Original Research Article

Study of parasitic nematodes of cashew trees in nurseries in western Burkina Faso

ABSTRACT

Cashew production is a very important source of income for thousands of people in Burkina Faso and employs more than 45,000 households from production to marketing. The cashew tree is subject to many phytosanitary problems that can cause huge yield losses. An inventory of parasitic nematodes associated with cashew trees in nurseries in a farming environment was carried out for the first time; the study also concerned the pathogenicity of the nematodes *Meloidogyne* and *Pratylenchus* on young cashew plants in a controlled environment.Cashew production is a very important source of income for thousands of people in Burkina Faso and employs more than 45,000 households from production to marketing. The cashew tree is subject to many phytosanitary problems that can cause huge yield losses. An inventory of parasitic nematodes associated with cashew trees in nurseries in a farming environment was carried out for the first time; the study also concerned the pathogenicity of the nematodes Meloidogyne and Pratylenchus on young cashew plants in a controlled environment.The inventory revealed that ten (10) genera of nematodes are associated with the cashew tree in the nursery and the most frequent ones present in the soil are represented by *Helicotylenchus* (78.43%), *Tylenchus* (62.75%), *Pratylenchus*(39.22), *Scutellonema* (33.33%) and T*ylenchorhynchus* (19.61%). The most abundant nematodes were represented by *Helicotylenchus* and *Tylenchus* with 336 and 53 nematodes/soil dm^3 respectively.Five genera of nematodes are associated with the roots of cashew seedlings in nurseries, the most frequent of which are represented by *Tylenchus* and *Pratylenchus*at levels of 62.75 and 52.94% respectively. Population densities of root-extracted nematodes were low with a maximum of 2 nematodes/g of roots.

Comment [kk1]: Please add the species names along with the genus

Keywords: cashew tree; nursery; parasitic nematode; Burkina Faso.

1. INTRODUCTION

The cashew sector in West Africa has been experiencing an ever-growing interest over the last decade, justified by the attractive prices of raw nuts and almonds at the international level.

Over the past ten years, West Africa has become the world's leading cashew-producing region. Indeed, the cashew tree is a species recognized for its economic importance in this part of Africa and mainly in Burkina Faso, in the same way as cotton.Fruit crops occupy a prominent place in Burkina Faso's agriculture and make it possible to meet part of the food needs and improve cash incomes. Among these fruit crops, cashew production plays an important role in the national economy. Indeed, the cashew sector has experienced a dynamism in recent years with the creation of a Burkinabe Cashew Council (CBA) which aims to improve producers' access to quality plants [1]. The cashew nut sector is not performing well with an estimated production of 85,000 tons in a production area of 250,000 ha for a yield of 354 kg/ha, i.e. less than kg/tree [2].In order to support the cashew sector, national research has been committed for the past ten years to the selection of highly productive plant material of very good quality nuts. For a large-scale distribution of cashew nuts, the main route chosen for the reproduction of productive trees remains grafting in nurseries. This route requires the production of rootstocks on rigid schedules, the failure to follow which causes enormous damage to the plant breeding program.The most common constraints are the non- or low germination of nuts after sowing, the slow growth and poor development (deformation of organs) of rootstocks after germination, and the mortality of growing plants. The cashew tree, like most fruit crops, is attacked by a large number of nematodes. Research on this crop is scarce in Burkina Faso and current work aims to assess nematological problems.Research carried out around the world has shown that the cashew tree is strongly attacked by parasitic nematodes to varying degrees depending on the climate. The objective of this research work is to identify the main nematodes associated with cashew trees in nurseries in western Burkina Faso in terms of frequency and abundance; The collection will take into account visual observations of the plants in the nursery and the taking of plant samples for the extraction and characterization of the different genera of nematodes observed.

2. Material et methods

2.1. Material

The inventory was carried out in the main cashew production areas in nurseries and focused on the popularized varieties from elite plants provided by the INERA breeding program to the various farmers (Photo 1).

Photo 1: Cashew tree nursery in a farming environment

Comment [kk2]: The root symptoms and upper ground symptoms photos should have been added

2.2. Sampling method and site selection

Samples were taken in the main cashew tree nursery production areas located in western Burkina Faso in the localities of Niangoloko, Banfora, Guena, Kourinion and Orodara. The number of pots is chosen according to the size of the nursery. Each plant in a pot is considered a sample.The cashew seedlings in the nursery were mostly 138 days old. A total of 51 samples were collected during the 2018 wet season in the main cashew production areas in western Burkina Faso.

