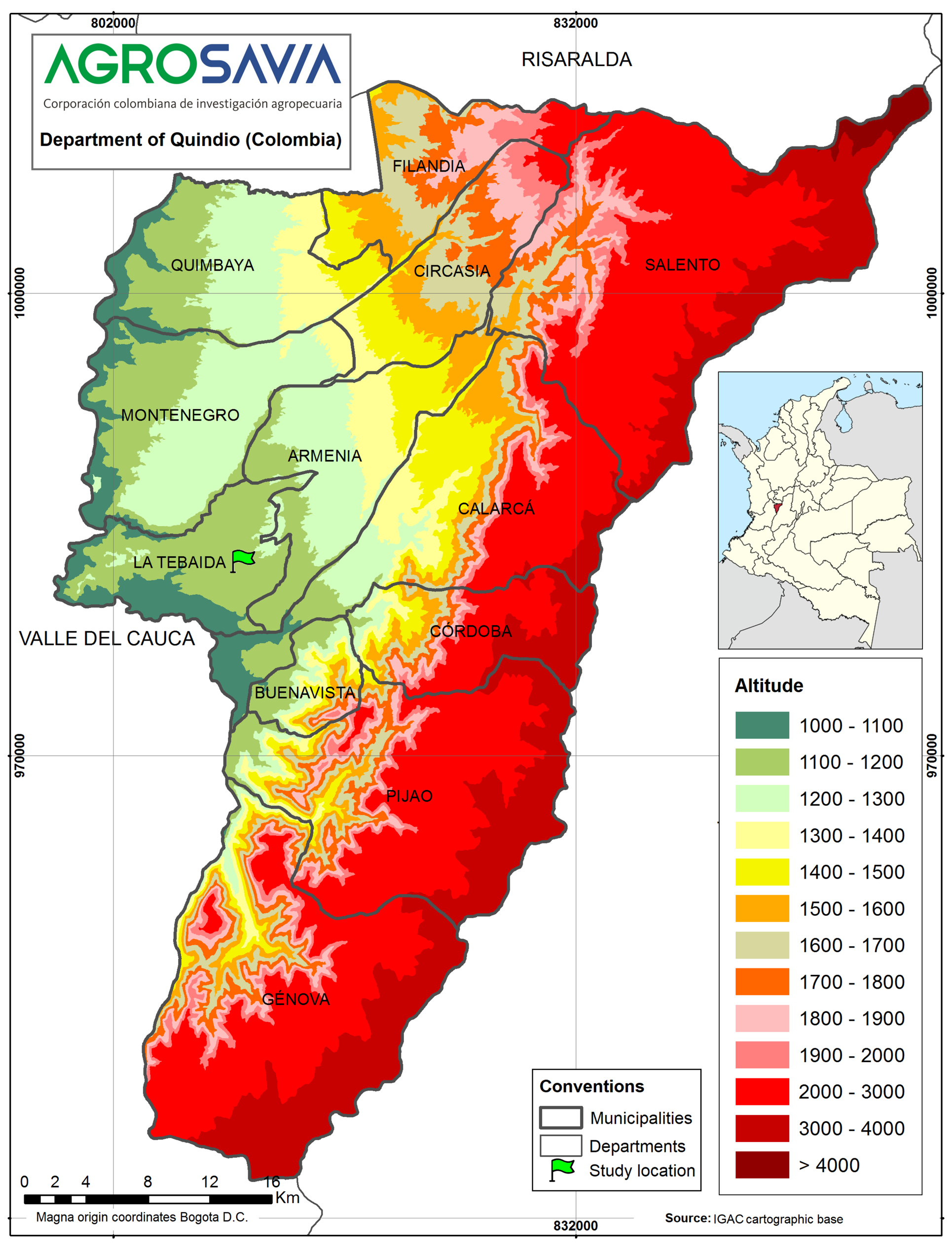

Fig. 1: Location of the study in the department of Quindío (Colombia). Map: AGROSAVIA (2021).

Variables and statistical analysis. Nematode populations were recorded in soil and roots according to Varón and Castillo (2001); AMF colonization according to Trouvelot *et al.* (1986), Vierheilig *et al.* (1998) and Dodd *et al.* (2001); and earthworms epigeous and/or endogenous according to Anderson and Ingram (1993). The data were analyzed using Poisson (*Ps*), Binomial Negative (*NB*), Poisson Inflated with Zeros (*ZIPs*) and Binomial Negative Inflated with Zeros (*ZINB*) models, selecting the best model by comparing Pearson's chi-square, full log likelihood, AIC and SBC, through proc countreg of the Statistical Analysis System 9.4 (SAS) software.

RESULTS

Both in soil and in roots the phytonematodes *Radopholus*, *Meloidogyne*, *Helicotylenchus* and *Pratylenchus*, were identified, which are part of the phytonematode complex of the plantain in the coffee zone of Colombia (Guzmán-Piedrahita & Castaño-Zapata, 2005); in addition, saprophytic nematodes, such as *Rhabditis*, *Plectus*, *Aphelenchus* y *Aphelenchoides*, were detected, which are classified as bacteriophages and fungivores (Yeates, 2007) (Tab. 1).

