RESEARCH NOTE – NOTA INVESTIGATIVA

PRESENCE OF SOIL NEMATODES IN ANDEAN TUBERS

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ABSTRACT

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A nematological analysis was conducted in the peridermis and underlying parenchyma tissue of different tuber varieties of Andean crops from Argentina and Bolivia. Plant-parasitic nematodes were detected most frequently. *Nacobbus aberrans* was the most widely distributed in the sampled localities and associated with tubers of numerous potato varieties. Nematodes of other trophic groups were also detected, including bacterial and fungal feeders, insect parasites, predators, and omnivores. Representatives of several trophic categories were detected within the same sample. Tubers were a suitable medium for nematode development and dissemination.

Key words: Andean crops, Argentina, Bolivia, feeding habits, soil nematodes, tubers.

RESUMEN

Lax, P., M. E. Doucet, C. Gallardo, S. Muruaga de L'Argentier, and R. Bautista. 2008. Presencia de nematodos del suelo en tubérculos andinos. Nematropica 38:87-94.

Se realizaron análisis nematológicos de peridermis y parénquima subyacente de diferentes variedades de tubérculos andinos procedentes de Argentina y Bolivia. Los nematodos fitoparásitos fueron los más frecuentes, destacándose *Nacobbus aberrans* que apareció ampliamente distribuido en las localidades evaluadas y asociado a tubérculos de numerosas variedades de papa. También fueron hallados nematodos con otros hábitos alimenticios: bacteriófagos, micófagos, parásitos de insectos, predadores y omnívoros. Se detectaron representantes de varias categorías tróficas en una misma muestra. Los tubérculos mostraron ser un medio apropiado para el desarrollo de esos nematodos y su dispersión.

Palabras clave: Argentina, Bolivia, cultivos andinos, hábitos alimenticios, nematodos del suelo, tubérculos.

Agricultural fairs are among farmers' most important cultural activities in the Andean region because it is where they trade their production with growers from neighboring communities (Ludo *et al.,* 1999). In Bolivia, these fairs are an important source for dissemination of *Nacobbus aberrans* through the exchange or sale of infested Andean potato tubers (*Solanum tuberosum* subsp. *andigenum*) (Rojas *et al.*, 1997).

Recent analyses of several varieties of Andean potato from Bolivia and Argentina confirmed the dispersal potential of *N. aberrans* and of other plant-parasitic harmful nematodes, such as *Meloidogyne* spp. and *Globodera* spp., through infected seed tubers (Lax *et al.*, 2006). The presence of other free-living and pathogenic nematodes of unknown agronomic significance was also detected. Nematological surveys of potato fields in the Andean Valleys of

Argentina revealed considerable diversity, with genera corresponding to different trophic categories (Mondino *et al.*, 2006). Such diversity was greater than that observed in potato fields (*S. tuberosum*) in the province of Buenos Aires, Argentina (Chaves and Torres, 1993).

The objective of this work was to determine the presence of soil nematodes in the peridermis and underlying parenchyma of tubers of different Andean crops from northwestern Argentina and central-southern Bolivia.

Tubers of Andean crops were collected from markets, agricultural fairs, and grower fields in March, July and October 2006. A total of sixty samples collected in 27 localities in Argentina and Bolivia were obtained. They consisted of 19 varieties of Andean potato, 2 varieties of 'Papalisa' (*Ullucus tuberosus*) and 2 varieties of 'Oca' (*Oxalis tuberosa*) (Table 1; Fig. 1). The tubers corresponded to the 2005-2006 crop cycle, and had been harvested in February-March 2006. All tuber variety names were provided by the producers.

Approximately 15 to 20 tubers per sample were randomly selected and peeled. The periderm and underlying parenchyma tissues were processed in water with a blender for 1.5 minutes according Costilla's modified method (1985a). The resulting suspension was poured through a coarse sieve (2 mm mesh) on top of a fine sieve (40 µm mesh). The remains of periderm and parenchyma were washed with abundant water and the material recovered in the fine sieve was placed in a container. When there was too much froth on the surface, the material was left to settle for 30 minutes and the froth was discarded to avoid interference in further observations. The resulting liquid solution was then observed directly under a stereoscopic microscope to detect the presence of nematodes. Specimens were identified according to the morphological characteristics defining each taxon (Andrássy, 1983; Jairajpuri and Ahmad, 1992; Hunt, 1993; Siddiqi, 2000). When the specimens could not be identified to genus, only the nematode family was determined. The trophic category of each nematode was determined following Yeates *et al.* (1993). The incidence of the main plant-parasitic nematodes detected in the tubers was estimated in all the localities evaluated for each country (Ramos *et al.*, 1998).