2.3. Extraction of samples in the laboratory

Comment [kk3]: Please attach the photographs of the nematodes isolated for the soil and roots

The samples taken are transported to the laboratory located in Bobo-Dioulasso for nematode extraction. Nematodes are extracted from soil using the elutriator method of [3] and data expressed in number of individuals/dm3 of soil (N/dm3). Nematodes present in the roots are extracted using the sprinkler method of [4] and data expressed in number of nematodes/g of fresh roots (N/g).

2.4. Data analysis

The datas were analyzed using the statistical software XLSTAT 2016. An analysis of variance using the ANOVA software was performed and the comparison of the means was made with the Newman-Keuls test at the 5% threshold.

3. RESULTSAND DISCUSSION

3.1. RESULTS

3.1.1. Frequency and abundance of parasitic nematode populations associated with cashew trees

About ten genera of nematodes have been observed on cashew plants in nurseries in western Burkina Faso on the prospected sites (Table I).

- Nematodes observed in soil

The most frequent and abundant nematodes are represented by *Helicotylenchus*as they were observed in 78.43% of the samples for levels between 0 and 3,480 nematodes/dm^3 of soil; The average density observed is 336 nematodes/dm^3 of soil. The genus *Tylenchus* is observed at frequencies of 62.75% for population densities of 53 nematodes/dm^3 of soil.Pratylenchus and Scutellonema are present at frequencies of 39.22 and 33.33% respectively for population densities of 29 and 18 nematodes/dm^3 of soil. *Tylenchorhynchus* is observed at a frequency of 19.61% for densities of 12 nematodes/dm3 of soil. *Xiphinema* and *Hoplolaimus* are observed at a frequency of 9.8% for population densities of 5 and 4 nematodes/dm^3 of soil, respectively.*Rotylenchulusreniformis* is observed at a frequency of 7.84% with a population density of 3 nematodes/dm*3* of soil. Low frequencies are observed for *Criconemella* and *Meloidogyne* as they were observed in 1.96% of the samples. The population levels are very low and 2 and 1 nematodes/dm^3 of soil respectively.

Table I: Frequency and abundance of the main parasitic nematodes associated with cashew trees in nurseries in western Burkina Faso

Kindsofnematodes	Frequence	Abundance			
		Minimum	Maximum	Everage	Error std
Soilnematode	%	(Numberof nematodes/dm^{3}of soil)			
Helicotylenchus	78.43	0	3480	336	85.0
Tylenchus	62.75	0	300	53	10.2
Pratylenchus	39.22	0	160	29	6.5
Scutellonema	33.33	0	120	18	4.3
Tylenchorhynchus	19.61	0	140	12	4.0
Xiphinema	9.80	0	100	5	2.4
Hoplolaimus	9.80	0	60	4	1.9
Rotylenchulusreniformis	7.84	0	80	3	1.8
Criconemella	1.96	0	100	2	1.9
Meloidogyne	1.96	0	40	1	1.8

Comment [kk4]: Should have mentioned as ;Genera'

- Nematodesextractedfrom the roots

Five (5) genera of nematodes are associated with the roots of cashew seedlings in nurseries (Table II). Common nematodes are represented by *Tylenchus* and *Pratylenchus* at levels of 62.75 and 52.94%, respectively. Population densities are low with 2 nematodes/g of roots. *Rotylenchulusreniformis, Scutellonema*and *Meloidogyne* are observed at frequencies of 19.61, 15.69 and 3.92% respectively for population densities of 1 nematode/g of roots.