Nematode population in 100 grams of soil										
Treatment	*R. similis*		*Meloidogyne* sp.		*Helicotylenchus* sp.		*Pratylenchus* sp.		Saprophytic	
	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2
M	172	46	9.1	206	183	197	42	65	34	86
MLx	179	27	21	30	155	184	44	12	41	88
L	258	7.5	22	117	348	341	77	4,3	27	66
ML	303	6.0	15	66	172	402	71	8,0	50	50
LLx	338	54	20	71	286	481	42	50	30	96
MLLx	486	13	23	72	179	340	61	5,8	57	108
P	309	20	3.0	13	151	259	51	25	24	87

Nematode population in 100 grams of root										
Treatment	*R. similis*		*Meloidogyne* sp.		*Helicotylenchus* sp.		*Pratylenchus* sp.		Saprophytic	
	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2
M	2478	4878	11425	2950	4135	1478	5402	8915	170	515
MLx	17060	709	14893	215	4389	713	57643	778	3721	225
L	3137	883	3846	1104	3650	2533	8868	2391	462	108
ML	5590	1446	2487	1084	3479	4051	8600	782	212	374
LLx	5797	3612	2494	781	3065	2036	16929	8546	745	461
MLLx	2584	1216	2538	3400	1703	2933	6846	2313	311	163
P	14534	2898	2011	175	3970	4270	25326	8072	458	677

Table 1: Nematode population under different treatments during two production cycles of the Dominico Hartón plantain.

The models obtained allowed us to appreciate a positive effect of cycle 1 (C1) for the amount of *Radopholus similis* and saprophytic nematodes in soil (*NB model*); if compared with cycle 2 (C2) (Eq. 1 and Eq. 2). A positive effect of L and M, their application together (ML) and their combinations with Lx (LLx and MLLx), was seen on *Meloidogyne* sp. in soil and roots in contrast to P; however, the application of MLLx in C1 had a negative effect with respect to C2 (*NB model*) (Eq. 3 and Eq. 4).

***R. similis* soil** = -3.00 + 2.72 cycle_1 **(Eq. 1)**

Saprophyte soil = 4.47 - 1.27 cycle_1 **(Eq. 2)**

***Meloidogyne* sp. soil** = 2.60 + 2.15 L + 2.72 M **(Eq. 3)**

***Meloidogyne* sp. root** = 5.16 + 1.83 L + 2.82 M + 1.82 ML + 1.49 LLx + 2.96 MLLx - 2.73 MLLx*cycle_1 **(Eq. 4)**

On *Helicotylenchus* sp. and *Pratylenchus* sp., in roots there was a negative effect of M and MLx relative to P; in turn MLx in C1 has a positive effect on the populations of these two nematodes and saprophytes in roots (*NB model*) (Eq. 5, Eq. 6 and Eq. 7).

***Helicotylenchus* sp. root** = 8.35 – 1.06 M – 2.16 MLx + 2.26 MLx*ciclo_1 **(Eq. 5)**

***Pratylenchus* sp. root** = 8.99 – 3.33 MLx + 4.16 MLx*ciclo_1 **(Eq. 6)**

Saprophyte root = 6.51 + 3.84 MLx*ciclo_1 **(Eq. 7)**

In the total populations of phytonematodes in soil and roots a negative effect of LLx and MLx, respectively, was observed; and a positive effect of C1 and MLx in C1, with respect to C2 (*NB model*) (Eq. 8 and Eq. 9).

Total soil = 5.76 – 0.72 LLx **(Eq. 8)**

Total root = 9.64 – 2.20 MLx + 1.08 ciclo_1 + 2.92 MLx*ciclo_1 **(Eq. 9)**

A positive effect of ML on C1 was observed with respect to C2 (Eq. 10 and Eq. 11) frequency and number of AMF arbuscules; whereas ML and C1 had a negative effect on the number of arbuscules compared to P and C2, respectively (*NB model*) (Eq. 11).

Mycorrhizal frequency = 3.35 + 1.27 ML*cycle_1 **(Eq. 10)**

Mycorrhizal arbuscules = 2.76 – 2.07 ML – 1.40 cycle_1 + 3.04 ML*ciclo_1 **(Eq. 11)**

For the earthworm's population C1 had a negative effect on epigeoid organisms compared with C2; for endogenous earthworms L, ML and their combinations with Lx (LLx, MLx and MLLx) had a positive effect relative to P; whereas C1, the application of MLLx and its interaction to it showed a negative effect (*ZIPs model*) (Eq. 12 and Eq. 13).

Epiphygeal earthworms = -22.90 – 1.38 cycle_1 **(Eq. 12)**

Endogenous earthworms = 4.50 + 0.38 L + 1.63 ML + 0.63 LLx + 0.16 MLx + 0.56 MLLx – 1.44 cycle_1 - 2.32 ML*cycle_1 – 1.95 MLLx*cycle_1 **(Eq. 13)**

The results obtained in this research suggest that the application of biofertilizers, contributes to the reduction of phytonematode populations, while favoring the presence of saprophytic nematodes; however, this is largely influenced by the habits of each genus present in the rhizosphere. This confirms the importance of using sustainable soil management practices to achieve an appropriate balance of biological populations.

AGROSAVIA
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