Nematode biodiversity in south-western Nigerian watermelon cropping systems, with reference to *Meloidogyne* and its management

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Thesis accepted in fulfilment of the requirements for the degree *Doctor of Philosophy in Environmental Sciences* at the North-West University

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Graduation May 2020

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To whom it may concern

The following student is conducting research in Environmental Sciences with zero risk.

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‘I dont know where the limits are, but I would like to go there’

Eliud Kipchog

ACKNOWLEDGEMENTS

I am grateful to God Almighty for his protection over me and my loved ones. Words can never be enough to express my most profound gratitude to Prof. Hendrika Fourie who supervised my PhD study. Her professional touches and compassionate supports provided the needed mentorship I require to grow as a scientist. Her moral and financial support as well as encouragements have contributed wonderful chapters to my life. She is indeed the best.

I would like to acknowledge with gratitude, my co-supervisor: Dr Danny Coyne. He did not only provide his lab for my use; he also provided the needed technical and professional support towards the completion of this thesis.

I cannot but appreciate the assistance of Dr. Milad Rashidifard who came in at the trying moment of my PhD study and assisted with the molecular analysis of my samples. I will not forget your help in a hurry.

I also will like to thank Prof Reyes Pena Santiago of Universidad de Jaen for assisting me with morphological identification of some of my Dorylaimid samples during my visit to his lab in Jaen.

The contributions of the following people are also worthy of mention here:

The Provost and management team of Federal College of Education Abeokuta, Nigeria for granting my study leave and TETFUND support.

I thank most especially, Dr FAO Akinnusi and Dr Oluwakemi Oni for standing by me when the start was shaky.

All members of Agric Family Federal College of Education Abeokuta, Nigeria for their prayers and encouragement that made this a success.

Dr Wunmi Adewuyi of the Nematology Unit of International Institute of Tropical Agriculture (IITA), Nigeria. For her technical support and encouragement during my research at IITA.

My colleagues at IITA (Dr. Taofeek Adegboyega, Dr. Yao Kolombia, Mr. Emannuel, Miss Akinsanya, Gbade, Mr. Tiri, Saheed and all other members of Nematology Unit of IITA)

Dr Akhona Mbatyoti for his assistance and support during my stay at Potchefstroom.

My Parents Alhaji and Mrs Mutritala Adetunji Bello for laying a solid foundation for my academic pursuit.

My lovely siblings (Kehinde, Tajudeen, Idowu and Ayoade) for their love, prayers and encouragements.

Mrs Ameenat Modupe Bello for her unflinching love, financial supports and prayers.

Finally, my lovely wife, Omolola and kids; Ike and Yasser for enduring those cold lonely nights to support my dreams. I promise to make this count.

ABSTRACT

Watermelon is increasingly produced and consumed in Nigeria and sub-Saharan Africa (SSA). However, limited information exists regarding the nematode fauna associated with the crop. Therefore, the overall aim of this study was to determine the nematode assemblages associated with watermelon, to investigate the reproduction potential of populations of the predominant plant-parasitic nematodes identified and to assess the host status of commercially available cultivars in south-west Nigeria to the predominant nematode pest species. Of the 30 free-living nematode genera identified from soil samples, *Cephalobus*, followed by *Rhabiditis*, *Aphelenchus* and *Aporcelaimus*, were predominant. Variation in nematode community structures across the 50 fields was apparent for mean maturity indices, metabolic footprints, feeding-type composition and coloniser-persister (c-p) structure. Faunal analyses characterised 52% of the fields as having stable and enriched soil food webs, which is beneficial for crop production. A new species, *Aporcelaimellus nigeriensis* sp. n., was furthermore identified and described from this study. Of the 12 plant-parasitic nematode species identified, *Meloidogyne* spp. were predominant, followed by *Helicotylenchus dihystera*, *Pratylenchus zeae* and *Scutellonema bradys*. Applying morphological and molecular techniques, four *Meloidogyne* spp. were identified from the sampling sites. *Meloidogyne enterolobii* was the most prevalent, followed by *M. incognita*, *M. javanica* and *M. arenaria*. *Meloidogyne arenaria* is reported for the first time from south-west Nigerian cropping systems. Significant associations were observed between the frequency of occurrence of the predominant nematode pest genera/species and soil properties as well as rainfall. The reproduction potential of 25 *Meloidogyne* spp. populations (containing single-species) and/or communities (containing mixed-species) obtained from watermelon fields were determined under glasshouse conditions, while the host response of six commercially available watermelon cultivars to the three predominant root-knot nematode species (*M. incognita*, *M. javanica* and *M. enterolobii*) were also done. For both studies an initial and repeat experiments were conducted over 56 days. For the reproduction potential experiments, ±5 000 eggs and second-stage juveniles (J2) of each of the 25 *Meloidogyne* populations and/or communities were inoculated on roots of two-leaf stage seedlings of the root-knot nematode susceptible tomato (*Lycopersicon esculentum* Mill.) cultivar Tropimech. For the host status experiments, roots of six commercially available watermelon cultivars were inoculated with