Table II: Frequency and abundance of the main parasitic nematodes associated with cashew trees in nurseries in western Burkina Faso

Kinds ofnematodes	Frequency	Abundance			
		Minimum	Maximum	Average	Error std
Root nematodes	%	(Number of nematodes/g of roots			
Tylenchus	62.75	0	34	2	0.8
Pratylenchus	52.94	0	27	2	0.7
Rotylenchulus	19.61	0	4	1	0.1
Scutellonema	15.69	0	3	1	0.1
Meloidogyne	3.92	0	2	1	0.0

3.1.2. Population densities of nematodes associated with cashew nurseries by site

- For soil nematodes

The population densities of nematodes observed on cashew plants in nurseries are given in Table III. The most abundant nematodes on cashew nurseries are represented by the genera *Helicotylenchus, Pratylenchus*and*Scutellonema*. The highest population densities are observed at the Kourinion site with a total population of 1,260 nematodes/dm^3 of soil ($P<0.05$). Significant differences ($P<0.05$) are observed for *Helicotylenchus*and *Scutellonema* for the Kourinion site with other sites. On the other hand, the site of Guéna is more infested for Pratylenchus with 107 nematodes/dm^3 of soil ($P<0.05$). Population densities are comparable for the nematodes *Meloidogyne, Xiphinema, Tylenchus, Criconemoides, Tylenchorhynchus, Hoplolaimus*and*Rotylenchulus* ($P<0.05$).

Comment [kk5]: In many places scientific names were not in italics

- For root nematodes

Root populations are represented by the genus *Pratylenchus* and the species *Rotylenchulusreniformis* at relatively different population levels. The Guéna site is more infested with 8 nematodes/g of roots compared to the other sites ($P<0.05$).

Table III: Population densities of parasitic nematodes to cashew trees in nurseries in western Burkina Faso

	Nematodes/dm^3 of soil											Nematodes/g root		
Locality	*Melo*	*Praty*	*Scut*	*Heli*	*Xiph*	*Tychus*	*Crico*	*Tycho*	*Hoplo*	*Roty*	Total	*Praty*	*Roty*	Total
Bandougou	0	17a	27b	367a	3	47	47	0	3	0	470a	4a	1	5
Banfora	0	15a	4a	43a	1	81	0	12	0	9	171a	1a	1	2
Guena	7	107b	13a	293a	10	47	0	0	0	0	483a	8b	0	8
Kourinion	0	38a	48a	1092b	8	37	8	0	17	0	1260b	1a	0	1
Niangoloko	0	5a	3a	117a	3	40	0	35	0	2	215a	1a	0	1
Probabilité	NS	*	*	*	NS	NS	NS	NS	NS	NS	*	*	NS	NS

The means followed by the same letter do not differ significantly according to the Newman-Keuls test at the 5% threshold.

Legend: NbreEch. : *Number of samples;* *Melo : Meloidogyne* ;*Praty : Pratylenchus* ; *Scut : Scutellonema* ; *Heli : Helicotylenchus* *Xiph :Xiphinema* ; *Tychus : Tylenchus* ; *Crico : Criconemoides* ; Tycho : Tylenchorhynchus ; *Hoplo : Hoplolaimus* ; *Roty :Rotylenchulus*

3.2. DISCUSSION

Comment [kk6]: In discussion part please mention the status of other planation crops along with cashews.

3.2.1. Populations of parasitic nematodes associated with cashew trees in nurseries

Our research work on parasitic nematodes associated with cashew trees in nurseries has revealed the predominance of *Helicotylenchus* and *Tylenchus* at high frequencies (more than 60%) and at high population levels, mainly for *Helicotylenchus*. The other genera are represented by *Pratylenchus, Scutellonema, Tylenchorhynchus, Xiphinema, Hoplolaimus, Rotylenchulus, Criconemella,* and *Meloidogyne*. Our work is in line with that of several authors, including [5] who identified 5 genera and 12 species of parasitic nematodes associated with cashew trees in Nigeria, the most important of which were represented by *Xiphinema* (with 3 species), *Scutellonema* (2 species), *Criconemella* (4 species), *Rotylenchulusreniformis* and *Trophorusimperalis*. Poor growth has been observed on cashew seedlings in nurseries caused by *Xiphinemaifacolum* in Liberia [6] cited by [7].

Studies in West Africa and Brazil have shown immunity or high resistance of cashew nuts to *Meloidogyne* root-knot nematodes [8] and [9] cited by [7], which may explain the low populations of *Meloidogyne* observed on cashew nurseries in western Burkina Faso. In a literature review on parasitic nematodes associated with cashew trees in Brazil, [10] noted the presence of several nematodes on cashew trees in Brazil of which the most important were represented by *Criconemoides, Scutellonema, Xiphinema*. [11] identified five (5) species of parasitic nematodes associated with cashew trees in Bhubaneswar, India, represented *Aphelenchusavenae, Hoplolaimus indicus, Rotylenchulusreniformis, Tylenchorhynchusmashhoodi.*