Plant-parasitic nematodes

Plant-parasitic nematodes were detected in 60% of the samples (Table 2). *Nacobbus aberrans*, the most frequently found species (45% of the total samples), was detected in 16 tuber varieties (15 varieties of Andean potato and one of 'Papalisa'). This species was present in 66.7% and 16.7% of the Argentine and Bolivian localities sampled, respectively. It has been reported that the incidence and the level of soil infestation of *N. aberrans* in the Andean region have gradually increased over time (Ortuño *et al.*, 2005).

Males and mature females (without egg masses) of *N. aberrans* were extracted from tuber samples collected in March, but were not detected in tubers analyzed in subsequent months. In a previous study, males of this species were not detected, whereas mature females were observed in the parenchyma of potatoes that had been stored for a longer period (Lax *et al.*, 2006). Although it has been previously reported that second-stage juveniles can be found in harvested tubers (Costilla, 1985b; González and Franco, 1997) they were not observed in tubers from the present study.

Meloidogyne spp. was detected in 15% of the samples analyzed, which represents a 33.3% and 16.7% incidence in Argentina and Bolivia, respectively. The two species detected were *M. incognita* and *M. javanica*.

Table 1. Origin and variety of tubers examined from Argentina and Bolivia.

Country, Province, Department	Locality	Site code	Tuber variety[1]
Argentina			
Pv. Jujuy			
Dp. Humahuaca	Aparzo	1	'Colorada', 'Churqueña'
	Calete	2	'Collareja'
	Cianzo	3	'Azul', 'Collareja', 'Chacarera'
	Coctaca	4	'Collareja', 'Runa'
	Humahuaca	5	'Azul', 'Chacarera', 'Colorada', 'Runa'
	Ocumazo	6	'Amajana rosada', 'Collareja larga'
	Palca de Aparzo	7	'Chacarera morada'
	Rachaite	8	'Oca rosada'
	San Roque	9	'Azul', 'Colorada'
Dp. Tilcara	Juella	10	'Collareja'
	Maimará	11	'Abajeña'
	Tilcara	12	'Collareja' (3), 'Ojo de señorita'
Dp. Tumbaya	Patacal	13	'Azul', 'Collareja'
	Punta Corral	14	'Colorada'
	Purmamarca	15	'Oca amarilla', 'Papa verde lisa'
Dp. Valle Grande	Caspalá	16	'Colorada', 'Naviceña'
Dp. Yavi	La Quiaca	17	'Collareja', 'Waych'a'
	Yavi	18	'Colorada', 'Collareja' (2), 'Morada', 'Rosada', 'Papa verde lisa', 'Waych'a'
Pv. Salta			
Dp. Iruya	Iruya	19	'Colorada', 'Oca amarilla', 'Tuni', 'Tuni blanca'
	Colanzuli	20	'Collareja', 'Papalisa', 'Redonda', 'Tuni'
Dp. Santa Victoria	Santa Victoria	21	'Collareja', 'Waych'a'
Bolivia			
Pv. Cochabamba			
Dp. Cochabamba	Cochabamba	22	'Colorada', 'Papalisa' (2), 'Runa'
	Lampaya	23	'Waych'a'
Dp. Potosí	Ojo de Agua	24	'Collareja'
	Villazón	25	'Negra imilla'
Dp. Santa Cruz	Santa Cruz	26	'Papalisa'
Pv. Tarija			
Dp. Tarija	Tarija	27	'Collareja', 'Negra imilla'

Abbreviations: Pv. = Province; Dp. = Department.
[1]One sample of the varieties indicated was analyzed, unless otherwise indicated in parentheses.

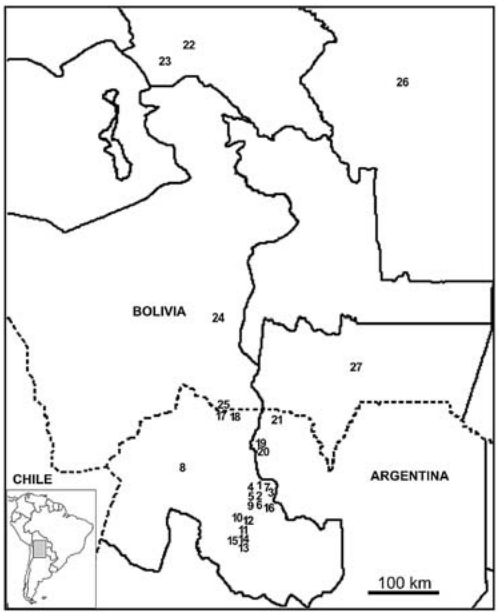

Fig. 1. Distribution map indicating the origin of tuber samples collected from 27 localities within Argentina and Bolivia.