±5 000 eggs and J2 of *in-vivo* reared, single-species populations of *M. incognita, M. javanica and M. enterolobii.* The reproduction potential of the *Meloidogyne* spp. communities and the host response of the cultivars were assessed based on the i) number of egg masses, ii) final nematode population (Pf) and iii) reproduction factor (Rf) per root system. No significant interaction existed between the initial and repeat experiments of the reproduction potential experiments, while a significant interaction was apparent between the two host status experiments. However, for the reproduction potential experiments higher Pf and Rf values were recorded for most of the cultivars for the initial compared to the repeat experiment. The highest Rf was obtained for a mixed community of *M. enterolobii* and *M. javanica* (L 15), while the lowest Rf was ascribed to a mixed species community (L16) containing *M. arenaria* and *M. enterolobii.* Host status assessments of cultivars showed that all cultivars evaluated were susceptible (Rf >1) to the three species of *Meloidogyne,* although substantial variation among the cultivars' host responses to the three *Meloidogyne* spp. existed. For example, cultivar Koloss F1 supported the lowest population densities for *M. enterolobii* (Pf = 40 002; Rf = 6.1); Sugar Dragon for *M. javanica* (Pf = 12 947; Rf = 2.6); and *M. incognita* (Pf = 10 670; Rf = 2.1); the highest population densities were maintained in roots of cultivar Charleston Gray for *M. enterolobii* (Pf = 73 522 ; Rf = 14.7); Erato F1 for *M. javanica* (Pf = 47 684 ; Rf = 9.5); and Charleston Gray for *M. incognita* (Pf = 63 395; Rf = 12.7). All Pf and Rf values recorded across the treatments were significantly lower than those of the susceptible tomato standard check. This study provides novel information regarding i) the free-living and ii) plant-parasitic nematodes associated with watermelon from SSA; iii) a new *Aporcelaimellus* sp. report; and baseline information on iv) the reproduction potential of *Meloidogyne* spp. populaitons and communities occurring in south-west Nigeria; as well as the v) the host status of commercially available watermelon cultivars grown across south-west Nigerian agro-ecological systems to single-species *Meloidogyne* populuations. The data generated from this study hence represent valuable and useful information to watermelon growers and can contribute towards sustainable cultivation of the crop in Nigeria.

Keywords: bio-indicators, cultivars, host status, molecular techniques, morphology, nematodes, reproduction potential.

PREFACE

This thesis is written in line with article format style prescribed by North-West University. Thus, the articles are in the publishable format, while the manuscript (Chapter 2, which has already been published) and other chapters (Chapters 3 and 4, which have been submitted for publication to the journal Nematology) are written according to the authors instructions of the internationally accredited journal Nematology. Chapter 5 has also been prepared for the submission in the latter journal. As required by North-West University, contributions of authors for each article/ chapter as well as their accent for use as part of the thesis are provided in Table A.

This thesis contains the following chapters:

Chapter 1 – Introduction and literature review: **European Journal of Plant Pathology (Springer) (only for referencing style)**

Chapter 2 – Article 1 (Published): **Nematology (Brill)**

Chapter 3 – Article 2 (Submitted): **Nematology (Brill)**

Chapter 4 – Article 3 (Submitted): **Nematology (Brill)**

Chapter 5 – Article 4 (Prepared): **Nematology (Brill)**

Chapter 6 – Conclusions and Recommendation: **European Journal of Plant Pathology (Springer) (only for referencing style)**

Chapters 1 and 6 were prepared according to the springer format of which an excerpt is available in Appendix A. The submitted (Chapter 3: Article 2, Chapter 4: Article 3 and Chapter 5: Article 4) as well as the unpublished (Chapter 6: Article 5) were prepared according to the instructions to authors of the journal Nematology (instructions for authors is available in Appendix B). Finally, the printed version of Article 2 as well as proofs of submission of articles 3 and 4 are provided in Appendices C and D, respectively.

Access links to raw data of Chapter 2; Article 1, Chapter 3, Article 2, Chapter 4: Article 3 and Chapter 5: Article 4 are available in Appendices E, F, G and H respectively.

Table A. Contribution of a Authors and consent of use as part of this thesis

Author	Article	Contribution	Accent
T.T. Bello	Article 1 – 4	Principal investigator: Responsible for conducting the study design, sampling, data analyses as well as interpretation. Also, the first author responsible for writing of articles and thesis.	
H. Fourie	Article 1 – 4	Promoter: Supervised the study design, and monitored the progress. Also provided intellectual input during the practical work and writing of articles and thesis.	Fourie
D. Coyne	Article 1– 4	Co- promoter: Provided intellectual input during the practical work and writing of articles and thesis.	
M. Rashidifard	Articles 2 and 3	Provided intellectual input on molecular analyses and gave guidance in writing the article. Also, the first author of Article 2	Rashidifard
R. Pena Santiago	Article 2	Provided technical input and responsible for the morphological description of the new species of nematode identifiedduring the study.	

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