3.2.2. Densities of parasitic nematodes associated with cashew trees in nurseries

The study also revealed that cashew nurseries are infested with parasitic nematodes at high population levels for nematodes belonging to the genera *Helicotylenchus, Pratylenchus* and *Scutellonema*. [1] focused on the major cashew production areas, mainly in the Cascades region (Banfora and Niangoloko) and the Hauts-Bassins (Bandougou, Guena, Kourinion) recognized as areas of ancient introduction. The importance of the nematode population densities on the sites of Kourinion (for *Helicotylenchus* sp. and *Scutellonema* sp.) and Guéna (for *Pratylenchus* sp.) shows the importance of promoting good nursery production practices, particularly in soil sterilization.

CONCLUSION

The study of parasitic nematodes associated with cashew trees in nurseries in western Burkina Faso is original and has revealed high population levels of nematodes belonging to the genera *Helicotylenchus, Pratylenchus*and *Xiphinema* likely to cause damage to plants. The other groups of nematodes are represented by the genera *Tylenchorhynchus, Xiphinema, Hoplolaimus, Rotylenchulus, Criconemoides* and *Meloidogyne.* Plants already infested in the nursery constitute a starting inoculum during transplantation and can spread the parasitic nematodes in disease-free areas. As recommendations, we propose that soils used for nurseries should be sterilized beforehand in order to have plants free of parasitic nematodes during transplanting.

REFERENCES

[1] - Tarpaga W.V., Bourgou L., Guira M. and Rouamba A. Agromorphologicalcharacterization of cashew nuts (Anacardium occidentale L.) in selection for high yield and superiorrawnutquality in Burkina Faso. 2020. Int. J. Biol. Chem. Sci. 14(9): 3188-3199, ISSN 1997-342X (Online), ISSN 1991-8631

[2] - Ricau P. The West African cashew sectorin2018: General trends and country profiles. Nitidae, 2019. p. 30.

[3] - SeinhorstJ.W.. Modifications of the elutriationmethod for extractingnematodesfromsoil. Nematologica, 1962. 8: 117-128.

[4] - Seinhorst J.W. The significance of the tcestand of the grand for the occurrence of disease by stem borer (Ditylenchusdipsaci (Ktthn) Filipjev). Journal of Plant Diseases, 1950. 56: 289-349.

[5] - Agu, J.M. Survey and Effects of Plant Parasitic Root Nematodes of Cashew (Anacardium occidentale) in SouthEastern - Nigeria C.M. AguJournal of American Science, 2007. 3(2).

[6] - Lamberti, F., Boiboi, J.B., Ciancio, A., Tuopay, D.K., Jimehez, E.A. and Elia, F. Plant parasiticnema-todesassociatedwithtreecrops in Liberia. NematologiaMediterranea 20, 79–85 (PDF) Nematode parasites of subtropical and tropical fruit treecrops. Availablefrom:

https://www.researchgate.net/publication/281397687_Nematode_parasites_of_subtropical_and_tropical_fruit_tree_crops [accessed Jan 05 2025]. 1992.

[7] - Luc M., Sikora R.A., Bridge J. Plant ParasiticNematodes in Subtropical and Tropical Agriculture. 2nd Edition. CAB International. Wallingford UK. 2005. 871p.

[8] - Netscher C. Treesresistant to Meloidogynespp. : use as a windbreaker in Senegal. Tropical Agronomy, 1981. 36 (2), p. 175-177. ISSN 0151-1238.

[9] - Da Ponte, J.J. and Saraiva, L.M. Immunity of the cashew nut, Anacardium occidentale L., to nematoidesdogeneroMeloidogyneGoeldi, 1887. CienciaAgronomia, Fortaleza. 1973. 3, 35–36.

[10] - Freire F.C.O., Cardoso, J.E., dos Santos, A.A. and Viana, F.M.P. Diseases of cashew nut plants (Anacardium occidentale L.) in Brazil. Crop Protection. 2002. 21, 489–494.

[11] - Pradhan P., Kumar Patra M. and Kumar Sahoo N. 2020. Association of Nematodeswith Fruit Crops in Bhubaneswar, India. International Journal of CurrentMicrobiology and Applied Sciences. 2020. Volume 9 Number 5. https://doi.org/10.20546/ijcmas. 2020. 905.219