Unlike *N. aberrans*, mature *Meloidogyne* females with egg masses were always found in the parenchyma regardless of harvest time. Mondino *et al.* (2006) indicated that in soil of potato fields in the province of Jujuy (Argentina), *Meloidogyne* spp. occurred more frequently than *N. aberrans* (73% and 61.5%, of the sampled sites, respectively). However, *N. aberrans* was the most frequently found species in the tubers from Jujuy area examined in the present work.

Globodera sp. cysts were found on the peridermis of the varieties 'Naviceña' and 'Colorada' from Caspalá (Jujuy, Argentina). Cysts of this nematode have been recently observed in eyes of 'Collareja' from two localities of the province of Salta, Argentina (Lax *et al.*, 2006).

Previous studies indicated that in soil collected from potato fields of Andean region of Argentina the following genera have been reported: *Criconema*, *Dolichorhynchus*, *Quinisulcius* (Mondino *et al.*, 2006), *Criconemella*, *Pratylenchus*, and *Tylenchorhynchus* (Doucet *et al.*, 2006; Mondino *et al.*, 2006). The same genera were also detected on some of the tubers analyzed in the current study. The genus *Dolichorhynchus* in Argentina was reported for the first time by Mondino *et al.* (2006). In the present work, nematodes of this genus were extracted from 'Collareja' potato (Calete, province of Jujuy). *Paratylenchus* sp. and *Helicotylenchus* sp. were also found in potato fields in northern Argentina (Mondino *et al.*, 2006) and in tubers from Cochabamba (Bolivia) in the current study.

None of the 'Oca' samples had plant-parasitic nematodes. *Nacobbus aberrans* and *Pratylenchus* sp. were found in 'Papalisa' samples from Cochabamba (Bolivia). Until recently, it has previously been reported that *N. aberrans* only parasitizes roots of cultivars of this plant (Main *et al.*, 1999; Cadima *et al.*, 2003) and not the tubers.

Nematodes of other Trophic Categories

Other nematode genera that would not be strictly plant-feeding types were detected in 36.7% of the samples analyzed (Table 3). From the taxonomic point of view, the most widely represented category was bacterial feeders, followed by fungal feeders. *Aphelenchus* sp. was the genus that appeared most frequently in the latter category. This genus was one of the more dominant ones found in the soil of the Andean Valleys of Argentina (Mondino *et al.*, 2006). Furthermore, *Panagrolaimus* sp., *Cruznema* sp., *Acrobeles* sp., *Acrobeloides* sp., *Aphelenchoides* sp., and *Tylenchus* sp. have also been reported from soils of this region (Mondino *et al.*, 2006). All these genera, together with *Diploscapter* sp., *Hexatylus* sp., as well as representatives of other families, were also detected in the tubers analyzed in the present work.

Table 2. Plant-parasitic nematodes *sensu stricto* detected in different varieties of Andean tubers from Argentina and Bolivia.

Nematode	Locality	Tuber variety
Dolichorhynchus sp.	Calete	'Collareja'
Nacobbus aberrans	Aparzo	'Colorada', 'Churqueña'
	Cianzo	'Azul', 'Collareja', 'Chacarera'
	Cochabamba	'Papalisa'
	Coctaca	'Collareja'
	Colanzuli	'Collareja', 'Redonda', 'Tuni'
	Iruya	'Tuni blanca'
	La Quiaca	'Collareja'
	Palca de Aparzo	'Chacarera morada'
	San Roque	'Azul'
	Punta Corral	'Colorada'
	Santa Victoria	'Waych'a'
	Yavi	'Collareja', 'Rosada', 'Waych'a'
Meloidogyne incognita	Celocha	'Collareja'
	Humahuaca	'Runa'
	Patacal	'Collareja'
N. aberrans, *Globodera* sp.	Caspalá	'Naviceña'
N. aberrans, *M. javanica*	San Roque	'Colorada'
N. aberrans, *M. incognita*	Santa Victoria	'Collareja'
	Tilcara	'Collareja'
N. aberrans, *M. javanica*, *M. incognita*	Ocumazo	'Amajana rosada'
N. aberrans, *M. javanica*, *M. incognita*, *Criconema* sp.	Ocumazo	'Collareja larga'
N. aberrans, *Pratylenchus* sp., *Criconema* sp.	Cochabamba	'Runa'
M. javanica, *Globodera* sp., *Criconemella* sp.	Caspalá	'Colorada'
Pratylenchus sp.	Juella	'Collareja'
	Santa Cruz	'Papalisa'
Paratylenchus sp., *Helicotylenchus* sp.	Lampaya	'Waych'a'
Quinisulcius sp.	Coctaca	'Runa'
Tylenchorhynchus sp., *Criconema* sp.	Yavi	'Colorada'

Even though several nematodes with different feeding habits co-existed in the same tuber sample, plant-parasitic nematodes were usually more abundant. Regarding phytoparasitic nematodes, the coexistence of highly harmful nematodes (*N. aberrans-Meloidogyne* spp., *N. aberrans-Pratylenchus* sp., *N. aberrans-Globodera* sp., *Meloidogyne* sp.-*Globodera* sp.) was observed in some tuber samples of the same origin. On some occasions plant pathogenic nematodes were found with nematodes belonging to other trophic categories. Tuber varieties 'Collareja larga' (Ocumazo) and 'Runa' (Cochabamba) exhibited the greatest nematode diversity (between 8 and 9

Table 3. Other nematodes detected in Andean tubers from Argentina and Bolivia.

Nematode	Locality	Tuber variety	Feeding type
Genus			
Acrobeles sp.	Tilcara	'Collareja'	Bacterial feeder
	Ocumazo	'Collareja larga'	
Acrobeloides sp.	Caspalá	'Colorada'	Bacterial feeder
	Cochabamba	'Runa'	
	Lampaya	'Waych'a'	
Aphelenchoides sp.	Cochabamba	'Runa'	Hyphal/plant feeder
	Iruya	'Tuni'	
Aphelenchus sp.	Cianzo	'Chacarera', 'Azul'	Hyphal/plant feeder
	Colanzuli	'Tuni'	
	Iruya	'Tuni', 'Tuni blanca'	
	Lampaya	'Waych'a'	
	Ocumazo	'Amajana rosada'	
	Purmamarca	'Oca amarilla'	
	Santa Victoria	'Collareja'	
	Tilcara	'Collareja'	
	Yavi	'Collareja'	
Cruznema sp.	Cochabamba	'Runa'	Bacterial feeder
Diploscapter sp.	Punta Corral	'Colorada'	Bacterial feeder
Hexatylus sp.	Humahuaca	'Runa'	Hyphal feeder/insect
	Punta Corral	'Colorada'	Parasite[1]
Panagrolaimus sp.	Iruya	'Tuni blanca'	Bacterial feeder
	Yavi	'Collareja'	
Tylenchus sp.	Cochabamba	'Runa'	Plant/hyphal feeder
	Ocumazo	'Collareja larga'	
Family			
Allantonematidae	Ocumazo	'Collareja larga'	Insect parasite
Anguinidae	Cochabamba	'Runa'	Plant/hyphal feeder
Cephalobidae	Yavi	'Colorada'	Bacterial feeder
Diplogasteridae	Cochabamba	'Runa'	Bacterial feeder/predatory
Dorylaimidae	Cochabamba	'Runa'	Omnivore
	Colanzuli	'Collareja'	
	Iruya	'Tuni'	
	Juella	'Collareja'	
	Ocumazo	'Collareja larga'	
	Tilcara	'Collareja'	
Rhabditidae	Cochabamba	'Colorada'	Bacterial feeder
	Ojo de Agua	'Collareja'	

[1]According to Siddiqi (2000).

different taxa, respectively). Results indicate that Andean tubers are suitable for the establishment of soil nematodes with different feeding habits. Tubers would facilitate the development of the life cycle of some nematodes and would ensure the dispersal of others.

The nematodes detected in the tubers are an indicator for the significant biodiversity of the soil nematodes in the Andean region. Until recently, the nematodes presence in potato fields in the region have been poorly evaluated, and emphasis has been put on the most important plant-parasitic nematodes. Further research work in the region is necessary to enhance the knowledge on nematode biodiversity and sanitary conditions of the farms mainly of those whose tubers will be exchanged as seed potato with other growers.

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